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Demography and the Evolution of Logistic Organization on the Northern Northwest Coast Between 11,000 and 5,000 cal BP

by

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A thesis submitted in partial fulfillment of the
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Anthropology

Thesis Committee:
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ABSTRACT

Focusing on the relationship between demography and sedentary behavior, this thesis explores changes to mobility strategies on the Northern Northwest Coast of North America between 11,000 and 5,000 cal BP. Drawing on a regional database of radiocarbon dates, it uses summed probability distributions (SPDs) of calibrated dates as a proxy for population change, in combination with syntheses of previously published technological, paleo environmental and settlement pattern data to test three hypotheses derived from the literature about the development of logistic mobility among maritime hunter-gatherers on the Northern Coast.

In all, each of the hypotheses proposes that early peoples on the coast were foragers that utilized high levels of residential mobility, who later adopted collector (logistic) strategies. Two of the hypotheses emphasize the role of population growth and/or packing and resource distribution in this transformation, while the third emphasizes population replacement. Other issues addressed within this thesis are whether or not the forager-collector continuum, as it is used for terrestrial hunter-gatherers, can be applied to those in aquatic settings. Also explored, is the question of whether the available data is sufficient for making and/or testing claims about early mobility patterns in the region.

The results of the demographic models suggest that while population levels were volatile, volatility declined through time and that there is no significant trend in either growth or decline of overall population levels throughout the region. This thesis also

confirmed that significant changes to mobility, as evidenced by the emergence of semi-sedentary to sedentary living, begin to appear by ~7,000 cal BP. However, there appears to be little, if any correlation between the advent of more sedentary and logistic behavior and any of the variables tested here. Thus this author suggests, in agreement with Ames (1985; 2004) and Binford (2001) that the distribution of resources and labor organization needs within aquatic environments are sufficient without any other drivers for the development and intensification of logistic mobility.

The principle analytic contribution of this research comes from the demographic modeling that relied on the construction of summed probability distributions. Though these methods have become commonplace in other settings (namely Europe), this thesis presents the first application of these methods within the time period and region covered. Moreover, this research is one of the only of its kind to address demographic histories within coastal landscapes that utilizes both marine and terrestrial ^{14}C samples. In order to explore possible biases within the database, comparisons of marine and terrestrial SPDs were made between sub-sections of the region (i.e. Haida Gwaii, Southeast Alaska and the Dundas Islands).

Though patterning between each of these areas was consistent, these comparative methods revealed an unexpected finding; a massive population crash throughout the region that began between ~9,000-8,800 cal BP and lasted till around 8,400 cal BP. Importantly, this crash was witnessed within all of the individual sub-areas and within SPDs made from both the marine and terrestrial ^{14}C samples, though the reasons behind this collapse and verification of its existence require future research. However, finding

this collapse at all further highlighted the need for use of correctly calibrated ^{14}C dates, as the gap in ^{14}C dates effectively disappears when using uncalibrated dates, which has been a longstanding tradition within Northwest archaeology.

ACKNOWLEDGEMENTS

This thesis is dedicated to my parents; my mom, Judy Sarvis, my dad Mike Brown and my stepfather Bruce Sarvis.

This work and completion of this thesis would not have been possible without help and support from a multitude of people and institutions. I want to say here that my family is amazing, they have helped me in every way imaginable, and I could write a whole chapter just on my appreciation for them. They were all thanked in person, but are not included here because there is simply not enough space to thank them properly and they know what they mean to me.

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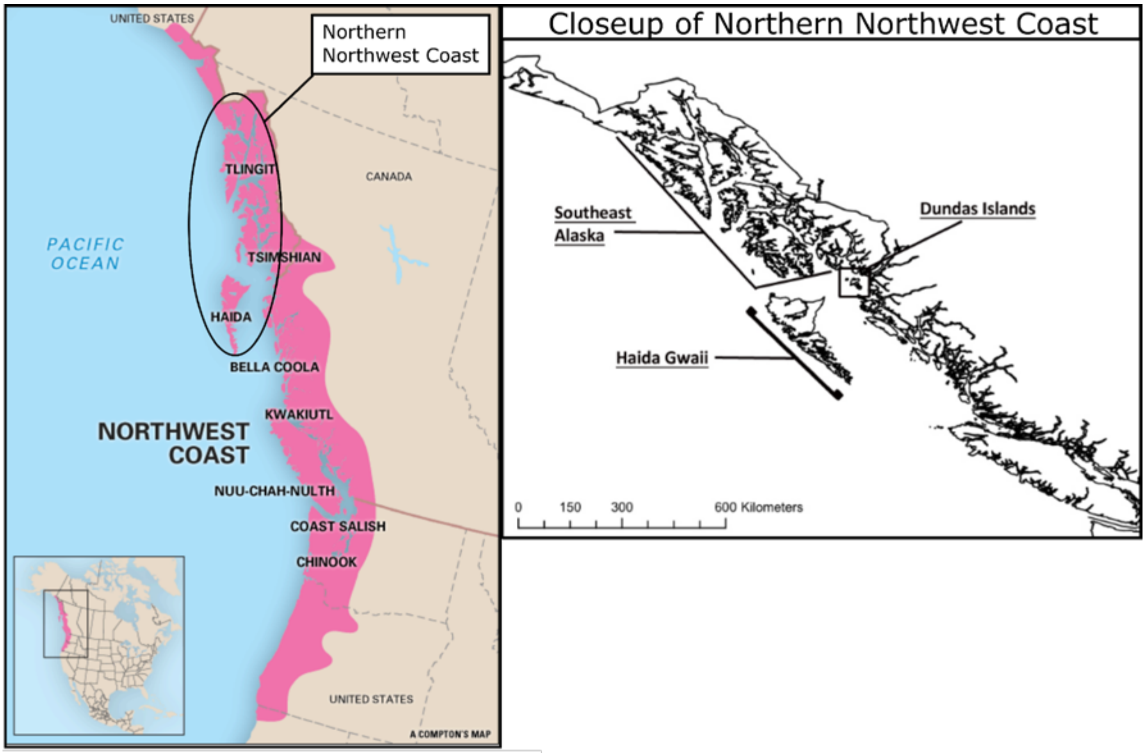
CHAPTER 1: INTRODUCTION

This thesis examines mobility pattern dynamics between ~11,000 and 5,000 cal BP on the Northern Northwest Coast of North America, with an emphasis on the relationship between the beginnings of sedentary behavior and demography. Using demographic modeling with radiocarbon (^{14}C) dates as data in combination with syntheses of previously published analyses on paleo-environmental, settlement pattern and technological data from the region, this thesis evaluates test implications derived from three hypotheses regarding the development of logistic strategies on the Northwest Coast. I use the term logistic and forager strategies as defined by Binford (1980), whereby, broadly speaking, people practicing logistic movement bring resources to the residence and people practicing forager strategies move their residence to resources (see section 2.2 for a more detailed discussion)

The study region (see figure-1), extends from Yakutat Bay in Southeast Alaska to the Southern tip of Haida Gwaii (formerly the Queen Charlotte Islands). It is part of the northern sub-region of the Northwest Coast culture area (Suttles 1990: 5-11). The Northwest Coast culture area as traditionally defined by anthropologists extends from Icy Bay in Southeast Alaska to Cape Mendocino in northern California (Suttles 1990; Ames 1994). The interior boundary of the northwest culture area generally follows the crests of various mountain ranges that parallel the coastline, starting with the St. Elias ranges in Alaska and extending south through the Cascade mountain range in Oregon (Suttles 1990: 1) (see figure-1).



Map/Still.*Britannica Online accessed July*.2016.

Figure 1: The Northwest Coast culture area (light color) with northern subarea circled; Language groups labeled. Study areas used in this thesis highlighted in the panel on the right.

The evolution of collector strategies among aquatic hunter-gatherers between 11,000-5,000 Cal BP is an important archaeological issue worldwide (see Jerardinoa 2012; Milner et al. 2007; Alvarez et al. 2011; Gutierez et al 2011; Habu et al. 2011; Orquera et al. 2011; Wagner et al. 2011; Goncalves et al. 2014), but is especially pertinent for the Northwest culture area, where aquatic resources and collector strategies are usually linked to the advent of social, economic, and political complexity in the Mid to Late Holocene among hunting and gathering peoples. While Logistic mobility and socio-political complexity are usually thought to be organizational responses to Middle Holocene environmental changes (~5,000 cal BP), authors have linked these variables in different ways (see Ames 1994, 1998, 2005; Fladmark, 1975; Ames and Maschner, 1999; Prentiss and Chatters, 2003, 2005, 2007; Matson and Coupland, 1995: 191). In contrast, Moss (2007: 500-501; 2011: 94) contends that the development of social and organizational complexity was independent of environmental change. While the exact causal mechanisms of social complexity are debated, most of these authors agree that the development of logistic mobility is a necessary if not solely sufficient precondition for the inception of social complexity (e.g. Binford 2001; Rowley-Conwy 2001, papers in Fitzhugh and Habu 2002; Prentiss and Chatters 2003). However, despite this crucial theoretical connection, little research has been devoted to the development of logistic mobility on the northern coast. Rather, these relationships are assumed without systematic evaluation (Ames 1985, 1994; 2005, 2013; Moss, 2007, 2011; Martindale et al. 2010), likely because, until the last decade, there was very little data against which to evaluate the various hypotheses.

Over the past 10 years or so, accumulating data (e.g. McLaren 2008; Archer 2011, 2013; Carlson 2012; Martindale et al. 2010) suggest north coast settlement and mobility patterns from 11,000-5,000 cal BP changed much more than originally believed. Prior to this recent research (see also; Martindale et al. 2009, 2010; Carlson and Baichtal 2015) it was suggested by some authors (see Coupland 1998; Moss 2007, 2011; Yesner 1998; Matson and Coupland 1995), that a change from high to low residential mobility and a developed maritime economy did not become widespread on the coast until after 4,500 cal BP. However, because data from this time period was so sparse, consisting of about dozen sites, only about half of which had any real excavations, it was impossible to say anything except that people had low residential mobility after 5,000 Cal BP (see Moss and Erlandson 1995; Ames 1994, 1998; Ames and Maschner 1999).

However, with the discovery of very early villages on the Dundas Islands (Martindale et al. 2010), a permanent residential structure on Lucy Island (Archer 2011, 2013) and relatively recent data from systematic surveys of Haida Gwaii shorelines (e.g. Fedje et al. 2011) it is becoming clear that settlement and mobility patterns were likely more complex than previously realized. Utilizing these newly available data, this thesis examines the evolution of mobility and settlement strategies on the North coast and compares these findings to various hypotheses regarding the timing and causes for the development of logistic organization.

As a conceptual framework for interpreting and analyzing settlement patterns and mobility strategies, I use Binford's (1980) Forager and Collector continuum (see section 2.2 for description). For the purposes of this thesis, I use settlement pattern to mean where people place their residences and the level of investment put into sites (e.g. how often visited, and size/abundance of sites). In my usage, this is distinct from mobility patterns, which refer to the frequency, magnitude and organization behind *how* people move across the landscape

Using this newly available data I evaluate three hypotheses for the development of logistic mobility (discussed in more detail below). The first, by Binford(1990, 2001). Who, emphasizes the importance of aquatic resources and population stress in the adoption of increasingly logistical strategies, .The second hypothesis is derived from a series of publications by Prentiss and Chatters (Chatters 1995; Prentiss 2005; Prentiss and Chatters 2003; Prentiss and Kuijt 2004; Chatters and Prentiss 2005; Prentiss 2009; Prentiss et al. 2014), who take a macro-evolutionary approach, arguing that punctuated changes within environmental regimes decimated existing foraging strategies, and selected for logistic ones across the coast. Lastly, I evaluate Ames' hypothesis (2002, 2004), who argues that more intensive collector strategies developed out of the complex labor organization necessary to efficiently exploit resources that were highly disjointed in time and space on the northern coast.

1.1: Thesis Structure and Outline

Chapter 2 is divided into three major sections intended to give the reader the necessary archaeological and theoretical backgrounds to understand and contextualize the arguments being made and evaluated throughout this thesis.

In chapter three I describe the data available to test the hypotheses and the methods employed in subsequent chapters.

Chapter four describes the results of the demographic modeling and then provides the summaries and interpretations of the available settlement pattern, environmental and technological data.

Lastly, chapter five first discusses how the results fit each of the hypotheses presented; emphasizing what aspects of each hypothesis can be corroborated or invalidated with the data at hand. I then explore what *can* be said about mobility and settlement pattern change between ~10,000-5,000 B.P. And provide my own interpretation of the analyses. Needs for future research are then addressed.

CHAPTER 2: BACKGROUND

2.1: Introduction

In this chapter I briefly summarize the archaeological and theoretical information necessary to understand the hypotheses and data used throughout this thesis, while also contextualizing the research within broader regional research. First, I provide a detailed review of the forager and collector framework. I place special emphasis on describing how hunter-gatherers who exploit aquatic resources differ from the traditional (largely terrestrially based) forager-collector model that is more familiar.. The term aquatic, as it is used throughout the rest of this thesis, follows Ames' (2002) usage, referring to hunter-gatherers that are largely reliant on water and water craft for their subsistence, transportation and other resources. This term, as I use it, is purposefully broad and makes no distinction between people who utilize riverine, littoral, or open ocean resources.

2.2: Foragers and collectors

Foragers and Collectors are terms that refer to the idealized ends of a conceptual spectrum, and are defined by the *type* of mobility strategy people employ. Based on descriptions from Binford (1980) and Kelly (2007: 115), I define mobility strategy as how people organize the movements of groups, individuals and their residences to exploit various resources. Binford's (1980) forager and collector concepts are used to describe and categorize variation in mobility organization. At the most fundamental level, foragers move their residence to resources and collectors move resources to their residence. However, these are not truly categorical distinctions and no group is ever 100% collector or forager. Therefore, while we categorize people as foragers or collectors, what we are actually doing is referring to a ratio of the behaviors, i.e. they procure resources in a collector-like fashion 70% of the time and like foragers the other 30% of the time. Furthermore, Binford (1980, 2001) did not envision these mobility strategies as static states, but as fluid, conscious strategies that were adaptive under different conditions.

Collector strategies are seen as being adaptive when various critical resources are spatially and temporally disjunct (usually in places with high-seasonality such as temperate or arctic areas), meaning that critical resources are available at the same time but in different places, which creates scheduling conflicts where, in order to get all necessary resources, people need to be in numerous places at the same time. This kind of resource distribution makes moving residences to resources inefficient because as you move closer to one resource you move yourself equally far away from other resources. Moreover, because many different resources must be collected in a finite amount of time, moving residence to one resource increasingly constricts the availability of another critical resource. Collector strategies solve these scheduling problems by *not* trying to move residences and large groups of people and instead sending out specialized labor or task-groups to each of the critical resources. This ensures that the cost of mobility remains as low as possible while also making sure that each of the needed resources are extracted.

On the other hand, forager strategies are seen as being adaptive when resources are temporally and spatially homogenous, meaning critical resources are all available in the same space and at the same time or sequentially through time. Usually this kind of resource distribution is found in warmer places such as tropical areas that have low-seasonality. Because environments, in which resources are homogenously distributed do not have the same inherent scheduling problems as those mentioned above, maximum efficiency and risk mitigation are best achieved by moving residences to new resource patches whenever necessary (Kelly 2007).

It is important to note though that regardless of any specifics, the decision to be more or less residentially mobile is simply, at its core, an evaluation of whether it is more cost effective to move people to resources or resources to people. Therefore, while forager and collector strategies often coincide with the differing environments, the environment itself is not necessarily causally related to forager or collector strategies. *Anything* that changes variability in access to resources can cause people to adopt different mobility strategies, including social and demographic factors. In other words, it is not the variability in the resources themselves but variability in access to them that makes either of these strategies adaptive. This distinction is critical to keep in mind for the discussion of aquatic hunter-gatherers below.

2.3: Aquatic Foragers and Collectors

The need to distinguish between aquatic and terrestrial hunter-gatherers when discussing foragers and collectors is necessary, as many of the environmental, resource and mobility pressures that face terrestrial hunter-gatherers cannot be generalized to aquatic environments, whose attributes are often quite distinct from even immediately adjacent terrestrial biomes (Binford 2001: 461; Ames 2002: 47; Fitzhugh 2002). However, at the conceptual level there is no difference between terrestrial and aquatic foragers and collectors. Cost of mobility and variability in access to resources are still the primary determinants of mobility strategies (Binford, 1990).

The major differences then between aquatic and terrestrial mobility strategies arise from the nature of the aquatic resources themselves and access to them. The magnitude of these differences is especially pronounced in northern latitudes in areas that are heavily forested, such as the coastal Pacific Northwest of North America, as these areas have much poorer terrestrial productivity than southern latitudes (Binford 2001: 83, 166-168). In regards to the nature of the resources themselves, aquatic resources differ in two primary ways from terrestrial ones; (i) aquatic resources tend to be highly clustered, and these clusters are often widely dispersed unevenly in space, which effectively creates a heterogeneous environment (Binford 2001: 368) and (ii) aquatic biomes typically support much higher levels of species and habitat diversity per unit of area than terrestrial ones. This is especially true in areas like the northern pacific coast, where the complex crenulated coastlines create multitudes of productive micro-environments in relatively small areas (Yesner 1980; Binford, 2001: 167, 366-369). Additionally, while individual aquatic resources may vary considerably in their seasonal availability and abundance (e.g. Herring or Salmon), the relatively high biodiversity in aquatic biomes typically means that significant amounts of subsistence resources are available year-round in the same general area (Yesner 1980; Binford 1990).

In addition to differences in the nature of the resources themselves, there are significant differences in access between terrestrial and aquatic resources. The first is that access to aquatic resources tends to be much more spatially restrictive than access to terrestrial resources (Yesner 1980; Binford, 2001: 167, 366-369; Fitzhugh 2002: 258). This is because, in part, there is often much less *coastline* than there is inland area, thus there is simply less space to be utilized. Further restricting space, is the fact that not all places on a coastline are created equal in regards to providing access to resources. For example, much of the coastline on the north coast can be made up of steep rocky cliffs, severe slopes, and may not have any place for people to effectively launch or dock boats at (Yesner 1980; Binford 1990, 2001: 167, 366-369; Fitzhugh 2002: 258). This issue of finding a suitable location is further exacerbated by the uneven clustering of aquatic resources, which means that usable coastline is first filtered by the actual existence of a resource cluster and then filtered again by the physical properties of the coastline in that area. In effect, this means that suitable residential locations in aquatic environments tend to be rarer and much more circumscribed than in terrestrial contexts (Yesner 1980; Binford 2001: 167-169).

Furthermore, in the case of aquatic hunter gatherers who rely on marine (open water) resources, the effectiveness of using residential mobility to access these resources is heavily mitigated by the fact that people cannot move their residences into the ocean itself. Thus all people can do is move residences along a coastline, which does little if anything to actually increase access to off-shore resources (Binford 1990, Binford 2001). This may seem obvious, but the implications for this kind of resource distribution effectively canceling out many of the benefits for residential mobility and *forcing* some level of logistic procurement should not be understated.

The combined effect of the qualities discussed above is that they greatly reduce the use of residential mobility as a productive strategy, by both reducing the incentive of moving (i.e. resource shortfalls are less likely in aquatic biomes due to the relatively high bio-diversity and year-round availability) and limiting the payoff of moving (i.e. residential moves do not increase access to resources that would be otherwise unavailable). As (i) the clustered and unevenly dispersed resource distribution of aquatic resources means that moving residence to one cluster puts you equally far away from another resource cluster; (ii) the year-round availability and high biodiversity of aquatic biomes means that residential locations can be utilized for longer durations, and therefore the number of moves necessary is reduced; (iii) even if a group wanted to move, suitable locations for doing so are often much rarer and widely separated, thus the cost of moving is high; and (iv) because marine resources cannot be moved to directly and because of the aforementioned uneven distribution of other resources, moving residences is largely ineffective for mitigating resource shortfall. This is because any resources available after the move are often the same or equal to those available prior to the move.

Therefore, people who exploit aquatic resources have much more circumscribed areas in which to place and move their residences and are forced to bring resources back to their residence as opposed to moving residences to resources (Binford 1990, 2001: 370), thus necessarily use some level of logistical organization. As Yesner (1980) and Binford (1990) observe, this creates a pattern among aquatic hunter gatherers of 'tethered' resource procurement and results in their using much less of the total landscape than terrestrial hunter gatherers, while spending considerably more time in the places they do use. Due to this restricted nature of suitable residential locations, aquatic hunter-gatherers can also be expected to revisit the same sites with much more regularity and frequency than terrestrial hunter-gatherers do. It should be noted here that the use of boats essentially intensifies this effect. Because, as mentioned above, needing to find locations favorable to boat access further restricts potential residential sites. Furthermore, boats also allow people to transport resources in bulk quantities, and more efficiently make long distance resource forays. Together, these qualities increase the relative effectiveness of logistic resource procurement, and overall make it easier to move boats to resources and back rather than the wholesale moving of residences to resources.

Further pushing aquatic hunter-gatherers towards logistic organization is that while terrestrial hunter-gatherers do not necessarily have to use aquatic resources, aquatic hunter-gatherers, even if they receive all of their subsistence needs from aquatic sources, often still rely on terrestrial or inland landscapes for various resources such as raw materials for clothing, tools, etc. Because is often difficult (if not impossible when utilizing near ocean resources) to place residences in both aquatic and inland landscapes, this further creates a disjuncture in resource availability that must be coped with by aquatic hunter-gatherers and typically results in less residential mobility and increased use of logistic forays (Binford 2001: 279).

Archaeologically, the ‘tethered’ behavior and consistent reuse of areas expected among aquatic hunter-gatherers tends to create much larger and continuous palimpsests than are typical for similar (or even much larger) terrestrial groups (Binford 1990). In fact, this behavior means even relatively small populations can leave behind considerable accumulations of archaeological material (Binford 1990).

Aside from the nature of the resources themselves and the physical issues of accessing them discussed above, another restriction to access that disproportionately effects aquatic hunter-gatherers is technological in nature. For example, outside of accessing various littoral resources (discussed below) exploiting and intensifying aquatic resources generally requires greater tool-kit complexity and diversity (Binford 2001: 369, 391-392; Yesner 1980). There are also minimum technological thresholds necessary before exploitation of aquatic resources can begin at all (e.g. boats) (Binford 1990, 2001: 368). This fosters an increased level of task specialization among aquatic hunter gatherers and often necessitates some level of task-specific groups (Binford 2001: 388-392; Yesner 1980).

This demand on technological and task complexity and specialization derives from two major qualities of aquatic resources: 1) people *need* specialized equipment, such as boats or suitable fishing line/pole, to even access useful quantities of aquatic resources, much less effectively procure them and 2) significant differences in the behavior and habitats among aquatic animals make capture technology much harder to generalize (Binford 2001: 390-392; Yesner 1980). For example, a bow-and-arrow is sufficient to exploit an extraordinary range of terrestrial animals ranging from bears and deer to birds and rodents. However, just to exploit various fish species, different kinds of poles, nets, leisters, etc. can be required, not to mention the different kinds of bait, lines and weights necessary to procure different species. This does not even take into account the wide array of different equipment needed to exploit sea-mammals (e.g. various harpoons and boating technology) (Binford 2001: 388-398).

However, there are a couple significant exceptions to this rule, namely tidal and shell fish resources, which require little if any specific technologies or task organization. Indeed, as Lyman (1991: 76) notes; little technology at all (such as boats) is needed to exploit littoral resources. However, while I acknowledge the analytic importance for the distinction between littoral and open ocean resources, because the earliest peoples studied here are already demonstrated to have already been using boating technology and taking open ocean resources by ~11,000 cal BP, my discussion lumps littoral and open ocean habitats together, unless specifically noted otherwise.

