A NURSERY FOR SEAMEN:

LIFE HISTORIES FROM THE ST. JOHN'S ROYAL NAVAL HOSPITAL CEMETERY, NEWFOUNDLAND

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Abstract

A cemetery associated with the St. John's Royal Naval Hospital, NL (~1725-1825) was partially excavated in 1979, uncovering the skeletal remains of at least 21 individuals. Isotopic analyses ($\delta^{13}C_{VPDB}$, $\delta^{15}N_{AIR}$, $\delta^{18}O_{VPDB}$, and $^{87}Sr/^{86}Sr$) were used to examine the diet and geographic origins of these individuals and compare them with recent results from other British Naval cemeteries. Their origins according to enamel carbonates and $^{87}Sr/^{86}Sr$ are mainly consistent with the British Isles and the bone collagen values were largely consistent with naval rations. There was some variability in $\delta^{15}N_{AIR}$ and $\delta^{13}C_{VPDB}$ values, suggesting different social classes and the consumption of C_4 foods associated with North America. While this study has highlighted deficiencies in the ability of isotopic analyses to define the variability within naval rations, it is the first to examine origins of early modern naval sailors isotopically, as well as the experiences of these sailors within the context of Newfoundland.

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Dedication

To Nana, Papa, and Grammie.

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Glossary

‰ – per mil (parts per thousand)

~ Approximately

< Less than

> Greater than

± plus or minus for standard deviation

µl – microliter

µm - micrometer

$^{87}Sr/^{86}Sr$ – ratio of strontium-87 to strontium-86

AIR – Ambient Inhalable Reservoir, the reference standard for nitrogen

Amps - amperes

C:N – atomic carbon and nitrogen ratio

C_3 – photosynthetic pathway

C_4 – photosynthetic pathway

CAM – photosynthetic pathway Crassulacean Acid Metabolism

CREAIT – Core Research Equipment and Instrument Training Network at Memorial University

CV – coefficient of variation

ColV – column volume (~1ml)

DW – drinking water

EA – Elemental Analyzer

GC – Gas Chromatography

HCl – hydrochloric Acid

HNO_3 – nitric Acid

IRMS – isotope ratio mass spectrometry

M – molar

MARC – Memorial Archaeology (laboratory sample number header)

MAAS – Memorial Archaeology Applied Sciences laboratory

MC-ICP-MS – multicollector inductively coupled plasma mass spectrometer

min - minutes

MNI – minimum number of individuals

MΩ – mega ohm

n – sample size

Royal Navy – also known as British Royal Navy

SE – standard error

Southside – Southside Hills, an area of St. John's on the south side of the harbor

TIMS – Thermal-ionization mass spectrometer

VPDB – Vienna Pee-Dee Belemnite, the reference standard for carbon and oxygen

VSMOW – Vienna Standard Mean Ocean Water, the reference standard for oxygen from fresh water

δ – delta

$\delta^{13}C_{carb}$ – delta value of carbon compared to VPDB, specifically from enamel carbonate

$\delta^{13}C_{col}$ – delta value of carbon compared to VPDB, specifically from bone collagen

$\delta^{13}C_{VPDB}$ – delta value of carbon compared to VPDB

$\delta^{15}N_{AIR}$ – delta value of nitrogen compared to AIR

$\delta^{15}N_{col}$ – delta value of nitrogen compared to AIR, specifically from bone collagen

$\delta^{18}O_{carb}$ – delta value of oxygen compared to VPDB, specifically from enamel carbonate

$\delta^{18}O_{DW}$ – delta value of oxygen compared to VSMOW

$\delta^{18}O_{p}$ – delta value of oxygen compared to VPDB specifically from enamel phosphate

$\delta^{18}O_{VPDB}$ – delta value of oxygen compared to VPDB

$\delta^{18}O_{VSMOW}$ – delta value of oxygen compared to VSMOW

σ – standard deviation

Chapter One

1 Introduction

In the fall of 1979 skeletal remains of 21 individuals were salvage excavated from an unmarked cemetery on the south side of St. John's harbour, Newfoundland. The identification of the cemetery sparked debate over who had been buried at what became known as the Southside Cemetery. Propositions that the cemetery was associated with the St. Mary's Anglican Church, which opened in the mid-19th century (Cousens 1960), were countered with suggestions that it was the earlier Royal Naval Hospital, which operated from the 18th to the early 19th centuries (O'Neill 2003); both had been located close to the cemetery. Histories about the Southside Cemetery have been perpetuated in the historical record without clear documentation, yet strong evidence presented here suggests a Royal Naval connection for the cemetery. Although there has not been extensive research into the Royal Navy in Newfoundland outside of the effects on the local population (see: Bannister 2003), it was sailors of unknown origins and experiences that made up the Navy's presence on and around the island, and their stories that have largely been lost to time.

The Royal Navy was active globally during the 18th and 19th centuries, not only during the battles that have been glorified in legends, but also in the daily monotony of convoying merchant ships across the Atlantic (Baynham 1969; Rodger 2005). The Royal Navy was also present in Newfoundland to protect the lucrative fishery that dominated the economy of the island (Cell 1969; Janzen 1984). Prospects of cod, seal, and salmon brought thousands of sailors annually to St. John's harbour, where they interacted with one another and the local community (Cell 1969). Due to the large number of fishermen who migrated seasonally to Newfoundland, the waters off of the island acted as a 'nursery for seamen', training the fishermen as sailors. The Royal Navy subsequently took a portion of these men to fill their numbers after the fishing season had ended (Mercer 2006; Mercer 2008). Though the Royal Navy's presence in Newfoundland is important to understanding the development of the island, the Navy must be understood more broadly within the context of the British Atlantic World.

While there have been few studies relating to naval sailors in Newfoundland, it is possible to garner new information from the skeletal remains recovered from the cemetery. Data derived from stable and radiogenic isotopic analyses are effective in determining social patterning of diet and geographic origins in archaeology because 'you are *what* and *where* you eat' (Budd 2003; Fry 2006). Chemical elements are incorporated into tissues from the food and drinks that are consumed (Katzenberg 2000; Bentley 2006). By analyzing multiple tissues that form during different periods of an individual's life, past life ways can be revealed, including how these may have changed over time (Katzenberg 2000).

The Royal Navy supplied strict rations through the Naval Victualling Board, consisting mainly of salt meat, pease, and hard baked biscuits (MacDonald 2004). Some variations to the rations were allowed; however, scholarly historical literature does not define how often these variances were taken advantage of, and seems to minimize the importance of alternate foods (MacDonald 2004; Rodger 2005). There is therefore an assumption that the strict regulations associated with victualling created a standard diet for all employed by the Royal Navy, regardless of where they were stationed (Rodger 2005).

Stable and radiogenic isotopes can be used to provide information on geographic origins, as well as diet (Katzenberg 2000; Bentley 2006). Although most Royal Navy sailors originated from England (Lewis 1960; Rodger 2005), sailors were also pressed into service abroad (Mercer 2006; Brunsman 2013), which meant an increase in the possibility of obtaining sailors of foreign origins during times of war. Historical studies have examined where sailors were brought into service, either voluntarily or by impressment (Ennis 2002; Mercer 2006; Mercer 2008; Brunsman 2013), but less focus has been attached to where these sailors had come from. Neither how common the impressment of non-British individuals was, nor the extent of non-sanctioned North American foods that were incorporated into the diets of the Royal Naval sailors is well understood. This will be the first study examining the variability of 18th and 19th century Royal Naval sailors' diets in conjunction with their origins using isotopic analyses.

1.1 Research Hypotheses

To examine the life histories of individuals buried at the Southside Cemetery in St. John's Newfoundland, a number of research questions were considered as part of this project, including:

1. What were the institutional origins of the Southside Cemetery? There are conflicting stories regarding the origins of the Southside Cemetery, be it the Royal Naval Hospital from the 18th and early 19th centuries (O'Neill 2003), or St. Mary's Anglican Church, which dates to the later 19th century (Cousens 1960).

2. Who was being treated at the hospital and for what ailments? There are 20 years of surviving muster records from the St. John's Naval Hospital in Newfoundland. Considering that there are very few known records surviving from the hospital, this makes the information garnered from these records very important to understanding the lives of sailors from the Naval Hospital, as well as the types of people who were buried at the cemetery.
3. How do childhood diets influence our understanding of geographic origins within the Royal Navy? Origins within the Royal Navy, even within Newfoundland have not been widely studied, focusing more on what regions the Royal Navy sourced sailors than where the sailors themselves originated (see: Lewis 1960; Mercer 2006; Mercer 2008; Brunsman 2013). Isotopic analyses allow us to reconstruct the origins of these sailors directly, not just through the variability of oxygen and strontium isotopes but also the childhood diets, which vary based on the locally available foods (Katzenberg 2000; Bentley 2006).
4. Were the suggested isotopic origins of those from the Southside Cemetery similar to the muster records? Some naval vessels recorded the origins of sailors within their muster records. By examining these records from vessels stationed in St. John's Newfoundland during the late 18th and early 19th centuries, an idea of the variability of origins of sailors who were stationed around the island and possibly could have sought treatment at the local Naval Hospital can be examined.
5. How do the isotopic childhood origins compare between Royal Navy sites? Diets and origins of two Royal Naval sites in Antigua and England have been

previously examined (Varney 2003; Varney 2007; Bell et al. 2009). The origins of Royal Navy sailors in Newfoundland has not been examined, and this information could provide evidence of whether the Navy sourced locally born sailors.

6. What were the adult diets of Royal Navy sailors and were they consistent with accounts of naval rations? There is some debate as to how the rationing of food may have been affected by resupplying while overseas (MacDonald 2004; Knight and Wilcox 2010; MacDonald 2010; Roberts et al. 2012), where locally available foods may have been more accessible to the sailors than the sanctioned foods of the Navy.
7. How do adult diets compare between Royal Naval sites? How these possible differences in rationing may have affected naval stations across the Atlantic and the sailors who served there can be assessed by comparing adult diets of Royal Naval sailors from the medieval Royal Naval shipwreck the *Mary Rose* (Bell et al. 2009), and the Royal Naval Hospital Cemeteries in England (Roberts et al. 2012), and Antigua (Varney 2003; Varney 2007) to those from the Southside Cemetery.
8. How do the diets from the Southside Cemetery compare to contemporary civilian sites within the colonial America and Newfoundland? Differences in the diets of individuals from Newfoundland and the colonial America were the result of access to different locally available foods such as fish, corn, and sugar cane (Ubelaker and Owsley 2003; France et al. 2014; Harris 2015). The comparison can identify individuals from the Southside Cemetery who are consistent with such a diet that may suggest time spent outside of the British Isles.

1.2 Organization of the Thesis

The thesis is organized as a single document. Chapter 2 reviews the historical background of the Royal Navy and its significance to Newfoundland, as well as the differences and similarities between diets in Britain and the Royal Navy. Chapter 3 examines previous accounts of the Southside Cemetery arguing that the cemetery was associated with the St. John's Naval Hospital and not the St. Mary's Anglican Church. It also examines historical muster records from the Naval Hospital and naval vessels in St. John's to better understand the lives of those who were stationed and or ill in Newfoundland during the turn of the 19th century. Chapter 4 overviews the isotopic theories that allow researchers to answer archaeological questions, including the use of carbon, nitrogen, oxygen, and strontium isotopes. These isotopic theories are then tied into archaeological theories of consumption and agency, which help to frame meaningful questions for this study. Chapter 5 overviews the materials and methodologies used to answer the questions posed in the previous chapters, while Chapter 6 presents the results of the analyses. Chapter 7 goes into further detail with these results putting them within the context of the broader British Atlantic World and the Royal Navy. The thesis ends with a discussion of possible next steps, and the relevance of the work completed in the thesis.

Chapter Two

2 History of the Royal Navy in Newfoundland

The Royal Navy was a global dominating force during the 18th and early 19th centuries. The Navy's complex infrastructure and organization helped to protect British interests at home and abroad. Dockyards located in key locations were concerned with keeping the fleet afloat and provisioned, while the hierarchically organized personnel worked together to protect the island nation and colonial interests throughout the British Atlantic World (Rodger 2005; Lavery 2013). Naval personnel came from socially diverse backgrounds, but worked closely together in the strictly controlled 'wooden world' of the Navy that governed many aspects of their life, including their diet (MacDonald 2004; Rodger 2005).

Mobilization of the Royal Navy during times of war necessitated the use of large numbers of men, some of whom were pressed into service from colonial ports. One such region that this occurred in was Newfoundland, where the lucrative fishing industry provided trained seamen to the Royal Navy (Mercer 2006; Mercer 2008). In turn, the Royal Navy provided protection for the industry and the island's inhabitants, as well as a local governing force (Bannister 2003; Candow 2011). Historians have explored the role of the Navy served in Newfoundland, though there are continued debates as to what Britain's intentions were for the island and the social experiences of the sailors serving in the region.

2.1 The Royal Navy

2.1.1 Global Expanse

The Royal Navy was tasked with protecting the large expanse of marine territory that connected Britain's global network of colonies during the 18th and 19th centuries (Rodger 2005). Britain regarded itself as an 'empire of goods', linking individuals and companies who were directly or indirectly involved in trade throughout the Atlantic (Wilson 2013: 56). The Royal Navy was crucial to the protection of the island nation and its colonies during times of war with European states. During peacetime, the fleet protected British interests from piracy and local colonial enemies. The Royal Navy was more often involved with war activities than not; between 1689 and 1815 Britain was at war more than half of the time (Lavery 2013: 58).

A large force based on land coordinated the work of the Royal Navy. The Royal Navy administration consisted of both the Admiralty, which was central to the naval personnel and strategic decisions, and the Navy Office, which was concerned with the administration of the Navy, including the supervision of the dockyards (Rodger 2005: 291-301). The dockyards were highly industrialized systems that built and serviced the naval vessels (Lavery 2013: 58-63), and included six main dockyards in southern England, as well as others in acquired territories in the Mediterranean, such as Minorca, the West Indies, including English Harbour, Antigua, and in North America, including Newfoundland and Halifax. Dockyards typically included armament stores, barracks for marines, victualing yards, and hospitals (Lavery 2013: 63-64). These institutions kept the vessels afloat and organized.

2.1.2 Naval Organization

The Royal Navy was organized into a hierarchical chain of command that mirrored the broader socio-economic classes of England (Colville 2013). Flag Officers were the highest ranked in the Navy, consisting of Admirals who were the highest rank, in charge of three squadrons, and Commodores who were senior captains within a squadron. Directly below these were Commissioned Officers: Captains and Lieutenants, who captained the vessel or helped with the administration on board and ensured that all crews were carrying out their duties. Warrant officers were specialized and included the purser, surgeon, gunner, carpenter and boatswain. Working for the warrant officers were the subordinate officers including the cook, armourer, gunsmith, sailmaker, master at arms, midshipmen, and master's mates (Colville 2013: 82). Midshipmen, also known as young gentlemen, were senior Petty Officers who were training to be commissioned officers; they needed to train for six years before being promoted to Lieutenant (Waller 2014: 37). Young gentlemen who were of the higher class but lacked the age, experience, and often education to be warrant officers or to receive a king's commission, spent times as protégés to the officers onboard (Lewis 1960: 24; Rodger 2005: 383-386). Officers and the young gentlemen had the right to walk the Quarter Deck, this was a higher deck on the vessels where they spent their leisure time, unless they were quartered elsewhere (Rodger 2005: 624).

While onboard, those who were not Officers spent their nights and leisure time on the lower decks, eating on mess tables organized between cannons and sleeping in hammocks strung from the deckhead (Colville 2013: 83-86). These men were assigned to either assist the subordinate officers, or handle the vessel. They were ranked depending on how experienced they were. Landsmen lacked sailing experience, but after a year would become ordinary seamen, and after two years would become able seamen. After becoming Able Seamen, some would be assigned specialized tasks such as Gunners Mate, or Carpenter's Crew, working to assist specialized Warrant Officers. In addition to these men, there were servants who helped the commissioned and warrant officers (Colville 2013: 82). Finally, there were the Marines, who could be commissioned or not. Although they were an infantry force, they helped in the daily running of the vessel (Colville 2013: 83). Although there was a hierarchy of command and a general organization of duties, the reality onboard a vessel was at times different.

In this 'wooden world', all of the personnel, regardless of rank, needed to work together to keep the vessel afloat and functioning (Rodger 2005: 392). This meant that the division of labour onboard was more fluid (Vikers and Walsh 2005: 90-91, 195-196). This is truer for smaller vessels, where the small numbers necessitated officers and seamen to work together (Landsman 2005: 90). The close quarters onboard sloops and schooners further obscured the differences between the Upper and Lower Decks (Landsman 2005: 91). Most vessels were not manned at full capacity; therefore, sailors could be promoted as needed to fill numbers (Rodger 2005). Although there was a strong hierarchy onboard in terms of command, socially these strict divisions were at times blurred the realities of life at sea.

2.1.3 Geographic Origins

In order for the Royal Navy to effectively protect a global empire, a large number of personnel were employed: at the time of the Napoleonic Wars at the turn of the 19th century approximately 150,000 sailors were spread across 800 vessels. During peacetime, these numbers dropped to 12,000 (Webb 1995: 19). Peacetime numbers were easily maintained by volunteers who supported the crown, were seeking adventure, or were looking for dependable shelter and the promise of a pension (Colville 2013: 78). It was during times of war when vessels would have to be quickly made serviceable, that manning the vessels presented a problem. If sufficient volunteers could not be found, Press Gangs would be sent to force individuals into service (Brunsman 2013).

Before the late 18th century, this was typically done in England before a vessel left port (Mercer 2008). However, if numbers fell while on a journey due to desertion, sickness, or death, Captains would be forced to fill their numbers from local sailors before leaving a foreign port (Rodger 2005: 314). Press Gangs were active globally during times of war, taking up to one in five sailors from merchant ships into the Royal Navy (Brunsman 2013). Before the 1780s, the main source of naval seamen was in western England such as Dartmouth and Poole, yet by the 1780s the labour market in these West Country ports had declined, which forced the Navy to find men elsewhere (Mercer 2008). Due to the abundance of migrant fishermen who could not all fit in the cod-filled hulls of their English vessels, Newfoundland was an ideal alternative (Cell 1969; Mercer 2006). The island became known as a ‘nursery for seamen’ as the fishery trained these sailors for at least one summer before the Royal Navy would seek volunteers or use impressment to fill their ranks (Mercer 2008). Between 1793 and 1815 a conservative estimate of 40% of Royal Naval recruits were brought in via impressment while in Newfoundland, this corresponds to a total of 1500 men (Mercer 2008). This had also occurred during the American Revolution when the Royal Navy diverted first to Newfoundland before sailing to the continent (Mercer 2010: 211).

Where the sailors actually originated, rather than where they were brought into service, has not been fully examined. A study by Lewis (1960) observed that officers were predominantly the sons of professional English men or the landed gentry. Almost all officers were of English origins, particularly from port cities involved in the Navy such as Plymouth, Chatham, and Portsmouth. Port cities in Ireland, and Wales also produced officers, as well as the Scottish Lowlands (Lewis 1960: 31-39). The numbers of officers originating from these locations were far fewer than those who were from England. For example, between 1793 and 1815, England produced five times the number of officers compared to Scotland and Ireland, and 10 times that of Wales (Lewis 1960: 60-76). This being said, there has been little research examining the variability of origins of the sailors themselves, focusing rather on the regions where the Royal Navy volunteered or impressed sailors, and for what reasons this occurred.

2.2 Diet

2.2.1 Diet of the British Isles

The early life diet of sailors within the British Isles would have differed based on socio-economic class and regionality. The labour class' diet was based on bread and/or oatmeal, with some vegetables that they could grow themselves or buy in local markets. Meat would only have been afforded once a week, with roast beef being the most popular followed by pork (Olsen 1999: 231-235). Increases in population size in the British Isles during the 18th century put a strain on the market, resulting in a diet low in meat and high in grain and root vegetables (Geissler and Oddy 1993: 22). Many of those in the lower class would have had a low caloric intake in comparison to their labour heavy workload (Shammas 1984). The middle class had a similar diet but with access to more meats and vegetables and fruit and in larger amounts (Olsen 1999: 235). The upper class could access better cuts of meat as well as game and seafood such as lobster, crab, and salmon (Olsen 1999: 235). Beverages included wine for the upper and middle class, with access to gin and locally home brewed beer, which was mainly consumed by the lower classes (Olsen 1999: 238-241). Poor water quality meant that few non-alcoholic drinks were consumed, with the exception of tea for middle and upper classes (Olsen 1999: 235).

Scottish lower classes also had little meat and relied on a high grain diet, particularly oatmeal in the lowlands. Animal by-products such as cheese and butter were more accessible than meat (Geissler and Oddy 1993: 10-19; Tames 2003: 25). The Highlands relied on oatmeal imports until the mid-1750s, when potatoes replaced oatmeal as the diet staple (Geissler and Oddy 1993: 19-20). Port communities had similar diets but included more fish and more access to imported food (Black 2008: 31). Otherwise, fish was not popular in diets since the abolition of “fish days” in 1600s (Tames 2003: 20-27).

2.2.2 Royal Navy Rations

Though the childhood diets of sailors from the British Isles would have been highly variable, diet in the Royal Navy was restricted and standardized by the need to supply large numbers of men who were dispersed across the world's oceans. Rations were formalized in 1733 in '*The Rules and Instructions Relating to His Majesty's Service at Sea'*, having standardized the traditional 17th century rations that consisted of bread, meat, pease, and oatmeal. This document was given to each ship and served as instructions on the daily rations of sailors (Table 2-1) that were supplied by the Victualling Board of the Royal Navy. The diet was updated on an informal basis over the next century, but the rationing regulations were left unchanged until 1847, when widespread canning of foods was introduced, which increased the number of foods available on long journeys (MacDonald 2004: 10).

Biscuits were a staple within the sailor's diet, with each sailor receiving one pound every day. This biscuit was a form of bread that contained only water and flour, and was therefore a simple food to make that would last months. The biscuit would have been very hard (hence the term hardtack) and was sucked on, or soaked in soup. The biscuit was at times replaced by soft bread if a baker, oven, and supplies could be found in port (MacDonald 2004: 15-18). Meat was mostly salted beef or pork that was prepackaged in Ireland. If prepackaged properly with brine and a solid cask, the meat could last months onboard with no rot. If the pieces were too large or too little salt was used, it could rot. While rot was uncommon, it was assumed to be much more frequent, contributing to the incorrect yet popular perception of poor food quality in the Royal

Table 2-1. Daily allowances of food for Royal Naval sailors in 1733 according to the '*Rules and Instructions Relating to His Majesty's Service at Se*a'. Reproduced from MacDonald (2004).

	Biscuit **(**Pounds Avoirdupois)	**Beer** (Gallons Wine Measure)	**Beef** (Pounds Avoirdupois)	**Pork** (Pounds Avoirdupois)	**Pease** (Pint Winchester Measure)	**Oatmeal** (Pint Winchester Measure)	**Butter** (Ounces)	**Cheese** (Ounces)
Sun	1	1		1	1 half			
Mon	1	1				1	2	4
Tues	1	1	2					
Wed	1	1			1 half	1	2	4
Thurs	1	1		1	1 half			
Fri	1	1			1 half	1	2	4
Sat	1	1	2					
Total	**7**	**7**	**4**	**2**	**2**	**3**	**6**	**12**

'Together with an allowance of vinegar, not exceeding half a pint to each man per week'

Navy (MacDonald 2004: 18-21). Although the diet was depicted as being insufficient for the sailors who were performing hard manual tasks, it actually gave them almost 5000 calories daily (MacDonald 2004: 177-178). This was more than many would have been receiving as labourers in England (Shammas 1984).

Beer was the beverage of choice on board naval vessels. Stagnant freshwater grows bacteria, which made sailors sick, while the alcohol in beer preserved the beverage longer. One gallon of beer was given to every sailor per day (MacDonald 2004: 39). However, in warmer climates, beer did not last long, prompting sailors to substitute it with wine in the Mediterranean and by rum in the Caribbean (MacDonald 2004: 39-42; Gibowicz 2007: 68-71). Tea was occasionally available to the sailors (MacDonald 2004: 43).

Though the rations were very strict, some variation did occur. Officers' rations were the same as the average seamen, but they would purchase additional items out of their own money. The most common variation to the prescribed rations was a result of officers having livestock onboard as a supply for eggs and meat. Another way that all sailors could supplement their diet was through fishing, as tackle was provided to all vessels. Salted fish were not supplied as rations in the 18^{th} century because the Royal Navy believed that the consumption of salted fish caused scurvy (MacDonald 2004: 25). Instead, sailors could fish off the deck, occasionally catching porpoise or sharks in warmer waters. Anything caught was to be divided first to the sickbay, and then divided amongst the crew (Thomas 1968).

An additional form of diet variation came from allowed substitutions to the rations (MacDonald 2004: 176). Rations were supplied when ships left port, but were often insufficient for the total journey, which could last for years at a time (Rodger 2005). Vessels would resupply when in port, or when other vessels they were travelling with returned from port and redistributed their supplies. Naval stations had official suppliers, but they could not always access official ration foods (MacDonald 2004: 52-53, 57-63). Captains could also resupply with non-traditional foods, but all victuals came out of pocket and they risked not being refunded for their choices (MacDonald 2004: 73-74). Although the influence that the variations in rations had on diet is not known, it likely would have varied with location. The influence of living in the British North Atlantic on diet has not been examined.

A final source of variation would be associated with the accuracy with which ships supplies were filled. The challenges of provisioning the naval vessels were not made easier by corruption within those people who ran the Victualling Board of the Navy, particularly the clerks. There was an immense amount of debt held by the board due to corruption, and reactive measures were not sufficient to get ahead of the problem (MacDonald 2010: 214-219). A lack of documentation related to the influence of constraints in supplies, availability of foods, inaccuracy of records, and corruption convolutes historian’s understanding of rationing in the Royal Navy (MacDonald 2010; Knight and Wilcox 2010).

2.3 Royal Naval Connection to Newfoundland

2.3.1 Newfoundland Fishery

The fishing industry began in Newfoundland at the end of the 15th century after Bristol merchants had begun exploiting the abundance of cod resources, prompting migratory fishermen to leave from English ports (Cell 1969: 1). In addition to England, many other countries took advantage of the cod-filled waters, including France, Spain, Portugal, and the Netherlands (Cell 1969: 24-25, 48-49, 109-111). The English fishery in Newfoundland was operated initially by migratory fishermen who would come only for spring and summer, leaving in the early fall. The English fished mainly inshore; they salted and dried their catches onshore, resulting in onshore development (Payntner 1963: 57-58). Over time, the English fishery established a permanent population on the island. This included planters who employed servants to fish for them, and boat keepers who would keep their boats on the island, travelling over from Britain with merchants in spring and returning in the fall (Head 1976: 56-58).

After the treaty of Utrecht (1713) gave French territorial acquisitions in Newfoundland to England, England gained access to the traditional French offshore fishing grounds called the Banks (Head 1976). The Bank fishery involved going out to the deep fishing grounds in larger boats for weeks at a time. Fish were preserved with some salt, but would later be dried on shore. Although the fish were of poorer quality than the inshore dried cod, the Bank fishery produced significantly more fish per boat than traditional inshore fishing (Head 1976: 72). This form of fishery put both the

English and the French in the same fishing grounds on the Banks, which was a source of friction during the 18th century (Matthews 1968: 394-395).

Poor catch rates in the decade following the Treaty of Utrecht meant the closure of many English ports that had been involved in Newfoundland fishery, leaving mainly Topsham and North Devon in West Country England as the dominant ports (Matthews 1968: 162; Cell 1969: 132-144). These were the ports that continued to dominate even as the fishery rebounded over the next half century. Although the fishery improved in the mid-18th century, the supply and demand for cod from Newfoundland varied. This was due to natural catch rates, piracy, and war which affected the availability of men and created tensions with Newfoundland's purchasing markets such as Spain (Handcock 2003: 25). The lucrative fishery and tumultuous relationship with other Europeans participating in the fishery created a demand for the Royal Navy to provide protection for those fishing and for those convoying the men and their catch to and from England and the ports they sold it to.

2.3.2 Settlement

While the Royal Navy protected the fishing industry in the waters off of Newfoundland during the fishing season, infrastructure on land needed protection year round, which necessitated settlement. Ports in England were 'focal points for migration' meaning that not only the port, but also surrounding areas supplied men to the fishery (Handcock 2003: 60). Settlement on the island developed directly out of the migratory fishery, starting with the planters and servants, followed by occasional merchants (Handcock 2003: 23, 68). Planters were those who owned fishing premises that the servants operated, all of which was supplied for by the merchants (Handcook 2003). Permanent settlement was very slow to develop and was concentrated in certain harbours (Head 1976: 82). There were attempts at establishing colonies at places like Ferryland and Cupids in the early 17th century, but all ultimately failed to create permanent colonies (Pope 2004). Although the 17th century saw small numbers of permanent population on the island, it did put into place a migration system for the next century (Handcock 2003: 23, 68). Between 1675 and 1700 the permanent population on the island was 1200. By 1730 the population was 3500, and by 1750 the population had doubled, growing to 12,000 by 1760. In the 1670s only 15% of the total population was permanently residing on the island, while that had grown to 50% in 1770, and to 90% by the end of the 18th century (Head 1976: 82).

Eighteenth century settlements were typically concentrated in main ports like St. John’s and Conception Bay, and these cities experienced the largest population gains from the mid-18th to 19th centuries. During this period there were also large increases in the population in Notre Dame Bay, Bonavista Bay, and Trinity Bay, followed by Southern Shore, Fortune Bay, Placentia, Mortier, and Burin (Handcock 2003: 98-104). Although main fishing ports typically were the source of immigration, the Irish came in large numbers at the beginning of the 18th century, settling mainly on the South Shore (Handcock 2003: 77-78).

This growth in population took place in spite of King William’s Act (1699), which prohibited settlement. There is some debate between historians as to how much influence this Act had, especially because of the industry’s benefits from infrastructure protection during regular Beothuk and French raids during the winter (Candow 2011: 24). While Janzen (1984) argued that the British government was openly opposed to permanent settlement in Newfoundland, Bannister (2003: 186) argued that Britain was using "the path of least resistance" by allowing common law to take precedence. Cadigan (2009: 58-59) argues that the naval government typically used the Act to help the residents of the island, rather than protecting the migratory fishery. His argument supports that Britain was against settlement, but clarifies that it was not always translated into Newfoundland. This leaves the debate of settlement unresolved, since Candow (2011: 24) later goes against this, saying that Britain knew how important settlement was to the security of the island's fishery.

The island's settlements were highly dependent on the fishing industry and the merchants who imported foreign goods. Although personal gardens were used to supplement diets, agriculture was limited by busy fishing schedules, low soil productivity, and the harsh environment (Cadigan 1995). Food supplied by boats originated mainly from England, and a small part from Ireland and the West Indies, but the importance of New England trade grew significantly in the 18th century along with some from the close British Colony of Nova Scotia (Head 1976: 101-108; Cadigan 1993).

2.4 Presence of the Royal Navy in Newfoundland

2.4.1 Army Presence in Newfoundland

To safeguard settlements in Newfoundland, a British Army presence was established on the island starting in 1697 and there were soldiers on the island intermittently until the garrison was officially closed in 1870 (Stacey 1936: 155; Candow 2011: 24-25, 30). Though there were small batteries up the coast, the main stronghold was in St. John’s, with the exception of the time period between 1713 and 1743 when the main garrison was in Placentia (Candow 2011: 36-38). Signal Hill and other fortifications in St. John’s were pivotal in the defence of the town throughout its history, and in turn, were important for the development of Newfoundland (Candow 2011: 26, 52). They served the basis for attacks by the French, particularly in 1762 when the town of St. John’s was taken (Prowse 1895: 213-223). Candow (2011) argues that fortifications in the Narrows were needed because the Navy was powerful, but it was not sufficient to ensure the safety of neither the town nor the island. This is why St. John’s garrison continued to be occupied in times of peace (Candow 2011: 62-63). The barracks at Fort Townshend allowed soldiers to have an active daily role by 1779 in military and civil duties, thereby protecting all aspects of the island, not just the fishery (Candow 2011: 64, 101). Soldiers were housed in barracks such as on Signal Hill or Fort Townsend. During this time there was some unintentional mistreatment of the soldiers due to decisions of officials stationed there, such as the placement of stone barracks on Signal Hill where the wind and salt water are not conducive to proper living conditions (Candow 2011: 100-104). Newfoundland military historians have focused largely on the physical conditions of the forts and the soldiers; along with the Army’s influence on by the local settlers and the fishing industry.

2.4.2 Historiography of the Navy in Newfoundland

Newfoundland is one of Britain's oldest colonies and understanding the naval presence on the island is important to understanding its development. St. John's was Britain's stronghold in Newfoundland, likely due to the natural defensive properties of the harbor, but also because the town was in the middle of the Avalon Peninsula, which was a prominent British fishing area (Candow 2011: 37). The Royal Navy used the harbour as a main base starting in the mid-17th century and it subsequently became an unofficial capital of Newfoundland (Cadigan 2009: 58). The Navy worked from the late spring to early fall convoying merchant ships throughout the Atlantic (Bannister 2003: 180). From the harbour in St. John's, they would also patrol the fishing waters to protect British capital and recruit able-bodied seamen from the fishing boats (Mercer 2006: 266).

The Royal Navy had a second role - beginning in 1729, a high-ranking officer was named governor of Newfoundland each year (Bannister 2003: 68). The governor led the naval government and along with his officers, held local judicial courts. They also jointly, with the Army garrison, provided services for the town such as town clock and fire protection (Bannister 2003: 183, Candow 2011: 101).

Many of the historical writings on the subject of the Royal Naval presence in Newfoundland have focused on the period around the American Revolution (1775-1783) up until the end of the end of the Napoleonic Wars (1815). The temporal focus of the subsequent section will be from 1699 with the production of King William's Act, which was the foundation from which naval government was founded, until 1825 when the naval station was shut down. Though the history of Newfoundland and its economic importance to Britain is long, there have not been extensive studies done on the naval presence in Newfoundland and there are in turn debates within the historiography.

The main authors who have written directly on the subject of the Royal Navy in St. John’s Newfoundland are: Deniel Woodley Prowse (Prowse 1895), Olaf Janzen (Janzen 1984; Janzen 2008), and Jerry Bannister (Bannister 2003), though others have also added to the historiography. Within this historiography there is a change over time from a progressive discourse to one about the changes within the history. The progressive history examines historical events in a positive linear fashion that observes an improved outcome. Newfoundland historians more recently have adopted a historical discourse that does not focus on the struggles experienced on the island, but tries to change the negative views and interpretations of Newfoundland’s history. The naval history has focused on the Navy’s effects on the island, rather than the naval sailors own social conditions.

2.4.3 The Royal Navy in Newfoundland

The historiography of the Royal Navy in Newfoundland starts with Prowse (1895). Though there were earlier books, Prowse’s history of the island has continued to be an influential historical writing into the present time. Prowse (1895) wrote a Whig, or progressive history of Newfoundland that focuses on the military and political achievements of the fishing island. He argues that the political, economic, and social conditions in Newfoundland improved over time.

Through the progressive discourse, Prowse (1895: 304) argues that the Royal Navy evolved from disorganized to being “the greatest sea power”. He presents the naval history in terms of naval tactics and politics, and argues that the Royal Navy originally took a convoy role protecting the merchant vessel, but served an additional role as a naval government for Newfoundland that was unsatisfactory to the residents (Prowse 1895: 287-288). He begins a number of arguments that continue to be adopted or debated in the historical writings of Newfoundland. Prowse states that the Navy helped to keep American Privateers off of land and from stealing many ships during the American Revolution. In regards to the Americans, he also argues that the point of Palliser's Act (1775) was to exclude the Americans from the fishery in Newfoundland (Prowse 1895: 344). Prowse (1895: 357-363) argues that the justice of the naval government system was brutal, unfair, and too influenced by the wills of the merchant class. It is because of this brutality and injustice that he argues that since its inception, the naval government was not effective in Newfoundland. The injustice and inadequacy led Britain to abolish the naval government and grant Newfoundland a representative government in 1832 (Prowse 1895: 287-288). Prowse (1895) separates the issues of traditional naval roles and naval government when referencing the actions of the Navy.

Although not directly focusing on Newfoundland, Baynham's (1969) social history of the lower deck of the Navy integrated politics and naval tactics to tell the stories of eight low ranked sailors. One of these sailors, John Nicol, was stationed in Newfoundland for part of his career. The writing was largely a summary of the individuals' travel journals, but the underlying argument was that the lower ranked sailors, such as Nicol, were concerned with local political and military actions rather than the bigger issues surrounding the American Revolution and the Seven Years War (Baynham 1969). In opposition to Prowse's (1895) elitist narrative, Baynham (1969) presents the experience of an average sailor in the Royal Navy. While most naval histories are presented as a description of war, Baynham (1969: 16-20) argues that this was not how it was experienced by the seamen of the late 1700s, for they were more concerned with local issues such as which enemy ships were nearby or the monotony of convoy transport from Newfoundland across the Atlantic. The book does however continue as a progressive history, not in relation to Nicol's condition specifically, but in comparisons of all the sailors' experiences with the Royal Navy. Baynham (1969: 182) argues that the treatment of sailors was brutal, but improved overtime. His work presents a new topic of naval impressment to the historiography of Newfoundland, for Nicol was pressed into service at least once during his career (Baynham 1969: 19). It also represents a focus on the transient nature of the Navy, considering Nicol's different ships, and their different postings and duties (Baynham 1969: 15-34). The Navy was typically only in Newfoundland for a few months of the year, and it would not have necessarily been the same men coming each year as evidenced by the change in the names of ships stationed there and the changes in the governor of St. John's as well (Baynham 1969: 15-34).

While the previous histories were more general, concentrating on broad periods of time, Janzen (1984) focuses on the Navy's defence of Newfoundland during the American Revolution. Janzen (1984) argues that the attack of the Newfoundland fishery by American privateers could not have been stopped because the Navy was ill-equipped and few in number. In 1778, when the French joined the war, there was seemingly more British naval defence, yet this was an observation in Atlantic waters in general and not specific to the Newfoundland fishery, which was instead protected by the newly constructed military fortifications (Janzen 1984). This article was a military and political history focusing on the movement of the Navy within Newfoundland.

Janzen (1984) argues that the Royal Navy was too interspersed to truly detract American Privateers. Many ships were stolen and fishing supplies destroyed in attempts to hurt the Newfoundland fishery and in turn Britain (Janzen 1984: 33-44). This is in opposition to Prowse (1895) who had understated the severity, arguing instead that the Navy was successful in keeping American Privateers from Newfoundland shores and suggests that they stole only a few ships. The tone of Prowse's (1895) discourse was likely meant to portray the Royal Navy in a more positive light. In relation to the military history, Janzen (1984) argues that the inability of the Navy to protect the fishery was the reason that the garrison was occupied after the war. This suggests that the garrison and its fortifications of St. John's were only truly important after this war.

Janzen (1984: 38-40) also argues that it was after the American Revolution that the military presence was truly influential to the island as well as the fortifications because they allowed the garrison to have a constant presence. This was the time that the government abandoned the restriction on building infrastructure not directly related to the fishery, thereby admitting that there was a population, not only a fishery to protect (Janzen 1984: 41).

Candow (2011), focusing on the Army in Newfoundland, argues that the military fortifications were always integral to the defence of the island. While Janzen emphasizes the role of the Navy in protecting the fishery, Candow argues that it was for the general safety of the whole island (Candow 2011: 24). Janzen is the first to integrate the naval and military aspects of the Royal Navy as well as making it clear that the Navy was highly transient during this period.

While Janzen (1984) focused on a time that the Navy was at war, Webb (1995) was concerned with the peacetime operations of the Newfoundland and Halifax naval stations following the loss of the 13 American colonies after the American Revolution. Webb (1995) argues that the Newfoundland naval station's involvement in the European tensions was peripheral and was mainly exhibited as pressure against French vessels involved in the rival fishery. It was also during this period that the station's patrol area was expanded to include not just the island of Newfoundland, but also the coast of Labrador all the way to the Hudson Straight and the islands of Madeleine and Anticosti (Webb 1995: 20). Webb asserts that while the Halifax naval station was focused on the loss of the American colonies, those serving in Newfoundland were focused on the protection of the island and keeping foreigners, mainly Americans, from trading with the island and participating in unsanctioned fishing. They also aided in the settlement of the loyalists both through the movement of the people and the supplies that they needed (Webb 1995: 23-32). Webb was the first to be concerned directly with peacetime operations of the Navy in Newfoundland.

While others have focused more on the military aspects of the Royal Navy in Newfoundland, Bannister's (2003) study is a legal and social history of the Royal Navy from 1699 to 1832, and its connection to Newfoundland through the naval government. Bannister (2003) argues that by the mid-1700s, the Royal Navy had created an effective and legitimate naval government that used both civil and naval authority, and enforced regulations using the legitimacy and force of the Navy. This history concentrates mainly on the elites of the Navy and of the citizens of Newfoundland.

Although Bannister's (2003) book focuses on the development of the naval government on the island, it also plays into the larger debates concerning settlement. He disagrees with Janzen (1984: 42) who had argued that the British government was openly opposed to permanent settlement in Newfoundland. Bannister (2003: 186) argues that Britain was using "the path of least resistance" by allowing common law to take precedence on the fishing island. Bannister (2003: 186) believed the naval government was serving both the fishery and the resident population. The British settlement of the island and whom the naval government's priorities were concerned with are connected, because the Navy was allowed to protect all parts of the island, not just the lucrative fishery. Bannister (2003) argued that Britain did this because the British government recognized the importance of the resident population.

Though only in a short section of his book, Bannister (2003) is the first to deal directly with the daily lives of sailors in Newfoundland since Baynham (1969), who was analyzing naval sailors' accounts across the Atlantic. While Baynham (1969) argues that naval rule and punishment was brutal, Bannister (2003) disagrees. He instead suggests that although punishment was used as social fear, the Royal Navy minimized how often it was needed by using public hangings to dissuade people from acting poorly in the future (Bannister 2003: 221). The Navy itself was not brutal to their own, nor were they to Newfoundland residents because they needed to avoid mutinous behavior (Bannister 2003: 220).

Bannister asserts that the naval government was neither corrupt nor inefficient (Bannister 2003: 22), as Prowse (1895) and others had earlier argued. He maintained that the government was legitimate and the discourse against it began in the early 19th century by reformers who in pushing for representative government distorted the truth by arguing that the naval government was ineffective (Bannister 2003: 185, 258). Though there were some disagreements between merchants and the naval government, they led to continual developments of the judicial system so that it effectively dealt with legal disputes (Bannister 2003: 22). A key point that Bannister (2003: 288) makes is that the "growth of judicial authority" cannot be associated only with "the goal of social justice". This puts the justice system within its temporal context and explains a number of problems that historians had with the naval government system.

