ARCTIC STEAM AND SAIL: RECONSTRUCTING HMS *PIONEER*

A Thesis

by

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ABSTRACT

In mid-nineteenth century Britain, the dramatic disappearance of Sir John Franklin and his men led to a large-scale search conducted throughout the Arctic by sailing ships and steamers. One such ship was HMS *Pioneer* (formerly the merchant vessel *Eider*), which was built as a topsail schooner with oscillating steam engine and later outfitted as part of an Arctic squadron. The vessel was refit with heating apparatus, experimental rubber boats, and other contemporary developments, and serves as a valuable example of the mid-nineteenth century responses to the challenges and concerns of Arctic exploration. This research focuses on the numerous contemporary written and visual depictions of the steamer and its voyage to explore HMS *Pioneer*'s context and importance in the shift from sail to steam. While HMS *Pioneer* was presented by contemporary accounts as a ground-breaking novelty, this research shows its place in a continuum with earlier Arctic ships, and highlights the conservatism of changes in rigging, outfitting, and social life on board.

DEDICATION

I dedicate this thesis to my mom:
thank you for pushing me to ask all the questions.

Study hard; hardly study.

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To my committee chair: Kevin Crisman: thank you for teaching the Rigging class that generated this thesis idea, and for your advice through my time at Texas A&M.

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CHAPTER I
INTRODUCTION

In the mid-nineteenth century, improvements in manufacturing techniques and technology in Europe led to increasing use of steam engines on board vessels. One such example was the *Eider*, a screw-propelled topsail schooner built to carry cattle across the English Channel in 1847. With the dramatic disappearance of Royal Navy Captain John Franklin's Arctic expedition in 1845, the British Admiralty was pressured to send out their best resources to find these heroes. The *Eider* was refit with hull reinforcements and a between-deck heating system as HMS *Pioneer*. Featuring an oscillating steam engine and screw propeller, as well as a topsail-schooner rig, this ship represents a fascinating glimpse into the shift from sail to steam, highlighting a key phase in this early steam technology. In addition, HMS *Pioneer* showcases the flexible nature of nautical innovation, with cold weather and harsh environmental conditions leading to adaptations in its engine and propeller. HMS *Pioneer* drifted out of sight of history after Edward Belcher's disastrous search expedition of 1854, but its place in the shift from sail to steam and in Arctic exploration makes its reconstruction a valuable case study in maritime archaeology.

Previous discussions of the technological shift from sail to steam have often failed to acknowledge the social, political, and cultural factors that influenced, and in turn were influenced by, the adoption of these engineering innovations (Leggett and Dunn 2012:1-3). Rather than considering one "side" of the engineering/society equation as a causal feature, new forms of analysis focus on broadening the analysis to encompass these three factors and form a better understanding of the impact of steam technology (Leggett and Dunn 2012:7).

This gap in historical knowledge is especially apparent in polar maritime history and archaeology, where most analyses focus either on a single aspect of polar exploration and shipboard life, be that technology, psychology, or nutrition (Campbell 1982; McIntyre et al. 2008; Palinkas and Suedfeld 2008; Webster 2015). Beyond that, most analyses of the Franklin search-era ships overlooks the tremendous importance of steam vessels in the search efforts, focusing entirely on the sailing ships (Hodgetts 2013).

As pointed out in previous scholarship, ships were never simply "ready-made objects," but living communities shaped by a multitude of forces during their voyages (Leggett and Dunn 2012:4). During the entire process of rigging, outfitting, and sailing the ship, HMS Pioneer was affected by the ingrained meaning attached to ships in the Royal Navy (Leggett 2012:73-74). This analysis will place HMS *Pioneer* within the historical context of the technological shift to steam, highlighting the adaptations made for Arctic service, as well as the social ramifications of these changes. To do so, the many contemporary accounts of these voyages will be utilized as sources of information, along with archaeological finds from contemporary vessels. Along the way, attention will be paid to contemporary attitudes and their effects on the way HMS Pioneer was designed, outfitted, and run during its two voyages to the Arctic.

Chapter II will address the historical background of the British Arctic expeditions, which culminated in the disastrous Franklin expedition and subsequent searches in the mid-nineteenth century. Chapter III will discuss two specific searches: Horatio Austin's 1850-1851 and Edward Belcher's 1852-1854 voyages, both of which included HMS *Pioneer* and her sister ship, HMS *Intrepid*. Chapter IV will critically discuss the sources of information on HMS *Pioneer*, including both contemporary descriptions of other vessels and accounts of the vessel itself. Chapters V, VI, and VII discuss a theoretical reconstruction of the ship, tackling the areas of sail and rigging, propeller and engine, and heat and coal, respectively. Chapter VIII grounds these analyses of technical specifications in reality by examining the combined effects of new technology and tough Arctic conditions on daily life for the crew and officers aboard. Chapter IX concludes with an examination of future research possibilities for HMS *Pioneer*.

CHAPTER II

HISTORICAL BACKGROUND OF BRITISH ARCTIC EXPLORATION

In the sixteenth century, as more of the world began to be explored by sea, European powers realized the potential of a route over the northernmost point of North America (Durey 2008:7-8). At the time it was thought that the polar sea north of the coast must be passable year-round, an idea that was not disproved until 1909. This Northwest Passage, also known as the Strait of Anian, would provide an alternate route to reach the Pacific and Indian Oceans, avoiding the Spanish and Portuguese-controlled Cape Horn or Cape of Good Hope. British exploration of the Arctic region began under the reign of Elizabeth I, but proceeded slowly and sporadically until the 19th century (Williams 2009:15-17).

In the nineteenth century, Britain enjoyed unprecedented peace due to its naval superiority, allowing focus to shift towards exploration. Following the end of the Napoleonic Wars in 1815, Britain's Navy faced increasing public discontent with high government spending. At the same time, as a small island nation, the United Kingdom's military strength primarily relied on a strong naval presence. Focusing on the Arctic prevented the Navy from large losses in young, innovative manpower, while still providing opportunities for advancement and glory (David 2000:xvi). The early to mid-nineteenth century also saw a new focus on the need for accurate charts and maps of the world, including the Arctic (Durey 2008:6-7). Sir John Barrow, a prominent figure in Arctic exploration during this period, extolled the scientific and academic advances that could be made, in "every way worthy of a great, a prosperous and an enlightened nation" (David 2000:xvi-xvii). The men who participated in these expeditions could look forward to double pay, as well as participation in heroic and patriotic struggles with nature that were incredibly popular (David 2000:8; Durey 2008:19-20). In short, they would get "something better than glory" (Anonymous 1882:20). All of these societal forces combined to see the nineteenth-century British Navy sponsoring increasing numbers of exploratory, mapping, and scientific expeditions into the Arctic regions.

Popular literature, entertainment, and thought about Britain's place in the world were all part of this web of connectivity. Increasing media presence in the lives of ordinary Britons meant that the public had ample opportunity to engage with the Arctic (however false or incomplete) with panoramas, *tableaux vivant*, lectures, books, illustrated newspapers, and museum exhibits (David 2000:131). This new wave of Arctic exploration, shaped by earlier stereotypes, affected British perceptions about the dangers and wonder of the polar regions.

It was within this cultural milieu that the ill-fated expedition of Sir John Franklin took place. Pushed by Sir Barrow, Franklin, wishing to make his mark upon history, was outfitted with the most well-supplied mission yet sent out to find the Northwest Passage (Durey 2008:11-12). Franklin, by then nearing retirement at the age of 59, was chosen based on his past experiences leading overland expeditions into the region (Franklin and Richardson 1828; Franklin et al. 1823). Previously, he had led one ship-based expedition (1818) and two overland exploring parties in the Canadian Arctic (1819-1822; 1825-1827). On this voyage, his ships were HMS *Erebus* and HMS *Terror*, built in 1826 and 1813, respectively (Durey 2008:13). Both were former bomb vessels, built with heavy frames and scantlings, and further reinforced and sheathed at the bow before departure. In addition, they carried small auxiliary steam engines and retractable screw propellers onboard (see Chapter VI for a complete history of steam power in the Arctic). When the ships departed Britain in 1845, the public expected that they would find the Northwest Passage within the year (Durey 2008:13; Sandler 2006:77).

By 1847, both independent searchers and the Admiralty had begun to fear for the fate of Franklin and his crews (Ross 2002:58). The Admiralty sent men and boats to Hudson Bay to prepare for a terrestrial search the next summer, while American captain William Penny searched by ship, launching the era of Franklin searches (Ross 2002:58). Between 1847 and 1859, 36 search expeditions traveled into the Arctic as part of the search for Sir Franklin and his men from Britain, the eastern United States, the Greenland whaling squadron, and Alaska (Ross 2002:65-67). These voyagers hoped to find or rescue the "gallant squadron," or to simply drop off supplies to all the ships in the area (Osborn 1852b:213). In total, 30 different ships (almost half of which took part in more than one expedition) took part in 36 "successful" Arctic expeditions by sea and on land from the Atlantic, Pacific, and Central routes (Ross 2002:66). The end of the Franklin search, according to most authors, was precipitated by Francis Leopold McClintock's discovery of bodies and artifacts from the doomed expedition in his 1859 voyage with the *Fox* (Ross 2002:58).

By 1859, Britain had lost its naiveté regarding the "conquering hero" myth of the British polar explorer. Due to extensive mapping and exploration of the region during the Franklin searches and following two decades, the Arctic was no longer an undiscovered country (Anonymous 1901:730). The Northwest Passage, discovered during the Franklin search, could supposedly be traversed by steamer in one summer (Anonymous 1881b:359). Exploration turned from mapping to a race to the Poles in vessels like the *Fram* (Anonymous 1912:316). Commercial enterprises in the area, principally whaling and sealing, increasingly turned to less-expensive steam or diesel engines (Kjær 2008:270-271). Still, many sailing vessels were still used, being repurposed for Arctic work, such as the *Fox* (Delgado 2009:26; Kjær 2011:14)

CHAPTER III

A SHORT CAREER: HISTORY OF HMS *PIONEER*

One of the early search expeditions was sent out by the British Admiralty in 1850. Seasoned naval veteran Captain Horatio Austin led two sailing ships, HMS *Resolute* and HMS *Assistance*, and two of the newly-introduced vessel type, the screw-steamers HMS *Intrepid* and HMS *Pioneer* (Sandler 2006:100).

When the Navy began preparing for Austin's 1850 expedition, there was not enough time to build new ships. Indeed, Lieutenant Sherard Osborn, commander of HMS *Pioneer*, described the whole process of outfitting and provisioning as "hurried" (Osborn 1852b:11). Instead, the Admiralty purchased two civilian ships to serve as screw-steamer consort vessels for the two sailing ships, which were the 'main force' of the Austin expedition (Osborn 1852b:16-17). The *Eider*, built by R&H Green at the Blackwall Navy Yard in 1847, was a merchant craft (Lloyd's Register of British and Foreign Shipping 1847-1851; Lyon and Winfield 2004:232). Based on Lloyd's register, it was clear that the *Eider* was already outfitted as a steamer before its purchase in February 1850, rather than being a refit sailing ship as was done later by the Navy (Brown 1990:166). HMS *Pioneer* was joined on the expedition by its sister ship, HMS *Intrepid* (formerly the *Free Trade*), also built by R.H. Green in 1847 (Admiralty 1847; Admiralty 1848). Both vessels belonged to the fleet of the Continental Cattle Conveyance Co., sailing from London to Oporto, Portugal and to Denmark.

All of the vessels were outfitted for Arctic service with strengthened bows, double-planked decks, bulkheads, and doors, and heating pipes throughout the hulls (Osborn 1852b:32-34; Sandler 2006:253). In addition, the propeller mechanisms of the steamers were modified to make it easy to remove them from the stern, preventing damage from crushing and shifting ice (Lyon and Winfield 2004:232; Osborn 1852b:34). The refits were completed by the end of April 1850.

In order to reconstruct the hull of *Pioneer*, reference was made to the dimensions given in official records, as well as the scale plans in Navy records (Lyon and Winfield

2004:232). The keel was 124 ft. 3 in. (37.87 m) long, with a hull breadth of 22 ft. (6.7 m) and depth of hold of 14 ft. 7 in. (4.44 m). From this, an estimated 'gun deck' (or, in *Pioneer*'s case, main deck) length of 143 ft. 6 in. (43.74 m) was calculated. By applying the ratios seen in the scaled-down version of the official Navy refit plans (as reproduced in Lyon and Winfield 2004:232) to the known length of the deck, the hull lines were reproduced to serve as the foundation for the rigging reconstruction.

When describing his command after the 1850 Arctic expedition, Lieutenant Sherard Osborn described it as a "very handsome, smart-sailing" vessel (Osborn 1852b:35). He was also interested in describing *Pioneer*'s steam capabilities; Osborn believed that steam, with its ability to propel the ship independently of the wind, was the way of the future (Osborn 1852b:57). The Royal Navy agreed with Osborn's assessment: in the upcoming Crimean War, steam-powered vessels played a major role (Brown 1990:135). At the time of HMS *Pioneer*'s career, the Navy was converting the fleet from sail to steam power (Greenhill 1993:11). Thus, this topsail schooner can serve as an important case study in the transition period between the end of the age of sail and the steamers that would dominate the 20th century. In addition, as an Arctic exploration vessel, HMS *Pioneer* offers the chance to explore the unique challenges and adaptations to the harsh environment.

Although Osborn, the 27-year-old commander of HMS *Pioneer*, was optimistic about their chances of finding the lost explorers, they returned to a disappointed public only one year later, bringing back dispiriting tales of finding three graves from Franklin's first winter (Osborn 1852b:35-36, 207).

With no news of the Franklin expedition's final fate, the Admiralty funded another voyage, commanded by Captain Edward Belcher and featuring the vessels from the 1850 expedition as well as HMS *North Star*, which served as a supply vessel (Sandler 2006:114). However, conditions among the officers quickly deteriorated on this second voyage (Sandler 2006:115, 128). Belcher argued with his officers and arrested Osborn and Lieutenant Walter Waller May (the latter served as an officer and artist on the expedition) (Markham 1875:35). Against the advice of the other officers, who all felt confident in their ability to find Franklin on this voyage, Belcher ordered the abandonment of four ships in the summer of 1854; they all sailed back in HMS *North Star* (Sandler 2006:128). This ended the short career of HMS *Pioneer* as an Arctic exploration and rescue ship.

CHAPTER IV
SOURCES OF INFORMATION

A myriad of sources were examined for this thesis. These included official and unofficial art produced during the voyage, newspapers, a crewmember's journal, official reports, ship plans, Admiralty reports, and books published about the voyages. Each of these sources has biases and missing information, but using them all, combined with archaeological studies of similar vessels from the same period allows for a more complete understanding of HMS *Pioneer*. Each of these sources will be discussed, grouped according to their application in the following chapters: Chapter V, reconstruction of sail and rigging plan, Chapter VI, propeller and steam engine, Chapter VII, heating system and coal use, and Chapter VIII, daily life.

Sources employed to reconstruct HMS *Pioneer*'s rigging included contemporary accounts of masting and rigging (most notably: Brady 1848; Fincham 1843; Kipping 1853; Young and Brisbane 1863), as well as archaeological accounts of similar vessel types (Hewitt 1998; Thomsen et al. 2008). Secondary sources clarified where primary sources lacked information. For information specific to HMS *Pioneer* and its sister ship, HMS *Intrepid*, Osborn's memoir of the voyage and artistic depictions of the vessels were consulted (see Figures 1-5) (M'Dougall 1857b; M'Dougall 1857c; May n.d.-a; May n.d.-b; Osborn 1852a; Osborn 1852b).

Contemporary depictions should be evaluated critically, since ship rigging was often depicted with varying degrees of accuracy, depending on the artist's knowledge of ships. Given that May served first as the mate in HMS *Resolute*, and subsequently as lieutenant in HMS *Assistance*, he likely had experience and familiarity with ship's rigging (Markham 1875:35). However, these images were produced for a non-naval audience that read popular and often sensationalized accounts of Arctic travel. A common practice of the time was to make images for mass production in these books by engraving from a painting, a process that sometimes called for the original image to be simplified or otherwise altered (David 2000:36). In addition, captains frequently altered the rigging during the voyage, depending on the handling of the ship and current conditions. See, for example, May's depictions of HMS *Pioneer* earlier in the voyage and after the winter of 1854, showing that the mizzen mast was removed (Figures 4 and 5).

Historical and technical accounts by exploring ships' crews, like the illustrations, must also be critically evaluated. For example, Lieutenant Osborn of HMS *Pioneer* harbored a desire to be a writer: he kept rough notes throughout the voyage, indicating that he probably intended to publish his experiences from the start (Osborn 1852b:38, 109). This was a common practice of his predecessors in exploration, although the accounts thus produced feature varying levels of precision and reliability (Osborn 1852b:118).

Osborn fully acknowledges that events or accounts in his book may be sensationalized, or, as he stated: "I have 'piled the agony' to make my work sell" (Osborn 1852b:212). Descriptions of landscapes and artifacts found by the search parties were heavily tinged with emotion. However, Osborn also included acknowledgements of uncertainty when his notes became ambiguous (Osborn 1852b:109). In addition, the short time between his return from the voyage and the publication of these *Stray Leaves from an Arctic Journal* (only one year) reduced the ability of the author to revise his account, which is why this version of the "Leaves" was chosen for review over a later publication by Osborne that combined his account with a copy of the Grinnell Expedition report and a summary of Sir Franklin's life and tragic death, which revised passages based on new information (Osborn 1865:173). As Osborn specifically noted that this passage was unaltered from the first (1852) edition, more of the account could have been changed, altering the original text. However, the text still has value to the nautical archaeologist: Osborn's descriptions can be compared and contrasted with a wealth of other Arctic accounts from the same period.

Osborn explicitly wrote for an audience including Lady Jane Franklin, the strong-willed widow of John Franklin who pushed for and funded private and government-sponsored expeditions to discover the fate of her husband (Osborn 1852b:5-

6). Osborn professed to regard Lady Franklin with “admiration,” calling her “noble” and “steadfast;” Sir Franklin was regarded as a hero, like a knight of old, by him, and this is seen in Osborn’s descriptions of finding the graves of three men from the Franklin expedition (Osborn 1852b:91). Osborne hoped to be one of the explorers who conclusively either found or rescued survivors from the Franklin expedition. Thus, Osborne had a vested interest in showing significant progress being made in the search, such as emphasizing the scattered remains and artifacts found.

Osborne also wrote for a public eager to hear news of Franklin and bone-chilling tales of adventure in the north. Osborne was writing his arctic accounts after a long history of arctic explorer accounts, including works by Sir Franklin, Sir John Ross, and Sir William Edward Parry (Osborn 1852b:118). Audiences had expectations about what kind of material they would read in these accounts, including references to ice, the lonely and stark beauty of the landscape, the terror inspired by natural disasters, native peoples encountered, and flora and fauna (Byrne 2013:21-22). Thus, Osborne included all of these tropes in his narrative, as well as referencing previous works about general descriptions of life in the north (Osborn 1852b:118). In addition, Osborne was very conscious of how technical his account was, and he glosses over potentially useful information for a nautical archaeologist, like the working of the steam engine, in favor of the general reader’s interest (Osborn 1852b:195). He does direct the reader to other sources of information, such as “Admiralty blue books” that provide more detailed accounts (Osborn 1852b:164).