As Ames (2002: 46) has noted, many of the traits associated with terrestrial collectors (e.g. task specific camps) may not be as apparent among aquatic collectors, because they often cannot field process (cannot field dress animals on a boat in the middle of the ocean) and the extra transport capability provided by boating technology allows people to bring resources back to the residence to process. This means that aquatic collectors may leave fewer, but perhaps more obvious archaeological signatures across the landscape. Because it can be expected that less field processing may be taking place, we may also expect to find evidence for a higher diversity of activities at residences among aquatic collectors (Ames 2002: 44). This expectation is further bolstered by the fact that logistic camps, with tool or raw material caches typical among terrestrial collectors, (Binford 1980) cannot be made to facilitate the harvesting of open water resources, as tool/equipment caches cannot be left in the middle of the ocean. Even for riverine resources, where logistic camps can be placed proximally, the use of boats, also mitigates the effectiveness of caching at logistic camps, as people can simply take their gear with them.

To summarize the points above, the major differences between aquatic and terrestrial hunter-gatherers that are salient to this research are:

1) Aquatic resources are usually more patchily distributed, creating more scheduling conflicts than is usual for terrestrial contexts.
2) Access to aquatic resources is often more spatially restricted, resulting in much more intensive use of fewer places on the landscape.

3) Technologies for exploiting aquatic biomes usually are more complex and diverse
4) Residential mobility is overall much more constrained in aquatic contexts, because there are fewer options for residential movements and because of the more disjunct nature of aquatic resources, moving residences rarely solves scheduling problems in resource availability.
5) Aquatic hunter-gatherers using boats, may leave fewer logistic camps, because (i) field processing of open ocean resources is difficult and (ii) because the bulk transport capability of boats makes investing in logistic camps less necessary since processing can be done back at the residence.

These points illustrate why aquatic hunter-gatherers are almost always much less mobile than their terrestrial counterparts, and why they must adopt some level of logistic organization as a way to cope with their constraints on mobility and the nature of their resources (Binford 2001: 278-279; Yesner 1980). This is also why, as mentioned above, Binford (2001: 270-280) suggests that aquatic hunter-gatherers be viewed as moving along a continuum of more or less use of logistic organization, as opposed to the forager to collector spectrum. Overall, Binford (2001: 279) believed that the critical theoretical difference in using the forager and collector concepts for aquatic hunter gatherers was that people who rely primarily on aquatic resources probably *cannot* be true foragers. Therefore, it may be more appropriate to think of aquatic hunter gatherers as existing along a continuum of collector-like behavior.

It is important to note though, that conceptually speaking, there are no fundamental differences in the rules that govern mobility strategies between aquatic and terrestrial hunter-gatherers. At its core, the basis for being a collector or a forager is always about (i) solving problems of disjunction in availability of resources and (ii) whether or not it is more effective to move resources to residences or residences to resources (Binford 1980, 1990, 2001; Kelly 2007). Therefore, the above generalizations should not be seen as re-writing or re-interpreting the forager-collector spectrum, it is simply meant to show how aquatically oriented hunter-gatherers face resource distribution problems and are more constrained in their solutions to them, than is often the case for terrestrial hunter-gatherers.

At this point, it is important to emphasize that (whether implicitly or explicitly) many authors often use the generic term, ‘collector’ to mean very different things. Using Binford's (1980, 1990, 2001) original framework, collectors are *defined* by their use of logistic strategies; thus they were basically interchangeable terms. However, in many cases, authors (e.g. Prentiss and Chatters) have used the term collector to imply a very specific suite of traits (i.e. storage, permanent villages, etc.), even though Binford (1990) vehemently denies that storage is necessary for collector strategies or that storage is absent among foragers. Therefore, to avoid confusion or misrepresenting the intent of authors, from this point forward in the thesis I use "Logistic strategies" and "collector" strategies. "Logistic strategies" will refer to the mobility strategy itself, and "collector" will refer to a suite of traits (e.g. permanent housing, storage, complex social organization, specialization, etc.).

2.4: Geography of the Northwest Coast

This section describes the geographic boundaries of the Northwest Coast culture area in order to contextualize the position of my research area. Furthermore, as the aquatic hunter-gatherer discussion above explains, many of the unique characteristics of aquatic hunter-gatherers are attributable to how resources are structured in aquatic contexts. Therefore, it is helpful to briefly review some of the geographic features of the north coast and how they differ from other regions of the Northwest Coast.

The Northwest Coast region extends from Icy Bay on the Yakutat peninsula in Southeast Alaska to the Chetco river in Southern Oregon (Suttles 1990: 16), and is usually divided into three major sub-regions: the Northern Coast (from SE Alaska to the southern end of Haida Gwaii), the Central Coast (from the southern end of Haida Gwaii to the U.S./Canadian border) and the Southern Coast (the coastlines of Washington, Oregon. The interior extent of the Northwest coast region is largely defined by mountain ranges paralleling the coast. These are the St. Elias and Coast Ranges in Alaska and British Columbia and the Cascade Mountain Range through Washington and Oregon (Suttles 1990: 16).

There are significant topographic differences along the Northwest coast that are particularly pronounced between the North and the Southern coast that produce meaningful differences in resource structure and availability. The North and Central coast (my study area) have crenulated and complex shorelines composed of many archipelagos and fjords. This complexity creates a high density of bays and estuaries that are protected from heavy ocean swells and which support many, productive microenvironments within relative small areas. On the other hand, the southern coast (mostly the coastlines south of

Puget Sound in Washington, Oregon and Northern California) has straight, exposed coastlines with little protection from ocean swells and winds. These coastlines lack the diverse microenvironments of the north coast, and overall support a much less productive marine habitat. Productive resources patches were more clustered on the southern coast, but rarer and highly dispersed than on the northern coasts.

2.5: Archaeological Background of the Northwest Coast

Though this study focuses on the development of logistic mobility and collector strategies on the Northern coast, answering this question has been a concerted focus for archaeologists all across the Northwest coast (NWC) (See Prentiss and Kuijt 2004, 2012; Ames 1998; 2004; Moss 2007, 2011; Matson and Coupland 1995; Ames and Maschner 1999). Therefore, it is necessary to review a basic sequence mobility patterns across the entire (NWC). The sequence is generalized and neither reflects local histories nor captures the variability across the Northwest Coast. Rather, it places my specific research within the context of regional-scale changes in mobility strategies.

The traditional view of mobility and settlement pattern history on the Northwest Coast, which has never been rigorously evaluated, has been broken into three major periods with high residential mobility peoples during the earliest period and then a transition to a poorly understood mobility strategy that appears much more sedentary, and lastly the appearance of ‘classic’ collector strategies and low residential mobility in the later periods.

The period between ~11,000-5,700 cal BP has been characterized by high residential mobility (forager), with relatively small populations who invested little in permanent structures and left relatively small and discontinuous assemblages at sites

(Ames 2003). These early sites also show a focus on living in ecotones near bays, estuaries, lakes and rivers (Ames and Maschner, 1999; A. Mackie and Sumpter 2005). Subsistence is characterized as wide ranging, with people utilizing the full range of available fauna (probably flora as well) to some degree (Ames and Maschner, 1999: 42-48). Although regional variation in subsistence practices is apparent along the coast; analyses of artifact and faunal assemblages at early sites such as Kilgii Gwaay (Fedje et al 2005: 200-203), Namu (Carlson 1995; Cannon 2000) and Glenrose Cannery (Matson 1996: 112-118) show that these differences are superficial when variability in environmental conditions and resource availability are taken into account. Therefore, differences in early coastal assemblages probably reflect regionally specific adaptations instead of fundamentally different cultural traditions or places of origin (Ames and Maschner, 1999: 66-68; Carlson 1996; Matson 1996: 115-118; Matson and Coupland 1995: 81).

Around 8,000 cal BP microblade technology almost completely replaces bifacial technology on the Northern Coast, while on the southern and central coasts bifacial technology undergoes a significant decline around 7,000 cal BP. However, this decline in in bifacial technology does not coincide with an equivalent increase in microblade technology, as on the north coast. After 7,000 cal BP, there is a significant but poorly understood regional diversification of technologies, that is most pronounced on the southern and central coasts, where diversification of form/style of bifaces increases considerably between regions (Carlson 1996: 3-10; Ames and Maschner 1999). These localizations of technologies and the replacement of bifaces by microblades are probably indicative of important changes to mobility and settlement patterns, even if what those changes were are hard to infer from the available data.

Since 1975 (Fladmark 1975) archaeologists, have viewed the period between 5,700 and 3,500 Cal BP as transformative, when, at least in some places, residential mobility significantly declines and investment in residential sites begins to increase substantially (e.g. Ames and Maschner 1999; Matson and Coupland 1995). However, others such as Moss (2011) and Moss et al. (2007) contend that timing of these changes is more apparent than real. These authorsuggests that sea-level change is responsible for the apparent changes in settlement and mobility patterns following 5,700 cal BP, by masking continuity with earlier patterns. They also argue that firm evidence for substantial changes in mobility and settlement patterns (i.e. large shell-middens) actually appears much later, around 4,300 cal BP. However, while keeping in mind Moss' and others critiques is important, we cannot evaluate hypothetical data that has been lost to sea-level change. And while very large shell-middens and perhaps region-wide evidence for significant changes to mobility and settlement patterns may not happen until later, there are many sites that indicate substantial changes were taking place between 5,700 and 5,000 cal BP.

Outside the North Coast area (covered in more detail later), the beginning of this period is marked by the first substantial evidence for large scale dwellings, intensive processing camps, significant storage facilities and an overall much more sedentary lifestyle. Significant sites for this period include the Maurer (~5,000 Cal BP), the Hatzic Rock (~5,700 Cal BP), the St. Mungo Cannery site (~5,000 Cal BP) and The Katzie site (~ 5,300 Cal BP). It is also possible that the Namu site on the Central Coast of British

Columbia may also represent a shift to sedentary behavior as early as 7,000 Cal BP (Cannon and Yang 2006), but is not discussed here because of debate over the evidence (see Monks and Orchard 2006). All of these sites (excluding Namu) are located along the Fraser River in British Columbia. The Katzie and St. Mungo Cannery sites are located in a near coastal setting, while the Maurer and Hatzic Rock sites are located further inland on the Lower Fraser valley.

The Maurer and Hatzic Rock sites both contain remains of semi-subterranean, post and beam houses that are ~7 x 11m in size (Mason 1994; Schaepe 2003), and show considerable investment, indicating that they were intended to be permanent or semi-permanent structures (Schaepe 2003: 145-150). This is attested to especially well at the Hatzic Rock site where there was evidence for multiple rebuilding episodes (Mason 1994: 113). As expected for sedentary to semi-sedentary sites, they also exhibited bulky pieces of site furniture, such as stone anvils, large hearth complexes and extensive use of expedient tools made from local sources (Mason 1994: 90-92, 101, 113; Schaepe 2003: 145-146). The St. Mungo Cannery site (Ham et al. 1986) is much less discussed than these others, but is interpreted as a small fishing village (>4 houses present), that was seasonally occupied in ~2 month intervals over 1,000 years.

While all of these sites are interpreted as representing at least semi-sedentary behavior (Mason 1994: 101-113; Schaepe 2003: 152), it is hard to say exactly what kind of mobility strategy was employed by the people living at them. These sites appear relatively isolated compared to the large villages that appear later[1]. Though, the similarities between the newly reported Katzie site (discussed below) and the St. Mungo

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[1] However, at both sites evidence was found that indicates there may have been one or more contemporary stuctures associated with these houses (Mason 1994: 39; Schaepe 2003: 147).

Cannery site opens interesting questions regarding the extent of these patterns. These sites also lack definitive storage features and there is insufficient faunal data to determine seasonality of occupation at Maurer and Hatzic Rock (Mason 1994: 124). Therefore, it is possible that these sites represent a form of tethered or serial foraging, with weak logistic organization as is hypothesized for similar early house sites on the Canadian and Columbia Plateau (see Ames 2000, 2012; Chatters 1995; Prentiss and Chatters2003).

Unlike the Maurer and Hatzic Rock sites, the recently reported Katzie site (KDC Archaeology 2014) shows some of the earliest evidence for unambiguous collectors on the coast, including multi-family plankhouses and intensive processing and storage facilities at around 5,300 Cal BP (KDC Archaeology 2014: 233-238). Other sites showing evidence of lower residential mobility and more attachment to specific places for the early part of this period include the early burial component at the Pender Canal site at ~5,000 Cal BP (Carlson and Hobler 1993), the Glenrose Cannery site (Matson 1996) and its associated fish weir features (Eldridge and Acheson 1992) at ~4,800 Cal BP and at the Namu site by at least 5,000 Cal BP and possibly as early as 7,000 Cal BP (Carlson 1996, 1998; Cannon and Yang 2006).

Overall, during this time, deposits at sites become much larger, richer and show significant increases in their longevity and continuity of use. Artifact assemblages also become more taxonomically diverse and aquatic resource intensification more pronounced (Ames and Maschner 1999: 88-97). Altogether, this evidence is taken as indicating a substantial decrease in residential mobility.

Interestingly, there does not seem to be a proliferation of sites like St. Mungo, Maurer, Hatzic Rock and Katzie after they appear; instead we find an odd archaeological gap between this early evidence for sedentism and logistic organization and the next firm evidence, which does not appear outside the North Coast until sometime after 3,500 cal BP, with widespread evidence not appearing until ~2,500 Cal BP.

While the foregoing discussion is oversimplified, it is a sadly accurate portrayal of how little is known about the evolution of mobility systems on the NWC. Thus while many details were omitted, including them would not change the general interpretation that people on the NWC were foragers until they were collectors, with a poorly understood middle period. Thus, the history of mobility strategies on the Northwest Coast appears much more dichotomous than it actually was.

2.6: North Coast Sub-Region Archaeological and Environmental Background

Southeast Alaska

The early Holocene in Southeast Alaska is best represented by the excavations at Hidden Falls, component 1 (~12,200 to 9,600 cal BP)) (Davis 1989), Ground Hog Bay 2, component 3 (~10,400 cal BP) (Ackerman 1968) Chuck Lake (~9,200 to 8,200 cal BP) (Ackerman et al. 1985) and On Your Knees Cave (~10,400 Cal BP) (Dixon 1999, 2008). These sites are usually characterized by a microblade/core and unifacial lithic industry (Davis 1990). However, the on Your Knees Cave site also features well-made, leaf shaped bifaces similar to the early bifacial technology on Haida Gwaii (Dixon 2008; Fedje et al. 20 08). Faunal data at these sites also indicate a marine subsistence and economic focus, especially the Chuck Lake site, which has the earliest evidence for a shell midden in all Southeast Alaska (Ackerman et al. 1985). Isotope analyses on human bone, which measures the percentage of marine foods in a diet, from On Your Knees Cave further corroborates this maritime focus by showing that people relied extensively on marine sources for their subsistence (Dixon 1999). People also seem to have emphasized a broad spectrum diet, using all available resources in the area in direct proportion to their actual abundance (Ackerman 1968; Davis 1989; Ackerman et al. 1985). Based upon the use of exotic obsidians from very distant sources and the appearance of sites on islands only accessible by boats, it is also inferred that people during this period practiced very high levels of mobility and had access to boating technology (Moss 2004; Ames 2005; Carlson 2012; Carlson and Baichtal 2015).

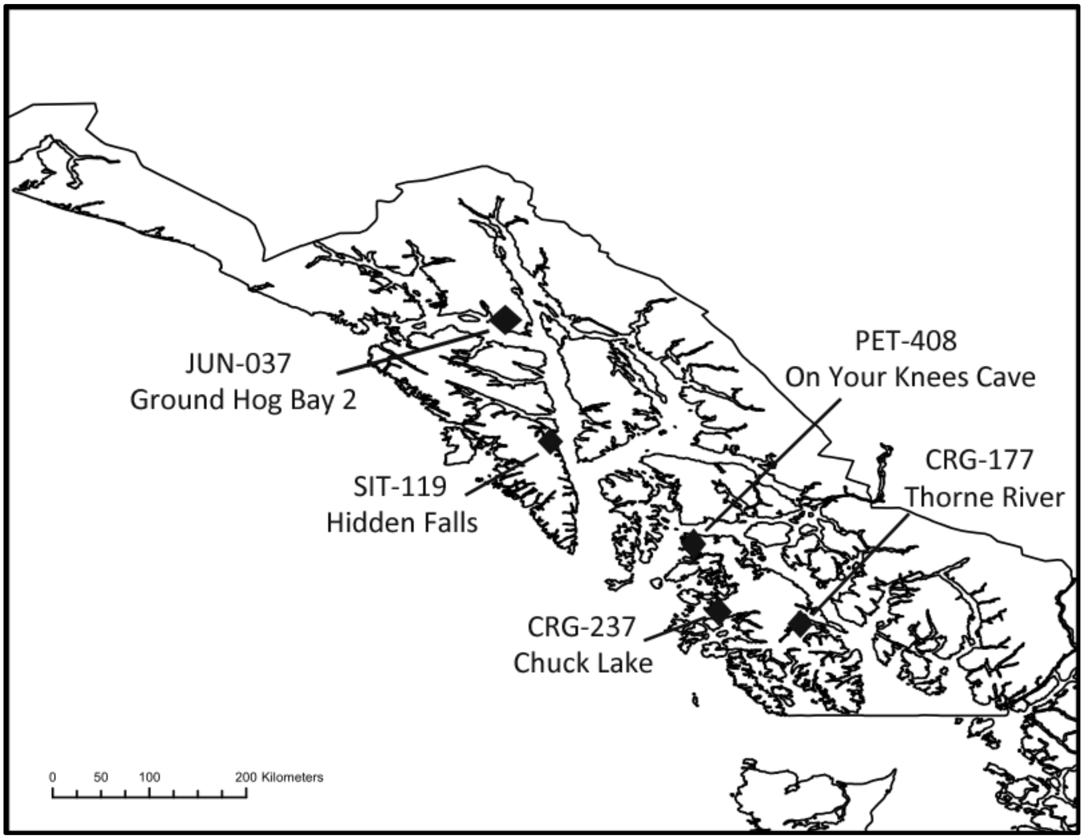


Figure 2: Map of Southeast Alaska sub-region, showing location, name and site number for a selection of significant sites that date between 11,000 and 5,000 cal BP.

There is a gap in the archaeological record of Southeast Alaska between ~9,000-6,000 cal BP, which has only recently begun to be filled (see Carlson 2012; Carlson and Baichtal 2015). This gap makes it very difficult to link developments during this early period with that following. Around 5,000 cal BP there is evidence for significant changes to artifact and faunal assemblages within Southeast Alaska, where we see an increasing use of shell fish resources and ground stone/slate technologies and more complex bone tool technologies (Davis 1990: 198-199; Moss 2004; Arndt et al. 1987). This period is almost entirely known from component 2 of the Hidden Falls site, which dates between ~5,300 cal BP and 3200 cal BP (Davis 1989). Excavations of this component also revealed more than 37 post-holes outlining a structure approximately 3x4m in size as well as numerous pit features (Lightfoot 1989: 199-208).

Davis (1989, 1990) uses this data to infer that around 5,000 cal BP, the number and permanence of structures increases in Southeast Alaska and hypothesizes that this, along with the coinciding increase in ornamentation objects such as labrets, use of groundstone (including slate) technologies, and more complex organic tools indicates a shift to logistic strategies and low residential mobility within Southeast Alaska. However, evidence for this shift is sparse and comes almost entirely from excavations from component 2 at Hidden Falls. There is also limited information from sites such as Lake Eva, Coffman Cove and Rosie’s Rock shelter for this period (Arndt et al. 1987; Davis 1990; Moss 2004; Ames 2005). However, these sites are mostly lithic scatters and midden sites, and do not corroborate the interpretation that this time period saw region-wide changes to more sedentary living (Moss 2004).

Dundas and Lucy Islands

The Dundas Islands are northeast of the northern tip of Haida Gwaii, south of Southeast Alaska and about 24km west of Prince Rupert Harbor (see figure 3). This location positions the Dundas Islands at a very dynamic historical crossroads between Tlingit, Haida and Tsimshian territories. Ethnographically and historically they were used mostly by the Tsimshian for seasonal procurement of resources such as sea mammals, fish and shell fish (Haggarty 1988). The Lucy Islands are a small group of tiny islands ~19km West of Prince Rupert Harbour. The largest of these islands (~240m by 760m) contains the known archaeological sites (Archer 2011). George McDonald began work at Lucy in 1968; his work showed that Lucy contained large shell middens, dating to ~2,500 years ago (McDonald and Inglis 1981). However, recent testing and excavations by David Archer (2011, 2013) pushed the antiquity of occupation at these sites to over 9,000 years ago (Archer 2011: 8). The discovery of a substantial (8.2x4.3m) residential structure (~6,300 Cal BP) and its associated midden burials (~5,800 and 5,300 Cal BP) also showed that the Lucy Islands may have been used more intensively in the past than during the ethnographic period, where they acted as a short-term logistic station for the collection of shell fish, birds and fishing (Halpin and Seguin 1990: 271).

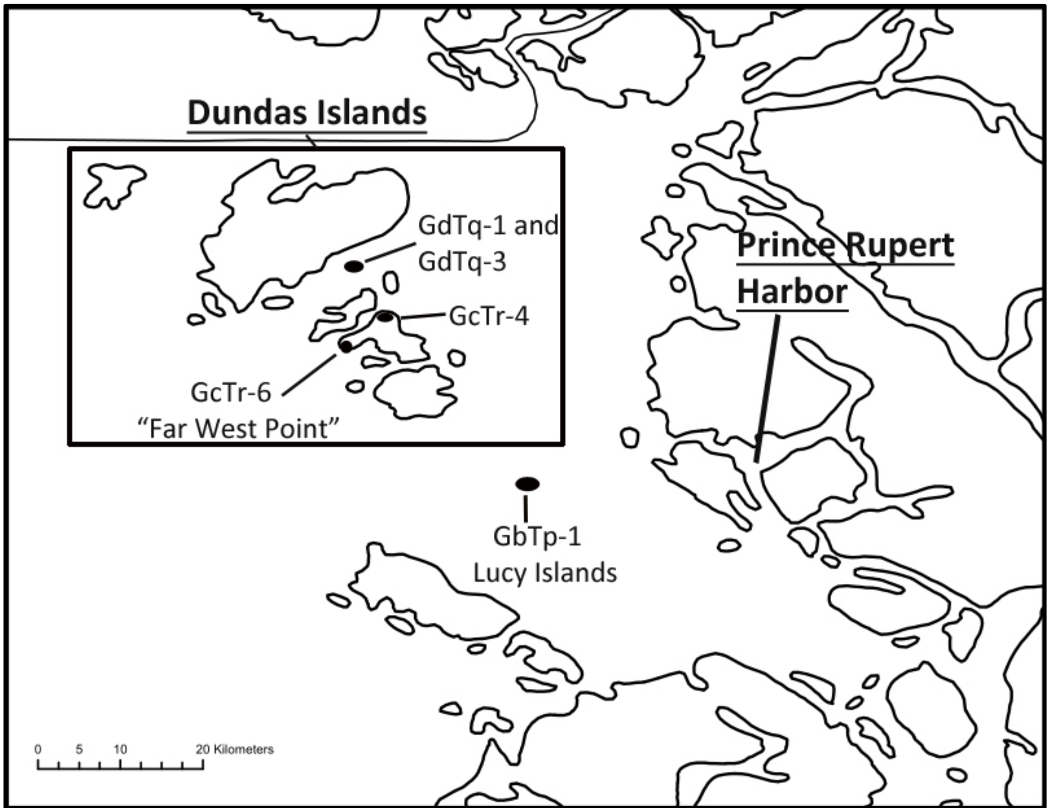


Figure 3: Map of Dundas and Lucy Island's showing location, name and site number of significant sites that date between 11,000 and 5,000 cal BP

Unlike the earliest sites on Haida Gwaii and in Southeast Alaska, which lack substantial shell middens, the earliest Dundas sites, such as Far West Point (~9,000 cal BP) and Lucy Island (~9,000 cal BP) sites show extensive early use of shell fish and the formation of dense shell middens (Martindale et al. 2010; Archer 2011; Archer and Mueller 2013). Recent dates run for this thesis (see appendix I) confirm the presence of one of the oldest currently known permanent structures (6845-6670 Cal BP) (and probable village) on the North Coast at site GdTq-3. This site is located on a tiny island in the Dundas group, lying south of Dundas Island and north of Baron Island and consists of four similarly sized houses (only one was dated) with associated moderately sized shell middens, overlooking a paleo-estuary.