Another who put a controversial subject within its local historical context is Mercer (2006) who examined the Murder of Lieutenant Lawry as a social and political history study. Mercer (2006) argues that Newfoundland was an important area for Royal Naval impressment because the fishery trained seaworthy bodies, yet there were also other common places where impressment occurred. The case of the death of Lieutenant Lawry, which occurred during a riot in late October of 1793, caused a short term local increased fear of impressment. This did not keep the Navy from using the colony for recruits; Press Gangs simply moved their work onto water and out of the town. While Mercer (2006) described the workings of naval impressment all within the context of Newfoundland, Baynham (1969: 21) simply stated that the sailor John Nicol was pressed into service without any description as to how this occurred. The subject of impressment is an aspect of the lives of Royal Navy sailors. Though serving on a Press Gang or being physically being impressed would not have been a daily situation, it was an experience that many sailors had to face. Mercer (2006) depicts how interconnected the roles of admiral and the governor of Newfoundland were. Whereas other places, such as Nova Scotia, had a governmental system that could balance Press Gangs, in Newfoundland the governor was also in charge of the men pressing others into service (Mercer 2006). This made conditions and regulations of impressment different from other areas in which Press Gangs were working (Mercer 2006: 270).

Janzen's (2008) examination of Royal Naval relations with Mi'kmaq migration to the island focuses on a slightly earlier time period than most other naval historians in Newfoundland, just before the American Revolution, from 1763 to 1766. Janzen (2008) argues that the Mi'kmaq was disrupted by French/English tensions in attempts at trade and procuring by Roman Catholic priests. The Navy patrolled the areas the Mi'kmaq were using as a disincentive towards their settlement in Newfoundland and trade with France (Janzen 2008). Like his previous article (Janzen 1984), Janzen (2008) focuses on both the military and governing aspects of the Navy. During the governorship of Hugh Palliser, the Royal Navy discouraged illegal trade and the settlement of the Mi'kmaq (Janzen 2008: 12). Janzen's (2008: 9) analysis of the relations with the Mi'kmaq after the Treaty of Utrecht suggests that this change in focus of the Navy came from Governor Palliser who was worried about the implications of Mi'kmaq settlement in Newfoundland, rather than the commodore Captain Thomas Graves who in 1763 was concerned about the trade of Mi'kmaq and French in Saint-Pierre. Janzen's argument that

Palliser was actively against the settlement of the Mi’kmaq also adds to the debate of whether or not Britain was actively against settlement.

Cadigan (2009) more recently wrote a book looking at the socio-political and environmental history of Newfoundland. He argues that the environment is a large factor in the possible size of population and placement of economy in Newfoundland (Cadigan 2009). Britain dominated the fisheries in Newfoundland starting in the 18th century and permanent settlement on the island began to rise. He asserts that the naval government was established to serve the people and the fishery, but it did not fulfill the needs of the mixed society and so the people pushed for a change to a representative government, which they received in 1832 (Cadigan 2009).

Within his book there are continuations of arguments that previous historians had made. Cadigan continues Janzen’s argument about the American Privateers and the improperly trained and staffed garrison that could not defend the St. John’s Harbour (Cadigan 2009: 75). However, he also disagrees with Prowse that King William’s Act (1699) was to stop the Americans from fishing (Prowse 1895: 344), arguing rather that it was meant to protect the migratory fishery. Cadigan (2009) argues that the naval government typically used the Act to help the residents of the island, rather than to protect the migratory fishery. His argument support that Britain was against settlement, but clarifies that it was not always translated into Newfoundland (Cadigan 2009: 58-59). This leaves the debate of settlement unresolved; for Candow (2011) later goes against this just as Bannister (2003) had done before him, saying that Britain knew how important settlement was to the security of the island’s fishery (Cadigan 2009: 24).

Cadigan (2009) disagrees with Bannister (2003) on many key arguments, making it clear that there are a number of continued debates within the naval historiography of Newfoundland. He argues that the justice of the naval government was “not ideal” – reverting to the previous argument that it was not fair, which Bannister had argued against (Cadigan 2009: 60). Cadigan (2009) also argues that the problems with the naval government began in the 1770s, rather than the beginning of the 1800s. He states that in the 1770s merchants became disenfranchised from the naval government’s administration because they did not believe that the government was protecting their property rights (Cadigan 2009: 75-76). In addition, the merchants were dissatisfied with their inability to speak up against the naval government because of class inequalities in St. John’s (Cadigan 2009: 82-83). The suggestion that problems with the government started as early as the 1770s does not conform to Bannister’s (2003: 258) argument that it was a reform discourse, because this movement did not begin until the turn of the 19th century.

Together, these readings contribute to the understanding of historical events and their outcomes. The naval history of Newfoundland has mainly been studied through the political lens because of the focus on the naval government. While some social histories have been written, they focus more on how the naval sailors affected the town of St. John’s, rather than the social conditions under which the sailors were working. Although originally the roles of Navy and naval government were studied separately, since Janzen (1984), they have been intertwined, but with more emphasis given to the naval government. The main focus of the histories has been on the Royal Navy’s general effect on government, trade, or on individual governor’s decisions.

Historian's use of a progressive dialogue ended in the 1980s when they began readdressing the naval history as representing continual change and disproving certain negative aspects that the progressive discourse had overlooked. The social debate in the naval historical writings comes through in the controversy of the naval governments' treatment of Newfoundland residents. Though the focus of these histories is very different, they both contain broader discussions concerning Britain's perception and interest in the island of Newfoundland and its inhabitants.

There are a number of prominent debates within these writings that are interconnected. The treatment of the sailors is connected to the extent to which the British were concerned with Newfoundland beyond just financial gains. Janzen (1984; 2008) and Cadigan (2009) argued that the British were against settlement, while Bannister (2003) and Candow (2011) argued that regulations against settlement were not meant to be enforced during the 18th and 19th centuries. This perception expressed by British officials compared to those on the island is associated as well with the controversy of the brutality of the naval government and how it led to the formation of representative government. This is directly associated with those who made the argument of whether the naval government was focused on protecting the fishery or the island as a whole including the residents with Prowse (1895), Janzen (1984; 2008), and Cadigan (2009) arguing against Bannister (2003) and Candow (2011).

Yet to be resolved are a number of these debates that center around how involved Britain or the naval government were with those residing on the island. This includes whether or not Britain was actively against settlement. Also unresolved is whether the focus of the naval government was solely on the fishery or also includes the residents. Another continued discussion is when the British military fortifications of St. John’s became integral to the safety of the island.

These are not the only questions left unanswered by the historiography. The first topic that was not addressed by these previous writings is that of the transient nature of the navy. The naval historians all addressed in their writings that the Navy was mobile, typically in relation to convoys or the summer naval occupation of the island. What was not analyzed was how the change of officials affected the naval government. If Britain had a *laissez-faire* attitude, this change of governors, captains, and general sailors was likely to have had a significant effect on the extent of the impact the Navy had on the island. An additional gap to the historiography is the examination of naval governors other than Palliser. Though he was governor during a critical period of Newfoundland history, the naval government served for almost a century and the changes over time have not been effectively examined. Finally, the experience of the naval sailors in Newfoundland has not been fully explored. The military history has focused on this aspect, but the naval history has not. The Royal Navy brought together a large and diverse group of sailors; their interactions, backgrounds, and social conditions are significant considering how large an increase in people this would have been to the population of St. John’s. While historians have gained valuable insight into the Navy in Newfoundland from the 18^{th} to early 19^{th} centuries, further studies of social experiences and the transience of sailors will give a more nuanced view of their role in the development of Newfoundland.

2.5 Conclusion

Manned with hierarchically organized sailors and marines, the Royal Navy was active globally to protect British interests as well as those of the colonies. While the diets of different social classes and regions within the British Isles varied, the Royal Navy served as a promise of food and a salary. How variable the Royal Navy served as a promise of food and a salary. How variable the types of rations were is something that is not well understood, particularly considering not only the corruption within the Victualling Board of the Navy, but the possible ease of access of non-sanctioned foods while stationed abroad. The Royal Navy was a large source of employment during the 18th and 19th centuries, yet not all volunteered for such a career. The Navy commonly resorted to impressment to fill their numbers; one important place where this occurred was in Newfoundland. The Royal Navy was present on the island as a form of government as well as protection for the lucrative cod fishing industry. Despite the Navy's importance to the development of the island, naval histories of Newfoundland have focused on the impacts their presence had on the local population through governance or naval movements during peacetime and war. Little to no attention was given to the men and occasional women who served in the Navy, leading to a less holistic understanding of the Royal Navy in Newfoundland.

Chapter Three

3 Background on the St. John's Naval Hospital and the Southside Cemetery

Construction workers uncovered human remains on the south side of St. John's Harbour in 1979, immediately resulting in discussions as to what historical institution they were associated with. Previous documentation and writings have given support to association with the St. Mary's Anglican Church and with the Royal Naval Hospital. Both were located on the Southside Hills, though nearly a century apart. The Royal Naval Hospital was likely functioning from the early 1700s to the early 1800s (O'Neill 2003), while the St. Mary's Anglican Church was built in 1859, but the cemetery not used until 1879 (Marshall 2012). A summary and analysis of these findings are presented to examine the development of information regarding the Royal Naval Hospital, and the probable association of the cemetery. An examination of historical documents from the St. John's Naval Hospital suggests a reexamination of previous understandings of the institution in necessary, and gives insights into the identity of those being admitted and for what ailments. Additionally, naval vessel muster records were analyzed for the sailors' origins to suggest the diversity of peoples and experiences that may have been brought together within the walls of the Naval Hospital in St. John's.

3.1 Southside Cemetery Excavations

In November of 1979, construction workers uncovered human remains while digging sewer lines on the Southside of St. John's Harbour. The Newfoundland Constabulary Criminal Investigation Division excavated the remains. There were two newspaper articles written about the remains just after their discovery. The first article published on November 9th 1979, highlighted that remains had been uncovered and that that was not the first time that skeletal remains had been found on the site, a similar situation having occurred approximately 15 years previously (Evening Telegram 1979a). An article published the following day highlighted a loss of history and information from the hasty recovery of the remains that resulted in the "failure to appreciate our heritage" (Evening Telegram 1979b). Not only was the location of the cemetery forgotten, but the histories of these individuals were also lost (Evening Telegram 1979b).

There has been a debate as to the provenance of the remains uncovered in 1979 since their discovery. The question of whether they were from St. Mary's Anglican Church or were associated with the earlier Naval Hospital arose in the original Evening Telegram (1979a and b) articles. Cannon R.R. Babb of St. Mary's Church was quoted as having said that "the cemetery of undetermined age was in use before the construction of the Old St. Mary's church, which used it from then on" (Evening Telegram 1979a), suggesting that the Southside Cemetery was used by both an unknown earlier group as well as the Anglican church. Yet, the next day the journalist did clarify that "maps and other records indicate there was a British naval cemetery in that vicinity and the remains could have come from" (Evening Telegram 1979b). These two suggestions, a church cemetery or a Naval Hospital cemetery, remained unresolved.

Tanya von Hunnius, as part of a graduate paleopathology course, produced a report on the collection from the Southside Cemetery. First, von Hunnius (1998) performed a search of locally accessible documents that referred to the cemetery on the south side of St. John's harbour as well as the Naval Hospital. She concluded that it was not certain whether or not the cemetery was associated with the naval hospital or St. Mary's church, but her personal opinion was that it was associated with the Royal Navy. The analysis of the remains determined that there were a minimum number of individuals (MNI) of 21 based off of the number of un-sided mandibles. According to cranial suture closure and dental attrition, and epiphyseal fusion**,** von Hunnius (1998) identified the individuals as being predominantly less than 30 years of age, with one to two sub adults. All but two that could allow for sex estimates were male. The mean stature was 5'6" which was close to the ideal height the Navy was looking for, considering the lower ceilings of the decks (von Hunnius 1998: 50-51).

The health of the remains was considered within the context of the Royal Navy (von Hunnius 1998). Two crania displayed cribra orbitalia (porotic hyperostosis on the orbital roof), though the exact reason for this condition is unknown due to the poor preservation and disassociated nature of the bones (von Hunnius 1998). Von Hunnius speculated that considering the context, this could be due to scurvy given the poor diets of the sailors (von Hunnius 1998: 52). The muscular attachments of some skeletal elements were more robust than others, a point that von Hunnius associated with the hierarchy within the Navy, with those of lower classes doing the hard labour such as rowing and rope pulling (von Hunnius 1998: 53-54). There was a high predominance of periodontal disease, which von Hunnius recognized as unsurprising in a potential naval population, as their poor dental hygiene and diet consisting of sticky foods such as oatmeal and hard biscuits, which are good producers of caries (von Hunnius 1998: 57).

Unfortunately, the co-mingled and poorly preserved nature of the remains precluded more definite paleosteological assessments (von Hunnius 1998: 57-58). Ultimately, the characteristics of the remains were consistent with a naval origin.

Though von Hunnius' (1998) report on the remains from the Southside Cemetery suggested a naval origin, reports since have emphasized that there is still evidence supporting both arguments (Mills 2002). To understand the possible origins of the remains, a general understanding of the institutions possibly associated with the remains must be examined.

3.2 Location and Origins of the St. John's Naval Hospital and the Southside Cemetery

There have been very few studies that have referenced the St. John's Royal Naval Hospital and the possible associated cemetery. Understanding the development of these ideas relating to the hospital is important to determining the facts behind the Royal Navy's medical presence in St. John's during the 18th and 19th centuries.

The first written recognition of the cemetery is found in the remarks by Keegan (1937). This historian claimed that a hospital was at the foot of St. Patrick's Street with a cemetery directly across the harbour. He claimed that construction workers found skeletons and coffins with military buttons inside. Keegan assumed that this was a military hospital and an associated cemetery (Keegan 1937: 123). In reference to the military hospitals in the city, he wrote (Keegan 1937: 123):

> One [military hospital] – a small one – was situated at the foot of Patrick Street on the site of the present gas-house. Moreover, there was doubtless a military burial-ground in a line directly south from this, at the foot of the South Side Hills, as

> some years ago, when excavating in this spot, workmen found skeletons and the remains of coffins, together with many military buttons. It is quite reasonable to suppose that this building may have been used for infectious cases only, being as this time isolated from the main garrison which was situated at Fort William, the site of the present skating and curling rinks.

The first description of the naval hospital itself was made by O'Neill (2003), originally having published in 1975, who was referring to a plaque that has since been removed. According to O'Neill (2003: 735-736), the plaque read:

> A small hospital for the treatment of sick and infirm seamen from ships of the Royal Navy serving in the Newfoundland squadron was built near this site about 1725. Originally designed for use during the summer when the squadron was on station this building was found inadequate for the increased number of patients from the large squadrons stationed here throughout the American Revolutionary War and was replaced by a larger building erected nearby in 1779. The old hospital was maintained until Newfoundland ceased to be a separate naval command in 1825. A brewhouse for the brewing of spruce beer to combat scurvy amongst the ships crews was maintained near this site during much of the 18th century.

This gives a clear start and end date to the use of the Naval Hospital in St. John's as well as when and for whom it was used. Also important to note is O'Neill's reference to the remains of Shanawdithit, the last known Beothuk who is said to have been buried in a cemetery on the south side of St. John's harbour. O'Neill refers to this cemetery as having been associated with the Royal Navy, stating that "sailors without any known religious affiliation were interred in this plot" (O'Neill 2003: 734-735).

Poole (1984: 1041) added stated that the original hospital building was converted to a storehouse;

> [A] hospital was built by the Royal Navy in 1725 on the Southside of St. John's near Fort Amherst. Used for the treatment of sick and infirm seamen, the hospital was considered inadequate. A new facility was built nearby in 1779 and the patients were transferred from the naval hospital. The old building was then

> used as a naval storehouse until 1786 when it was torn down. The new hospital continued to operate until 1825 when the Island ceased to be a naval command post for the British Forces.

This very general history of the Naval Hospital remained unchanged until the 21st century with the work by Newfoundland archaeologists analyzing cartographic evidence, adding and clarifying parts of the story of the Naval Hospital. Archaeologist Stephen Mills (2002) produced a Stage 1 Historic Resources Assessment of the land proposed to be used for the sewage treatment plant on the south side of the Harbour, researching the potential of the land including the location of Naval Hospitals and the buildings associated with St. Mary's Church. Through the examination of multiple maps, mainly the 1751 (Figure 3-1**,** Figure 3-2) and 1798 (Figure 3-3**,** Figure 3-4) maps of St. John's Harbour, Mills (2002: 7) identified a change of location and orientation between what is denoted as being the Naval Hospital. He connected this change as being associated with the building of a new hospital during the American Revolution (Mills 2002: 7). Mills also acknowledged the presence of multiple buildings belonging to St. Mary the Virgin Anglican Church, including the church itself, the rectory, and the parish halls on Southside road (Mills 2002: 8-11). Mills (2002: 12) suggests that the presence of a Church of England Cemetery was evidenced by the burial of Shanawdithit that was recorded in a Parish Register, but the suggested cemetery was dismantled in 1903 with the construction of the Newfoundland Railway yard, whose remnants currently cover the known location of the 1979 discovery of human remains.

Figure 3-1. A section of "A Part of St. John's Harbour, 1751" by Braham James, highlighting the south side of St. John's Harbour, NL. Microfiche on file at Queen Elizabeth II Library, Memorial University, NL.

Figure 3-2. A section of "A Part of St. John's Harbour, 1751" by Braham James, emphasizing the Naval Brewhouse and the square to the west (left) that corresponds to the location of the burials from the 1979 construction work on the south side of the harbour, St. John's, NL. Microfiche on file at Queen Elizabeth II Library, Memorial University, NL.

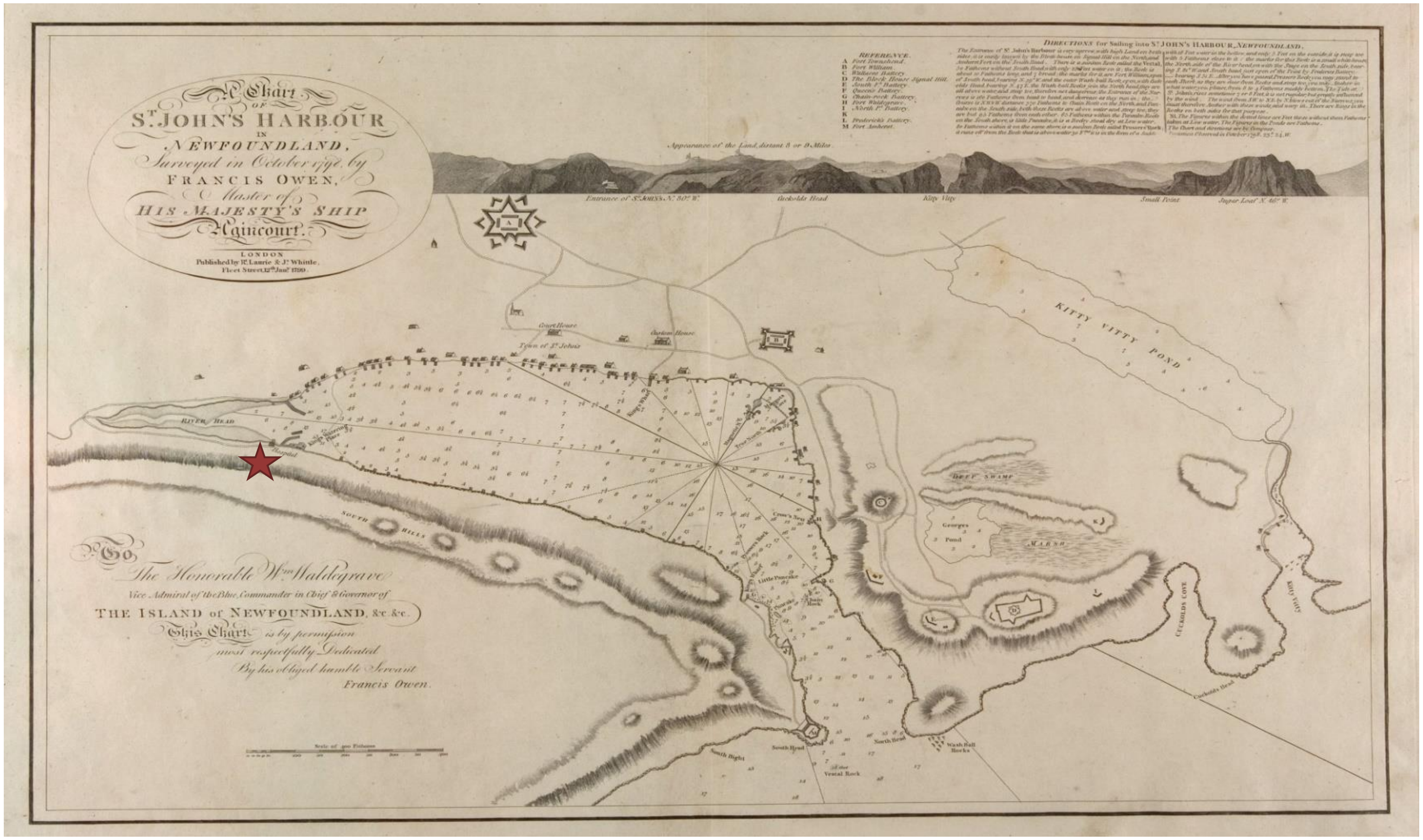


Figure 3-3. “A Chart of St. John’s in Newfoundland” surveyed in 1798 by Francis Owen, Master of His Majesty’s Ship Agincourt. Note the Kings Wharf and hospital, denoted by a red star, at the end of River Head at the bottom of the Southside Hills. Centre for Newfoundland Studies, Digitized Maps.

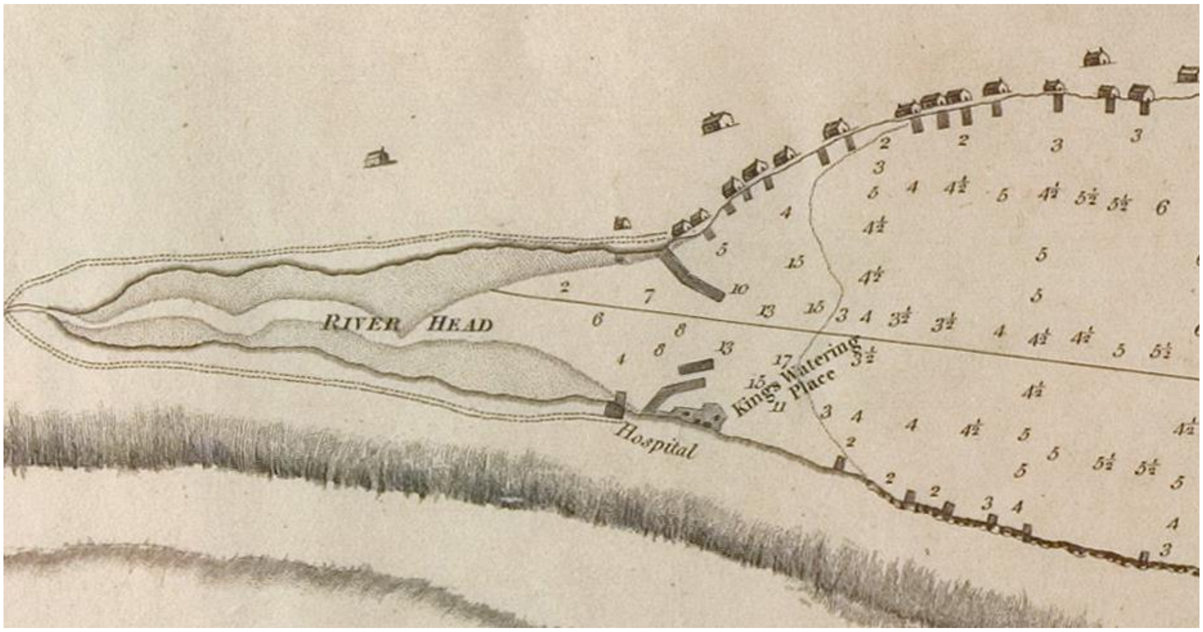


Figure 3-4. “A Chart of St. John’s in Newfoundland” surveyed in 1798 by Francis Owen, Master of His Majesty’s Ship Agincourt. Enlarged to highlight the detail of the Hospital and King’s Water Place at River Head, St. John’s, NL. Centre for Newfoundland Studies, Digitized Maps.

Recognizing the debate of the cemetery’s provenance, Mills (2002) examined two land registry deeds (Figure 3-5**,** Figure 3-6) suggesting that the burial ground is beside the Glebe land, which is the land of St. Mary’s Church and the Reverent H. Bridge. Yet two coins found on the eyes of an individual buried at the cemetery date to the last quarter of the 18th century and a wool shroud that was not used later than 1814 (Hett 1980), suggest that the cemetery was in use congruently with the naval hospital (Mills 2002). In turn, the uncertainty of the provenance of the cemetery remained.

Archaeologist Gerald Penney produced a memo about the history of the Watering Place Brook, which was used during the 17th to 19th centuries as the King’s

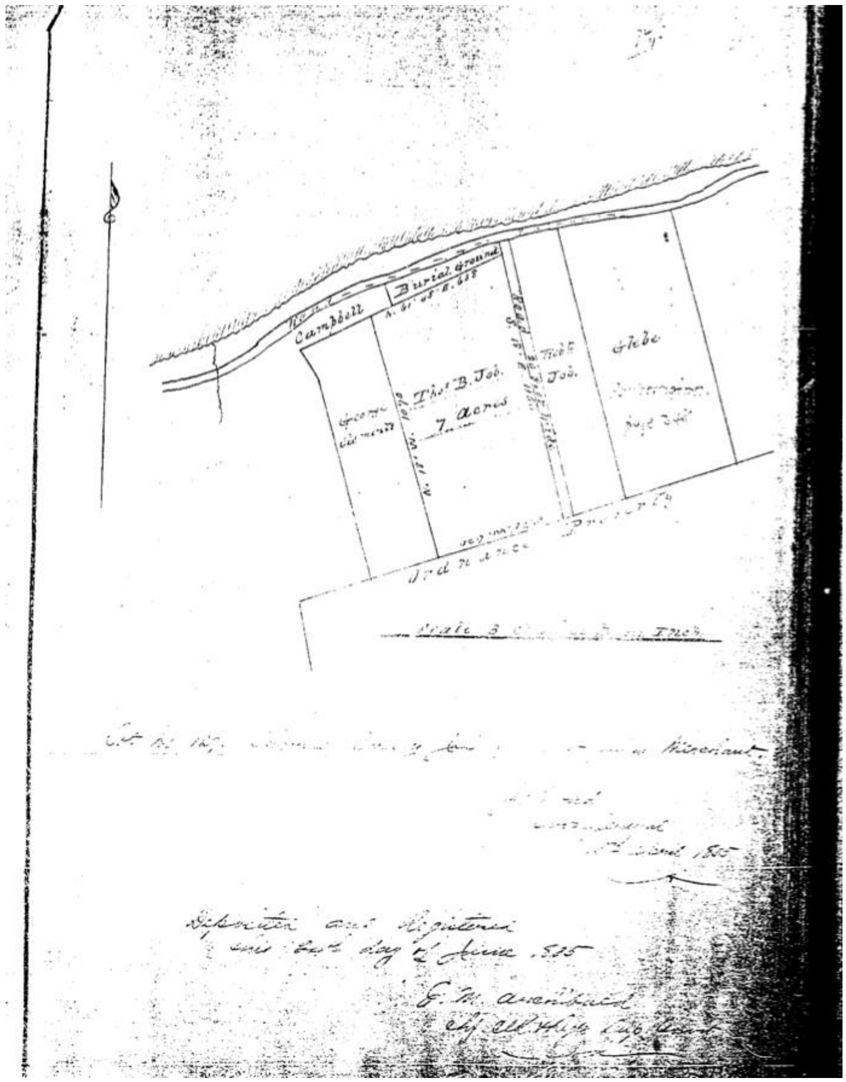


Figure 3-5. Copy of the 1835 Land Registry deed to Thomas Bully Job for Lot 127 south side of St. John's Newfoundland showing the location of the burial ground on Southside Road (copied from Mills 2002); original source Original Registry, Volume 2 Folio 49 No. 127 Provincial Lands Registry Division Howley Building St. John's Newfoundland)

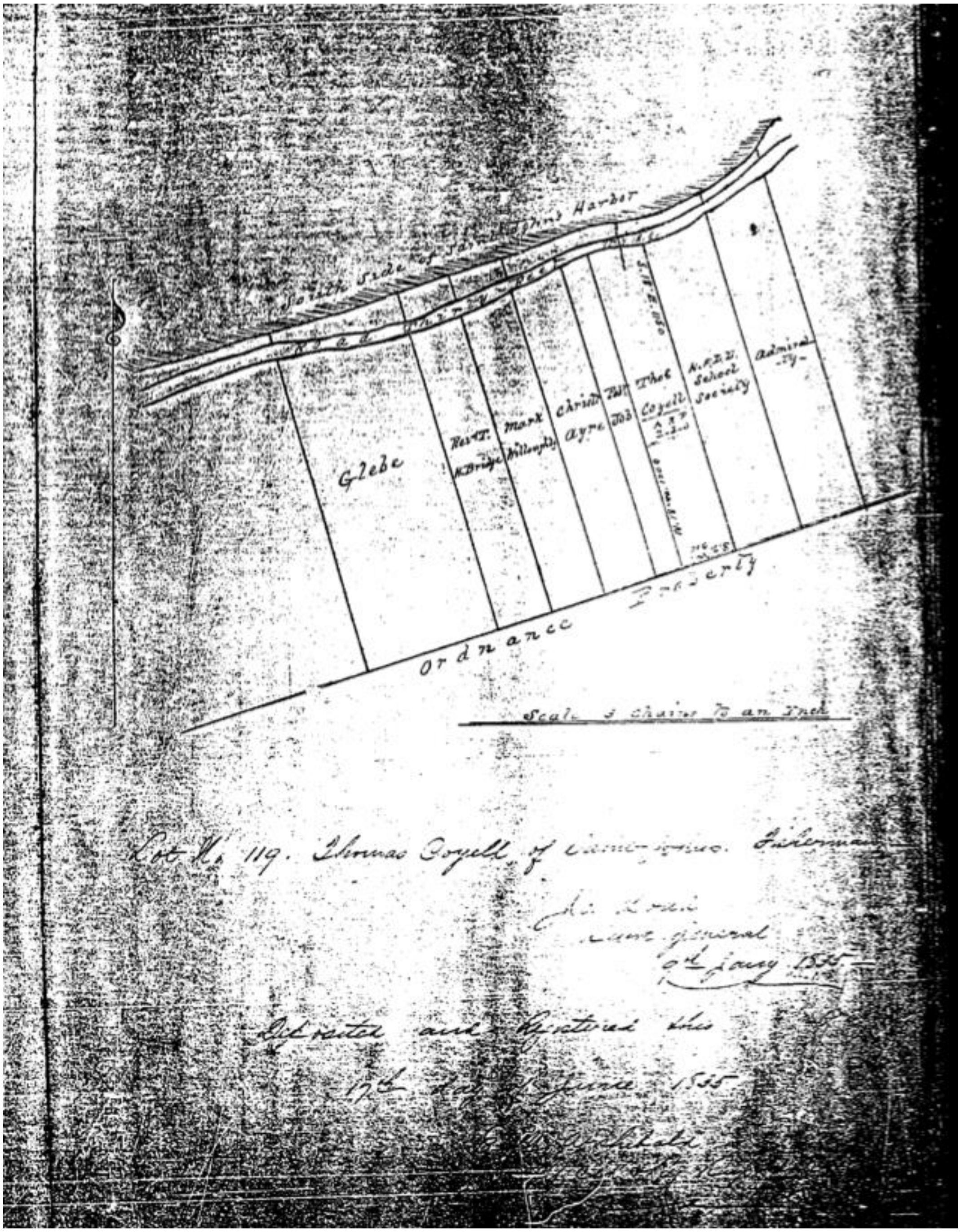


Figure 3-6. Copy of the 1835 Land Registry Deed to Thomas Coyell for Lot 199 south side of St. John’s Newfoundland showing the location of the Glebe land and the future location of St. Mary’s church (N.F.L.D. School Society Land). Copied from Mills 2002 (original source from Original Registry. Volume 2 Folio 46 Np. 119 Provincial Lands Registry, Howley Building, St. John’s Newfoundland).

Watering Place (Penney 2005). This contained a brief report of known writings regarding the watering place, and a summary of the structures and place names along the Southside Hills. He examines and describes all maps that pertain to the watering hole; however, this location happens to overlap with the presence of the Navy, and the Naval Hospital. Penney (2005) suggested that the first presence of possible Royal Naval structures is the 1741 reference to “Men of Warr tents where they brew”. The first appearance of the Kings Wharf and the Naval Hospital was in 1751 (Figure 3-1**,** Figure 3-2). Penney suggests that it was likely in the 1740s that the hospital was created, as denoted by the cartographic evidence. The Naval Hospital still appeared at this location in 1765 map of St. John’s harbour. The Wharf, though not angled, was present in 1765, but the Naval Hospital was there unchanged in location. Like Mills (2002), he recognized the change in orientation of the hospital in the 1798 map (Figure 3-1**,** Figure 3-2). The 1813 map, not depicted here is the last surviving of relevance to the Naval Hospital, places an unidentified large structure where the Naval Hospital had previously been located (Penney 2005).

3.3 Summary and Critical Analysis of the Southside Cemetery Origins

From these previous studies there is one consistent concept: that the St. John’s Naval Hospital was in use from 1725-1825, having been rebuilt once during the American Revolution. This discourse is maintained throughout these histories, yet the original source is not clearly documented anywhere. O’Neill (2003) suggests that this was the information given on a plaque close to the site of the hospital, yet from where its creators compiled the details of the hospital is unknown. These dates of the hospital are also brought into question, sometimes within the same documents that use these dates; for example, as it was suggested that Shanawdithit died at the hospital in 1829 and buried in the cemetery (O'Neill 2003: 734-735), yet this would have been after the hospital supposedly closed. The information presented without clear documentation has remained unchallenged without clear documentation until this century. A critical analysis of these documents follows.

There are a number of aspects of the history of the cemetery and the Naval Hospital on the Southside that are suspicious because they do not line up with the broader historical context. For example, O'Neill (2003) presented a rather questionable piece of information, suggesting that the Naval cemetery on the Southside was only for those with no known religious affiliation. This seems to be speculation as it was very common for Royal Naval Hospitals to have their own cemeteries (see Varney and Nicholson 2001; Shortland et al. 2008; Hodgins and Pamment-Salvatore 2009).

The mysterious military hospital referred to by Keegan (1937) is interesting as there is no known other documentation for this hospital from which Patrick could have been sourcing his information, save the 1787 map which places the 'Royal Hospital' on the north, not the south side of the harbour (Figure 3-7**,** Figure 3-8). The term 'Royal Hospital' solely denotes a royal patronage for the hospital; this occurs with army and naval hospitals, but also with publically accessed hospitals such as the infamous Bethlam Royal Hospital in London England (Hargraeves 2009; Rubin 1989: 124). Keegan (1937) names it a *military* Hospital, which although this can mean either Army or Navy, he refers to the garrison implying that he meant the Army. There are multiple

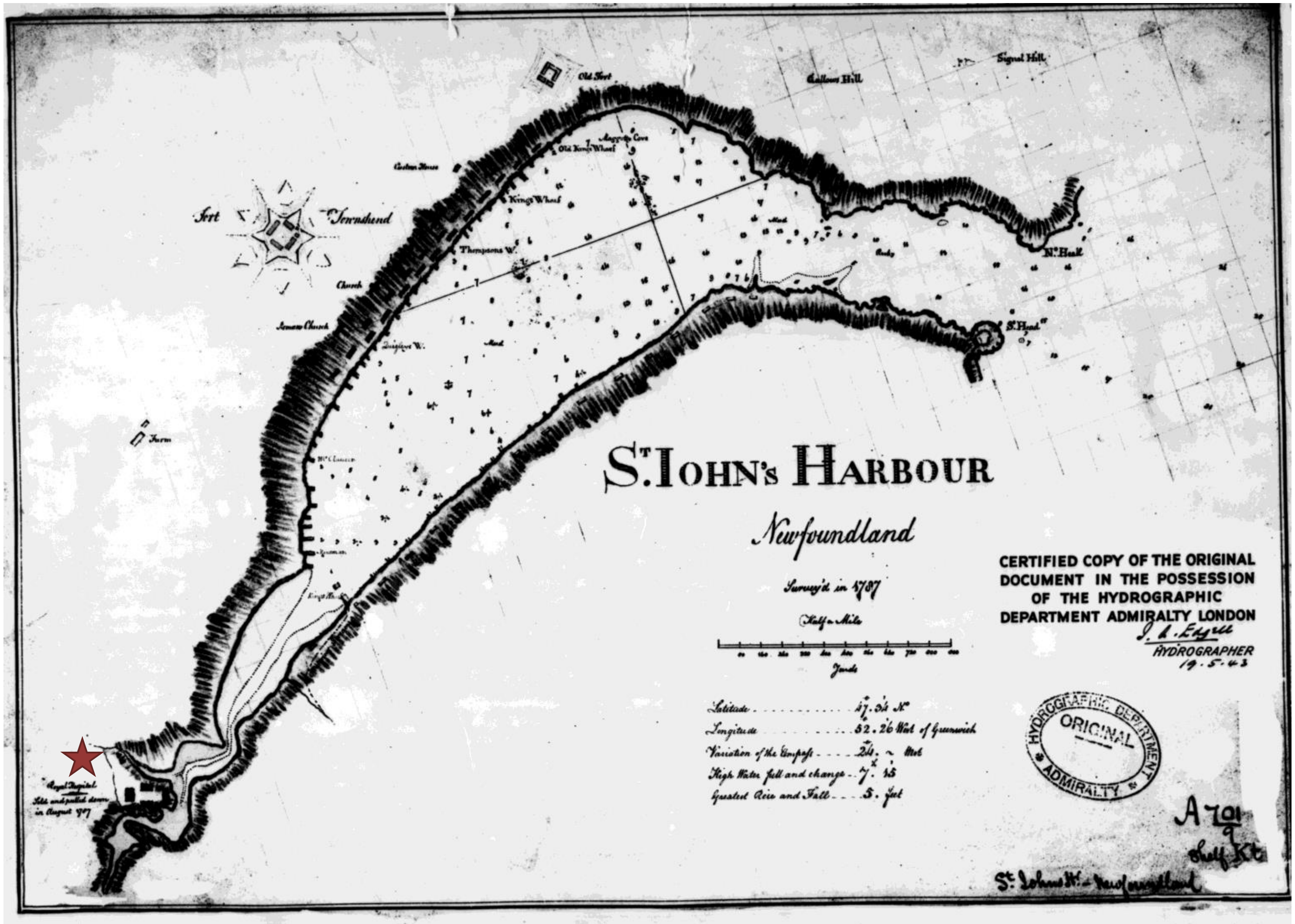


Figure 3-7. 1787 Map of St. John's Harbour. Note the location of the 'Royal Hospital' on the North Side of the Harbour. [For enlargement see Figure 3-8]

Figure 3-8. 1787 Map detailing the Royal Hospital on the North side of the Harbour along with the King's Wharf on the South side. The writing below the Royal Hospital reads" Sold and pulled down in August 1787."

possible explanations for this map, though without other documentation it can only be informed speculation. The hospital is not depicted on other maps from the period (see Figure 3-1, Figure 3-2), suggesting that if it was in use by either the Army or the Navy, it was done briefly.

The presence of the ‘Royal Hospital’ on the north side of the harbour will for now have to remain a conundrum. One alternate explanation is that the creator of that map was misinformed, as the map was created in the same year in which the structure depicted was torn down. Interestingly, this date is only one year later than the original 1725 Naval Hospital was said to have been torn down after some use as a storehouse (Poole 1984: 1041). Therefore, it is also possible that the hospital depicted in on this map (Figure 3-8, Figure 3-9) was simply misplaced within the harbour.

The important part of Keegan’s (1937) account to this study is the presence of a cemetery on the south side of the harbour across from St. Patrick’s Street, the known location of the cemetery where remains were uncovered in 1979 (Mills 2002). It must be noted that though the location of the remains Keegan (1937) said were uncovered sometime before 1937 is unknown, it does suggest that military personnel used the cemetery. This is due to the supposed presence of the military buttons (Keegan 1937: 37). Though Keegan was insinuating that the buttons were Army and not Navy, without the artifacts to corroborate his account, it is impossible to say whether or not they were of either faction of the military. This military connection to the cemetery is something that the hasty recovery in 1979 did not find.

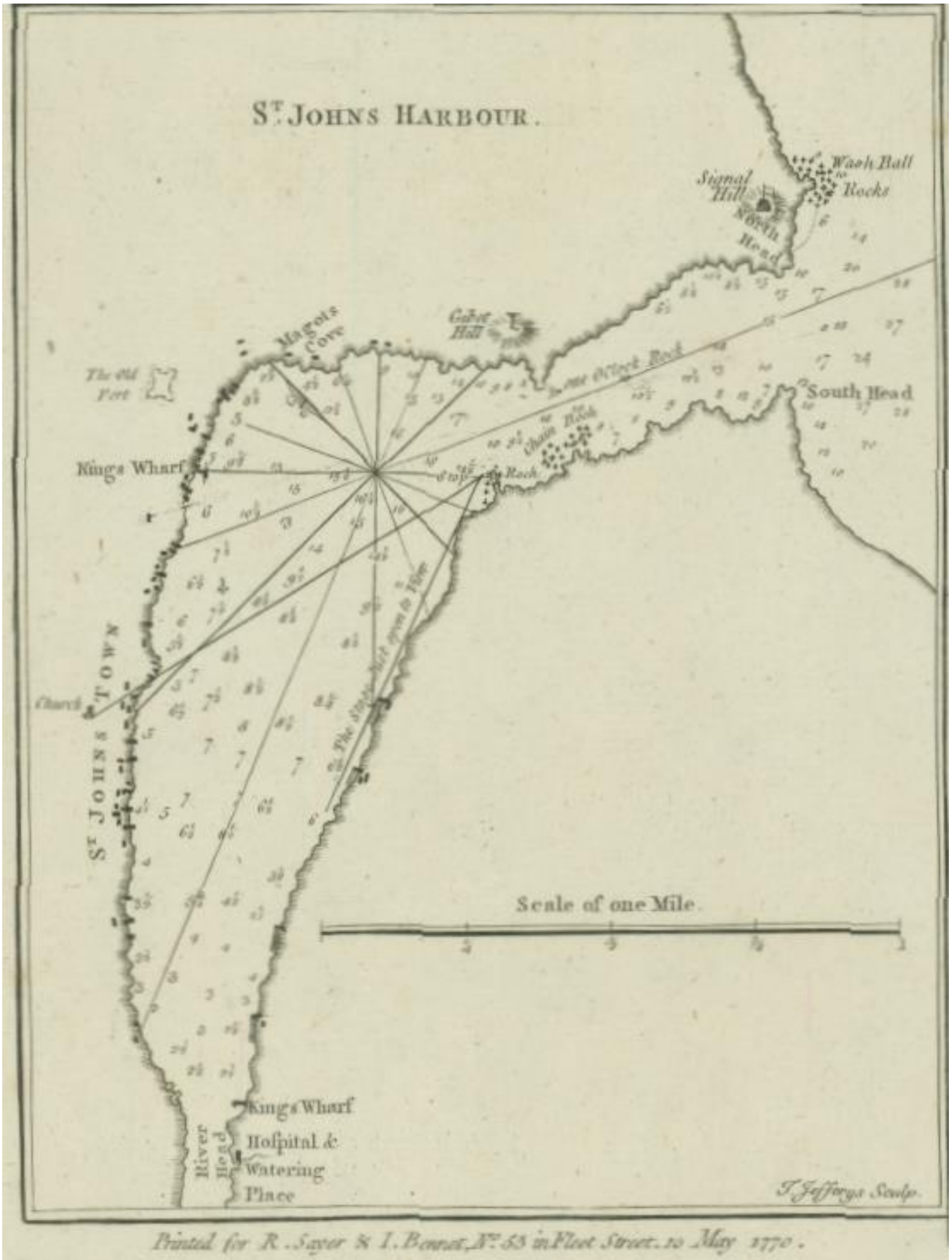


Figure 3-9. 1770 Map of St. John's Harbour created by R. Sayer and J. Bennett (firm), and T. Jefferys. This is part of a larger map that also included Trinity harbour, Carbonear, Harbour Grace, and Brigus Head to Fermouse. Note the King's Wharf, Hospital and Watering Place at the south of the harbour.