As an officer, Osborn gives an account through an upper-class lens in his experience of shipboard life. He emphasizes the equality and comradeship he experienced in the expedition by citing the opportunities afforded the Arctic officer to work and socialize alongside his men (Osborn 1852b:65). However, class divisions were still maintained on this, a Navy expedition: men referred to officers as “sir” and were inspected for health and cleanliness daily throughout the winter (Osborn 1852b:132). On board HMS *Pioneer*, officer and crew quarters were separated by 300 tons of coal, as well as separate eating locations and times (Osborn 1852b:33-34). The class divide between officers and men probably resulted in errors of omission in how routines or tasks were really carried out: for example, Arctic foxes were sent out in the winter with messages in the hopes of contacting the Franklin expedition; Osborne assumed that the animals headed off into the wilderness (Osborn 1852b:138). As a "sub" (sub-officer, or lower-ranking officer, and therefore more likely to be confided in by crew), he was let in on the crew's secret that they were re-catching and eating the messenger foxes. After this, rules on fox-hunting grew stricter, and perhaps the crew no longer confided their secrets in the lieutenant. Unfortunately, these mistakes or gaps in accuracy are impossible to discern in Osborne' narrative since he would have no knowledge of them; comparison of accounts with crew journals, for example, show the common differences in crew and officer accounts (Unknown 1850-1851:3 January).

The *Arctic Leaves* of Lt. Osborn, although plagued at times by the melodramatic phrasing and its class and rank biases, has much information to offer on equipment and sailing techniques peculiar to the polar regions, such as ice anchors, wintering the ship, and "making the cannon." For the nautical archaeologist, this first-person accounts like these, in conjunction with government outfitting records, allows for the creation of a detailed list of the equipment on board one of these vessels. However, even more importantly, Osborn's narrative shows which supplies were actually used by the crew, such as the India-rubber boat mentioned in one brief passage, as compared to the frequency of the mention of ice-anchors (Osborn 1852b:40, 67, 193). Finally, unofficial accounts like this, although lacking in the technical detail so loved by the ship drafter, offer insight into the relationships and communication between officers and crew and among the multiple search expeditions sailing in 1850-1852.

Reconstruction of the propeller and engines relied on Osborn's accounts as well as Admiralty records and filed patents. As the merits and limitations of Osborn's accounts were discussed above, nothing more will be said about the *Arctic Leaves*, except to note Osborn's vested interest in proving the superiority of steam power, leading to extravagant statements such as "they all were delighted with the performance of the steam vessels" (Osborn 1852b:57).

To obtain a balanced view of the situation, this author also consulted a journal written on board HMS *Resolute* during Austin's expedition; this ship was commonly towed by HMS *Pioneer* during the voyage (Osborn 1852b:41). The authorship of this account is unclear: a note at the beginning indicates that it belonged to a Mr. May, mate, who gave the book to William Harvey; a note in the last entry states that "This is the Resolute log Book By William Harvey" (Unknown 1850-1851:title page, 10 January). The hand for both of these entries is similar to the writing throughout, although in a different ink. A Mr. May was mentioned by Osborn as "my kind friend," indicating that he was likely an officer on HMS *Resolute* (Osborn 1852b:112). William Harvey, on the other hand, served as the bosun's mate onboard, a lower social position (Harvey 1853). One should also note that later portions of the book (a blank, unlined notebook, with marbled endpapers) were used to record various life events in the Harvey family, drafts of letters, schoolroom copied lines, arithmetic, and childish drawings, making the Harvey origin for the journal more likely.

Analysis of the engines and other hull refits relied on Admiralty records and patents (Admiralty 1847; Admiralty 1848; Brown 1842), including both Admiralty surveys of the ships, conducted before purchase of the vessels, and shipyard drafts, used as proposed plans for refits and changes to the hull. Both these sources are more technical than the published accounts and personal records discussed previously. Thus, they are not restricted by the sensationalism that could plague personal accounts of Arctic voyages. However, they are confined by content: the Admiralty was interested in recording only a narrow range of information about these vessels, and might ignore features or designs considered "standard" or otherwise beyond special notice. In addition, these accounts discuss ideals, rather than reality. That is, the ship plans and other notes proposed design changes and other refits: whether these changes were actually made onboard may be deduced from comparison with the written accounts mentioned previously, as well as cross-reference with archaeological ship remains from the same period.

In reconstructing the heating system and coal use on board HMS *Pioneer*, extensive use was made of patents filed by John Sylvester throughout the 1830s and 1840s (Sylvester 1832; Sylvester 1835; Sylvester 1843; Sylvester 1845). As sources of information, these were idealized versions of reality, like Admiralty records. However, since this type of heating apparatus was just beginning in use, and was a treasured item during the long winter months, accounts of its use can be compared with accounts in the HMS *Resolute* journal, as well as accounts in the *Illustrated Arctic News* (see discussion below) and Edward Belcher's accounts from its second expedition (Belcher 1855).

Finally, reconstructing the experiences of daily life on board relied on comparisons between Osborn's *Arctic Leaves*, the HMS *Resolute* journal, and analysis of the *Illustrated Arctic News* published on board. The production of newspapers on Royal Navy ships had a long history, with examples known beginning in the 18th century, although the use of printed illustrations a new technology (Coppinger 2011:120). Detailed critique of the former two sources appeared above; see below for information about the context and limitations of the contemporary newspaper.

Two newspapers were in production on Austin's 1850-1851 expedition as the ship crews wintered in the shelter of Griffiths Island: the *Illustrated Arctic News* and the *Aurora Borealis* (Osborn 1852b:121). The *Illustrated Arctic News* (*IAN*) was based on the relatively new *Illustrated London News* (first printed in 1842), and published historical, instructive, moral, and satirical content as well as news from the other ships of the squadron (Cavell 2008:25). During the Austin expedition, five monthly issues were produced, from 31 October 1850 to 14 March 1851. Contributions were made by both officers and crew, and the periodical was edited by Lieut. Osborn of HMS *Pioneer* (Lieutenant Osborn's name was misspelled by the publishers of the *IAN*) and Mr. George F. McDougall, second master of HMS *Resolute* (Osborne and McDougall 1852:title page, 1). Illustrations, including colored images, were produced by McDougall.

The *Aurora Borealis*, the other newspaper in production among the squadron, was not illustrated, and provided a publication opportunity for more literary endeavors

(Osborn 1852b:121; Osborne and McDougall 1852:5). While the *IAN* was controlled by officers in HMS *Resolute* and *Pioneer*, the *Aurora Borealis* (*AB*) was edited and published by officers of HMS *Assistance* and HMS *Intrepid*. As part of the friendly rivalry and competition between the ships, the editors of the competing newspapers sought the best articles and bemoaned when their Editor's Box was not in "as flourishing a condition as that of our cotemporary[sic]" (Osborne and McDougall 1852:21). The "Rory Bory," as it was nicknamed, consisted of smaller sheets, with four pages in the *AB* equivalent to one page in the *IAN* (Osborne and McDougall 1852:42, 57).

All articles in the *IAN* (and likely those appearing in the *AB* too) had to be seen and approved by the editors, both officers on their respective ships. To avoid cries of favoritism or other conflicts over the journals, contributors were advised to place potential articles in the Editor's Box, using disguised but legible handwriting and pseudonyms (Osborne and McDougall 1852:11). While the main body of the articles was produced in manuscript form (handwritten), the large type for the headings, as seen on the playbills and other promotional material, was cut on board by the seamen (Osborne and McDougall 1852:31).

This discussion of editors brings to the forefront a major bias inherent in using the *IAN* as a source of information about seafaring life: it was edited by officers. Osborn, for example, was in charge of HMS *Pioneer*, with 60 men (of whom, about 15 were officers); he had a vested interest in suppressing the shirking of work and other more overt forms of mutiny (Osborn 1852b:33). Thus, the "the censors" were the same people editing and publishing (Osborn 1852b:122). Rebellious crewmembers, in turn, would likely have avoided putting pen to paper and writing down complaints for fear of reprisal and punishment. Unfortunately, the use of pseudonyms prevents the researcher from determining which articles (if any) were authored by crew as opposed to officers. In addition, the majority of articles present throughout the IAN were written by Osborn or McDougall themselves (S.O. and G.F.Mc.D.).

Censorship and alterations to the original text were also made on shore, as was done in previously-published ships' newspapers like HMS *Hecla*'s *Gazette*. The manuscript available for study is a facsimile of the original leaves, published in 1852 by Ackermann & Co. of London, by appointment to the Crown (Osborne and McDougall 1852:title page). As part of the publication process, "A few articles have been omitted for fear the bad taste" and "on the score of raciness" (Osborne and McDougall 1852:preface). This self-editing process in order to present a good face on the expedition to the public can also been seen in the subtle pronouncements that "every individual…enjoyed himself heartily and rationally" and "the fun grew fast & furious, tho' never exceeding the bounds of propriety" (Osborne and McDougall 1852:28, 54). Here you will not find tales of drunkenness, lewd words, or other scandals; they did occur, though, as mentioned in the hungover *Resolute* journal's author on 6 January, following the second Masquerade Ball (Unknown 1850-1851).

Finally, one must consider the content of the newspaper itself: the *IAN* was a newspaper published for entertainment. Each issue generally consisted of a greeting from the editors, satirical pieces (covering some aspect of a sailor's life and hardships), factual pieces (usually geographical or historical in nature), songs, and the Editors Portfolio (including descriptions of the past months' major events, such as plays, etc.). Satire and caricature must not be taken at face value, but examined to find common themes in the seafaring life. In addition, the *IAN* was influenced by British culture, as seen in the inclusion of Punch (a long-standing folk character). Accepting all articles as truth may result in errors.

CHAPTER V

RECONSTRUCTION: SAILS AND RIGGING

To reconstruct HMS *Pioneer*'s rigging, which was arranged as a three-masted topsail schooner on the Austin expedition, reference will be made to contemporary rigging and masting manuals (Brady 1848; Fincham 1843; Kipping 1853; Lever 1819; Young and Brisbane 1863) as well as archaeological evidence from similarly-rigged vessels. A yard and rigging plan were produced for HMS *Pioneer* (see Figure 6).

Sail-power

Although HMS *Pioneer* used steam power when the wind was too light or contrary, it was still primarily sailed in open waters (Osborn 1852b:15). Steam power was still limited by the vast amounts of fuel needed to power relatively inefficient engines. Thus, in the sliding scale between fully-powered steamers and auxiliary, *Pioneer* was best classed as an auxiliary steam-powered topsail schooner (Greenhill and Allington 1993:146). Thus, it is prudent to examine the rigging and masting of this vessel in detail.

Masting the Ship

Contemporary rigging manuals acknowledged the problems inherent between combining sail and steam power, such as the need to replace much of the main-mast rigging with chain to prevent ropes catching fire (Kipping 1853:121). One consistently-noted challenge was the obstruction that spars became on a steam-vessel (Fincham 1843:113). Spars added weight to already heavily-loaded vessels, as well as providing a surface for wind to act against. Vessels with high, large spars would have to expend more fuel and move slower against contrary winds. At the same time, rigging had to be sent up quickly if and when the wind changed favorably in order to take advantage of their sailing abilities. As Fincham notes, this results in a wide range of forms and proportions for steam-vessel spars (Fincham 1843:113). His proportions are only a guideline, therefore, on the actual proportions used on auxiliary steamers of the time; his tables of measurements are extrapolated for all sizes of vessel based on mathematical formulas based on smaller ships (Marquardt 2003:223). Still, this does provide a useful starting point for reconstructing the rigging of a 19th-century vessel.

Throughout the description of the masting process, the reader is advised to see Table 1 for all relevant measurements, based on Fincham (Fincham 1843:122). In addition, in order to clarify the position of the rigging in the final drawing, the mast-head fittings were simplified (leaving off, for example, the lower mast-head battens and gratings). For detailed descriptions and diagrams, see Fincham (1843:209-210) and Kipping (1853:14-17).

The lower masts are the largest spars on the vessel, and have to resist the strain put upon them by the topmasts and topgallant masts, as well as yards and the weight of the standing rigging's various blocks, deadeyes, and ropes. The location in the hull of the masts was based on measurements from the navy's scale plan. However, the raking angle as measured from the horizon was not taken from the plans, due to the reproduction's small size, which would compound any errors in the measured angles. Instead, mast rake was calculated from Kipping's table for three-masted schooners (1853:5).

The greatest diameter of the lower masts is at the partner beams or deck line, and is in proportion to their length (Fincham 1843:152). Their smallest diameters are at the heel, hounds, and head of the mast (Fincham 1843:162). In order to provide the most support with the least weight, masts were tapered by quarters, with the greatest decrease seen in the last quarter of the mast (Fincham 1843:164). Without this, Fincham warns, the taper would cut across the grain of the wood where strain is still relatively high, causing the mast to sheer too easily. The lengths of masts used in this analysis were based on a length on deck of 143 ft. 6 in. (43.74 m) (Fincham 1843:122). Housed lengths were taken to mean the length of the mast extending below the deck, while hounded (length of the mast up to the hounds of the masthead) plus headed length (length extending beyond the masthead) was used to determine the total length of masts.

The bowsprit's length, location on deck, and angle of steeve were drawn after the naval plans (as seen in Lyon and Winfield 2004:232). This was decided after attempting to draw the bowsprit as described by Fincham for the lower masts (Fincham 1843:234). However, the housed length and the total length were found to give an angle of steeve that was much too high for this low-masted vessel. This disparity may have been due to *Pioneer*'s Arctic refit; it is known that the bow was heavily reinforced, and this could have entailed raising the prow in preparation for steaming into the ice. Alternatively, Fincham's method of calculating-up in size from known models may be less reliable than thought.

Since Fincham describes schooners as commonly employing both an upper and a lower cap, this was the method chosen at the lower mast-heads and bowsprit (Fincham 1843:262, 267-268). The length of topmast used to calculate cap dimensions was the length of the topmast (not including any subsequent poles) (See Table 2). On the lower mast caps were set cross trees (two on the fore and main-mast, one on the mizzen) and a bolster for the standing rigging to drape over (Fincham 1843:210; Kipping 1853:14-17). Since the cross tree dimensions are supposed to be based on trestle-tree measurements, in this case the cross-tree dimensions were based on the lower cap size (Fincham 1843:25). Hounds were formed below the mast-head according to Fincham (1843:208). This very small mast-head arrangement was designed based on the contemporary images, which show no elongate trestle-trees (Figures 1 and 2). In addition, it must be noted that while trestle-trees were described among the fittings for steamer mast-heads, not all steamers were schooner-rigged (Kipping 1853:120).

As described in Fincham (1843:113), steam-vessels were commonly outfitted with their topmasts and topgallant masts all in one pole. Based on the consistent description of these upper masts as "poles," it was decided to dispense with the fore-topmast cap employed on larger ships at the join between the fore-topmast and the fore-topgallant mast; instead, it was joined with a flared socket as seen with royal poles and topgallant masts (Kipping 1853:25). Their large diameters were at the heel, while small diameters are placed at the hounds and head (Fincham 1843:152, 162). They are tapered according to the same method seen in lower masts, although with smaller differences in diameter, this tapering produced less of an effect.

The jibboom was a small spar that rested on a saddle upon the bowsprit, extending forward as an attachment point for upper rigging (Fincham 1843:265-266; Kipping 1853:22-23). The dimensions of the jibboom, saddle, and placement of bees are as described in Fincham (see Tables 1 and 2). The jibboom length, however, would have been added to by the addition of a flying jibboom. In steamers, this would have been a jibboom and flying jibboom in one, since low headsails made longer versions unnecessary (Kipping 1853:23).

Finally, the dolphin-striker, also known as the martingale, was added below the bowsprit cap to the jibboom, perpendicularly to the bowsprit, to assist in holding the bowsprit down against upward pull from the rigging (Brady 1848:79). Information on spar lengths for this piece is sparse, since its dimensions depended primarily on the angle of steeve (Brady 1848:322). However, by looking at illustrations, it seemed that the ratio of length seen between the bowsprit and the martingale was about 1:0.75 to 1:1 (see Figure 2, especially). When this was tested, the 1:1 ratio appeared too heavy and long for the size of the masts; therefore, a dolphin-striker length of 7.5 ft. (2.3 m) was estimated. The large diameter for the dolphin-striker was based upon the ratio between length and diameter given for first and second class sloops (Brady 1848:321). Tapering for the end was estimated as the same amount for the jibboom.

Yards

Yards are those spars designed to hold sails in the optimum configuration to catch the wind. Yard measurements were taken from Fincham (see Table 4) (Fincham 1843:120, 152, 163). The yards were tapered in the same manner as masts (see above). HMS *Pioneer* had lower fore and main yards, fore and main topmast yards, a fore-topgallant mast yard, mizzen boom, and fore, main and mizzen gaff yards. Even though Osborn describes his ship as schooner-rigged (that is, with only fore-and-aft sails), it is clear from contemporary illustrations that it was a topsail schooner (Figure 3). Looking at Figure 3, it appeared that the ship has a main topgallant sail as well, or at least a split main topsail, however, the authorship of the small plate is unknown and the depiction is likely stylized. Additionally, this yard is not shown in any other illustration, and is not mentioned for steam-vessels in any other source.

The yards were furnished with cleats in the center on either side of the mast, as well as with stops on the yardarms as rigging attachment points (Fincham 1843:275-278). In earlier ships, the yard-arms had cleats, but it was found that stops weakened the yard less and provided just as much support for rigging. In the center of the yard, the surface would be made octagonal, and had wooden battens nailed to it for protection from damage (Kipping 1853:28-30). Given that it was rare for HMS *Pioneer* to travel under sail in the Arctic (most of Osborn's memoir focused on moving under steam, although this may be a result of his bias in wanting to report steam-power's usefulness), studding-sail boom irons were not added. In addition, boom irons (to spread studdingsails) were usually only place on fore-yards (Marquardt 2003:167). The height of the lower yards below the masthead was calculated using Rule 89 (Fincham 1843:37), as shown below (see Table 4):

Main-mast heading=9/68*Depth

Depth=9/68*main-mast heading

Depth*1/17=position of yard below the mast head

The distance of the topsail yards below their mast heads was taken to be 1/9 the length of the topmast (here based on the length of the mast without the poles). As can be seen in Table 4, the increasing relationship between the head of the mast and yard height allowed extrapolation for a relationship of 1/5 for the fore-topgallant yard height, since no proportion was given in Fincham (1843:37).

Fore-and-aft sails were spread using gaffs and booms, with the angled gaff raising the top of the sail. All lower masts on HMS *Pioneer* featured a gaff. The lower foremast did not feature a boom, since it would have interfered with the engine's smokestack (Figure 1). The mizzen-mast required a boom to spread sail aft; however, it was unclear if HMS *Pioneer* carried a main boom or not. Unfortunately, contemporary iconography was unhelpful; either the fore-and-aft spars were not set up in the image (Figure 5), or the area was obscured with smoke or wintering gear (Figures 1 and 2). It was decided to not include a main boom to reduce the weight of spars carried on board, especially since the foot of the fore-and-aft mainsail could be extended via line to the mizzen mast. This is in contrast to Figure 1, where a spar appears in the same area on the mainmast as on the mizzen. However, this main-mast spar has a higher angle of attachment to the mast, more consistent with a gaff. As seen in the illustration, smoke from the steam engine is pouring up into the mainmast head, carrying sparks and potentially damaging unprotected spars. This spar most likely represented a gaff lowered on deck to prevent unnecessary damage.

Boom and gaff dimensions were taken from Fincham's tables (Fincham 1843:120). To the lengths present there was added 4.5 foot (1.37 m) jaws on both gaffs and boom (Fincham 1843:280, 282). These jaws were hooped and bolted to the tongue of the gaff or boom, with a semicircular end that fit half-way around the mast in question (Kipping 1853:31-32). The spar would then be fastened in place with a single parral (Marquardt 2003:166). The greatest diameter of these spars was taken at 4 ft. (1.22 m) from the inner end (outside the jaws) on the gaffs, while 1/3 of the way from after end for the boom (or driver boom) as described (Fincham 1843:152; Kipping 1853:32). The smallest diameters were located at the outer and inner ends (Fincham 1843:163), and tapering was applied the same as masts and yards.