Preliminary faunal evidence from the Dundas Islands points to an interesting subsistence picture. The midden and village sites were occupied year-round and when compared with the Prince Rupert Harbor middens, the Dundas Island sites contained exceptionally low amounts of non-shellfish material (Martindale et al. 2010; Hallman et al. 2013). However, despite their low abundance, the types and relative abundance of fish present were quite similar to the Prince Rupert Harbor middens (e.g. salmon, rockfish, and herring) (Martindale et al. 2010). This led Martindale et al. (2010) to suggest that these assemblages cannot be accurate representations of diet as such an extraordinary reliance on shellfish is not possible nutritionally. However, the question of how and why Dundas has such a disproportionate reliance on shellfish remains unanswered.

The relatively large shell middens at Lucy Island and and the Far West Point site on the Dundas Islands, show that substantial use of shellfish occurs much earlier than previously believed (See Fladmark 1975; Yesner 1998; Ames and Maschner 1999; Matson and Coupland 1995). The early permanent structure on Lucy (6529-6185 cal BP) is also one of the earliest so far on the coast. However, despite the early appearance of permanent structures on Dundas, village aggregations do not appear to become common there until sometime after 5,000 cal BP, and especially after 3,500 cal BP, which follows a pattern similar to histories of Prince Rupert Harbor and Southeast Alaska. Unfortunately, inferences relevant to this thesis about hunting, processing and other activities related to technology are impossible to make at this point. There is currently little artifactual data for either the Dundas or Lucy Islands (Archer 2011: 20-21; Martindale et al. 2010), in part because of a lack of excavation. For example, the 2005-2007 projects (Martindale et al. 2010) used coring for their surveys, with only limited excavation at sites GdTq-3 and GcTq-4. However, the lack of artifacts is also the result of extremely low artifact densities within the sites, similar to many other sites around Prince Rupert Harbor.

Haida Gwaii

Haida Gwaii (a.k.a the Queen Charlotte Islands) is a large archipelago located off the west coast of Northern British Columbia separated from the mainland by Hecate Strait and from Southeast Alaska by Dixon Entrance (figure 1). It is the traditional homeland of the Haida. Systematic archaeological work in Haida Gwaii began with George MacDonald (1969), and continued with foundational work by Fladmark (1970, 1975, 1989), followed by Severs (1974), Acheson (1982, 1998) and Fedje and Christiansen (1999). A thorough review of archaeology on Haida Gwaii is presented in Fedje and Mathewes (2005). These investigations and those following revealed many significant sites for understanding early hunter-gatherer adaptations to this coastal landscape (see Kilgii Gwaay and Richardson Island). In contrast to other regions on the north coast though, much more is known about Haida Gwaii pre-5,000 cal BP than post (Fedje and Mackie, 2005: 156).

The earliest cultural complex on Haida Gwaii is called the ‘Kinggi Complex” (Fedje and Mackie 2005) (>11,000 to ~9,800 cal BP). The earliest sites (>11,000 cal BP) from this period are the Gaadu Din and K1 Karst Caves sites, which are bear hunting sites associated with variations of large leaf-shaped bifaces (Fedje et al. 2004, 2008: 19-25). The latter half of the Kinggi complex is best known by work done at the Richardson Island and Kilgii Gwaay sites (figure-4) (Fedje and Mackie 2005: 158; Fedje et al. 2008).

However, other important sites such as Arrow Creek 1 and 2 (Fedje et al. 1997); Collison Bay (Q. Mackie et al. 2011: 72) and the Lyell Bay sites (Q. Mackie et al. 2011: 73) are also representative of the Kinggi complex

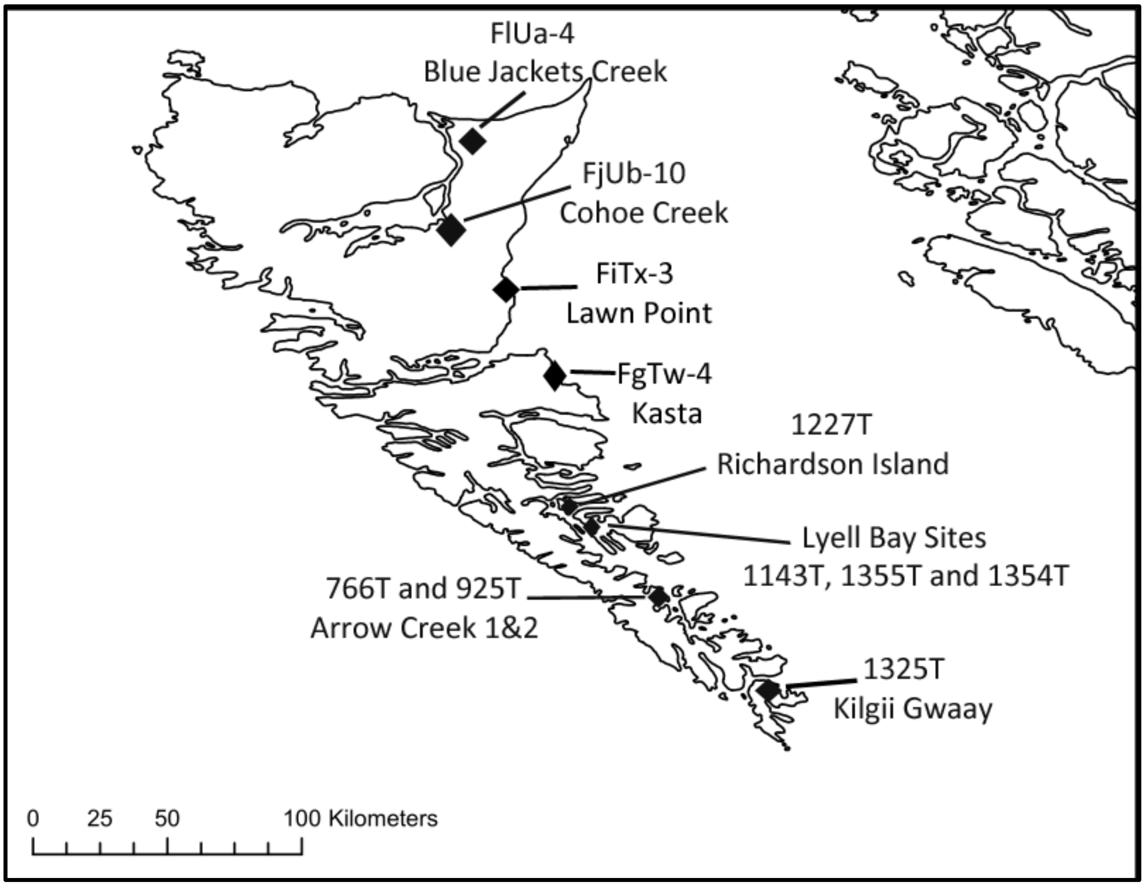


Figure 4: Map of Haida Gwaii showing the locations, names and site number of significant sites dating between 11,000 and 5,000 cal BP.

The Kingii Complex is characterized by a mobile people using generalized tool-kits (Fedje and Mackie 2005:158). From the Kilgii Gwaay wet-site, we also know that people made extensive use of organic tools such as bone awls and barbed points, as well as cordage, and various wooden tools and wood working tools (Fedje et al. 2001; Fedje and Mackie 2005: 158). Subsistence was diverse with people using seemingly every available resource (e.g. shell fish, black bear, salmon, deer, caribou, rock-fish, halibut, etc.). Evidence from faunal assemblages (i.e. halibut) also suggests that people were making routine use of boating technology to take open water fishes.

Based upon the number and complexity of features, site location, and seasonality studies at the Kilgii Gwaay and Richardson Island sites, various authors (see Fedje et al. 2001, 2005; Storey 2008; Q. Mackie 2011) have also suggested that these sites represent logistically oriented basecamps, focused around exploiting wide ranges of aquatic resources. However, despite this logistic orientation, the short term (but regular visits) to these sites indicate that residential mobility was still very high during this period. In other words, it seems that people may have moved residences often (at least seasonally based on faunal evidence), to the same series of locations throughout the year, but once at these locations used logistic forays to acquire resources. Thus, residential moves though frequent, were not made to resources themselves, but to centralized nodes that provided access to wide varieties of critical resources.

The “Moresby Tradition” (~10,000-5,700 cal BP) is best known from sites such as Lyell Bay, Lawn Point, Richardson Island and Cohoe Creek. The transition from the Kinggi tradition to the Moresby traditions is mostly marked by the replacement of bifacial technology with microblades. However, this replacement takes place over ~1,000 years (~9,000-8,000 cal BP) and stratigraphic evidence from Richardson Island shows that the two technologies co-occur in the same strata (Fedje and Mackie 2005: 159; McLaren and Smith 2008) . There also seems to be no other change to the tool-kit with the adoption of micro-blades, which is taken to further indicate a local adoption of micro-blade technology (Carlson 1996; Magne 2004; Storey 2008: 2).

Overall, the Moresby Tradition shows continuity with Kinggi Tradition sites, the faunal assemblages look the same (sans black bear from earlier sites), all lithics are made from local material, and sites retain a marine focused positioning and economy (Fedje et al. 2008). The later portion of this period (~6,800-5,700 cal BP), which is represented primarily at the Cohoe Creek site does show significant difference from earlier portions of the period (~10,000-8,000 cal BP). At the Cohoe Creek site after ~6,100 cal BP we see the accumulation of the first significant shell middens, compact and discrete living floor surfaces, large scale caching/storage of raw materials and subtle changes in subsistence, the most noticeable of which is the appearance of relatively large amounts of caribou and jack mackerel (Christensen and Stafford 2005: 272). However, Christensen and Stafford (2005) argue that these differences are due more too local availability than any change in subsistence strategy. It should be noted that these changes may be much older at the Cohoe Creek site, but features associated with components older than 6,100 cal BP were either destroyed or have little certainty in their provenience (Christensen and Stafford 2005: 245-273).

Based on seasonality studies from shell fish and fish from Cohoe Creek, Christensen and Stafford (2005: 259) also suggest that it was occupied on a semi-sedentary basis through winter, marking a critical change in mobility patterns in Haida Gwaii during this time. These authors further suggest that the lithic assemblages from Cohoe Creek are transitional between early and late period sites. Overall, the Cohoe Creek site does indicate that at least in some places, by the end of the Moresby period people were investing more in place (i.e. larger midden accumulation, more permanent structures and storage), and living in places for longer periods. However, it should also be noted that Cohoe Creek is the only well excavated site on Haida Gwaii that represents the period between 6,500 cal BP and ~5,000 cal BP.

The late period for Haida Gwaii is termed the “Graham Tradition” (~5,700-200 Cal BP). The early portion of this period is almost completely unknown on southern Haida Gwaii and is only known from Cohoe Creek (Ham 1990; Christensen and Stafford 2005), Skoglund’s Landing (~4,700 cal BP) (Fladmark, 1986; 1990) and Blue Jackets Creek (~5,100 to 4,000 cal BP) (Severs 1974) on northern Haida Gwaii (Graham Island). However, besides Cohoe Creek these sites are poorly reported or have had little analysis done, making any detailed reconstruction for this part of Haida history unreliable. In fact, the same can be said for this entire period up until ~2,000 cal BP.

Despite the small number of site records, some broad statements about the early Graham Tradition (~5,700-4,500 Cal BP) can be made. During this time midden deposits increase in size and abundance, indicating an increased reliance on shellfish. Other aspects of faunal assemblages remain similar to earlier periods except for an increase in halibut and salmon. Some technological change is apparent as microblade technology is phased out in favor of groundstone and bipolar flaking technologies. There is also an increased use of harpoons and organic tool technology, as well as the first appearance of adornment items (e.g. combs and pendants) (Mackie and Acheson 2005; Fedje et al. 2008). There is also an increase in permanent residential structures (evidenced by increased size and abundance of post molds, compact living surfaces and more complex stratified deposits (Ham 1990; Christensen and Stafford 2005; Fedje and Mackie 2005), with later appearances of cemeteries/burials like those seen at Blue Jackets Creek (~5,100-4,500 Cal BP) (Severs 1974; Breffitt 1993).

The increase in permanent residential structures, groundstone and bipolar flaking suggests a movement towards increasing sedentism and lower residential mobility, while the increasing relative abundance of salmon, halibut and shellfish suggests that task-specialization may have been becoming more common. The combined appearance of these traits is interpreted as representing a shift to logistically oriented strategies and the beginnings of sedentary living.

2.7: Theory and Hypotheses:

In this section I develop the hypotheses being evaluated, and their respective test implications. While I try to capture the foundational elements or core essence of each hypothesis, this discussion presents generalized summaries, leaving out many nuances and complexities. This is done in order to create coarse grained test-implications and a broad level coherence that fit the scale and precision of the available data (see table 1 for summaries of hypotheses and test implications).

Binford:

Summarizing Binford's most recent hypotheses (Binford 2001) regarding the development of logistic mobility; population packing is the prime determinant in predicting its development. As population densities increase, the cost of residential mobility also increases (Binford 2001: 420). This rising cost is manifested in two primary ways: 1) larger populations increase the frequency at which a group has to move (which means paying the cost of moving more often), because larger populations consume resources faster than smaller ones and 2) larger populations are altogether just more difficult to move and therefore more costly (Binford 2001: 267). Therefore, larger populations not only cause groups to pay increasingly high costs for moving residences, but require that groups pay this cost more frequently. This process continues until moving residences to a new place is no longer a tenable strategy. When this happens people will adopt logistic/collector mobility strategies to offset mobility costs. Therefore, we should expect collector strategies to emerge where population levels relative to resource patch access exceeds a certain threshold (Binford, 2001: 438).

Binford also believed population size and density were not purely intra-group pressures (2001: 442). Instead, population sizes at a regional scale were just as, if not more, likely to force logistic mobility. For example, looking at cost #1 above, as populations' increase, the rate at which they consume resource patches and the number of times they have to move also increases. This means groups become increasingly likely to encounter each other or consume each other's resources, which pushes people into smaller and smaller areas a process Binford (2001: 442) describes as "packing" whereby a group's subsistence range is reduced because of regional population increases. It is important to note here that the two costs discussed above operate differently on a group. The first is a *relative* increase in cost, where what is a 'large' population is different depending on the environmental productivity and heterogeneity of resource availability. The second however is an absolute cost. Regardless of environmental productivity or resource incongruity, the actual costs to move a set number of people do not change with scale. Therefore, Binford suggests that there is a threshold of total people where the only way to mitigate increasing mobility costs is to either fission the group or adopt logistic mobility. (Binford 2001)

While Binford demonstrates that the above description is generally true for all hunter-gatherers, he also makes special cases for hunter-gatherers who exploit or have access to aquatic resources in temperate or arctic environments and argues that aquatic hunter-gatherers in these cases will differ from the above model in a number of specific ways (Binford 2001: 444); (i) hunter-gatherers in temperate/arctic settings will switch from terrestrial strategies and adopt the use of aquatic resources very early; (ii) these hunter-gatherers will focus on aquatic resources long before population packing takes hold; and (iii) access to and the nature of aquatic resources creates an inherently heterogeneous environment, making at least low-level logistic mobility strategies necessary (i.e. cannot move residence into the middle of the ocean, so you *have* to move resources to residences). However, it is important to note that while Binford believed that aquatic hunter-gatherers, regardless of other conditions, would almost *have* to be logistically organized; characteristics often associated with a ‘classic’ collector pattern (i.e. permanent structures, significant site furniture, extensive use of storage, etc.) would not be adopted until population levels made immediate return subsistence strategies untenable (Binford 2001: 341).

Therefore, according to Binford (2001), we can expect that a switch from a terrestrial to an aquatic focus should take place very early in the archaeological record and that high levels of logistic mobility will be seen <u>after</u> significant increases in population levels. In summation, some evidence of low-level logistic mobility can be expected throughout the sequence, but evidence for high-levels of logistic mobility should coincide with increasing population levels.

Ames:

Similar to Binford, Ames views collector mobility as an adaptive strategy for solving complex labor and communication problems resulting from temporally and spatially incongruous resource availability, where critical resource distributions overlapped in time but not space (Ames, 1981, 1985: 155-158). Therefore, Ames has argued that early peoples on the coast were aquatic foragers with high residential mobility, using boats for maintaining social networks and accessing critical resources. Over time, the patchy nature of resource distribution on the coast effectively expedited the adoption of less residential mobility, which led to a kind of 'tethered foraging' (Ames 2003). Overall, to this point Binford and Ames' hypotheses are extremely similar. However, moving from here I emphasize a couple of distinctions which I slightly exaggerate for the purposes of distinguishing between the two.

With this in mind, a key distinction between Binford and Ames is that unlike Binford, Ames suggests that external stimuli (i.e. environmental conditions) may force the initiation of more sedentary and/or logistic mobility among aquatically oriented peoples, but these stimuli are not responsible for the continued development of these strategies. Instead, Ames argues that logistic mobility itself creates a need to further increase the complexity of labor organization. In short, logistic mobility arising out of the naturally disjointed character of coastal resources, may actually amplify the disjuncture of resource availability by hindering the ability of the group to move to different resources (Ames 2004, 1985: 174). As such, Ames views the development of highly complex logistic mobility as a process of continual development from less complex, but still logistic mobility patterns (Ames, 1985: 165-167, 2002). Furthermore, Ames argues that **local** demographic pressures are probably insufficient to push people towards less residential mobility and thus packing must occur at the regional level in order to force more sedentary and logistical mobility (Ames 1985: 172-174; 2004).

Following this argument, logistic organization may be expected to increase gradually until a demographic threshold is reached. At this point, organizational demands, causes the intensification of logistic organization by making the fluid or flexible use of foraging strategies impractical. As discussed above, Ames' also suggests that the more logistic strategies are used the more complex they become. Therefore, following possibly slow and gradual increases in logistic organization, once reached this threshold may cause a kind of positive feedback loop, which leads to a swift and punctuated appearance of much more complex organization.

Following Ames' argument then, we should expect to see a continuous, if not necessarily gradual proliferation of redundant sites across the landscape (Ames 2004, 1985: 165-167), with later ones perhaps exhibiting more evidence of specialized tool-kits that represent the more specific catchment goals of an increasing specialized labor force and a general continuity in positions of sites on the landscape. We should also expect to see evidence for regional population packing coinciding with any major changes to organizational complexity and intensification of logistic strategies.

Prentiss and Chatters – Brief Plateau Background:

Prentiss and Chatters (2003) (See also Chatters and Prentiss, 2005; Prentiss et al. 2006; Prentiss, Kujit and Chatters, 2009; and Prentiss et al. 2014) present a very different hypothesis for the development of collector strategies across the Northwest. Their hypothesis draws from 'punctuated equilibrium' and belongs to a theoretical school called ‘Macroevolution’ (Prentiss 2009: 111-113; Prentiss and Chatters 2003). Although their arguments have changed subtly through time, their core argument has changed little. Prentiss and Chatters maintain that collector strategies evolved first on Haida Gwaii then spread across the Northwest replacing forager systems which had been decimated – gone extinct as strategies - because they failed to adapt to sharp environmental changes Prentiss and Chatters say occurred around 5000 years ago. As mentioned previously, because their argument is rooted in their studies in the Northwest Plateau culture area, I provide an extremely brief background on mobility changes on the Plateau to contextualize their argument below.

Brief Plateau Background:

Generally speaking, prior to approximately 6,000 cal BP, people on the plateau are characterized as using high residential mobility, investing little in sites and practicing an overall foraging pattern. After 6,000 cal BP, we begin to see mobility changes with the appearance of a large structured pit-house at the Johnson Site, in Oregon (Ames 2012: 172). However, it is not until about 5,000 cal BP that pit-houses, such as at Hatwai (Ames and Marshall 1981) and the Baker site (Wilson et al. 1992), become widespread on the plateau (Ames 2000; 2012: 172; Harris 2012: 54; Chatters and Prentiss 2005).

Chatters (1995) and Chatters and Prentiss (2005) argue that these early pit-houses, that were located in highly productive eco-tones and lacked discernable storage features were occupied by people practicing a sedentary or tethered foraging mobility strategy. They suggest that the highly productive eco-tones provided year-round access to many resources, which were subject to low seasonal variance in availability. These qualities allowed people to practice immediate return strategies (typical of foragers) while staying in the same location year-round. Thus, despite their sedentary living, these people remained foragers.

Between 4,200 and 3,800 cal B.P. this pattern disappears across the plateau. When pit-houses reappear around 3,800-3,600 cal BP they occur in clusters or villages, individual houses are much smaller than before and are associated with numerous and large storage cache pits. In all, these features clearly indicate that people are practicing classic collector strategies (Ames 2000, 2012: 178; Prentiss and Kujit, 2012: 55-62).

Prentiss and Chatters argue that the disappearance of pit-houses around 4,200 cal BP is the result of sudden climatic events that drastically decreased the productivity and increased the variance of resources within the ecotones mentioned above. This change made the sedentary foraging strategies dependent on stable and productive ecotones untenable. Because this environmental change is hypothesized as being very sudden, people on the Plateau would not have time for their RMS to cope; therefore people either died out or moved to the coast. Prentiss and Chatters then argue that this would have left an empty niche on the Plateau that could have only been filled (due to environmental constraints) by people practicing a logistically organized RMS. A critical point here is that Prentiss and Chatters believe that collector strategies did not *evolve* in response to environmental change, but replaced failed forager systems.

Prentiss and Chatters Hypotheses:

Critical to their argument is Prentiss and Chatters' belief that mobility strategies are a foundational aspect of what they term a group's "Resource Management Strategy" (RMS). They define a RMS as a shared set of ideas for behaving within a social and community context. It includes peoples' strategies for subsistence pursuits, labor management, task scheduling, mobility, and maintenance of social networks (Chatters and Prentiss 2005). Because they see all of these elements of the RMS as fundamentally connected, both with each other and with the environment, Prentiss and Chatters argue that change to one piece of the RMS (i.e. mobility strategy) creates a cascade of changes to the other pieces. Therefore, switching between a forager and collector strategy can only be done with wholesale upheaval of the rest of the social system. In turn, this prevents people from switching mobility strategies quickly and thus during times of rapid environmental change, it is argued that foragers do not have *time* to become collectors (Prentiss and Chatters 2003; Chatters and Prentiss 2005)

The key distinction between these authors' arguments and Ames' and Binford's is that Prentiss and Chatters do not attribute the development of logistic strategies to in-situ adaptations. Instead, collector strategies are one of many equally viable strategies present in the Northwest through the Holocene, which just *happened* to be better adapted when the environment changed. Because they attribute the spread of collector strategies largely to chance, they spend very little time discussing why collector strategies developed in the first place. In fact, Prentiss (2009) herself says that these authors have little to say about why or how a collector strategies first developed.

Despite this, these authors argue that the origin of collector strategies was on Haida Gwaii, and probably appeared around 5,000 cal BP specifically citing Skoglunds Landing and Blue Jackets Creek as proof that the first collectors appeared here. Prentiss and Kujit (2012: 53) actually argue that there is no evidence for collectors *anywhere* on the north coast until after 4,000 cal BP, which they suggest demonstrates that collector strategies are too complex to have developed in-situ from people practicing forager life-ways. Prentiss and Kujit (2012: 54) also argue that the lack of change on Haida Gwaii after 3,600 cal BP shows that people living here had already perfected collector adaptions. However, this is a bit of a spurious argument, as there is effectively *no data* from Haida between 4,000 and 2,000 cal BP (Mackie and Acheson 2005: 287).