Mills (2002) suggests that the evidence from the Land Registry deeds also suggest that the cemetery was where Shanawdithit was buried. However, there are many varying accounts of the location of Shanawdithit's death, and even whether or not she was given a Christian burial, as she had not converted during her time in captivity (Poole 1984; Marshall 1996; Howley 2000). Therefore, the suggestion by Mills (2002) that the cemetery was the same one in which Shanawdithit was buried does not suggest that it was a Church of England Cemetery. Also, there was significant industrialization and selling of land in the early 19th century, which could explain why the cemetery does appear next to what was the church land. This was true as well from the late 19th century to today. The view of Riverhead has changed drastically as can be seen from a photograph taken sometime in 1880s depicting the Southside from above Job's Bridge looking into Waterford Valley (Figure 3-10). The approximate location of the 1979 excavations of the Southside Cemetery is directly across the harbour from the gas works which is the jut of land with structures on it, just left of the centre of the photograph (Figure 3-10). The inconclusiveness of this evidence leaves open the possibility of the cemetery being associated with either institution.

Information that can be corroborated from historical documents includes the presence of a Naval Hospital on the south side during the 18th century. The hospital was likely rebuilt or moved location and orientation between the 1770 and 1798 maps (Figure 3-1, Figure 3-2, Figure 3-9) (Mills 2002; Penney 2005). The presence of the cemetery is

Figure 3-10. A photograph from ~1880 of the Southside Hills looking towards Riverhead in St. John’s Harbour, NL. Notice the Gasworks on the north side of the harbor across from which is the Southside Cemetery. City Archives Holdings, St. John’s, NL.

only located on one map, that being the land registry deed and this location is consistent with where the remains were found in 1979 (Figure 3-5) (Mills 2002). Another map's object overlays what is known to be the cemetery's location; the square on the 1751 map that is beside the naval brewhouse (Figure 3-1, Figure 3-2) (Cuff and Penney 2014). Without a proper map legend, it is not possible to determine if this was depicting the cemetery or some other structure. There were two coins found on the eye sockets of one individual during the 1979 excavation that date to the last quarter of the 18th century, a century before the St. Mary's Anglican Church first began interring the deceased (Hett 1980). The possible depiction of the Southside cemetery in the 1751 map, the dates from the coins, and all other aspects explained above come together to suggest a high probability of the cemetery found in 1979 was associated with the Royal Naval Hospital that was located close by.

3.4 Rational for Assuming the Origin of the Southside Cemetery is the St. John's Naval Hospital

St. Mary the Virgin Anglican Church was built in 1859 to serve the congregation of Anglicans on the south side and west end of St. John's. Between 1911 and 1914 the church had an extension built to accommodate more people, raising it from 400 to 650 people. A new church was opened in 1962 away from the original site (Cousens 1960; Mills 2002). The history of the development of St. John's Naval Hospital follows.

A review of St. Mary's Church burial records suggests that the cemetery encountered in 1979 was not that of the Anglican Church. Although the church was opened in 1859, burials did not occur until 1879 (Marshall 2012). Many of the burial records for this cemetery have been transcribed to digital sources. Those used here were produced by Jill Marshall in 2012. All data presented below is from these records. During the first year the cemetery was used, more females than males were buried; 11 and 3 respectively (Table 3-1); in 1880 and 81, the numbers were closer to equal between the two sexes. Therefore, it would be very likely to find a large number of female remains in a cemetery associated with this church. St. Mary's Church burial records from 1879-1881 indicate that the interred had a mean age of death of between 18 and 30. This being said, there was a large range in ages, many were under the age of 5, and some just a few days old. Based on these records, not only would it be likely to find females, but also very young children within the remains found at a cemetery associated with St. Mary's Anglican Church. This is not the case in the remains found in 1979 according to von Hunnius (1998).

Table 3-1. The sex and age of females and males buried at the St. Mary's Anglican Church, St. John's, NL from 1879 to 1881.

	1879	**1880**	**1881**
Female	11	20	21
Male	3	22	26
Mean age	29.6	29.1	18.0
Minimum age	7 days	1 day	13 days
Maximum age	69	91	87

Considering the late time period, there were many more permanently settled inhabitants, rather than migratory fishermen who would be buried at this site (Head 1976). It would be likely that the majority of these individuals would have isotopic values for oxygen and strontium that represent Newfoundland. This is a hypothesis that can be tested from the remains found and will be addressed in Section 7.1.

3.5 Information in the St. John's Naval Hospital Muster Records

From previous accounts outlined above, it is known that there was a Naval Hospital in St. John's serving naval seamen, but what is not known is the nature of the hospital or the diversity of sailors who were treated there. In order to gain a better sense of the workings of the hospital, the surviving muster records of the hospital (1793-1811) as well as the muster records of a number of naval vessels that were stationed in Newfoundland during the time of the hospital were all examined at the National Archives in Kew, England. While the hospital records give a glimpse into the identity and ailments of the sailors, the vessels muster records show the diversity of origins of the sailors who were present and may have sought treatment.

The history of the Naval Hospital in St. John's has been speculated about with variable evidence over the past century. Although previously the Naval Hospital has been referred to as the 'Southside Naval Hospital' (von Hunnius 1998), the naval records identify it as the St. John's Naval Hospital, as it will henceforth be referred to as. The records directly from the hospital, though only representing 20 years, have given valuable insight into the development of the hospital and those who were treated. They allow a means by which to test previous accounts of the hospital. The hospital records are annual quarterly summaries of the hospital’s transactions, recording all payments made for rent of buildings, cost of food, and salaries of employees. In addition, they record the name, rank, and ailment that brought the individuals to the hospital, how long they remained, and whether they were returned to a ship, ran, or were buried. These accounts were kept for the purpose of recording how much the Royal Navy owed the operation of the hospital, but the information is of great value to researchers. Unless otherwise stated, the following information comes from the St. John’s Naval Hospital records at the National Archives in Kew, England (TNA ADM 102/733-734).

3.5.1 St. John’s Naval Hospital Structure

The first aspect of the St. John’s Naval Hospital that can be clarified through the quarterly finances is the structure of the hospital itself. In all previous accounts, it was said that the two buildings (the original and that built during the American Revolution) were purpose-built (Poole 1984; O’Neill 2003). While there are no known surviving records from that earlier time, the known structures used during the 20 years of hospital muster records bring the assumptions about the original construction into question. Firstly, when the records start in 1793 the infirm sailors are all recorded as being quartered at Garrett Keating’s House. They are transferred in 1797 to two separate buildings, with the last transfer occurring a year later into ‘A house on the Southside for which we pay no rent” (TNA: ADM 102/733). None of these four structures are purpose-built, all being owned privately or previously owned, which brings into question why they Royal Navy would have changed how they quartered the infirm sailors, unless there were financial concerns. It is also common for the Royal Navy, particularly in early years of the hospitals, to rent out houses or other areas of towns within which they would house sick sailors (Coad 1983: 142). Second, the fact that there were 2 changes just within the 20 years is not consistent with previous assumptions. These changes all occurred during the 1790s, the time when according to previous notions, the hospital was still the one that had been built during the American Revolution (Poole 1984; O'Neill 2003). It is unknown if Garratt Keating's house was the original structure from the American Revolution, or if previous accounts were even more incorrect, and that changes in the buildings used for the Naval Hospital were more common than previously thought.

The history of these hospital structures also gives information regarding the identities of individuals associated with the running of the Naval Hospital. The Navy boarded sailors at a house rented from Garratt Keating from at least 1793 to October 1796; a storehouse was also rented from him until October of the following year. The 1794 census indicates that there are a couple rental properties owned by Garratt Keating in St. John's, though it is unclear if his premises was in the town, or if he may have lived elsewhere (Census 1795). Therefore, the exact location of this hospital remains unclear. From May 1797 until sometime during the summer of 1798, the naval patients were housed in accommodations rented from Marmaduke Hart and Ann Saunders. Marmaduke Hart was a prominent merchant in St. John's who was contracted along with William Eppes to provision the naval squadron in St. John's (Keith Matthews Collection: H055A). The locations of the Hart premises is unclear from the 1795 census, therefore a possible location of the infirm during this period is unknown. This is not the case for Ann Saunders. She was a widow with three children and two servants living in a home owned by W. Colbert in area 4 of St. John's, which was between the Engine House and the King's Beach (Census 1795). She worked as a nurse in the St. John's Naval Hospital starting in the summer of 1795 leaving her position at the hospital after the infirm left her house. It is unclear what happened that caused the patients to have to move suddenly to non-ideal conditions, but the infirm were not long separated.

During the fall they were moved again to a house on the south side of the harbour 'for which they paid no rent'. In September and October of 1798 there were numerous individuals who were paid for the repair of the windows on the house, the rental of horses to move the bedding to the house, and a boat to carry provisions from the town of St. John's to the Southside. In the fall of 1798 an inventory of what was at the house on the south side of St. John's Harbour was taken, identifying numerous deficiencies in the goods used to house and feed the sailors. It is very clear that the buildings used for the hospital were modified to serve patients, not built to do so as was the case in many other ports across the Atlantic (Coad 1983: 142-153; Rodger 2005: 195). This final movement in 1798 would have been to the location of the Naval Hospital noted on the 1798 map of St. John's Harbour (Figure 3-3).

3.5.2 Assumptions within the Naval Hospital Muster Records

There are a number of assumptions that were made in the analysis of the hospital muster records that must be taken into consideration for the following analyses. First, the surgeons tending to the patients changed from year to year, or between and during quarters. A change in surgeons could affect the description of the ailments treated because the interpretations of the symptoms would be seen differently depending on their experience and training. The analysis assumed that this bias did not affect the trends in the data.

Second, the standardized sheets the Naval Hospital had for record keeping changed over the period of time examined. There were also times that the hospital ran out of record paper, so they modified muster record sheets or recorded notes on plain paper, at times neglecting some of the information that would be presented on standard forms. There was also variability in the level of detail that surgeons reported. For example, sometimes they neglected to record the rank of the sailor, their ailment, how long they had been victualled, and or for what reasons they were discharged from the hospital. The analysis assumed that these variabilities did not impact the trends in the data.

Third, only a few vessels overwintered in the harbour, and most vessels arrived in the early spring (Bannister 2003). The analysis separated the data annually from spring to spring, which was in line with the use of the naval use of the harbour. This was considered a more meaningful separation than a calendar year. However, the spring seasons from all years at the Naval Hospital in St. John's were not recorded the same; therefore, this study chose dates closest as possible to May or June as a start date for the year.

Finally, there is the possibility of interpreter error in transcribing the ranks and or ailments of those admitted to the hospital. When there was difficulty in determining what was written, the author left the field blank, and returned to it at a later date, this typically resulting in a clearer answer. These biases were considered during the interpretation of the results.

3.5.3 Ranks of Naval Hospital Patients

To treat sailors at the hospital, certain medical personnel were needed. First and foremost are the surgeons, of which there was only one at a time. The surgeon who was required to tend to the hospital was from the last naval vessel into port that spring from the first convoy over (LAC: C-4848). The majority of these naval surgeons during the early 19th century were trained in Scotland (Kauffman 2003: 18), and were required to participate in a qualifying course before serving on naval vessels (Rodger 2005: 196).

Nurses were also present at the hospital. Although there were always at least two nurses there, when large numbers of sailors were admitted, more nurses were brought in. According to the victualling records, it looks as if the nurses would have been housed, fed, and compensated for their time, but it remains unclear if their lodgings would have been at the hospital itself. During the early 1790s the nurses who most frequently tended to the sailors were Jane Thompson, Mary Forbes, and Jane White; these would be the nurses who were first called in before others, as the other names typically did not show up more than once. In the next decade, common nurses were Ann Campbell and Elizabeth Campbell. There was also a washerwoman who was hired out for most days of the year during the 1800s. During the early 1790s labourers were hired only rarely, yet by the 1800s labourers and a cook had a constant presence at the hospital.

In addition to the workers at the hospital, there were the patients for which the hospital cared. The St. John's Naval Hospital admitted sailors and marines from all ranks (Table 3-2). This being said, those of the lowest ranks (able seamen, boys, landsmen, ordinary seamen, and private marines) represented the vast majority of all admitted to the

Table 3-2. Number and Percentage of all ranks admitted to the St. John's Royal Naval Hospital from 1793-1797, 1806-1809, 1810-11.

		1793-94		1794-95		1795-96		1796-97		1806-07		1807-08		1808-09		1810-11	
		#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Commissioned Officer	Lieutenant	1	0.5	0	0.0	3	1.5	2	1.8	0	0.0	1	1.0	0	0.0	0	0.0
	Lieutenant Marines	0	0.0	0	0.0	0	0.0	2	1.8	0	0.0	0	0.0	0	0.0	0	0.0
	Major Marine	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Midshipman	0	0.0	2	2.7	3	1.5	1	0.9	4	5.1	1	1.0	0	0.0	1	1.9
	Surgeon Lieutenant	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Warrant Officers	Boatswain	1	0.5	0	0.0	2	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Carpenter	1	0.5	1	1.4	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4	0	0.0
	Gunner	3	1.5	5	6.8	8	4.0	1	0.9	1	1.3	1	1.0	4	5.5	0	0.0
	Master	0	0.0	0	0.0	1	0.5	4	3.6	0	0.0	0	0.0	0	0.0	0	0.0
	Purser	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	2.7	0	0.0
	Surgeon	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0
Petty Officers and Inferior Warrant Officers	Admiral Cook	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Armoury	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0
	Boatswain Mate	0	0.0	1	1.4	1	0.5	0	0.0	2	2.6	3	3.1	2	2.7	1	1.9
	Captain Foretop	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4	2	3.8
	Captain Crew	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Captain's Mate	0	0.0	0	0.0	0	0.0	0	0.0	4	5.1	3	3.1	0	0.0	0	0.0
	Carpenter's Crew	1	0.5	1	1.4	8	4.0	3	2.7	0	0.0	0	0.0	2	2.7	0	0.0
	Carpenter's Mate	0	0.0	1	1.4	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4	0	0.0
	Caulker	0	0.0	0	0.0	1	0.5	2	1.8	0	0.0	1	1.0	0	0.0	0	0.0
	Clerk	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	1	1.9

	Corporal Marines	0	0.0	0	0.0	1	0.5	0	0.0	1	1.3	0	0.0	2	2.7	0	0.0
	Coxswain	2	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Gunner's Mate	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4	4	7.7
	Master at Arms	0	0.0	1	1.4	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4	0	0.0
	Master Mate	4	2.1	2	2.7	5	2.5	0	0.0	1	1.3	0	0.0	0	0.0	2	3.8
	Quarter Gunner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	3	4.1	0	0.0
	Quartermaster	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.9
	Ropemaker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Sailmaker	0	0.0	1	1.4	2	1.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Sailmaker Mate	1	0.5	0	0.0	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0
	Sergeant Marines	1	0.5	0	0.0	2	1.0	0	0.0	0	0.0	0	0.0	1	1.4	0	0.0
	Sailmaker Crew	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Yeoman	1	0.5	1	1.4	1	0.5	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0
Ratings	Able seaman	59	30.3	31	42.5	48	23.9	40	35.7	20	25.6	17	17.7	15	20.5	14	26.9
	Boy	1	0.5	0	0.0	3	1.5	5	4.5	1	1.3	5	5.2	0	0.0	1	1.9
	Landsman	43	22.1	5	6.8	38	18.9	23	20.5	11	14.1	13	13.5	4	5.5	6	11.5
	Ordinary Seaman	44	22.6	10	13.7	38	18.9	12	10.7	25	32.1	24	25.0	21	28.8	10	19.2
	Private Marine	23	11.8	9	12.3	32	15.9	15	13.4	2	2.6	18	18.8	12	16.4	8	15.4
Other	Admiral Retinue	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Captain's Servant	2	1.0	1	1.4	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Plan Corp	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Russian Cadet	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0
	Soldier	3	1.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Supernumerary		0.0	1	1.4	2	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Unknown	1	0.5	0	0.0	0	0.0	0	0.0	4	5.2	0	0.0	0	0.0	0	0.0
	Total	**195**		**63**		**201**		**112**		**78**		**95**		**73**		**51**	

hospital; between 71 and 87%, with a total mean of 80% for all years examined (Table 3-3). The second most frequently admitted group were petty officers, which made up between 6.2 and 21.2% of admissions, with a total mean of 11%. Third were the warrant officers, which made up between 0.0 and 9.6% of annual admissions, and 4% of all admissions. The least frequent were those of the commissioned officers who made up between 0.0 and 4.5% of annual admissions and represented 2.6% of the total admissions of the years in question.

It is interesting to note that the percentages of the ranks admitted to the hospital closely mirror the percentages present on vessels stationed in Newfoundland. For sloops and the 4th Rate Ships, the lower ranked individuals made up between 73 and 84% of those onboard, while the officers and petty officers made up between 3 to 8% and 12 to 18% respectively (Table 3-4) (Waller 2014: 138). Therefore, the frequencies of those admitted to the St. John's Naval Hospital were proportional to the frequency of the ranks aboard the naval vessels.

One specific interesting group that was present at the St. John's Naval Hospital was Boys. This group included individuals who were typically 14 and up to 17 years of age (Waller 2014: 226-227). Their presence at the hospital explains the appearance of at least one adolescent individual within the skeletal collections from the Southside Cemetery (von Hunnius 1998).

Higher ranking officers also presented as patients at the hospital. The other naval hospital reports do not report officers being treated (Varney and Nicholson 2001;

Table 3-3. Number and Percentage of ranks admitted to the St. John's Royal Naval Hospital from 1793-1797, 1806-1809, 1810-11.

	1793-94		1794-95		1795-96		1796-97		1806-07		1807-08		1808-09		1810-11		Total
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	
Commissioned Officers	2	**1.0**	2	**2.7**	6	**3.0**	5	**4.5**	4	**5.1**	2	**2.1**	0	**0.0**	1	**1.9**	**22**
Warrant Officers	5	**2.6**	6	**8.2**	11	**5.5**	5	**4.5**	2	**2.6**	1	**1.0**	7	**9.6**	0	**0.0**	**37**
Petty Officers	12	**6.2**	8	**11.0**	21	**10.4**	7	**6.3**	9	**11.5**	13	**13.5**	14	**19.2**	11	**21.2**	**95**
Seamen, Landsmen, and Privates	170	**87.2**	55	**75.3**	159	**79.1**	95	**84.8**	59	**75.6**	77	**80.2**	52	**71.2**	39	**75.0**	**706**
Other	6	**3.1**	2	**2.7**	3	**1.5**	0	**0.0**	4	**5.1**	3	**3.1**	0	**0.0**	0	**0.0**	**18**
Total	195		73		200		112		78		96		73		51		**878**

Table 3-4. Number and percentage of ranked sailors consisting of a full crew onboard a sloop and a 4th rate vessel in the Royal Navy.

Rank	**Sloop**		**4th Rate Vessel**	
	#	**%**	**#**	**%**
Warrant Officers	10	8.3	13	3.8
Petty Officers	22	18.3	40	11.8
Low Ranked Sailors and Marines	88	73.3	286	84.4
Total	120	100	339	100

Shortland et al. 2008; Hodgins and Pamment-Salvatore 2009); the fact that they were reported in St. John's suggests different circumstances specific to the town that influenced or forced the officers into the Naval Hospital. One possibility is that St. John's was a migratory fishing town with potentially few respected physicians with whom to seek treatment, and it is possible that the officers instead sought treatment at the hospital. Another influencing factor may have been that many of the officers may not have had the financial means to pay for a physician, even though they were from higher-class births (Lewis 1960). It may have been more difficult to make payments for physicians in the middle of deployment because sailors were paid, if at all, when they returned to England (Rodger 2005: 40).

The high-ranking sailors or marines were not the only unusual individuals seen within the confines of the Naval Hospital in St. John's. Firstly, three soldiers were admitted to the hospital on October 5th and 6th of 1793. At least two, but likely all three of these were supernumeraries, or individuals onboard a naval vessel that were not part of the core crew, from the *HMS Stately*, yet still victualled by the Navy (TNA: ADM 102/733; TNA: ADM 36/12110). If Keegan's (1937) account that there were military buttons found at assumed Southside Cemetery is accepted, the soldiers may also be an explanation for any military buttons found. Though none of these soldiers died during their treatment, their presence suggests that there could have been other soldiers sent to the Naval Hospital Cemetery who did perish.

The final individual of interest is Michael Affremoff (likely a misspelling of Afremov), who was a Russian Cadet sent from the *HMS Isis* and was admitted for venereal disease in July of 1807. This individual is important, as he is the only individual whose title itself suggested an origin from abroad, and not just from England. When the data of all naval ranks and particularly individuals and groups specified above are all considered together it is clear that sailors, marines, and related civilians from various walks of life came together within the walls of the St. John's Naval Hospital for treatment.

3.5.4 Ailments of Naval Hospital Patients

The vast majority of the ailments that brought sailors to the St. John's Naval Hospital were not related to the acts of war, but rather accidents and what we now know to be infectious diseases and lifestyle ailments. There is a large change than can be seen in the types of cases that caused the sailors to seek treatment at the hospital between the1790s and early 1800s. During the late 1700s (1793-1797) the most common cases seen at the hospital were fevers, with yearly means falling between 66.7 and 19.5% of all cases and a mean annual percentage of 37.2±20.7 (Table 3-5**,** Table 3-6). Another common illness

Table 3-5. Number and percentage of ailments for which patients were admitted to the St. John's Royal Naval Hospital separated by decades examined.

	1793-97		1806-09, 1810-11	
	mean	**mean annual %**	**mean**	**mean annual %**
Abscess	0.7	0.6	3.3	2.5
Accident	9.9	2.1	13.9	6.1
Debility	0.5	0.0	6.9	7.3
Dysentery	3.3	0.0	0.7	0.9
Fever	37.2	20.8	4.5	1.8
For Internment	0.0	0.0	5.0	4.5
Pneumonia	0.9	0.8	12.0	7.1
Rheumatism	3.7	3.0	5.4	3.3
Scurvy	13.4	13.6	0.7	1.5
Consumption	2.2	1.0	7.8	7.5
Ulcer	7.0	4.9	5.4	3.7
Venereal	1.6	1.8	9.1	4.3
Other	19.8	9.0	25.3	3.2

Table 3-6. Number and percentage of ailments for which patients were admitted to the St. John's Royal Naval Hospital

	93-94		94-95		95-96		96-97		06-07		07-08		08-09		10-11	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**#**
Abscess	1	1.8	1	2.6	0	0.0	1	1.3	5	7.6	2	2.1	1	2.2	1	2.0
Accident	20	35.7	9	23.7	14	14.6	12	15.0	16	24.2	11	11.6	4	8.9	7	14.0
Debility	0	0.0	0	0.0	2	2.1	1	1.3	0	0.0	16	16.8	1	2.2	5	10.0
Dysentery	0	0.0	0	0.0	21	21.9	3	3.8	0	0.0	1	1.1	0	0.0	1	2.0
Fever	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
For Internment	0	0.0	0	0.0	0	0.0	0	0.0	1	1.5	3	3.2	2	4.4	6	12.0
Pneumonia	0	0.0	1	2.6	1	1.0	2	2.5	5	7.6	14	14.7	10	22.2	3	6.0
Rheumatism	6	10.7	0	0.0	9	9.4	8	10.0	4	6.1	10	10.5	1	2.2	2	4.0
Scurvy	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Consumption	4	7.1	1	2.6	4	4.2	4	5.0	7	10.6	4	4.2	0	0.0	9	18.0
Ulcer	2	3.6	4	10.5	18	18.8	14	17.5	3	4.6	5	5.3	5	11.1	1	2.0
Venereal	0	0.0	3	7.9	1	1.0	2	2.5	7	10.6	6	6.3	7	15.6	3	6.0
Other	23	41.1	19	50.0	26	27.1	33	41.3	18	27.3	23	24.2	14	31.1	12	24.0
Total	**56**		**38**		**96**		**80**		**66**		**95**		**45**		**50**	

was scurvy representing between 1.8 and 32.5% of all cases, with a mean annual percentage of 13.4±13.6. Accidents (including fractures, breaks, contusions, scalds, and general wounds) represented 7.0 to 12.0% of all cases, with a mean annual percentage of 9.9±13.6.

During the early 1800s (1806-09, 1810-11), the frequency of cases changed dramatically. Fevers and scurvy no longer topped the list, having mean annual percentages of 4.5±1.8 and 0.7±1.49 respectively (Table 3-5, Table 3-6). Instead accidents, pneumonia, venereal disease, and tuberculosis were the common afflictions. Annually, accidents represented between 8.5 and 22.5% of all cases, with a mean annual percentage of 13.8±6.1. Pneumonia represented between 5.8 and 21.3% of all cases with a mean annual percentage of 12.0±7.14.

Venereal diseases had a mean annual percentage of 9.1±4.3, representing between 5.8 and 14.9‰ cases annually. Various diseases associated with tuberculosis (consumption, scrofula, the King's Evil, and phthisis) were also more prevalent in the 1800s representing between 0.0 and 17.3% of all cases with a mean annual percentage of 7.8±7.5. Though the separation of the years produces meaningful differences, it is important to note that there are large standard deviations for most ailments, particularly those that produce high annual mean percentages.

In order to understand these shifts in the ailments experienced by the sailors, it is first important to comprehend British society's and the Royal Navy's understanding of medicine during the 18th and early 19th centuries. Their comprehension of the causation of these diseases was based on the humoral theory, not the present-day germ theory

(Wear 1991; Haycock 2009). Humoral medicine was based on a long-standing theory that the health of a person was maintained through the balance of four humours, which are bodily fluids (Wear 1991). This limited understanding of health meant that disease was interpreted on an individual basis, not within the context of endemic group diseases. Environmental influences on the humours such as climate and miasmas (bad air) became increasingly important during the 17th and 18th centuries with colonization into new environments (Riley 1987; Wear 1991).

Although humours were the basis for medicine in the 18th and 19th centuries, there was a movement away from individual based cures based on these humours within the context of the Royal Navy. The Royal Navy needed universal cures to facilitate the speed and efficacy of treatment of large groups of sailors (Cook 1990; Aslop 2007). In addition to group based treatments, the Royal Navy focused on preventative medicine (Aslop 2007; Crimmin 2007; Kopperman 2007). Illness was dangerous to sailors and the Navy at sea, as they needed large numbers of men to effectively sail the boat and be ready in case of an attack. It was much easier to prevent illness then to cure it; therefore the Navy's focus went into finding effective preventative measures for common diseases that afflicted sailors (Crimmin 2007; Kopperman 2007).

The late 18th and early 19th centuries were a time of change within the world of naval medicine that was putting more emphasis on hygiene and diet onboard naval vessels (Allison 1943; Crimmin 2007; Kopperman 2007). More frequent cleanings of the vessels decks were done with a mixture of fresh water and vinegar, which acted as a disinfectant (LAC: C-4848), though it was not understood within this context. Fevers were largely related to infectious diseases, with the exception of those that were caused by mosquito bites such as malaria or yellow fever (Kupperman 1984: 237; Stevenson 2007). Therefore, an increase in the time put into hygiene onboard was having obvious effects on the prevalence of fevers in the early 1800s.

The other large shift in the prevalence of scurvy is also due to changes in naval protocol. James Lind discovered that the consumption of citrus fruits was the prevention and cure of scurvy, though it took nearly four decades until the Navy could produce a means of preserving the fruits to allow for use on long voyages (Lind 1753; Allison 1943; Tröhler 2005). In the mid-1790s and early 1800s it became customary for sailors to be given an allotment of daily limejuice and or fresh fruits when available to prevent the development of scurvy (Allison 1943; MacDonald 2004; Baron 2009). Both of these changes to naval medicine caused dramatic shifts in the types of diseases and ailments that were afflicting patients at the St. John's Royal Naval Hospital.

Another way to examine the ailments is to separate the frequency by the ranks. To do this, cases were only considered if both the ailment and the rank were given. If conditions were drastically different between the ranks, it is possible that these may be exhibited by inconsistencies in the frequencies of the ailments according to ranks. There are 12 reasons for admittance to the hospital that explain 72% of all cases. These include: abscess, accident (including broken, fractured, or hurt appendage, contusion, scald, and wound), debility, dysentery, fever, for internment, pneumonia, rheumatism, scurvy, tuberculosis (including consumption, scrophula, King's Evil, and phthisis), ulcer, venereal. All other ailments were grouped as 'other'. Taking the number of each rank that was admitted to the hospital and dividing it by the total number of all cases determined the expected frequency of each rank admitted. This frequency was then multiplied by the number of cases of a given ailment to give the expected number of ailments.

The number of ailments observed was compared to the expected number in a chi-squared test. There was only one circumstance where there was a significant difference between the observed number of cases and the expected number. This was with the frequency of rheumatism, there were 6 commissioned officers who were admitted while there was an expected number of 1.3, which resulted in a chi value of 16.49 which is a p value <0.005 (Table 3-7). It is interesting to note that all six of these commissioned officers were Lieutenants or Marine Lieutenants and this ailment made up 67% of all cases that brought commissioned officers into the hospital. Considering that rheumatism is the inflammation of joints or muscles it could be expected that those of more advanced age were more afflicted by this condition. In turn the more senior officers presenting themselves more frequently at the hospital would be consistent with this situation. Overall, it is somewhat surprising that there are not significant differences between the frequencies of ailments by rank. Considering what we now know of infectious diseases, this likely speaks to issues concerning the close quarters with which these individuals lived and worked. It must be remembered that this represents only 10 years' worth of data from hospital records, and that this cannot necessarily be expanded to represent the entire presence of the hospital in Newfoundland, nor the Atlantic world in general. More hospital specific research must be done to identify the nuances differences in the ailments affecting naval sailors within Newfoundland and throughout the Atlantic.

Table 3-7. The number and percentage of ailments for which patients were admitted to the St. John's Royal Naval Hospital separated by ranks.

	Illness															
	Abscess (n=11)				**Accident (n=82)**				**Debility (n=14)**				**Dysentery (n=29)**			
Rank	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**
Commissioned Officer	0.0	0	0.3	0.31	2.4	2	2.3	0.04	0.0	0	0.4	0.39	3.4	1	0.8	0.04
Warrant Officers (WO)	0.0	0	0.3	0.34	6.1	5	2.5	2.50	0.0	0	0.4	0.43	6.9	2	0.9	1.41
Petty/Inferior WOs	27.3	3	1.3	2.43	1.2	1	9.4	7.46	28.6	4	1.6	3.61	6.9	2	3.3	0.52
Ratings	63.6	7	8.9	0.41	84.1	69	66.4	0.10	71.4	10	11.3	0.16	82.8	24	23.5	0.01
Others	9.1	1	0.2	3.57	2.4	2	1.4	0.27	0.0	0	0.2	0.2366	0.0	0	0.5	0.49

	Fever (n=247)				**Internment (n=10)**				**Pneumonia (n=37)**				**Rheumatism (n=47)**			
Rank	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**
Commissioned Officer	2.4	6	7.0	0.13	0.0	0	0.3	0.28	5.4	2	1.0	0.88	12.8	6	1.3	**16.49**
Warrant Officers (WO)	2.4	6	7.5	0.31	10.0	1	0.3	1.58	0.0	0	1.1	1.13	8.5	4	1.4	4.59
Petty/Inferior WOs	8.9	22	28.2	1.36	20.0	2	1.1	0.65	8.1	3	4.2	0.35	19.1	9	5.4	2.47
Ratings	83.0	205	200.1	0.12	60.0	6	8.1	0.55	83.8	31	30.0	0.03	57.4	27	38.1	3.22
Others	2.8	7	4.2	1.91	0.0	0	0.2	0.17	0.0	0	0.6	0.63	0.0	0	0.8	0.79

	Scurvy (n=103)				**Tuberculosis (n=14)**				**Ulcer (n=42)**				**Venereal (n=17)**			
Rank	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**	**%**	**n**	**expect**	**chi**
Commissioned Officer	1.0	1	2.9	1.25	2.8	1	1.0	0.00	0.0	0	1.2	1.18	5.9	1	0.5	0.57
Warrant Officers (WO)	1.0	1	3.1	1.46	2.8	1	1.1	0.01	0.0	0	1.3	1.28	0.0	0	0.5	0.52
Petty/Inferior WOs	13.6	14	11.8	0.43	16.7	6	4.0	1.05	4.8	2	4.8	1.63	11.8	2	1.9	0.00
Ratings	83.5	86	83.5	0.08	75.0	27	28.7	0.10	92.9	39	34.0	0.73	70.6	12	13.8	0.23
Others	0.0	0	1.7	1.74	2.8	1	1.2	0.04	2.4	1	0.7	0.12	5.9	1	0.3	1.77

Table 3-7 (cont'd)

	Other (n=284)			
Rank	**%**	**n**	**expect**	**chi**
Commissioned Officer	8.5	24	8.0	31.93
Warrant Officers (WO)	9.9	28	8.7	43.17
Petty/Inferior WOs	13.4	38	32.4	0.97
Ratings	65.5	186	230.1	8.45
Others	2.8	8	4.8	2.13

3.5.5 Duration of Hospital Stays

There is a large problem in the determination of the duration of their treatment as some surgeons recorded this differently than others. Some would record for the total stay of the patient, going back and correcting previous documentation if the surgeon stayed longer than one quarter, and others did not. Also, the fact that some sailors necessitated more than one quarter-year for treatment, the mean duration of treatment is likely affected by some patients being represented twice within the documentation. The matching of patients is time consuming and nearly impossible with differences in documentation and therefore this was not attempted. Instead it must be recognized that this is a potential bias within this interpretation.

The mean time spent at the St. John's Naval Hospital during the years investigated was between 19 and 39.3 days with a total mean of 32.9 days (Table 3-8). This being said there were very large standard deviations for all years, meaning that the patients' length of stays were highly variable. The shorter mean duration of treatment during 1793-94 is likely due to the high influx of individuals suffering from fever and convalescence (Table 3-8). These ailments both had low stay times with means of 19.6 and 12.8 respectively, which pulled down the average length of stay. The *HMS Stately* was a third-rate ship of the line vessel carrying more than 500 men (TNA: ADM 36/12110), and it is clear from the records that an outbreak of fever must have hit the vessel, for as soon as they entered the port of St. John's they deposited many of their men to the hospital for treatment. The majority of those treated through the 10 years of documents examined stayed within the confines of an annual quarter; therefore, even considering the biases to time, sailors

Table 3-8. Data summary for patients at the St. John's Naval Hospital from 1793-1797, 1806-1809, 1810-11.

	1793-94	**1794-95**	**1795-96**	**1796-97**	**1806-07**	**1807-08**	**1808-09**	**1810-11**	**Mean**
Mean Treatment (in Days)	19.0±12.1	35.7±21.6	39.3±32.4	35.1±39.3	29.4±25.0	39.6±30.3	33.8±41.9	36.9±29.1	32.9±29.6
									Total
Number of individuals who ran	8	5	2	5	0	0	0	1	21
Number of Burials	4	6	12	6	3	9	3	7	50
Number of Deaths	4	6	12	6	2	7	2	3	42

typically stayed away from active duty for approximately one month.

It is interesting to note that St. John’s Naval Hospital was a place from which to run for the sailors. There were a total of 21 individuals who ran from the hospital during the years examined, with anywhere between 0 to 8 occurring per year (Table 3-9). Very little is known about the circumstances of their running, except for the logical assessment that it is much easier to run from the Navy while on land and within the confines of the hospital, which may not have been as well guarded as the naval vessels. There is at least one death known of that occurred while a sailor who had been admitted for venereal disease was attempting to run; he drowned while attempting to escape, likely dying in the waters of the harbour. St. John’s was a large fishing town and was a central location for merchant shipping throughout the Atlantic (Bannister 2003; Head 1976); therefore, it not only offered a good opportunity to escape not only the Navy, but also a potential employment as a way to start a new life.

3.5.6 Deaths and Burials Recorded in the Hospital Muster Records

There were a total of 50 burials during the years in question, with some of the deaths having occurred at the hospital itself, while others were brought there for internment. There were between 3 and 12 burials occurring per year, with a mean of 6.3 ± 3.1 ($n=50$, 1σ) (Table 3-9). This is slightly more than the deaths that occurred at the hospital, with a mean of 5.3 ± 3.3 and ranged between 2 and 12 annually (Table 3-9). Sailors of all ranks were not only brought to the hospital for internment, but also died at the hospital, and were recorded as being buried (Table 3-7, Table 3-10). The causes of deaths were only recorded for those who perished at the hospital. The most common

Table 3-9. Causes of death of patients from the St. John's Naval Hospital from 1793-1797, 1806-1809, 1810-11.

Ailment	Number Died
Apoplexy	2
Carrious Itch	1
Compound Fractured Leg	1
Consumption	3
Debility	1
Diarrhea	2
Dysentery	4
Fever	10
Fractured cranium	1
Fractured thigh	1
Inflamed Bowels	1
Insanity and Debility	1
Palsy	1
Perineumonia	2
Phthisis	4
Pneumonia	1
Rheumatism	2
Ulcered Leg	2
Unknown	2
Total	**42**

cause of death was fever, followed by dysentery, phthisis (pulmonary tuberculosis), and accidents (Table 3-9). The Navy paid for the cost of all burials, including the coffins. There were no discrepancies between the costs of burials that would suggest different treatment for higher ranked sailors. Unfortunately, it is not recorded where the sailors were buried; only that a burial occurred, so a location of a cemetery cannot be corroborated from these records.

3.6 Origins of St. John's Sailors According to Vessel Muster Records

While the St. John's Naval Hospital treated sailors, marines, and those associated with the Navy of all ranks, the diversity of their origins is not something that can be garnered from the hospital records. In order to gain a sense of the origins of sailors who were serving in the Royal Navy in St. John's that was the sources for potential patients at the Naval Hospital, naval vessel muster records were examined. These vessels were of various sizes and were serving in St. John's during the time of the hospital. The origins of these vessels was examined and grouped by means of country (Table 3-11).

The first vessel examined was the HMS Stately, carrying a crew of 522 men and was in port during the fall of 1793 (ADM 35/12110). The second vessel examined was the HMS Pegasus (ADM 36/10705) who carried approximately 200 individuals. This was a sixth-rate frigate that was captained by Prince William Henry who later became the King of England (Pegasus) and was in port during the summer of 1786 (ADM 26/10705). The third vessel was the HMS Mercury (AMD 36/16983), which was in St. John's during the summer of 1806 carrying 195 crewmembers.

Table 3-10. Ranks of sailors and marines who died at the St. John's Naval Hospital or were brought there for internment between the years 1793-1797, 1806-1809, 1810-11.

		Died at Hospital	Brought for Internment
Warrant Officers	**Gunner**	3	0
Petty Officers and Inferior Warrant Officers	**Admiral Cook**	1	0
	Carpenter's Mate	1	0
	Corporal Marines	1	0
	Gunner Mate	0	1
	Master Mate	1	0
Ratings	**Able seaman**	12	2
	Boy	1	0
	Landsman	6	0
	Ordinary Seaman	5	0
	Private Marine	9	3
Other	**Unknown**	2	1

The fourth was the *HMSchooner Trepassey* (ADM 36/14273) who had a crew of only 9 men and was in St. John's during the winter of 1799 and travelled throughout Newfoundland and Nova Scotia for at least the following 3 years. The final vessel was the *HMSchooner Herring* (ADM 36/14273) that was in port during the fall of 1806 and carried 18 crewmembers. The vessel was very active in the waters of the Atlantic, commonly transferring between St. George's Harbour, Bermuda, to various locations along the coast of Newfoundland and Nova Scotia from 1804 to 1806.

Table 3-11. The number and percentage of origins of all sailors victualled by the *HMS Stately* (October 1793), the *HMS Pegasus* (March 1786), the *HMS Mercury* (July 1806), the *HMSchooner Herring* (August 1806), and the *HMS Trepassey* (June 1802) (ADM 36). Birth places are separated by country or region. 'Unknown' denoted those who exact location could not be determined from the name given, and are separated from the number of individuals for whom there were no origins given.