As based on Fincham (1843:37), the gaff yards were all set one diameter of the corresponding square-sail yard below them. As for the angle formed by the gaff, a range of 25-30° above the horizon was acceptable (Fincham 1843:36). Since fore-and-aft spars presented the least drag for the greatest effect in favorable winds, contemporary authorities recommended making the fore-and-aft sails as big as possible on steam vessels (Fincham 1843:113). Initially, therefore, the higher angle of 30° was chosen for all gaff yards. However, when adding the standing rigging, the amount of clearance needed between the ends of these yards and the stays necessitated lowering the angle for the fore- and main-gaffs to 25°. The mizzen boom (on ships) was set 4 ft. 6 in. (1.37 m) above deck, and at an angle just high enough to clear the taffrail (Fincham 1843:32).

Rigging: Standing Rigging

Once all of the spars were place on HMS *Pioneer*, the standing rigging was placed to provide support and stability for the masts and yards. When determining the dimensions of rigging, principal rope dimensions were applied from Brady (Brady 1848:340-363). It is important to note that in the 19th century, rope sizes were reported in circumference; for this reconstruction, these sizes were converted to diameters ($D = C/\pi$) Block, deadeye, and other tackle dimensions were taken both from Brady (1848:364-383) and Kipping (1853:132-136).

Shrouds were sets of heavy standing rigging supporting masts on either side, and were always the first rigging element laid on a mast (Kipping 1853:93). On lower masts, they extended from the mast head down to the deadeyes (Brady 1848:44-45), passing over the cross-trees (Kipping 1853:93-94). On steamers' main masts, due to the heat from the engine exhaust, the upper third of the shrouds was made of chain instead of rope, with the shrouds bolting in to a chain looped around the mainmast (Kipping 1853:121). The deadeyes on the shrouds were, in turn, joined via lanyards to deadeyes set in the channel (a wooden shelf on the outboard sides of the hull that extended shrouds out at a greater angle). These were then attached to chain plates and preventer plates to the side of the vessel (Kipping 1853:101-102). Based on the number of shrouds seen in contemporary illustrations and on similarly-sized three-masted schooners, there were four pairs of shrouds on the fore- and main-mast, and three pairs on the mizzen-mast (Figures 1 and 2) (Thomsen, Meverden and Jensen 2008:Section 7:page 2). The shrouds were typically laid starting from the first pair (also known as pendant shrouds), extending down to run along the centerline of the mast (Lever 1819:25). From there, the shrouds angled aft, with the extent of the channels determined by the number of shrouds and size of the deadeyes. Based on archaeological evidence, chain plates for this size of vessel were typically around 3-3.5 inches (7.6-8.9 cm) wide and possibly 3 ft. 4 in (1.02 m) long (Souza 1998:153; Thomsen, Meverden and Jensen 2008:Section 7:page 2).

Topmasts also had shrouds, which essentially attached similarly to the lower shrouds, but extending from the head of the topmast to a deadeye located on the end of the lower-mast crosstree (Kipping 1853:94, 106). As in lower shrouds, lanyards connected these deadeyes to deadeyes in the upper end of futtock shrouds at the lower-mast head, and from thence to futtock plates on an iron collar located below the hounds (Brady 1848:57). On large ships it was common to apply catharpens (also known as futtock-staves) to the futtock shrouds; these staves would be pulled together via a lanyard to reduce the area taken up by rigging in the tops (Brady 1848:46). However, on ships with lighter rigs (like steamers) this would be considered "unnecessary lumber aloft," and was dispensed with (Brady 1848:57).

In placing the deadeyes, each one had to attach to the end of a crosstree. Accordingly, and based on contemporary images (Figures 1 and 2), two shrouds were placed on the main and fore mains, and one on the mizzen. On the fore masts, the topmast shrouds extended to the head of the topgallant pole, rather than the topmast pole, as shown in Figure 1.

In order to provide access for sailors to ascend the masts and adjust sails, the principal shrouds were equipped with ratlines, or lines that formed ladder framing (Young and Brisbane 1863:303). On the lower shrouds, these were placed over a sheer batten (also known as a shroud truck or side leader) (Brady 1848:382). Since no dimensions were given for these, they were drawn as half the width of the channels, extending slightly fore and aft of the shrouds, so as to not interfere with the backstays. Ratlines were placed 15-18 in. (0.38-0.46 m) apart, or about the height of a lifted foot apart.

Next, backstays were placed over the shrouds on topmasts; backstays were not present on lower masts (Kipping 1853:102). Kipping mentions both 'breast' and 'standing' backstays, however, Brady states that breast backstays are not necessary for mast stability (Brady 1848:66; Kipping 1853:95). Backstays were athwart-ship lines like shrouds, extending from the head of mast to the channel, attaching via deadeyes to the channel, behind the shrouds (Kipping 1853:95). On illustrations of HMS *Pioneer*, it looks like the backstays extend from the topgallant pole, similarly to the topmast shrouds; nothing appears attached at the topmast pole (Figures 1 and 2). Based on the

Osborn illustration, there were two pairs of backstays placed on the fore and main masts, and one on the mizzen. Spacing between the backstay deadeyes and the shrouds was set at 8 in. (20.3 cm) (Brady 1848:67).

Finally, stays were placed that extended forward from the mast, matching the pull of the backstays (Brady 1848:56). Stays were often accompanied by preventer stays (also known as spring stays) on heavy lower masts that acted as a fail-safe when rigging became worn (Kipping 1853:102). Spring-stays (especially for light topmasts) were not always included in upper rigging. The preventer/spring stay always attaches below the primary stay (Biddlecombe 1990:Plate IX). Lower stays on ships extended from just above the shroud ties to outboard of the bowsprit saddle (forestay) or to an eyebolt in the deck (mainstay) (Brady 1848:54-55, 58; Kipping 1853:95). However, this arrangement is untenable in a schooner-rig, where the gaff must be free to swing around the points of the wind for maximum efficiency. With this configuration, the main and fore-gaffs, even when lowered to 25°, would still hit the stays when tacking. Therefore, the main and mizzen lower stays must be arranged as seen in Kipping (1853:120) and Young and Brisbane (1863:490-491) (the foremast stay is the same as on a ship). Therefore, the main-stay leads from the head of the main-mast to the head of the foremast, with two jumper-stays set up to an eyebolt in the deck aft of the foremast (Kipping 1853:120). These jumper-stays are attached on the lower end with blocks, so that as the fore-and-aft sail tacks, the appropriate stays can be loosed and tightened as necessary. The mizzen mast simply has two jumper stays leading to an eyebolt, since it is much lower and lighter than the two masts forward.

Bobstays, in this period of chain, attached with hearts or deadeyes to a collar under the bowsprit to a plate bolted to the cutwater of the hull (Kipping 1853:102).

Attached to the jibboom and dolphin-striker were the martingale stay and martingale back-ropes. The martingale stay fit from the end of the jibboom to the dolphin-striker, to pull the jibboom down against pressure from the headsails (Brady 1848:72; Kipping 1853:109). The martingale backstays (a pair) run from the dolphin-striker (looped above the martingale stay) to inboard of the hull.

Finally, the last piece of standing rigging added was the foot ropes and stirrups, to form a working platform for crew out on the yards (Young and Brisbane 1863:156-157). Foot ropes would hang below the yards, with stirrups extending to hold the foot-ropes in place (Brady 1848:81-82). There were two to four stirrups per each side of a yard, depending on its length (Kipping 1853:114). The foot ropes would hang about 3 feet (0.91 m) below the yard, so that a man standing would have the yard at waist height. Foot ropes were placed on all square lower yards as well as the foretopmast yard (basically, any yard not outfitted with a halliard, see below for discussion).

Rigging: Running Rigging

Running rigging dimensions are based on the same sources as standing rigging. The interested reader is referred to Table 6 for running rigging and tackle dimensions. In addition, it should be noted that with standing rigging, descriptions of placement and features differs slightly between Kipping (1853) and Brady (1848). In this instance, the Kipping description is regarded as more accurate, due to the audiences that were being written for: even though Brady wrote specifically about the rigging of steamers, he was primarily focused on an American naval audience; in contrast, Kipping is much more interested in iron-supplemented rigging (which was being used more frequently in Europe) and merchant applications. Given that HMS *Pioneer* was first developed as a merchant, and her small crew size, Kipping's descriptions were relied upon more heavily (Osborn 1852b:47). However, Brady (1848) is used in reference to block sizes, given his specific focus on steamer-tackle.

Lifts were placed on square yards to allow vertical adjustment of the ends (Young and Brisbane 1863:235-236). An eye was fitted over the yard-arm-end, securing against the cleat, and looped through a single block at the top cap, in between the lower mast head and upper mast foot (Kipping 1853:114). From thence, the line passed through the lubber's hole (or equivalent) and was set up on deck. On topyard and topgallant yards, the lift ends could also be tied to the futtock plates in the top (Kipping 1853:115-116). There was a pair (one for each side of the yard) on each yard.

Braces extended aft from the yard-arms, and were used to adjust the fore-and-aft angle of a square yard (Young and Brisbane 1863:54). Although, typically, the fore-brace would attach to the main-stay, due to the nature of schooner rigging (see stay discussion above), the fore-braces were configured differently on topsail schooners (Kipping 1853:114). As seen in Plate V, one option was having the fore brace tied to the foremost main stay, pass through a block, and then reattach to the shroud (Young and Brisbane 1863:490-491).

Since the same problem of fouling with the gaff sail would result if ship-style braces were used on the main yards, it was decided to use the same attachment system for the main braces (Kipping 1853:114).

The foretopsail brace has its standing part attached to the topmast head (as seen on Plate V, not as described by Kipping), with the end running through a block on the yardarm, back to the topmast head, and from thence down to the deck (Kipping 1853:115; Young and Brisbane 1863:490-491). In order to prevent fouling with the gaff, the main topsail brace was rigged in the same manner.

Based on general schooner sail plans of the time, the foretopgallant brace extended from an eye on the yard-arm to a single tail-block on the mainmast head, and from thence down to the deck (Kipping 1853:117; Young and Brisbane 1863:490-491).

Halliards and tyes (or ties) were used to raise and lower yards along the mast axis. The tye was the portion extending from the inner yard cleats, while halliards attached via blocks at the lower end to facilitate the 'hauling up' of the yards. There were no halliards on the lower yards; these would be permanently fastened in place with chain slings and iron trusses around the yard and mast (Kipping 1853:115). Larger ships (with larger yards) used double tyes (with a tye-block fastened on the yard). In this reconstruction, double tyes were used on the foretopsail yard (since it is almost as long as the lower mainyard, and required more support), while single tyes (with only an eye around the slings) were used elsewhere.

The foretopsail halliard had its standing end tied to the mast head, with the running end passed through a tye block at the inner cleats, then up through a "bullockblock" at the after side of the mast-head assembly, then down towards the deck (Kipping 1853:116). This end then reeves through a double fly-block, down into a single block hooked into the chains of the main-mast, up again through the fly-block, and tied off onto the block when secure.

The main topsail yard and fore topgallantsail yard are rigged with single tyes. The standing end loops in an eye around the yard at the slings, up through a single block (or sheave hole in the pole mast) at the head, then down to a single fly-block and single block in the chains of the mast-head (sometimes these lower halliard blocks were dispensed with entirely, depending on the purchase necessary) (Kipping 1853:117).
Information in rigging treatises on fore-and-aft running rigging is even scarcer, since most manuals were concerned primarily with the sailing standard of the day: the ship. As such, the application of rigging on gaffs and booms is extrapolated from plate illustrations of schooners and descriptions of mizzen-rigging. Once again, block measurements were taken from Brady (1848).

Throat halliards raised the fore-most end of the gaff. The standing part of the throat halliard was positioned 8 in. (20.3 cm) from the forward end of the gaff (Fincham 1843:282). After its standing portion and a single block were attached here, the running end reeved through a double block under the lower cap, down through the single block, up again through the top block, and through a leader in the top (Kipping 1853:117).
The peak halliard worked in a similar fashion to raise and lower the after end of the gaff. The standing part could typically be fastened around either the head of the topmast or around the neck of the double block at the cap (Kipping 1853:117-118). Either way, the peak halliard would reeve through single blocks on outer and middle portions of the gaff before being sent down to the deck. These single blocks were fastened at a hoop secured around the gaff. From Fincham's diagram, it appears that the inner hoop is located at approximately half the total length of the gaff (including jaws) (Kipping 1853:32). Then, the outer hoop was placed halfway between the end of the gaff and the inner hoop. This reconstruction is relatively uncertain, given that Kipping's diagrams were based on other sources (such as Fincham 1843).

Vangs were descending lines that pulled the gaffs downwards, counteracting the halliards as well as keeping the yard steady at amidships. Single vangs, in use at this time, were simply rope folded in half and 'eyed' at the middle. This eye was then passed around the gaff-end, and one end of the running rope was led to each side of the vessel (Kipping 1853:118).

The boom was raised upwards with a topping lift. A line ran from a hoop towards the end of the boom to a single block at the trestle-trees (Kipping 1853:118). Based on the diagram of a boom, the hoop was about 1/4 of the length of the boom in from the end (Kipping 1853:32).

At this time, boom sheets and guy pendants (to hold the boom in place and down) were combined into one. Although Kipping references only boom sheets for schooners, HMS *Pioneer*'s mizzen boom projects further over the transom than contemporary schooners (Kipping 1853:118). This paired arrangement featured a double-block on each side of the hull, at the quarters. From here, a line reeved on each side through a pair of single blocks (one per side) on the boom just aft of the taffrail.

This overview of the process of rigging and outfitting HMS *Pioneer*, highlights the challenges of accommodating steam in sailing vessels. In this period, steam was still seen as secondary to sail, a more reliable method of propulsion. HMS *Pioneer*'s rigging was reconstructed based on contemporary artistic illustrations, practical instruction manuals for sailors, officers, and craftsmen, and on archaeological material. Combining attributes of a topsail schooner and a steamer resulted in a possible reconstruction of how this vessel sailed out to search for Franklin in 1850. However, HMS *Pioneer* also used steam power to a much greater extent than previous Arctic vessels, the subject of the Chapter VI.

CHAPTER VI

RECONSTRUCTION: PROPELLER AND STEAM ENGINE

From the earliest developments of shipboard steam engines, the value of having a power source independent of the wind was quickly realized (Cunningham 1861:502). With this new capability, the Admiralty knew, lay great advantage in being able to defy nature, unlike sails. However, the large, cumbersome paddlewheels so common on the United States' lake and river systems were not suitable for warships, or for the grinding, perilous conditions in the Arctic. Instead, the British navy focused on the propeller, first proposed in 1834, which heralded a new horizon for steamships in the Navy (Cunningham 1861:503).

Two major propeller designs vied for supremacy during early development of the technology. The Archimedean screw, based on a design from antiquity consisting of a spiraling surface along a horizontal shaft, was first publicized by the steamer *Archimedes* in 1839 designed by Francis Petit Smith of Kent, England. In direct competition to this was the Swedish-born John Ericsson's propeller (Brown 1990:101; Corlett 1993:86-87). The two designs were adapted by the British and American navies, with the Admiralty pinning its hopes on a version of the Archimedean screw.

Screw propellers had the advantage of being completely submerged underwater, unlike paddle wheels; this afforded greater ship stability by lowering the center of gravity and lessened the chances of enemy fire hitting the mechanism on a warship. However, before this point, marine steam engines were designed to optimally rotate paddle wheels, which had different mechanical requirements than the new screw propellers (Hewitt 1998:91). Accordingly, when studying the advent of screw propellers, one must look at developments in marine engine design to understand the various adaptive strategies in use, such as the oscillating engine used on *Pioneer* (Hewitt 1998:91-92).

To reconstruct HMS *Pioneer*'s propeller, the researcher must turn to early screw ship trials. Following the widely-publicized success of the *Archimedes* trials in 1839, the Admiralty sponsored numerous trial ships to determine (basically by trial-and-error, since at this time the physics of screw propulsion were poorly understood) the best configurations of engine, hull shape, and screw size (Brown 1990:102-104). HMS *Rattler* was one such trial ship. Various experiments on screw shape and size shaped the type of propeller carried by vessels in the late 1840s and early 1850s (Brown 1990:111-114). The trials tested variations on the Archimedean screw, with the propeller placed in an arched-rectangular opening cut between the deadwood and the sternpost. This arrangement was compared to the earlier Ericsson patent calling for the placement of a propeller aft of the rudder; later trials showed the flaw in this placement, leading to a shift forward of the rudder when Ericsson's model was adopted by the U.S. Navy (Brown 1990:101; Corlett 1993:86-87). The *Rattler* trials showed that a longer propeller actually reduced efficiency, contrary to popular thought (Brown 1990:111). The results of the 1844-1845 trials suggested that the Smith-designed propeller was the best; this model was from 8 ft. 2 in. (2.5 m) to 10 ft. in diameter (3.05 m), was positioned 10 in. (0.25 m) forward of the center of the aperture, and extended 1 ft. 2 in. aft (0.36 m) (Brown 1990:112).

Based on these criteria and the known propeller aperture for HMS *Pioneer*, the screw propeller was drawn with a diameter of 9.09 feet (2.77 m) behind the deadwood, forward of the sternpost (Admiralty 1848:2). The pitch (or angle of slope for the propeller blade) was based upon the angle formed by drawing between the fore upper surface and the aft-lower surface, however, it must be noted that this period witnessed many experimental propellers. Still, after 1840, this style based on the Archimedean screw was semi-standard; given the risks and skepticism inherent in Arctic travel, it seemed reasonable to assume that the Admiralty would opt for a proven design for the Arctic voyages (Corlett 1993:101; Osborn 1852b:35).

Part of ensuring that the engine and propeller could keep functioning was to make the propeller retractable, and thereby remove it from crushing ice. This was likely similar to the retracting mechanisms used on HMS *Erebus* and HMS *Terror*. In addition, the vessels could have been outfitted with an iron brace on the rudder to protect it and the propeller, like on *Fox* (Delgado 2009:34). Throughout the voyage, whenever crushing ice threatened the safety of the propeller, it was unshipped, along with the rudder (Unknown 1850-1851:3 July). The crew, once convinced of the value of steam propulsion, was constantly concerned about "the safety of the 'screw'" (Osborn 1852b:57). Part of the wintering operations, finished by mid-October, doubtless consisted of unshipping the valuable rudder and propeller, to prevent damage during the long winter months, although it was not specifically mentioned in these sources (Osborn 1852b:118; Unknown 1850-1851:17 September).

Steam Engine Development

The earliest ships were propelled by human muscle or wind power harnessed via sail. However, with the scientific queries in the production and expansion of steam in the 18th century, as well as the resulting development of steam engines for terrestrial uses, this was about to change (Tredgold 1851:First Paper, 5-6). To summarize the numerous experiments, it was determined that water, heated over 212°F (its boiling point) produced steam, which either expanded in an open container or produced pressure in a closed one (Tredgold 1851:First Paper, 14-15). This force could be used to move a reciprocating piston, which was then connected either directly or indirectly (via cranks, shafts, and gears) to a paddle to make motion (Tredgold 1851:First Paper, 82).

Some of the problems these early 19th-century engines faced were generating adequate steam with the least amount of fuel, loss of heat in pipes and cylinders, and building pressures. Steam was generated by heating water in a boiler, which could require vast amounts of fuel. The ideal boiler increased the surface area of water being heated (making it faster to heat, using less fuel) as well as avoiding pressure loss. Accordingly, the early boilers were rectangular, with James Watt's design having a cylindrical top, flat sides, and a concave bottom (Tredgold 1851:First Paper, 126). In order to reduce heat loss, especially in the large cylinders within which the pistons moved, jacketing filled with warm water or a vacuum was introduced (Tredgold 1851:First Paper, 87). Many of these early engines were dangerous, with uncontrolled rising pressures. By 1817, British laws required safety valves on boilers (Milton 1953:4).

In adapting the steam engine to shipboard use, one of the most important considerations was space. In both naval and merchant vessels, space was a valuable commodity, whether required for goods, provisions, men, or guns. Besides shifting the focus on design in marine engines to generating the most power in the least amount of space (and weight), technological consideration had to address the issue of fuel. Through experimentation, it was found that the fuel which produced the most efficient heat was coal (Tredgold 1851:First Paper, 106).