Although Prentiss and Chatters claim little can be said about the initial appearance of collector strategies, Prentiss (2009: 119) suggests that we can make the following generalizations about their beginnings (i) collector strategies appeared first in places that were isolated (ii) collector strategies arose first in areas with significant resource abundance and (iii) that the shift to a collector strategy was very abrupt. Prenitss (2009: 119) then suggests that collector strategies arose because the isolation on Haida Gwaii made high mobility strategies less attractive and that they evolved in order to take advantage of the abundant resources on Haida Gwaii.

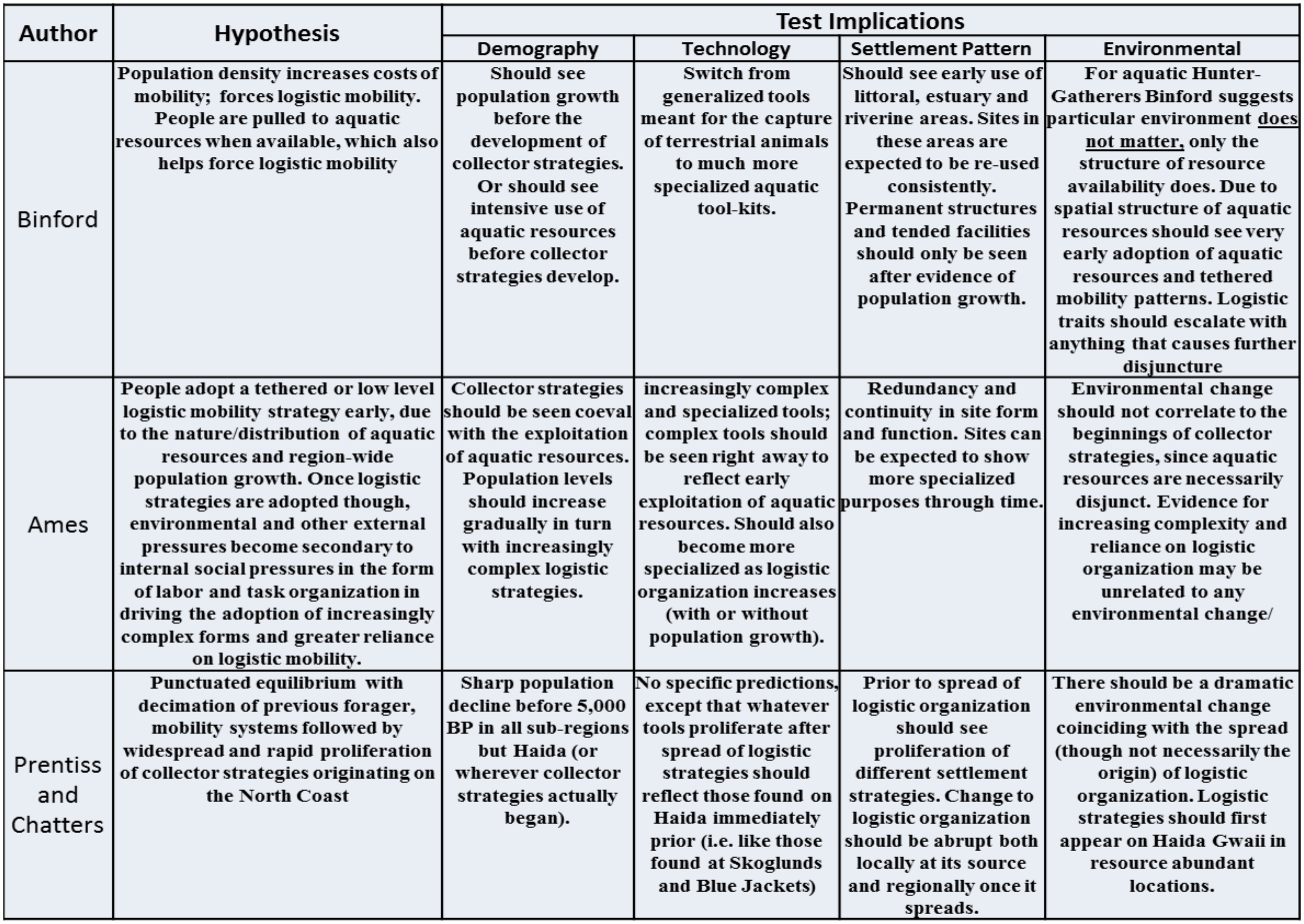
Overall, following Prentiss and Chatter’s arguments on the North Coast, we should expect to see the development of collectors on Haida Gwaii first, and a variety of different mobility strategies employed elsewhere (none collectors though). Following the appearance of collectors on Haida Gwaii we should then see sharp population declines in the Southeast Alaska and Dundas Sub-regions, which is then followed by the relatively abrupt appearance of collector strategies in these areas and we should *not* see any major population declines on Haida Gwaii. Meanwhile, as evidence for collector strategies spreads throughout the North Coast, the artifact assemblages, settlement patterns and overall site-structure for these new collector sites should look similar to the ones that were first present in Haida Gwaii. Lastly, Following Prentiss’ (2009) and Prentiss and

Kuijt's (2012) comments we should also expect to see a very abrupt transition to collector strategies.

What should be apparent when comparing these hypotheses is that Ames and Binford appear to have very similar ideas about the evolution of complex logistic strategies. Both stress that demographic pressures and resource distribution are critical in its development. In both cases it is also clear that while environmental changes can certainly be influential, they are usually more tertiary as a causal mechanism, especially among aquatic hunter-gatherers. However, a notable distinction between these authors is that Ames' stresses the role of internal social pressures in shaping and causing more complex logistic organization, while Binford tends to view this development as more reactionary to external stimuli.

Compared to Ames and Binford, Prentiss and Chatters' hypotheses are very different. This difference stems mostly from Prentiss and Chatters' adherence to Macro evolutionary principles, which emphasize a competitive theoretical framework, whereby changing environments (or any top-down selective pressure) place new selective pressures on existing social structures, causing some to fail and die out and others to succeed and replace. Thus, within this competitive environment, widespread social change must be abrupt as people are either replaced or adopt, wholesale, the new and most efficient organizational strategy allowing them to survive and/or compete. In this framework, due to the deep interconnectedness with the entire social system, mobility strategies cannot evolve quickly in-situ. In turn, this makes adaptation to sudden environmental changes almost impossible.

Table 1: Showing summaries of current hypotheses and their respective test implications



Author	Hypothesis	Test Implications			
		Demography	Technology	Settlement Pattern	Environmental
Binford	Population density increases costs of mobility; forces logistic mobility. People are pulled to aquatic resources when available, which also helps force logistic mobility	Should see population growth before the development of collector strategies. Or should see intensive use of aquatic resources before collector strategies develop.	Switch from generalized tools meant for the capture of terrestrial animals to much more specialized aquatic tool-kits.	Should see early use of littoral, estuary and riverine areas. Sites in these areas are expected to be re-used consistently. Permanent structures and tended facilities should only be seen after evidence of population growth.	For aquatic Hunter-Gatherers Binford suggests particular environment does not matter, only the structure of resource availability does. Due to spatial structure of aquatic resources should see very early adoption of aquatic resources and tethered mobility patterns. Logistic traits should escalate with anything that causes further disjuncture
Ames	People adopt a tethered or low level logistic mobility strategy early, due to the nature/distribution of aquatic resources and region-wide population growth. Once logistic strategies are adopted though, environmental and other external pressures become secondary to internal social pressures in the form of labor and task organization in driving the adoption of increasingly complex forms and greater reliance on logistic mobility.	Collector strategies should be seen coeval with the exploitation of aquatic resources. Population levels should increase gradually in turn with increasingly complex logistic strategies.	increasingly complex and specialized tools; complex tools should be seen right away to reflect early exploitation of aquatic resources. Should also become more specialized as logistic organization increases (with or without population growth).	Redundancy and continuity in site form and function. Sites can be expected to show more specialized purposes through time.	Environmental change should not correlate to the beginnings of collector strategies, since aquatic resources are necessarily disjunct. Evidence for increasing complexity and reliance on logistic organization may be unrelated to any environmental change/
Prentiss and Chatters	Punctuated equilibrium with decimation of previous forager, mobility systems followed by widespread and rapid proliferation of collector strategies originating on the North Coast	Sharp population decline before 5,000 BP in all sub-regions but Haida (or wherever collector strategies actually began).	No specific predictions, except that whatever tools proliferate after spread of logistic strategies should reflect those found on Haida immediately prior (i.e. like those found at Skoglunds and Blue Jackets)	Prior to spread of logistic organization should see proliferation of different settlement strategies. Change to logistic organization should be abrupt both locally at its source and regionally once it spreads.	There should be a dramatic environmental change coinciding with the spread (though not necessarily the origin) of logistic organization. Logistic strategies should first appear on Haida Gwaii in resource abundant locations.

CHAPTER 3: METHODS

3.1: Introduction to Radiocarbon Methods and Analysis

To investigate demographic patterns I use the relative frequency of radiocarbon (^{14}C) dates through time as a proxy measure for changes in relative population levels. This method was first formalized by Rick (1987) and with various methodological refinements, has proven to be a powerful tool for understanding demography. The method has since become widely used across the world to investigate population dynamics (e.g. Timpson et al. 2014; Richter et al. 2013; Kelly et al. 201; and see Downey et al. 2014 and Woodbridge et al. 2014 for a more thorough proof-of-concept discussion). The utility of this method, especially for the North Coast, cannot be overstated, as the availability ^{14}C dated sites constitutes the only source of data prior to ~4,000-5,000 cal BP that has large sample sizes and has been sampled relatively equally between multiple areas throughout the region. Given the strength of the ^{14}C data and the weaknesses within the available environmental, technological and settlement pattern data, the ^{14}C data from which the demography work is based forms the most regionally comparable, representative and overall most robust set data for any of the analyses.

In the following sections I discuss how data was collected and audited, and the sample sizes available. I then give a detailed account of the method used to construct summed probability distributions (SPD), the problems associated with using SPDs to proxy demography and how these problems are addressed.

3.2: Data Collection and Sample Discussion

In the first part of this chapter I describe how I gathered radiocarbon data for the demographic analysis. I also discuss quality control for the data and the nature of samples for the study region as a whole and the sub-regions within. Section 3.3 then provides a step-by-step walkthrough and justification of the methodology I employ to reconstruct demographic trends using ^{14}C data.

The radiocarbon data used includes dates collected from several sources: the Canadian Archaeological Radiocarbon Database (CARD), dates produced by ongoing research projects mentioned above, and from an exhaustive review of journal articles, theses/dissertations, CRM (Cultural Resource Management) reports and various other kinds of published and unpublished sources. Locating articles, theses and dissertations was initially not done systematically. Lack of access, ignorance and time constraints most certainly resulted in missing some sources of data and information. To counter these problems, a more strategically efficient literature search focused on obtaining theses and dissertations from institutions that are known to have a research focus on the Northwest Coast. Personal communication with researchers working in the area also guided my literature search. Bibliographies from these sources were then used to help locate more sources. Effective redundancy in data collection was decided after significant expenditures of time no longer produced any new data. Time spent on data collection started in 2012, and the dates used throughout this thesis are all those found as of 2/28/2015.

CRM reports for the research area were investigated in a much more systematic way, although the search cannot be said to be truly exhaustive. Since CARD stopped operating in full capacity in 2005, and since my previous research found that most dates from Canadian sites taken prior to 2005 were already in CARD, I focused on reports that were produced since 2005. Using my access to the British Columbia Heritage system, every report that was registered as part of the ‘North Coast’ area from 2005 to present was downloaded and combed for radiocarbon dates. Individual site reports and older CRM reports were also used to clarify any issues from dates already in CARD. Though SE Alaska is outside Canada, many sites and ^{14}C data from this area were also found in CARD. The SE Alaska data was also supplemented by literature research following the same methods as described above. A point that needs to be made about the SE Alaska data is that I did *not* have access to the Alaska state database or any other direct access to CRM or non-publically available research reports. While many reports were made available in physical copy through Dr. Ames’ personal library, it needs to be noted that due to these constraints, the SE Alaska data is probably less complete than other regions.

As a part of collecting radiocarbon dates, I also recorded context, stratigraphy, material dated, and quality information among other details (see supplemental material). Dates lacking sufficient context or recorded information to insure their relationship with human activity were then culled from my data base. This process often required finding multiple sources for dates as the needed information was unreported or inconsistently reported in published literature. These inconsistencies and missing data were not just limited to the literature search. A substantial portion of dates already in CARD also needed to be ‘fixed’ and updated with meaningful contextual information. While it is impossible for me to quantify the amount of data that I may be missing, the thoroughness and time spent looking for any missing data allows me to be fairly certain that any data that are missing would not have a significant effect on the results of analysis.

Overall, for the North coast area my sample includes 93 (32 marine) ^{14}C dates from Alaska, 143 from Haida Gwaii (43 marine) and 91 (53 marine) from the Dundas and Lucy Island area for a total sample of ~330 dates. Appendix I and II lists the dates used for this research, presents a streamlined version of the database used, as the information contained within the actual database does not fit within these pages. However, the full version used will be available in digital form from me by request or through online supplemental material, available through PDX Scholar.

3.3: Demographic Analysis

To reconstruct demographic patterns I make use of summed calibrated radiocarbon date distributions. Summed probability distribution (SPD) plots are constructed by plotting the probability ranges of calibrated dates along a time-scale and summing together all overlapping probability distributions, such that increasing overlap between distributions creates increasingly large peaks on the plot. The logic of using these as a population proxy is based on the assumption of a monotonic relationship between the relative number of radiocarbon dates recovered and population size (Rick 1987; Collard et al. 2010). The monotonic aspect of this relationship, means that while the relationship between population and ^{14}C dates remains constant (i.e. increase in one leads to an increase in the other), the magnitude of this relationship is *not* constant;

meaning that while the number of ^{14}C dates always increases with population, *how much* these increase together can vary through time.

This method was first used by Rick (1987) and has since been used extensively to proxy population dynamics elsewhere (see Williams, 2012; Selden, 2012; Shennan and Edinborough, 2007; Riede and Edinborough, 2012; Shennan et al. 2013). This process relies on an inferential chain that makes three major assumptions 1) More dateable deposits will be left when populations are larger 2) larger deposits of material will be relatively more visible archaeologically than smaller deposits, and 3) more preserved material will lead to more ^{14}C dates (Rick 1987)

Though the process described above is widely used across the world, the utility of SPDs as a proxy for demography has been strenuously debated. I do not address this debate directly and instead refer the reader to the following sources: Bamforth and Grund, 2012; Buchanan et al. 2010; Collard et al. 2010; Contreras and Meadows 2014; Downey et al. 2014; Kerr and McCormick, 2014; Shennan et al. 2013; Steel, 2010; Timpson et al. 2014 and Williams, 2012. However, the major criticisms of the SPD method can usually be broken down as follows; (i) that differences in the number of ^{14}C dates from any given time-period or site are not reflective of population, but instead reflective of researcher bias, differences in available funding, availability of dateable material, etc. (ii) that the shape of SPDs is strongly driven by vagaries in the calibration curve and thus are not meaningful reflections of population change and (iii) a general skepticism that SPDs relate to population levels at all, or a skepticism that even if they do, that archaeological sampling and production of ^{14}C dates is too skewed to make accurate inferences from SPDs. The specifics of these issues are discussed in more detail below.

With the above general issues in mind, it is clear that before making reliable inferences from SPDs, there are methodological issues that need to be addressed in order to accurately proxy demographic changes through time (Surovell et al. 2009; Bamforth and Grund, 2012; Williams, 2012; Shennan et al. 2013). Some of these problems include taphonomic loss, sampling bias, adequate sample size, use of marine samples, and the effects of the calibration curve itself.

The lower limit of appropriate sample size for SPD analysis is hotly debated (see Timspon et al. 2014; Shennan et al. 2013 and Williams, 2012 for good discussions). In reality though, this debate has much more to do with the quality of sampling as opposed to any real magic number of samples. For example, while Williams (2012) suggests a minimum sample size of 500, his conclusion is based on reconstructing demography over a 50,000 year period. However, Shennan et al (2013) and Hintz et al. (2013) demonstrate that much smaller sample sizes (~100-200) can accurately capture demographic trends over a couple thousand years. In both papers though, the authors demonstrate that the ‘law of large numbers’ does play out in archaeological sampling and enough samples will eventually overcome research bias and create an accurate reflection of the true distribution for the time-period and area under question. With this in mind, I have a sample of ~330 dates for my region that covers about 6,000 years. If William’s (2012) suggested sample size of 500 for a 50,000 year period was shown to be representative, we can be fairly certain that the *size* of my sample is sufficient.

Sampling bias is a more insidious problem. This problem can refer to any kind of sampling bias, but for demographic reconstruction, it usually refers to certain time-periods or types of sites receiving more attention than do others. Consequently, these areas (which may be more or less likely to yield radiocarbon dates) may be disproportionately represented because of research focus, not because of past human behavior.

The calibration curve itself can also introduce significant biases into this kind of analysis. These biases result from 'peaks' and 'plateaus' in the calibration curve, which either compress a wide range of dates into a single spot (peak) or spread a series of closely clustered dates across a wide range (plateau). As a result, peaks in the calibration curve can give us a false signal for a growing population and a plateau can smooth away any variation and give a false signal of stability and continuity (Williams, 2012; Bamforth and Grund, 2012; Shennan et al. 2013). In order to help correct for sampling bias and the effects of the calibration curve I used various methods put forth by Shennan et al. (2013), Williams (2012), and Collard et al. (2010).

Within sampling bias, there are two major problems that affect the use of SPDs (i) 'intellectual bias', when certain *kinds* of sites are overrepresented. An example of this can be burial features; because researchers tend to focus more on these and they are more likely to be dated, variation in the SPD can come to reflect changes in relative frequency of burial practices instead of demography and (ii) 'Oversampling' results when some sites are more intensely dated than others. An example of oversampling would be if one researcher had money to obtain 10 dates while another 40. In this case, using an SPD, we would make the inference that site two had four-times the population, when in reality we are actually tracking that one researcher had four-times the money. In both cases, variation within the SPD can be caused by researcher tendencies as opposed to real demographic trends.

To help control for these problems, radiocarbon dates go through a process of ‘binning’ and ‘summing’. The first process of ‘binning’ involves segmenting time into chunks (or bins) and then fitting radiocarbon dates into these bins based on their age for each site. Once binned, the dates that fall into each bin are ‘summed’. The summing of radiocarbon dates effectively combines all the radiocarbon dates within a set interval (200 years here) from each site. A weighted average of the age and error is then created from all of the dates that fit within each interval to create a ‘summed’ date. Together, these processes normalize the different sampling intensities between sites, while also making sure each time segment has a sufficient sample size (see Williams, 2012; Shennan and Edinborough, 2007; Collard et al. 2010; for a much more detailed discussion).

For this research, binning was done first by grouping all the dates from each site together and then ordering them from youngest to oldest. Within each site (using un-calibrated ages, see appendix III for explanation as to why) I created a new bin whenever a date was more than 200 years older than the first date in the bin. 200 year bins were chosen because in simulation studies this was the length of time that showed to be most robust for offsetting the effects of research bias while still capturing meaningful variation within the SPD (Shennen et al. 2013; Kevan Edinborough personal communication 2014). The ‘summing’ process was done using the ‘R_Combine’ command in the OxCal program on the *uncalibrated* dates. This command creates an average of all the dates being combined. However, as opposed to simple averaging of the ages and standard errors, R_Combine creates a weighted average for the date and standard error by taking into account the full range of probabilities within each date. While the mathematics behind R_Combine command function can be technically complex, effectively it is just creating a more accurate weighted average of all the dates than a simple average would be (see Ramsey 2009 for a full description). As noted in Collard et al. 2010, using R_Combine in this fashion can introduce slight distortions to the data, as this function tends to underplay the actual variability within the combined ^{14}C dates. However, this distortion is usually slight and the benefit of being able to create a true average of the dates within each bin as opposed to simply picking a single date from it (which usually systematically biases bins) vastly outweighs this issue.

Once all of the uncalibrated dates are summed and binned, they must then be calibrated. Calibration of the dates is essential for accuracy. This is because uncalibrated dates are not ‘real’ dates but actually a scale-free measure for the relative amount of ^{14}C in an object (Ramsey 2008, 2009). As a result, uncalibrated dates are not particularly meaningful in any other context except very broad, ordinal ranking of events. Dates for this study were calibrated using the program OxCal 4.2.4 (Ramsey 2009, 2014) and the Marine13 and IntCal13 calibration curves for marine and terrestrial samples respectively (Reimer et al. 2013). Once calibrated, the dates were then summed, producing a SPD.

In order to offset the effects of peaks and plateaus in the calibration curve I used a 200 year rolling moving average. A ‘moving-average’ is calculated by averaging the value of each point on a scale with those closest to it over a defined number of periods. Moving averages are used to smooth out volatility (or noise) within a dataset in order to better understand real trends. For SPD analysis, the wiggle effects of the calibration curve are the ‘noise’ that a moving average is used to smooth out. A 200 year moving average was chosen for this analysis because as Timpson et al (2014), Williams (2012) Collard et al (2010) and Shennan et al. (2013) have demonstrated, the volatility of the Northern Hemisphere calibration curve (IntCal13) is most pronounced on a scale below 200 year intervals, therefore a 200 year moving average should mostly smooth out all but the most pronounced effects the calibration curve.

Once a moving average removes most of the small, spurious fluctuations in the SPD, the very large effects of the calibration curve can then be addressed by using a comparative simulation approach. Originally proposed by Ramsey (2001) and reiterated by Bamforth and Grund (2012) and Weninger et al. (2015), this method creates an SPD from simulated ^{14}C data to create a kind of null-hypothesis from which to compare our actual SPD. This simulation gives us a picture of what an SPD based on *completely unchanging* relative frequency of ^{14}C dates through time would look like. Therefore, any peaks and valleys observed in this simulation *are entirely* the result of the calibration curve and random sampling. If the SPD from the real data looks much like the simulated one, either no inference about population change can be made, or we can say that populations were probably very stable.

Next, because almost half my ^{14}C data set is from marine dates, it is important to address the comparability issues between marine and terrestrial samples for use in SPDs. The major problems stem from two sources; the first is that marine samples must be calibrated using a ‘Delta_R’, which is a localized correction factor that must be applied to marine samples coming from the region in question. The use of a local Delta_R is necessary because the carbon reservoir for marine sources can be very different than terrestrial ones and these reservoirs are substantially impacted by very localized oceanographic conditions (Ramsey 2008). Delta_R's for Haida Gwaii and Southeast Alaska were obtained from Southon and Fedje (2003) and Carlson and Baichtal (2015) respectively, while the Delta_R for the Dundas and PRH sub-region has recently been updated (Ames and Martindale 2014). The need for the Delta_R is discussed in detail below.

However, even if a perfect Delta_R is constructed, the bigger compatibility issue between terrestrial and marine samples arises because they must be calibrated using entirely different calibration curves (e.g. IntCal and Marine Cal). Because these curves are fundamentally different, it is incredibly difficult to create a single SPD using both marine and terrestrial samples[2]; there is no solution to this problem at this time (see section 3.3 for explanation). However, a useful approach to help address this problem is to model the SPD's for marine and terrestrial samples separately and then overlay them on each other to search for where and why they illustrate the same or different patterning through time. Once this is done a qualitative assessment of their composite pattern can be made for interpreting demographic trends (Kevan Edinborough, personal communication, 2014) (See below for further discussion).

The bulk of this radiocarbon analysis can be done using OxCal (Ramsey 2009) or CalPal (Weninger 2015), which are free software platforms and have built in programs designed specifically for radiocarbon analysis. However, fitting the data to an exponential

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[2] This is not the same as using a 'Mixed Curve' of the IntCal and Marine calibration curves to calibrate samples (e.g. human bones), which have high marine content and partial terrestrial signatures.

model and applying a moving average is done using PAST software, all of the SPD figures were also produced with this software (Hammer et al. 2001).