Region/ Country	***Stately***		***Pegasus***		***Mercury***		***Herring***		***Trepassey***	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Africa	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0
America	9	1.3	1	0.5	5	2.6	0	0.0	1	14.3
Barbados	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0
Denmark	0	0.0	1	0.5	1	0.5	0	0.0	0	0.0
England	288	41.7	104	56.8	71	37.2	8	19.5	4	57.1
France	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Germany	1	0.1	0	0.0	1	0.5	0	0.0	0	0.0
Guernsey	0	0.0	0	0.0	0	0.0	1	2.4	0	0.0
Ireland	109	15.8	17	9.3	27	14.1	0	0.0	0	0.0
Isle of Man	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Italy	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Jersey	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
Netherlands	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Newfoundland	3	0.4	1	0.5	0	0.0	2	4.9	1	14.3
Norway	1	0.1	0	0.0	1	0.5	0	0.0	0	0.0
Nova Scotia	0	0.0	0	0.0	1	0.5	5	12.2	0	0.0
Portugal	1	0.1	2	1.1	1	0.5	0	0.0	0	0.0
Prussia	1	0.1	0	0.0	4	2.1	0	0.0	0	0.0
Scotland	86	12.4	11	6.0	9	4.7	0	0.0	0	0.0
Senegal	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
St. Kitts	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
St. Thomas	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
Sweden	2	0.3	0	0.0	0	0.0	0	0.0	0	0.0
Wales	15	2.2	4	2.2	3	1.6	0	0.0	0	0.0
West Indies	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Unknown	37	5.4	10	5.5	7	3.7	0	0.0	0	0.0
Not Recorded	132	19.1	30	16.4	57	29.8	0	0.0	1	14.3
Total Crew	**691**		**183**		**191**		**41**		**7**	

3.6.1 Assumptions associated with the Naval Muster Records

Like the Naval Hospital records, there are a number of assumptions that were made during the analysis of the Naval vessel muster records of the muster records. First and foremost is that the standardized forms changed over time demanding more information from the sailors; however, the records were not always complete. Pursers at times neglected to record the individuals’ birthplaces entirely and the amount of detail about their origins varied, at times giving the street name or only the continent. This has made interpreting their origins difficult, particularly because there are many place names that occur within more than one county or country, in such cases during this study, an unknown origin was registered. Therefore, there is the possibility of interpreter error in transcribing the records. The origins for the warrant officers and higher-ranking officers are also not consistently recorded, including their servants. Therefore, it is only the origins of the petty officers and lower ranked individuals that can be analyzed. The analysis assumed that these biases within the recording methods did not affect the trends of the data.

3.6.2 Naval Origins

The vast majority of origins of all vessels were from the British Isles, and England was always the most numerous of these. The British Isles made up a total of between 19.5 and 72.2% of all origins, yet the smaller percentages came from the two schooners whose small crew numbers have skewed the values (Table 3-12).

Table 3-12. The number and percentage of birth places of all sailors victualled by the HMS Stately (October 1793), the HMS Pegasus (March 1786), the HMS Mercury (July 1806), the HMSchooner Herring (August 1806), and the HMSchooner Trepassey (June 1802) as separated by geographic region (ADM 36). The individuals for whom their origins could not be determined or were not recorded were grouped together.

Region/ Country	***Stately***		***Pegasus***		***Mercury***		***Herring***		***Trepassey***	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
British Isles	499	72.2	136	74.3	110	57.6	8	19.5	4	57.1
Europe	9	1.3	1	0.5	5	2.6	0	0.0	0	0.0
Africa	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0
West Indies	2	0.0	1	0.5	1	0.5	0	0.0	0	0.0
North America	12	41.7	104	56.8	71	37.2	8	19.5	2	28.6
Unknown	169	24.5	40	21.9	64	33.5	25	61.0	1	14.3
Total	**691**		**283**		**191**		**41**		**7**	

Outside the British Isles in Europe, other places where people were originating, though in small numbers, included Denmark, France, Jersey, Guernsey, Italy, the Netherlands, Norway, Prussia, and Sweden. There were at most only nine Europeans onboard the vessels examined, making up a maximum of 4.6% of the crew. Most of these were Northern countries, or islands close to England such as Jersey and Guernsey.

There were at least two sailors from Africa, one specifically from Gorée in Senegal. As there were numerous battles in Africa, even specifically Gorée (Newton 2013), it is unsurprising to find some Africans within the vessels stationed in Newfoundland. Areas within the West Indies were also occasionally noted as having been their origins, specifically Barbados, St. Kitt's, St. Thomas, and the West Indies in

general. Finally, North America was also noted as being the origins of naval sailors and was at least as numerous as those from Europe, even more common on the smaller schooners that did not leave the North Eastern waters. The schooners were therefore were less likely to fill any lost numbers with foreigners outside of British and locals.
Even though these may not be totally representative of all origins of sailors stationed in Newfoundland, it does give a sense of the diversity of backgrounds coming together in Newfoundland waters. It is from possibly similar groups of Royal Naval sailors that the beds of the St. John's Naval Hospital would have been filled.

3.7 Conclusion

The remains uncovered in the 1979 excavations at the Southside Cemetery have been shrouded in uncertainty over what institution they were associated with. While some have attributed the cemetery to being associated with the 18th and early 19th centuries Naval Hospital, others have suggested the later St. Mary's Anglican Church. Considering the known date of at least one individual from the Southside Cemetery, numerous maps, and the lack of a broadly mixed group that would be expected of a church, the cemetery is very probably associated with the Naval Hospital.

When the accounts of the muster records of the St. John's Naval Hospital are compared to the accounts of previous historians and archaeologists, it seems that the structure and history of the hospital are more fluid than previously considered. The individuals that were admitted to the hospital were mainly low ranked and non-specialized sailors and marines. However, the distribution of admitted ranks corresponds to the percentage of all ranks onboard the naval vessels (Figure 3-4), suggesting no preference towards lower ranked sailors being treated. The ailments that sent these sailors and marines to the hospital were varied, but diseases associated with life at sea such as scurvy and fever dropped significant by the turn of the 19th century. Those that died and were buried at the hospital have a similar variability of ranks and ailments. The St. John's Naval Hospital does not recount the origins of those admitted, but by looking at Naval Vessel muster records of vessels stationed in the town from late 18th and early 19th centuries, it is clear that the majority came from England, with fewer from Ireland, Scotland, and Wales. Yet this was not exclusive, as there were some from Newfoundland, America, West Indies, and Europe.

When all of these records are considered, a number of questions and hypotheses regarding the individuals uncovered in the 1979 excavations arise. First, if the individuals were from the St. John's Naval Hospital, and not St. Mary's church, the vast majority should have diets that reflect those of Britain and the Royal Navy. Second, the origins of the sailors should be mainly that of the British Isles, and few from Newfoundland and or other foreign regions. Although this study has begun to answer questions referring to the St. John's Naval Hospital and its associated cemetery, the answers have brought with it more questions: What was the extent of the cemetery? Where were the multiple Naval Hospital structures and were they purpose built? How long was the Naval Hospital in use? These are all questions that with further research will hopefully be answered.

Chapter Four

4 Isotopic Background and Insights into Consumption Theory

Archaeological skeletal collections contain invaluable information about past populations. Isotopic analyses can help to directly reconstruct aspects of the individuals' lives. These analyses work under the premises that "you are *what* and *where* you eat" (Budd et al. 2003; Fry 2006). By sampling small pieces of skeletal material, different proportions of isotopes (elements with a different number of neutrons) can enlighten researchers to aspects in relation to individuals' diets and geographic origins. However, to interpret these data within proper context, there must be an understanding of consumption behaviour to unlock the aspects of decisions that led to ingestion of food at various stages of life. This is particularly important when considering the sailors who lived and worked within the control of the Royal Navy, as well as understanding their personal agency to work within, and outside, the structure of the institution to gain access to unsanctioned foods. Along with an understanding of isotopic theory in bioarchaeology, consumption and agency theories will serve as the framework of interpretation of data from the Southside Cemetery.

4.1 Uses of isotopic analyses in archaeology

Isotopic analyses have increasingly been used in archaeology over the past few decades to answer previously unattainable questions mainly related to diet and mobility from the archaeological record (Katzenberg 2000; Bentley 2006). Carbon isotopic analysis was first used to identify the introduction of maize via trade and local agriculture into the diets of Archaic and Woodland peoples from Ohio and Illinois (van der Merwe and Vogel 1978). Since these early studies it has been used more broadly in association with nitrogen isotopes ($\delta^{15}N$) to identify the diets of individuals and dietary variability within and between populations, regions, and time periods. This includes work examining the influence of age and sex on variability in diet (Katzenberg 1993), and identifying movement of individuals or groups based on differences in dietary values (Schroeder et al. 2009). Oxygen ($\delta^{18}O$) and nitrogen can also be used separately to examine the timing of weaning and birth origins in past populations (Fogel et al. 1989; Shurr 1998; Wright and Schwarcz 1998). Oxygen and strontium ($^{87}Sr/^{86}Sr$) isotopes have also been used to identify migration in archaeological populations (Schwarcz et al. 1991; Sealy et al. 1995; Evans et al. 2012).

Stable isotope analyses were originally used for examining archaeological populations in the more distant past, for whom the archaeological contexts were vague or controversial (DeNiro 1987). There is a growing movement to use these techniques to answer questions pertaining to more recent historical populations, as historic documents are commonly focused towards upper classes, ignoring those within lower social classes or women, leaving important components of the historical narrative missing (i.e. Schwarcz et al. 1991; Ubelaker and Owsley 2003; Müldner and Richards 2005; Roberts et al. 2012). Isotopic analyses allow archaeologists to pose new and intriguing questions about these peoples, but this can only be done with an understanding of the characteristics of isotope systems.

4.2 What are Stable Isotopes?

Isotopes are atoms of the same element with differing numbers of neutrons. Neutrons are neutral subatomic particles, and additional neutrons add to the mass of an atom but do not change the overall charge (Hoefs 2009). Many isotopes are stable, meaning that they do not lose their neutrons over time. There are a number of these elements that are important to ecological and archaeological studies, particularly with human and animal remains (Katzenberg 2000; Bentley 2006). These include carbon (^{12}C, ^{13}C), nitrogen (^{14}N, ^{15}N), oxygen (^{16}O, ^{18}O), and strontium (^{86}Sr, ^{87}Sr). The isotopes of these elements are incorporated from different sources, be it food, water, or atmospheric, and therefore reflects different aspects of an individual's life. Carbon isotope ratios are used to provide information on the origin of food material, and nitrogen is used to determine trophic level. Oxygen and strontium ratios provide information on geographic origins.

4.2.1 Carbon Isotopes

Carbon is present as three isotopes: ^{12}C, ^{13}C, and ^{14}C. The natural abundance of carbon isotopes is 99% of ^{12}C, 1% ^{13}C, and <0.1% of ^{14}C. The first two carbon isotopes (^{12}C and ^{13}C) are stable, while ^{14}C is radiogenic (meaning that it degrades over times with an unstable nucleus and emit subatomic particles). The two stable carbon isotopes are used in isotopic analyses and are represented $\delta^{13}C$ value compared to an international standard (Peedee Belemnite (PDB) carbonate), which is highly enriched in ^{13}C. The original standard material has run about, and been replaced with a calibrated reference named Vienna Pee Dee Belemnite (VPDB) produced by the National Bureau of Standards (Craig 1954; Craig 1957; van der Merwe 1982).

The equation to find $\delta^{13}C$ is:

$$\delta^{13}C = 1000* [(^{13}C/^{12}C) \text{ sample})/(^{13}C/^{12}C) \text{ standard } -1]$$

To understand how carbon isotopes are incorporated into humans and the animals they eat, it must be understood how they are first incorporated into plants. Carbon is incorporated into the plant material by the fixing of atmospheric O_2 and CO_2 into sugar, primarily through two photosynthetic pathways that vary between types of plants: C_3 and C_4, depending on which enzyme is used in adenosine triphosphate production during photosynthesis. The difference between the pathways (C_3 versus C_4) refers to the number of carbons in the intermediate step in sugar formation. The most prevalent pathway is C_3, which is common in plants that are native to temperate areas, including wheat, and peas (Brown 1999: 481); C_4 plants originated in hotter and drier areas, and the pathway is more common in grasses, corn, maize, sugar cane and sorghum (Brown 1999: 473). The C_3 pathway discriminates against ^{13}C creating very low $\delta^{13}C$ values, with C_3 plants having a mean of -26.5‰ $\delta^{13}C$ and ranged from -33 to -22‰ (Smith and Epstein 1971; DeNiro and Epstein 1978: 183; van der Merwe 1982). The C_4 pathway does not discriminate against ^{13}C and produces higher $\delta^{13}C$ values, typically averaging -12.5‰, and ranged from -16 to -9‰ (DeNiro and Epstein 1978: 183; van der Merwe 1982). A much less common photosynthetic pathway is Crassulacean Acid Metabolism (CAM**)**, which switches between C_3 and C_4 pathways depending on the environmental conditions (van der Merwe 1982).

Plants differently source marine and terrestrial carbon. While terrestrial plants use atmospheric CO_2 for photosynthesis (Schwarcz et al. 1991), marine plants can have variable $\delta^{13}C$ values due to carbon sourcing that includes dissolved CO_2, bicarbonates, and carbonates causing the values to vary between -31 to -7‰ (van der Merwe 1982). Dissolved bicarbonate has a $\delta^{13}C$ value of approximately 0‰, while atmospheric CO_2 has a value of -7‰. This results in a positive shift in marine materials compared to those of terrestrial origins (Schwarcz et al. 1991).

When C_4 plants are not present in the diet of animals, it is possible to differentiate between marine and terrestrial $\delta^{13}C$ values (Schoeninger and DeNiro 1984). Schoeninger and DeNiro (1984: 631) found that marine animal carbon $\delta^{13}C$ values averaged -13.5±2.1‰, while terrestrial animals averaged -18.9±2.2‰. When C_4 foods were consumed, there was a large (8‰) overlap in the $\delta^{13}C$ values, which reduces the ability to discriminate between sources (Schoeninger and DeNiro 1984: 635). The levels of ^{13}C in freshwater are between these values, which can further complicate the interpretation of human diet, because the carbon reflects a mixture of terrestrial and aquatic sources, and C_4 and freshwater values (Schoeninger and DeNiro 1984).

The $\delta^{13}C$ values vary with animals' metabolism and trophic level in a process called fractionation. In terrestrial ecosystems, plants are consumed by herbivores and herbivores by carnivores. Each step can cause a trophic shift where the heavier isotope ^{13}C is accumulated at a slightly different rate than the lighter isotopic, resulting in discrimination and fractionation (Bocherens and Drucker 2003). The trophic shift in $\delta^{13}C$ values is relatively small between steps in the food chain (DeNiro and Epstein 1978; DeNiro and Epstein 1981; Bender et al. 1981; Macko et al. 1982). The exact amount differs between studies and in turn Bocherens and Drucker (2003) have suggested that a range of 0-2‰ increase in $\delta^{13}C$ values is employed when considering trophic shifts.

4.2.2 Nitrogen Isotopes

Nitrogen makes up approximately 78% of the gas in the atmosphere (Hoefs 2009). To be incorporated into animal or plant matter, nitrogen needs to be incorporated into organic compounds (Hoefs 2009: 54-57). Nitrogen is present predominantly as ^{14}N (>99.6%), with small amounts of ^{15}N (Rosman and Taylor 1998). The atmospheric $^{14}N/^{15}N$ ratio is constant, and therefore determines the $\delta^{15}N$ value of 0.0‰ and this is the calibrated reference standard for stable nitrogen analysis, known as Ambient Inhalable Reservoir (AIR) (Junc and Svex 1958). The $\delta^{15}N$ value is using the same equation as for $\delta^{13}C$, but with ^{15}N compared to ^{14}N. Most nitrogen fixation (conversion into nitrate or nitrite) occurs via microorganisms, but some legumes can also directly fix N_2 (DeNiro and Epstein 1981; Hoefs 2009: 55). Non-legume plants must source their nitrogen from nitrates and nitrites in the soil, which can be isotopically altered due to previous assimilation of plants (Hoering and Ford 1960; Delwiche and Steyn 1970; Virginia and Delwiche 1982). Cyanobacteria directly fix atmospheric N_2 in the ocean, while marine plants consume dissolved nitrate and ammonium; therefore, their values depend on the local marine environment (DeNiro 1987).

Animals receive their nitrogen directly from plants or through other plant-consuming animals. During the incorporation of nitrogen into animal tissues, there is an increase in the $\delta^{15}N$ values between 3-5‰ with each step up the food web due to the body's efficiency in the excretion of the heavier isotope (DeNiro and Epstein 1981; Macko et al. 1982; Bocherens and Drucker 2003: 49; Hedges and Reynard 2007). Due to this trophic shift, and the increased number of steps in the marine food chain, marine foods typically contain higher nitrogen isotope values than their terrestrial counterparts (Schoeninger and DeNiro 1984). Schoeninger and DeNiro (1984) found that marine $\delta^{15}N$ collagen values to average 14.8±2.5‰, while terrestrial averages were 5.9±2.2‰, with only a 1‰ overlap. The $\delta^{15}N$ values in freshwater are intermediate between marine and terrestrial and the values in anadromous fish and the values of migratory birds fell between the two due to their changing feeding environments during their life cycle (Schoeninger and DeNiro 1984).

4.2.3 Oxygen isotopes

Oxygen isotopes can identify places of origin based on the geographic variability of isotope values in drinking water. Oxygen has three stable isotopes, the third being ^{17}O, but only ^{16}O and ^{18}O are used in isotope analyses, with natural abundances of 99.76% and 0.02% respectively (Rosman and Taylor 1998). For isotope analyses, the ratio of $^{16}O/^{18}O$ is compared to Standard Mean Ocean Water (SMOW). This standard was developed by Craig (1961: 1833) based on Epstein and Mayeda (1953), who established that ocean water is fairly homogenous in oxygen isotope ratios. The $\delta^{18}O$ values are derived by comparing ^{18}O to ^{16}O, and the values of the standards. Therefore, ocean water is set as 0.0‰, while most drinking water values fall below that of ocean water.

Oxygen isotope ratios vary mainly due to evaporation and condensation in marine and environmental waters, as these processes cause fractionation with enrichment or depletion of ^{18}O (Dansgaard 1964). Latitude and altitude increases correspond with a depletion of ^{18}O (Dansgaard 1954), with altitude increasing levels by ~0.25‰ per 100m of ascent (Darling and Talbot 2003). The changes are due to the influence of temperature and humidity on the amount of the heavier isotope ^{18}O (Dansgaard 1964: 445). Temperature is the primary factor in differences to the delta values at higher altitudes and latitudes (Dansgaard 1964: 445). The high amounts of precipitation in tropical areas and summer months in mid latitude regions, also known as rainout events, lead to lower $\delta^{18}O$ values (Dansgaard 1964: 446).

In Britain, due to the slow movement of groundwater, the oxygen isotope values are theoretically a reflection of precipitation values, though depending on the drainage of the local soil and bedrock this can be more weighted towards summer or winter precipitation (Darling et al. 2003: 187-188). In Britain, groundwater values are typically within 0.5‰ of the annual rainfall and therefore these values are a good proxy for one another in the region (Darling et al. 2003: 188). Like groundwater, lakes can hold large amounts of water for long periods of time, leading to an enrichment of ^{18}O due to evaporation (Gat 1996: 249-250). However, because lakes are recharged with an influx of freshwater, very few areas develop very high values (Darling et al. 2003: 184). Soil water contains an average of local precipitation values (Tang and Feng 2001). Plants source their water through root systems in the soil and show no fractionation to the stem water (Wershaw 1966; DeNiro and Epstein 1979; White et al. 1985; Flanagan and Ehleringer 1991). However, this is not true for leaves, which are the site for evaporation, causing an enrichment in their oxygen values (Gonfiantini et al. 1965).

Animals incorporate their water from various sources depending on their physiology and environment (Kohn 1996). Although some water can come from plant foods, it is likely that drinking water constitutes the majority input for animals, particularly for humans (Longinelli 1984; Kohn 1996). The $\delta^{18}O$ values of animals' blood oxygen and bone phosphate or carbonate are directly correlated, but there is a fractionation that occurs between them due to the excretion of oxygen, mainly in the form of CO_2, urine, and sweat (Kohn 1996: 4813). This will be further explored in Section 4.3.1.2.

4.2.4 Strontium Isotopes

Strontium isotope ratios inform archaeologists on the geographic origins of individuals; these isotopes are found in bedrock and make their way into the biosphere through plants, in turn representing the location of the food that animals ate. Although there are three stable isotopes of strontium, ^{84}Sr (~0.56%), ^{86}Sr (~9.87), ^{88}Sr (~82.53), it is ^{86}Sr that is compared to the only naturally forming radiogenic isotope ^{87}Sr. ^{87}Sr (7.04%) forms through the β-decay of ^{87}Rb, which has a half-life of 4.88×10^{10} years (Faure 1986). Unlike the other isotopic systems ($\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$), strontium is expressed solely as a ratio of $^{87}Sr/^{86}Sr$.

Rocks and minerals will naturally differ in their strontium isotope ratios due to the original abundance of ^{87}Rb and ^{86}Sr in the rock and the age since formation. For example, old rocks (>100my) with high Rb/Sr ratios at the time of formation will have higher ratios, above 0.710, while those that are younger and with low Rb/Sr ratios will have values lower than 0.704 (Bentley 2006: 141). Weathering of these parent rocks produces no detectable isotope fractionation (Dasch 1969: 1525-1532), but the situation is complicated if rocks contain multiple minerals with different weathering rates (Bentley 2006: 141).

Strontium in soil is not only from the parent bedrock, but can be carried in via water, wind, glacier movement, or precipitation (Graustein 1989; Miller et al. 1993: 438; Sillen et al. 1998). It is therefore a mixing of these sources that contribute to the overall strontium ratios of the soil that are available for uptake by plants and animals; these ratios are referred to as bioavailable strontium (Åberg 1995: 315-316).

Strontium ratios in river water will vary depending on the local bedrock, on which the river is flowing, soluble minerals within the river, and the ages of these rocks. Strontium ratios have been seen to correlate with the intensity of river flow, as those that heavier flow are more likely to carry strontium isotope ratios of continental rocks that are older in age (Åberg 1995: 314-315; Aubert et al. 2002). However, more easily eroded rocks such as limestone can 'swamp' those of harder minerals such as silicates, making river water values relatively high (Palmer and Edmond 1992: 2099-2105).

Due to the long residency of strontium in ocean water (Bentley 2006: 146), oxygen isotope ratios reflect the accumulated values from continental erosion; global seawater is homogenous and currently has a ratio of 0.7092, but has grown more radiogenic over geologic time (DePaolo and Ingram 1985; Hess et al. 1986). Ocean strontium can be redeposited on land through sea spray (Whipkey et al. 2000: 45). Whereas coastal regions are predominantly affected by strontium from ocean water, interior continental regions are more affected by dust and atmospheric deposition (Graustein 1989; Andersson et al. 1990; Åberg 1995: 310-315).

Unlike $\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$, the high masses of the strontium isotopes used in these analyses mean that there is no fractionation during their incorporation into plants and animals (Graustein 1989: 503-505; Åberg 1995: 315-321; Capo et al. 1998: 215). The lighter elements such as carbon, nitrogen, and oxygen, have more fractionation during uptake and metabolism because of the relative difference that 1 neutron makes to the size of the element. Strontium is a much larger element, and a difference of 1 neutron makes relatively little difference to the size and less of an impact on metabolic reactions. Herbivores receive their strontium mainly from the plants that they eat, and carnivores indirectly via the consumption of herbivores (Montgomery 2010).

4.3 Isotopes in archaeological samples

The use of isotopes in archaeology involves their measurements in numerous tissues, but two of the most common are within tooth enamel, or hydroxyapatite and bone collagen.

4.3.1 Tooth enamel

Tooth enamel is made up of densely packed hydroxyapatite mineral crystals (Hillson 2005: 146-148). Hydroxyapatite, [$Ca(PO_4)_6(OH)_2$] contains calcium, phosphate, and hydroxyl ions. Strontium ions exchange with those of calcium due to their similarities in ionic size (Capo et al. 1998: 198). Although oxygen is naturally present in the phosphate and hydroxyl ions of the hydroxyapatite, carbonate ions will substitute for both phosphate and hydroxyl groups (LeGeros and LeGeros 1984). Though carbonates are more likely than phosphate to break apart from hydroxyapatite, they both contain carbon and oxygen and are more easily extracted, giving information on both dietary and geographic origins (Wright and Schwarcz 1998: 4). Depending on the research questions, this is sometimes the preferred material.

Human enamel is denser and harder than both bone and tooth dentine, which are highly susceptible to post-deposition diagenesis (Budd et al. 2000). Diagenesis is the modification of skeletal tissue in the burial environment, mainly the chemical alteration of the tissues. Due to this, and the fact that enamel does not turnover after it is fully developed, it is commonly sampled for archaeological research (Budd et al. 2000). Molars are predominantly chosen for sampling (Evans et al. 2012). Different molars reflect different ages of childhood development: the crown of the first molar begins to mineralize just before birth and erupts by age 8, the second molar is formed from the ages of 2.5 to 8, erupting by age 14, and the third molar mineralizes from ages 8 to 14.5 and usually erupts by age 20, though this is highly variable (Table 4-1) (Gustafson and Koch

Table 4-1. Age of molar mineralization and eruption from Gustafson and Koch (1974) and Anderson et al. (1976) modified from White et al. (2012).

Molar	Age During Mineralization (years)	Age During Eruption (years)
First	birth-3	5-8
Second	2.5-8	10-14
Third	8-14.5	variable

1974; Anderson et al. 1976; Scheuer and Black 2000: 151-161). The choice of which molar to sample depends on what stage of life the researcher is trying to access.

4.3.1.1 Enamel - Carbon

Carbon in animals is incorporated from consumed plants or other animals. The carbon average of the total animal would be similar to that of the original diet, with the exception of alteration due to respiration, which is depleted in ^{13}C in CO_2(DeNiro and Epstein 1978: 499). However, tissues will vary in their composition relative to diet (Vogel 1978; van der Merwe 1982: 549; Schoeller et al. 1986). The total diet (protein, carbohydrates, and lipids) of animals is directly correlated with the values of bone and tooth enamel carbonate (Ambrose and Norr 1993: 26). Ambrose and Norr (1993) found an offset of diet to carbonate of +9.5‰ in a controlled feeding study of rats. Due to C_4 and marine foods having similar $\delta^{13}C$ values and the fact that carbonate contains a total diet; it can be difficult to differentiate between the two sources without further context (Schoeninger and DeNiro 1984).

4.3.1.2 Enamel - Oxygen

Oxygen values of enamel carbonate is directly correlated with blood oxygen values, which largely comes from drinking water. There is enrichment in ^{18}O between drinking water and enamel carbonates and phosphates due to the preferential excretion of the lighter isotope (Kohn 1996). Attempts to determine origins of individuals must consider the offset of these correlated values. There have been a number of proposed equations to account for the fractionation from drinking water to bone phosphate and carbonate (Longinelli 1984; Luz et al. 1984; Levinson et al. 1987; Daux et al. 2008; Pellegrini et al. 2011; Chenery et al. 2012). Daux et al. (2008) put together data from Longinelli (1984), Luz et al. (1984) and Levinson et al. (1987) along with their own data to produce a higher sample number of 42. Their equation arguably produces the smallest analytical errors (Daux et al. 2008). The equation Daux et al. (2008) presents is:

$$\delta^{18}O_{DW} = 1.54(\pm 0.09)^* \ \delta^{18}O_p - 33.72(\pm 1.51).$$

It is possible to use this equation to reconstruct what the original drinking water values would be and compare these with known oxygen values to determine geographic origins. Oxygen has been mapped globally both by predictive modeling and direct sourcing. Bowen et al. (2005) created a predictive global map of oxygen isotope variability. Although this modeling is an invaluable source where direct samples do not exist, it is just predictive and some regions have less density of recording stations, leading to less reliable produced data. It is therefore more reliable to use sampled oxygen values from regions to determine where individuals were from. Darling et al. (2003) and Darling and Talbot (2003), for example, have mapped the precipitation and groundwater for all of Great Britain. Evans et al. (2012) mapped extensive human data from Great Britain and saw that there was a good relationship between the predicted $\delta^{18}O$ values and what was seen in the oxygen phosphate values of the human tissue. Dutton et al. (2005) mapped $\delta^{18}O$ values for the precipitation and river waters of continental USA, whereas Laffoon et al. (2013) mapped oxygen carbonate values for the Caribbean.

By comparing human enamel carbonate to drinking water, while considering the offset, it is possible to identify geographic origins of individuals and migrants into the area. This was first done by Schwarcz et al. (1991) to identify origins of soldiers from Snake Hill, Ontario. It has become used extensively in bioarchaeology to identify locals and migrants across the world (ex: Dupras and Schwarcz 2001; Budd et al. 2004). Budd et al. (2004) argued that it was possible to identify individuals who spent their childhoods outside of a region as well as suggest possible childhood locals both in Britain and Europe. Pollard et al. (2011) suggested that conversion equations produce high uncertainty, between 1 and 3‰ in $\delta^{18}O_p$ values; where possible direct samples of enamel carbonate or phosphate from known local populations should be used in determining the origins of populations or individuals.

This fractionation in $\delta^{18}O$ values also affects mother's milk, which is more enriched in ^{18}O than drinking water. In turn, the young who are breastfeeding will be more enriched than the local drinking water. Wright and Schwarcz (1998) saw differences on the level of -0.7‰ between enamel carbonate from first molars to third molars, and a different of -0.5‰ between third molars to premolars. Wright and Schwarcz (1998) suggest that this represents the difference between individuals breastfeeding to having been fully weaned.

Another uncertainty when sampling $\delta^{18}O$ in human enamel carbonate is with the effects of cooking on the drinking water. As water evaporates during cooking there is an enrichment of ^{18}O in the remaining liquid. This is in part affected by exchanges in oxygen isotopes between food water with the cooking water if they were collected from different regions (Daux et al. 2008). Although most oxygen comes from drinking water, not everyone drinks only water; ales and teas were typically the beverage of choice for many individuals in the early modern and medieval periods as water quality in many populated regions was very poor (Olsen 1999; MacDonald 2004; Brettell et al. 2012). The boiling and heating required to make these drinks causes higher $\delta^{18}O$ values. Brettell et al. (2012) showed that boiling water would increase the $\delta^{18}O$ values by 0.4‰, while the production of ale, both in the heating of water during the production of wort and the fermentation itself, could increase the $\delta^{18}O$ values by 1.3‰. Stews that were typically cooked for long periods of time could also increase the oxygen ratios by up to 10.2‰. Brettell et al. (2012) hypothesized that if the water consumption came 20% from ale, 10% from teas, 20% from stews, and 50% from fresh water, the resulting oxygen isotopic difference from drinking water would be up to ~2.3‰. This difference is in part going to be affected by the water of where the food was sourced. The cooked food water and the final water will be closer than the initial water, though how much of a difference will depend in part on the $\delta^{18}O$ values of the original water or the food water within. Isotopic fractionation within foods that are heated water varies from 1.2‰ to 6.2‰, with the highest occurring with vegetables (Daux et al. 2008: 1145).

4.3.1.3 Enamel - Strontium

In determining the origins of individuals using strontium ratios, it must be considered that the origins of the majority of the strontium incorporated into human hydroxyapatite comes from plants, specifically their leaves (Comar et al. 1957: 485). Tooth enamel contains an average of the strontium ingested during the time of crown development (Hillson 2005). The majority of strontium stores can be found in hydroxyapatite of bone and teeth, replacing calcium within the hydroxyapatite compound (Parker and Toots 1970: 929). Due to concerns of diagenic alterations to strontium tooth enamel is typically preferred for archaeological sampling (Bentley 2006).

Due to the mixing of strontium sources, an understanding of bedrock geology is not sufficient to identify geographic origins. Researchers have instead begun to map bioavailable strontium regionally; this is either done by sampling the vegetation (Chenery et al. 2012), water (Evans et al. 2010 – with vegetation), animals (Evans and Tatham 2004), or multiple sources (Laffoon et al. 2012). Either modern or archaeological faunal remains can be used for this sampling (Price et al. 2002; Bentley and Knipper 2005). This mapping has been done for various regions including the British Isles (Evans et al. 2010) and the Caribbean (Laffoon et al. 2012). These regional strontium baselines defined by the mapping can then be used to identify locals and non-locals from within a population and suggest possible origins (Schroeder et al. 2009; Montgomery 2010; Chenery et al. 2012; Evans et al. 2012). This is complicated by numerous areas falling within the ‘strontium of doom’ of 0.709 to 0.710 (Montgomery et al. 2014), in large part due to their proximity to sea water. Therefore, the identification of origins is best done in conjunction with other isotope systems such as $\delta^{18}O$ (Evans et al. 2012).

4.3.2 Bone collagen

Bone is made up predominantly of two components**:** hydroxyapatite, which represents the mineral fraction of bone, and collagen, which is the organic (Veis 1984). Bone collagen is a triple helical structure of 3 repeating amino acids, and contains carbon as well as the only significant portion of nitrogen in the skeletal system (Ramachandran and Ramakrishnan 1976; Ambrose 1990). Bone collagen is sampled because it represents more recent diet as it does turnover, meaning that the bone remodels and incorporates more recent dietary isotopes, though this occurs quite slowly (Hedges et al. 2007). Bone tissue typically turns over in adults at the rate of 1.5 to 4% per year depending on the age of the individual and the type of bone (Hedges et al. 2007). Turnover depends both on the bone formation rate and the surface-to-volume ratio of the bone itself, bones such as ribs turnover faster than femora or ilia (Parfitt 2002; Hedges et al. 2007).

4.3.2.1 Bone Collagen - Carbon

As was previously stated, bone collagen does not have an equal offset from diet. For example, Vogel (1978) found that a South African animal, the Kudu, had bone collagen +5.3‰ higher than diet, and 3‰ higher in flesh, while that of fat was lower by

-3‰. Ambrose and Norr (1993) determined that carbon in bone collagen was primarily from the protein aspect of diet. They found that the offset from diet was +5.7‰ on a total C_3 diet. Numerous researchers have found different $\delta^{13}C$ values for bone collagen, between 3‰ and 5‰ (Vogel 1978; Bender et al. 1981; DeNiro and Epstein 1981). There is only a very small trophic shift (<1‰) in $\delta^{13}C$ values, and therefore they cannot be used to differentiate between C_4 and marine sourced foods (Schoeninger and DeNiro 1984).

4.3.2.2 Bone Collagen - Nitrogen

As nitrogen is incorporated into animals, there is a trophic shift that occurs in the $\delta^{15}N$ values of bone collagen between 3-5‰ (DeNiro and Epstein 1981; Macko et al. 1982; Bocherens and Drucker 2003: 49; Hedges and Reynard 2007). Due to this trophic shift, $\delta^{15}N$ values can be compared to $\delta^{13}C$ values to differentiate between C_4 foods and marine plants, as well as the presence of freshwater foods (Schoeninger and DeNiro 1984).

4.4 Consumption theory

Isotopic analyses allow archeologists to reconstruct past diets and origins, but an additional framework must be employed in order to comprehend decisions that lead to individuals consuming the foods that they did. A theory that embodies this concept is consumption theory. This theory examines consumer behaviour to determine individual and or group patterns of decision, acquisition, and use of material items as related to the satisfaction of human needs and desires (Henry 1991; Carroll 1999). Most archaeological studies that use this theory look at the base group of a household; a household being defined as a "group co-residing in a single structure" (Holt 1991). Within the context of this study, the sailors within a single ship in the Royal Navy could meet this definition of a household, those buried at a naval cemetery would not all be from one naval vessel, but rather a number of vessels over the culmination of many years. Carroll (1999) argues that the community is the best level at which to analyze local and global scale consumption patterns. Therefore, the cemetery represents individuals related to, or possibly functioning within the Royal Navy, which can be defined as a community. It is at the level of the community of the Royal Navy that this study will consider consumption theory.

Consumption theory can be broken down into four main aspects of consumerism: decision, acquisition, use, and post-use deposition (Henry 1991). Holt (1991) separates the factors influencing decisions of what material objects, or in this study consumable food, are be acquired into 'biological needs' and 'cultural needs' (Figure 4-1). Biological needs include food and medicine, whereas cultural needs relate to status, ethnicity, and ritual. These needs are influenced by three parameters: socioeconomic, spatial and temporal, and cultural factors. Socioeconomic factors include the variables such as class, income, market price, and individual preferences. Spatial and temporal factors include aspects such as geographic location, state of knowledge, and level of technology. Finally, cultural factors affecting decision include numerous variables, for instance ideology, traditions, and symbolism. The means of acquisition are separated into purchase, barter, home production, hunt and gather, theft, and gift (Henry 1991; Holt 1991). The third aspect of consumerism is use, which includes considerations such as whether the object is

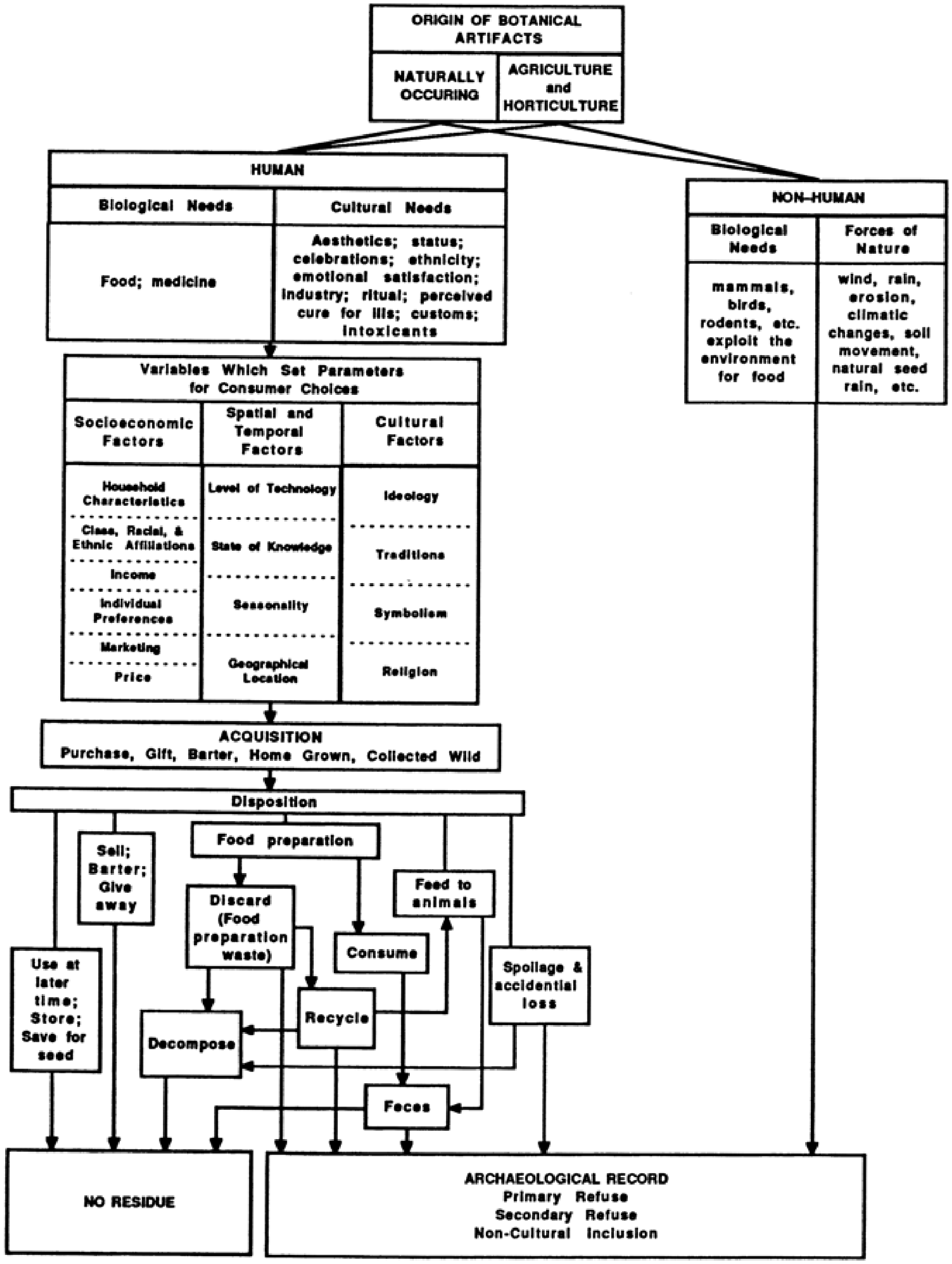


Figure 4-1. A model for the decision, acquisition, use, and post-use deposition of food derived from Holt (1991)

ingested, played with, or worn. Aspects of post-use disposition include whether the object is re-used, given away, or thrown out.

Only aspects of decision and acquisition are being evaluated for the purposes of this study. Use is only important in so far as the food was consumed. Due to the nature of skeletal remains, very little information about use and post-use deposition can be garnered. Therefore, aspects of decision and acquisition are most important to interpreting isotopic values in skeletal remains. In terms of post-depositional use, what is done with remaining food or scraps afterwards is neither accessible from bone nor relevant to the research questions and will not be considered.

The factors affecting decision can be used to explain variability in diet. Socioeconomic factors include class differences between officers and sailors, and related differences in disposable income for extra food not sanctioned by the Victualling Board. Sailors were not typically paid until the end of a season, which meant that only those with disposable income, likely family money, that could commonly afford extra food. This can be evidence by officers having chickens and other livestock onboard the vessels (MacDonald 2004). Another example of potential impacts is associated with geographic location, since residence in the Americas could expose individuals to different food with C_4 isotopic values such as maize and sugar cane. Although they were not part of the sanctioned rations, these foods may have been accessed while vessels were stationed in the Americas.

4.5 Agency theory

How individual sailors were capable of accessing different foods not sanctioned by the Navy can be explored through agency theory. This theoretical framework examines the abilities of individuals within social structures to exercise their personal motivations (Dornan 2002). There are two parts to the theory: agency and practice. Agency is defined as the capability of an agent to act a certain way within or outside their social structure, while practice is what agents actually do within their social structure (Hegemon 2003). As a whole, agency theory studies not only the personal motivations and practices, but also material culture that relates to social interactions, and the interconnections between agency and structure (Dobres and Robb 2005).

Agency theory can be used to interpret the food consumption decisions of the individual sailors within the structure of the Royal Navy. By addressing personal differences related to the prescribed rations, personal practices of the sailors can function as agents in moving within and outside their social structure to access food. This theory will work alongside consumption theory to help decipher the life histories of the sailors. As suggested by socioeconomics of consumption theory, the differences in disposable income could explain differential access to unsanctioned food and what the personal motivations were to access different foods. These complimentary theoretical frameworks in association with precise isotopic data will permit both an analytical and historically-informed interpretation of the lives of individual sailors in the Royal Navy.

4.6 Conclusion

Isotopic analyses directly reconstruct diets and origins and are therefore an analytical technique that has been used increasingly to help answer archaeological questions. While $\delta^{13}C_{carb}$ values from tooth enamel carbonate can help to differentiate what foods were consumed during various parts of childhood, $\delta^{18}O_{carb}$ and $^{87}Sr/^{86}Sr$ speak to the origins of the individual. Bone collagen represents more recent averages of protein aspects of diet. In order to understand what aspects of a persons' life lead to their consuming various foods and drinks that are visible from isotopic analyses, theoretic frameworks such as consumption theory in tandem with agency theory are very helpful. Not only does it help explain why isotopes can differentiate origins by diet, but also how social status affects access to different foods. These theories give more nuanced understanding of life within the Royal Navy as experienced by sailors.