The first commercially viable steam-powered vessel in Britain was the *Comet* of Mr. Henry Bell, in 1812 (Sennett 1902:1; Tredgold 1851:Third Paper, 50-51). It was propelled by two paddle-wheels on each side (Thurston 1939:249). In these very earliest steam-vessels, proposed methods of propulsion could be widely varied, with one idea being to hang two boards off the back end of the ship and move them up and down like a swimmer's kicking feet (Tredgold 1851:First Paper, 318-319).

The most common arrangement soon became the side-paddlewheel, moved by a side-lever engine (Sennett 1902:2-3; Thurston 1939:291). Over time, however, different types of engines were developed, including grasshopper engines, double-cylinder engines, and oscillating engines (Sennett 1902:3-4). Paddlewheels, which required a lower rate of rotation for ideal motion through the water, meant that all engines of the time were adapted to their mechanical requirements (Hewitt 1998:91).

Still, paddlewheels were not ideal for many ships. Variations in the draught of the ship, caused by changing cargo or provisions levels, affected the depth and efficiency of the wheel (Sennett 1902:4). Rough conditions, such as those experienced in open seas could tilt one paddle out of the water. In winds or a fast current, the paddle wheels could hinder progress by adding drag to an otherwise streamlined vessel form. In addition, the large, cumbersome wheels raised the center of gravity of a vessel (especially when combined with the tall walking beam engines favored on American inland waterways), causing instability. Finally, on naval vessels the wheels inhibited the use of broadside guns and were vulnerable to gunfire themselves (Sennett 1902:4). For all these reasons, the Royal Navy preferred Smith's Archimedean screw designs over other options, and trials, as outline earlier, gradually improved the efficiency and speed of their design (Brown 1990:102-104; Thurston 1939:294-295).

As previously mentioned, oscillating engines, also known as vibrating engines, had been invented earlier, but in the 1840s, they began to be more widely manufactured (Anonymous 1840:14-15; Brown 1842:4). They consisted of a cylinder suspended on two hollow trunnions, thereby able to oscillate (tilt) back and forth; the piston rod was attached directly to the crank (Main and Brown 1864:155). In screw-propelled vessels, the engine was oriented horizontally, saving space and lowering the center of gravity (Sennett 1902:7, 10). However, screws required a greater speed (rate of rotation) to be effective compared to paddlewheels. Designs shifted from heavy, long-stroked engines to short-stroked, high speed, lighter engines (Thurston 1939:299). This was accomplished either by adding multiplying gears or increasing the steam pressure (Main and Brown 1864:146; Sennett 1902:6). Boilers were still box-shaped to reduce the amount of space needed on board ship (Milton 1953:5). Despite complaints about their perceived defects (prone to breakdown, difficult to repair), oscillating engines began to replace side-lever engines because of their advantages when paired with the screw propeller (efficiency in rough conditions, lower space requirements, and greater ship stability) (N 1868a; N 1868b; Thurston 1939:300). This change occurred slowly, especially in a merchant service where the advantage of protection from enemy fire was irrelevant (Sired 1850:275-277).

Small increases in engine performance were achieved with direct-acting engines by decreasing energy losses inherent in more complex engines (Thurston 1939:300). In 1854, the passenger steamer *Arctic* was refit with a "combine steam engine" to increase fuel savings by a reported 70% (Anonymous 1854a:220). This process, produced by Wethered's Steam and Stame Apparatus, involved injecting regular boiler steam with superheated "stame" produced by a certain portion of boiler steam being funneled past the furnace to "dry" and heat it twice (Anonymous 1854c:45).

The next big shift was the widespread adoption of surface condensers by about 1860 (Sennett 1902:10). The main benefit this achieved was to decrease the formation of lime-scale deposits in the boilers (Thurston 1939:300-301). Previously, it was believed that precipitate formation was affected by its concentration in the boiler: this new system, allowing for more pressure, showed that deposits were affected by temperature, instead (Thurston 1939:301; Tredgold 1851:First Paper, 36).

With this knowledge, compound engines, with expansion conducted in ever-larger cylinders, allowed for high-efficiency engines (Sennett 1902:10). These engines are also known as double-expansion engines, and led to changes in pressure from 30 lbs. to 90 lbs. per square inch in 1880 (Sennett 1902:12). Using higher pressures meant less fuel was needed to heat the water into steam, saving on fuel economy.

As pressures increased, boilers changed form to provide more structural support. First, cylindrical boilers were introduced (Sennett 1902:10). With introduction of triple-expansion or triple compound engines in 1871, pressure tolerances had to increase (Milton 1953:5; Sennett 1902:14). For example, the engine of SS *Propontis* required 150 lbs. pressure in 1874 (Sennett 1902:14). To supply this, an oval-shaped boiler was initially used. This oval design turned out to give trouble in practice, and so the cylindrical Scotch boiler replaced it (Milton 1953:5-6).

Finally, developments in engine design led to the quadruple expansion engine (Sennett 1902:14). These were supplied with steam first by water-tube boilers on naval vessels or tank boilers on merchants, with pressures up to 250 lbs. per square inch (Milton 1953:9-10).

Steam Engines in the Arctic

The first voyagers into the Arctic in the 16th century went by sail, and continued doing so until John and James Ross. The Rosses, privately funded by Felix Booth, a gin magnate, sailed in the paddle-steamer *Victory* to search for the Northwest Passage. After overwintering from 1829-1832, they abandoned *Victory* and returned to England (Durey 2008:10-11). However, the use of the engine and paddlewheels proved so problematic that the entire machinery was removed and abandoned within the first year (Ross 1835:7).

The building and outfitting of this vessel took place before the adoption in Britain of the screw propeller, so the choice of paddlewheels is not surprising, even though they would be highly vulnerable to crushing damage from the ice. In order to reduce this damage, Ross contracted with a Mr. Robertson to design paddlewheels which could be lifted up and housed inside large paddle boxes above the waterline (Ross 1835:3). Other adaptations made for the Arctic included the use of a novel boiler design by Mr. Ericsson and Mr. Braithwaite, intended to be light and use much less fuel than the current design (Braithwaite 1835:1). Ross' excitement over proving the efficacy of steam for propulsion is evident in his previously-published treatise on the use of steam in marine warfare; he was an early adopter of steam technology (Braithwaite 1835:1).

However, this excitement quickly turned to resentment over the failure of the engines to work properly in the Arctic conditions (Braithwaite 1835:i). The first cause of the disaster was undoubtably caused by the way the voyage was outfitted: with great speed and secrecy. Sir John Ross did not tell his manufacturers what type of voyage he was planning, simply alluding to "war purposes" (Braithwaite 1835:2). This secrecy was insisted upon by Ross' backer, Sir Booth, probably to forestall any other explorers from realizing their plans and beating them in the race to the Passage (Ross 1835:2). In addition, this need for speed, and the dependence on sailing in time to the Arctic to avoid the seasonal ice, meant that errors in the planning stage did not have time to be corrected. For example, Ross had requested copper boilers (a more elastic and durable material than iron), but Braithwaite and Ericsson delivered iron boilers (Ross 1835:2). In addition, when the boilers kept leaking during trial runs, Braithwaite and Ericsson simply recommended adding malt dust to the water; this was common practice to stop new boilers from leaking (Braithwaite 1835:15).

The second problem was the experimental nature of the machinery. Braithwaite and Ericsson probably oversold the practicality of their design in order to have it approved by Ross, but the engines, boilers, and paddlewheels were all untested configurations (Braithwaite 1835:2; Ross 1835:2). Unlike usual orientations for engines, *Victory*'s was placed horizontally below the waterline, per Ross' instructions (Braithwaite 1835:2-3). In addition, the engines were operating at high pressure, with condensing steam; condensed steam had been used in low-pressure engines, but not in high-pressure one (Braithwaite 1835:3). The machinery was complex, with each gear introducing a new failure point. Finally, the paddlewheels, designed by Mr. Richardson, were kept secret from the engine designers, since Richardson had not taken out a patent on the design yet (Ross 1835:3). The novel paddlewheel had boards at a 45° angle to the axis of the shaft, rather than parallel boards (Braithwaite 1835:7). In addition, with the heavy weighting of the ship, the wheels' shaft was less than one foot above the waterline, far from the usual placement (Braithwaite 1835:9).

Finally, the design of the *Victory*'s engine suffered from a lack of experience and testing in real conditions. Although the paddlewheels and engine each worked separately, they failed as a combined unit (Braithwaite 1835:6; Ross 1835:3-4). Braithwaite blamed the failure on deep paddlewheels and incorrect calculations of the power required, while Ross blamed faulty boiler manufacture for not producing enough steam (Braithwaite 1835:17-18; Ross 1835:4). Ross also failed to account for high levels of wear on the bellows needed to keep the steam drawing (Braithwaite 1835:3).

From this engineering disaster, however, attentive readers of the time would have absorbed two lessons about using steam in the Arctic: first, machinery should be kept simple and easy to repair (Braithwaite 1835:5); secondly, bringing along experts in repairing and maintaining the engines was essential (Ross 1835:7).

HMS Erebus *and HMS* Terror

Sir John Franklin renewed the use of steam power in the Arctic. His ships, the former bomb vessels HMS *Erebus* and HMS *Terror*, were built in 1826 and 1813, respectively (Durey 2008:13). As bomb vessels, they were heavily reinforced for strength. For service in Arctic and Antarctic waters, the vessels were sheathed and reinforced at the bow and auxiliary engines were added (Durey 2008:14). Like the *Victory* before them, Franklin's ships used sail as their main power source: in fact, they only carried enough fuel to travel 12 days at 3-4 knots, according to calculations by Lieutenant John Irving of HMS *Terror*. This trend of using steam only as auxiliary power would continue until more reliable engines and propellers were developed (Greenhill and Allington 1993:146).

Certain vessels, however, began to widely use steam in this time period: so-called "steam-aids" or towing vessels (Ross 2002:61). Originally used in tight harbor navigation where sail could be unreliable and dangerous, their use quickly spread to longer towing voyages for Arctic-bound vessels (Anonymous 1894:343). On Franklin's expedition, several steam-powered vessels helped tow the two main ships to the Orkney Islands (Ross 2002:61). These included HMS *Rattler* (a steam frigate), *Monkey*, and *Blazer*, thus allowing the expedition to get off to a faster start than would be possible under sail.

HMS *Erebus* and HMS *Terror*'s low-horsepower engines were taken from railroad cars (Durey 2008:14). They were attached to retractable screw propellers, rather than trying utilize paddlewheels as on the *Victory*. This was the first use of screw propulsion in the Arctic, and the retractable screws, on a mechanism similar to later use, would have protected this valuable component (Sennett 1902:320). To conserve their fuel, Admiralty orders instructed Franklin to use the engines only when necessary. In practice, the relatively weak engines would only have been able to break weak new ice, not the sort encountered "in circumstances of difficulty" (Durey 2008:14).

When Franklin and his men failed to reappear, many people blamed their disappearance on their use of steam-propulsion (Osborn 1852b:34). Recent scholarship has explored this theory, suggesting the presence of engines, theoretically able to drive them out of encircling ice, may have led the commander to make more risky decisions such as pushing further into the ice with a mistaken assurance that they could work free (Durey 2008:14). However, this seems doubtful in light of Lt. Irving's calculations of their capabilities, and Francis Crozier's (Franklin's second-in-command) dour attitude towards the usefulness of the engines. More likely, Franklin and his men were well aware of the experimental nature of screw technology, and skeptical of its usefulness.

Steam in the Franklin Search Period

As both official and unofficial backers sent ships, supplies, and men out into the Arctic to rescue or find any trace of Franklin and his crew, steam propulsion was employed to a limited degree. Of the 30 ships sent to either search for Franklin, relieve previous searchers, or drop supplies, only five were steamers (Ross 2002:65).

Why was this number so low, in comparison to the great number of large commercial steamers built just in 1850 (B 1850:275)? First, it should be noted that many of the widely-used steamers used paddlewheels and the side-lever engine. Although this arrangement worked on open-ocean crossings, large vessels with big engines were not adapted to narrow ice lanes in the Arctic. Secondly, unlike these purpose-built vessels, ships sent into the Arctic were generally purchased from merchant companies like whalers (Anonymous 1881a:245). Next, speed in getting the search finished was important, especially in the early years, when rescue was eagerly expected. Using vessels already built, with minimal reinforcing needed, was ideal (Delgado 2009:25). Thus, for example, *Phoenix*, one of the earliest naval screw ships built in 1832, was sent out in 1853 after being refit (Anonymous 1853:102). Waiting for steam ships to be built was not a viable option. Finally, the search for Franklin only lasted 12 years, a fairly short period of time in which to build ships to withstand Arctic pressures. It must be remembered that screw propulsion was a risky new idea; on a mission of such importance, tried techniques would be preferred.

However, this list of 30 ships sent into the Arctic, while impressive, does not include tenders, tugboats, and other "steam-aids" that brought ships partway through the journey (Ross 2002:62). These ships were often critical to the success of the expedition. They ensured that convoys reached the Arctic in a timely fashion, before the season closed. In addition, they often carried extra supplies, like provisions or fuel, for the ships to top off their stores before sailing into the isolated Arctic.

Even the steam ships used as main parts of Arctic expeditions acted merely as "consorts." This same language, where the sailing ship is still the primary vessel, is seen in Osborn's account (Osborn 1852b:35). This was also seen in distributions of men and provisions. Due to limitations of space and the need for as much fuel as possible, HMS *Pioneer* and HMS *Intrepid* carried only 12-18 months provisions as compared to three years of supplies in the two sailing vessels in their expedition. Effectively, screw steamers could not operate independently of sailing ships.

HMS *Pioneer*'s engine was a 60 nhp (nominal horsepower, calculated based on the engine's geometry) two-cylinder, single expansion, oscillating steam engine manufactured by James Watt & Co. (Brown 1990:188; Lyon and Winfield 2004:232). The oscillating engine, unlike previous engines developed for paddle-wheels, was adapted to the different mechanical requirements of screw propulsion (Hewitt 1998:91-92). In addition, the oscillating engine, compared to contemporary engines of other design, was low-weight, compact (a vital factor both in cargo-carrying merchant ships and Artic exploration vessels when coal took up vast amounts of space), durable, and reliable (Hewitt 1998:93).

In 1842, James Brown, of James Watt & Co., took out a patent on a design improvement for oscillating engines that increased safety and possible engine size (Andrew et al. 2000:29). Brown's patent redesigned condensers with separate air pumps, so cylinders could operate independently, increasing the reliability of engines (Brown 1842:3). Given the naval records of HMS *Pioneer*'s engine as well as our knowledge of the contemporary technology available, it is probable that the vessel was outfitted with an engine similar to the one excavated from the *Conside* (Hewitt 1998:97). This would have fit in the central portion of the hull, by the boiler box and exhaust pipe illustrated in the Naval plans (Lyon and Winfield 2004:232). Based on archaeological evidence from the *Fox*, a steam yacht sent out on McClintock's 1857 search for Franklin, the engine would have rested on a bedplate to support the heavy weight amidships (Delgado 2009:25, 32). However, care must be taken when discussing engine design, given the rapid changes in this technology during the latter half of the nineteenth century.

As discussed earlier, the late nineteenth century saw the growing use of high pressure, compound engines, whereas HMS *Pioneer* and HMS *Intrepid* had horizontal oscillating engines. Boilers in use on Austin's expedition did not need to generate such high pressures, and were thus likely the box-form discussed in Milton (1953:5). As seen on *Fox* and in contemporary illustrations of the vessel, the boiler funnel of HMS *Pioneer* was located between the fore and main mast (see Figure 1) (Delgado 2009:30; Osborn 1852a).

It is clear from Osborn's account (biased though it may be), that this new generation of steam-ships had more than the simple auxiliary-steam propulsion of HMS *Erebus* and HMS *Terror*. With *Pioneer*'s engine and coal supplies, it could steam for 5000 miles alone (8046.7 km), or tow its sailing cousin 3000 miles (4828 km) (Osborn 1852b:35). Both ships were outfitted with marine engines, not adapted railway models (Osborn 1852b:33). In accounts of working through the ice, in addition to using old techniques of pulling the ship along by hand, Osborn also details strategies for ramming into leads in the ice (Osborn 1852b:69). Although the ship could not charge through solid 6 inch (15.24 cm) thick ice, it was able to move easily through 9 inch (22.86 cm) broken ice (Osborn 1852b:42, 63). The screw-steamer did prove valuable in Arctic exploration (Osborn 1852b:41).

During the Franklin search, public interest in Arctic exploration peaked, and newspaper articles, personal accounts, and traveling exhibits were in high demand (David 2000:240-241). Part of this interest focused on the technology in use, with news articles remarking on the ships (Anonymous 1850:146). For example, an account of the start of Dr. Elisha Kent Kane's 1855 expedition notes the *Release*, a sailing ship, and the *Arctic*, using a screw propeller (Anonymous 1855a:108).

However, popular opinion on the use of steam propulsion, in the early years of the search, used phrases like "shipwreck" and "disaster" in their predictions (Osborn 1852b:17). Early steam navigation was littered with catastrophes, and with greater use of steam vessels came more accidents (Anonymous 1854b:405; Anonymous 1855b:86). These early accidents sometimes resulted from speeding along in dangerous conditions, though that would not be a main concern in the Arctic (Anonymous 1854b:406). At other times, the danger was in running out of fuel with no chance of resupply (Kjaer and

Foxworthy 2004:37). In the isolated north, the main concern was the single screw breaking, which could leave a vessel helpless (Anonymous 1894:343). This is another reason why steam was never the only form of ship propulsion in the Franklin search: sailing rigs, however rudimentary, acted as a safety net.

The End of an Era

As the Franklin search ended with the discovery of conclusive evidence for the loss of both ships and all their men on King William Island in 1859, the face of Arctic discovery began to change (Ross 2002:58-59). Exploration expeditions gradually shifted to steamships as their main vessels, with sailing ships as consorts (Capelotti 2008:263). In the words of a contemporary commentator, steam was "no longer the harassed handmaiden" of sailing ships (Anonymous 1894:343). The rise of the screw steamer also showed the hazards of relying on a single screw on a ship with increasingly rudimentary sails (Anonymous 1894:343-344). By 1894, the double-screw ship was becoming standard on the seas; the higher initial cost paid in dangerous areas like the high northern seas, where towing costs or drifting helpless were not desirable outcomes, were outweighed by the dangers and potential for loss.

CHAPTER VII
HEAT AND COAL

Reliable and efficient heating systems were vitally important on HMS *Pioneer*'s expeditions. This was a shift in focus from earlier voyages, where no such provisions were made. There was likely a two-fold reasoning for this: search expeditions were increasingly being asked to overwinter at least one Arctic winter, unlike contemporary whalers, which left at the end of the season, and thus did not need heating systems. Secondly, there was an increased focus in the nineteenth century on sailors' health and well-being, as evidences by treatises on lime-juice and concerns over "bad air" (Armstrong 1857:614; Editor 1850:400).

Hence, there were heated arguments published in contemporary trade magazines debating the merits and drawbacks of various heating systems (Eugenius 1827:219-220; Warm 1827:395-396). A key component to these arguments was the question of "bad air," that is, whether heating air to the high degree required in these systems rendered it unfit for human use. Besides the effects from heating up air, the early Victorians were growing concerned about ventilation, or getting fresh air into heated rooms. This question was vitally important on ships as well, since humidity was readily blamed for ill health among the crew (Winton 1977:90-91).

The solution on HMS *Pioneer* was the Sylvester Heating Apparatus, installed in the hull during its refit for Arctic service (Editor 1850:400). A description of the likely design of the Apparatus can be extrapolated from the full account by S. Egan Rosser, in 1850, of the heating arrangement on board HMS *Investigator* (Armstrong 1857:609-614).