It is important to note here that none of the SPDs presented throughout the thesis are adjusted for taphanomic effects. Without question, taphanomic processes have significant effects on the shape and interpretations of SPDs, and important work has been done to help accurately correct for these processes in mainland European applications of SPD analysis (see Van Andel 2003; Surovel 2007; Shennan et al. 2013). The basic (and simplified) assumption of these corrections is that there is an exponential loss of sites through time, and by weighting younger sites less than older ones in SPDs we can correct for this effect. However, as others have noted (see Munoz et al. 2010; and Peros et al. 2011) because these taphanomic corrections were created using data from European mainland contexts, there may be some issues when transplanting them to North American contexts. This is especially true in coastal regions that have highly complex and localized sea level histories (i.e. the Northwest Coast). Data from the northern Northwest Coast is also much more subject to significant influence by researcher bias because of the comparatively few people who do research in the region. For various practical and intellectual reasons, this bias has greatly emphasized periods prior to ~8,000-9,000 cal BP and after 5,000 cal BP. Thus, almost the entirety of my study period (11,000-5,000 cal BP) has been categorically overlooked by archaeologists. Because of these factors, while taphonomic corrections are used successfully elsewhere, I felt that it is currently unclear what needs correcting for the time-period and region covered here and that it was best not to introduce any further distortion to the data.

3.4: Problem Solving the Marine Curve and Delta_R's:

Marine samples, especially shell fish, must be calibrated using a marine curve (instead of the terrestrial calibration curve) because the carbon cycle in the ocean works in a very different way than on land. The primary cause of this difference is from the slow mixing and exchange of carbon from deep and surface waters (Ramsey 2008). Deep waters cycle carbon much slower than the atmosphere, therefore when shells absorb carbon from deep water sources, they are actually absorbing carbon that is already hundreds of years old. Therefore, shells have a carbon signature of something that is much older and thus produce a ^{14}C date that is older than it should be. The marine curve controls for this by accounting for the slow carbon mixing in oceans and calibrates marine samples accordingly. Usually this amounts to around a 400 year correction, though it varies through time.

Because the marine curve must account for different carbon cycling than the terrestrial one, the marine curve is constructed using coral growth as opposed tree-ring comparisons. As a result of using different proxies, the shape of each curve is intrinsically different. This difference is also not systematic and the magnitude of differences between curves changes through time. Overall, this means that, on a fundamental level, marine and terrestrial samples cannot be combined for the purposes of creating SPDs.

However, this does not mean that terrestrial and marine samples cannot be used together effectively. In fact, there are actually methodological advantages in *not combining* these data sets. Because most marine samples are not taken for the purposes of being paired with terrestrial samples[3], marine and terrestrial data sets often track different things, and fill in apparent gaps that might exist in one data set or another. This helps us understand where sampling bias can be artificially inflating sections of our SPD and can be used to avoid invalid interpretations made by just using one data set or another.

For example, if we look at our SPDs from terrestrial and marine sources and find they have very different patterning, we can use this to investigate the data and see why. This process can be critical for avoiding spurious inferences from a single data set, especially if the marine and terrestrial data have inversely correlated patterns. To illustrate this problem, imagine that shell middens become more common through time and thus shell/marine material becomes more likely to be dated than rarer charcoal samples. If one had just looked at the terrestrial SPD it would appear as if populations plummeted as middens became more common. And had we just looked at the marine SPD it may appear that populations sky-rocketed with the appearance of middens. However, by looking at the two together, a more nuanced picture occurs, that may suggest populations were more static than either SPD suggests and that a change in site-type is affecting sampling. In these cases, where the data say very opposing things, it is hard, if not impossible to make any definitive statements about the patterns without an in-depth exploration of the data, except that we should be cautious in our interpretations of demographic changes.

Ideally, what we are looking for is a general agreement in the patterning of events between the marine and terrestrial SPDs. If the two data-sets match up very well and both

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[3] Delta_Rs are constructed by comparing terrestrial and marine samples that date (roughly) the same event and then looking at the difference between the two. Dates taken for this purpose are referred to as paired samples.

have robust sample sizes, inferences about population dynamics become much stronger, especially since preservation and sampling biases surrounding marine and terrestrial samples can be very different.

However, as mentioned above, establishing if there is a good fit between these data is further complicated by having to use Delta_R corrections for marine samples. A Delta_R is a correction that accounts for localized variations in carbon absorption by marine samples and is applied to a marine sample after the global marine correction has already been applied. It is important to note that Delta_Rs are not trivial and range anywhere on the Northwest coast from -200 to -800 years (meaning the sample is 200 to 800 years younger than it appears) and therefore are a critical component to any use of marine ^{14}C dates. Delta_Rs can also vary significantly between even very proximal locations. For example, the newest Delta_R for the Prince Rupert Harbor region is estimated at around -288 years. However, just north in Southeast Alaska, Delta_Rs are estimated to be between -550 and -800 years. With local corrections being so volatile, yet so critical for the correct calibration of marine samples, it is easy to see why they have the potential to make temporal comparisons between marine and terrestrial SPDs very difficult.

Knowing this about Delta_Rs and knowing that the marine calibration curve is constructed differently and has a different shape than the terrestrial one also cautions against reading too much into small differences in timing between terrestrial and marine based SPDs. Thus, when I say that the patterns should match well, I am referring to the shape of the SPD, more than a correlation in the exact timing between curves. How much allowance one should make or expect when correlating the patterns between marine and terrestrial SPDs is a fairly subjective endeavor and expectations must be adjusted for each research context. As there is no *a priori* reason that the marine and terrestrial SPDs *should* match, much less correlate perfectly. For example, differences in soil and other preservation conditions may favor the survival of shell fish as opposed to other organics. Moreover, changes in subsistence can dramatically change the relative abundance of marine and terrestrial dateable material. Thus, while a strong correlation between SPDs can help corroborate patterns; little correlation does not necessarily invalidate a pattern. These problems should also caution against interpretations made by analysts using this method who have little or no background in the area they are analyzing.

CHAPTER 4: ANALYSIS

In this chapter I apply the methods described above to the actual data in a step-by-step process. I also introduce, describe and summarize the environmental, technological and settlement pattern data (Section 4.4 and subsections within).

Section 4.1 looks at the comparability of the marine and terrestrial SPDs after accounting for possible biases and errors being introduced from different Delta_R effects (see appendix VI) 4.2 investigates the effects of the marine and terrestrial calibration curves on the marine and terrestrial SPDs. Section 4.3 then discusses the demographic trends seen in the SPDs after controlling for the effects of the calibration curves and the differences between the marine and terrestrial SPDs. Lastly, to account for spurious oscillations caused by the calibration curve and overrepresentation of data from certain sites, the ^{14}C dates went through the process of summing/binning. Afterwards a 200 year moving average was then applied to the SPDs. For the sake of brevity I do not show these steps below, instead all SPDs based on the actual archaeological data shown below have already undergone these processes. For a short example of this process please see Appendix V. Appendix VI further provides detailed analyses regarding the effects of using different Delta_R corrections as well as exploring how the different sub-regions are effecting the overall shape of the region-wide SPDs and whether or not the region-wide SPDs are being significantly biased by one of the sub-regions.

4.1: Comparability of Marine and Terrestrial SPDs

Figure-5 below demonstrates the good overall match between the SPDs generated for the marine and terrestrial samples. Analysis detailed in Appendix VII further shows that the patterns within these SPDs are not overly biased by any particular sub-region within my study area and that the Delta_Rs used appear to be fairly accurate.

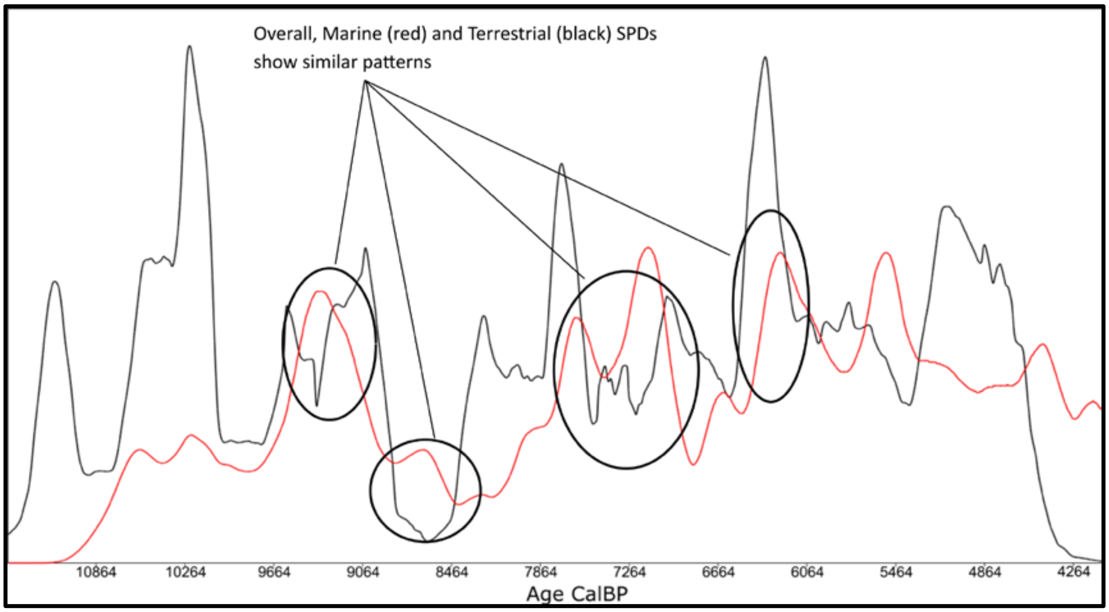


Figure 5: Showing similarity comparison between marine (red) and terrestrial (black) SPDs. Circles highlight specific areas of congruent patterning.

The good match in patterning between marine and terrestrial SPDs shown in figure-4 is significant because it suggests that neither pattern is being largely driven by differences in sampling strategies between researchers (e.g. some researchers are more willing to date shell than others) and that they are not tracking entirely separate sequences of events. With this in mind, I now turn to examining how patterning within the marine and terrestrial SPDs may be being driven by the calibration curve.

4.2: Effects of the Calibration Curve

In this section I look at the effects of the calibration curve on the shape of SPDs. As many authors have noted (See Williams 2012, Timpson 2014; Weninger et al. 2015) the shape of any SPD will be influenced by the shape of the calibration curve itself. For example, peaks on the calibration curve will either create artificial 'spikes' in the SPD or exaggerate existing ones. Meanwhile, plateaus on the calibration curve will smooth away any volatility in the SPD and create artificial periods of stability (a flat line) on the SPD.

As discussed in the methods section, rolling averages are used to mitigate the influence of the calibration curve, but to more accurately address these influences it is important to compare my constructed SPDs to what are effectively null-models, which will reflect (i) what no change in relative density of radiocarbon would look like over the study period. It is important to note that there will almost always be portions of the SPD exaggerated by the calibration curve. Therefore, it is important to look past short term wobbles being exaggerated and instead examin whether or not the calibration curves create artificial *patterns* of growth, decline or stability. This comparison will be done for both the terrestrial and marine samples. Though I use GLM (generalized linear models) to illustrate patterns within the SPDs, I do not discuss any of the statistical values for the GLM model in detail as the GLM in this section is used for illustrative purposes only. The reasons for this are given in Appendix VII. It should be noted here though that while the GLM shows growth in both the marine and terrestrial SPDs created from the actual archaeological data, none of GLMs were statistically significant (P = .219; for marine and

P= .903; for terrestrial) meaning that we cannot say with any certainty that they depart from zero trend.

4.3: Marine Sample Analysis

Figure-5 below shows what an SPD using the marine curve would look like if there was no change in the relative amount of ^{14}C dates through time and serves as a sort of null hypothesis. This SPD was constructed by simulating a radiocarbon date for every calendar year in 70 year intervals with a 30 year error. These simulated radiocarbon dates were then calibrated and used to construct the SPD. Since multiple ^{14}C dates can calibrate to the same calendar date, the simulation randomly generates one of the possible options. This process is reiterated hundreds of thousands of times. The final figure below shows the most likely outcome of these generated dates.

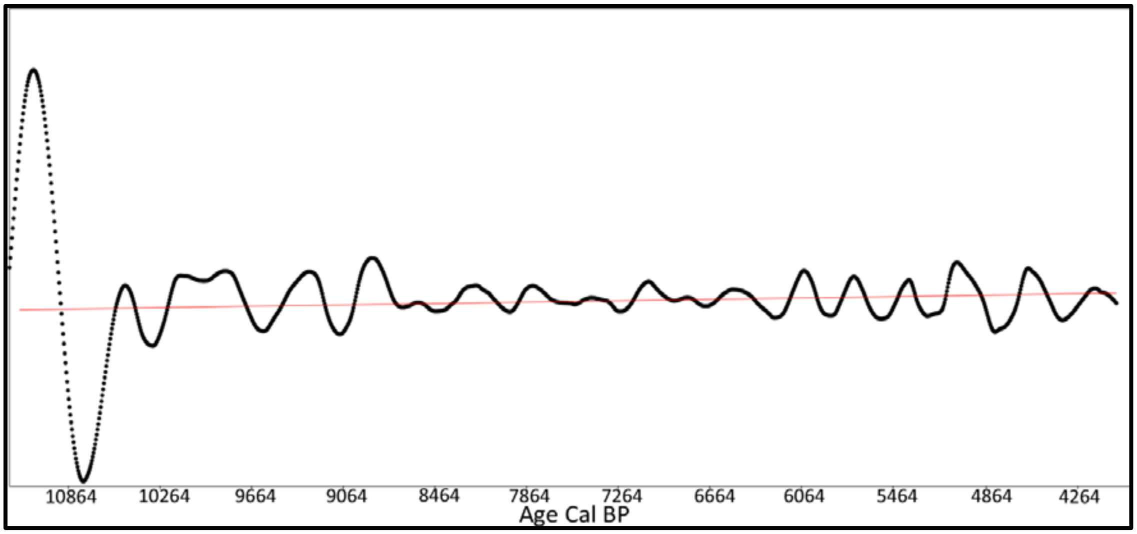


Figure 6: Showing SPD created from a simulated, uniform distribution of calendar dates using the Marine13calibration curve. The red line shows a best-fit GLM line (P=.987), indicating that there are no significant trends through time

As figure 6 shows, there is volatility in the SPD even when there is no change in relative density in real or calendar time. The red line through the graph is a fit line from a generalized linear model (GLM), which indicates that despite the volatility, the mean density remains stable through time.

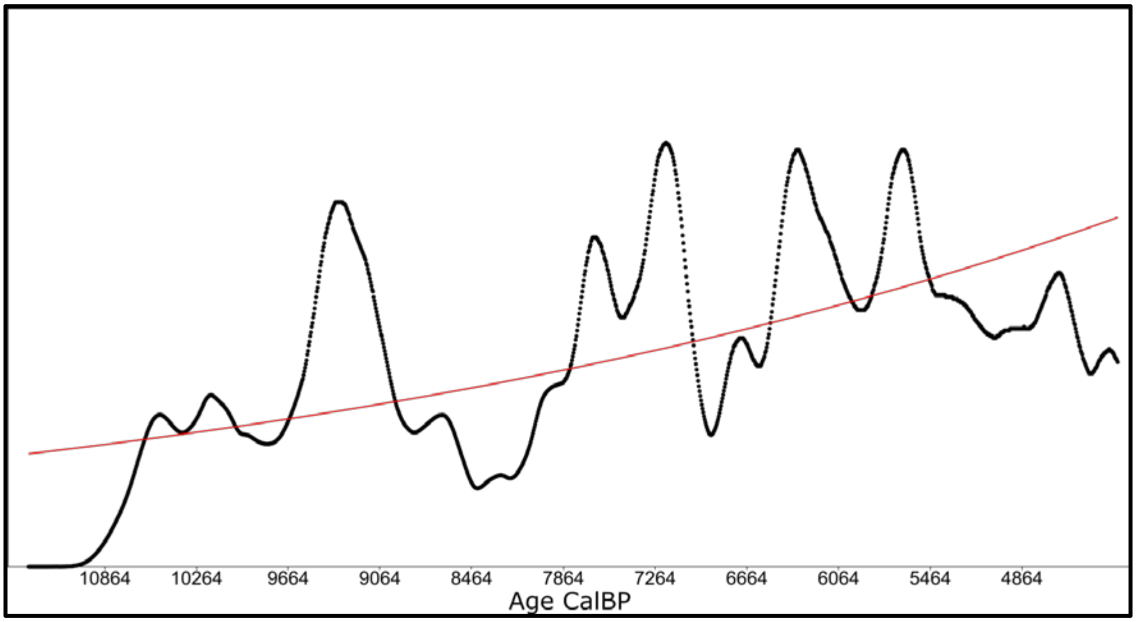


Figure 7: Total marine SPD from the actual archaeological data. Red line shows best fit GLM (P=.219). Though GLM is statistically insignificant, Note that the signal of growth is much stronger in this SPD than the control sample.

This SPD (figure 7) created from the actual (marine) archaeological data is very unlike the null model above (see figure 8 below for direct comparison). Not only does it have much less short term volatility, its peaks and valleys are in entirely different places. Another significant difference between the real SPD and the null models is that the real one shows a stronger signal of growth over time, indicating that whatever the effects of the calibration curve, they are overridden by the signal in the actual data. However, the calibration curve is also clearly exaggerating certain aspects of the marine SPD. On a closer comparison major increases in the actual marine SPD at 6,500 and 5,400 correspond very closely to similar peaks in the null-models, meaning that the magnitude of their increase is probably much less than is apparent. In general, this is why you cannot read too much into oscillations between high and low peaks on an SPD, as these are almost always exaggerated by the nature of the calibration curve itself (Weninger et al. 2015). Some have argued that these short-term oscillations represent demographic boom and bust cycles. However, given the effects of the calibration curve and sampling issues, these short term spikes are probably spurious and do not reflect any real demographic events.

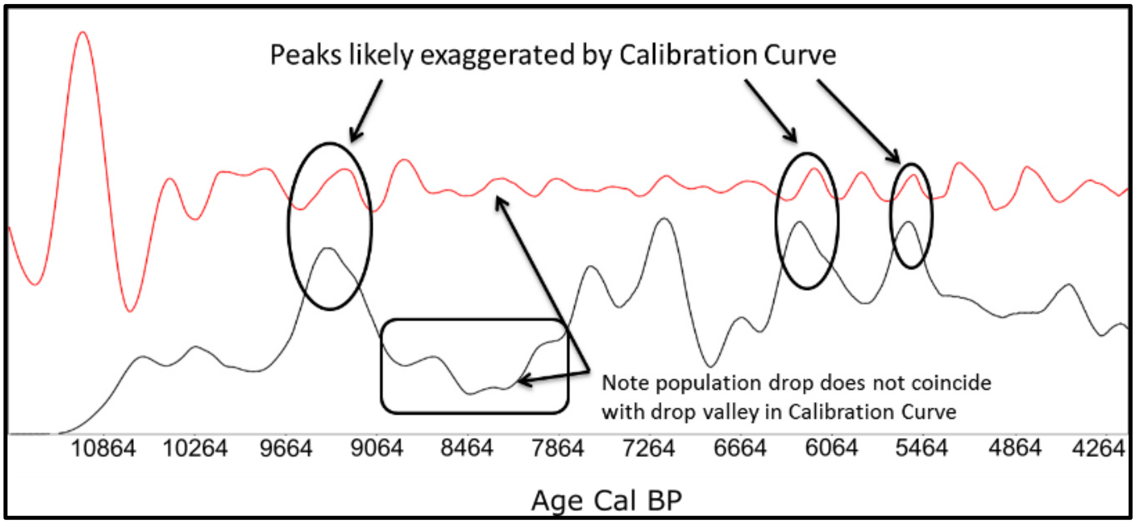


Figure 8: Direct comparison between uniform density control (red) and archaeological (black) marine SPDs.

Comparison between the marine null-model and the actual marine SPD suggests that while the marine SPD is obviously influenced by the calibration curve, it also differs considerably in many ways and demonstrates a stronger increase in its central tendency than is represented in the null-models. Therefore, we can conclude that on a broad level, general patterning in the marine SPD is not simply an artifact of the calibration curve.

4.4: Terrestrial Sample Analysis:

Figure-8 below displays the results of the same random sampling simulation used for the marine null-model (see figure-7), but uses the terrestrial curve instead. As with the marine control sample, we can see that there is a lot of volatility with this graph. Again though, this volatility centers around a stable central tendency, as the GLM fit line shows there is no meaningful change in the central tendency throughout.

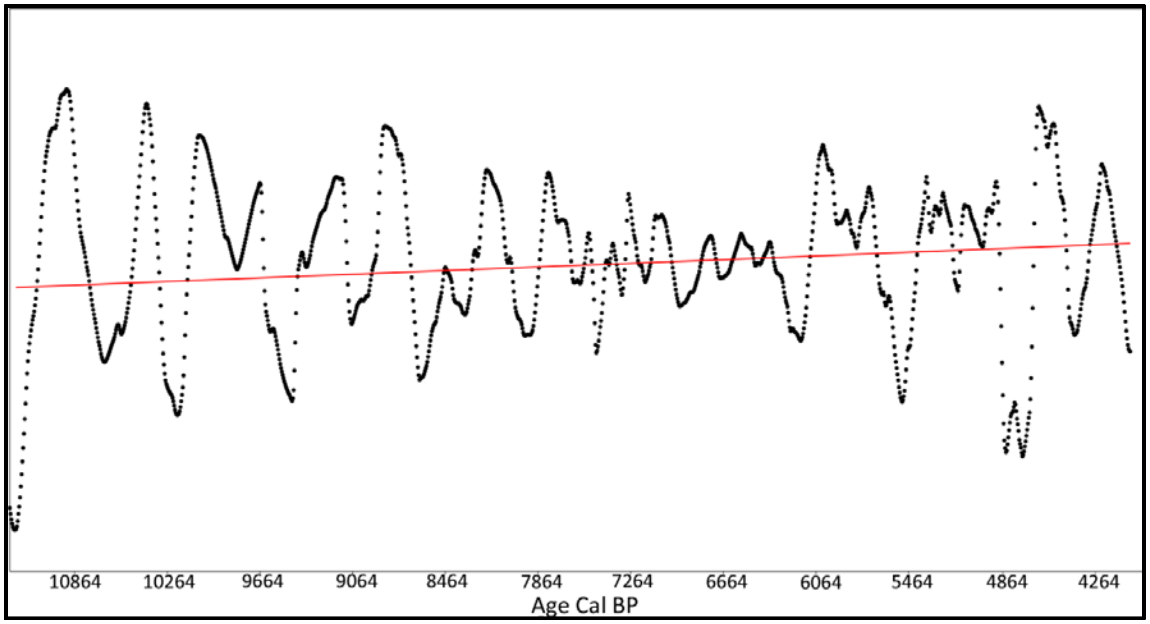


Figure 9: Null-model of SPD created from a simulated, uniform distribution of calendar dates and using the IntCal13 calibrations curve. Note that GLM best fit line (P=.903) shows there is no change in relative probability through time.

Figure-9 shows the shape of the terrestrial SPD using the actual archaeological data. When compared with the previous null-model we again see that there is little similarity in their overall patterns. The actual terrestrial SPD has important noticeable features such as the dramatic dip at ~8,800-8,400 that is not present at all in the null-model. The general increase in stability following 8,400 is also much stronger in the real SPD than in the control sample. With these comparisons in mind I feel that it is safe to infer that patterning within the terrestrial SPD is not totally attributable to the effects of the calibration curve.

To better illustrate the differences between the control and actual terrestrial SPD figure-11 overlays the two. Again, looking at this figure it becomes very clear that patterns present in the actual SPD are not driven by the calibration curve.