Chapter Five

5 Materials and Methods

The following chapter describes the materials and methods used in the analysis of remains from the St. John's Royal Naval Hospital in order to reconstruct the life histories of those buried at the Southside cemetery. It has been broken into four parts: materials, basic demography, isotope analyses, and interpretation of results. The description of the collection and the materials sampled is followed by a basic demographic profile of age and sex based off of the elements sampled. Although von Hunnius (1998) had previously performed similar analyses on the assemblage, many of the elements that were sampled in this study were not included. The methodologies used for all analyses, including carbonate, strontium, and bone collagen are described and their precision given. Finally, the equations used for the interpretation of enamel carbonate data are present to allow for the reproducibility of data interpretation as well as the statistical analyses used for the interpretation of all data.

5.1 Materials Sampled

5.1.1 Southside Cemetery, St. John's, NL

The remains from the cemetery at the bottom of the Southside Hills, St. John's, NL were collected by the Newfoundland Constabulary Criminal Investigation Division in 1979 and were sent to Memorial University Health Sciences (Mills 2002). The collection was then curated by The Rooms, and housed in the Department of Archaeology, Memorial University of Newfoundland (MUN).

The identifier used for collections of remains housed at MUN is a number series; for Southside this number is NP163. Due to how the samples were collected, the remains were co-mingled. In turn, a letter and a number identify all skeletal elements separately, not by the individual. For example, for the cranial elements, NP163 A identifies all calvarium with any other associated elements such as complete skulls, NP163 B identifies all unassociated mandibles, and NP163 C identifies the maxillae and associated elements with no associated calvarium. The elements will henceforth be referred to by their element number (e.g., A3, B10, and C4).

In order to examine questions related to the childhood origins and diets of the sailors, as well as their diets during adulthood, the bone and enamel of the remains were sampled. However, due to the nature of the co-mingled remains, traditional sampling of bone collagen from elements such as ribs and femora were not possible as these elements are unassociated in this assemblage. Instead, to allow for the reconstruction of life histories, cranial elements were chosen; these include both bone collagen from mandibles and palatine bones, and enamel from molars. For enamel carbonate, 3 first molars, 19 second molars, and 16 third molars were sampled from different individuals (Table 5-1). For strontium isotope analysis, 19 second molars and 1 first molar (the mandible contained no other late forming teeth) were sampled. For bone collagen, 21 mandibles were sampled. These mandibles had very dense and thick cortical bone that would be

Table 5-1. Tissue and type of sampling for each individual associated with the Southside Cemetery, St. John’s NL. NP163 is the internal site number identifier. The skull elements are separated by three identifiers A= cranium with an associated mandible, B=mandibles with no associated cranial elements, C=maxillae with no other associated cranial elements. Presence of a sample is indicated by x.

	Mandible		Palatine		M1		M2			M3	
NP 163	$\delta^{13}C_{col}$	$\delta^{15}N_{col}$	$\delta^{13}C_{col}$	$\delta^{15}N_{col}$	$\delta^{13}C_{carb}$	$\delta^{18}O_{carb}$	$\delta^{13}C_{carb}$	$\delta^{18}O_{Carb}$	$^{87}Sr/^{86}Sr$	$\delta^{13}C_{carb}$	$\delta^{18}O_{Carb}$
A1	x	x	x	x			x	x	x	x	x
A2	x	x	x	x			x	x	x	x	x
A3	x	x	x	x			x	x	x	x	x
A4	x	x	x	x			x	x	x	x	x
A5	x	x			x	x	x	x	x	x	x
A6	x	x					x	x	x	x	x
A7	x	x	x	x			x	x	x	x	x
A8	x	x	x	x			x	x	x	x	x
A9	x	x					x	x	x	x	x
A10	x	x					x	x	x		
B1	x	x					x	x	x	x	x
B2	x	x					x	x	x	x	x
B3	x	x			x	x	x	x	x	x	x
B4	x	x					x	x	x	x	x
B5	x	x					x	x	x		
B6	x	x					x	x	x	x	x
B7	x	x									
B8	x	x			x	x			x		
B9	x	x					x	x	x	x	x
B10	x	x					x	x	x	x	x
B11	x	x					x	x	x		
C4			x	x							
C5			x	x							
C6			x	x							

very slow to turn over; palatine bones were also sampled to provide samples from bone with faster turnover that would reflect more recent diets. There were nine palatine bone samples taken, six of which are associated with mandibles in order to allow for later comparisons.

5.1.2 St. Paul's Anglican Church, Harbour Grace, NL

In order to have comparative values of $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ in Newfoundland, samples were taken from individuals from the St. Paul's Anglican Church Cemetery (CkAh-06). Part of the historic cemetery at St. Paul's was salvage excavated after construction workers found human remains during the excavation of a trench that was meant to serve as a foundation for renovations on the church (Pike 2013). The church itself was originally built in 1764 with a stone structure built in 1820, is believed that the partially excavated cemetery dates to sometime between these dates (Pike 2013). There were a minimum of 19 individuals recovered, 8 of which were recovered in the blackdirt pile (Pike 2013). Enamel carbonate samples were taken from the second molars of six individuals, the only adults who had preserved teeth. Bone collagen samples were taken from individuals in this assemblage by Kelly-Anne Pike. Together these will serve as the dietary and drinking water representation of historic European descended individuals living in Newfoundland.

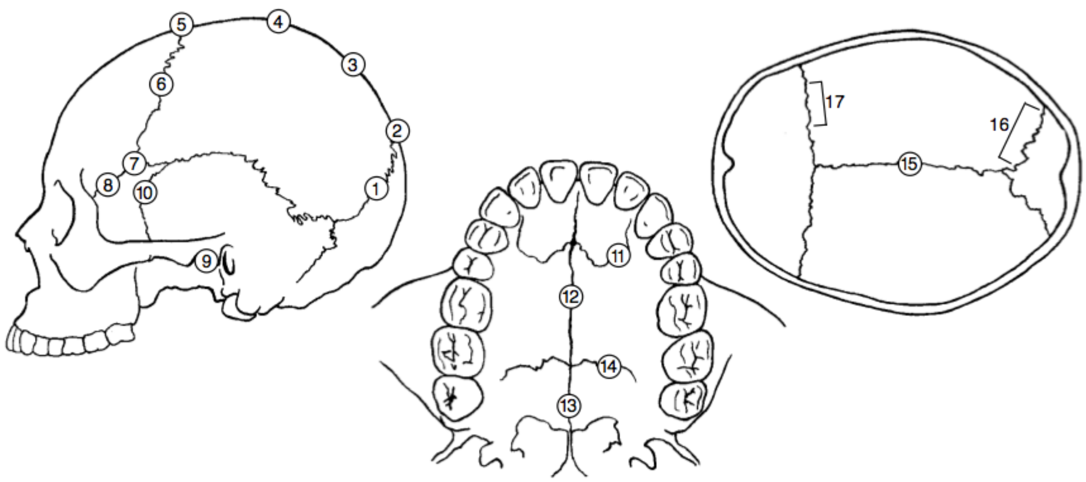
5.2 Demography Methodology

5.2.1 Materials

Skull elements that were identified for sampling were reexamined for sex and age by the author. This was done because previously work by von Hunnius (1998) excluded many samples used in this study's analyses from age and sex estimates. The first step to the demographic profile of the assemblage to be sampled was to determine the minimum number of individuals (MNI). The skull fragments were all sided, and then examined to determine which element was most prevalent. The number of these sided elements was determined to be the MNI of the assemblage.

The determination of sex and age by only skulls is not ideal, as other elements, including those in the pelvic girdle, allow a better estimation; however, the comingled nature of this assemblage necessitated using the cranium. Age estimation was performed based on ecto- and endo- cranial suture closures as developed and described by Meindl et al. (1985) and modified by Buikstra and Ubelaker (1994). The 17 sites of cranial suture closure by Buikstra and Ubelaker (1994) were used (Figure 5-1). These regions were scored from 0 to 3, being unfused to completely obliterated (Figure 5-1). The cranial vault sutures (sites 1-7) and the lateral-anterior sutures (sites 6-10) were scored separately. If any were missing within one of the scoring groups (vault or lateral-anterior), aging was not attempted. The age ranges between these two scoring groups were different; therefore, they were grouped as being a 'Middle Adult'.

The sexing of the skull is possible due to the sexual dimorphism between females and males; male skulls are larger and more robust than female (Gülekon and Turgut



Site	Description
1 Midlambdoid	Midpoint of left lambdoid suture
2 Lambda	Intersection of sagittal and lambdoid sutures
3 Obelion	At obelion
4 Anterior sagittal	One-third the distance from bregma to lambda
5 Bregma	At bregma
6 Midcoronal	Midpoint of left coronal suture
7 Pterion	Usually where the parietosphenoid suture meets the frontal
8 Sphenofrontal	Midpoint of left sphenofrontal suture
9 Inferior sphenotemporal	Intersection of left sphenotemporal suture and line between articular tubercles of the temporomandibular joint
10 Superior sphenotemporal	On left sphenotemporal suture 2 cm below junction with parietal
11 Incisive suture	Incisive suture separating maxilla and premaxilla
12 Anterior median palatine	Score entire length on paired maxillae between incisive foramen and palatine bone
13 Posterior median palatine	Score entire length
14 Transverse palatine	Score entire length
15 Sagittal (endocr.)	Entire sagittal suture endocranially
16 Left lambdoid (endocr.)	Score indicated portion
17 Left coronal (endocr.)	Score indicated portion

Meindl and Lovejoy (1985) "vault" sutural ages (add scores for sites 1–7).			Meindl and Lovejoy (1985) "lateral-anterior" sutural ages (add scores for sites 6–10).		
Composite Score	*Mean Age*	*Standard Deviation*	*Composite Score*	*Mean Age*	*Standard Deviation*
0	—	—	0	—	—
1–2	30.5	9.6	1	32.0	8.3
3–6	34.7	7.8	2	36.2	6.2
7–11	39.4	9.1	3–5	41.1	10.0
12–15	45.2	12.6	6	43.4	10.7
16–18	48.8	10.5	7–8	45.5	8.9
19–20	51.5	12.6	9–10	51.9	12.5
21	—	—	11–14	56.2	8.5
			15	—	—

Figure 5-1. The 17 suture sites used for age estimation according to Buikstra and Ubelaker (1994) which is modified from Meindl et al. (1985). All suture sites are scored from 0 (open) to 3 (completely obliterated) and then added according to the two tables at the bottom of the figure.

2003; White and Folkens 2005). Buikstra and Ubelaker (1994) proposed a five-point scale of robusticity from extremely gracile (1) to extremely robust (5) (Figure 5-2). These five points are used to identify five aspects of skull morphology: nuchal crest, mastoid process, supraorbital margin, supraorbital ridge, and the mental eminence (Buikstra and Ubelaker 1994). The scores of these aspects are then averaged to give an estimation of the sex of the individual. In a study by Walker (2008), accuracy for sex estimations using the crania were between 84 to 88%. The more traits that are used, the more accurate the estimates, though this is also affected by which traits are used since some are more accurate than others (Rodger 2005; Walker 2008).

The terminologies and meanings of the determination of sex that are used for this study are consistent with those defined by White et al. (2012: 408), which are:

- female or male can be interpreted as the analysts having “full confidence in the determination of sex for the remains”
- probably female or male means that the “analysts does not have full confidence in the determination, but feels that the remains are probably the stated sex”
- sex indeterminate means that “the remains have been analyzed, but are lacking sufficient diagnostic morphology for a determination of sex”

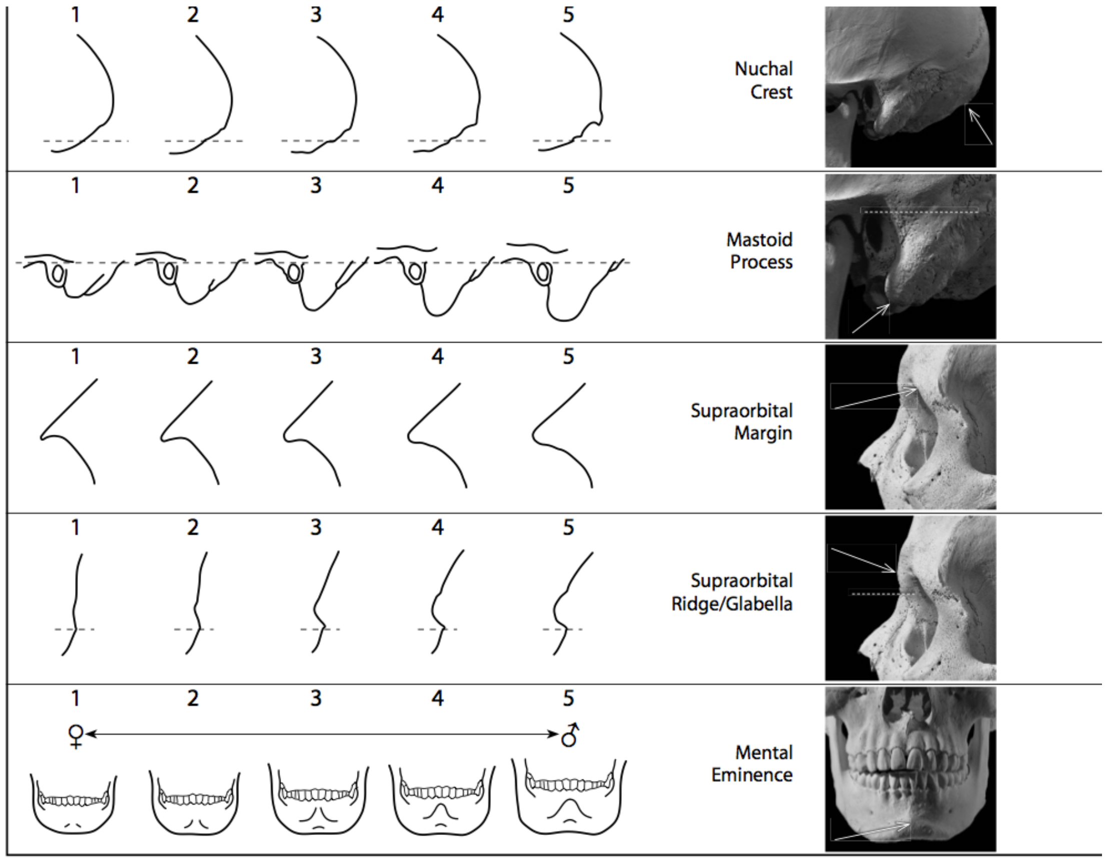


Figure 5-2. The five morphological traits used for sexing the skull along with the five point scale of robustness as established by Buikstra and Ubelaker (1994); one being the extreme effeminate and five being the extreme masculine. An average of these traits as approximated from each individual within a population is used to determine sex. This figure is replicated from White et al. (2012).

5.3 Isotope Analysis Methodology

5.3.1 Samples

Enamel carbonate and bone collagen samples were taken by the author at Memorial Archaeology Applied Sciences Laboratory (MAAS). Enamel strontium samples were cut at MAAS, but all other sample preparation was done in the Clean Laboratory at Memorial University Earth Sciences Building. Before any preparation, all elements were photographed, documented, and samples were assigned separate internal sample numbers (MARC).

As mentioned earlier, the remains of Shanawdithit were possibly buried at the Southside cemetery, yet her skull was exhumed and removed to London where it was destroyed in a German bombing raid during the War (O’Neill 2003: 734-35); therefore, there is no possibility of her remains having been sampled as part of this study.

5.3.2 Carbonate Bioapatite

5.3.2.1 Sample

Enamel samples from molars were preferentially chosen from areas that were void of pathologies such as caries or linear enamel hypoplasia, with teeth that were loose being preferentially taken. All samples were cleaned using mechanical abrasion prior to sample acquisition using a Grobet USA Micromotor Drill with diamond tipped burrs. Approximately 5 mg of enamel powder was ground into a sample boat and transferred into a 2ml microcentrifuge tube. Prior to and between each sample collection, drill burrs and disks were cleaned in ultrapure deionized water (18 mega ohms [MΩ] Zeneer Power TOC Power) by ultrasonication for 5 min, followed by a brief rinse in 0.81 M HNO_3.

5.3.2.2 Enamel Pretreatment

The samples were pretreated following established protocol from a modified version of Lee-Thorp et al. (1997). In order to remove biogenic and organic matter, 1.8ml of NaOCl solution (~1.7% v/v) was added to each tube and agitated frequently for 25 min. The sample was then immediately centrifuged at 10,500rpm for 5 min, decanted, and rinsed three times using ultrapure deionized water. The water was decanted and replaced with 1.8ml of 0.1M acetic acid (CH_3COOH) solution to remove soluble carbonate ions. The solution was agitated frequently for 8 min and immediately centrifuged at 10,500 rpm for 2 min. The solution was decanted and the sample was rinsed and centrifuged three times using deionized water, centrifuging and decanting between each rinse. The samples were covered with perforated parafilm and lyophilized (Virtis Benchtop 2K freeze dryer) for 48 hr.

5.3.2.3 Analysis

The samples were brought to the Stable Isotope Laboratory of CREAIT where ~5 mg of pre-treated enamel was weighed out into glass tubes and tightly sealed. Under the supervision of Alison Pye, these samples were flushed with helium overnight while in a heating block (50ºC), before being injected with phosphoric acid (Metcalfe et al. 2009). This process generated CO_2 and H_2O. The vial was then sampled using helium as the carrier gas and passed through Nafion tubing that removed the water, then run through the Gas Chromatography (GC) column to separate the gases. These separated gases were sent to the DeltaVPlus I Isotope Ratio Mass Spectrometer (IRMS). The resulting gases from the elemental analyzer were carried to the source of the mass spectrometer, which caused the ionization of the gasses. They were then accelerated and focused through the magnetic field before reaching the Faraday cups, which record the strength of the voltage that are used to create the ratio of the isotopes. These ratios are then compared to international standards to allow for the comparability of data. The equation used to calibrate the data against international standards is as follows:

$$\delta^{18}O = (^{18}O/^{16}O\ \text{sample})/(^{18}O/^{16}O\ \text{standard})-1\ {*}1000$$

With this equation, the data is denoted with a δ value and is expressed as parts per thousand (‰).

5.3.3 Strontium Analyses

5.3.3.1 Sample

The enamel samples for strontium analyses were taken from the 16 second molars and 1 first molar. The enamel was abraded, slightly further than the intended cut, using a Grobet micromotor drill. A sample of ~20 mg was cut from each tooth. Using ultrapure deionized water, the samples were ultrasonicated in a 10 ml beaker three times, rinsing and changing the water each time. These were then placed in a centrifuge tube, covered in acetone, agitated, and the acetone was decanted off. The samples were covered in perforated parafilm and left in the fume hood to dry overnight.

5.3.3.2 Column Chemistry

These samples were then brought to the Clean Laboratory in the Earth Sciences Building at Memorial University where they were treated. A modified methodology of Deniel and Pin (2001) and Copeland et al. (2008) was used for the columnar chemistry. The sample was dissolved in 2 ml of distilled 8M HNO_3 in 3mL PFA (perfluoroalkoxy) vials (Savillex, MN) (also 1.5 ml for those that went onto the Multi-Collector Inductively-Coupled-Plasma Mass-Spectrometer (MC-ICP-MS); 0.5 ml of this was separated for ICPMS. Columns were fabricated using the methodology described in Charlier et al. (2006) using 1ml pipette tips and medium porosity (70µm) polyethylene fritware sheets (Bel-Art Products, New Jersey, USA). Some samples were run with new Sr. spec resin (Eichrom, IL), while others were run with regenerated resin. The cleaning of the Sr. spec resin involved soaking the used columns in deionized nano-pure water followed by 8M HNO_3, then 6M HCl, each time removing any resin that floated on the surface. The regenerated columns were then stored in nano-pure water until they were needed. This is a modified version of the product outlined by DeMuynk et al. (2009). If a new column was to be used, it was prepared by rinsing with 2 column volumes (ColV) (~1 ml each) of deionized nano-pure water (18.3 megaohms [MΩ]). This was followed by a rinse of 1 ColV of 8M HNO_3. If new resin rather than previously prepared and cleaned columns was being used, it was then added to the column. DeMuynk et al. (2009) showed that strontium resin can be regenerated and produces non cross-contaminated values. To prepare the column for the sample, it was rinsed with 2 ColV of 6M HCl, followed by 3 ColV of nanopure deionized water, then 3 ColV of 8M HNO_3. One ml of the sample was then loaded onto the resin, collected in the savillex vial, and reloaded.

The resin with the sample was then washed with 3 ColV with 8M HNO_3. Strontium was then eluted with 2 ColV of deionized water. The procedures following this step depended on if the sample was to be run on a Thermal-Ionization Mass Spectrometry (TIMS) or MC-ICP-MS.

Although the TIMS has traditionally been preferred for isotopic analysis, improvements to the instrumentation of MC-ICP-MS have meant that both are viable choices for strontium isotopic analysis (Yang 2009). The access to the technical machinery therefore dictated the use of both the TIMS and MC-ICP-MS for this study.

5.3.3.3 Thermal-Ionization Mass Spectrometry

For analysis of the sample using the Finnigan MAT 262V Thermal-Ionization mass spectrometer (TIMS) the sample was dried down on a hot plate (~4 hr). The Tungsten filaments used for the samples on the TIMS were degassed up to 5 amps. The samples and standards were loaded using a Birck solution. For standards, 1 μl of the solution with 1 μl of the standard was used to load them onto the filament. Samples were loaded using 1 μl of the solution and 1 μl of the sample that is redissolved in 4M HNO_3, followed by an additional 1 μl of loading solution. The samples and standards when loaded were heated with 0.8 amps for ~10 min, or until dry, then to 1.5 amps for ~5minutes, followed by 2.5 amps for a couple seconds.

The samples were then loaded into the source. When the filament was heated, ions were produced which are accelerated and focused. This beam travels to the analyzer, which is a series of magnets that separated the beam based on the mass charge ratio of the particles. These ion beams were then sent to the collector where they were simultaneously measured in Faraday cups. The voltages of these ion beams are used to calculate the isotopic ratios and are then calibrated using international standards.

5.3.3.4 Multi-Collector Inductively-Coupled Plasma-Mass-Spectrometry

Instead of the samples being dried down as with the TIMS, 0.075µl of 8M HNO_3 was added to the eluted strontium solution. The samples were then brought the Earth Sciences Micro Analysis Facility under the supervision of Dr. Rebecca Lam where they were analyzed on a Thermo Scientific Neptune MC-ICP-MS. The sample was introduced into the plasma ion source where the ions are produced, accelerated and focused. The ion beam is then separated in the analyzer via an electro-magnetic field into beams with ions separated according to their mass/charge ratios. These ion beams are measured simultaneously by a series of collectors, which calculate the isotopic ratio based on the different voltages of the ion beams.

5.3.4 Carbon and Nitrogen from Bone Collagen

5.3.4.1 Sample

Location of bone collagen samples were preferably chosen from locations that were already broken, though good preservation of some elements precluded this. Approximately 200-300mg of bone was cut using a Jobmate rotary tool, and then was cleaned by mechanical abrasion using a stainless steel bit of the same rotary tool. The bones were all coated in acroloid, possibly Rhoplex, but mechanical abrasion removed most of the substance. Samples were soaked in acetone overnight in closed centrifuge tubes, and then dried down in a fumehood covered with parafilm with holes in it until no acetone remained (~24 hr). The following extraction of bone collagen was done according to a modified version on the Longin method (1971) by Richards and Hedges (1999).

5.3.4.2 Demineralization

The cortical bone samples were placed in screw top test tubes and filled to ~2/3 with chilled 0.5M HCl. The test tubes were covered loosely and placed into a ~4ºC refrigerator. Demineralization was determined to be complete when the sample was malleable and there were no more bubbles produced from a reaction with fresh HCl. This took approximately 2 wk. When demineralization was complete the spent acid was decanted off and the samples were rinsed in deionized water three times. The tubes were refilled with deionized water and shut tight until the remaining samples were fully demineralized, whereby all the samples were rinsed and fresh deionized water was placed in the test tubes.

Before gelatinization, the samples had to be to acidified to improve the solubility of the bone collagen fibrils (Brown 1999; Brock et al. 2013). A large drop of 0.5M HCl was added to the filled test tubes and using a pH strip it was ensured that they were at a pH of 3.

5.3.4.3 Gelatinization

The gelatinization of the bone hydrolyzes the bone collagen fibrils, which removes the larger non collagenous proteins (Brock et al. 2013). All test tubes were placed into a heating block at ~70ºC with the lids on tight. The tubes were covered with aluminum foil to insulate them and were left for 48 hours. After removing the test tubes from the heating block, the solution was filtered using Epee filters (pore size 40-90μm, Elkay, UK) in order to remove non-collagenous particulates.

5.3.4.4 Lyophilization

To remove all water from the gelatinized collagen, all samples were lyophilized. The filtered samples were covered in parafilm with holes and placed into a -20ºC freezer, tipped on an angle to increase surface area. The samples were left there for 24 hr and then moved to a -60ºC freezer for another 24 hr. After this was complete, the samples were placed in a Virtis Benchtop 2K Freeze Dryer with the condenser at -70ºC and the vacuum at <20mT, where they were left for 48 hr. After this time they were taken out and immediately covered with parafilm. The final weight was then assessed from which the collagen yield was determined.

5.3.4.5 Analysis

The samples were then brought to the Stable Isotope Laboratory of CREAIT where ~1mg of collagen was weighed out for each samples into a 7x7 tin capsule (Elemental Microanalysis, Southampton, UK). Under the supervision of Alison Pye, the samples were released one at a time from an autosampler and combusted in the Carlo Erba NA1500 Series II Elemental Analyzer. The resulting gases flowed into the reduction chamber with the carrier gas helium where the combusted elemental carbon and nitrogen were converted into CO_2 and N_2. The gasses were then carried through a chemical trap, which removed any excess water before flowing to the gas chromatograph where the CO_2 and N_2 were separated. The resulting gasses from the elemental analyzer were carried to the source of the DeltaVPlus IRMS, which causes the ionization of the gasses and they are then accelerated and focused through the magnetic field before reaching the Faraday cups. These record the strength of the voltage, which corresponds to the ratio of the isotopes. These ratios are then compared to international standards to allow for the comparability of data.

5.4 Precision of Isotope Analyses

5.4.1 Carbonates

The first run of enamel carbonates consisted of all of the first molars and the majority of the second molars, and the internal precision determined using the check standard MUN-CO-1 (internal standard $CaCO_3$) was ±0.06‰ for $\delta^{13}C$ and ±0.07‰ for $\delta^{18}O$ (n=3). The internal precision for the second run, consisting of the remaining second molars and the third molars and was ±0.01‰ for both $\delta^{13}C$ and $\delta^{18}O$ (n=4 of MUN-CO-1).

5.4.2 Strontium - Thermal Ionization Mass Spectrometry (TIMS)

All sampled were monitored for interferences from Rb were normalized for the mass bias to $^{88}Sr/^{86}Sr$=8.375209. Analysis of the international strontium isotope standard NIST SRM987 during the analytical session gave a value of $^{88}Sr/^{86}Sr$ =0.710138±0.000040 (n=9). The difference from the certified value of $^{88}Sr/^{86}Sr$= 0.710240 (Johnson and Fridrich 1990) was $^{88}Sr/^{86}Sr$=0.000102, this value was used to correct the data. The precision differed for each sample, typically being between 0.000011 and 0.000016; however, the smaller number of blocks of data (one to two) for some samples caused the precision to be as elevated as 0.000497 (Table 5-2). The mean precision of the samples was 0.000069 (2SE) ranged between 0.000011 and 0.000497 (Table 5-2). This mean precision is significantly higher due to the outlier (A6), without, which it is 0.000021. All data with the exception of A6 are therefore accurate to the fourth decimal place, past which is not interpretably relevant for archaeology.

Table 5-2. The TIMS $^{87}Sr/^{86}Sr$ values for all individuals from the Southside Royal Naval Hospital Cemetery. The samples values are corrected against the standard NIST SRM 987 and the sample precision to 2se is identified.

Individual (NP163…)	**$^{87}Sr/^{86}Sr$ (Corrected)**	**2SE**
A1	0.71010	0.000011
A3	0.71049	0.000029
A5	0.71034	0.000044
A6	0.70967	0.000497
A7	0.71150	0.000041
A8	0.71016	0.000016
B2	0.71051	0.000014
B4	0.70961	0.000013
B5	0.70919	0.000014
B8	0.71026	0.000011

5.4.3 Strontium – Multicollector-Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS)

All sampled were monitored for interferences from Rb and Kr and were normalized for the mass bias to $^{88}Sr/^{86}Sr=8.375209$. Analysis of the international strontium standard NIST SRM987 gave a value of 0.710268±0.00001 (n=13), which had a difference of -0.00003 to the accepted value and all data gathered using the MC-ICP-MS were corrected by this amount.

5.4.4 Bone Collagen

The internal precision for the bone collagen run was determined using the check standard B2155; the precision for $\delta^{13}C$ was ±0.13‰ and ±0.23‰ for $\delta^{15}N$ (n=4). There were replicates run for thirty percent of the samples (n=9). The $\Delta\delta^{13}C_{col}$ of all replicates had a mean of ±0.02‰ and the $\Delta\delta^{15}N_{col}$ had a mean of ±0.01 with a range of -0.23‰ to 0.24‰ and -0.35‰ to 0.59‰ respectively.

5.4.5 Collagen Quality Control

Due to the porosity of bone structures, bone is highly susceptible to diagenesis (Wang and Cerling 1994). While pretreatment of the samples is meant to remove contaminants, preservation indicators must also be used. The first is that of collagen yield, where the mass of the bone sample is compared to that of the resulting collagen in the following equation:

$$\% \text{ Collagen Yield} = 100 \times \text{Collagen Mass (mg)} / \text{Bone Sample Mass (mg)}$$

Modern bone contains ~20% collagen by weight, though collagen yields as low as 1% represent acceptable levels within which appropriate values can be obtained (Ambrose 1990; van Klinken 1999). In addition, weight % carbon and nitrogen are also used. For carbon, 15-47% and for nitrogen 5.5-17.3% are acceptable levels, which correspond to the atomic carbon/nitrogen ratio of between 2.9 to 3.5 (Ambrose 1990; van Klinken 1999).

5.5 Materials Interpretation

5.5.1 Oxygen Carbonate Drinking Water Conversion

The $\delta^{18}O_{carb}$ values are compared to those of known average drinking water ($\delta^{18}O_{DW}$) values globally in order to identify possible origins of the individuals within the population. The conversion of $\delta^{18}O_{DW}$ values to $\delta^{18}O_{carb}$ values is imperative for the interpretation of the data because of the physiological influence on the ratio of oxygen isotopes that is explored in Chapter 3.

The conversion of these values is done according equations from three studies. The conversion of drinking water to phosphate values is done according to Daux et al. (2008) using the following equation.

$$\delta^{18}O_p = 21.8961039 + 0.64935065 * {}^{18}\delta O_{DW}$$

The transformation from phosphate to Vienna Standard Mean Ocean Water (VSMOW) is performed in this study using the equation developed by Millard and Schroeder (2010), which is a combination of the data from Iacumin et al. (1996) and Bryant et al. (1996), resulting in the following equation:

$$\delta^{18}O_{VSMOW} = 8.425852 + \delta^{18}O_{Phosphate} * 0.991276764$$

Coplen (1988) suggested that all $\delta^{18}O_{VSMOW}$ and $\delta^{18}O_{VPDB}$ values are to be normalized to allow for the comparison of data produced on different mass spectrometers. Due to this process being widely accepted, the conversion of $\delta^{18}O_{VSMOW}$ to $\delta^{18}O_{VPDB}$ is necessary for the comparison of $\delta^{18}O_{Phosphate}$ and $\delta^{18}O_{VPDB}$. The final equation used is to convert VSMOW to carbonate is done according to Coplen (1988).

$$\delta^{18}O_{VPDB} = -29.98321871 + \delta^{18}O_{VSMOW} * 0.970016781$$

The use of these equations on drinking water values allow for the direct comparison to carbonate data in order to establish possible origins of the individuals buried at the Southside Cemetery.

5.5.2 Statistical Analyses

Samples were tested for normality and equal variance with a p-value of 0.05. When data failed assumptions, it was log transformed and tested again. When data met assumptions they were compared by ANOVA and a Tukey's Post-Hoc Test when the differences were significant. When data failed assumptions it was compared non-parametrically using Mann Whitney U-test and a Dass-Steel-Christlow-Flinger Post Hoc Test when differences were significant.

5.6 Conclusions

Due to the methods of excavation at the Southside Cemetery, the assemblage was treated as an ossuary, sampling cranial tissues for isotopic analyses to allow for the determination of sex and age (Meindl et al. 1985; Buikstra and Ubelaker 1994). In order to answer questions related to childhood origins and diet, enamel carbonate from first, second, and third molars was sampled for $\delta^{13}C_{VPDB\ and}$ $\delta^{18}O_{VPDB}$ using a modified procedure outlined by Lee-Thorp et al. (1997). As multiple isotopic systems are preferred to establish origins, $^{87}Sr/^{86}Sr$ was also sampled from second molar enamel using a modified procedure of Deniel and Pin (2001) and Copeland et al. (2008). In order to determine adult diet bone collagen from mandibles and palatine bones were sampled for $\delta^{13}C_{VPDB}$ and $\delta^{15}N_{AIR}$ using a modified procedure by Richards and Hedges (1999). The two cranial elements were sampled to access different long term averages of diet, as palatine bone will represent slightly more recent diet than the mandible, which is very slow to turnover isotopically. The $\delta^{18}O_{VPDB}$ data of these individuals is not directly comparable to known isotopic baselines of drinking water such as that of England (Darling et al. 2003). This study has chosen to use the equations outlined by Daux et al. (2008), Millard and Schroeder (2010), and Coplen (1988).

Chapter Six

6 Results

Stable and radiogenic isotope analyses were performed on mandible and palatine bone, and tooth enamel samples from 21 individuals associated with the Southside Cemetery as described in Chapter 5. A brief demographic profile of the individuals from which samples were taken is presented to give context to the individuals before the results of the analyses are presented. Statistical analyses on data from comparative collections of Royal Navy cemeteries and civilian cemeteries are also presented. The data presented below is further examined in relation to the diet, origins, and life histories of the individuals buried at the Southside Naval Hospital Cemetery in Chapter 7.

6.1 Demographic Profile of the Southside Cemetery

There are a total number of 42 identified skull fragments, specifically the cranial, calvaria, mandibles, and maxillae. Due to the methods of excavation most of the associations between bones of an individual were lost; the exception for this is with the skull where the cranium and mandible of a few individuals remained intact. Of these fragments, 21 mandibles and 9 palatine bones were sampled. Ten of these were mandibles from complete or partially complete skulls, while an additional 11 were from unassociated mandibles; 6 of the palatine bone samples were from complete skulls while an additional 3 had no known association.

There are a minimum of 18 individuals based on the presence of the right portion of the mandible. Possible matches for two right mandibular fragments were identified based on morphology and completeness. The individual B10 possibly could have matched with A4 or B8, while B11 could possibly have matched with B7 or B2. This is largely consistent with what was determined by von Hunnius (1998), with the exception that she had identified individuals A1 as a male and A2 as a female; these two individuals were identified as the opposite sexes by me and two other graduate students.

Due to there being no or few features on palatine bones and mandibles that are used for the determination of sex or age, these elements were identified as indeterminate in individuals with no associated crania. Of the remaining bones from individuals sampled, 12 were also indeterminate for sex, 1 was a possible female, 7 were possible males, and 1 was a male, using the methods described in chapter 5 (Table 6-1) (Buikstra and Ubelaker 1994). Age estimation was only possible for four individuals, with the determination that they were all middle adults (Buikstra and Ubelaker 1994).

6.2 Sample Integrity

The collagen yields for bone collagen samples ranged from 5.5 to 28.3% with a mean of 14.3% (Table 6-2). Acceptable collagen yields would represent values above 1%, with modern bone values around 22% (Ambrose 1990; van Klinken 1999). For this study, weight percent carbon ranged from 42.3 to 47.5% with a mean of 44.7%, while weight percent nitrogen had a mean of 16.8% and ranged from 15.1 to 16.8% (Table 6-2). The atomic carbon and nitrogen ratio (C:N) ranged from 3.2 to 3.4 with a mean of 3.3 (Table 6-2). These values fall well within the accepted values of 2.9 to 3.5 (Ambrose 1990; Schwarcz and Schoeninger 1991). Acceptable concentrations of carbon and

Table 6-1. Age and sex estimation of cranial samples associated with the Southside Cemetery, St. John's NL. NP163 is the internal site number identifier. The skull elements are separated by three identifiers A= cranium with an associated mandible, B=mandibles with no associated cranial elements, C=maxillae with no other associated cranial elements. Age is identified as middle adult (MA) or indeterminate (I) as defined by Buikastra and Ubelaker (1994). Sex is identified as male (M), possible male (PM), possible female (PF), and indeterminate (I) as defined by Meindl et al. (1985).

NP 163	**Sex**	**Age**	**NP 163**	**Sex**	**Age**	**NP 163**	**Sex**	**Age**
A1	PF	MA	B1	PM	I	C4	I	I
A2	PM	MA	B2	I	I	C5	I	I
A3	PM	MA	B3	PM	I	C6	I	I
A4	M	MA	B4	I	I			
A5	I	I	B5	I	I			
A6	PM	I	B6	I	I			
A7	I	I	B7	I	I			
A8	I	I	B8	I	I			
A9	I	I	B9	PM	I			
A10	PM	I	B10	I	I			
			B11	I	I			

Table 6-2. Bone collagen samples from the Southside Cemetery, St. John's, NL separated by sample elements A) Mandible and B) Palatine. The $\delta^{13}C_{VPDB}$(‰), $\delta^{15}N_{AIR}$(‰), weight % carbon and nitrogen, and atomic C/N ratios are identified for each individual.

A) Mandible samples

Individual (NP163…)	**$\delta^{13}C_{VPDB}$ (‰)**	**$\delta^{15}N_{AIR}$ (‰)**	**Collagen Yield (%)**	**% wt. C**	**% wt. N**	**Atomic Ratio C:N**
A1	-19.7	12.3	15.1	47.0	16.8	3.3
A2	-19.5	12.4	15.2	45.8	16.3	3.3
A3	-17.5	13.2	7.80	47.5	16.8	3.3
A4	-18.3	14.7	19.8	46.0	16.6	3.2
A5	-19.5	11.7	14.1	42.9	15.4	3.2
A6	-19.7	12.5	18.2	43.9	15.8	3.2
A7	-20.6	11.6	13.5	45.2	16.1	3.3
A8	-19.2	11.1	19.0	42.4	15.1	3.3
A9	-20.5	9.5	8.7	43.7	15.6	3.3
A10	-20.2	10.1	14.5	42.7	15.4	3.2
B1	-19.9	13.6	17.2	43.6	15.8	3.2
B2	-19.6	10.7	12.5	44.4	15.9	3.3
B3	-20.0	11.4	13.0	44.1	15.7	3.3
B4	-19.7	10.9	8.6	42.3	15.1	3.3
B5	-18.9	11.7	16.3	44.4	16.0	3.2
B6	-20.6	9.5	12.9	44.7	16.0	3.3
B7	-17.2	12.1	15.9	45.3	16.2	3.3
B8	-19.1	11.7	8.0	43.9	15.4	3.3
B9	-19.0	11.2	13.2	44.7	16.1	3.2
B10	-20.5	10.6	12.5	45.5	16.1	3.3
B11	-18.7	11.9	7.7	46.8	16.2	3.4

B) Palatine

Individual (NP163…)	**$\delta^{13}C_{VPDB}$ (‰)**	**$\delta^{15}N_{AIR}$ (‰)**	**Collagen Yield (%)**	**% wt. C**	**% wt. N**	**Atomic Ratio C:N**
A1	-18.9	12.4	28.3	44.5	15.9	3.3
A2	-19.3	12.1	21.3	44.0	15.9	3.2
A3	-17.1	12.8	8.8	46.4	16.8	3.2
A4	-18.3	14.5	21.2	45.5	16.4	3.2
A7	-20.5	11.4	23.2	44.1	15.8	3.3
A8	-18.6	11.3	5.5	45.0	16.1	3.3
C4	-17.3	12.2	12.1	45.1	16.1	3.3
C5	-18.1	12.2	13.1	44.6	16.1	3.2
C6	-19.3	11.4	11.7	44.8	16.2	3.2

nitrogen (weight % C and N) are between 15-47% and 5.5-17.3% respectively (Ambrose 1990; Schwarcz and Schoeninger 1991; van Klinken 1999). Although there are two samples with bone collagen yields above what would be expected for modern human bone collagen yields (palatine bone A1 and A7), their % wt. C and N and atomic ratio C:N are well within the normal range. In addition, their palatine bone collagen values are very similar to their matched mandible values. This, together with the other collagen indicators suggests that the values are reliable. Since all bone collagen samples pass the sample integrity indicators, all samples were included in the interpretation of these results.

The enamel for carbonate and strontium within this study were not directly examined for sample integrity. This being said there has been extensive research to support the reliability of the $\delta^{13}C_{VPDB}$, $\delta^{18}O_{VPDB}$, and $^{87}Sr/^{86}Sr$ values presented. First of all is the sampled tissue itself. The hydroxyapatite crystals within tooth enamel are densely organized, meaning that the enamel's porosity is very small (Hillson 2005). This drastically decreases the likelihood of post-depositional diagenesis compared to bone bioapatite (Sponheimer and Lee-Thorp 1999a). Second, enamel carbonate has proven to be reliable even in fossils that are ~3 million years in age (Sponheimer and Lee-Thorp 1999a; Sponheimer and Lee-Thorp 1999b; Lee-Thorp and Sponheimer 2003). Strontium values into the Neolithic in enamel have proven reliable (Budd et al. 2000). This being said, there have been more recent burials that have been affected diagenetically (Schoeninger and DeNiro 1982; Budd et al. 2000).

Third, even if direct integrity sampling had been done such as Fourier transform infrared spectroscopy (FTIR), which examines the crystallinity of the sample as well as proportion of carbonate to phosphate and hydroxyl sites, it is not always reliable. Increased crystallinity of the enamel can occur with no interpretable change to $\delta^{13}C_{VPDB}$ and $\delta^{18}O_{VPDB}$ values and vice versa (White et al. 1998; Lee-Thorp and Sponheimer 2003). These considerations together with the very short time that the individuals from the Southside Cemetery would have been buried (<200 years), all carbonate and strontium data have been used during the interpretation of results for this study.