On HMS *Investigator*, the stove (called a *cockle* in contemporary terms, dimensions about 3 feet [1 m] square) was located in the hold, situated on a planked and copper-laid platform above the "kelson" (keelson). This arrangement formed a small hollow chamber, into which air flowed from outside via an iron pipe fitted with a cowl or wind sail on the main deck. From the hollow chamber, the air entered into the lower portion of the cockle via small holes in the planked platform. Inside the stove, a lower fire-box was surmounted by a tube chamber above, with the whole enclosed by a sheet-iron jacket: air passed between these layers to be heated twice (Armstrong 1857:609-611). The fire box was likely fitted with rollers, as described in John Sylvester's 1845 patent, as an improvement in maintaining the fire over his 1832 patent (Sylvester 1832:2; Sylvester 1845:2). Shutters were used to vary the flow of air into the firebox, thus allowing some temperature control (Sylvester 1845:3).

From the cockle, warm air ascended through a set of branching "caliducts" forward and aft in the ship: one end passed through the officer's staterooms into the after-cabin, the other extended forward into the crew's foc's'le (Armstrong 1857:612). Meanwhile, smoke from the stove was brought up to the upper or spar deck via a vertical smoke flue, where it branched into a double-plated horizontal oval smoke-tube, which extended from the main to the fore hatchway, giving off more heat, and serving as a useful place for the crew to dry damp laundry (Armstrong 1857:613). These smoke-flues were removable, a vital feature in ships, where space was precious (Armstrong 1857:614). Once at the fore hatchway, the smoke from the Sylvester's Apparatus and from the galley fires was directed out of the ship via a ventilating chimney or funnel, which faced away from prevailing winds and was covered with a cowl to prevent backdraft; this same cowl method was used on the air intake pipe into the stove to prevent a dangerous fire flare-up (Armstrong 1857:609, 613).

Crew descriptions of the heat given off by the Sylvester's Apparatus ranged from endearing gratitude ("nor let…Sylvester fall") to complaining about the time and effort required to keep it properly lit and ventilated (Osborne and McDougall 1852:38, 57). Officers and crews seemed to have different ideas about hygiene and heat, with officers keen on ventilating the ship regularly, and the crew complaining about the cold air that the process let into the ship. One other note must be taken based on these accounts: although the Sylvester was designed to use coal, it appears that any fuel source, including sticks or lignum vitae, were used to heat the small stove (Armstrong 1857:614; Osborne and McDougall 1852:12).

Although it appears that the Sylvester's Warming Apparatus could be fueled with whatever materials available, the engines and galley stoves (and other equipment, when alternative fuels were scarce) were all powered by coal. HMS *Pioneer* carried 300 tons of coal, which was stored in the central part of the hold. Conserving the supply of coal seems to have been a constant concern, as Austin's squadron was constantly being resupplied by its consorts until they were forced to leave by encroaching ice (Unknown 1850-1851:30 May, 18 June, 21 June).

Even with assistance from accompanying transport ships, this stockpile of coal, along with the 12 to 18 months of provisions carried on board, reduced the crew to 30 people, including officers. This was only half of the number of men carried on the sail-powered ships, even though *Pioneer* and *Intrepid* were 50 feet (15.2 m) longer (Osborn 1852b:34-35, 47). Thus, as discussed above when configuring the rigging, even though this was a naval vessel, adaptations were most likely made to reduce the number of men needed for basic sailing maneuvers. In addition, watches not on immediate duty on board the sailing ships HMS *Resolute* and HMS *Assistance* were frequently sent over to aid the men of HMS *Pioneer* or HMS *Intrepid* in large-scale operations such as coaling, unshipping rudders, or working through the ice (Unknown 1850-1851:23 June, 3 July, 2 August). Thus, it can be seen that the new technologies being used, as well as the harsh Arctic conditions, affected daily life and traditional schedules on board. These effects on daily life will be discussed next.

CHAPTER VIII
DAILY LIFE

The Start of the Season

In the 1850 season, as Capt. Austin's expedition began, his vessels constantly encountered other search parties with the same objective: find Franklin or evidence showing what happened to him and his men. Captain Penny's expedition features most prominently in Osborn's account, since the two groups wintered nearby and searched areas together. Captain Penny was in command of two sailing vessels, the *Lady Franklin* and the *Sophia* (Osborn 1852b:63). In addition, Sir John Ross searched for his missing colleague with the *Felix*, and was joined by Captain Forsyth in the *Prince Albert*, a ship bought by Lady Franklin for the search (Osborn 1852b:67). Another privately-funded group that Osborn encountered was the Grinnell expedition, funded by philanthropist John Grinnell for the American Navy, and captained by Lieutenant de Haven, with the *Advance* and *Rescue* (Osborn 1852b:107-108). Whalers and other search groups were reported by Osborn, but played a minor role in his narrative. In all, Osborn estimated 500 American and British sailors and officers were involved in the Franklin search in the spring of 1851 (Osborn 1852b:147).

Between these groups, Osborn reported a friendly rivalry, with ships racing each other through channels and bays to be the first to find evidence of Franklin and win both the prize money and fame (Osborn 1852b:43, 108). At the same time there was an intense comradeship between these people all at the mercy of the elements: ships would warn each other of danger, lend equipment, and give provisions to their fellows (Osborn 1852b:41-42. 86, 106).

"A Hurried Outfit and Departure"

Captain Austin's expedition force was composed of four vessels: two sailing ships and two screw-propelled steamers (Osborn 1852b:16). The two sailing vessels were HMS *Resolute* and HMS *Assistance*; both were bluff-bowed boats rigged as barks, which meant they featured three masts, with the fore and mainmast carrying square sails, and the mizzenmast rigged with a fore and aft sail (Osborn 1852b:32). This rig balanced the ability to attain high speeds from the square sails with the weatherliness and maneuverability of a fore and aft rig provided by the mizzenmast sails.

These barks' hulls were "strengthened according to the most orthodox arctic rules," which resulted in a very wide, box-like hull, designed to push the ice ahead without damaging the vessel (Osborn 1852b:32-33). This strengthening was accomplished by adding layers of tough planking to the hull, forming a double-planked hull, a common practice of the time.

The second half of the expedition consisted of two screw-propeller steamers, HMS *Intrepid* and HMS *Pionee*r. They were sister ships, and as noted, were formerly used for cattle-transportation (Osborn 1852b:33). The vessels were both rigged as three-masted schooners, as well as having two 30-horsepower engines in each of their holds (Osborn 1852b:32-33). Schooners are defined by their exclusively fore and aft rig, making them superb at sailing into the wind, but with the disadvantage of less speed before the wind compared to the square sail. However, in an Arctic environment, with highly changeable weather and constantly shifting ice floes, the ability to move forward against contrary winds or to avoid the looming iceberg were valuable attributes (Osborn 1852b:52).

Osborn lauded the screw-propeller system housed in his ship as "the first ever tried in the Polar regions," even though Franklin's expedition was also fitted with screw-propellers, although how much they were used remains a mystery (Brief Critical Reviews 1989:322; Osborn 1852b:7). Osborn was very interested in promoting mechanical propulsion over sail power, so estimations of speed power produced by the engines may be exaggerated for effect. Still, the usefulness of ready power in contrary or nonexistent winds cannot be denied.

Unfortunately, Osborn considered the operation and maintenance of the screw-propeller engines of "technical interest" only (Osborn 1852b:195), although the reader can determine the capabilities of the engines (see Table 8). For the nautical archaeologist, this accounting of speed attained by the engine, along with the size of the engine and date outfitted, can help determine the likely style of engine used. In addition, analysis of the engine shows the increasing importance of steam, as can be seen in the increases in power capacity between the Franklin (20 horsepower engines) and Austin (30 horsepower engines) expeditions in just five years (Osborn 1852b:32; Osborn 1865:286).

HMS *Pioneer* was frequently compelled to tow the *Resolute* due to nonexistent or contrary winds or bad ice conditions, and Osborne described their sailing counterparts as "helpless babes" or "huge incubi" dragging the pace of the search down (Osborn 1852b:205). Speed was crucial when fickle winds and weather could change a passable strait into an ice-choked hazard in a few short hours (Osborn 1852b:56). Still, the greatest advantage of these steam engines was not speed, but maneuverability in low or no wind, something impossible without the exhausting heaving and wearing maneuvers which will be discussed later. It is also important to note that the term "screw" is used to refer to the propeller and engine itself, as well as to reference the entire ship, such as in "[the Intrepid] was pushed up the iceberg high and dry; and…the bonnie screw came down again right and tight" (Osborn 1852b:193). As in the above example, accurate knowledge of terms is important for the archaeologist, as when comparing damage seen on a vessel to historical accounts.

The much greater speeds attained by HMS *Pioneer* and HMS *Intrepid* were also due to their hull design. The sharp bow of the original design on these transport ships allowed the hull to slip between ice floes and wedge open a path through the ice; hull improvements during the refit process reduced the damage taken doing this manuever (Osborn 1852b:34). The hull was strengthened by having a layer of doubling planking fastened over the original frames; each deck of the vessel was also doubled (Osborn 1852b:33-34). As Osborn noted, having two sets of holes fastening the hull together severely weakened the frames; he identified most of the ship's strength as coming from the doubled hull and decks instead, termed "bread-and-butter" construction (Osborn 1852b:34). The fine bow shape was maintained by shifting the doubling location from the outer surface of the hull to the inner, so although *Pioneer* appeared wider after her refit, the bow had the same dimensions as before. The presence of doubled sets of fastening holes on a wreck could indicate to the archaeologist a vessel modified for ice conditions, rather than one built specifically for polar conditions.

On the screw-steamers, the screw, rudder, and sternpost were designed so that even if they were ripped off by the ice, the vessel would still be able to "swim" (Osborn 1852b:34). Whether these design modifications would allow the steamer to move in this damaged state is unclear. HMS *Intrepid*'s rudder and screw-framing were damaged in pack ice, but was apparently able to return to England without any towing necessary (Osborn 1852b:194). After that event, it did appear to need more help in navigating and clearing through the ice pack, almost causing HMS *Pioneer*'s crew to spend another winter in the Arctic (Osborn 1852b:204-206). However, the ship was able to travel back to England in its damaged condition.

All of the vessels involved in the expedition had similar internal modifications for wintering on the ice (Osborn 1852b:34). Each ship and steamer had a hot-air distribution system running through the lower decks and cabin (Osborn 1852b:33). To further insulate from the frigid environment, all doors and bulkheads were doubled. Cooking was accomplished on board in a "cooking battery," with food served either in the crew's mess or officer and captain's gunroom. Crews slept forward, while aft the rows of officer's cabins on either side completed the description of the internal layout (Osborn 1852b:34).

The expedition's sailing ships were manned by 60 men, one-quarter of them officers; Osborn remarks upon this as a large proportion, compared to usual sailing ships (Osborn 1852b:33). By contrast, the steamers carried 30 men, including five officers (Osborn 1852b:35). In the steamers, two of the officers were engineers, whose sole responsibility was to keep the screw propellers in working order (Osborn 1852b:35). Indeed, the importance of the propellers was apparent to everyone in the squadron after only 11 days in the ice (Osborn 1852b:57).

Descriptions of the boats brought on the expedition are frustratingly vague. Most of these small craft are described simply as "boats," used to recover gear, tow the ships, explore and land on land, check for moving ice, and innumerable other tasks (Osborn 1852b:24, 54, 74, 98). In addition, in an environment where shifting ice could sink a ship with barely any warning, boats were outfitted for emergencies, to allow the crew to survive and carry out their mission (Osborn 1852b:58). These boats were propelled either by oars or a simple sail (Osborn 1852b:189).

The only named boats were launches and gigs. The launch belonged to Sir John Ross, and referred to the boat sent to take supplies off *Pioneer* after it grounded hard on a limestone outcrop (Osborn 1852b:86). The only mention of a gig is to one used by Captain Penny, in what Osborn interprets as an official visit, indicating that a gig was a boat or term used for formal occasions (Osborn 1852b:82). For the nautical archaeologist, accounts from this era referring to launches and gigs might also refer to specialized supply-carrying or official boat uses, which also indicate a general size. For example, a "gig", which would only need to carry the captain or a small group for official visits, was likely smaller than the "launch," which had enough space on board to take a significant amount of cargo out of HMS *Pioneer*.

In addition, there were specifically mentioned boats, such as the "India-rubber boat, constructed upon a plan of my dear friend Peter Halkett" (Osborn 1852b:67). This was an inflatable vessel, apparently relatively slow, that Osborn used to go out on shooting expeditions. Amazingly, Osborn did not sink this vessel, although its use is not mentioned again.

Another set of specific boats were the craft specifically built for search expeditions in the spring, before the ships were clear of ice (Osborn 1852b:172). These were probably more seaworthy than their counterparts used for odd-jobs around the ship. Again, no other mention of these boats is made, and the account of spring expeditions does not include any boat excursions.

Boats could be equipped with boat stoves, which were also used in sledge excursions (Osborn 1852b:114). This stove was 18 inches by nine inches (45.7 cm by 22.9 cm), and was fueled with lignum vitae. Given that they were used in both boat and sledge expeditions, the stove was likely not fixed in place, and was probably not stored with the boats on deck. Thus, indeterminate remains, either interpretable as a sledge or a boat, should not be identified based on the presence of a "boat" stove.

The final mode of transportation carried in the North was the sledge, used to haul equipment with a group on an overland expedition. The sledges consisted of two iron-shod runners, held together with a system of cross-braces or battens (Osborn 1852b:151). On each corner of the rectangular sledge, an upright iron stanchion fit into a socket. This frame could then be fit with a gutta-percha or oiled-canvas fabric, which would form a temporary boat in an emergency (Osborn 1852b:151). Based on the observations made on sledge-tracks found at the Franklin expedition's winter quarters, the sledge runners were placed approximately two feet (0.61 m) apart (Osborn 1852b:95). Although the wood material was tough and seasoned, the lashings and metal and wooden fittings on the sledges deteriorated relatively quickly, after only autumn and spring runs (Osborn 1852b:151, 170). In a marine environment, the only pieces left for the nautical archaeologist would likely be the runners and iron stanchions, though corrosion would play a factor in preservation.

Each sledge consisted of 440 pounds (181 kg) of "deadweight" (including the weight of sledge and standard supplies, like a boat cooking stove, blanket-bags, and spare clothes and boots) (Osborn 1852b:151-152). To this was added the weight of food and essential belongings for each man (about 172 pounds [78 kg] per man, with 6-7 men on a sledge), for a total fully-loaded sledge weight of 1408 pounds (638 kg) (Osborn 1852b:153). This worked out to 201 pounds (91 kg) per man, which was considered the maximum load any man was capable of dragging.

Although Penny's expedition had dogs to pull the heavy sledges, Austin's squadron relied on manpower to pull a sledge, despite one man's suggestion of taming a wild bear to pull his sledge for him (Osborn 1852b:46, 148). This involved attaching everyone to drag ropes, and simply pulling until the destination was reached (Osborn 1852b:112). If the breeze was favorable, a sail or a kite could be raised in help pull the sledge (Osborn 1852b:161).

Other supplies stowed on the expedition ships included food (usually dense, high in energy, and non-perishable), equipment for shipboard tasks (such as boathooks, anchors, and lots of line), guns and ammunition (to catch birds, bears, and other wildlife in order to supplement provisions and stave off scurvy), communication equipment (including rockets, kites, balloons, fire-balloons, pigeons, and Arctic fox collars), and clothing, such as the seal-skin trousers given to an embarrassed Osborn by his Danish host (Osborn 1852b:31, 45, 47, 134-138, 153). Finally, both steamers had to carry vast quantities of coal to run their engines. Initially, each vessel carried 260 tons, but when their supply-ship left them in Greenland, each ship was packed tight with 300 tons of coal (Osborn 1852b:34-35). Osborn comments on the "coal-dust every where and on every thing" (Osborn 1852b:24). All of the ships were packed with as many provisions and supplies as possible, so much so that, when the departing Americans offered them more supplies, Osborn declined on the grounds that there was no more room (Osborn 1852b:106).

Of the provisions carried, the most notable for the nautical archaeologist is the "ice-anchor," illustrated and described by Osborn (1852b:39-40). The ice anchor was a relatively small hook, able to be lifted by one man in a boat. The anchor was deployed by the man cutting a hole in a convenient and stable iceberg, and setting the anchor in place (Osborn 1852b:40). In the island-choked regions of the Canadian Arctic, icebergs often ran aground, and thus were the closest, most stable surface for anchoring (Osborn 1852b:39). A standard anchor would easily be lost in the grinding, scraping pack ice, as well as presenting a hazard on the bow of the ship. Ice floes could move ships suddenly and violently, and a static cable could tear a ship apart. The comparatively flimsy ice anchor would fail or become detached first, allowing the ship to escape unscathed.

Into the Ice

Although Osborn mostly just referenced common sailing maneuvers by name, without elaborating on the process, he did detail ice maneuvers, designed to orient and steer the ship in the constantly-shifting ice pack.

"Tracking," "hauling," or heaving a ship was used when no favorable breeze was present (Osborn 1852b:54). Generally, it involved pulling the ship through the water or ice using manual force. If the ship was near a stable ice floe, men would pull on lines attached to the ship, in an arrangement similar to moving canal-boats in England, although without the horses. Thirty-five to 40 men would put strap on "track belts," which were attached to whale lines (ropes) connecting to the ship (Osborn 1852b:54). Another option was to kedge by setting their "ice-anchors," running their lines through the hawse holes, and pulling the ship along with the capstan. Men would be dispatched to move the anchors as needed (Osborn 1852b:195). Finally, if no convenient floe was nearby, boats could tow the ship (Osborn 1852b:54).

Steamships could move without the aid of wind, and so their crews were spared much of this labor. The engines allowed propulsion control so fine that steamships could keep place in a current by moving in figure eight motions (Osborn 1852b:101). If the captain did not have enough space to turn the vessel, "making a cannon" essentially involved driving the ship at the opposite side of the channel on an angle (Osborn 1852b:55-56). This motion, like in miniature golf, would force the ship to turn quickly.

Finally, to break through ice, the steamships relied on quick blows with the bow, aided by their screw propellers (Osborn 1852b:195). The ship would lunge forward under steam, striking the ice at a weak point or in an opening lead in the pack. Then, the ship would be hauled back by men on the side, the loose ice cleared away, and the process repeated. In the Austin expedition, with two steamships, the ships switched back and forth to allow time for ice to be cleared away from the precious propeller (Osborn 1852b:195).

Winter is Coming

In order to prepare for the harsh winter, the ship had to be battened down tightly to prevent heat loss, while still allowing daily activities to take place. Osborn's narrative does not record the start of winter adaptations to the ship, possibly due to a brief warm spell mentioned for the week of 14 September (Osborn 1852b:109). At any rate, by 2 October, preparations for wintering were well underway (Osborn 1852b:110). Due to the reference during this period to fights in the messes over smoke and heat levels, wintering started in late September (Osborn 1852b:110). The wintering process ended with Captain Penny's return to his own ship; it lasted until some point after 17 October, and before 8 November (Osborn 1852b:117-119). Therefore, wintering a vessel took roughly one month.

In wintering, all excess lumber and other provisions were removed from the upper deck and the boats were taken off and attached to the ice around the ship in case of emergency (Osborn 1852b:118). A sturdy felt, set 15 feet (4.6 m) above the upper deck formed an enclosed exercise space, with holes cut for smoke and air ventilation (Osborn 1852b:118, 130). The housing had to be sturdy enough to withstand the up to 400 tons of snow deposited in a single storm (Osborn 1852b:130-131). This was accomplished by bracing the inside with spars and spare timbers. The heating pipes and stove were started, and toilets were cut so the men did not get sick (Osborn 1852b:118).