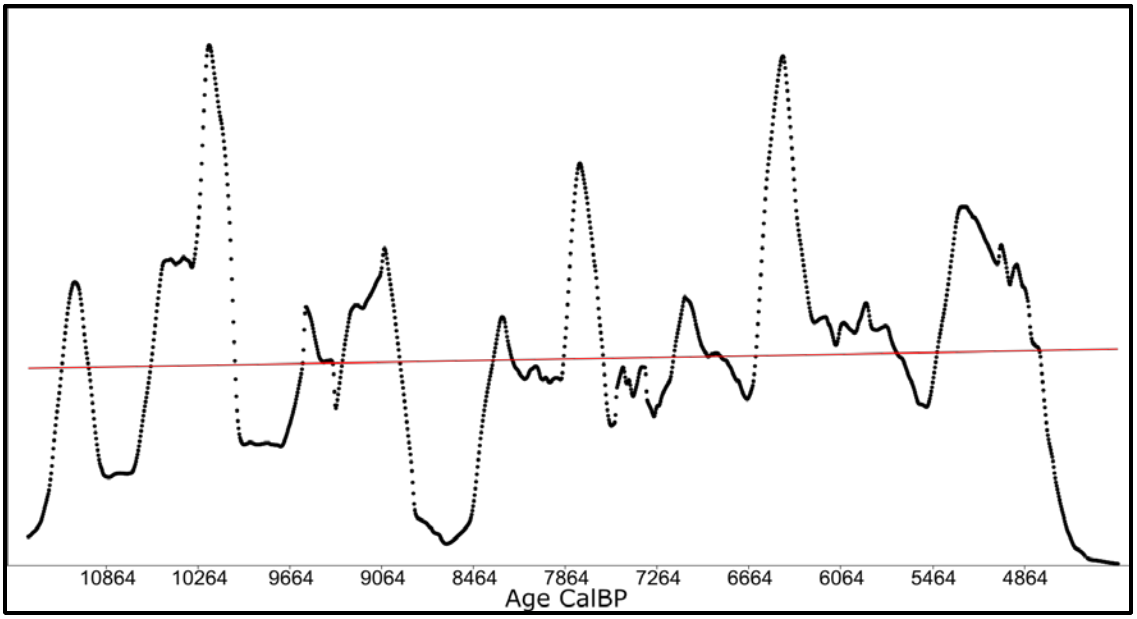


Figure 10: Showing terrestrial SPD created from the actual archaeological data. Note that GLM (P=.903) indicates that there is no change over time.

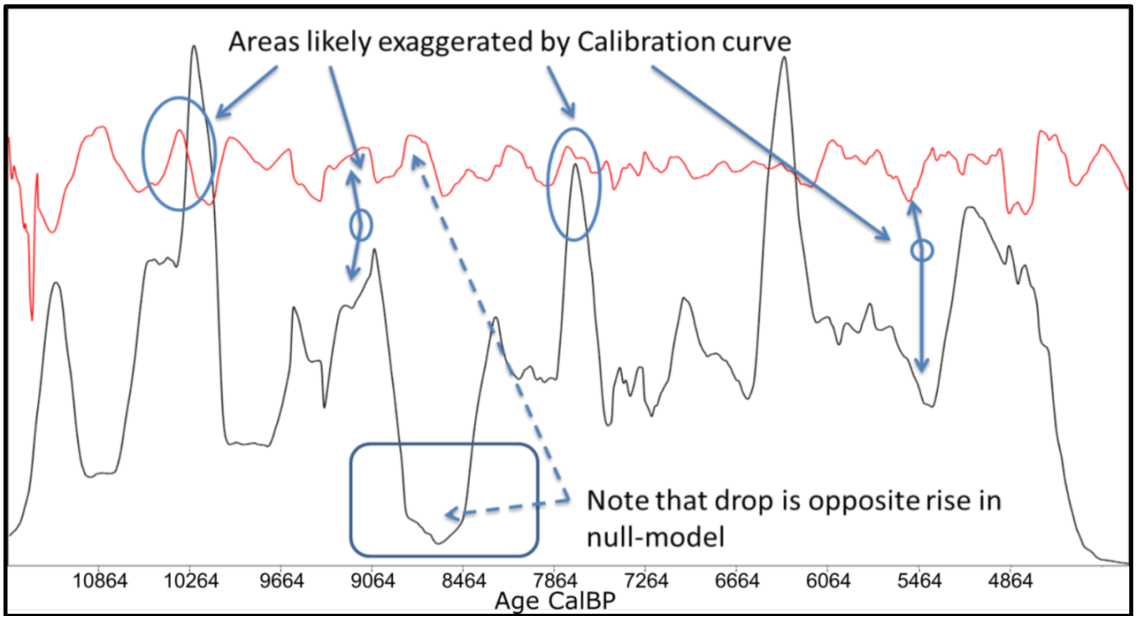


Figure 11: showing comparison between control (red) and real (black) terrestrial SPDs. Highlighted areas show places where calibration curve is likely exaggerating shape of real SPD.

4.5: Summary of Comparisons

In both the marine and terrestrial cases, there is little reason to believe that the general patterning of SPDs is significantly driven by the shape of the calibration curve itself. However, this does not mean that various parts of both SPDs were not being exaggerated by the shape of the calibration curve, which cautions against reading too much into any of the individual peaks and valleys. The GLM method employed here suggests that there are differences in the central tendencies between the real and control SPDs, which is shown by a weak but noticeable growth in the relative probability density of radiocarbon dates in the actual SPDs through time.

4.6: Assessing Demographic Trends

Having examined the SPDs for various internal biases, analysis of the overall marine and terrestrial SPDs for demographic trends can proceed. Keeping in mind the various problems and biases discussed above, some interesting demographic trends are apparent within these SPDs. However, directly interpreting SPDs is trickier than it seems, and is somewhat intuitive. This is why the previous steps in the analysis were essential, as they allow us to better understand what is 'noise' and what is real within the SPD. In general, as demonstrated recently by Weninger et al. (2015), peaks are much more likely to be exaggerated than valleys, and sharp peaks are almost always artifacts of the calibration curve and sampling. Therefore, considerable caution should be taken when interpreting sharp peaks or valleys as increases or declines in population, since these peaks would often be much more muted if the calibration curve was perfect.

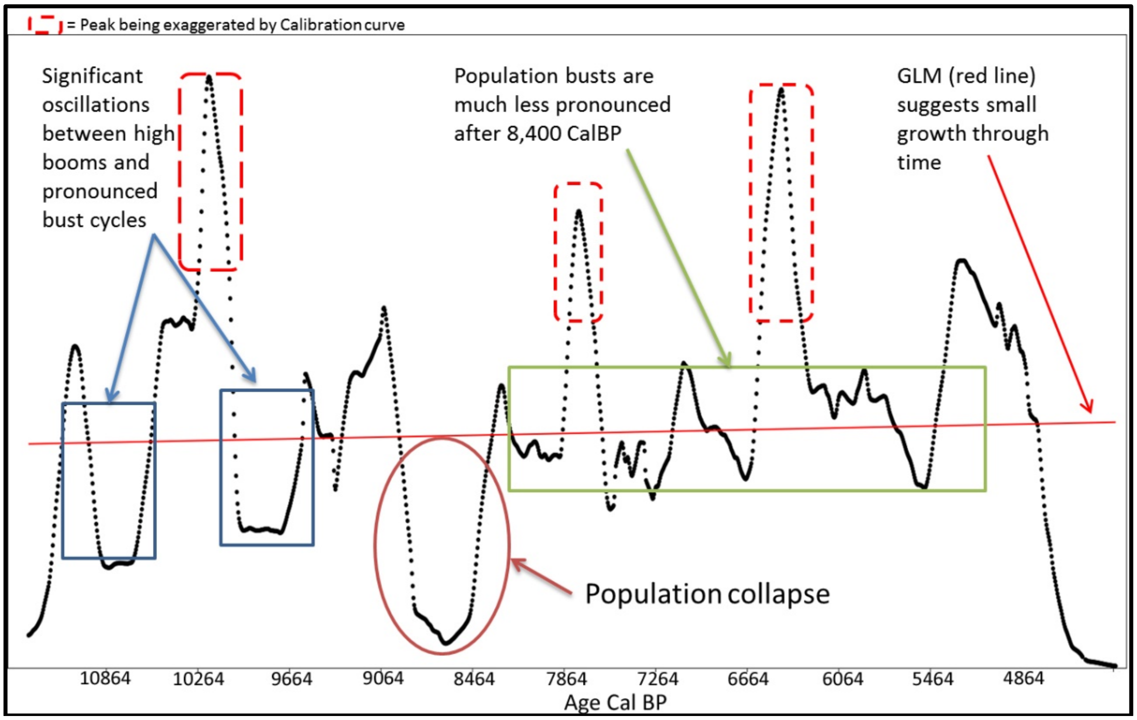


Figure 12: Terrestrial SPD with GLM detailing significant demographic events. The GLM shows a slight signal of growth, but is statistically insignificant at the .05 level.

Figure 12 displays the total terrestrial SPD with significant changes in demographic patterns highlighted. The first of these patterns is in the early Holocene, where population levels reach heights similar to those seen throughout the middle Holocene. However, there is some dramatic variance within the period between ~11,000 and 9,000 cal BP, which is best indicated by the much wider nadirs between SPD spikes for this time. The period between ~9,000 and 8,400 Cal BP, indicated by a red circle in figure-11, highlights an area of massive population collapse with a probability density close to approaching zero. This crash is the most pronounced of any trend throughout the whole period under study, is seen in every sub-region and in both the marine and terrestrial SPDs. Moreover, this drop occurs when there is a peak in the control sample (see figure-10), further strengthening the inference that this population collapse is real. The last trend (post 8,400 cal BP), which follows the collapse, shows a region wide recovery in population, that reaches heights greater than seen in the early Holocene. Unlike the early Holocene peaks, however, the population nadirs following 8,400 cal BP are not as severe and much shorter lived. The peaks during this later period, once the influence of the calibration curve is accounted for, are also not as high relative to the nadirs. Taken together, this indicates that while there is an overall (slight) increase in population, this is almost entirely accounted for by stabilization in population size and not necessarily by higher absolute populations at any given time. To test the validity of this stabilization, coefficient of variation (CV) statistics were calculated for periods prior to and after the population collapse. The CV value prior to collapse is 51.79, while CV post-collapse is 32.42. A Fligner-Kileen (Fligner and Kileen 1976) test for equality of variance was then run to see if the differences between these values were statistically significant. This test found that CV values were significantly different at the .0001 level. Since a lower CV value indicates *less* variation, this test suggests that variance in population levels decreased significantly following 8,400 cal BP.

This stabilization in the terrestrial SPD following ~8,400 Cal BP may be interpreted as simply reflecting more stable populations. However, it may also be suggestive of a region-wide shift in use of the landscape, which may (i) indicate population packing and (ii) be masking a stronger signal of growth. For example, if people changed their mobility strategies to focus on the use of fewer sites more often (as in residential movements become focused around fewer sites) and for longer periods (time spent at each site increases) this would, overall, create a pattern of fewer, but more continuous and archaeologically visible sites. In turn, these larger and more visible sites are usually more likely to be investigated archaeologically and therefore to be dated. As a result, the decrease in variance seen in the SPD may be more a reflection of decreased variance in archaeological sampling detecting sites due to their increased visibility.

By this same line of reasoning, an increased number of people utilizing fewer numbers of sites per time period will *not* be reflected as population growth in an SPD (which uses number of sites as a proxy for population) even though the number of people on the landscape may have increased significantly. Given that there actually is a slight growth in the terrestrial SPD and a significant decrease in variance, I find this suggestive that the SPD is reflecting a change in mobility patterns towards more structured use of the landscape and towards longer term use of sites probably brought about by a packing of the landscape reducing the utility of residential mobility as a tool for risk mitigation. With this in mind, I would also argue that there may be much more population growth than is currently being detected by the SPD as well. This hypothesis that is further bolstered by the fact that the period between ~8,500 and 6,500 Cal BP has had comparably much less sampling effort than earlier or later periods on Haida Gwaii (Fedje et al. 2011) and Dundas Islands (Martindale et al. 2010), which may further hide a signal of increasing population levels.

Aside from the population collapse in the middle, it is important to note that observed growth in population is probably quite minimal, though the increase in stability is significant. Therefore, it would be more accurate to picture this time period as one of remarkable continuity in the average population levels, with decreasing amounts of variance through time. Figure 13 shows that the marine SPD has a very similar trend to the terrestrial, though the marine SPD has a slightly stronger signal for growth during the latter period.

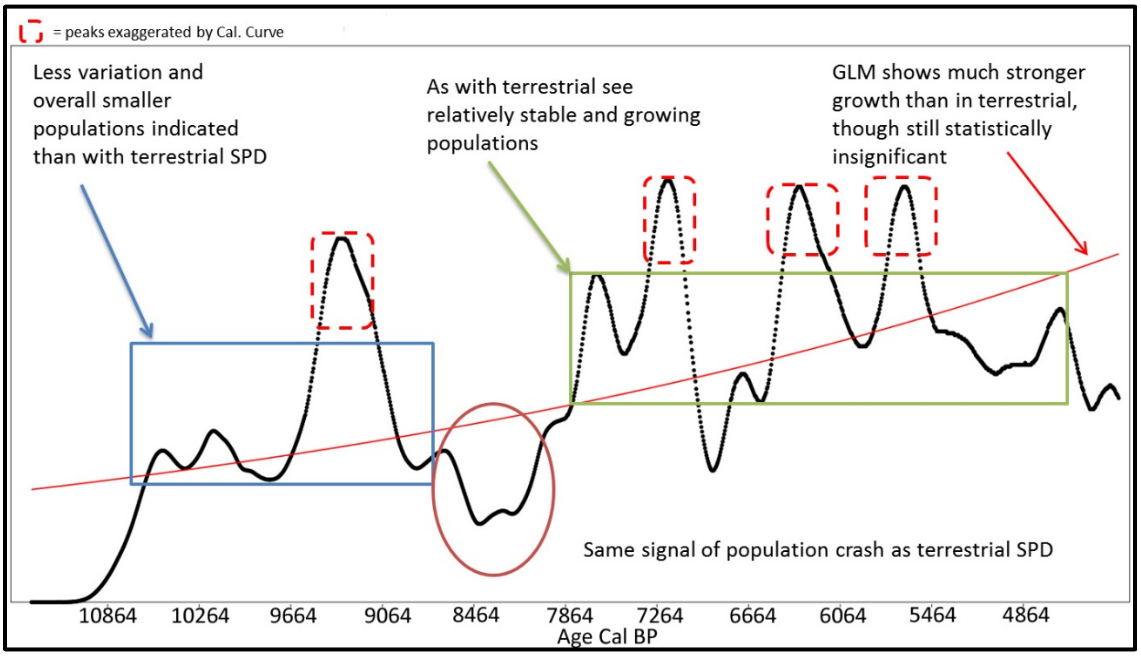


Figure 13: Showing marine SPD with GLM highlighting significant population events. Note that GLM shows moderate signal of growth, but signal is insignificant at the .05 level.

Brief Summary of Major Results

The figures above paint a picture of boom and bust cycles that center on a relatively stable population mean. However, while still a tentative finding it does appear that populations after ~8400 Cal BP are subject to much less severe oscillations, which may be a product of population packing, and show a stronger signal of growth.

The major exception to this overall trend is the catastrophic population collapse between ~8,800 and 8,400 Cal BP. This collapse was found in every sub-region and was present in both the marine and terrestrial samples and thus is likely a region-wide phenomenon. To date this is the first mention of this collapse. Interestingly, after this region-wide collapse, populations recover quickly to previous population levels. This suggests that something either greatly accelerated the natural growth rate of the people who survived the crash or that people moved back into the area after 8,400 cal BP.

Currently, there is little evidence regarding the possible causes or effects of such a population collapse. While it enticing to relate it to a strong cold snap that happened at ~8,400 cal BP (discussed below in more detail), the timing of these events are offset substantially. The localized timing of climate events, however, can be prone to fairly large errors. Thus the population collapse and environmental change may correlate better than initial analysis suggests. It is also possible that this collapse is a product of sea-level changes obscuring sites of this age. Though, given how localized sea-level histories are in the area and that all sub-regions in the study area were effected, this seems somewhat unlikely.

The oddity of this event is further enhanced by the fact that there are no major differences in the material record between sites proceeding and those coming immediately after the crash. Moreover, there is currently no genetic evidence (see Cybulski 2001; Cui et al. 2013) for a population replacement in any part of the region for this time period, which makes a population replacement event unlikely. Therefore, while this event clearly requires further research, for now, I am left without much to say in regards to its causes or possible effects on mobility patterns.

4.7: Environmental, Technological and Settlement Pattern Summaries

4.7.1: Synthesizing Environmental Data:

Because the hypotheses being evaluated cite environmental pressures as a significant factor in changes to mobility and because studies of hunter-gatherers are often intrinsically linked to environmental variables (see Kelly 2007) a synthesis of the available environmental data for the study area is provided below. As with any historical dataset, paleo-environmental data must be carefully evaluated and can be extraordinarily difficult to summarize coherently. Among other, broader issues (i.e. sample representativeness), cohesion in environmental syntheses is difficult to obtain largely because paleo-environmental data comes from very different sources, which all proxy environmental change in different ways and at potentially very different scales (Cronin 2010: 28-38; Elias 2010). Temporal resolution among the proxies is conditioned by two major components in environmental data (i) the speed at which a variable responds to change and (ii) the amount of detail or nuance the proxy is capable of capturing (Evans et al. 2001: 55). For this research I rely on previous studies that have emphasized three different proxies: 1) pollen and macrobotanical data, 2) glacial expansion and contraction data, 3) the GISP2 ice-core data from Greenland. Although not an environmental proxy, I also provide a very brief illustration and description of sea level change between 11,000 and 5,000 cal BP>

Pollen/Macrobotanical Data

The data from pollen/macrobotanical sources often come from cores taken from lakes and bogs/mires. These proxies track climate changes through shifts in vegetation and soil development or sedimentation. The strength of this proxy is that it can provide excellent detail about changes in the actual resource availability for humans, but is probably the slowest proxy for tracking change. The slow tracking of this proxy is because change of species composition in forests, especially in dense forests with long lived trees (like the Northwest coast), is inherently a slow process. Trees can be extremely long lived and can be quite tolerant of variation in environmental conditions, especially if the climatic variation comes in short intervals. This means that not only does climate change have to be particularly large in magnitude, but it must also persist for extended periods of time in order to force plant composition change in long-lived, dense forests (Elias 2010; Heinrichs et al 2002). Our ability to detect this change is further complicated because of the extended time it takes for new species to stand out in an archaeological context. Because of these factors, pollen and macro-botanical data can lag hundreds and up to a thousand years behind initial climate change (Elias 2010).

Glacier Data

Glacier data, which tracks the advance and retreat of glaciers, can have much greater temporal resolution than pollen data, even getting at a decadal level scale. However, glacial data provides much more limited information about resource availability than pollen/macrobotanical data. Broadly speaking, changes in glacier activity track changes in temperature and moisture, with advances happening during cold and moist conditions and glacial retreat happening during warm and dry conditions. This picture is muddled by climate changes that do not fit into these two states. Thus it is possible for glacial advance to occur when moisture increases but there has been no change in temperature and vice versa. Elevation must also be taken into consideration when extrapolating from glacier data, as glacial histories mostly reflect changes at higher altitudes and may not always be reflective of climate change experienced at lower levels (Clapperton and Seltzer 2001; Luckman and Villalba 2001)

Greenland GISP2 Ice-Core Data

This data set tracks temperature (among various other variables) at extremely fine scales (up to 1-3 years in some special cases), by measuring changes in chemical compositions trapped within the Greenland ice-sheets. However, while this is probably the *most globally* precise and accurate of any of the environmental proxies, it can lack precision when used to infer changes within localized contexts (O'Brien et al. 1995). This is because the GISP2 data is more or less an aggregation of changes happening across the world (Peltier and Fairbanks 2006). For example, this means that if Europe begins to experience a spike in cold temperature, but North America stays the same, the GISP2 may still show a cold event, even though certain regions across the world never experienced it.

Sea Level Data

Sea level change is an important variable to understand when interpreting the archaeological history of coastal areas due to its effects on habitability and site visibility. However, because sea level histories have shown to not only be highly complex, but also incredibly localized (McLaren 2008; Carlson 2012; Fedje et al. 2005; Shugar et al. 2014) I cannot give a detailed account of sea level change for each sub-region. This problem is further compounded by the fact that the regional and local sea level histories for the North Coast area have only recently begun to be systematically studied and as such we have quite varied information between areas and time periods making regional comparisons difficult (Shugar et al. 2014). With these qualifications in mind, below I give a very brief and generalized view of broad trends in sea level change.

Interpreting Proxies

With aforementioned in mind, it is imperative that any environmental reconstruction use multiple proxies that are constructed through different methods Cronin 2010; Evans et al. 2001) and are the effects of different kinds of change. Furthermore, trends observed regionally, can play out very differently at local scales. It is also important to recognize the differences in lag between these proxies when making interpretations (Cronin 2010: 38-39; Evans et al. 2001). For example, if the glacier and GISP2 data point to a climate warming about 2,000 years ago, but the pollen/macrobotanical data shows a warming at 1,500 years ago, it is likely that they are tracking the same event, as pollen/macro-botanical data will almost always lag (Cronin 2010: 38-39; Elias 2010) Therefore, it should be completely expected that different proxies will, at first glance be contradictory or offset.

For example, if we see glacier advance as signaling a cold/moist period and the expansion of trees that indicate warmer temperature at the same time, instead of interpreting this as a clear contradiction we should seek to understand the other possibilities, such as; we know that glaciers will advance with an increase in moisture, not just a decrease in temperature. So it is possible that this is signaling a change to a warmer and moister climate, but not one that got so warm as to inhibit the freezing of the increased moisture. In my environmental synthesis, I emphasize that each proxy records different things at different scales. Instead of focusing on discrepancies, I focus on highlighting congruence. The following section summarizes the data from each proxy and then combines them together in a generalized, synthetic format at the end. The temporal data for all environmental proxies is presented as calendar years before present (1950). Any ^{14}C dating that was used has also been calibrated and presented as such.

4.7.2: Pollen Data

The following synthesis is based on the work by LaCourse and Mathewes (2005), Hebda et al. (2005), McLaren (2008), Pellatt and Mathewes (1997), Turunen and Turunen (2003), Hetherington et al. (2003), Banner et al. (1983) and Cronin (2010: Chapter 8). All of these studies took place or drew data from the North coast region. Data is primarily from pollen and macrobotanical data gathered from lake sediments, bogs/mires, and intertidal sediment cores. Because pollen and macrobotanical studies can be, by their nature, extremely localized, this data set was by far the most ambiguous and contradictory on a regional level. For the purposes of coherence the following synthesis has qualitatively averaged many of the beginning and end dates for inferred climate changes.

Table 2: Summary of pollen/macrobotanical data, all dates given as calendar years before 1950.