6.3 Isotope values of enamel bioapatite and bone collagen

6.3.1 Summary Statistics

6.3.1.1 Carbonates

The $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ of enamel carbonate from 19 second molars, which represent ages of 2.5 to 8 (Gustafson and Koch 1974; Schied 2007), were measured (Table 6-3**,** Table 6-4**,** Figure 6-1). The $\delta^{13}C_{carb}$ values had a mean of -13.8±1.1‰ (n=19, 1σ) and ranged from -15.3 to -11‰, which is consistent with C_3 terrestrial diets (Ambrose and Norr 1993). One individual (A3) fell outside the main cluster with a $\delta^{13}C_{carb}$ value of -11.0‰, suggesting some incorporation of C_4 plants and or marine foods (Figure 6-1). The $\delta^{18}O_{carb}$ values of the second molars had a mean of -5.2±0.9‰ (n=19 1σ) and ranged from -4.0 to -7.0‰ (Table 6-3, Table 6-4, Figure 6-1). The expected $\delta^{18}O_{DW}$ ranges for the British Isles, where the majority of Royal Navy sailors would hypothetically be coming from, fall between -4 to -9‰ (Darling et al. 2003); however the oxygen carbonate values are not directly comparable. When the groundwater values of

Table 6-3. Stable and radiogenic isotope data for all individuals sampled from the Southside Cemetery, St. John's, NL. All data is separated by tissue including mandible and palatine bone collagen data, and enamel carbonate and strontium from 1st (M1), 2nd (M2), and 3rd (M3) molars.

Individual (NP163…)	Mandible		Palatine		M1		M2			M3	
	$\delta^{13}C$‰	$\delta^{15}N$ ‰	$\delta^{13}C$‰	$\delta^{15}N$ ‰	$\delta^{13}C$ ‰	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	$\delta^{18}O$ ‰	$^{87}Sr/^{86}Sr$	$\delta^{13}C$ ‰	$\delta^{18}O$ ‰
A1	-19.7	12.3	-18.9	12.4	-	-	-14.8	-5.7	0.7101	-13.4	-5.4
A2	-19.5	12.4	-19.3	12.1	-	-	-13.0	-4.9	0.7091	-12.8	-5.0
A3	-17.5	13.2	-17.1	12.8	-	-	-11.0	-7.7	0.7105	-11.0	-7.2
A4	-18.3	14.7	-18.3	14.5	-	-	-15.2	-5.3	0.7093	-14.1	-4.5
A5	-19.5	11.7	-	-	-13.9	-6.3	-13.4	-5.0	0.7103	-13.7	-5.9
A6	-19.7	12.5	-	-	-	-	-12.9	-5.8	0.7097	-12.6	-6.6
A7	-20.6	11.6	-20.5	11.4	-	-	-14.9	-6.4	0.7115	-15.1	-5.9
A8	-19.2	11.1	-18.6	11.3	-	-	-14.1	-5.0	0.7102	-14.0	-4.5
A9	-20.5	9.5	-	-	-	-	-14.7	-5.0	0.7113	-14.7	-4.7
A10	-20.2	10.1	-	-	-	-	-13.4	-4.4	0.7097	-	-
B1	-19.9	13.6	-	-	-	-	-12.4	-4.0	0.7089	-12.5	-4.4
B2	-19.6	10.7	-	-	-	-	-13.4	-4.4	0.7105	-13.2	-4.0
B3	-20.0	11.4	-	-	-14.6	-4.8	-13.9	-5.6	0.7104	-13.9	-4.2
B4	-19.7	10.9	-	-	-	-	-13.2	-5.5	0.7096	-13.1	-5.2
B5	-18.9	11.7	-	-	-	-	-14.9	-4.0	0.7092	-	-
B6	-20.6	9.5	-	-	-	-	-15.0	-5.9	0.7102	-15.0	-5.9
B7	-17.2	12.1	-	-	-	-	-	-	-	-	-
B8	-19.1	11.7	-	-	-8.3	-3.7	-	-	0.7103	-	-
B9	-19.0	11.2	-	-	-	-	-13.3	-5.1	0.7103	-13.5	-5.4
B10	-20.5	10.6	-	-	-	-	-15.3	-5.3	0.7116	-15.3	-5.1

B11	-18.7	11.9	-	-	-	-	-14.3	-4.7	0.7118	-	-
C4	-	-	-17.3	12.2	-	-	-	-	-	-	-
C5	-	-	-18.1	12.2	-	-	-	-	-	-	-
C6	-	-	-19.3	11.4	-	-	-	-	-	-	-

Table 6-4. Summary statistics for all tissues sampled associated with the Southside Cemetery, St. John's, NL [mean ± SD (n)]. * There was one first molar used for Sr because there were no second molars present. • The ‰ in the column heading is not relevant for $^{87}Sr/^{86}Sr$ values.

Tissue	Isotope	Mean ± SD (‰)	Minimum (‰)	Maximum (‰)	Standard Error (1σ)	Coefficient of variation
Mandible	$\delta^{13}C$	-19.4 ± 0.9 (21)	-20.6	-17.2	0.2	-4.8
	$\delta^{15}N$	11.6 ± 1.3 (21)	9.5	14.7	0.3	10.9
Palatine	$\delta^{13}C$	-18.6 ± 1.1 (9)	-20.5	-17.1	0.4	-5.7
	$\delta^{15}N$	12.2 ± 1.0 (9)	11.3	14.5	0.3	8.1
M1	$\delta^{13}C$	-12.3 ± 3.5 (3)	-14.6	-8.3	2.0	-28.4
	$\delta^{18}O$	-4.9 ± 1.3 (3)	-6.3	-3.7	0.8	-26.3
M2	$\delta^{13}C$	-13.8 ± 1.1 (19)	-15.3	-11.0	0.3	-8.0
	$\delta^{18}O$	-5.2 ± 0.9 (19)	-7.7	-4.0	0.2	-16.6
	$^{87}Sr/^{86}Sr$•	0.7102 ± 0.0008 (20)*	0.7089	0.7118	0.0002	0.1175
M3	$\delta^{13}C$	-13.6 ± 1.1 (16)	-15.3	-11.0	0.3	-8.3
	$\delta^{18}O$	-5.2 ± 0.9 (16)	-7.7	-4.0	0.2	-16.9

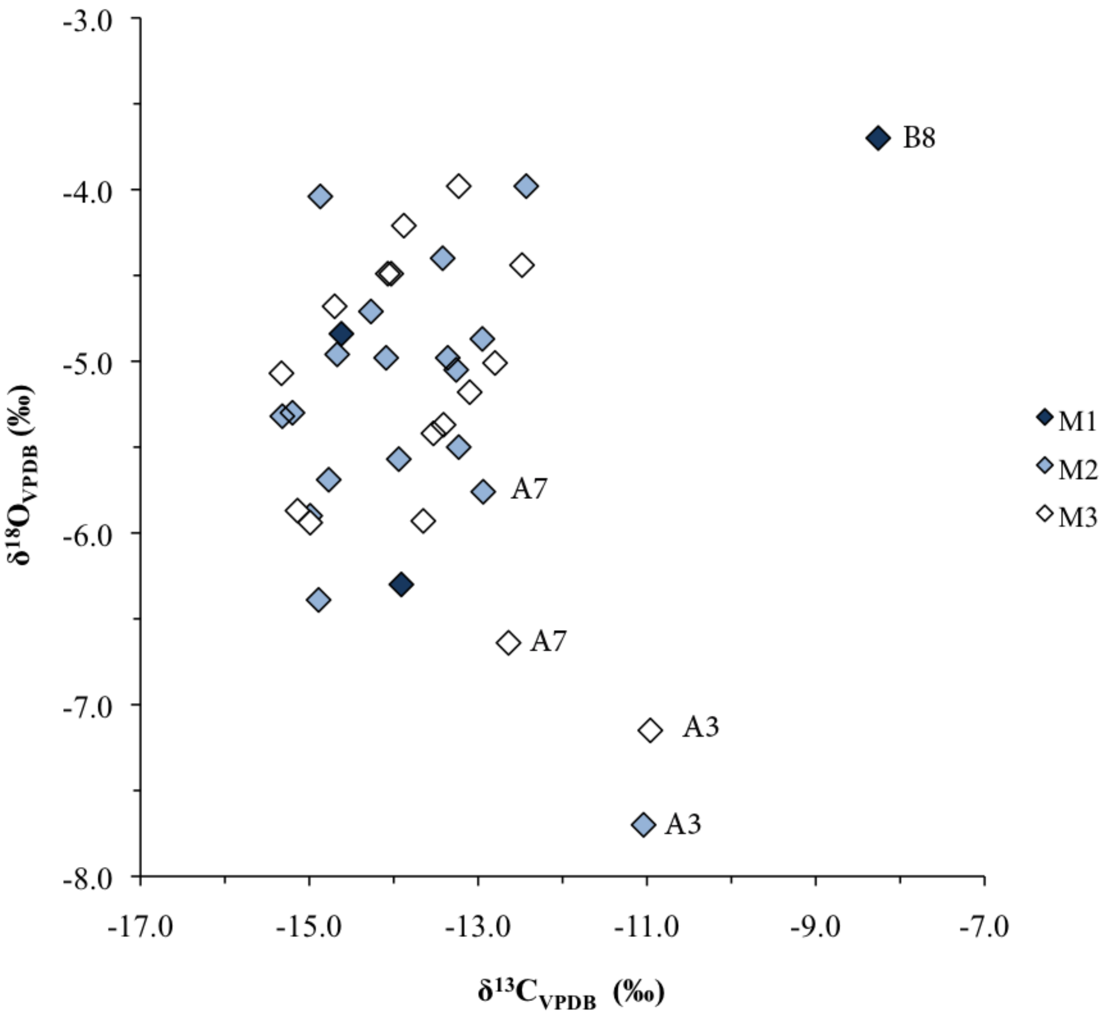


Figure 6-1. The δ^{13}C and δ^{18}O values of enamel carbonate in the 1st (M1), 2nd (M2), and 3rd (M3) molars associated with the Southside Cemetery, St John's, NL.

Britain are converted into carbonate values, the range for $\delta^{13}C_{carb}$ falls between -3.3 to -6.4‰. It must be reiterated that there is a large uncertainty associated with the conversion of these values and therefore the origins may be more variable than they appear from the data (Pollard et al. 2011). This being said, all individuals are well within this range except one (A3), for which $\delta^{18}O_{carb}$ values fall lower than the extreme ranges expected for Britain (Table 6-3).

Three first molars were also sampled and the $\delta^{13}C_{carb}$ values ranged from -14.6 to -8.3‰ with a mean of -12.3±3.5‰ (n=3 1σ) (Table 6-3, Table 6-4, Figure 6-1). Two individuals (A5 and B3) were consistent with C_3 diets, while the third (B8) was consistent with a mixed C_3 with C_4 and/or marine diet. The $\delta^{18}O_{carb}$ values had a mean of -4.9±1.3‰ (n=3 1σ) and ranged from -6.3 to -3.7‰. Since these teeth develop from birth to 3 years old (Gustafson and Koch 1974; Schied 2007), the $\delta^{18}O_{carb}$ values represent the mother's diet and area in which she was residing, rather than that of the child's. When the ~0.7‰ fractionation shift due to breastfeeding is considered for $\delta^{18}O_{carb}$, all of the individuals fall within the expected values of Britain.

Sixteen third molars were examined for carbon and oxygen in enamel carbonate. The mean of $\delta^{13}C_{carb}$ was -13.6±1.1‰ (n=16 1σ) and ranged from -15.3 to -11.0‰ (Table 6-3, Table 6-4, Figure 6-1). These are predominantly reflective of C_3 terrestrial diets, with some individuals having values associated with a mixed C_3 with C_4 diet or with marine foods. The $\delta^{18}O_{carb}$ values for third molars had identical means and ranges as the values for the second molars (-5.2±0.9‰ and ranged from -4.0 to -7.0‰), but with some individuals showing changes between the paired molars, which are further examined in Section 6.3.1.2. Two individuals had lower $\delta^{18}O_{carb}$ values than Britain (A3 and A7).

Although there were too few individuals to allow meaningful statistical analyses between all molars, comparing second and third molars was done using a paired-t test, which gives more power than a t-test, with only those samples that had both second and third molars (n=16). The $\delta^{13}C_{carb}$ values of second and third molars are not statistically different (mean difference = -0.163, $t_{1,15}$=-1.42, p=0.174). These individuals were also not statistically different for $\delta^{18}O_{carb}$ (mean difference -0.169, $t_{1,15}$ = -1.161, p=0.264).

6.3.1.2 Strontium

The $^{87}Sr/^{86}Sr$ values were obtained from 19 second molars and 1 first molar and had a mean of 0.7102±0.00083 (n=20 1σ) and ranged from 0.7089 to 0.7118 (Table 6-3, Table 6-4,

Figure 6-2). These values fall relatively close to the value for modern seawater, which is 0.7092 (Hess et al. 1986). These $^{87}Sr/^{86}Sr$ values can be found in many areas, including Britain, which ranges from 0.7078 to 0.7140 in England and Wales and as high as 0.7165 in Scotland (Evans et al. 2012); also the Caribbean, which ranges from 0.7077 to 0.7104 (Laffoon et al. 2012). This being said, four individuals have higher values than the Caribbean known ranges, excluding them from having originating there (A7, A9, B10, B11). There are no bioavailable strontium values for the United States, but they can be approximated from geological samples; the eastern seaboard varies from $^{87}Sr/^{86}Sr$ =0.800-0.705 (Bataille and Bowen 2012: 49). This is a very large range, overlapping the ranges of the Caribbean and United Kingdom data, therefore no

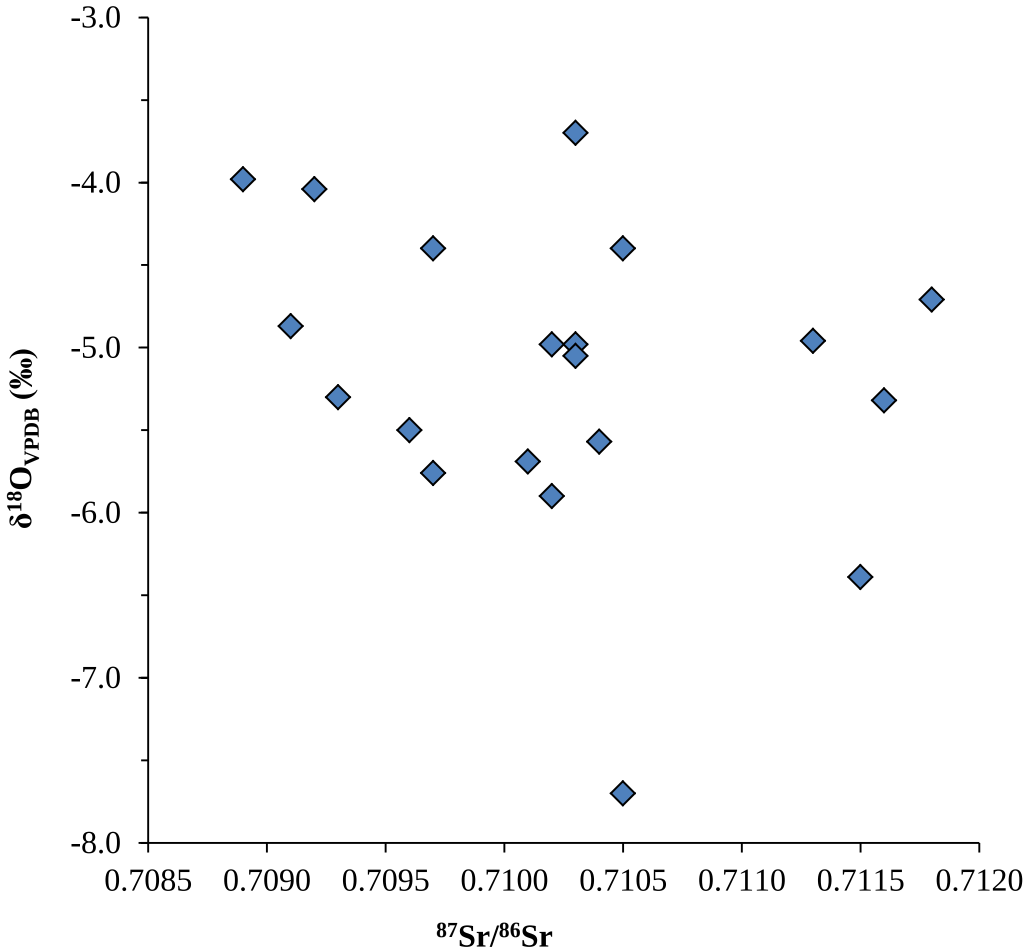


Figure 6-2.The $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values of enamel from the second molars of samples associated with the Southside Cemetery, St. John's, NL.

individuals from the Southside Cemetery can be ruled out as having spent their childhood in the colonial America.

6.3.1.3 Bone Collagen

The bone collagen of 21 mandibles was sampled. The $\delta^{13}C_{col}$ values ranged from -20.6 to -17.2‰ with a mean of -19.4±0.9‰ (n=21 1σ) and the $\delta^{15}N_{col}$ from 9.5 to 14.7‰ with a mean of 11.6±1.3‰ (n=21 1σ) (Table 6-3, Table 6-4, Figure 6-3). These are predominantly consistent with a C_3 diet, but the higher $\delta^{15}N_{col}$ values suggest they were eating omnivorous terrestrial animals. The higher $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values suggest a mixed C_3 terrestrial diet with the incorporation of some marine foods (A4), some may also have consumed some C_4 foods (A3 and A7).

The bone collagen of 9 palatine bones was also sampled. The $\delta^{13}C_{col}$ had an almost identical range from -20.5 to -17.1‰ with a slightly higher mean of -18.6±1.1‰ (n=9 1σ) (Table 6-3, Table 6-4). The $\delta^{15}N_{col}$ values had a higher mean at 12.2±1.0‰ (n=9 1σ). These samples represent C_3 terrestrial diet with two individuals incorporating some C_4 and or marine foods (A3 and C4) and one individual (A4) having a C_3 terrestrial diet with the possible consumption of some freshwater fish.

6.3.1.4 Minimum Number of Individuals

The MNI of the collection is 18 according to the sided right mandibles. It is possible that two right mandible fragments (B10 and B11) may be associated with left fragments. These fragments were compared isotopically to establish whether it was possible they were associated (Table 6-3). Although there were some that were close for carbonates (B10 and A4), there were none for collagen suggesting that they are not the

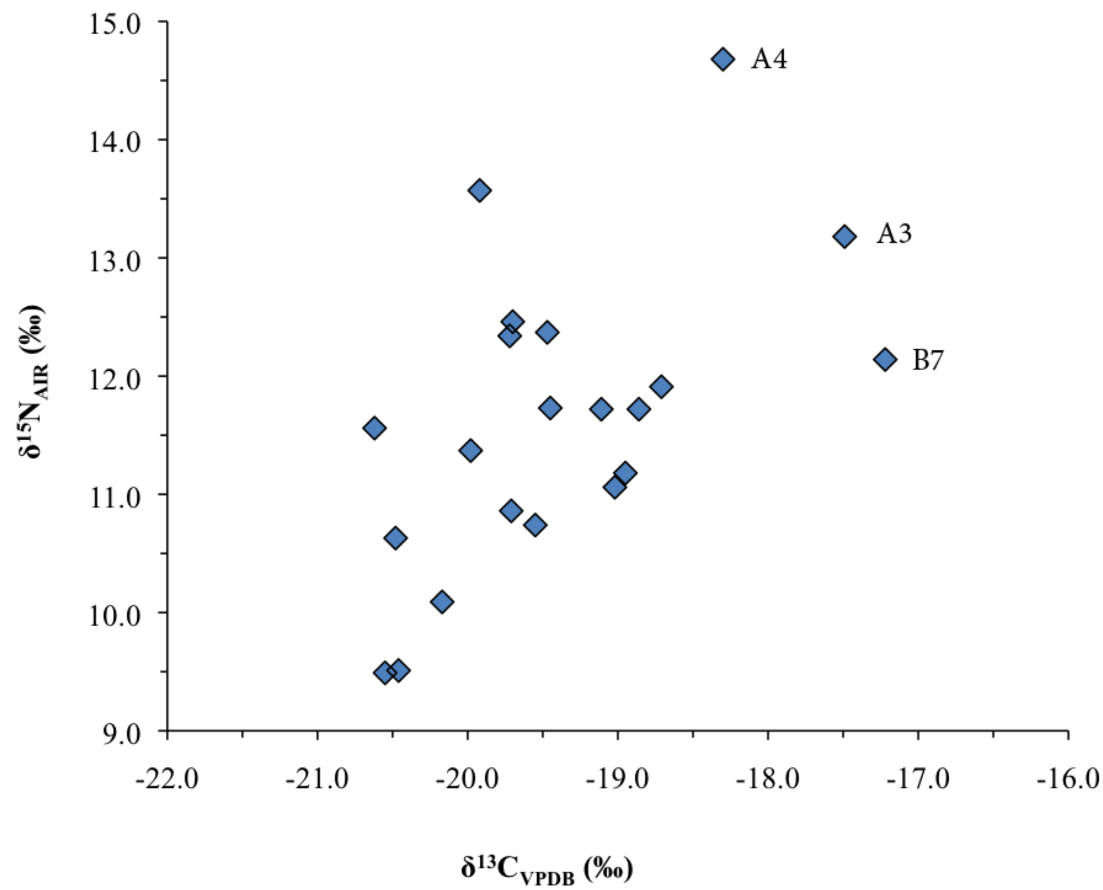


Figure 6-3. The $\delta^{13}C$ and $\delta^{15}N$ in mandible bone collagen of samples associated with the Southside Cemetery, St. John's, NL.

same individuals. Due to difficulties in matching isotopic values of different elements, it cannot be said for certain, but it is probable that the MNI is not 18, but more likely 21 (Table 6-3).

6.3.2 Inter-tooth Comparison of enamel bioapatite

A comparison of inter-tooth values was done to assess possible change in diets or geological locations over time. Only those individuals that had at least two molar samples were considered for the comparison of carbonate values. The difference between first and second molars ranges between -0.6 to -0.7‰ for $\delta^{13}C_{carb}$ and -1.3 to 0.7‰ for $\delta^{18}O_{carb}$ (Table 6-5). These outliers are greater than 3 SD of the mean of the analytical error and they fall outside of the expected analytical error of ±0.18‰ and ±0.21‰ (3σ) for carbon and oxygen, respectively (there were insufficient samples to produce a reliable box and whisker plot and 3SD should represent 99.7% of expected data). For A5, this is can be explained by either a change in location or the effects of breastfeeding on oxygen (Brettell et al. 2012), while B3 saw an opposite change than what would be expected, suggesting a possible change of location to an area of higher rainfall or lower temperature.

The differences between the values of first and third molars (A5 and B3) are -0.3 and -0.7‰ for $\delta^{13}C_{carb}$ and -0.4 to -0.6‰ for $\delta^{18}O_{carb}$ (Table 6-5). The individual A5 once again falls within the range expected for either a change in location or for the effects of increased consumption of boiled water such as beer, tea, or stews that would likely be more accessible to individuals in later childhood (Brettell et al. 2012). The mean

Table 6-5. Inter-tooth comparisons in the $\delta^{13}C$ and $\delta^{18}O$ values of enamel carbonate samples of 1st (M1), 2nd (M2), and 3rd (M3) molars from the Southside Cemetery, St. John's, NL.

Individual (NP163…)	**$\delta^{13}C$ (‰)**			**$\Delta\delta^{13}C$ (‰)**			**$\delta^{18}O$ (‰)**			**$\Delta\delta^{18}O$ (‰)**		
	M1	**M2**	**M3**	**M1-M2**	**M1-M3**	**M2-M3**	**M1**	**M2**	**M3**	**M1-M2**	**M1-M3**	**M2-M3**
A1		-14.8	-13.4			-1.4		-5.7	-5.4			-0.3
A2		-13.0	-12.8			-0.1		-4.9	-5.0			0.1
A3		-11.0	-11.0			-0.1		-7.7	-7.2			-0.6
A4		-15.2	-14.1			-1.1		-5.3	-4.5			-0.8
A5	-13.9	-13.4	-13.7	-0.6	-0.3	0.3	-6.3	-5.0	-5.9	-1.3	-0.4	0.9
A6		-12.9	-12.6			-0.3		-5.8	-6.6			0.9
A7		-14.9	-15.1			0.3		-6.4	-5.9			-0.5
A8		-14.1	-14.0			-0.1		-5.0	-4.5			-0.5
A9		-14.7	-14.7			0.0		-5.0	-4.7			-0.3
B1		-12.4	-12.5			0.1		-4.0	-4.4			0.5
B2		-13.4	-13.2			-0.2		-4.4	-4.0			-0.4
B3	-14.6	-13.9	-13.9	-0.7	-0.7	-0.1	-4.8	-5.6	-4.2	0.7	-0.6	-1.4
B4		-13.2	-13.1			-0.1		-5.5	-5.2			-0.3
B6		-15.0	-15.0			0.0		-5.9	-5.9			0.0
B9		-13.3	-13.5			0.3		-5.1	-5.4			0.4
B10		-15.3	-15.3			0.0		-5.3	-5.1			-0.3

difference between second and third molars for both $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ was 0.2‰. The range of differences for $\delta^{13}C_{carb}$ was -1.4 to 0.3‰ and -1.4 to 0.9‰ for $\delta^{18}O_{carb}$ (Table 6-5). The majority of the differences fall within analytical error (±0.21‰ 3σ), but those that fall outside with higher oxygen values (A5, A6, and B1) can be explained by a change in location or by consuming more beer or stews. Others (B3, A4, A3, A6, and A7) change in the opposite fashion suggesting again a change of location.

6.3.3 Comparison of mandible and palatine bone collagen

Considering that the analytical error of $\delta^{13}C_{col}$ is ±0.39‰ (3σ) and ±0.69‰ for $\delta^{15}N_{col}$, most of the differences between the palatine and mandible can be explained by analytical error rather than a change in diet. The exception is with A1 and A8 who had an increase of 0.8 and 0.6 between the $\delta^{13}C$ values of palatine and mandible with no corresponding change in $\delta^{15}N$ outside of analytical error (Table 6-6). This may be explained by an increase in consumption of C_4 foods later in life.

Table 6-6. Intra-tooth comparisons in levels of $\delta^{13}C$ and $\delta^{15}N$ values of mandible and palatine bone collagen of individuals from the Southside Cemetery, St. John's, NL.

Individual (NP163…)	**$\delta^{13}C$ (‰)**		**$\Delta\delta^{13}C$ (‰) (Palatine-Mandible)**	**$\delta^{15}N$ (‰)**		**$\Delta\delta^{15}N$ (‰) (Palatine-Mandible)**
	Mandible	**Palatine**		**Mandible**	**Palatine**	
A1	-19.7	-18.9	0.8	12.3	12.4	0.0
A2	-19.5	-19.3	0.2	12.4	12.1	-0.2
A3	-17.5	-17.1	0.4	13.2	12.8	-0.4
A4	-18.3	-18.3	0.0	14.7	14.5	-0.1
A7	-20.6	-20.5	0.1	11.6	11.4	-0.1
A8	-19.2	-18.6	0.6	11.1	11.3	0.3

6.4 Newfoundland $\delta^{18}O_{carb}$ values

There are no local comparative enamel carbonate values for the Avalon Peninsula of Newfoundland; in turn, six enamel carbonate samples from the 2nd molars of as many individuals were taken from the St. Paul's Anglican Church, Harbour Grace, NL (ca. 1764-1820) as part of this study. The $\delta^{13}C_{carb}$ values had a mean of -11.6±0.6‰ (n=6 1σ), and ranged from -12.4 to -10.9‰ (Table 6-7). This is consistent with a mixed C_3 with some C_4 or marine foods. Though considering the context of Newfoundland as a fishery, it is likely from a mixed C_3 terrestrial marine diet. The $\delta^{18}O_{carb}$ values had a mean -7.1±0.3‰ (n=6 1σ), and ranged from -7.5 to -6.6‰. Their oxygen is all closely clustered together. The estimation for Harbour Grace, NL is $\delta^{18}O_{DW}$ -10.5‰ (Bowen et al. 2005), which corresponds to $\delta^{18}O_{carb}$ -7.3‰ using the equations from Coplen (1988), Millard and Schroeder (2010), and Daux et al. (2008). In turn, these values correspond closely to what is expected for the Avalon Peninsula of Newfoundland and is a comparative group, which will be explored further in Chapter 7.

Table 6-7. The $\delta^{13}C$ and $\delta^{18}O$ values of the second molar enamel carbonate of individuals sampled from the St. Paul's Anglican Church Cemetery, Harbour Grace, NL.

Individual	M2	
	$\delta^{13}C_{carb}$ (‰)	$\delta^{18}O_{carb}$ (‰)
3	-12.4	-7.4
7	-11.2	-7.1
21	-10.9	-7.0
22	-12.2	-7.2
Backdirt A	-11.3	-7.5
Backdirt B	-11.6	-6.6

6.5 Conclusions

The purpose of this chapter is to present isotopic data from the Southside Cemetery and the comparative $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ data from St. Paul's Anglican Cemetery. The individuals from the Southside Cemetery had childhood $\delta^{13}C_{carb}$ values mainly consistent with pure C_3 terrestrial diets, but with a couple individuals showing the incorporation of C_4 or marine foods. The $\delta^{18}O_{carb}$ values were mainly consistent with the converted $\delta^{18}O_{DW}$ values for the British Isles, with the second molars of one individual and the third molars of two individuals (A3 and A6) falling lower than the ranges expected for Britain.

The $^{87}Sr/^{86}Sr$ values of those from the Southside Cemetery were varied, but fell within the ranges expected for many areas, including those of the British Isles. The bone collagen samples of those buried at Southside Cemetery suggested a mainly pure C_3 terrestrial diet, likely the consumption of omnivorous terrestrial animals, while others were consuming some marine foods and possibly freshwater fish.

The enamel carbonate values from St. Paul's Anglican Cemetery suggest a distinct childhood diet from the majority of those from the Southside Cemetery, with a mixed C_3 and marine diet. The $\delta^{18}O_{carb}$ values from this cemetery can be considered as a comparative baseline for the values expected from the Avalon Peninsula of Newfoundland. The interpretation of the results presented in this chapter will be further examined in Chapter 7 within the context of the institution of the Royal Navy and the British Atlantic World.

Chapter Seven

7 Discussion and Conclusions

This discussion elaborates on the isotopic results from the Southside Cemetery in connection with the information collected from the National Archives documents, and other historical isotopic studies. There is some doubt as to which institution was using the Southside Cemetery, with some authors identifying the location of the Southside Royal Naval Cemetery (O'Neill 2003; von Hunnius 1998) and others identifying it as an Anglican Church cemetery (Mills 2002), a combined cemetery (O'Neill 2003), or a Military cemetery (Keegan 1937). Childhood origins and diets are interpreted within the context of the British Atlantic World by comparing the data to other contemporaneous sites in Newfoundland (this study), America (Ubelaker and Owsley 2003; France et al. 2014), and the Caribbean (Laffoon et al. 2013). This is also compared to Royal Naval sites (Varney 2003; Varney 2007; Bell et al. 2009) to understand the global variability of origins within the Royal Navy. In order to comprehend how rations varied across the Atlantic, $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values from the Southside Cemetery were compared to sites in Newfoundland (Pike and Grimes unpublished data; Harris 2015) and colonial America (France et al. 2014), as well as other Royal Naval sites (Varney 2003; Varney 2007; Bell et al. 2009; Roberts et al. 2012). The chapter ends with a summary of the conclusions from the study, the significance of the findings, and suggestions for future research.

7.1 Origins of the Southside Cemetery

From the cranial fragments examined from the Southside Cemetery, the sex of individuals were identified using multiple cranial features as one female, eight males or possible males, and the others were indeterminate. Von Hunnius (1998) had identified individuals with at times only one positive sexual identifier to suggest that there were 2 females, 15 males, and 2 unknown individuals. Identification based on single identifiers is unadvisable as it can cause false identifications; it is better to suggest possible and probable sexes (White and Folkens 2005). Regardless, the large number of male individuals with only one possible female is inconsistent with what would be expected from a cemetery associated with the St. Mary's Anglican Church Cemetery. It is however consistent with a Royal Naval Hospital Cemetery, as the Navy employed almost exclusively males (Waller 2014).

The presence of only one possible female within the collection is not completely surprising. Although there were no females registered as patients at the St. John's Naval Hospital from 1793 to 1811, there were a number of females employed at the hospital. It is possible that a female associated with the Royal Navy became a patient in the hospital and died, or was buried in the cemetery.

It is not only the sex of the individuals that suggests that they are not of the St. Mary's Anglican Church Cemetery. The isotope values of the individuals from the Southside Cemetery were predominately consistent with origins from the British Isles; the $\delta^{18}O_{carb}$ values (mean and standard deviation of -5.2±0.9‰ (n=19 1σ)) fell within the range reported by Darling et al. (2003), and all but two individuals (A3 and A7) were very different from the values seen in this study in individuals from the St. Paul's Church in Harbour Grace, NL ($\delta^{18}O_{carb}$ -7.1±0.3‰ (n=6 1σ)) (Table 6-7, Figure 7-1). St. Mary's Anglican Church cemetery would be expected to primarily have individuals of Newfoundland origin, since the island was no longer home to the migratory fishery during the mid to late 19th century (Matthews 1968). The isotopic evidence suggests that the individuals were from the St. John's Royal Naval Hospital, not the St. Mary's Anglican Church.

7.2 Isotope Evidence for Origins of Individuals

7.2.1 Southside Cemetery

Most of the molars available from the collection were second (n=19) and third molars (n=16), and there were a few first molars (n=3). Together, the collection of teeth represents the broad range of childhood experiences. Second and third molars were available from 16 individuals and there were no statistically significant differences with a paired t-test of $\delta^{18}O_{carb}$ values of the second and third molars ($F_{1,15}$=1.05, p=0.32). This suggests that no drastic changes in lifestyles occurred during childhood within this population. Other isotopic Royal Naval studies have not compared the differences between molars.

The $\delta^{18}O_{carb}$ values of almost all individuals fall within the expected values of the British Isles for all molars (Darling et al. 2003). This is true as well for the $^{87}Sr/^{86}Sr$ values that fall relatively close to the value for modern seawater and within the broad range of the values expected for the United Kingdom (Evans et al. 2010).

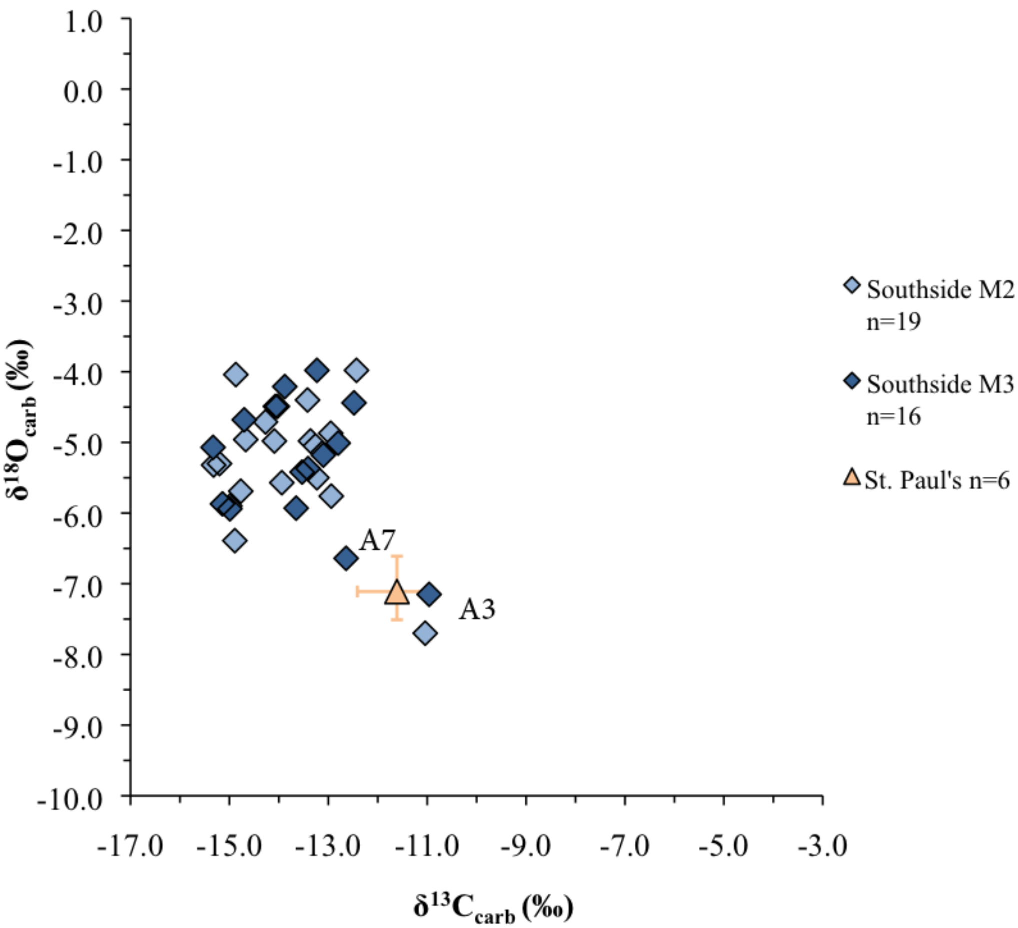


Figure 7-1. Comparison of the $\delta^{13}C$ and $\delta^{18}O$ values of enamel carbonate from second and third molars associated with the Southside Naval Hospital Cemetery, St. John's, NL compared to the 95% CI of enamel carbonate samples from St. Paul's Anglican Church, Harbour Grace, NL.

Although there is no statistical difference between the two groups of molars, some of the individuals do exhibit a change in the values, either from the consumption of more boiled food or alcohol, or due to a true movement to a different region or county (Brettell et al. 2012). Overall it represents little difference to the spread of the data, except there is one additional person (A7) falling outside of the range expected for the British Isles. One explanation for this is from the uncertainty associated with the conversion of $\delta^{18}O_{DW}$ to $\delta^{18}O_{P}$, which is between 1-3‰. This means that the individual could be associated with the British Isles, or they were always from outside the region, yet the uncertainty has skewed our ability to properly interpret this result. Another explanation is that they moved to an area with lower $\delta^{18}O_{DW}$ values during the time that their third molar was mineralizing.

Even considering this uncertainty, it is useful to graphically suggest the $\delta^{18}O$ values of the second molars of these individuals to consider possible regional origins. When these data are spread out by one-mil increments as seen on groundwater contour maps of the British Isles (Figure 7-2), a total of four individuals fell within the expected range of $\delta^{18}O_{DW}$ -4 to -6‰ (Table 7-1, Figure 7-3). Considering all individuals had less radiogenic $^{87}Sr/^{86}Sr$ than would be expected from a Scottish origin, the prospects of an origin in Scotland were excluded (Figure 7-4) (Evans et al. 2010). The areas consistent with the origins correspond to coastal southern Ireland, as well as the English counties of Cornwall and Devon (Darling et al. 2003). There were 6 individuals who fell between $\delta^{18}O_{DW}$ -6 and -7‰, which is consistent with parts of interior and eastern Ireland, and

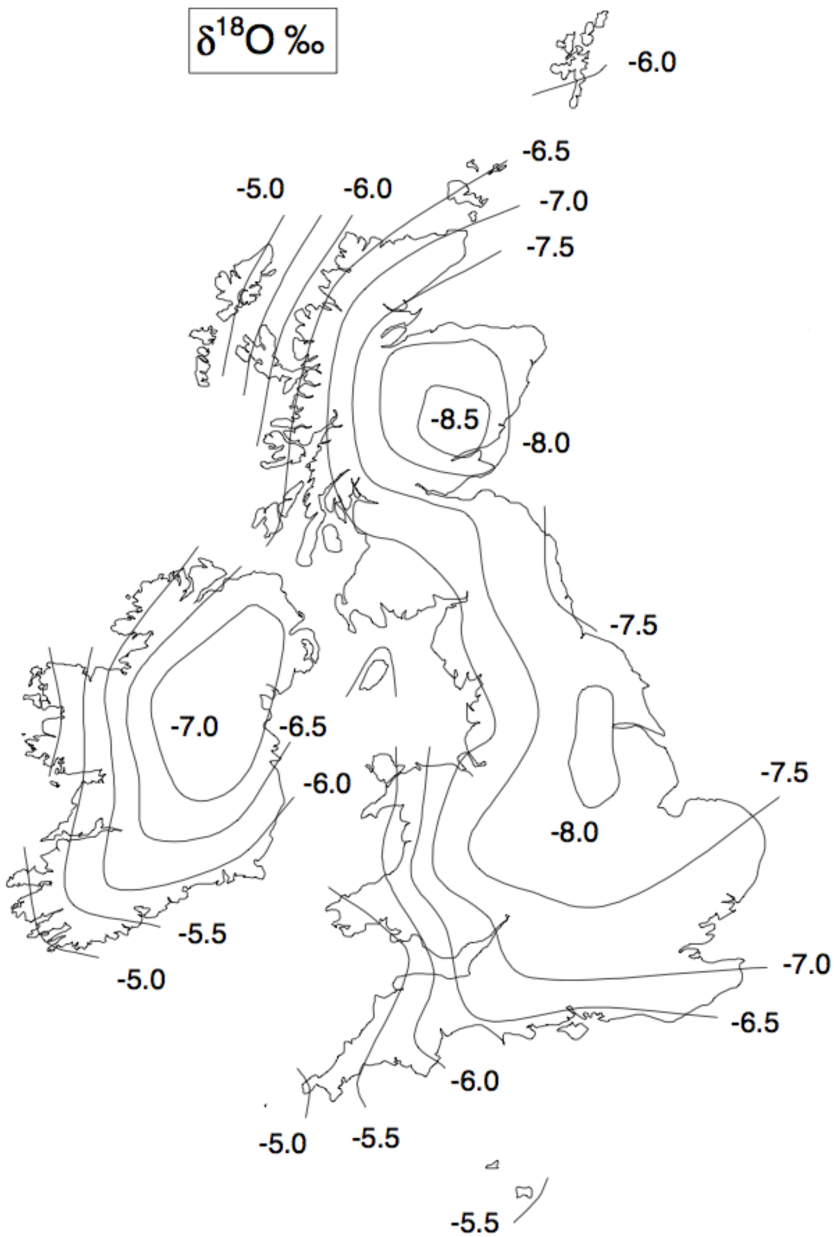


Figure 7-2. Map of the distribution of $\delta^{18}O_{DW}$ values of groundwater across the British Isles from Darling et al. (2003)

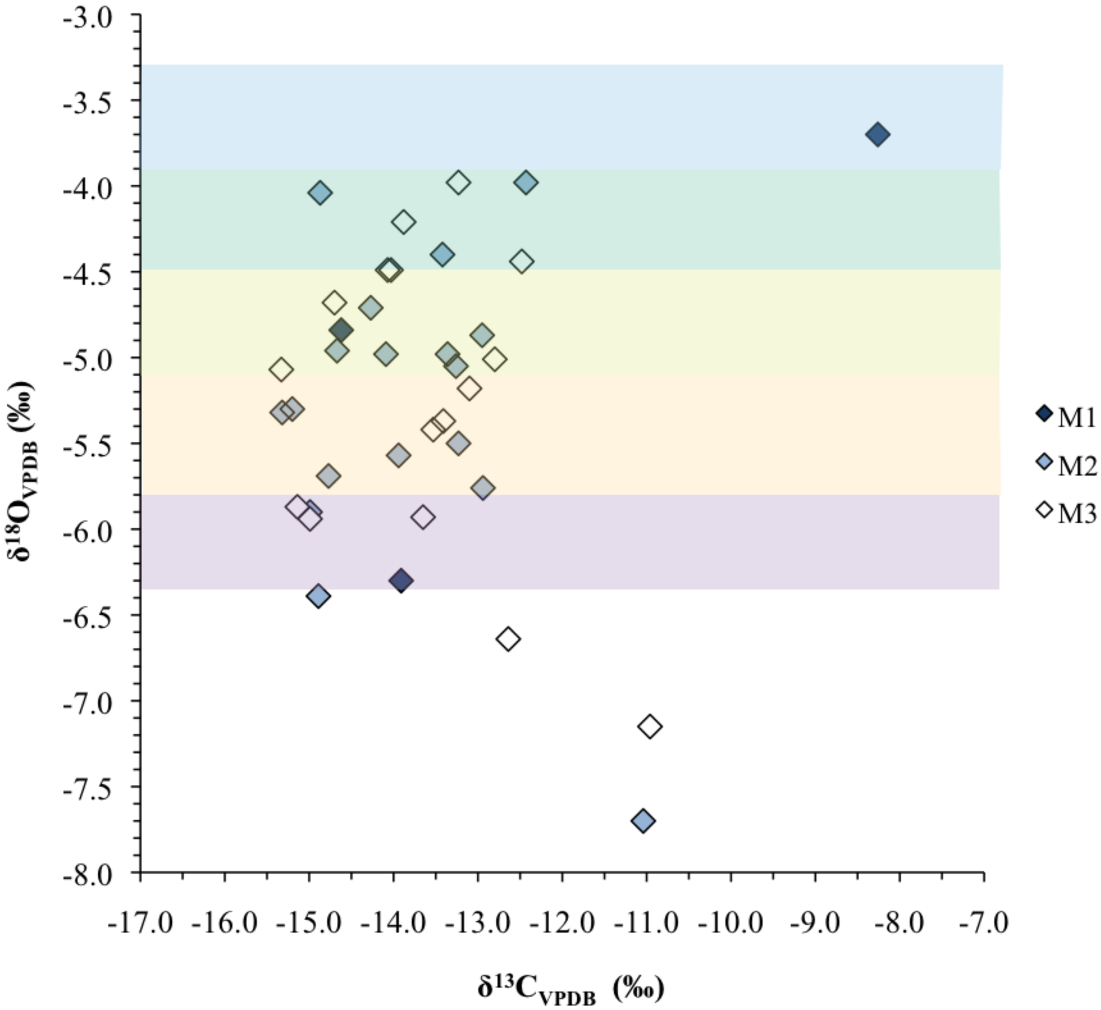


Figure 7-3. $\delta^{18}O$ and $\delta^{13}C$ carbonate data of first (M1), second (M2), and third (M3) molars of individuals from the Southside Cemetery, St. John's, NL. The boxes correspond to the converted $\delta^{18}O$ drinking water values of the British Isles. The gradient from blue to purple follows the corresponding drinking water values in 1‰ increments from -4‰ to -9‰.