One of the real concerns of Arctic travel was the long winter, in which the sun left the world on November 8 and did not return until February 7 (Osborn 1852b:119, 140). Osborn's strategy for keeping morale up involved daily routine, as well as boredom-averting activities. These activities included: a theatre, casino, saloon, two newspapers (one illustrated), evening classes, and lectures (Osborn 1852b:121). For the nautical archaeologist, this would produce artifacts that do not seem connected with the ordinary routine on a working ship.

Social Conditions

Finally, archaeological and historical reconstructions of ships must always include consideration of the lives of those who lived onboard. This will include an analysis of the supplies and provisions carried on board; luckily, official and personal accounts of these voyages provide much detail (Belcher 1855; Eyre and H.M.S.O. 1852; M'Dougall 1857a; Osborn 1852b; Osborne and McDougall 1852). A spatial analysis of the living and working areas will be considered, including considerations of social status and rank on board.

The Silent Background of Daily Life

The *Illustrated Arctic News* articles cover short fictional stories, accounts of search or sledge excursions, and descriptions of notable events like balls, plays, or pantomimes. Rarely, however, is daily life mentioned in the newspaper. A simple explanation may be found in the purpose of the *IAN*: "to relieve the monotony of sunless days-to show to all, that fun & good fellowship" could be found in the harsh Arctic winter (Osborne and McDougall 1852:1). The stories focused on special events, but glimpses of work routines, daily rations, and other sundry events can be seen in them.

In addition, information can be gleaned from McDougall's images, which offer a contemporary look at scenes of Arctic life. This is in direct opposition to previous British depictions of the Arctic, which relied on stock "scenes" that were usually stereotypical (David 2000:82-84). Some of these "stock scenes" were repeated in the *IAN*: thus one sees the images of "Esquimaux canoes," desolate scenery, and nature's danger, which were also common in British depictions of the Arctic for the public (Osborne and McDougall 1852:2, 7, 35). However, many more of the images feature daily occurrences in a sailor's life, including writing by candlelight with a glass of something nice at hand, being woken up for midnight watch, and hauling ice for fresh water (Osborne and McDougall 1852:1, 5. 33). In addition, scenes show common tools and clothing choices by sailors (Osborne and McDougall 1852:8, 19, 21, 33, 54).

Other aspects of daily life are not as visible in the historical record, although Admiralty records and plans drafted by the commanders of Arctic expeditions give detailed accounts of supplies and provisions. Instead, this analysis will concentrate on themes reflected in the *IAN* and their impact on Arctic seafaring life, starting with boredom and touching on issues of language, status, authority, fear, conflict, race, gender, nostalgia, and community. Sources of information primarily spring from the pages of the *IAN* itself, although insights will be compared to contemporary accounts of the voyage and wider British culture as well.

Boredom

Boredom was a constant presence in overwintering in the Arctic: landscapes were harsh and monotonous. The disappearance of the sun for three months out of the year, and frequent inclement weather increased this pressure: travel and other forms of activity were inhibited (Osborne and McDougall 1852:55). Days were circumscribed by routine maintenance of the ships, which varied little. Events like the plays put on in the Royal Arctic Theatre, fancy dress balls, Evenings at Home, and other entertainment mentioned served to relieve the boredom. Officers and crew alike were encouraged to participate in all these events, as well as running the newspapers and schoolroom (Osborn 1852b:121).

Nevertheless, by the end of the winter, even these amusements were growing stale. Advertisements for the plays in the *IAN* take a new tone, emphasizing the "newness" of the scripts, actors, and scenery (Osborne and McDougall 1852:53). Novelty was the order of the day to stave off boredom.

Language and Slang

Sailors' language has traditionally been a category of speech and writing all to itself, with references to various workings of the ship and the seaman's life peppered throughout. For this publication, care seems to have been taken to ensure the reading public could understand some of the more obscure sailor's slang, with notes added to explain various terms, such as the "seven-beller" (Osborne and McDougall 1852:38). In addition, the owner of this copy of the facsimile (Admiral Sir Richard Vesey Hamilton) scrawled handwritten notes in pencil in the margins (Osborne and McDougall 1852:frontispiece). As this was a personal copy, he held nothing back in his own language, adding obscenities when particularly moved (Osborne and McDougall 1852:17). As mentioned earlier, the censorship process at sea and in Britain meant foul language (likely originally present) was excised from the manuscript. However, instances of slang still abound, showing the priorities of the sailors.

First, many slang terms seen in the *IAN* referred to alcohols of varying types and qualities. "Old Tom" was served, along with rum, at the Grand Bal Masqué on HMS

Resolute in December (Osborne and McDougall 1852:23). "Old Tom" referred to a sweet, old-fashioned style of gin popular at the time. Other alcohol served was the "blue ruin" of gin and "the intoxicating draught called eight-penny" (Osborne and McDougall 1852:26). Clearly, alcohol was an important aspect of seafaring life reflected in the language.

While terms like these likely proliferated in sailing society, other slang terms seen in the IAN appear to be specific to polar travel and the voyage. For example, "Old Zero" or "Emperor Zero" appears frequently as a trickster and adversary figure to be respected and avoided in the Arctic (Osborne and McDougall 1852:12, 21, 31, 42, 53). In his words and actions, Zero was eager to get into the ship and cause havoc to the men. He is depicted ruling over his icy domain in long white robe, golden crown, flowing white beard and hair, standing next to a large thermometer (Osborne and McDougall 1852:55). "Zero" serves as a counterpart to "Old Father Neptune" of the open sea: representing the forces of nature which must be respected by the ship and its crew. By the end of the winter, his character was personified and mocked by the crew in a pantomime performance, which was so popular among the squadron that it featured a repeat performance (Osborne and McDougall 1852:31, 53).

Slang terms were also used to indicate social status, such as the "seven-bellers;" men who were engaged but unmarried (Osborne and McDougall 1852:19, 38-39). They were depicted as socially distinct from their unmarried colleagues, bonded together by longing and sweet words for their loves back home. Engagement represents a period of liminality between the unmarried and married state, and this contributed to the formation of a special term for these men who unable to engage fully with either bachelors or married men.

The term "seven-bellers" itself indicates some of the anxiety inherent in their condition: based on the bell system (bells rung every half-hour, from one to eight times, in order to mark changes in the watch), the call of seven bells was situated directly before eight bells, at 3:30, 7:30, or 11:30 AM or PM. Traditional watch schedules in the Royal Navy placed seven bells right before the changing of the watch (Volo and Volo

2002:98-99). Any man standing his watch at seven bells would be anxious to get off duty, eagerly awaiting eight bells, just as these men eagerly awaited the return voyage so they could marry. The "seven-bellers" were also seen as indecisive because they were not able to commit and marry before a long, hazardous voyage: they "want-Oh! they don't know what!" (Osborne and McDougall 1852:19).

Finally, language denoted class status. Although the newspapers were all edited by officers, both crew and officers could contribute articles, lending a variety of voices and tones to the content. One such variation is the "wentilation" letter, responding to a call in the previous number to submit articles about the best way to ventilate the ships (Osborne and McDougall 1852:57). This ventilation process utilized the Sylvester warming apparatus, as discussed in Chapter VII of this thesis. This letter suggested that results from the Sylvester varied, and opinions about the best way to ventilate were a common source of friction between men. "Joe Muggins," the author, writes using deliberate misspellings and speech patterns to support his claim to be a common crewmember. "Joe" complains about the officers constantly opening the valves to let cold air and "that black-guard Mr. Zero" into the officers' mess. Figuring out the identity of the actual author is impossible given the use of pseudonyms, but I think it likely that the piece was penned by a junior officer or midshipman, with no authority within the gunroom to change his situation, but needing an outlet to vent frustrations. This conclusion is drawn from "Joe's" knowledge of the gunroom situation, as well as the heavy use of lower-deck slang and speech patterns: no other article in the *IAN* uses this form of language, thus it was likely employed on purpose as a disguise.

Status: Officers, Marines, and Crew

Beyond language, status differences between the officers, marines, and crew were maintained on board through segregation of the classes while preparing for events, in food options, and in socializing. While all these examples pertain to special occasions (fancy dinners, plays, and the like), the social separation reflected here likely occurred during daily tasks and chores as well.

Actors for theatrical productions were divided into the crew (who primarily produced farces and pantomimes) and officers (producing more serious plays as the winter progressed) (Osborne and McDougall 1852:10, 31, 53). This division likely continued backstage, with costumes, props, and backdrops produced separately as well.

Divisions by class were also seen in the large dinners (most notably, around Christmas): officers were invited to the gunroom table and treated with gin and gingerbread brought special from Britain, or to the *Resolute* captain's table for a 22-dish dinner and toasts (Osborne and McDougall 1852:29-30). Crewmembers ate in their messes, which were gaily decorated, on "Fresh Beef, Plum-puddings, Cakes, &c, &c." (Osborne and McDougall 1852:30). At Christmas, the marines and sailors "fraternized on this occasion," indicating that normally they formed separate social and occupational groups.

Finally, class divisions were determined by schedule: officers ate Christmas dinner later than the crew, at 3:30PM, continuing on into the night with toasts and music provided by the crew band (Osborne and McDougall 1852:30). This division in schedule was also seen at the Grand Ball: crewmembers were expected to vacate after 10:30 PM, but officers from the squadron were invited to linger and drink toasts (Osborne and McDougall 1852:54). All of these divisions were considered essential to maintaining discipline in the Arctic. These men were living shoulder-to-shoulder: maintaining authority required a certain distance between officer and crew, and between seaman and marine.

Poking Fun: Authority and Satire

Authors in the *IAN* used the medium of satire, however, to critique officers and other authority figures. As stated earlier, pieces like this that crossed lines into disrespect or potential mutiny would never appear in these pages, but likely existed on board.

The "Officer of my Watch" is lampooned as a lazy drunkard, taking advantage of the green new sailor to shirk his duties, including standing watch and recording events in his logbook (Osborne and McDougall 1852:1-2, 15). This satire comes from a fictional series of three letters sent from home by a young, inexperienced officer; his social status is inferred from the amounts of money spent (£36 on cigars) and mentions of socializing with the commodore (Osborne and McDougall 1852:1-2). Although not targeting any specific officer on the expedition, it does reflect common critiques of superior officers of the time: lazy and irresponsible. It may also be read as a critique by a superior of the fictional "correspondent" as inexperienced and naïve, not willing and able to learn.

Critique more specific to authority on this squadron's voyage may be seen in the "wentilation" letter (Osborne and McDougall 1852:57). In it, the crew is universally critical of the usefulness of the ventilation system, while the officers are comically committed to discovering just the right air flow to keep the Sylvester working properly.

Finally, even the distinguished editors were not immune to using satire as a means to critique: they point out meeting a "brother Officer" practicing his clown routine in a ravine three miles from the ships (Osborne and McDougall 1852:41). In this instance, the satire is used to discipline (through humiliation) an officer more committed to playing the fool than leading with dignity.

One of the most difficult problems faced by the men on board these Arctic vessels, as was true on all ships of the time, was maintaining control, through either authority or discipline. Crewmembers far outnumbered officers, and contemporary accounts show that dissent, resentment, and even mutiny were far from uncommon on board many ships. In the Arctic vessels, as on most ships, life was isolated and crowded, work was difficult, and survival depended on maintaining a sense of order and community. In the Arctic, these factors were compounded by the dark, frigid environment, with no sunlight during much of the winter and only rare opportunities to send messages home. Officers and crew alike shared the harsh conditions, including cold and hunger (Osborn 1852b:66; Winton 1977:87). Authority was maintained during sailing, wintering, and sledging expeditions through interlocking systems of communication, common goals, and morale-boosting amusements.

Communication

To insure that all officers among the squadron were following orders and carrying out tasks as assigned, Captain Austin employed several methods: official orders, formal meetings, and dinners.

Official orders consisted of short letters detailing a course of action, such as one example from Captain Austin to Lieutenant Osborn from 6 September 1851 (Anonymous 1839-1875). In this missive, Osborn is instructed to take HMS *Pioneer* away from the rest of the squadron (including HMS *Resolute* and HMS *Assistance*) to search for HMS *Intrepid*, which had not returned from her search for clear sea-lanes among the ice. Osborn was also instructed to take on provisions and supplies sufficient for 18 months "in order that they may be prepared to meet an unexpected detention" (Anonymous 1839-1875:Letter 6 September 1851).

In other words, this letter highlighted one of the problems with this form of communication: since conditions could and often did change rapidly in the Arctic (shifting winds, pack ice, etc.), official orders had to be drafted to cover every eventuality. Thus, Austin outlines the course of action to be taken if HMS *Intrepid* had found clear water, where and when to rendezvous if no trace was found, or contingencies to return to England if the two steamers became separated from the ships. Still, even these strict orders recognized unforeseen circumstances and trusted the officer's judgment, covered with the phrase "Having full reliance in your prudence intelligence and good management I do not deem it necessary to enter into further particulars" (Anonymous 1839-1875: Letter 6 September 1851).

Another facet of seafaring life revealed in these orders was the chain of command in a squadron consisting of multiple vessels (of varying sizes and types: steam and sail both), with multiple levels of command. Austin, as the captain of HMS *Resolute*, had command both over his vessel and over the senior officers in the rest of the squadron. As recorded in both this letter and his service record, Osborn was commissioned as a lieutenant on HMS *Resolute*, serving in charge of HMS Tender *Pioneer* (Anonymous 1839-1875:Service Record, Letter 6 September 1851). This also highlights the liminal position of steam ships in the Royal Navy of the time, as these "tenders" functioned as assistants to the real ships in the fleet: those that sailed. This subordinate position of the vessels was reflected in the social position of the men operating the steam machinery (stokers and engineers), who occupied the lowest rung of naval hierarchy, despite receiving higher pay (Chamberlain and Morris 2013:52).

Official orders were also important in maintaining authority over the crew; an incident highlighted in Osborn's *Arctic Leaves* illustrated this in an anecdote of HMS *Pioneer* being squeezed by the ice: "The men who, whaler-fashion, had, without orders I afterwards learnt, brought their clothes on deck, ready to save their little property, stood in knots, waiting for directions from the officers" (Osborn 1852b:64). Waiting for orders was a crucial skill to hone in the crew for officers, as without this the men could easily abandon ship onto the ice. For the ship and the expedition, this would be disastrous, as the effort of all was needed to run the vessel.

The other avenues by which instructions were given to officers were meetings and signal flags. An example of an official meeting included one mentioned by the author of the HMS *Resolute* journal: "at 8.45 the siglnal [sic] was made for all the commanders to assemble on bord [sic] of the resolute" (Unknown 1850-1851:21 May). Signal flags were used to give instant messages to the rest of the ships of the squadron, such as orders for the steamers to take ships in tow, or to rendezvous with the other vessels (Osborn 1852b:206; Unknown 1850-1851:10 June).

Common Goals

Besides ensuring that officers and men received instructions in duties and tasks to be carried out during the voyage, authority in the Arctic depended on ensuring that officers and crew were united by common goals. On the Austin expedition, this was the goal to push westward along Franklin's route (based on his orders from the Admiralty, and weather conditions encountered), in order to find or rescue the ships and the men aboard (Osborn 1852b:147). Officers reminded themselves of this goal with frequent toasts after dinner (Osborne and McDougall 1852:30). Among officers, who were generally career Navy men, they had the added incentive of likely knowing friends and comrades on the missing Franklin expedition (Osborn 1852b:13).

In order to bolster these feelings among the crew, who did not have the same social connections to the missing Franklin expedition, officers would work side-by-side with their men "in laborious duties" both on and off the ship (Osborn 1852b:66, 114). This sort of 'fellow-feeling' was also encouraged among the ships' crews, with ships cheering each other on during and after a bout of hard work, such as coaling (Unknown 1850-1851:23 June, 17 August). In addition, the off-duty watch from a ship would frequently assist other vessels in the squadron with various duties, such as coaling, hauling through the ice, and cutting docks (Unknown 1850-1851:3 July, 7 July, 2 August).

However, to maintain authority during the long, difficult Arctic winters, several methods were employed to remind the crew of the noble cause for which they were suffering. First, daily and weekly routines allowed officers to address their men as one body, especially during "Devine servis" (Unknown 1850-1851:26 May, 7 July, 13 July, 27 October, 3 November).

Other opportunities to remind crew of the expedition's goals were found in the publications and other amusements produced by the crew (and supervised by officers). For example, lyrics published in the *IAN* extolled the men to carry on in the strenuous task of sledge pulling by reminding them "When friends need our help, we'll dare it the more" (Osborne and McDougall 1852:57). The *IAN* also served as a way to distribute the fleet's latest knowledge of Franklin's fate, based on search expeditions and communications with the other vessels wintering in the Arctic the same year (Osborne and McDougall 1852:35). Although acknowledging the discouraging nature of the finds (including graves), the account emphasizes the unknown fate of Franklin and the possibility of rescue from their current mission. Thus, hope, patriotism, and enthusiasm for work were encouraged. Finally, this leads into the constant issue facing all these Arctic search expeditions: keeping morale high and boredom at bay (Winton 1977:99).

Amusements

It was a great fear in nineteenth-century ships that ‘idle hands make the Devil’s work;’ this was an especially pressing concern in the Arctic, when the long winter months forced crews indoors, with minimal light, for much of the time (Winton 1977:93, 99). One method of combating this was to assign more duties. In addition to the imposed routines and daily tasks of cleaning lower decks and personal effects (Osborn 1852b:118; Unknown 1850-1851:8-9 November), officers would give out busy-work, such as producing oakum from worn-out rope, to the crew (Unknown 1850-1851:11 December).

At the same time, in order to keep up morale, amusements, including presents, liberty visits, newspapers, plays, masked balls, and evening school, were organized by officers to keep the crew amused. The crew enjoyed these entertainments, and eagerly entered into “voluntary occupation” onboard (Osborn 1852b:119). These forms of entertainment are to be contrasted with those spontaneous activities generated by the crew themselves, such as games of rounders or quoits, dancing, or building snow sculptures (Osborn 1852b:66, 118-119; Unknown 1850-1851:1, 3 January). These activities were for “ther own Amusment [sic],” although tacitly sanctioned by those in authority giving the men leave to carry out these games (Unknown 1850-1851:1 January). Sometimes these activities did not have officer approval, as was the case with traps set for foxes around HMS *Pioneer* and HMS *Resolute* (Osborn 1852b:138; Unknown 1850-1851:29 December, 4 January).

Officers and crewmembers put on separate plays in theatrical productions (Osborne and McDougall 1852:10, 31, 53). The crew produced farces and pantomimes, while the officers put on more dramatic or serious fare. Captain Austin, as the squadron leader, arrived at the first production of the Royal Arctic Theatre seated in a sledge pulled by eight men, assisted by two “lively servents,” and lit up with Bluelight flares (Unknown 1850-1851:9 November).

The crew of Austin’s Arctic expedition had “presents ishude out” including comforters, mittens, and meerschaum pipes, as well as the traditional rations of grog and hot chocolate (Osborn 1852b:116-117; Unknown 1850-1851:19 June, 6 September). Sailors protested if their "traditional" allowances were not respected. On special occasions, like Christmas, the men received a special dinner of fresh beef, plum-pudding, and cakes (Osborne and McDougall 1852:30). Officers received similar rations, with gifts of gin and gingerbread carried from home at Christmas (Osborne and McDougall 1852:29). After months on rations of boiled pork, biscuit, tea, and lime-juice, this variety would feel like luxury (Osborn 1852b:153). In addition, these traditional English foods for the holidays would invoke nostalgia in the crew, who were "keeping up Cristmas as mery as possable" (Unknown 1850-1851:25 December).

Maintaining Authority

Throughout all of these daily amusements and special events, authority was rigidly maintained. One example was in visits of crew and officers between ships, such as whalers and other expeditions, like that of Captain William Penny, or liberty to walk about on the ice as exercise (Unknown 1850-1851:7 July, 26 September, 17 October). These liberty walks were circumscribed: if conditions on the ice changed, libertymen were recalled to assist in shipboard activities (Unknown 1850-1851:7 July). Walking around off the ship was also constrained to the ice, with specific permission needed for any crewmember or officer to travel to land (Unknown 1850-1851:13 October). For example, two men walking landward "alone" (without an officer present) were recalled via gun and had their grog ration withheld. Austin likely feared desertion, even in that desolate environment.