11,000-10,000: End of the Younger Dryas event. The end of this period sees significant warming and stabilization of the Holocene climate in general.
10,000 - ~8000: Post 10,000, the weather is much warmer and drier than modern and the environment was much less forested than today, with open plains and parkland much more prevalent. This period is sometimes referred to as the "Holocene Xerothermic"

~8300-7500: A dramatic cold period begins here. This cooling is much more severe and long lasting than that experienced in the little-ice age. Terrestrial productivity plummets during this time, as very wet and cold conditions facilitate rapid buildups and expansions of bog and mire systems across the North coast. This time was much colder than modern. To date, this neoglacial cooling event (palynologically) is poorly understood, but is widely corroborated across the entire northwest of North America. The exact timing of this event is *highly* variable between studies. The duration shown here represents the total range of begin/end dates for this event from different studies. Up until ~8300-8000 climate studies are remarkably consistent across the North coast area. This period marks the beginning of highly localized and regionally discordant climate change that is characteristic of the middle through late Holocene.
7500-7100: After the cold event, a maximal warm and wet period takes hold. The Holocene has yet to be this warm again.
7100-6900: Maximal warming ends and a cooling trend begins. Rainfall and moisture remains similar to the previous period.
6900-5000: Gradual cooling trend continues. However, temperatures remain well above modern. Evidence indicates that forest and terrestrial productivity *begin* to recover at ~6900.
~8300-7500: cooling event. Sometime between 6500-5000 temperature cooled to modern levels. This same period is also when we see the proliferation of Western Red Cedar. Moisture remained high throughout this time. Around 5000 we also see that forests and terrestrial productivity returned to pre-8000 levels.

4.7.3: Glacial Data

The following is a synthesis and summary of Denton and Hughes (1981), Peltier and Fairbanks (2006), Banner et al. (1983), Harvey (1980) and Cronin 2010) and is based on data from St. Elias mountain range, the Yukon area, the Canadian Rockies, White River Valley AK, and Baffin Island in NE Canada. It should be noted that data from Alaska and the Yukon were given precedence in interpretations and research further from my study area (Peltier and Fairbanks and Miller) were used to fill in missing data gaps.

Table 3: Descriptive summary of glacial data, all dates given as calendar years before 1950

11,000-10,000: This period marks the beginning of the Holocene and the Younger Dryas, which is a return to full glacial conditions and is indicated by a major glacial re-advance of glaciers across the northern hemisphere. This period is significantly colder than any other time in the Holocene.
10,000-8400: This period is not well documented in glacial studies. However, it is uniformly understood to be a time of significant warming that was in stark contrast to the preceding Younger Dryas. The period immediately after 10,000 cal BP also marks a general stabilization of the climate, when the magnitude of variance is minimal compared to that of the Pleistocene and the Pleistocene-Holocene transition.
8400-8000: This period is characterized by a dramatic drop in temperatures and widespread glacial advances. Other than the Younger Dryas this is by far the most pronounced cold regime so far experienced in the Holocene. However, the timing and duration of this cold period is quite variable across studies. Different studies from different regions have it originating between 8700-8200 and ending sometime between 8000-7800. It is possible that all of these are true, as glacier activities can be highly variable in different parts of the world. The St. Elias and White River data are most consistent with one another and show that this cold spike lasted between 8200-7900 BP.
7900-5300: A significant warming event called the Hypisthermal began ~7900 BP and is characterized by much warmer and possibly drier conditions than present today. The reconstructed magnitude and length of this event vary widely among researchers. There is actually a lot of variability in temperatures (and perhaps moisture) during this period, but the coolest points never reach modern ranges. This has caused some researchers to signify this entire time range (some even as recent as 4900) as the Hypisthermal. Others, however, divide this period into multiple segments to better reflect its variability, especially the time period between ~7100-7400 which may have seen significant warm spike that exceeded anything else known throughout the Hypisthermal.
5300-4900: A significant cold spike begins during this period and lasts until ~5000-4900 when another warmer and possibly moister regime begins. It is about this time that mean annual temperatures and variability in them approach those present today.

<u>4.7.4: Ice-Core Data</u>

The ice-core data I present here comes from the GISP2 ice cores. There actually 4-6 major sources for ice-core data, those offer slightly different data and measure different chemical compositions. However, the GISP2 is one of the most commonly used and graphically, the most easily interpretable. With this being said, the actual GISP2 ice-core image (see figure 14), is not necessarily an accurate representation of climate trends as it does not reflect the statistical error (2-3%) that derives from the counting statistics used when measuring chemical compositions of the ice sheets. Therefore, while the image itself is a useful, quick and relatively reliable guide to climate changes throughout the Holocene, one must refer to actual analyses of the ice-core data when making detailed comparisons. The synthesis presented here comes from work by O'Brien et al. (1995), Denton and Karlen (1973), Harvey (1980) and Peltier and Fairbanks (2006).

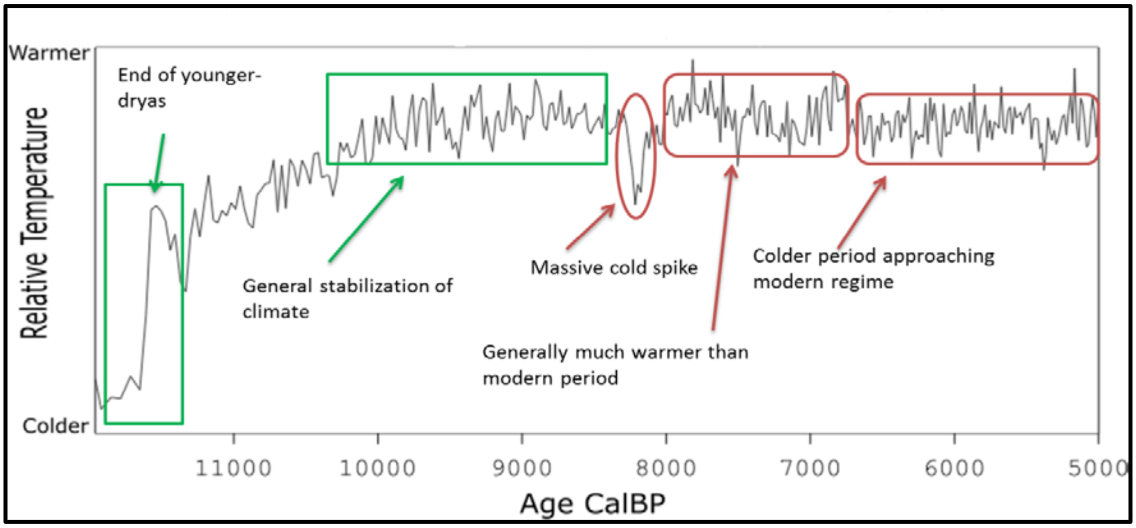


Figure 14: Graphical representation of fluctuating temperatures from GISP2 Ice Core from CalPal software (Weninger 2015)

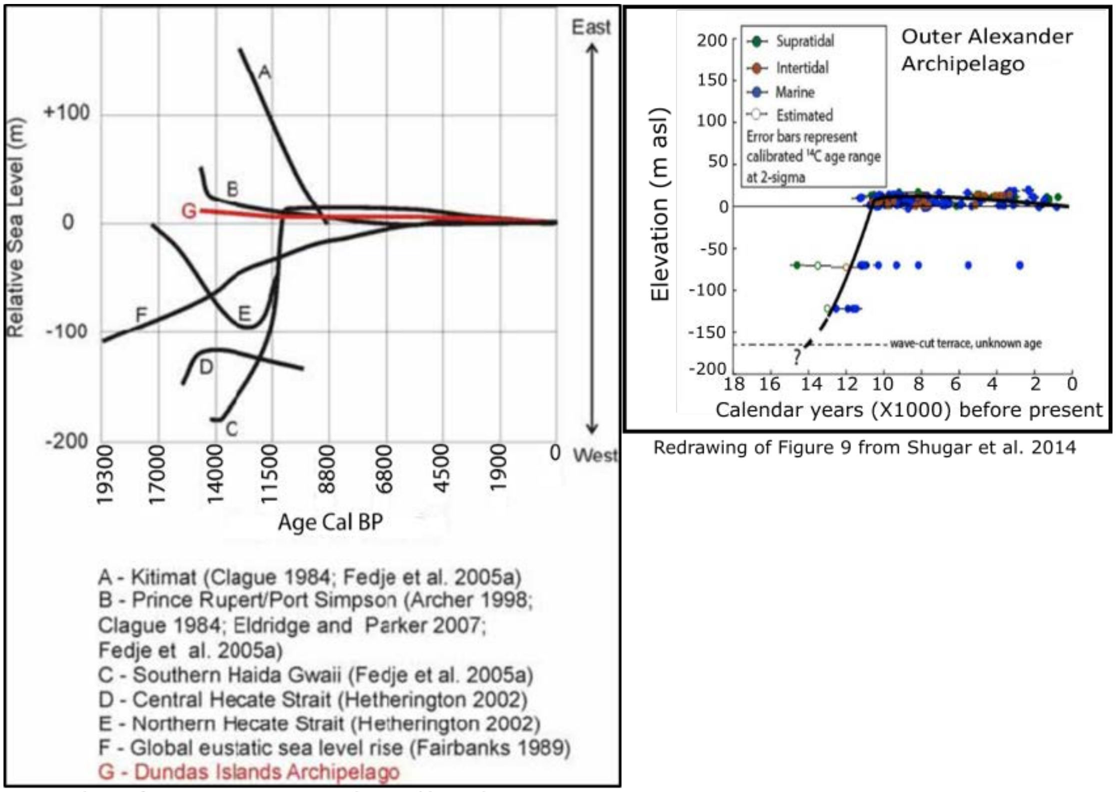
Table 4: Descriptive summary of GISP-2 ice core data, all dates given as calendar years before 1950

11,000-10,000: End of Younger Dryas and establishment of more stable Holocene climate
10,000-9500: Significant warming period throughout North coast.
9500-9000: A relatively volatile period that sees significant oscillation between warm and cold periods. It should be noted that these 'cold' periods are still warmer than modern temperatures.
9000-8400: Marked by a stable warm period that lacks the significant oscillations characterizing the previous period.
8400-7800: This period is characterized by a massive cold regime that lasts several hundred years. The period between 8400-7800 also sees a temporary cessation in global, eustatic sea-level rise (Peltier and Fairbanks 2006). This cold regime begins at ~8400, but it most pronounced between 8300- ~7800
7800-7500: Shortly after 8,000 there was a significant burst in warming that lasted for ~200-300 years. This period is considerably warmer than today, and may be the warmest period so far known throughout the Holocene.
7500-6900: A gradual cooling trend begins, though temperatures remain well above modern.
6900-6600: A slight return to warmer temperatures is indicated here, though they remain far below the maximal temperatures seen around 7500.
6600-5400: A gradual cooling trend, very similar to the one seen between 7500-6900, is seen. This cooling trend continues apace until ~5400 when another dramatic cold regime, on par with the little ice-age takes hold.
5400-3500: After the cold regime that lasts between ~5400-5100, we see a very slight warming. Though temperatures remain colder than any sustained period prior to this time. By approximately 5,000 the climate regime is believed to be analogous to the modern climate. Oscillations during this period are very small and no other significant perturbance is seen until ~3500 when another dramatic cold spike, very similar to the 5400-5100 is seen.

4.7.5: Sea Level Change

The following synthesis is based upon work done by Duncan McLaren (2008) and McLaren et al. (2011); Carlson (2012); Fedje et al. (2005) and Shugar et al. (2014). Generally speaking, these figures show that Haida Gwaii and the Alexander Archipelago in Southeast Alaska have very similar sea level histories. In both cases sea levels from

~14,000-11,500 Cal BP were far below modern and that sea levels after 14,000 Cal BP rose dramatically reaching a peak (maximum marine transgression) around ~11,000-10,000 Cal BP. Since this time sea levels have been dropping steadily until coming close to modern levels around ~5,000 Cal BP. This sea level history means that coastal sites dating prior to 11,500 are submerged and far from the modern shoreline, while sites dating he modern coastline (Carlson 2012; Carlson and Baichtal 2015; Fedje et al. 2011).



Redrawn from McLaren 2008 to show calibrated age spans

Redrawing of Figure 9 from Shugar et al. 2014

Figure 15: Showing relative sea level change across the North Coast area. Picture on left is taken from McLaren 2008 and is redrawn to reflect calibrated ^{14}C ages instead of uncalibrated. Picture on right shows sea level curve for the Outer Alexander Archipelago

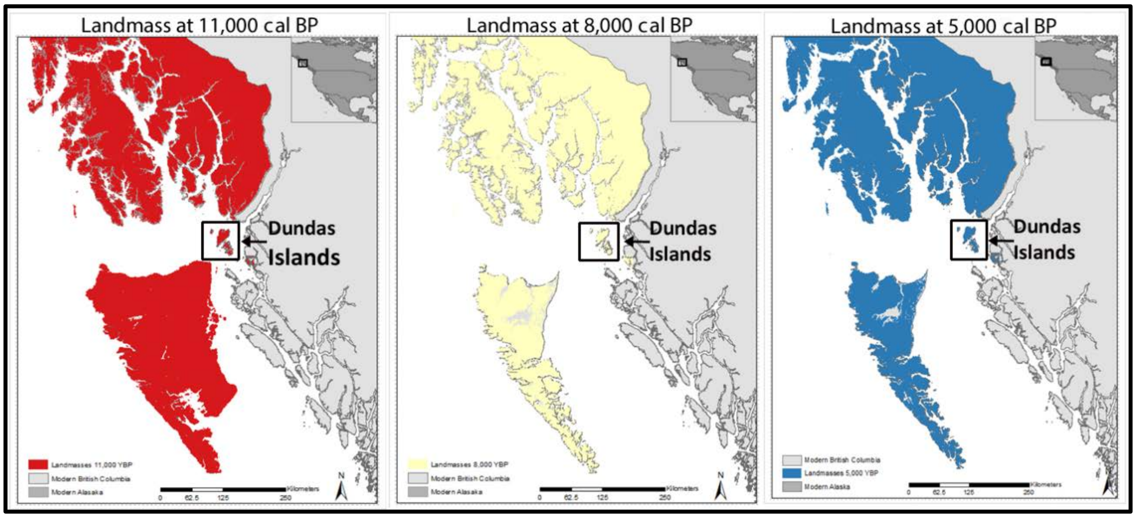


Figure 16: Shows illustrative example of sea level change and available landmass between 11,000 and 5,000 cal BP. Based on published sea level fluctuations found in Shugar et al. 2014. Modeling and illustrations done by Robert Gustas (2015). Note that sea level was much higher at 8,000 cal BP than 5,000 Cal BP.

Interestingly, the picture for the Dundas Island group shows much less dramatic variance in its sea levels history. Sea levels have been relatively stable on Dundas for much of the Holocene, though it has been slowly dropping for thousands of years (Figure 15). Therefore, the oldest sites are further inland than younger sites, which are closer to (or on) the modern coastline. Archer 's (2011; Archer and Mueller 2013) work on the Lucy Island group has shown that the Lucy Islands share the same sea level history as the Dundas Islands.

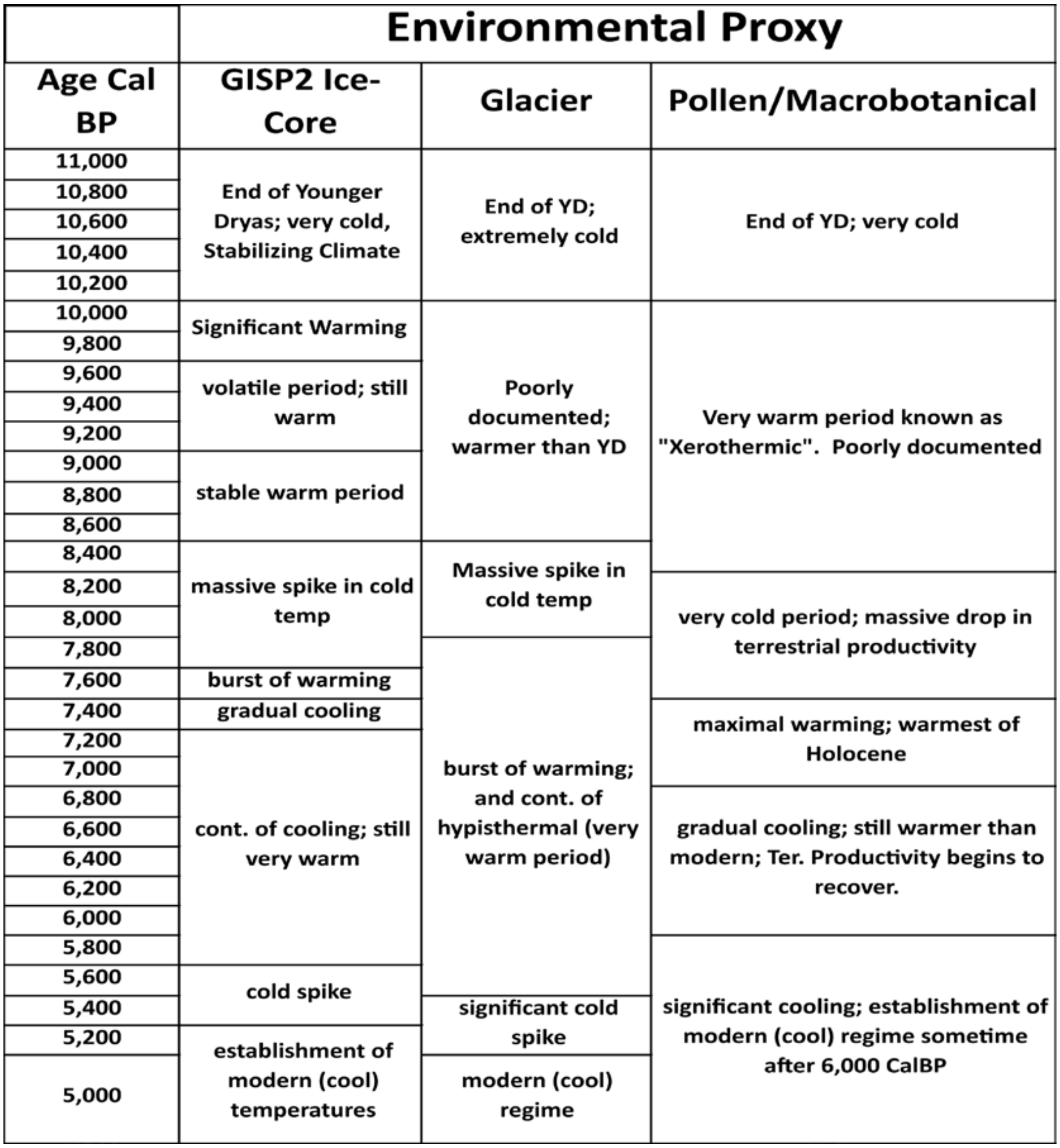
4.7.6: Environmental Summary

Overall, there is a remarkable concordance among these different environmental proxies. In all cases the general patterns of change and timing of change are in strong agreement (Table 2). The largest incongruities among these proxies seem to be in the timing of events within the period of 7,800-5,500. For example, while the ice-core data shows the end of the ~ 8,300 cold spike sometime between 8000-7800 and a subsequent maximal warming, the pollen data indicate that these events did not happen for another 300-500 years. Moreover, the ice-core data indicates a significant cold spike around 5,300, while the pollen and glacier data see this period as a gradual continuation of a cooling trend. In general, the pollen data indicates climate change on a 200-300 year lag, which as discussed by S.A. Elias (2010:77) is entirely expected. If we allow for expected discrepancies in the exact chronology between proxies, given that the trends in climate, while offset, never actually contradict one another, I am confident of making the following generalizations about climate events across the North coast during my study period.

1. A substantial warming period followed the end of the Younger Dryas; which coincides with dramatic sea-level change resulting from the fast melting of glaciers and isostatic rebound
2. ~8,400 to 7,800 (depending on proxy) there is a massive cold spell, the most severe known throughout the Holocene outside the Younger Dryas. The end of this cold spike coincides, and is suggested to be causally related to, a substantial decline in terrestrial productivity due to the spread of mire and bog systems. It is not until sometime after 6,900 that we see evidence for terrestrial productivity beginning to recover. It is important to note here that some studies such as Pellatt and Mathewes (1997) and Mann et al. (2001) have suggested that this cold spike was experienced differently at different times on the coast, and that on the North Pacific, the transition to this event may have been earlier and much faster than in other places.

3. After 7,800 the climate stabilizes and shows very little volatility. Generally this period is characterized as a gradual cooling from a very warm period that immediately proceeded the cold spell, but temperatures always remain above modern until sometime between ~6,000-5,300 when another cold spell (similar in severity to the Little Ice Age) happens followed by a return to temperatures (after ~100-200 years) that are analogous to the modern climate

Table 5: Descriptive summary of different environmental proxies



	Environmental Proxy		
Age Cal BP	GISP2 Ice-Core	Glacier	Pollen/Macrobotanical
11,000	End of Younger Dryas; very cold, Stabilizing Climate	End of YD; extremely cold	End of YD; very cold
10,800			
10,600			
10,400			
10,200			
10,000	Significant Warming	Poorly documented; warmer than YD	Very warm period known as "Xerothermic". Poorly documented
9,800			
9,600	volatile period; still warm		
9,400			
9,200			
9,000	stable warm period		
8,800			
8,600			
8,400	massive spike in cold temp	Massive spike in cold temp	
8,200			very cold period; massive drop in terrestrial productivity
8,000			
7,800		burst of warming; and cont. of hypisthermal (very warm period)	
7,600	burst of warming		
7,400	gradual cooling		maximal warming; warmest of Holocene
7,200	cont. of cooling; still very warm		
7,000			
6,800			gradual cooling; still warmer than modern; Ter. Productivity begins to recover.
6,600			
6,400			
6,200			
6,000			
5,800			significant cooling; establishment of modern (cool) regime sometime after 6,000 CalBP
5,600	cold spike		
5,400		significant cold spike	
5,200	establishment of modern (cool) temperatures		
5,000		modern (cool) regime	

4.4.7: Technological Data Synthesis

Technological analysis can be an extremely powerful tool for understanding settlement and mobility dynamics across a landscape (See Binford 1979, 1980; Chatters 1987; Kelly 2007). Therefore, it is necessary to review and synthesize the available technological data on the North coast. It is important to note that the following section does not introduce new data. I simply summarize previous analyses and raw data, then relate these to regional questions of settlement and mobility pattern change.

It is important to reiterate here that this section does not present *any* novel analyses and is simply summary of already published analysis. Furthermore, it is not a synthesis of all available analyses, and instead focuses technological data as it pertains to mobility or settlement patterns. With this in mind, the secondary goal of this section is to highlight how little is actually known about technological change through this time period. Lastly, despite the serious limitations in the technological data, it is covered here because Prentiss and Chatters hypotheses rely extensively on technological relationships and because Ames and Binford both see technological changes as key indicators of changing mobility strategies.

At first glance the amount of technological data available for the period between ~11,000-5,000 cal BP seems considerable. There are literally hundreds of lithic bearing sites recorded throughout Southeast Alaska and Haida Gwaii (See Carlson 2012 and Fedje and Mathewes 2005). However, the majority of these sites are isolated finds with little context. Furthermore, prior to ~4,000 cal BP on the North coast, technological data comes almost entirely from lithics; which, while very useful, paint only partial pictures of people’s economic strategies (Croes 2003: 51).

It should also be noted that technological data from this period comes largely from Haida Gwaii, with much smaller assemblages coming from Southeast Alaska. Meanwhile, effectively *no technological data* exists from the Dundas Islands, Lucy Islands and the Prince Rupert Harbor area. For these reasons, the data from Haida Gwaii dramatically biases the following synthesis. . This problem is further exacerbated after

~8,000 cal BP when excavations from *just* Haida Gwaii represent almost 100% of the technological data for this time period. In general, technology for the period between 8,000-5,000 cal BP is poorly known across the North Coast. Therefore, any inferences based upon the data discussed above should be regarded as (1) tentative at best and (2) as a reflection of what was happening on Haida Gwaii. However, the few excavated sites in Southeast Alaska that are contemporaneous with those on Haida Gwaii show many similarities, which hopefully mitigates some of the interpretive biases from such a Haida Gwaii heavy dataset (see table-6).