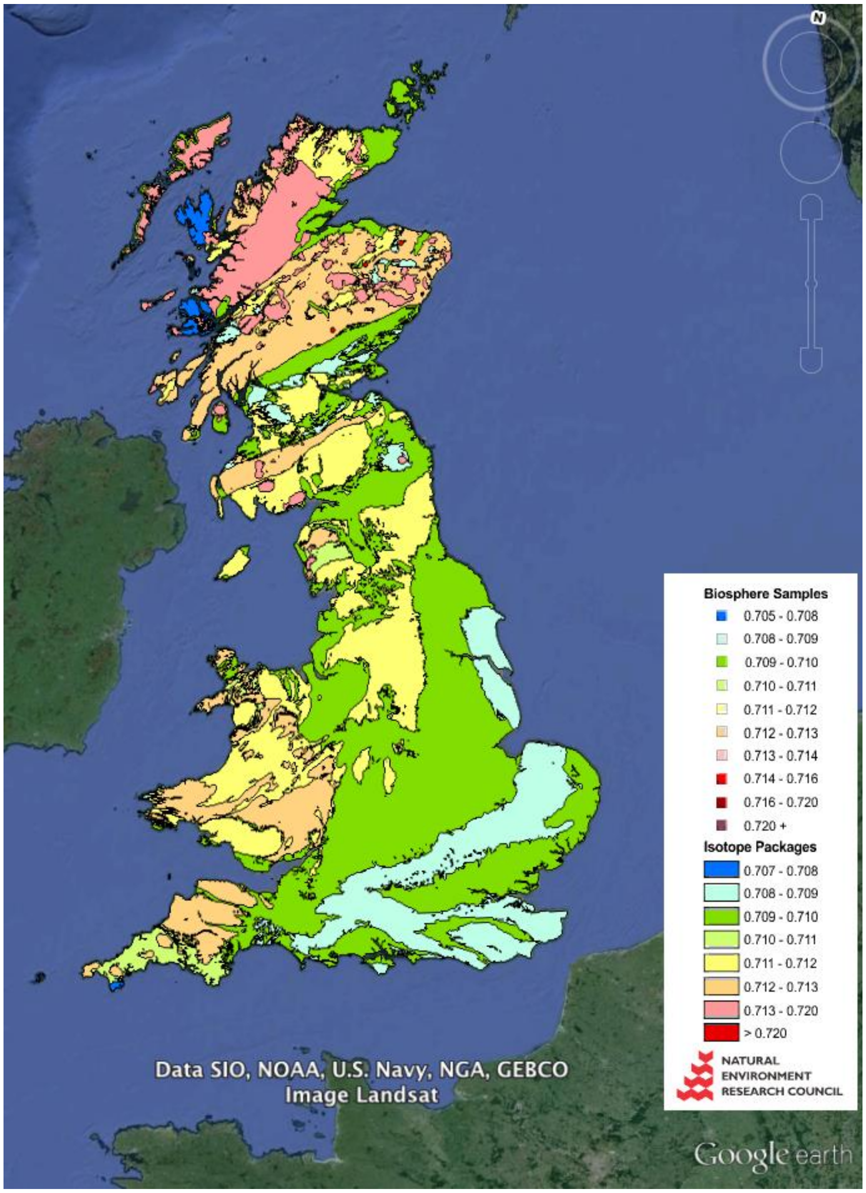


Figure 7-4. Map of the distribution of $^{87}Sr/^{86}Sr$ values across England and Scotland according to Evans et al. (2010) taken from a package developed by the Natural Environment Research Council for Google Earth.

Table 7-1. Number and percentage of second and third molars falling within the drinking water value ranges of the British Isles

$\delta^{18}O_{DW}$ (‰)	Second Molar		Third Molar	
	n	%	n	%
-4.0 to -4.9	0	0.0	0	0.0
-5.0 to -5.9	4	23.5	3	25.0
-6.0 to -6.9	5	29.4	4	33.3
-7.0 to -7.9	6	35.3	4	33.3
-8.0 to -8.9	3	17.6	3	25.0
>9.0	1	5.9	2	16.7

interestingly, West County England including Dorset, Poole and East Devon (Table 7-1) (Darling et al. 2003).

West Country England was the basis for the migratory fishery in Newfoundland, and considering that impressment and volunteering for the Royal Navy typically occurred at the end of fishing season (Mercer 2008), it is not at all surprising to see a large portion of the individuals having $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ values that fall within this region. In addition, there were four individuals who fell between $\delta^{18}O_{DW}$ -7 to -8‰ and this is equally unsurprising because England had yearly quotas for men from different counties or ports, and most of the large numbered areas come from these regions, such as London, Yorkshire, and Newcastle (Mercer 2008). The distribution of the Royal Naval sailors is consistent with what would be expected from not only the Royal Navy in general, but specifically to Newfoundland considering the large number of individuals who fall within the West Country areas. Even with the uncertainties associated with Pollard et al. (2011) as well as Brettell et al. (2012), the data suggests that the individuals from the Southside

Cemetery were coming from broad regions across the British Isles. This collective data supports the concept of a nursery for seamen, taking trained sailors into the Navy from the West Country and Newfoundland (Mercer 2008).

The childhood diets of those from the Southside Cemetery are almost exclusively C_3 based on the values of all molars. There is also no statistical difference in a paired t-test between the $\delta^{13}C_{carb}$ values of second and third molars ($F_{1,15}$=1.97, p=0.181). When the values of the teeth are compared on an individual level, there is some difference seen, yet all changes but two (A1 and A4) are within the range explained through analytical error (Table 6-5). The individual A1 had more C_3 and/or marine foods within their diet, as did A4; however, the amount of change still puts them within an almost pure C_3 diet (Ambrose and Norr 1993). The outlier within this group (B8) has a strong incorporation of marine or C_4 foods in the diet while breastfeeding, though they had no second or third molars to see how this possibly changed later in childhood. This shows that there is very little variability seen within the childhood diets of those at the Southside Cemetery, with all but three individuals (A3, A7, and B8) being consistent with a C_3 diet and appropriate range of $\delta^{18}O_{carb}$ values expected from Britain.

7.2.2 Possible Origins Outside of the British Isles

Even though the majority of these individuals fall within the range of $\delta^{13}C_{carb}$, $\delta^{18}O_{carb}$ and $^{87}Sr/^{86}Sr$ values expected for the British Isles, there are numerous other areas that overlap with these ranges that present other possibilities of origins. While the muster records from naval vessels in St. John's suggest that the vast majority of Royal Naval sailors who were stationed in the town in the late 18th and early 19th centuries were from the British Isles, particularly England, they do suggest some variability to these origins. One of the suggested origins is that of Newfoundland.

There are two individuals (A3 and A6) from the Southside Cemetery who fall within the $\delta^{18}O_{carb}$ range of the Avalon Peninsula of Newfoundland suggested from St. Paul's Anglican Church Cemetery (mean of -7.1±0.3‰, n=6, 1σ) (Table 6-7). The $\delta^{13}C_{carb}$ values for St. Paul's Anglican Church had a mean of -11.6±0.6‰ (n=6, 1σ). Both individuals fall within these values, which are consistent with slightly more marine food consumption.

Another possible place of origin for these individuals is that of colonial America, yet colonial American individuals are very difficult to differentiate isotopically from those of the British Isles due to the overlap in $\delta^{18}O_{DW}$ values. When the $\delta^{18}O_{P}$ values of individuals from the 18th and 19th centuries are converted to $\delta^{18}O_{carb}$ (Daux et al. 2008), the mean value is -4.4±1.5‰ (n=219, 1σ) and ranged from -7.5 to 0.1‰ (Table 7-2, Figure 7-5). Many of these samples were from bone or dentine phosphate rather than enamel, which are more likely to be affected by diagenesis. However, these give a sense of the possible range of $\delta^{18}O_{carb}$ values expected for America. These values overlap with the $\delta^{18}O_{carb}$ values expected for the British Isles (-3.3 to -6.1‰; Darling et al. 2003). It must be noted that it is possible that European immigrants are included within these samples (France et al. 2014). For comparison, individuals from three farmer and middle class cemeteries that date between 1750 and 1850 had a mean $\delta^{18}O_{carb}$ value of

Table 7-2. Comparative 17th to 19th century $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ values from enamel carbonates as well as $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ from bone and dentine collagen from St. Paul's Anglican Church and Wester Point in Newfoundland, as well as broad-based samples from across what is now the United States, including specifically Trinity, Walton, and Woodville cemeteries. Additionally, Jamestown and Maryland in America, and the Antilles in the West Indies [mean ± SD (n, range (max-min))].

Site	$\delta^{13}C_{carbonate}$	$\delta^{18}O_{carbonate}$	$\delta^{13}C_{collagen}$	$\delta^{15}N_{collagen}$	Citation
St. Paul's, NL	-11.6 ± 0.6 (6, 1.5)	-7.1 ± 0.3 (6, 0.9)	-16.7 ± 0.7 (7, 1.8)	14.8 ± 1.8 (7, 4.3)	This Research (carbonate); Pike and Grimes unpublished data (collagen)
Wester Point, NL	-	-	-18.1 ± 1.9 (6, 4.5)	13.7 ± 3.1 (6, 7.3)	Harris 2015
America	-	-	-14.2 ± 2.6 (175, 12.7)	10.7 ± 1.0 (175, 7.0)	France et al. 2014
Trinity, Walton, Woodville Cemeteries	-9.2 ± 2.4 (33, 8.9)	-5.1 ± 1.1 (33, 5.0)	-13.7 ± 2.4 (31, 10.8)	10.4 ± 0.9 (31, 3.8)	France et al. 2014
Jamestown	-10.0 ± 2.4 (17, 7.4)	-	-	-	Bell et al. 2009
Maryland	-9.2 ± 2.3 (10, 4.4)	-	-	-	Varney 2003
Antilles	-11.5 (46, 7.3)	-2.5 (46, 2.3)	-	-	Varney 2003

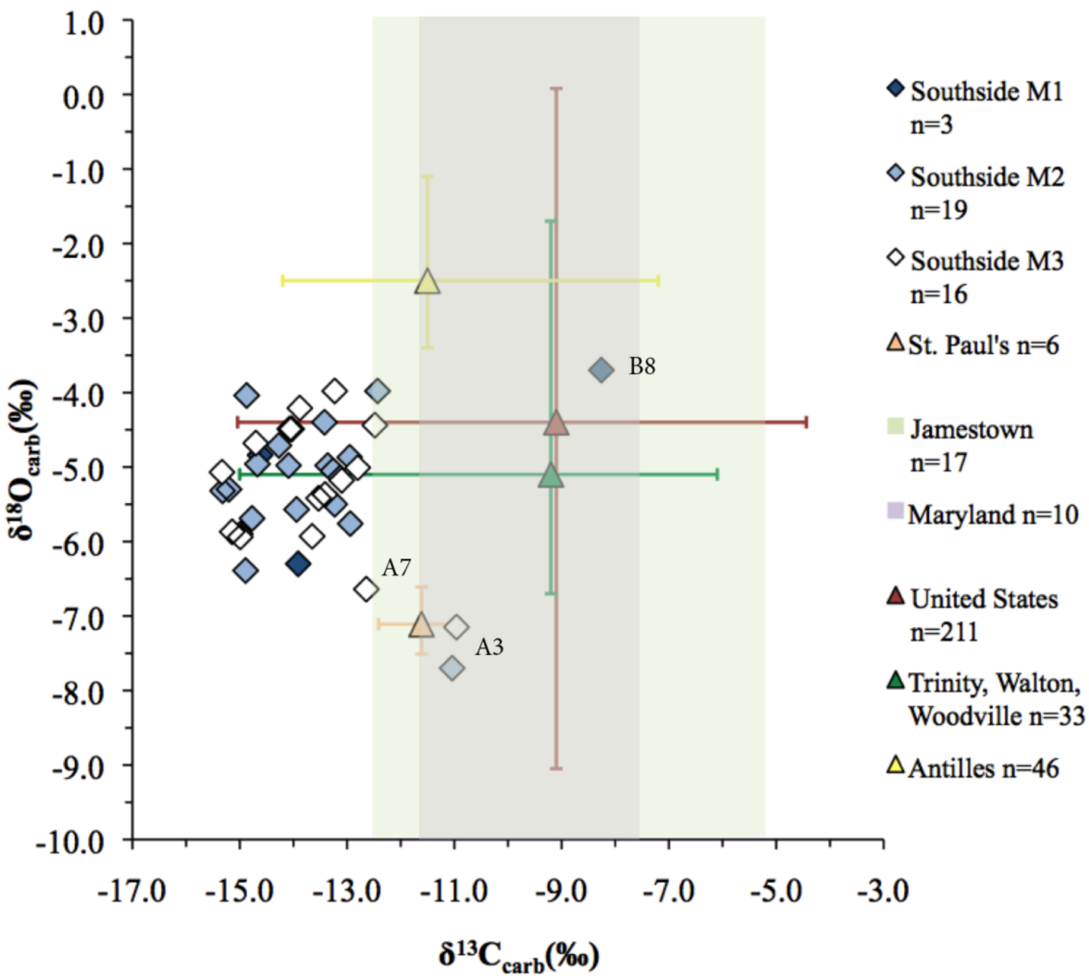


Figure 7-5. The $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ values of first (M1), second (M2), and third (M3) molars from the Southside Cemetery, St. John's, NL, compared to the mean and range from 17th to 19th century sites in North America. These include St. Paul's Anglican church, Harbour Grace (unpublished data) and Wester Point (Harris 2015) in Newfoundland, individuals from across the east coast of the United States (France et al. 2014), as well as specifically Trinity, Walton, and Woodville Cemeteries from within this data (France et la. 2014), and the Antilles (Laffoon et al. 2013). In addition, the boxes are the range of $\delta^{13}C_{carb}$ of individuals from Jamestown and Maryland in what is now the United States (Ubelaker and Owsley 2003).

-5.5±1.1‰ (n=33 1σ) and ranged from -6.6 to -1.6‰ (Table 7-2, Figure 7-5). These cemeteries are more likely to contain local individuals.

Another way to potentially separate out individuals from America is through the use of $\delta^{13}C_{carb}$ values, as the diets suggest a mixed C_3/C_4 food consumption, which would be atypical from the British Isles (Ubelaker and Owsley 2003). This can be seen when considering the $\delta^{13}C_{carb}$ values from France et al. (2014) study with a mean value of -9.1±2.4‰ (n=219 1σ) and ranged from -15.0 to -4.4‰ (Table 7-2, Figure 7-5). There are some individuals consuming typical European diets within this study, either due to a more recent immigration or a personal preference for traditional European foods, yet overall the vast majority of individuals have a significant influence of C_4 foods within their diets. It is this aspect that can be used, along with $\delta^{18}O_{carb}$ values, to differentiate individuals who were possibly from colonial America. This can also be seen from the values from individuals of the 17th century sites at Jamestown and Maryland (Ubelaker and Owsley 2003). Jamestown had a mean $\delta^{13}C_{carb}$ value of -10.0±2.3‰ (n=10 1σ), and ranged from -5.1‰ to -12.5‰, while Maryland had a mean $\delta^{13}C_{carb}$ value of -9.3±1.3‰ (n=17 1σ) and ranged from -11.8‰ to -7.3‰ (Table 7-2, Figure 7-5; Ubelaker and Owsley 2003). If we do presume a mixed diet for America with overlapping and slightly higher $\delta^{18}O_{carb}$ values to the British Isles, the data suggests that there is one individual, B8, who falls within this range as they have a $\delta^{18}O_{carb}$ value of -3.7‰ and a $\delta^{13}C_{carb}$ value of -8.3‰.

There were a number of individuals noted in the muster records as having originated from islands within the West Indies. This region, specifically the Lesser and Greater Antilles, would expect to have a mean $\delta^{18}O_{carb}$ value of -2.5 (n=46) and ranged from -3.4 to -1.1‰ with a mean $\delta^{13}C_{carb}$ value of -11.5‰ and ranged from -7.2 to -14.2 (n=46; there was no standard deviation provided for the data) (Table 7-2, Figure 7-5; Laffoon et al. 2013). Although not falling directly within the ranges, it is possible that individual B8 could be from the Caribbean if not from America, but this is the sole individual from the Southside Cemetery whose values fall close to those of the Caribbean.

7.3 Inter-site Comparisons of Royal Naval Origins

7.3.1 English Harbour

Results from the Southside Cemetery can be compared to other Royal Naval sites to examine the global variability of diets and origins. English Harbour, Antigua had a Naval Hospital Cemetery that was active from 1793 to 1822 (Varney and Nicholson2001). This study conducted by Varney (2003; 2007) as part of her doctoral research, took bone collagen samples from different bones of 30 individuals, mainly samples from ribs, femora, and mandibles. These individuals ranged in age from newborn to mid-50s, but only post-pubescent individuals and adults were considered for this study, reducing the number of individuals to 26. Of these, six were identified as being of African ancestry and five as being of European ancestry. All individuals for whom sex determination was possible were identified as male. Enamel carbonate samples were taken from 19 of these individuals from late forming teeth, though only the $\delta^{13}C_{carb}$ data were interpreted in the original source; therefore, the interpretation of the $\delta^{18}O_{carb}$ values is suggested here for the first time.

The individuals buried at English Harbour Naval Hospital Cemetery, Antigua had a mean $\delta^{13}C_{carb}$ value of -11.1±3.3‰ (n=19 1σ) and ranged from -14.7 to -0.9‰ (Table 7-3, Figure 7-6). The majority of these individuals had a mixed C_3 and C_4 diet, with some eating C_3 and others largely C_4 diets (Varney 2003; Varney 2007). The $\delta^{13}C$ values of the five identified as having European ancestry fell between -14.7 and -10.2‰, while the $\delta^{13}C$ values of the six individuals of African ancestry fell between -12.8 and -0.9‰. The difference between those of African and European ancestry suggests that the shift in the diet is in part explained by ancestry, where substantially more C_4 foods are in the diet of those of African ancestry than those of European (Table 7-3; Varney 2007). The individuals of European ancestry fall close to the range and mean of the sailors from the Southside Cemetery; however, there is a much higher standard deviation for those of European descent from English Harbour than those sailors from St. John's Naval Hospital (Table 7-3).

The $\delta^{18}O$ values from the English Harbour samples had a mean of -5.0±1.5‰ (n=19, 1σ) and ranged from -7.7 to -1.6‰ (Table 7-3, Figure 7-6). These data present a large range of possible childhood origins. These origins are further complicated by the fact that storing water, such as in cisterns, for long periods of time can increase the $\delta^{18}O_{DW}$ values of drinking water (Wright and Schwarcz 1996).

Table 7-3. Comparisons between Southside Cemetery stable isotope values of $\delta^{13}C$ and $\delta^{18}O$ in enamel carbonate and $\delta^{13}C$ and $\delta^{15}N$ in bone collagen with historical samples of other Royal Naval Hospital Cemetery studies [mean ± SD (n, range (max-min))].

Site	$\delta^{13}C_{carbonate}$	$\delta^{18}O_{carbonate}$	$\delta^{13}C_{collagen}$	$\delta^{15}N_{collagen}$	Citation
Southside	-13.8 ± 1.1 (19, 4.3)	-5.2 ± 0.9 (19, 3.7)	-19.4 ± 0.9 (21, 3.4)	11.6 ± 1.3 (21, 5.2)	This Research
English Harbour	-11.1 ± 3.3 (19, 13.8)	-5.0 ± 1.5 (19, 6.1)	-17.8 ± 2.7(26, 10.3)	11.7 ± 1.0 (26, 4.3)	Varney 2003
Plymouth	-	-	-18.8 ± 1.0 (50, 4.7)	11.1 ± 1.4 (50, 6.4)	Roberts et al. 2012
Haslar	-	-	-20.1 ± 0.7 (29, 3.4)	11.9 ± 0.6 (29, 2.4)	Roberts et al. 2012
Mary Rose	-14.7 ± 0.7 (18, 2.9)	-4.4 ± 0.8 (18, 3.5)	-19.4 ± 0.3 (18, 1.1)	11.4 ± 1.0 (18, 4.2)	Bell et al. 2009
English Harbour European	-12.3 ± 1.6 (5, 4.5)	-5.1 ± 2.1(5, 5.5)	-18.8 ± 1.3 (8, 3.8)	11.9 ± 0.9 (8, 2.4)	Varney 2003
English Harbour African	-9.2 ± 5.2 (6, 11.9)	-4.7 ± 1.1 (6, 3.3)	-15.9 ± 4.1 (6, 9.0)	11.7 ± 1.2 (6, 3.3)	Varney 2003

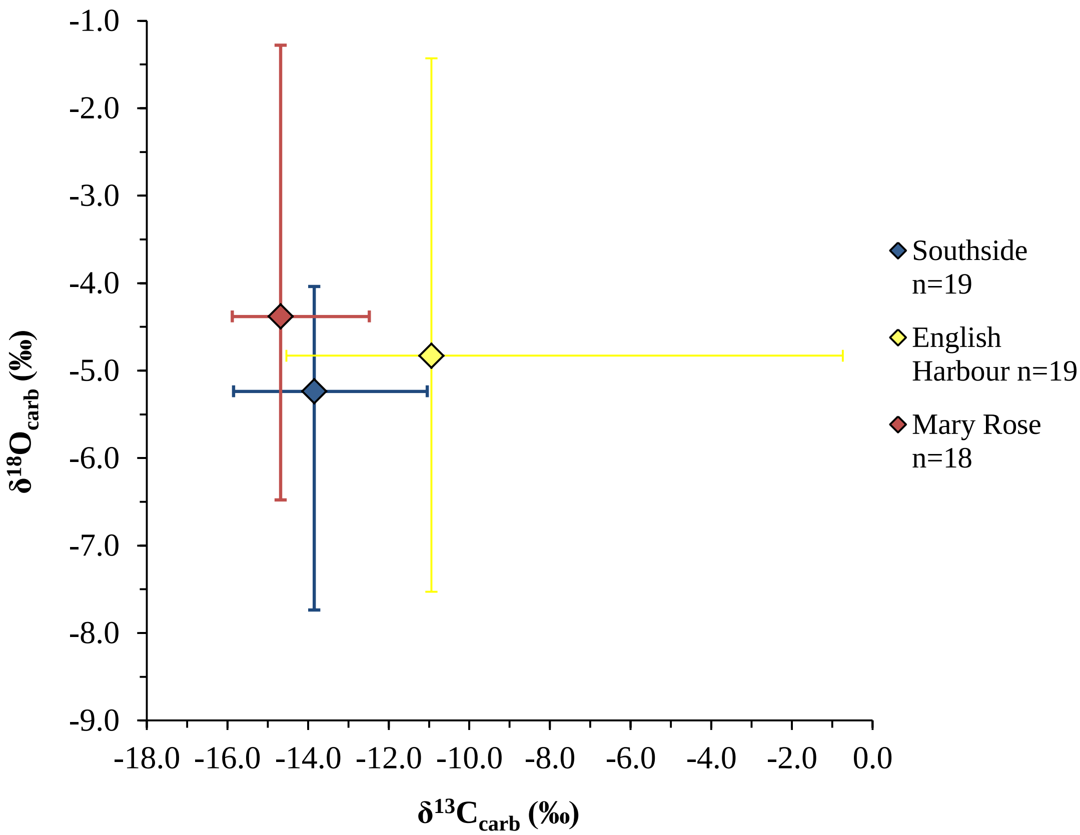


Figure 7-6. The mean and range $\delta^{13}C$ and $\delta^{18}O$ values in enamel carbonate of samples associated with the Southside (this study) and English Harbour (Varney 2003) Royal Naval Hospital Cemeteries and the *Mary Rose* (Bell et al. 2009).

While the lower values may be from the British Isles, the higher values are consistent with Caribbean origins (Darling et al. 2003; Laffoon et al. 2013). The mean $\delta^{18}O_{carb}$ values of individuals of European ancestry had a mean of -5.1±2.1‰ (n=5 1σ) and ranged from -7.1 to -1.6‰, while those of African ancestry had a mean of -4.7±1.1‰ (n=6 1σ) and ranged from -6.1 to -2.8‰ (Table 7-3, Figure 7-6), suggesting that those of African descent came from a narrower range of areas than those of European descent. Though those of European ancestry were more variable than those of African ancestry, both had high oxygen values suggesting some of those of European ancestry spent their childhood in the Caribbean, or consumed relatively high $\delta^{18}O$ values drinking water.

When compared to the values in individuals from the Southside Cemetery, the mean $\delta^{13}C_{carb}$ values in individuals of European descent is slightly higher, but with a similar standard deviation (-12.3±1.6‰ and -13.8±1.7 respectively) (Table 7-3). Those samples identified as having European ancestry had a mean that was more similar to the Southside Cemetery, but with a much larger standard deviation, suggesting more varied origins by those buried in the English Harbour Naval Hospital Cemetery.

7.3.2 Mary Rose

The *Mary Rose* was the flagship of Henry VIII that sank in 1545 off of the southern coast of England (Bell et al. 2009). This represents an earlier time period of the Royal Navy with which to compare the later cemeteries. The study published by Bell et al. (2009) sampled the bone collagen and enamel carbonate for $\delta^{13}C$, $\delta^{18}O$, and $\delta^{15}N$ from mandibles, maxillae, and late forming teeth from 18 individuals. The $\delta^{13}C_{carb}$ values had a mean of -14.7±0.7‰ (n=18 1σ) and ranged from -16.2 to -13.3‰ (Table 7-3, Figure 7-6). These values are consistent with the consumption of a pure C_3 terrestrial diet (Bell et al. 2009). The $\delta^{18}O$ values had a mean of -4.4±0.8‰ (n=18 1σ) and ranged from -6.7 to -3.2‰ (Table 7-3, Figure 7-6). There have been three papers interpreting these oxygen results (Bell et al. 2009; Bell et al. 2010; Millard and Schroeder 2010). The original authors suggested that of the individuals sampled, 12 had values falling within the expected range for England and the other 6 fell within the range expected for warmer climates (Bell et al. 2009). However, Millard and Schroeder (2010) pointed out that Bell et al. (2009) were not using standard equations to convert the $\delta^{18}O_{carb}$ values to $\delta^{18}O_{DW}$. In turn they suggested that all but one individual came from the British Isles (Millard and Schroeder 2010).

The childhood diets of those from the *Mary Rose* have $\delta^{13}C_{carb}$ values are slightly lower than those of the Southside Cemetery, suggesting much less incorporation of C_4 or marine foods by those of the *Mary Rose*. The mean $\delta^{18}O_{carb}$ values for those buried at the Southside Cemetery were slightly lower than those of the *Mary Rose*, but with similar standard deviations, suggesting that both populations were coming from areas of similar $\delta^{18}O_{DW}$ values (Table 7-3).

7.3.3 Inter-site Comparisons

The $\delta^{18}O$ values from all Royal Navy sites are statistically different from each other ($p<0.05$), with the exception of the *Mary Rose* and Southside Naval Hospital Cemetery ($p=0.043$) (Table 7-4b). This is consistent with individuals from both the *Mary*

Table 7-4. Statistical comparisons of the A) Carbonate $\delta^{13}C$ B) Carbonate $\delta^{18}O$ C) Bone Collagen $\delta^{13}C$ and D) Bone Collagen $\delta^{15}N$ values of Royal Navy sailors from the Southside English Harbour (Varney 2003), Plymouth, and Haslar (Roberts et al. 2012) Royal Naval Hospital Cemeteries and the *Mary Rose* (Bell et al. 2009).

A.

Site 1	Site 2	q	p-value
English Harbour	*Mary Rose*	2.323	<0.001
English Harbour	Southside	1.487	<0.001
Mary Rose	Southside	-0.836	0.043

B.

Site 1	Site 2	k	p-value
English Harbour	*Mary Rose*	5.834	<0.001
English Harbour	Southside	4.198	<0.001
Mary Rose	Southside	-3.549	0.043

C.

Site 1	Site 2	k	p-value
English Harbour	Haslar	-4.318	0.019
English Harbour	*Mary Rose*	-9.315	<0.001
English Harbour	Plymouth	13.390	<0.001
English Harbour	Southside	-7.022	<0.001
Haslar	*Mary Rose*	-2.743	0.296
Haslar	Plymouth	19.697	<0.001
Haslar	Southside	-1.682	0.757
Mary Rose	Plymouth	25.295	<0.001
Mary Rose	Southside	1.575	0.799
Plymouth	Southside	-22.108	<0.001

D.

Site 1	Site 2	k	p-value
English Harbour	Haslar	2.925	0.234
English Harbour	*Mary Rose*	-7.352	<0.001
English Harbour	Plymouth	10.776	<0.001
English Harbour	Southside	-4.238	0.023
Haslar	*Mary Rose*	-10.387	<0.001
Haslar	Plymouth	7.112	<0.001
Haslar	Southside	-7.331	<0.001
Mary Rose	Plymouth	19.776	<0.001
Mary Rose	Southside	2.989	0.214
Plymouth	Southside	-16.078	<0.001

Rose and the Southside Naval Hospital Cemetery having similar origins, mainly the British Isles.

It appears that most individuals from the Southside Cemetery fall within the boundaries of the expected $\delta^{18}O_{carb}$ values for England, but the distribution was much quarter than in those associated with the *Mary Rose*; this suggests that individuals from the Southside Cemetery are from a broader range of areas within the British Isles. English Harbour has twice the variability in $\delta^{18}O_{carb}$ values, and therefore likely origins, than Southside Cemetery or the *Mary Rose* (Bell et al. 2009). My analysis of these data shows that English Harbour includes higher $\delta^{18}O_{carb}$ values than the Southside Cemetery and both higher and lower $\delta^{18}O_{carb}$ values that those from the *Mary Rose*, likely due to broad origins of these sailors from across the Caribbean, British Isles, and North America. Even when the European individuals are separated from those of known African origin, which better isolates the sailors from the dockyard, there is more than double the variability, even though the mean values are similar between English Harbour and the Southside Cemetery (Table 7-3).

The enamel carbonate values were compared between the Southside and English Harbour Naval Hospital Cemeteries and the *Mary Rose*. The $\delta^{13}C_{carb}$ values from all sites are statistically different from each other ($p<0.05$) (Table 7-4a, Figure 7-6).

The childhood diets of individuals from the Southside Cemetery consist of almost exclusively C_3 terrestrial foods, but with some having access to C_4 or marine foods. This is not the case with the individuals from the *Mary Rose*, which are very tightly clustered with a pure C_3 diet (Bell et al. 2009). While it is useful to compare diets and origins of those from the *Mary Rose*, it must be remembered that the New World was still in a phase of exploration rather than settlement and production, which meant that there would have been little access to New World foods, and limited recruitment of people for use in the Royal Navy. English Harbour is almost twice as variable in dietary $\delta^{13}C_{carb}$ than the Southside Cemetery, and three times that of the *Mary Rose* (Table 7-3). The Caribbean was a crossroads of cultures and trade, which would mean exposure to a broader range of foods, and easy access to traditional European and American foods, which came together to produce the varied diets seen at English Harbour.

7.4 Diet in the Royal Navy

When the expected $\delta^{13}C$ and $\delta^{15}N$ values of naval rations are compared to the dietary values of individuals buried at the Southside Cemetery, inferences about variation in diet can be made.

7.4.1 Southside Cemetery

When reconstructing the likely $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values of naval rations it must be considered that bone collagen preferentially contains the protein aspect of diet. In turn, bone collagen values show little influence from direct consumption of C_4 foods like maize and sugar cane (Ambrose and Norr 1993). The influence of high amounts of protein would likely mask the isotopic values associated with the direct consumption of any non-protein C_4 foods, such as rum in the Caribbean (MacDonald 2004) as well as spruce beer which was made with molasses, a sugarcane derived C_4 food (Thomas 1968: 60). Therefore, we would expect a pure C_3 terrestrial diet with a trophic level between the consumption of herbivores and omnivorous as there was consumption of both beef and pork, along with animal byproducts such as butter and cheese (MacDonald 2004).

Individuals associated with the *Mary Rose* should reflect typical values for a Royal Naval diet from the time period, since these samples predate the influence of North American foods. So Royal Navy sailors in Newfoundland, of British origins, should have values close to the mean and standard deviation of those of the *Mary Rose* ($\delta^{13}C_{col}$ -19.4±0.3‰ and $\delta^{15}N_{col}$ 11.4±1.0‰ (n=18 1σ);Table 7-3). These values are similar to what was estimated by Roberts et al. (2012) using studies by Schoeninger and Moore (1992) and Hedges and Reynard (2007) with $\delta^{13}C_{col}$ values of approximately -21‰ and a $\delta^{15}N_{col}$ value between of 10 and 12‰.

Based on the $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values from this study, the individuals from the Southside Cemetery were mainly consuming C_3 terrestrial foods, at an omnivorous trophic level. This was not exclusive, as some individuals were clearly consuming lower trophic C_3, marine and or C_4 foods. The C_3 terrestrial omnivorous diet is what would be expected considering the large amounts of beef and particularly pork, both of which are known to be within the diets of sailors (MacDonald 2004). Justification for the consumption of pig (*Sus scrofa*), which is typically an omnivorous animal, comes from numerous studies of medieval and post-medieval faunal remains in Britain and Newfoundland. Although few of these date to a truly contemporaneous time period, it is still useful to compare. Guiry et al. (2015) pulled together pig data from Bocherens et al. (1991), Müldner and Richards (2005), Tripp et al. (2006), and Müldner and Richards (2007) for a cumulative $\delta^{13}C_{col}$ mean of -21.5±0.5‰ (n=31 1σ) and $\delta^{15}N_{col}$ value of

7.7±1.3‰ (n=31 1σ). These are similar values to the salt pork imported to Newfoundland from both Ferryland and Dos de Cheval with a mean $\delta^{13}C_{col}$ value of -21.5±0.5‰ (n=21 1σ) and range from -22.2 to -20.6‰, and a $\delta^{15}N_{col}$ value of 7.4±1.1‰ (n=21 1σ) and range from 6.0 to 9.6‰ (Guiry et al. 2012). When these terrestrial $\delta^{13}C_{col}$ values are paired with higher $\delta^{15}N_{col}$ values and considered with a 3 to 5‰ trophic shift in $\delta^{15}N_{col}$ (DeNiro and Epstein 1981; Macko et al. 1982; Bocherens and Drucker 2003; Hedges and Reynard 2007) and ~1‰ $\delta^{13}C_{col}$ (Schoeninger and DeNiro 1984), these values closely mirror many of those from Southside Cemetery. This is not to say that their protein was exclusively pork, or that there are no other possible combinations that could produce the same values, but considering the historical context of the Royal Navy it is likely that pork made up a significant portion of their diet.

Though the majority of individuals from the Southside Cemetery were consistent with a Royal Naval diet, the diets of those from the majority of the British Isles were likely very similar to this diet, but with less meat in the diets of the poor (Olsen 1999: 231-235). Because most British dietary studies from the medieval period and the later 19th century (i.e.: Mays 1997; Müldner and Richards 2005; Müldner and Richards 2007; Beaumont et al. 2013), there are no broad-based British studies with which to compare these data and it is therefore it is not possible within the parameters of this study to separate those who were eating a naval diet from those that were consuming a British diet. This convolutes the ability to discern the variability of naval diets globally.

If there was a standardization of the Royal Naval diet, you would expect to see the variability of diet within the population going down over time, from more variable childhood diets to strict naval rations. The tissues that were sampled during this study are not directly comparable, as carbonates contain total diet, while bone collagen is mainly to protein portion of diet (Ambrose and Norr 1993), yet it is still useful to examine if variability in diet changed over time. Looking at the second and third molars and the mandible and palatine bone, we see that the standard deviations stay relatively constant at 1.1, with only the mandible being slightly lower at 0.9. However, when the coefficient of variation (CV) is examined, which would take out any bias from the differences in values between the tissues, there are some differences seen with second and third molars having a CV of -8.0 and -8.1% respectively, and the mandible and palatine bones having -4.6 and -5.9% respectively (Table 6-4). Dietary lipids may have offset the $\delta^{13}C$ values of bone collagen by ~3‰ (Vogel 1978), or it is possible that there was increased consumption of C_4 and/or marine foods. All of these would increase the variability between bone collagen and enamel carbonates. Therefore, it is likely that some if not all of this difference in variability can be explained by the incorporation of non-protein parts of diets into the carbonate values.

If it is accepted that physiological rather than dietary processes can explain differences between values seen, these data suggest that there is not a standardization of diet seen within this population. If there was no change in diet between childhood and adulthood, a strong linear relationship would be expected between the $\delta^{13}C_{carb}$ values and the $\delta^{13}C_{col}$ values; however, this is not the case for the individuals from the Southside cemetery (Figure 7-7, r^2 = 0.18). Though the majority of individuals saw no interpretable change within their diets, considering the ~5‰ offset between the $\delta^{13}C$ values in collagen

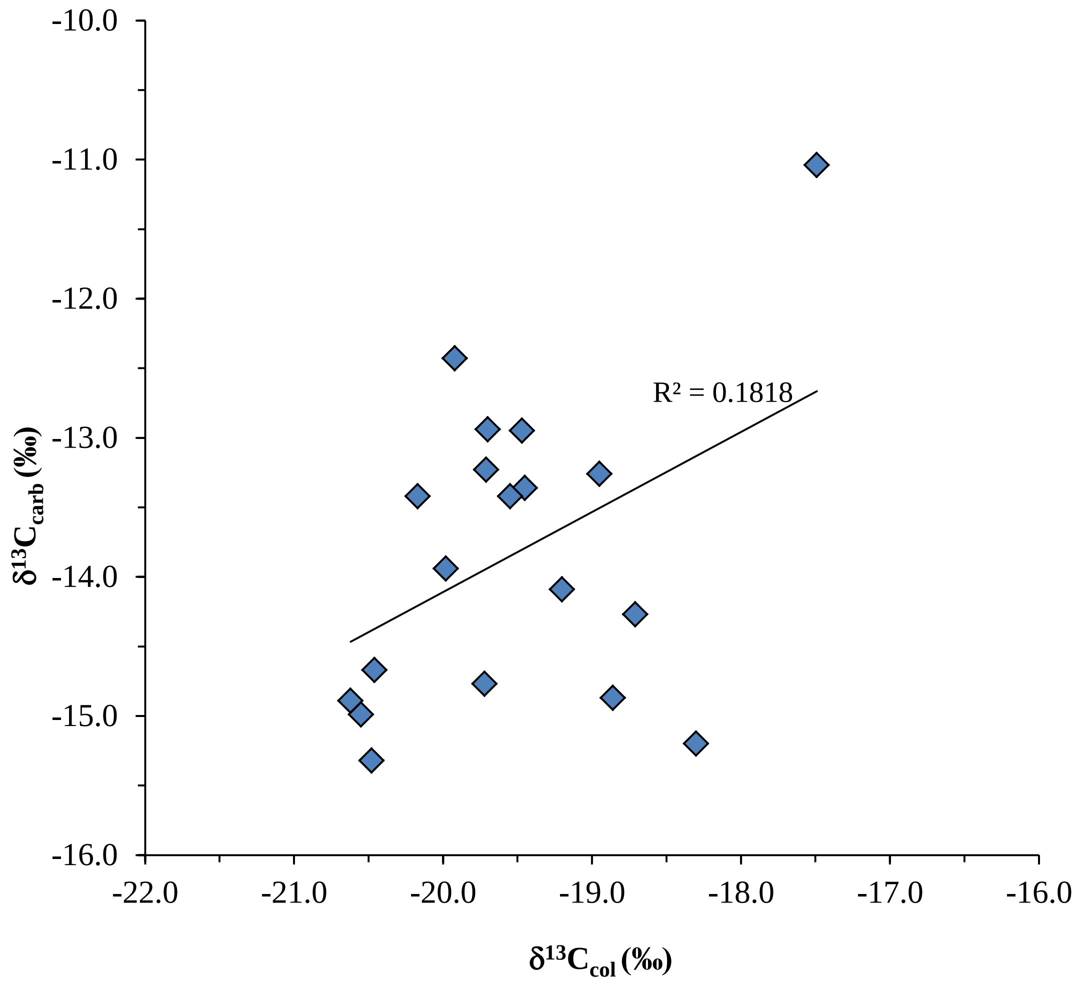


Figure 7-7. Comparison of $\delta^{13}C$ values from mandibular bone collagen and second molar carbonate of the Southside Cemetery to ascertain changes in diet over time.

and carbonates, some individuals did have a change in dietary values. Though some of these changes were towards the diet expected for the Royal Navy, others moved away.