In addition, this liberty to walk around as exercise reflected the increasing Victorian knowledge that confinement onboard ship was not healthy (Winton 1977:90-91). The often humid and stuffy environment below-decks was being recognized as a source of disease and general ill health, and the new Sylvester's Heating Apparatus installed in HMS *Pioneer* was one solution (Lyon and Winfield 2004:232).

Authority in the Arctic was also reinforced through the two newspapers published in the squadron: the *Illustrated Arctic News* and *The Aurora Borealis*, the former an illustrated journal featuring news and satirical articles, the latter a literary review journal (Osborne and McDougall 1852:5). However, as has been shown, the *IAN* used its articles to promote a healthy comradery among the crew, and to reinforce existing structures and models of authority. For example, one account tells of the editors coming across their "brother Officer" three miles (4.8 km) away from the ship among the ice, practicing his clown routine for an upcoming production (Osborne and McDougall 1852:41). Their mocking tone is used to chastise the officer (unnamed, but onboard a ship with relatively small numbers of people, it would not have been difficult to identify the man in question) for being committed to playing the fool. In short, officers were supposed to lead with "precept and example" (Osborn 1852b:66).

The unfortunate officer referred to above was practicing for one of the numerous plays and fancy dress/masked balls held within Austin's squadron. On the surface, these occasions allowed for a relaxing of the hierarchy, with officers and men alike dressing up and acting a different part (Osborne and McDougall 1852:25). However, authority was still rigidly maintained: during the two balls produced on board the HMS *Resolute*, the officers were allowed to stay later than crewmembers, who were required to return to their ships and resume duties at 10 PM (Osborne and McDougall 1852:25, 54; Unknown 1850-1851:5 December).

Finally, authority was maintained through the use of the Arctic "evening school," where crewmembers could learn or improve their reading and writing (Osborn 1852b:122). During this period in nineteenth-century Britain, increasing support for social reforms combined with evangelical philanthropy in increasing concerns about education (McCord et al. 2007:261). As their social superiors, officers were expected to set and enforce that good example (Osborn 1852b:66). Thus, the school onboard Austin's fleet was seen as a chance for those in authority to sculpt the morals and values of the crew, often discussed in patronizing and condescending terms. For example, a struggling sailor might have "an occasional burst of petulance," while his fellows listened to an officer's tales of Parry's exploits with "attentive, upturned faces…like children to some nursery-tale" (Osborn 1852b:122).

As for how much rhetoric and knowledge the crew imbibed while attending school, the author of the *Resolute* journal appears to have attended regularly starting on 22 November (Unknown 1850-1851:22 November). The classes, starting at 6 PM on weeknights, did not affect the author's handwriting, which was fair. However, it is interesting to note temporary spelling errors seen shortly after school began (misspelling usual as "usuil") until corrected again (Unknown 1850-1851:26-27 November). No other significant changes can be seen, although the author's account may have been rewritten after beginning school attendance. Unfortunately, this will remain an unknown.

Fear: *Tuto et sine metu*

Underlying currents of fear are seen throughout the *IAN* articles, ranging from fear of physical harm from nature, like bear attacks or frostbite to more psychological, like fear of being forgotten and abandoned by family, or losing a sweetheart to another man (Osborne and McDougall 1852:6, 21, 39, 57). Fears among officers, often left unspoken but visible between the lines of text, revolved around madness and rebellion amongst the crew (Coppinger 2011:121).

The *IAN* attempted to stave off these fears by reassuring readers that "our Chair will be there, and our name will not be forgotten" (Osborne and McDougall 1852:21). Other tactics included distraction, while satires like the Correspondent's Letter to his "Much loved Penelope" allowed a safe outlet for sailors to express those fears (Osborne and McDougall 1852:38). In order to quell worries about mutiny and insanity, officers enforced busy-work and maintaining the veneer of authority with their subordinates, as discussed previously.

Conflict and Hidden Tensions

Living in confined areas, with little variation in routine, constant contact with the same personalities, and no chance for privacy must have led to conflicts among the squadron. For example, even walking three miles away and hiding in a ravine was no guarantee of privacy (Osborne and McDougall 1852:41). However, in their mission to uplift spirits and prove that happiness could exist in the Arctic Circle, the editors did not publish pieces directly confronting conflicts and other tensions.

However, reading between the lines allows the researcher to discern various micro-aggressions occurring in a sailor's daily life. Among the ships, the competing newspapers and social events put on by officers show conflict. The *IAN* editors criticize their shipmates for not participating in civic pursuits by lamenting the lack of stories submitted to the Editor's Box (Osborne and McDougall 1852:21). At the same time, power conflicts among the crew about who was published, and why, led the editors to issue a statement calling for their shipmates to "concede to us the right of rejecting without comment, any Publications adjudged to be ill adapted for the Columns of our Periodical" (Osborne and McDougall 1852:11). This simmering conflict between crewmembers was also deflected by the call for pseudonyms, to avoid cries of favoritism.

Officers among the four ships of the squadron also experienced tension in their social circles, most notably over dinner invitations and attendance at events. This caused the officers of HMS *Pioneer* (of whom Sherard Osborn was the leader) to cry "[we], (who by the bye are always At Home) also gave an entertainment the same evening" (Osborne and McDougall 1852:29). The At Home, a regular event hosted by Capt. Austin of HMS *Resolute*, was cited by *Pioneer*'s officers as an example of their unflagging "team spirit" and willingness to work with their colleagues on board the other vessels after they were criticized for hosting their own separate event.

Racism in Black and White

Racism was clearly ingrained in depictions of the Other in the *IAN*. From the Chinese man portrayed in stocks to the avaricious messmate "of the Jewish Persuasion," minority groups were not depicted favorably, highlighting the casual racism of the 19th century sailor (Osborne and McDougall 1852:6, 16). The races of crewmen on board the squadron's four ships are not known by the researcher, however, an "Esquimaux" man, Erasmus York, did accompany the squadron (Osborne and McDougall 1852:19). Like earlier depiction of the natives inhabiting the Arctic regions, York is characterized as childlike, unable to distinguish fantasy (a play) from reality (David 2000:134; Osborne and McDougall 1852:19). The depiction of York also reflects at the same time the Victorian fear of the Other's 'savage' sexuality, fearing uncontrolled sexual appetitites would lead to a moral decline in the nation: as York searches through casks trying to find "the lovely English Koonah" (Osborne and McDougall 1852:19). Among sailors in the Arctic, those fears generally took the form of either fearing outbreaks of "sodomy" among lonely crewmembers, or crewmen going "native" after contact with indigenous women.

Female Roles: Sweethearts and Actors

At the same time, the British sailors were contending with lack of female companionship in the Arctic. Coping mechanisms for plays with female roles were found by having men cross-dressing as women, such as "fair Lydia Whiffles" and Eudiga and Ulrica (Osborne and McDougall 1852:19, 56). "Lydia," whose stage appearance took place after an intermission of poetry and drop scenes, was performed by an unnamed crew member. In contrast, the roles of Eudiga and Ulrica were taken by officers, Mr. McDougall and Mr. Pearse. Unnamed crew also dressed as women for the fancy dress balls hosted, where female roles for dancing were required (Osborne and McDougall 1852:23). The owner of the manuscript, Admiral Hamilton, dressed for the Grand Bal Masqué as a woman in a red, flounced dress. These "ladies" would be in much demand as dancing partners, although men also danced together (Osborne and McDougall 1852:26).

At the time, Hamilton was 21 years old; as a younger man, this might have been seen as his duty to improve morale by playing a necessary part. As his later rank attests, this also appears to have had no effect on his career. Unfortunately, lack of data and descriptions from these men mean no more conclusions can be drawn.

However, in ordinary life, sailors still mourned the absence of sweethearts and wives, wishing that they could lay "her gentle hand in thine" (Osborne and McDougall 1852:33). Nostalgia for the ideal home life featured heavily in these expressed longings for family, leading to the next theme.

Nostalgia: Home and the Holidays

Nostalgia and longing for "the sweet Village Church," "family Table," or "the amusement of the domestic Circle" permeates satirical accounts, descriptions of holiday events, and almost every aspect of life depicted in the *IAN* (Osborne and McDougall 1852:9). The scenes of a sailor's domestic life were given a rosy-tinted gloss in all of these accounts, as petty conflicts at home were forgotten in the miserable present. In addition, since professional sailors, constantly at sea, would have had limited experience with family life, these "nostalgic" reminisces may have been more similar to fantasy and ideals than reality.

Such longing nostalgia was one option for coping: other sailors doubtless turned to drink: "we became thirsty souls and drank deeply of the intoxicating draught called eight-penny" (Osborne and McDougall 1852:26). Even today, drinking remains problematic on isolated polar stations (Hale 2015).

Nostalgia was connected to these sailor's reality by assiduously recreating (however possible) continuity with British traditions, including celebrations of Christmas and HRH Prince Albert's birthday, singing of patriotic tunes, and consumption of treats brought from England (Osborne and McDougall 1852:10, 29). Captain Austin, the leader of the squadron, attempted to recreate familiar domestic scenes with "Evenings at Home," filled with familiar songs (Osborne and McDougall 1852:18).

Community: Common Goals

Events such as the Evening at Home also served another purpose: strengthening the community. Faced with constant daily reminders of the harsh environment, these sailors exerted social pressure on each other to conform to common goals and pull together, a sentiment eloquently expressed in the metaphor of sledging, a backbreaking task (Osborne and McDougall 1852:44). As expressed early in the winter: "we depend entirely on each other…it behoves [sic] us all to contribute what we can to the common weal" (Osborne and McDougall 1852:9).

In addition, the crew and officers continued to remind each other of the purpose for their suffering: to find Franklin and his men (Osborne and McDougall 1852:30, 35-36). This zeal to find Franklin was also exerted by drawing parallels between Franklin and their expedition: it was easy to imagine their own squadron vanishing without a trace in the blowing snow.

Historical treatises were also used to reinforce community goals, as in Osborne's fable of an 18th-century expedition searching for another group of lost comrades (Osborne and McDougall 1852:45-46). In the tale, the searchers are so engrossed by their own quest for glory and discovery that they passed near their lost comrades, abandoning them to death. The moral of the tale was clear: remember why we are here and stay true, as you'd want your shipmates to search for you.

CHAPTER IX
CONCLUSIONS AND FUTURE RESEARCH

This research has discussed HMS *Pioneer*'s voyages, captained by Lieutenant Sherard Osborn under Captain Horatio Austin and Edward Belcher, respectively, on the two Arctic expeditions of its short Royal Navy career. By situating the auxiliary steam topsail schooner in the historical context of the British push for Arctic exploration and concern over Sir John Franklin's missing expedition, the choices and turmoil of her officers and crew can be examined in the light of changing technology.

HMS *Pioneer*'s significance rests on its unique place in this cultural and technological shift. On the one hand, Arctic voyages were a long-standing tradition of the island nation, with a history of exploration stretching back to the sixteenth century. However, contemporary shifts in the way ships were propelled, with the advent of increasingly reliable and efficient oscillating steam engines and the durable, damage-resistant screw propeller allowed the use of innovative technologies to venture into the frozen north.

Although contemporary opinion was divided on the usefulness of steam in the Arctic, partially based on the failures of earlier steam power such as Ross' voyage in HMS *Victory* and Franklin's missing HMS *Erebus* and HMS *Terror*, a new generation of naval officers was rising. Lieutenant Sherard Osborn, only 27 years old at the time of the Austin expedition, was an ambitious young naval officer eager to show the utility of Arctic steam. Indeed, these hopes were justified with the successful use of HMS *Pioneer* and HMS *Intrepid*, serving as towing consorts for their lumbering sailing companions in uncertain Arctic breezes. Steam vessels had the advantage of being able to travel in whichever direction was open, even backwards, without relying on uncertain winds. Steam-power also allowed more focus on ramming and otherwise forcing ice lanes open, something that sails simply could not accomplish effectively. This shift was visible throughout the Navy: by the Crimean War in 1854, steam vessels were indispensable, and the reliance upon engine power continues to the present day.

Thus, HMS *Pioneer* serves as a valuable case-study on this formative period in nautical archaeology and maritime history, when innovative new technologies met a conservative institution. This process was thus examined in four main areas: sails and rigging, propeller and engine, heating and coal, and daily life. Based on contemporary accounts including official reports and art, popular books, illustrated newspapers, and personal journals, supplemented by comparative analyses of similar archaeological material, a full view of the structure and daily life on board HMS *Pioneer* was reconstructed.

However, even with the long-held interest the Arctic has held for academics, there are still significant areas of research. One question raised by this research has been the uncertainty of data. Even historical ships, with their wealth of information recorded by contemporaries, are uncertain territory for the nautical archaeologist attempting to map technological changes, as has been shown. Further research, therefore, is always enhanced by comparison and contrast with quantifiable data from archaeological sources. Although archaeological data has its own taphonomic biases, it, along with other avenues of comparative research, such as textual analyses, can provide a valuable counterbalance (Driver p. 626).

Aiding in this need for comparative archaeological research, changing global climate conditions are rendering the areas where these ships were lost open to direct investigation and the potential for new discoveries in previously inaccessible areas. The most recent and prominent example, of course, was the discovery of HMS *Erebus* by Parks Canada in 2014 (Parks Canada 2016; Patel 2015). Previously, popular thought had assumed these vessels were ruined by shifting winter and summer ice-thaw cycles and other taphonomic forces; the discovery of the nearly complete hull opens the way to more intense research in the area. Questions raised in this thesis, such as adaptations or repairs made *en route* to HMS *Pioneer*'s oscillating engine, may finally receive answers.

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APPENDIX A: TABLES

Table 1. Mast Dimensions

In feet								
Masts	Hounded	Headed	Housed	Rake (degrees)	Large Diameter	Heel Diameter	Hound Diameter	Head Diameter
Fore	47	9.2	13.2	99.46	1.25	1.04	0.84	0.73
Main	55.9	9.6	13.2	100.62	1.44	1.21	0.98	0.84
Mizzen	46	6.8	12.4	101.77	1.18	0.98	0.8	0.68
Topmasts	To Stops	Topgallant pole	Sky-sail pole	Large Diameter				
Fore topmast	26.8	12.8	5.4	0.64				
Main topmast	34.8	6.8		0.81				
Mizzen topmast	25.2	4.8		0.58				
In Meters								
Masts	Hounded	Headed	Housed	Rake (degrees)	Large Diameter	Heel Diameter	Hound Diameter	Head Diameter
Fore	14.3256	2.80416	4.02336	30.3154	0.381	0.31699	0.25603	0.2225
Main	17.0383	2.92608	4.02336	30.669	0.43891	0.36881	0.2987	0.25603
Mizzen	14.0208	2.07264	3.77952	31.0195	0.35966	0.2987	0.24384	0.20726
Topmasts	To Stops	Topgallant pole	Sky-sail pole	Large Diameter				
Fore topmast	8.16864	3.90144	1.64592	0.19507				

Table 1 Continued

In Meters								
Masts	Hounded	Headed	Housed	Rake (degrees)	Large Diameter	Heel Diameter	Hound Diameter	Head Diameter
Main topmast	10.607	2.07264	0	0.24689				
Mizzen topmast	7.68096	1.46304	0	0.17678				

Table 2. Mast-Framing Dimensions

In Feet				
Lower Mast Cap	Length	Breadth	Depth	
Fore	2.48	1.91	0.38	
Main	3.08	2.44	0.49	
Mizzen	2.28	1.61	0.35	
	Space between lower mast and topmast at cap			
Fore	0.32			
Main	0.41			
Mizzen	0.29			
Upper Mast Cap	Length	Breadth	Depth	
Fore	*	*	0.37	*Assumed to be the same as lower mast cap
Main	*	*	0.47	
Mizzen	*	*	0.34	
	Length	Width	Thickness	
Bowsprit Cap	2.05	0.34	0.33	
Hounds	Length	Breadth		
Fore	3.68	0.64		
Main	3.84	0.81		
Mizzen	2.72	0.58		
Crosstrees	Breadth	Depth	Foremost Length	Aftermost Length
Fore	0.39	0.26	8.9	10.9
Main	0.51	0.34	11.6	13.6
Mizzen	0.35	0.24	8.4	10.4
Bolster	Width	Depth		
Fore	0.47	0.41		
Main	0.59	0.52		
Mizzen	0.44	0.39		

Table 2 Continued

In Meters				
Lower Mast Cap	Length	Breadth	Depth	
Fore	0.7559	0.58217	0.11582	
Main	0.93878	0.74371	0.14935	
Mizzen	0.69494	0.49073	0.10668	
	Space between lower mast and topmast at cap			
Fore	0.09754			
Main	0.12497			
Mizzen	0.08839			
Upper Mast Cap	Length	Breadth	Depth	
Fore	*	*	0.11278	*Assumed to be the same as lower mast cap
Main	*	*	0.14326	
Mizzen	*	*	0.10363	
	Length	Width	Thickness	
Bowsprit Cap	0.62484	0.10363	0.10058	
Hounds	Length	Breadth		
Fore	1.12166	0.19507		
Main	1.17043	0.24689		
Mizzen	0.82906	0.17678		
Crosstrees	Breadth	Depth	Foremost Length	Aftermost Length
Fore	0.11887	0.07925	2.71272	3.32232
Main	0.15545	0.10363	3.53568	4.14528
Mizzen	0.10668	0.07315	2.56032	3.16992
Bolster	Width	Depth		
Fore	0.14326	0.12497		
Main	0.17983	0.1585		
Mizzen	0.13411	0.11887		

Table 3. Bowsprit and Other Headgear Spars

In Feet						
	Whole length	Housed	Steeve (degrees)	Large Diameter	Heel Diameter	Head Diameter
Bowsprit	28.8	8.2	18	1.44	1.44	0.97
	Length	Large Diameter	Small Diameter	Flying Jibboom		
Jibboom	27.4	0.41		7.3		
	Length	Width	Location (from the fore side of cap)			
Saddle	0.72	0.2	9.13			
	Length	Large Diameter	Small Diameter			
Dolphin-striker	7.5	0.29	0.2			
In Meters						
	Whole length	Housed	Steeve (degrees)	Large Diameter	Heel Diameter	Head Diameter
Bowsprit	8.77824	2.49936	5.4864	0.43891	0.43891	0.29566
	Length	Large Diameter	Small Diameter	Flying Jibboom		
Jibboom	8.35152	0.12497	0	2.22504		
	Length	Width	Location (from the fore side of cap)			
Saddle	0.21946	0.06096	2.78282			
	Length	Large Diameter	Small Diameter			
Dolphin-striker	2.286	0.08839	0.06096			

Table 4. Yard Dimensions

In Feet							
Lower Yards	Length	Yard-arm	Large Diameter	Yard-arm Diameter	Placement on Masts (depth below stops)		
Fore	50.1	2	0.96	0.48	4.3		
Main	48.2	1.95	0.92	0.46	4.1		
Gaff Yards	Length	w/o Cleats	Large Diameter	Angle	Jaws	Inner Diameter	Outer End Diameter
Fore	33.5	2.1	0.71	25	4.5	0.71	0.41
Main	29.8	2.4	0.63	25	4.5	0.63	0.36
Mizzen	25.9		0.54	30	4.5	0.54	0.31
	Length	w/o Cleats	Large Diameter	Diameter 1/3 from after end	Diameter at outer end	Diameter at inner end	Angle
Mizzen Boom	39.05		0.69	0.69	0.52	0.46	5
Upper Yards	Length	Yard-arm	Large Diameter	Yard-arm Diameter	Placement on Masts		
Fore topmast	42.2	3.5	0.7	0.3	2.4	below topmast head	
Fore topgallant	26.5	1	0.44	0.19	2.44	below stops	
Main topmast	29.9	1.2	0.5	0.21	31.8	above main yard	
Yard-Arm Cleats	Distance from end	Length	Depth				
Fore	2	0.58	0.11				
Main	2.1	0.6	0.11				