A major bias within our ability to interpret change in diets is the very slow turnover of bone collagen (Parfitt 2002; Hedges et al. 2007). It is highly probable, considering the context of the St. John's Naval Hospital, which all individuals buried at the Southside Cemetery were eating a Royal Naval diet, even though it is unknown how variable this diet may have been. However, many of these sailors would not have been involved in the Royal Navy long enough for the isotopic values of their mandibles to exhibit this change. In turn, it is likely that some individuals' diets represent their lives and careers before the Navy. Therefore, the lack of a visible standardization of diet does not necessarily mean that the rations themselves were not standardized. Those buried at the Southside Cemetery are a group of individuals who happened to end up in the Navy. Their time and experiences within the Royal Navy were different, as can be seen within the isotopic values of their skeletal tissues. Although these individuals all died and were buried together at the Southside Cemetery that is associated with the Royal Navy, the individual life histories must be considered within the historical context of not only the Royal Navy, but the dynamics of the British Atlantic World.

7.4.2 North American Dietary Comparisons

The British Atlantic World offered numerous trade opportunities in goods and food, yet as evident in the $\delta^{13}C_{carb}$ values of childhood diets, individuals within North America commonly consumed more local C_4 foods rather than an almost exclusive C_3

diet typical of much of Europe and the British Isles. The naval vessel muster records suggested some countries outside of the British Isles that may coincide with individuals buried at the Southside Cemetery. Because most of these sailors would not likely have spent their entire adult career as a naval seaman, it is useful to consider other regions that may explain the outliers for $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values.

A location suggested by the naval records was North America, specifically port cities in America. By examining the diets of those from America as analyzed and described in France et al. (2014), it is clear that the bone collagen that represents mainly the protein aspect of diets is also affected by C_4 foods. Those from America had a $\delta^{13}C_{col}$ mean of -14.2±2.6‰ (n=175 1σ) and ranged from -20.9 to -18.2, and a $\delta^{15}N_{col}$ mean of 10.7±1.0 (n=175 1σ) and ranged from 6.2 to 13.2‰ (Table 7-3, Figure 7-8; France et al. 2014). While this shows a general range for colonial America, many of these data come from sites much later than the Southside Cemetery. In turn, those values from the three farmer and middle class cemeteries (Trinity, Walton, and Woodville) are useful as a more comparable population. They jointly have a mean $\delta^{13}C_{col}$ value of -13.7±2.4‰ (n=31 1σ) and ranged from -15.9 to -10.1‰, with a $\delta^{15}N_{col}$ mean of 10.4±0.9‰ (n=31 1σ) and ranged from 8.7 to 12.5‰ (Table 7-3, Figure 7-8; France et al. 2014). These high $\delta^{13}C_{col}$ values are not seen in any individual from the Southside Cemetery, suggesting that C_4 was not as significant a part of anyone's diet in Newfoundland.

Individuals from St. Paul's Anglican Church, Newfoundland were sampled as part of this study for carbonate, but bone collagen had previously been sampled for $\delta^{13}C_{col}$ and

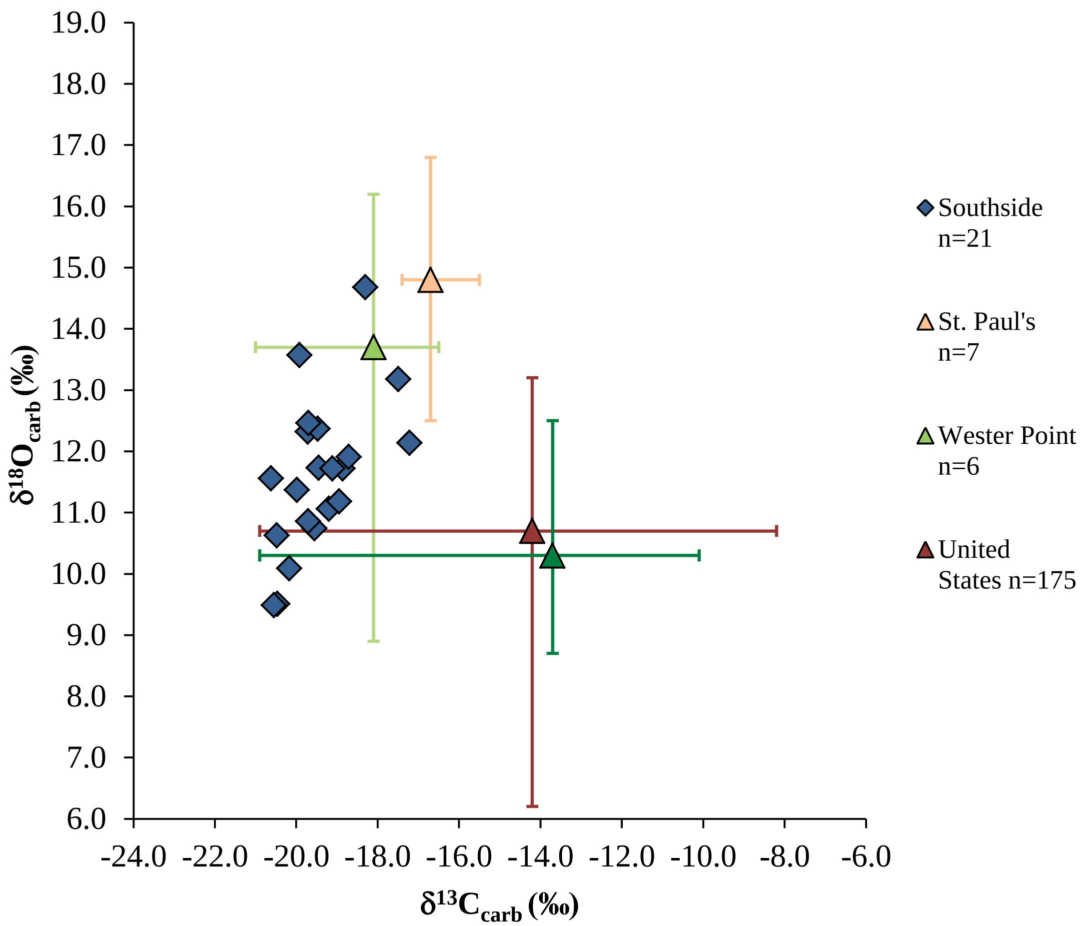


Figure 7-8. Comparison of the $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ data from the Southside Cemetery compared to the mean and range from St. Paul's Anglican Church (Pike and Grimes unpublished data) and Wester Point (Harris 2015) from Newfoundland, as well as data from what is now the United States (France et al. 2014) with the Trinity, Walton, and Woodville Cemeteries (France et al. 2014) grouped and shown separately.

$\delta^{15}N_{col}$ (Pike and Grimes unpublished data). The $\delta^{13}C_{col}$ values had a mean of -16.7±0.7‰ (n=7 1σ) and ranged from -17.4 to -15.6‰, and the $\delta^{15}N_{col}$ values had a mean of 14.8±1.8‰ (n=7 1σ) and ranged from 12.5 to 16.8 (Table 7-2, Figure 7-8). This is consistent with a mixed terrestrial marine diet, which is no surprise considering Newfoundland's dependence during the 18th century on the fishing industry (Matthews 1968; Cell 1969; Cadigan 2009). Another contemporary site from Newfoundland is Wester Point, where individuals had a mean$\delta^{13}C_{col}$ value of -18.1±1.9‰ (n=6 1σ) and ranged from -21.0 to -16.5‰, and a mean $\delta^{15}N_{col}$ value of 13.7±3.1 ‰ (n=6 1σ) that ranged from 8.9 to 16.2‰ (Table 7-1, Figure 7-8; Harris 2015). Harris (2015) argued that two of these individuals were consuming a terrestrial diet, while four were consuming a mixed terrestrial marine diet. As there were no enamel carbonate samples taken, it is not possible to ascertain if these differences could have been due to the inclusion of immigrants from Europe, considering the terrestrial diet.

If it is assumed that the mixed terrestrial-marine influenced diet is a likely typical of a Newfoundland diet in the 18th to 19th centuries, with the understanding that some individuals may have chosen to eat little marine food, the data allows a separation of possible Newfoundlanders. There are three individual who fall very close to the mean and standard deviation from St. Paul's (A3, A4, B7). Although only one of these were suggested from tooth enamel to have originated in Newfoundland, it is possible that the other two were involved in the fishing industry in Newfoundland, another similar career, or lived in a coastal region that offered them a significant amounts marine foods.

7.5 Individual Life Histories

The individuals buried at the Southside Cemetery likely died while being treated at the St. John's Royal Naval Hospital, or died while in port and were brought there for internment (ADM 102/733-734). Many of these naval sailors were of lower ranks who likely had not been serving in the Navy for very long (ADM 102/733-734). While many Royal Navy sailors originated from the British Isles, specifically England, the Royal Navy brought together a diverse group of individuals (ADM 36). Considering this historical context as well as the earlier conclusion (7.4.1) that origins could likely have been causing some of the variability seen within the population from the Southside Cemetery, it is imperative to consider the data holistically. This is done by comparing what the isotopic values of childhood tissues (enamel) suggest about the individuals lives when compared to those tissues that represent a more recent average of life (bone collagen). The following section examines life histories of individuals whose isotopic values suggest different life experiences, putting this within the context of the Royal Navy and the British Atlantic World. The individuals were selected either because they were outliers, or in the case of A5 this individual fell very close the average values for the entire population from the Southside Cemetery.

7.5.1 NP163 A5

This individual of indeterminate age and sex falls very close to the average values for all tissues sampled for this study. With a $\delta^{13}C_{col}$ value of -19.5‰ and $\delta^{15}N_{col}$ value of 11.7‰, they were likely eating a C_3 terrestrial diet with significant portions of omnivorous animals during their adulthood. Considering their $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ values changed very little overtime, and the second molar $\delta^{13}C_{carb}$ value of -13.4‰ and $\delta^{18}O_{carb}$ -5.0‰, it was likely that they were eating a pure C_3 terrestrial diet during childhood and living a location consistent with the British Isles. Their $\delta^{18}O_{carb}$ value in the second molar was consistent with the southeastern coast of England, up to the western coast of Scotland. Their $^{87}Sr/^{86}Sr$ values are consistent with this location as well, though the lower ratio suggests southern England as the more likely location.

7.5.2 NP163 A3

This individual was a probable male that is not close to the average diet or origins during any part of life examined, which suggests an atypical entry into the life of a naval sailor. Their diet saw little change outside of error between mandible and palatine values ($\delta^{13}C_{col}$ values of -17.5 and -17.1‰ and $\delta^{15}N_{col}$ values of 13.2 and 12.8‰ respectively), both being a mixed C_3 marine diet, which suggests that their diet was stable during their adulthood. Their childhood diet was also stable, consisting of mixed C_3 and marine foods as suggested by a higher $\delta^{13}C_{carb}$ value of -11.0‰ in both second and third molars. This non-standard European diet can be explained by C_4 foods; however their $\delta^{18}O$ value does not match those of the colonial America (France et al. 2014). Instead, their $\delta^{18}O_{carb}$ values fall within two standard deviations of the mean from Harbour Grace, NL, which is $\delta^{18}O_{carb}$ -7.1±0.6‰ (n=6 1σ). This is strong evidence towards the individual having originated from the Avalon Peninsula of Newfoundland, and is further strengthened when considered with their adult diet, which falls within two standard deviations of the mean

($\delta^{13}C_{col}$ value of -16.7±1.4 and $\delta^{15}N_{col}$ 14.8±2.6‰) of individuals from the St. Paul's Anglican Church Cemetery in Harbour Grace, NL (Pike and Grimes unpublished data). From the muster records, it is known that Newfoundland was used as a nursery for seamen, impressing people from both international and Newfoundland areas (Mercer 2006; ADM 36). It is probable that this individual entered the Navy either from impressment or volunteering in Newfoundland, but due to some accident or disease, his life ended at the St. John's Naval Hospital and he was buried at the associated cemetery.

7.5.3 NP163 A6

This individual was a probable male of indeterminate age whose $\delta^{18}O_{carb}$ values and childhood diet bring to question his origins. The $\delta^{18}O_{carb}$ values of his second and third molars were -5.8‰ and -6.6‰ respectively. Although Britain has $\delta^{18}O_{DW}$ values of up to -9.0‰, which converted to $\delta^{18}O_{carb}$ (Daux et al. 2008) is -6.4‰, these levels are only seen in the tap water from the highlands of Scotland (Darling et al. 2003). Drinking water $\delta^{18}O$ values above -8.0‰ are found exclusively in the counties of Lincolnshire, Nottinghamshire, and Aberdeenshire, although the $^{87}Sr/^{86}Sr$ ratio of the individual (0.7097) is inconsistent with those found in Aberdeenshire (>0.7100) (Evans et al. 2012). Although it is possible that the individual originated from an area of England with lower $\delta^{18}O_{DW}$ values and therefore associated $\delta^{18}O_{carb}$ values such as Lincolnshire or Nottinghamshire, the $\delta^{18}O_{carb}$ value of -6.6‰ cannot be explained by the consumption of boiled water (Brettell et al. 2012), but could possibly have been affected by uncertainty discussed by Pollard et al. (2011). It is interesting that the $\delta^{18}O_{carb}$ value of -6.6‰ falls within the value for Newfoundland according to St. Paul's, and would also correspond to other parts of North America such as Halifax ($\delta^{18}O_{DW}$ -9.4‰). The slightly higher $\delta^{13}C_{carb}$ values of -12.9‰ from second molars and -12.6‰ from third molars suggests some incorporation of either C_4 or marine foods within their childhood diet, which also supports the idea that this individual was living in Northern North America for his childhood. However, his adult diet corresponds to what would be expected for a naval diet with a $\delta^{13}C_{col}$ value of -19.7‰ and a $\delta^{15}N_{col}$ value of 12.5‰. It is therefore possible that this individual was a long time naval sailor.

7.5.4 NP163 B8

This individual's young childhood diet and origins stand out from other individuals. The $\delta^{13}C_{carb}$ value of -8.3‰ from the first molar is consistent with a very mixed C_3 with C_4 or marine foods, even considering a trophic shift from breast-feeding. The high $\delta^{18}O_{carb}$ value of -3.7‰ is found in few places in the British Isles including western Cornwall, south-western Ireland, and the Outer Hebrides. The strontium ratios likely exclude the Hebrides as these have strontium ratios >0.713 and this individual has a $^{87}Sr/^{86}Sr$ ratio of 0.7103 (Evans et al. 2012, Figure 7-4). When the context of the mixed diet, very high oxygen values, and a strontium ratio close to seawater are considered together, it is probable that this individual came from either colonial America or the Caribbean. Though considering that the highest $^{87}Sr/^{86}Sr$ values in the Caribbean is 0.7092 (Laffoon et al. 2012), the more isotopically variable United Sates is slightly more likely (Bataille and Bowen 2012: 49). What is very interesting is that the individual has very traditional European dietary values during their adulthood, with a $\delta^{13}C_{col}$ value of -19.1‰ and $\delta^{15}N_{col}$ value of 11.7‰. This constitutes a change from their mixed childhood diet, yet matches what would be expected for the Royal Naval diet, so it is possible that they spent at least their early childhood in the America or the Caribbean, but were involved in the Royal Navy for a long period of time, or they moved to England in their late childhood. It is unfortunate that more dental tissues, such second or third molars, were not present for sampling, as a longer life history may have better elucidated this individual's story in coming into the Royal Navy.

7.5.5 NP163 A4

This individual was identified as being a middle aged male, and although the stable isotope values fall very close to the average of the Southside Cemetery for his childhood diet and origins, his bone collagen values as an adult do not. He has the highest $\delta^{15}N_{col}$ values of any individuals (14.7‰), but only a $\delta^{13}C_{col}$ value of -18.3‰. This suggests that they had access to mainly C_3 terrestrial foods with some marine and or freshwater foods. Without a proper faunal baseline from the time-period, it is difficult to determine the likely proportions of different foods. His $\delta^{18}O_{carb}$ values for second and third molars both fall within the British Isles (-5.3 and -4.5‰ respectively), though considering the slight difference in values, it is possible that he moved sometime between his young childhood and teenage years. There are two main possible explanations for their $\delta^{18}O_{carb}$ values. First, was that they moved in later childhood towards an area of higher rainfall in Britain, such as from southeastern England towards the West Country

England. Southeastern England corresponds with a strontium ratio of 0.7093 (Figure 7-4); although these $\delta^{18}O_{carb}$ values correspond to $\delta^{18}O_{DW}$ that can be seen up the western coast of England, the strontium ratios increase dramatically towards Scotland. Therefore, southeastern England is more likely than central western England. An alternate explanation is that they began consuming more water in the form of alcohol or stews that were boiled for long periods of time, raising their $\delta^{18}O$ values (Brettell et al. 2012). However, the true effect that alcohol and stews can have on the diet has been theoretical, and not largely compared within more recent individuals. This type of study could greatly increase our ability to identify origins in the medieval and early modern periods.

7.5.6 NP163 B7 and C4

The individual B7 has a $\delta^{13}C_{col}$ value of -17.2‰ and a $\delta^{15}N_{col}$ value of 12.2‰ from mandibular bone collagen, suggesting a mixed C_3/marine diet, possibly with some C_4 foods as their $\delta^{15}N_{col}$ value is not highly elevated. This individual's mandible has almost identical values to the palatine bone of C4 which were $\delta^{13}C_{col}$ -17.3‰ and $\delta^{15}N_{col}$ 12.2‰. Although it is not truly possible to match values between tissues as there are different turnover rates between them, these carbon values are higher than any other samples from the Southside Cemetery without known matched mandible and palatine bones. Therefore, it is likely that they represent the same individual. Other possible explanations include that the mandible associated with C4 was not recovered, so there are actually more people recovered from the hospital cemetery. Or, that the individual C4 does not match with B7 and that they had a drastic change towards higher carbon and nitrogen values later in life which precludes out ability to match the palatine bone with an existing mandible. No other tissues such as molars were available to test this hypothesis. Either way, this individual (or individuals) are not consistent with what would be expected from the Navy, with too much consumption of marine and C_4 foods, suggesting that they were not in the Navy for a large portion of their adulthood.

7.5.7 NP163 A1

This individual was identified as being a middle aged possible female and is the only individual from the Southside Cemetery to have a change in $\delta^{18}O_{carb}$ values between second and third molars, of 1.4‰, which is much larger than what would be expected for analytical error. The first molar had a $\delta^{13}C_{carb}$ value of -14.8‰ and a $\delta^{18}O_{carb}$ value of -5.7‰, while the second molar had a $\delta^{13}C_{carb}$ value of -13.4‰ and $\delta^{18}O_{carb}$ value of -5.4‰. Interestingly, the $\delta^{13}C_{carb}$ values are shifted towards a slightly mixed C_3 and C_4 or marine diet, and a place with higher oxygen values, yet it is unclear where this would be. All that is known is that at some point after childhood she ended up in Newfoundland in some way associated with the Royal Navy. Her mandibular $\delta^{13}C_{col}$ value of -19.7‰ and $\delta^{15}N_{col}$ 12.3‰ were slightly lower than the more recent palatine values of $\delta^{13}C_{col}$ -18.9‰ and $\delta^{15}N_{col}$ 12.4‰. Her high $\delta^{15}N_{col}$ values likely exclude her from the lower classes, but she was not consuming a traditional Newfoundland diet either, so it is possible that she had not been there for a long period of time, as her $\delta^{13}C$ value had only shifted very slightly between mandible and palatine bones, or that she lived in Newfoundland during her adulthood, but chose to consume a diet low in marine protein. While I use the identifier 'she' it must be reiterated that the skull alone is not the best identifier of sex; therefore, it is possible that this individual was not a female.

7.6 Variability of Royal Naval Diet

In order to consider the global variability of diets within the Royal Navy, the isotopic values of bone collagen are compared to those from contemporaneous Royal Naval Hospital Cemeteries in England and the Caribbean.

7.6.1 English Harbour

Bone collagen samples from 26 individuals from the English Harbour Naval Hospital Cemetery were extracted by Varney (2003; 2007). They had a mean $\delta^{13}C_{col}$ value of -17.8±2.7‰ (n=26 1σ), and ranged from -20.8 to -10.5‰. They had a mean $\delta^{15}N_{col}$ values of 11.7±1.0‰ (n=26 1σ) and ranged from 9.9 to 14.2‰ (Table 7-3**,** Figure 7-9; Varney 2003; Varney 2007). These data indicate that the majority of individuals were consuming a mixed C_3 and C_4 diet from terrestrial animals, though it was highly variable, especially for carbon with diets ranging from pure C_3 terrestrial to pure C_4 terrestrial values (Varney 2003, Varney 2007). These can be further separated by ancestry with those of European descent having a mean $\delta^{13}C_{col}$ value of –18.8±1.3‰ (n=7 1σ) and ranged from -20.8 to -17.0‰, with a mean $\delta^{15}N_{col}$ value of 11.9±0.9‰ (n=7 1σ) and ranged from 10.4 to 12.8‰, which is consistent with a pure C_3 terrestrial diet (Table 7-3) (Varney 2007). Those of African ancestry had a mean $\delta^{13}C_{col}$ value of -15.9±4.1‰ (n=8 1σ) and ranged from -10.5 to -19.5‰, while the $\delta^{15}N_{col}$ mean was 11.7±1.2‰ (n=8 1σ) and ranged from

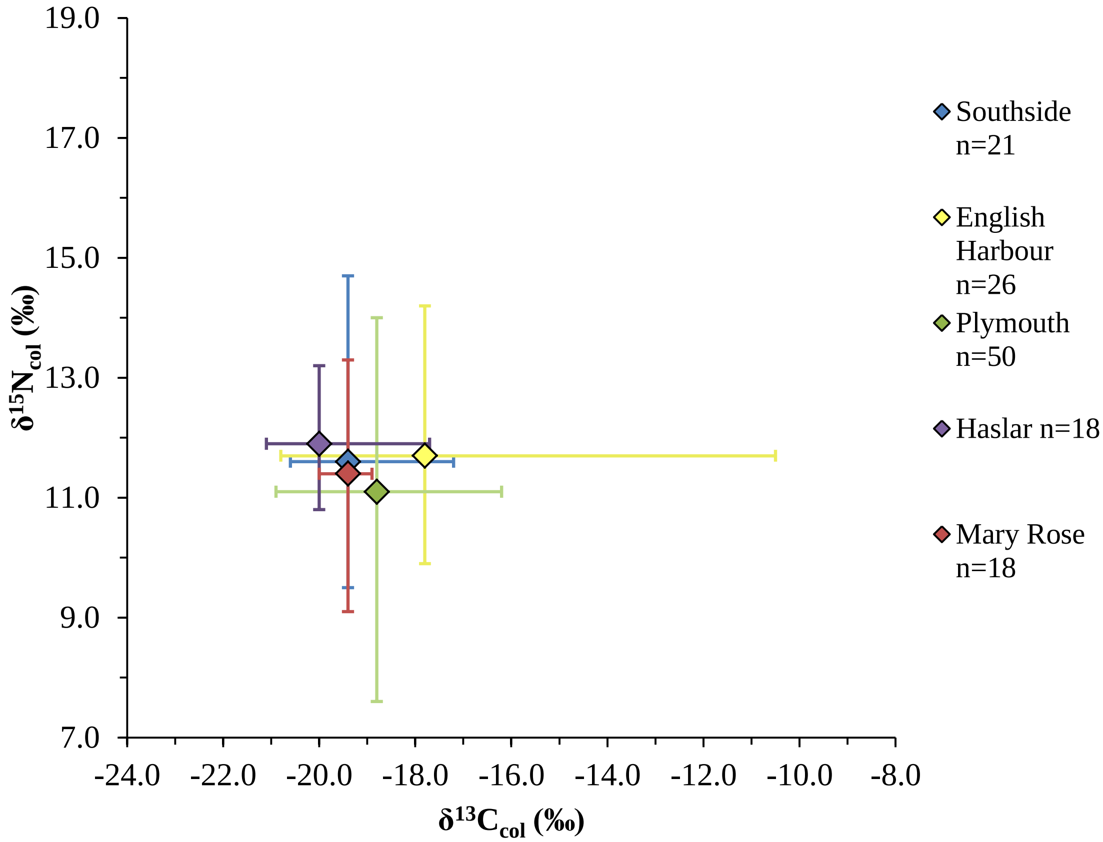


Figure 7-9. Comparison of mean and range for $\delta^{13}C_{VPDB}$ and $\delta^{15}N_{VPDB}$ values of bone collagen from studies of Royal Naval Sailors remains from the 18th and 19th C. The comparison to the $\delta^{13}C$ and $\delta^{15}N$ values in bone collagen of samples associated with the Southside (this study), English Harbour (Varney 2003), Plymouth, and Haslar (Roberts et al. 2012) Royal Naval Hospital Cemeteries and the *Mary Rose* (Bell et al. 2009).

9.9 to 13.2‰. This suggests that diets were more varied individually by those of African descent, with individuals eating more C_4 foods and others a more typical European C_3 terrestrial diet (Varney 2007).

The bone collagen values of those individuals identified as being of European descent have very similar $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values to the Southside Cemetery, but with slightly higher standard deviation for the Southside Cemetery, suggesting more variability in the trophic level of the diet. While some individuals from the Southside Cemetery had a mixed terrestrial or marine diet, while there were no identified Europeans from English Harbour with such diets.

7.6.2 Plymouth

The Plymouth Naval Hospital was active from 1762-1824, and the cemetery contained mostly seamen with some marines as well as low ranked specialists (Roberts et al. 2012). Roberts et al. (2012) extracted bone collagen from the ribs of 50 individuals from the Plymouth Naval Hospital Cemetery. They had a mean $\delta^{13}C_{col}$ value of -18.8±1.0‰ (n=50 1σ) and ranged from -20.9 to -16.2‰ (Table 7-3, Figure 7-9; Roberts et al. 2012). They had a mean $\delta^{15}N_{col}$ value of 11.1±1.4‰ (n=50 1σ) and a ranged from 7.6 to 14.0‰. These data are consistent with the majority of individuals consuming a pure C_3 diet. Roberts et al. (2012) attributed the slightly higher carbon values as having originated from the consumption of some C_4 foods, likely during service in the Caribbean and continental United States.

The diets are similar between those buried at the Southside Royal Naval Hospital Cemetery and Plymouth, with higher $\delta^{13}C_{col}$ values for Plymouth, and higher $\delta^{15}N_{col}$ values for the Southside Cemetery, but with almost equal standard deviations for both populations. This suggests a similar variability in diet, but with those from Plymouth consuming slightly more C_4 foods.

7.6.3 Haslar

The Haslar Royal Naval Hospital, Gosport was active from 1753-1826, and there were once again a majority of seamen who were buried, but with some prisoners of war and soldiers (Roberts et al. 2012). Roberts et al. (2012) sampled ribs from 29 individuals, along with femora and dentine from 22 and 25 of those same individuals, respectively. In terms of comparative tissues, ribs were chosen to be used in this study as there were more data and they represented the most recent dietary average. This decision is further supported as there were no statistical differences seen between the three tissues according to a Kruskal-Wallis test ($\delta^{13}C$ k=2.685, df=2 p-value = 0.261; $\delta^{15}N$ k=0.889, df=2, p-value = 0.641). They had a mean $\delta^{13}C$ value of -20.1±0.7‰ (n=29 1σ) and ranged from -21.2 to -17.8‰, with a mean $\delta^{15}N$ values of 11.9±0.6‰ (n=29 1σ) and ranged from 10.8 to 13.2‰ (Table 7-3, Figure 7-9; Roberts et al. 2012). These data are consistent with consuming a pure C_3 diet, but with a few individuals consuming a C_4 diet, the $\delta^{15}N_{col}$ values suggest an omnivorous terrestrial diet.

The $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values of those from the Haslar and the Southside Naval Hospital Cemeteries were similar, with slightly higher $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values at the

Southside Cemetery, yet equal standard deviations between the two groups. Therefore, those at the Southside cemetery were eating an isotopically similar diet to those at Haslar, but with some consuming higher trophic level animals at Southside.

7.6.4 Mary Rose

Bell et al. (2009) took bone collagen samples from the mandibles or maxillae of 18 individuals. They had a mean $\delta^{13}C$ value of -19.4±0.3‰ (n=18 1σ) and ranged from -20.0 to -18.9‰, with a mean $\delta^{15}N$ value of 11.4±1.0‰ (n=18 1σ) and ranged from 9.1 to 13.3‰ (Table 7-3, Figure 7-9; Roberts et al. 2012). These data are consistent with a pure C_3 diet, with two individuals who likely had some aquatic food or higher trophic level terrestrial meat consumption based on their higher nitrogen values.

The *Mary Rose* and Southside Cemetery have almost identical means for $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$, but the carbon values are less variable for the *Mary Rose*. This suggests that those from the *Mary Rose* were eating a more uniform diet, and considering there were none with high $\delta^{13}C_{col}$ and $\delta^{15}N_{col}$ values, it is unlikely that they were eating large amounts of C_4 or marine foods, unlike some individuals from the Southside Cemetery.

7.6.5 Inter-site Comparisons

The $\delta^{13}C$ values from Royal Naval Hospital Cemeteries in English Harbour and Plymouth are significantly different from all other sites; though Haslar is not significantly different from the *Mary Rose* or Southside (p=0.296 and p=0.757 respectively) (Table 7-4c, Figure 7-9). Southside is also not significantly different from the *Mary Rose* (p-value=0.799). The $\delta^{15}N_{col}$ values from English Harbour are statistically different from all but Haslar (p=0.235) (Table 7-4d, Figure 7-9). The Southside Cemetery is statistically different from all but the *Mary Rose* (p=0.214).

Values from individuals of the *Mary Rose* are tightly clustered within a C_3 terrestrial diet, yet values in studies conducted after this medieval time period have been more variable. The diets from Haslar (Roberts et al. 2012) and the *Mary Rose* (Bell et al. 2009) are both consistent with this diet, exhibiting closely clustered low $\delta^{13}C_{col}$ and mid ranged $\delta^{15}N_{col}$ values. Plymouth (Roberts et al. 2012) exhibits more variability in $\delta^{13}C_{col}$ values, with few that are as low as those seen at Haslar, and there was a broad range of $\delta^{15}N_{col}$ values (Roberts et al. 2012). It is very interesting that large numbers of low trophic level terrestrial diets are seen in individuals from Plymouth. In Britain, there was limited access to meat or meat products for individuals from the lower class in Britain (Olsen 1999: 231-235), which would result in lower $\delta^{15}N_{col}$ values like those seen at Plymouth. Almost a quarter of the individuals from Plymouth have low $\delta^{15}N_{col}$ values (<10.0‰), and more than half of these were less than 20 years of age, so they would likely have been boys in the Navy at the time of their passing. Younger people would have been in the Navy for less time and therefore would not have had the time for their naval diets to change their bone collagen values, even considering higher bone turnover in children (Hedges et al. 2007). This suggests a very broad range of individuals coming together at Plymouth for treatment: lower class individuals, average naval sailors, and people with access to C_4 foods. However, the individuals did not have the strong C_3 terrestrial omnivorous diets seen at Haslar.

Southside Cemetery shows a mix of all walks of life seen at Plymouth and Haslar. We know that the diets of some from the Southside Cemetery vary from the estimated Royal Naval diet due to a number of factors including potential origin outside the British Isles, and access to different foods (like marine foods), that were otherwise not preferred in the British diet and not seen in large proportions in the naval diet.

This shift is also seen in values determined at English Harbour, and was in part associated with different ethnic origins (Varney 2003; Varney 2007). There were some dietary differences due to where the individuals were coming from. The European individuals buried at English Harbour had omnivorous C_3 terrestrial and slightly mixed C_3/C_4 terrestrial diets. Many of the African individuals did have a C_3 terrestrial diet, but some individuals exhibited agency in accessing non-European traditional C_4 foods, showing a mixed C_3/C_4 diet.

Roberts et al. (2012) said that the differences in diets from Haslar to Plymouth were due to more time spent in the Caribbean by those at Plymouth and therefore they had more time to have access to C_4 foods that were subsequently incorporated into their bone collagen. What is not considered is whether or not this is due to the origins of the sailors themselves. Many naval sailors would not have made a career of the Navy, but have been forced into or volunteered for the Navy during a war (Mercer 2006). This was mentioned by Roberts et al. (2012), but not clearly taken into consideration during their interpretation of the Naval Hospital Cemeteries data. Therefore, diets with C_4 foods may likely be explained by the sailors' origins, rather than the differences in the naval diet itself. This is something that needs to be further explored.

7.7 Conclusions

This thesis examined samples from the skeletal remains of 21 individuals uncovered in 1979 from the Southside Cemetery in St. John's, NL associated with the St. John's Naval Royal Hospital. Stable and radiogenic isotope analyses were supplemented with historical archival information to examine the life histories of those exhumed from the Southside Cemetery. A number of research questions were considered as part of this project. The thesis has advanced the understanding of the cemetery and the individuals that were uncovered, and enhanced our understanding of the activities of Royal Navy in Newfoundland during the late 18th and early 19th centuries. On a local level, the study has uncovered strong evidence to support the association of the Southside Cemetery to the Royal Navy and begun to reveal the lives of the naval sailors who served during the time of the 'nursery for seamen' in Newfoundland, yet have been forgotten to history. Within the context of the British Atlantic World, the geographical origins and dietary results have suggested that the Royal Navy brought together, through volunteers and impressment, a diverse group of sailors to live and serve within the Wooden World of the Navy.

Most of the remains examined were male, and there was an absence of young individuals in the sample. Their geographic origins according to $\delta^{18}O_{carb}$ and $^{87}Sr/^{86}Sr$ are mainly consistent with the British Isles. This is further suggested by the childhood diets that are comprised of mainly C_3 terrestrial foods that typically dominated the diet in the British Isles. An examination of contemporaneous Royal Naval vessel muster records suggest that the origins of most sailors would be England, with less so from Ireland, Scotland and Wales, and even fewer outside of the British Isles. The combination of sex and age distributions, stable and radiogenic isotopes, and information from the muster records strongly suggest that the individuals from the Southside Cemetery were associated with the St. John's Naval Hospital.

The $\delta^{18}O_{carb}$ data from those uncovered from the Southside Cemetery were compared to other samples from the Royal Naval Hospital Cemetery in English Harbour, Antigua, as well as to individuals from the medieval Royal Naval shipwreck the *Mary Rose* to understand the diversity of origins of these sailors. Origins suggested for those of the Southside Cemetery were similar to the *Mary Rose* (Bell et al. 2009), yet were more variable throughout the British Isles. English Harbour had some consistencies with England, but individuals were much more variable because of the inclusion of slaves and labourers of African ancestry who likely were born in the Caribbean or possibly in Africa (Varney 2003). The increased variability of origins in the sailors from the Southside Cemetery and particularly English Harbour compared to the *Mary Rose* can be understood within the context of a connected Atlantic World during the 18th and 19th centuries, where the medieval times of maritime exploration had been superseded by the vast and interconnected trade of commodities, and unfortunately people, that brought together a diverse group of people within the Royal Navy.

One of the objectives of this project was to examine whether the diets of naval sailors were consistent with that of rations, or if sourcing food in North America had created a more variable diet. The majority of individuals fit within what would be expected for someone consuming a standard Royal Naval diet. Not everyone from the

Southside Cemetery fit within this naval diet. When individuals from the Southside Cemetery were compared to contemporaneous civilian sites, there are those who overlap in terms of diets that would be expected from people living in North America, be it the Caribbean (Laffoon et al. 2013), colonial America (France et al. 2014; Ubelaker and Owsley 2003), or Newfoundland (Harris 2015). This is true for both childhood and adult diets. Yet, because some of these individuals from the Southside Cemetery are also not consistent with having originated in the British Isles, it begs the question of the reasoning for this variability being seen. While this variability may be explained by spending more time in a geographic location with access to C_4 foods while in the Navy, the more likely explanation for many is related to the location in which they lived. This can in part be explained by their childhood origins, as access to food in America with shifted isotopic values (C_4 and marine foods) would result in a different adult diet before joining the Royal Navy, as well as there not being enough time spent in the institution for their dietary values recording in the bone collagen to change.

While there were individuals from all Naval Hospital Cemeteries whose diets matched what would be expected from naval rations, just as those from the *Mary Rose* had, there was variability seen. Much of this variability was within the $\delta^{15}N_{col}$ values, suggesting different social classes, as well as some individuals that consumed marine foods. The inclusion of C_4 foods within diets, particularly seen at Plymouth can be explained by more time in the Caribbean or continental North America (Roberts et al. 2012). Whether this time was spent there while serving in the Navy, as suggested by

Roberts et al. (2012), or if it is associated with the normal diets of people living in North America for long periods of time, is a question that necessitates further research.

If we return to the concept of Newfoundland as a ‘nursery for seamen’, the data from the Southside Cemetery falls within this discourse, with men being pulled from the fishery to fill the ranks of the naval vessels (Mercer 2006; Mercer 2008). Direct evidence from these data includes those individuals who fall within the $\delta^{18}O_{carb}$ range for Newfoundland, and or diets closer to mixed marine foods. There were also a large number of individuals whose $\delta^{18}O_{carb}$ values are consistent with those of drinking water from West Country, England where the Newfoundland fishery was based out of and from where the fishery would have sourced their workers (Matthews 1968; Mercer 2008). Although it is not known how long these sailors served before they died, this data serves to support this notion. This is clearly not the only manner by which individuals who died at the St. John’s Royal Naval Hospital entered the Navy, yet it is important to the development of the island and the fishery of Newfoundland.

7.8 Future Work

This study has highlighted numerous deficiencies in our understanding of the history of the Royal Navy generally and within Newfoundland, as well as the ability of isotopic analyses to answer questions relating to diet and origins of individuals. Half of the surviving annual St. John’s Naval Hospital Muster records are yet to be analyzed, which may shed further light onto the changes of ailments afflicting naval officers over time. This is true as well for other Naval Hospitals globally, as it was common for vessels to come into port and admit patients; yet the illnesses, if infectious, were more representative of where they had been than where they were. Not only should the remaining decade of records from the St. John's Naval Hospital be examined, but comparative studies at the other hospitals would be useful to determine how disease may have affected sailors differently throughout the Atlantic World. It would be interesting to test if this change in frequencies of diets occurs globally or if it was a local phenomenon, also if the frequencies of ailments by ranks were not different abroad as well. It would be useful to examine the diets of the patients to see how much it differed from the naval rations by examining the food stuffs bought quarterly and recorded within the muster records from the St. John's Naval Hospital. This would be direct evidence of how naval rations may have differed in North America, but within the context of healing.

A main limiting factor to this study was the lack of comparative isotopic data that might better situate this project within the British Atlantic World. Although differences within the diets of those buried at the Royal Naval Hospital Cemeteries in England and the Caribbean have previously been studied (Varney 2003; Roberts et al. 2012), it is not possible to correlate differences with any certainty to different experiences with the rations of the Navy due to the unknown length of service for these individuals. One possible way to partially mitigate this is to look at the origins of individuals within the Royal Navy and to compare differences in diet with differences in origins. For example, restricting comparisons to individuals of similar ages, with similar geographic origins, would allow more insight to try to explain dietary discrepancies to the Naval rations.

Another challenge was related to the absence of a faunal baseline of early modern diets, which would allow us to better interpret data from this time period. Finally, more work needs to be done on practical applications of increased $\delta^{18}O_{carb}$ values suggested by Brettell et al. (2012). Although in theory brewed alcohol and long simmered stews could significantly influence $\delta^{18}O_{carb}$ values, it is not known if this can be seen in the isotopic values of individuals and if so by how much. Such a study would be able to better tune where individuals were originating from within the British Isles.

There is more to learn about the Southside Cemetery itself, including the question of its physical boundaries. At some point in the future, the city of St. John's will need to update or repair the sewer that originally cut through the cemetery in 1979, and it would be useful for everyone involved to know where the remains are to help protect the site. Some form of survey, such as ground penetrating radar, should be conducted to delineate the cemetery's boundaries to mitigate further disturbance of the site.

The time period of the individuals from Southside Cemetery correspond to the timing of increasing lead exposures associated with dietary exposures. Little is known about how sources of lead differed from England to the colonies, and how it varied within the Royal Navy and North America in general. In this project, the absence of good baseline data for $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$, and $^{87}Sr/^{86}Sr$ isotopes complicated interpretation and the determination of diet and origins without a baseline from England, yet there exits good baseline information on lead isotopes from Britain (see Budd et al. 2004; Millard et al. 2014; Montgomery et al. 2000; Montgomery et al. 2005; Montgomery et al. 2010).

Developing a better understanding of lead contamination in skeletal remains may yield more information of the movement and origins of these individuals.

This study has added to the small but growing literature on historic archaeological isotopes. Deficiencies in the ability of isotopes to answer questions related to Royal Navy diet have been highlighted. Few studies look at origins of naval sailors using historical documents and this is the first to do so isotopically. It has identified the probable association of the Southside Cemetery to the Royal Navy, while still identifying local individuals within a geographically disperse institution. It was lamented at the time of the remains' exhumation that history had forgotten who these people were. Isotopic analyses and archival research has begun to tease out the stories and life histories of these sailors that had been lost to time.

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