Table 4 Continued

In Feet							
Yard-Arm Cleats	Distance from end	Length	Depth				
Fore topmast	1.76	0.52					
Fore topgallant	1						
Main topmast	1.24	0.38					
Sling Cleats	Distance bewteen cleats	Length	Depth				
Fore	1.46	1.38	0.2				
Main	1.26	1.44	0.23				
Fore topmast	mast diameter	0.93					
Fore topgallant	mast diameter						
Main topmast	mast diameter	0.67					
In Meters							
Lower Yards	Length	Yard-arm	Large Diameter	Yard-arm Diameter	Placement on Masts (depth below stops)		
Fore	15.2705	0.6096	0.29261	0.1463	1.31064		
Main	14.6914	0.59436	0.28042	0.14021	1.24968		

Table 4 Continued

In Meters							
Gaff Yards	Length	w/o Cleats	Large Diameter	Angle	Jaws	Inner Diameter	Outer End Diameter
Fore	10.2108	0.64008	0.21641	25	1.3716	0.21641	0.12497
Main	9.08304	0.73152	0.19202	25	1.3716	0.19202	0.10973
Mizzen	7.89432	0	0.16459	30	1.3716	0.16459	0.09449
	Length	w/o Cleats	Large Diameter	Diameter 1/3 from after end	Diameter at outer end	Diameter at inner end	Angle
Mizzen Boom	11.9024	0	0.21031	0.21031	0.1585	0.14021	5
Upper Yards	Length	Yard-arm	Large Diameter	Yard-arm Diameter	Placement on Masts		
Fore topmast	12.8626	1.0668	0.21336	0.09144	0.73152		
Fore topgallant	8.0772	0.3048	0.13411	0.05791	0.74371		
Main topmast	9.11352	0.36576	0.1524	0.06401	9.69264		
Yard-Arm Cleats	Distance from end	Length	Depth				
Fore	0.6096	0.17678	0.03353				
Main	0.64008	0.18288	0.03353				
Fore topmast	0.53645	0.1585	0				
Fore topgallant	0.3048	0	0				

Table 4 Continued

In Meters							
Yard-Arm Cleats	Distance from end	Length	Depth				
Main topmast	0.37795	0.11582	0				
Sling Cleats	Distance bewteen cleats	Length	Depth				
Fore	0.44501	0.42062	0.06096				
Main	0.38405	0.43891	0.0701				
Fore topmast	mast diameter	0.28346					
Fore topgallant	mast diameter	0					
Main topmast	mast diameter	0.20422					

Table 5. Standing Rigging

In Feet	Shrouds	Rope size (diameter)*	Deadeyes**	
*based on Brady (1848)	Fore	0.24	0.52	
**based on Kipping (1853)	Main	0.24	0.54	
	Mizzen	0.18	0.52	
	Topmast Shrouds	Rope size (diameter)*	Deadeyes**	Length of futtock shrouds*
	Fore topmast	0.15	0.27	3
	Main topmast	0.15	0.27	3.8
	Mizzen topmast	0.12	0.27	2.8
	Stays	Rope size (diameter)*		
	Fore	0.33		
	Main	0.33		
	Mizzen	0.21		
	Fore topmast	0.23		
	Main topmast	0.23		
	Mizzen topmast	0.13		
	Fore topgallant	0.11		
	Standing jib	0.15		
	Martingale	0.2		
	Backstays	Rope size (diameter)*		
	Fore topmast	0.23		
	Main topmast	0.23		
	Mizzen topmast	0.19		
	Martingale backropes	0.12		

Table 5 Continued

In Meters	Shrouds	Rope size (diameter)*	Deadeyes**	
	Fore	0.07315	0.1585	
	Main	0.07315	0.16459	
	Mizzen	0.05486	0.1585	
	Topmast Shrouds	Rope size (diameter)*	Deadeyes**	Length of futtock shrouds*
	Fore topmast	0.04572	0.0823	0.9144
	Main topmast	0.04572	0.0823	1.15824
	Mizzen topmast	0.03658	0.0823	0.85344
	Stays	Rope size (diameter)*		
	Fore	0.10058		
	Main	0.10058		
	Mizzen	0.06401		
	Fore topmast	0.0701		
	Main topmast	0.0701		
	Mizzen topmast	0.03962		
	Fore topgallant	0.03353		
	Standing jib	0.04572		
	Martingale	0.06096		
	Backstays	Rope size (diameter)*		
	Fore topmast	0.0701		
	Main topmast	0.0701		
	Mizzen topmast	0.05791		
	Martingale backropes	0.03658		

Table 6. Running Rigging

In Feet	Lifts	Blocks at cap (sister)	Block at yard-arm (single)	Throat Halliard	Blocks*	
	Fore	0.37		Fore	0.31	
	Main	0.4		Main	0.31	
	Foretop	0.48	0.27	Mizzen	0.32	
	Maintop	0.48	0.24	Peak Halliard	Blocks*	
	Foretopgal lant	0.16		Fore	0.31	
	Braces	Blocks at yard-arm (single)		Main	0.31	
	Fore	0.37		Mizzen	0.27	
	Main	0.48		Boom topping-lift	Blocks*	
	Foretop	0.37		Mizzen	0.32	
	Maintop	0.4		Boom sheet	Double block	Single block
	Foretop-gallant	0.19		Mizzen	0.27	0.27
	Halliards/ Tyes	Tye block (on yard)	Fly block			
	Foretop	0.42	0.58			
	Maintop	0.42	0.48			

Table 6 Continued

In Meters	Lifts	Blocks at cap (sister)	Block at yard-arm (single)	Throat Halliard	Blocks*	
	Fore	0.11278		Fore	0.09449	
	Main	0.12192		Main	0.09449	
	Foretop	0.1463	0.0823	Mizzen	0.09754	
	Maintop	0.1463	0.07315	Peak Halliard	Blocks*	
	Foretop-gallant	0.04877		Fore	0.09449	
	Braces	Blocks at yard-arm (single)		Main	0.09449	
	Fore	0.11278		Mizzen	0.0823	
	Main	0.1463		Boom topping-lift	Blocks*	
	Foretop	0.11278		Mizzen	0.09754	
	Maintop	0.12192		Boom sheet	Double block	Single block
	Foretop-gallant	0.05791		Mizzen	0.0823	0.0823
	Halliards/ Tyes	Tye block (on yard)	Fly block			
	Foretop	0.12802	0.17678			
	Maintop	0.12802	0.1463			

Table 7. Tonnages and Characteristics of Austin Expedition Vessels, 1850 (Osborn 1852b:32-35)

Name of vessel	Length	Tonnage	Propulsion system	Crew size (Men/Officers)
Intrepid	150 feet (45.7 m)	400 tons burthen	Screw propeller, two engines of 30 horsepower each; three-masted schooner rig	30/5
Pioneer	150 feet (45.7 m)	400-500 tons	Screw propeller, two engines of 30 horsepower each; three-masted schooner rig	30/5
Assistance	100 feet* (30.5 m)	unknown	Sail-bark rigged	60/25
Resolute	100 feet* (30.5 m)	700 tons fully loaded	Sail-bark rigged	60/25

*length estimated from Osborn's commen that the steamers were 50 feet longer than the ships, although they carried only half as many men (Osborn 1852b:47).

Table 8. Speed Estimates of HMS *Pioneer* Unburdened and Towing HMS *Resolute* (Osborn 1852b:57-58).

	Average Speed	Average Speed Towing
HMS *Pioneer*	5 mph (8 kph)	3 mph (4.8 kph)

APPENDIX B: FIGURES

Figure 1. Chromolithograph of HMS *Pioneer* working through the ice (from Osborn 1852a).

Figure 2. HMS *Intrepid* and *Assistance* in winter quarters. *Intrepid* is on the right (from M'Dougall 1857a).

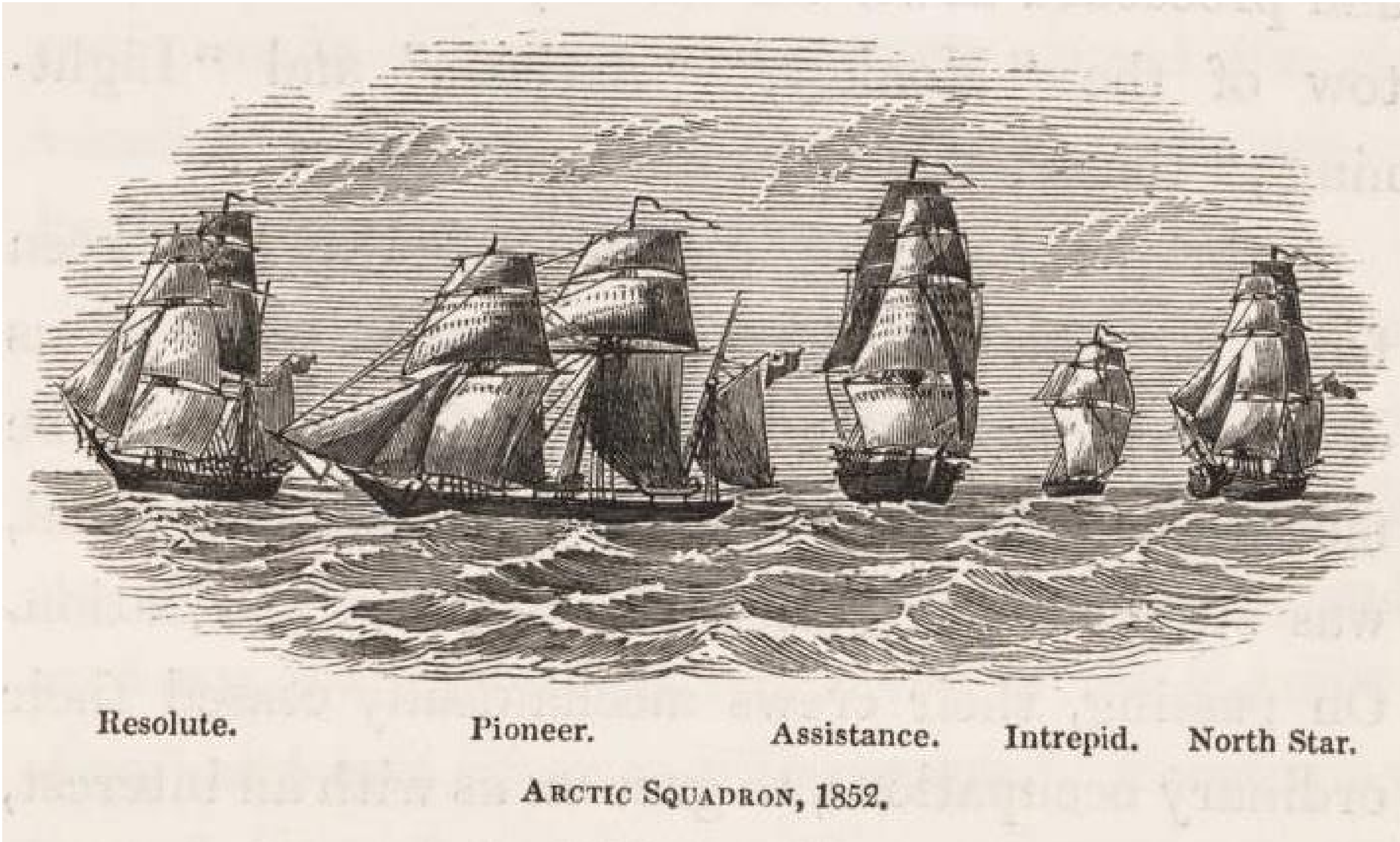

Figure 3. Belcher's expedition making sail. HMS *Pioneer* is the second vessel from the left (from M'Dougall 1857b).

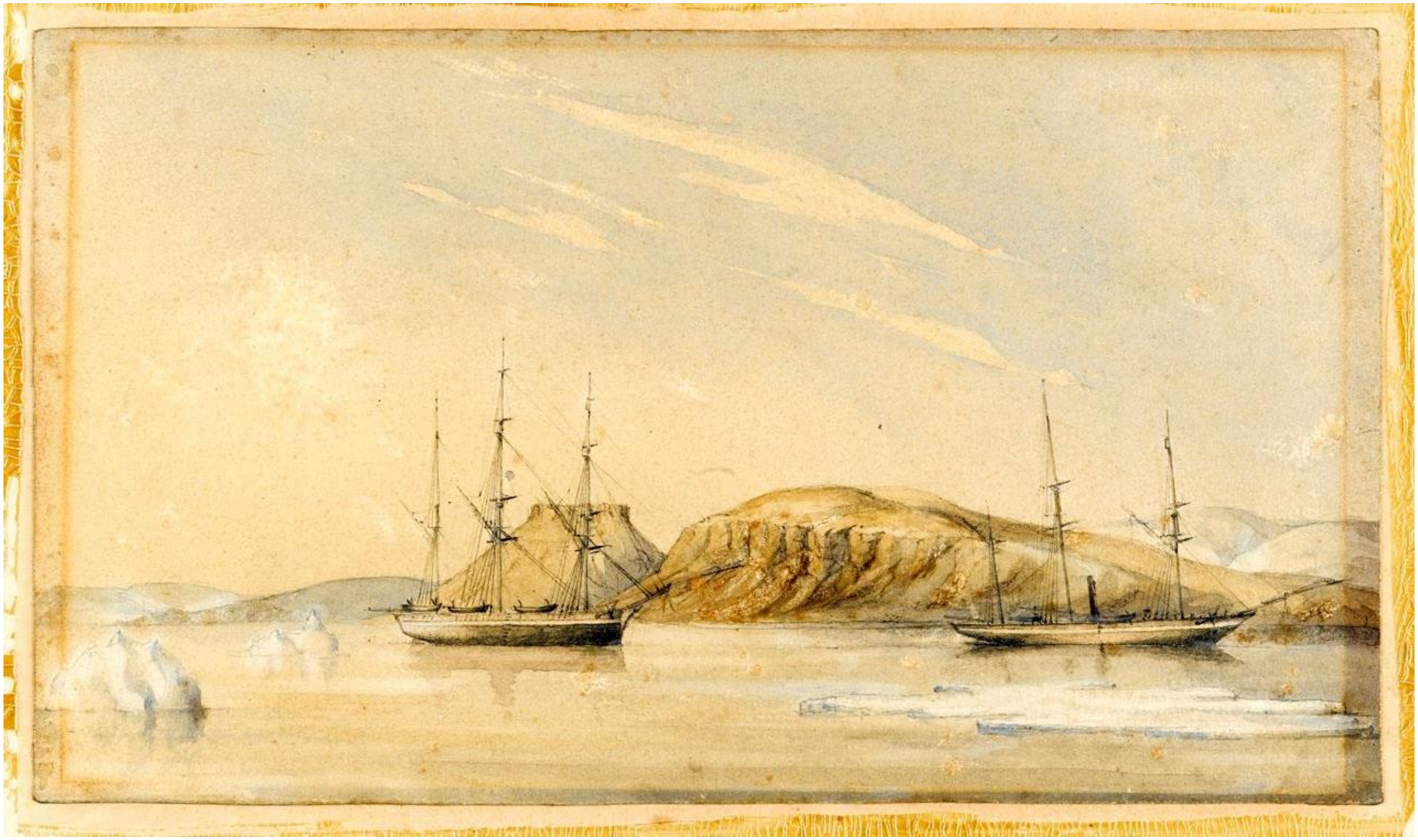

Figure 4. The ship HMS *Asssistance* being towed by *Pioneer*, by the Belcher expedition's artist (May n.d.-a; copyright National Maritime Museum, Greenwich, London, PAF8119).

Figure 5. HMS *Pioneer* (on the right) making sail after wintering, with missing mizzen mast. Possibly sketched later than May's other illustration; perhaps *Pioneer* damaged its mizzen mast (May n.d-b, copyright National Maritime Museum, Greenwich, London, PAG8031).

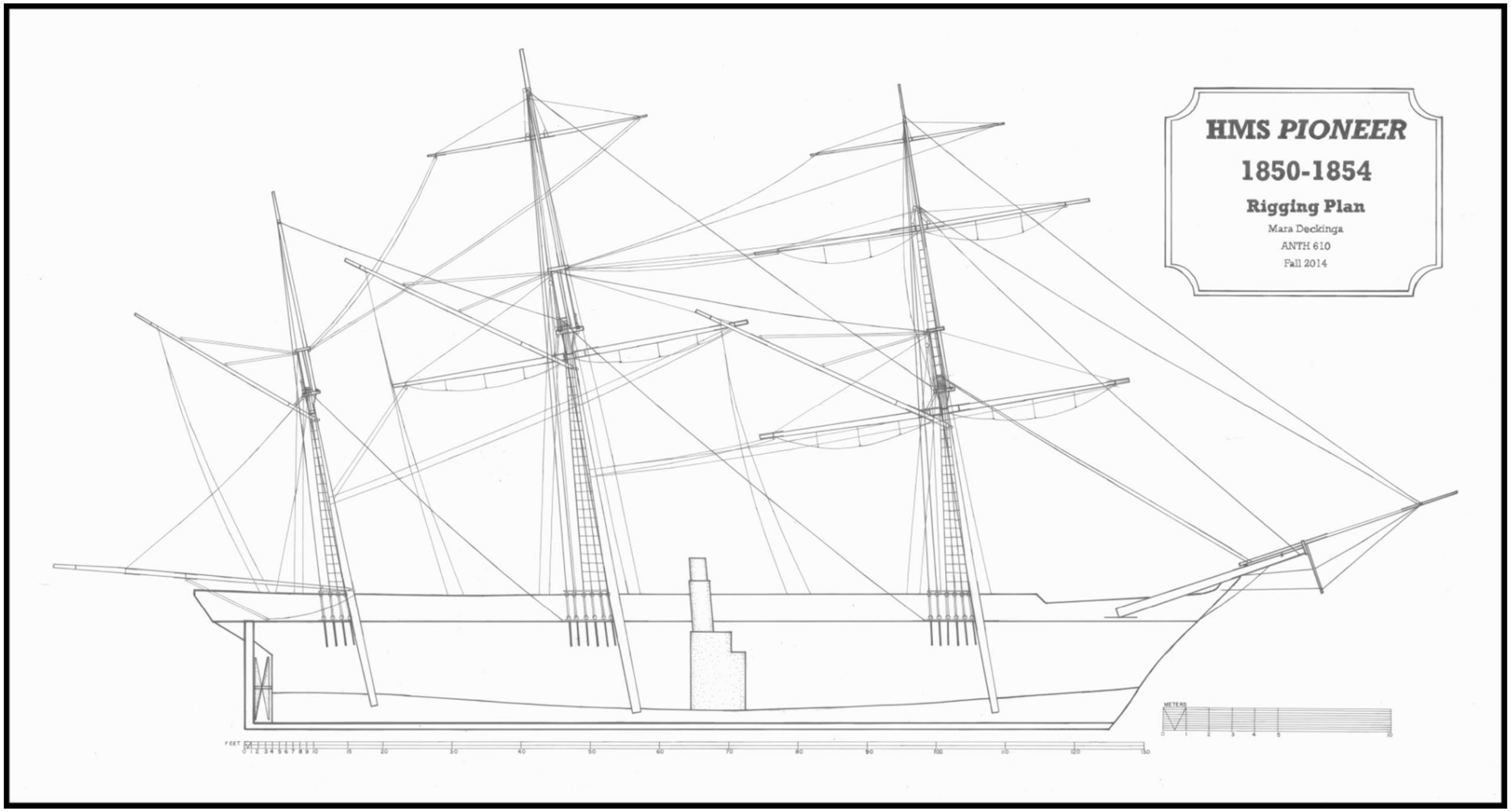

Figure 6. HMS *Pioneer* reconstructed spar and rigging plan, by Mara Deckinga.