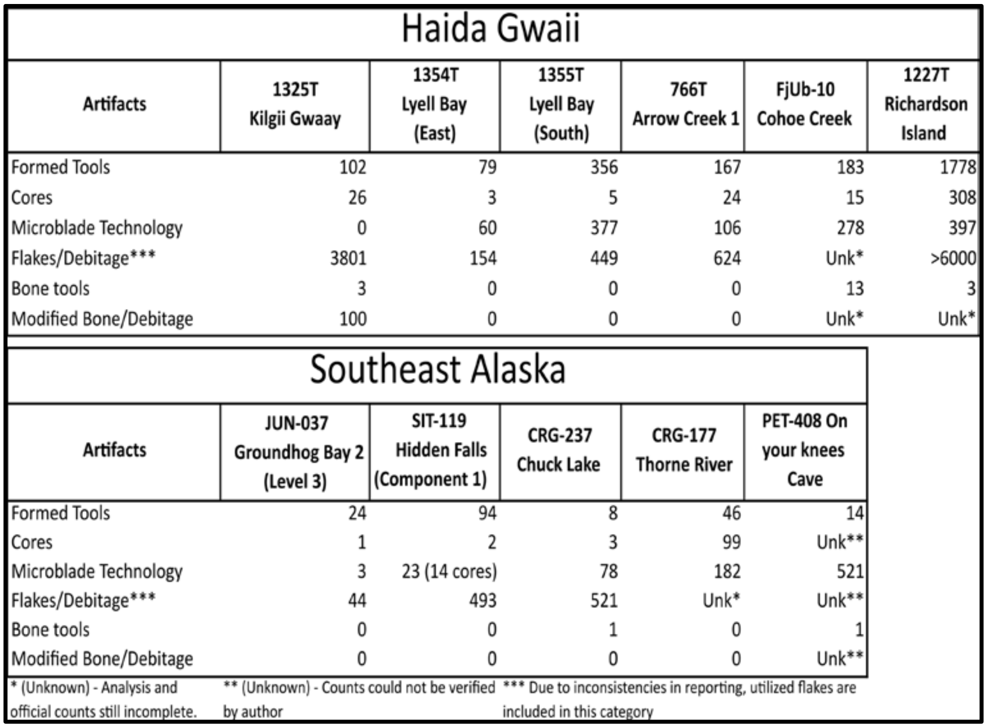
Technological summary and synthesis

The earliest known technological data on the coast are found in Southeast Alaska and Haida Gwaii dating to ~11,000 cal BP and are characterized by a leaf-shaped style, bifacial projectile point technology, which is very similar between the two regions (Carlson 2012; Storey 2008: 2; Ackerman 1996; Fedje and Christensen 1999; Fedje et al. 2004, 2005: 232-237). Where preservation permits, sites dating to this early period (e.g. Kilgii Gwaay) have also produced well developed bone and wood technologies, including bone awls, unilaterally barbed bone points, bone percussors, splinter awls, and other miscellaneous worked bone (Fedje et al. 2001. Kilgii Gwaay also produced evidence of basketry, fiber clothing and rope (Fedje and Mackie 2005). After ~9700 cal BP (10,000 in SE AK), bifacial technology begins to be replaced by a microblade technology (Storey 2008; Fedje et al. 2005: 232-237). This transition is best seen at the Richardson Island site, on Haida Gwaii, where extremely detailed and well dated stratigraphy shows this transition with a very fine-grained resolution (Magne 2004). This site demonstrates that microblades and bifaces co-existed and were experimented with between ~9700 cal BP and 8800 cal BP, after which microblades come to dominate lithic assemblages. While Southeast Alaska lacks this fine grained temporal resolution, the general picture there corroborates the findings on Haida Gwaii, except that these transitions tend to occur ~ 300 years earlier (R. Carlson 1996).

An interesting aspect of this transition is that multiple analyses have found almost no difference between microblade and bifacial assemblages, except for the relative abundance of bifaces and microblades (Fedje et al. 2005: 239; Storey 2008; Carlson 1996). In both types of assemblages simple unifacial tools are actually the most dominant tool form (Storey 2008). Furthermore, both microblade and bifacial assemblages are found with abundant scrapers, scraper planes, adzes, cobble choppers, gravers, large unifaces and spokeshaves (Storey 2008). At Richardson Island, Storey's (2008) analysis of the unifacial technology also shows that aside from microblades and bifaces, there is little standardization among tool types and most appear to be made expediently and from locally available material (Storey 2008; Fedje et al. 2011). Both Storey's (2008) and Magne and Christensen’s (2005) studies also show that the only appreciable changes to tool-kit composition on Haida Gwaii before ~5,700 cal BP was the increasing size of cobble and spall tools (which replaced scraper planes) at ~9,000 Cal BP and a switch to using entirely local materials. The next evidence for meaningful technological change comes from the middle components of the Cohoe Creek site (5,700-5,100 Cal BP), on Haida Gwaii, where a proliferation of bone and antler technology is seen, along with the introduction of bipolar flaking techniques. The organic tools at Cohoe Creek were found to be very similar to those found at Kilgii Gwaay, but show increased diversity and complexity in their design. The organic tools at Cohoe Creek also show clear affinity to similar designs found in the later components at the Blue Jackets Creek site (Christensen and Stafford 2005).

In general, Southeast Alaska follows the same pattern as Haida Gwaii, with microblades becoming dominant after ~10,000 cal BP, and having well-developed organic tool industry very early. Southeast Alaska also shows a general increase in size of cobble and chopper tools (Carlson 1996; Ackerman 1996, 1985). However, sites in Southeast Alaska appear to have less emphasis on unifacial tools, and tools tend to be made from high-quality, exotic materials more often (Ackerman 1996; Carlson 2012).

Table 6: Raw artifact data from select, well excavated contexts on Haida Gwaii and Southeast Alaska



Haida Gwaii

Artifacts	1325T Kilgii Gwaay	1354T Lyell Bay (East)	1355T Lyell Bay (South)	766T Arrow Creek 1	FjUb-10 Cohoe Creek	1227T Richardson Island
Formed Tools	102	79	356	167	183	1778
Cores	26	3	5	24	15	308
Microblade Technology	0	60	377	106	278	397
Flakes/Debitage***	3801	154	449	624	Unk*	>6000
Bone tools	3	0	0	0	13	3
Modified Bone/Debitage	100	0	0	0	Unk*	Unk*

Southeast Alaska

Artifacts	JUN-037 Groundhog Bay 2 (Level 3)	SIT-119 Hidden Falls (Component 1)	CRG-237 Chuck Lake	CRG-177 Thorne River	PET-408 On your knees Cave
Formed Tools	24	94	8	46	14
Cores	1	2	3	99	Unk**
Microblade Technology	3	23 (14 cores)	78	182	521
Flakes/Debitage***	44	493	521	Unk*	Unk**
Bone tools	0	0	1	0	1
Modified Bone/Debitage	0	0	0	0	Unk**

* (Unknown) - Analysis and official counts still incomplete.
** (Unknown) - Counts could not be verified by author
*** Due to inconsistencies in reporting, utilized flakes are included in this category

Technology Conclusions

Overall, early assemblages were locally diverse but regionally homogenous and showed a very flexible tool-kit, whose composition and proximity to the ocean suggests generalized coastal foraging (Willis and Lauriers, 2011: 118). Besides the widespread adoption of microblade technology around 8,800 cal BP and bipolar flaking at ~5,600-5,000 cal BP, there are little if any functionally significant changes in the lithic tool-kit assemblages through the Holocene on the North coast. Even the adoption of microblade and bipolar flaking is debatably related to functional, performance attributes. As Fladmark (1975) has noted, microblades and bipolar flaking do not necessarily produce functionally different tools as much as they relate to the conservation of raw materials.

The organic tool data available is intriguing, given that sites like Kilgii Gwaay show a well-developed industry involving the use of tools similar to ones seen thousands of years later on the North Coast. However, the finds at Cohoe Creek do show an evolution in the complexity and specialization of organic tools starting ~6,100 cal BP. Still, the tool-kit assemblages do retain a generalized quality through time.

Table 7: Descriptive summary of technological data through time.

	Technology Summary			
Age cal BP	Lithic Attributes		Organic tool Attributes	Overall Tool-Kit Attributes
11,000	Well made leaf shaped bifaces. Constructed with high-quality non-local material	The following traits are ubiquitout in region and change little over time; Expediant and informal unifacial tech. consisting of (among other things) scrapers, scraperplanes, cobble choppers, gravers, flake tools and spokeshaves.	Well developed but generalized bone-tools including; barbed points, awls and percussors. Also evidence for basketry, fiber clothing and rope	Generalized; mostly expedient tech. use of exotic material suggests higher mobility and more curation of tools
10,800				
10,600				
10,400				
10,200				
10,000				
9,800	Microblade tech. begins replacing bifaces			
9,600				
9,400				
9,200				
9,000	Bifaces almost entirely replaced by microblade tech. On Haida all lithics now made from local material. AK retains use of exotic tool stone.		Little to no organic preservation during this time	
8,800				Microblades replace bifacial tech. On Haida, see more use of local materials. No other changes to tool-kit.
8,600				
8,400				
8,200				
8,000				
7,800				
7,600				
7,400				
7,200				
7,000				
6,800				
6,600				
6,400				
6,200			Bone/antler tools start to become more complex and specialized	Overall, still generalized. Start seeing more specialization, suggesting more task specific tools
6,000				
5,800				
5,600	Change to Bipolar flaking begins.			
5,400				
5,200				
5,000	Appearence of ground/pecked stone		Substantial increase in organic tool complexity and specialization	Same as above, but more specialization

4.4.8: Settlement Pattern Data Synthesis

The following analysis and synthesis of settlement patterns on the North coast combines data from three different kinds of sources: (i) site-location analyses, which aim to show how people have positioned themselves on the landscape; (ii) site type analyses, which show changing patterns in *types* and size of sites; (iii) seasonality studies that primarily use shell fish and other faunal material to show what seasons the sites might have been occupied. Generally speaking, all the analyses and syntheses presented here comes from various chapters within Fedje and Mathewes (2005), Steffen (2006), Storey (2008) Carlson (2012), Carlson and Baichtal (2015), McLaren (2008), McLaren et al. (2009), and Martindale et al. (2010) unless otherwise noted in text.

In total, there has been very little settlement pattern analysis on the north coast that relates to the period between 11,000-5,000 cal BP. To date, I am only aware of a single study done by A. Mackie and Sumpter (2005) that has systematically looked at site location and site type change through time, and was done solely for Haida Gwaii. This, combined with biased, judgmental sampling that has focused on shorelines and the inconsistent reporting of environmental context for sites that date to this period make interpreting patterns during this period highly problematic. Despite these issues, though, recent work by Carlson (2012) and Carlson and Baichtal (2015), McLaren (2008) and Martindale et al. (2010) have produced sufficient data for us to make some broad level, region-wide statements about settlement dynamics between 11,000 and 5,000. Table-8 below highlights key information of sites discussed in the following sections.

Table 8: Summary of ages and significant data for select sites mentioned throughout text

Location	Site Name/#	Age Span (cal BP)*	Significant Features/Data
AK	Hidden Falls 49-SIT-119 (comp. 1)	11,600-9,600	Temporary camp, with possible hearth. Lithic concentration. Unifacial/microblade technology
AK	Hidden Falls 49-SIT-119 (comp. 2)	5,300-3,200	Association of artifacts/features with earliest dates of this component is unclear. Spring camp. Postholes (3x4m structure), ground slate/stone, labrets, complex organic tools, fauna shows increased reliance on halibut/salmon. End of microblade use.
AK	Chuck Lake 49-CRG-237	9,200; 8,200	Temporary camp, lithic scatter. Bone tool (harpoon), oldest shell midden in SE AK. Fauna showing marine focus.
AK	Groundhog Bay - JUN-037 (Lvl-3)	10,400-9,200; 8,300-6,000	Temporary camp, lithic scatter, hearth feature
AK	On-Your-Knees-Cave 49-PET-408	10,600	Human remains. Isotope analysis shows diet was almost entirely marine
AK	MitKof Island Fish Weir 49-PET-456	5,600	Earliest fish weir. Evidence of site investment/more sedentary behavior
Dundas	GdTq-3	7,100-5,300	Large shell midden. Earliest structure known on North Coast with central hearth, possibly inhabited year-round. Possibly whole village only 1 of 4 houses in a row were dated

Lucy	Lucy Island GbTp-1	9,000-4,500	Early isolated shell middens (9,000-4,500); Early house - 8.3x4.2m (6,500-6,200; 5,400); formal burials of related people associated with house (5,700-5,300)
HG	Arrow Creek 2 925T	10,000-9,200; 8,200-7,800; 6,500	Possible hearth, possible fish trap (small rock wall feature)
HG	Arrow Creek 1 766T	11,300-10,000	Lithic concentration. Short use site.
HG	Lyell Bay East/South 1354T and 1355T	10,200-8,200; 7,500; 6,100-5,800	Lithic concentrations. Short term camps
HG	Richardson Island 1227T	11,000-9,200	Hearths, drying racks, large lithic assemblage, possible pit-house. Shows long term, planned annual/seasonal re-use of site. Diverse faunal data. Seasonal use base camp
HG	Kilgii Gwaay 1325T	10,800-10,400	Organic tools preserved; presence of basketry, drying racks, cordage, bone/wooden tools. Shell midden, diverse faunal assemblage emphasizing fish and black bear. Seasonal use base camp
HG	Cohoe Creek FjUb-10	7,000-4,900	Large shell midden. Early winter village, stratified living floor surfaces, postholes, complex hearths, storage features, diverse faunal assemblage. More complex bone/antler tools than seen previously. Appearance of bipolar reduction on Haida. Inhabited between 4-6 months at a time (possibly all year long).

HG	Blue Jackets Creek FlUa-4	~5,000	Extensive cemetery. Substantial evidence for at least semi-sedentary behavior. Attachment to place

*****Age span is an approximation based upon the calibrated median ages of ^{14}C dates from each site and/or component. Multiple spans were assigned when large gaps between ^{14}C dates were encountered.

Settlement Pattern Summary

11,000-8,000 cal BP: Almost all known early sites are found on relic shorelines, in areas that would have been near protected estuaries, bays or riverine environments proximal to the ocean. The location of these sites emphasized ecotones that maximized diversity in available resources and show an obvious marine focus (Carlson 2012; A. Mackie and Sumpter 2005). For example, the Kilgii Gwaay, Richardson Island and Chuck Lake sites, were positioned to access shorebirds, open ocean resources, shell fish, riverine fish (such as salmon), and sea and terrestrial mammals.

The vast majority of sites dating to this time are known from Haida Gwaii and Southeast Alaska; though recent research by Martindal et al. (2010) and Archer (2011) have uncovered numerous sites of this age on the Dundas and Lucy Islands as well. On Haida Gwaii, most are simple lithic sites that show broad ranging activities and a short term use (Fedje et al. 2011; Mackie et al. 2011). However, sites such as Arrow Creek 1, the Lyell Bay south and east, Richardson Island and Kilgii Gwaay all show very dense deposits, with continual re-use and/or substantial or site investment. Specifically, the Richardson Island and Kilgii Gwaay sites display much more consistent and long term re-use and often have more complex features (Steffen 2006) than anything known in

Southeast Alaska for this time period (Fedje et al. 2013; Fejde and Mackie 2005). For example, multiple post-hole features, interpreted as drying racks, were found at both Richardson Island and Kilgii Gwaay (Steffen 2006: 226; Fedje et al. 2011) and possibly the structural remnants of a small pit-house also present at Richardson Island (Steffen 2006; Storey 2008; Fedje et al. 2005). The hearth complexes, especially at Richardson Island, show multiple re-use episodes over hundreds of years (Steffen 2006: 216), further suggest intensive use of particular spots on the landscape and an altogether more structured seasonal round than typically associated with high mobility foragers.

Interestingly, there are no currently known analogues for these kinds of sites in southeast Alaska, which may indicate that residential mobility was much higher there. This is further indicated by the differences in material use, where exotic, high quality materials were routinely used in Southeast Alaska (Ackerman 1996; Carslon 2012),while almost exclusively local materials were used across Haida Gwaii (Storey 2008; Fedje et al. 2011)

However, much of the research targeting this time period in SE Alaska (i.e. Carlson 2012) has had much more limited excavations, thus absence of evidence for more complex sites is to be expected. Regardless though, based upon the relatively thin stratigraphy and limited horizontal extent at most these sites, it is very possible that the differences mentioned above will hold true as more data is added.

A possible exception to the general trend of utilizing productive riverine and estuary locations is from Lucy Island and possibly Far West Point on the Dundas Islands, where consistent shell fish exploitation and seemingly little else was being done on an isolated island, which, must have been accessed by boat (Archer 2011; Archer and

Mueller 2013). As opposed to the Haida and Alaska sites, these sites emphasized the exploitation of a single resource and would have been accessed by specific, planned forays for this resource. This makes the Lucy island site and early middens on Dundas, such as Far West Point, possibly the earliest evidence for logistic forays on the North coast. However, it is also possible that these sites represent resource areas that were seasonally exploited by people practicing a sequential foraging pattern, whereby foraging people revisited the exact same locations for specific resources during different times of the year. In this way, these sites may have been part of a similar seasonal round as that seen at Richardson Island, where a specific spot was utilized extensively over a very long period of time.

8,000-7,000 cal BP: Sites become much more common across the coast, especially shell-midden sites on Dundas and Lucy Islands. No other appreciable change from the previous period is noted here.

7,000-5,500 cal BP: This period is characterized by the beginnings of substantial settlement changes across the study area. Shell midden sites continue to become more common and larger. The earliest evidence of large, permanent structures is at site GdTq-3 on the Dundas Islands. This house may date as early as ~7,000 cal BP, is rectangular in shape and has a central hearth (Martindale et al. 2010). This house is also one of four that are grouped together, likely representing an early village. Shortly after, another structure similar to the one at GdTq-3 is present on Lucy Island and dates as early as ~6,500 cal BP (Archer and Mueller 2013). Furthermore, the house floors, structures and stratified hearth features at Cohoe Creek on Haida Gwaii, are firmly dated to between 6,300-5,700 cal BP, but older deposits at the site date back to more than 7,000 cal BP (Christensen and Stafford 2005: 251-254); it also important to note that GdTq-3, Lucy Island and Cohoe Creek are all associated with sizeable shell middens. Furthermore, formal burials associated with the structure on Lucy Island date between ~5,900-5300 cal BP (Archer 2011; Archer and Mueller 2013) and the earliest dated fish weir on Mitkof Island (49-PET-456) in Southeast Alaska, dates to 5,600 cal BP (Moss and Erlandson 2000). The presence of this tended facility and the formal burials on isolated islands further suggests a changing mobility system by showing that people were making significant social and economic attachments to specific spaces on the landscape (Schulting 1995: 14-19).

Seasonality studies at GdTq-3 and Cohoe Creek also point to a considerable change in residential pattern. GdTq-3 may have been inhabited year-round (Hallman et al. 2012, Burchell et al. 2013), while Cohoe Creek was occupied throughout winter and possibly through the spring (between 4-6 months) (Christensen and Stafford 2005), which indicate that a change to semi-sedentary (possibly fully sedentary) lifestyles had taken place by this point. Furthermore, the longevity or continued use of these sites was dramatically greater than earlier sites. GdTq-3 was occupied between ~7,000 and 5,000 cal BP; Cohoe Creek between 6,700- 4,700 cal BP (although Christensen and Stafford (2005) suggest possibly as early as 7,100 cal BP) and the Lucy Island house was at least occupied intermittently between 6,500 and 5,000 cal BP. Although long-term use of sites is not unprecedented, given older sites like Richardson Island, multi-season occupation is novel at these sites, and the overall duration of occupation is also greater than previously seen throughout the area. Thus, while Richardson Island is proposed to represent low levels of logistic organization (Steffen 2006: 220) and demonstrates a clear antecedent to later mobility and settlement patterns, it lacks many of the features indicating substantial investment in place seen after 7,000 cal BP.

The curated mass capture features, such as the earliest known fish weir on Mitkoff Island, in Southeast Alaska dating to ~5,600 Cal BP (Moss and Erlandson 2000) in combination with the substantial storage/caching features found at the Cohoe Creek site also indicate changes to long term planning and intended reuse of the site for specific activities. These attributes are important as they are commonly associated with logistically oriented residential and base camps, and further suggest increasing attachment to place and significant changes to mobility patterns (Binford 1980, 2001; Kelly 2007). However, despite major changes in apparent mobility strategies during this time, it is interesting that no appreciable change in site-location was seen at any of these sites. And, the fine grained excavations at Cohoe Creek showed no meaningful differences in subsistence between it and much earlier sites, once environmental context was controlled for (Christensen and Stafford 2005).

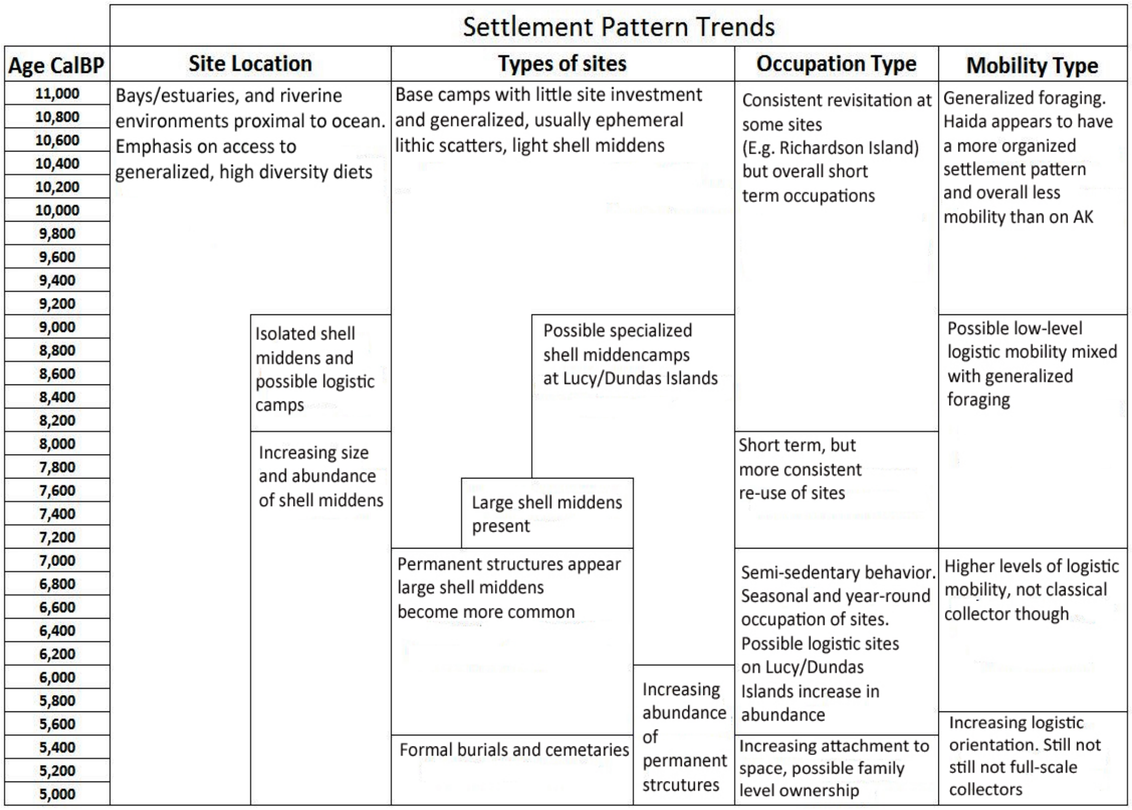
5,500-5,000: Interestingly, this period does not see a proliferation of houses or villages, though all of those mentioned above were occupied through this time period. However, the village and expansive cemetery features at the Blue Jackets Creek site on Haida Gwaii, may date as early as 5,300 cal BP (Severs 1974). Excluding the cemetary, this site is similar in many respects to the Cohoe Creek site, but shows more intensive occupation and tools recovered (especially wood/bone ones) were much more varied and complex. Blue Jackets Creek is poorly reported though, and no final report analyzing site features has been published. Thus the association of any of the features with the earliest dates is uncertain.

It is also possible that villages, such as GcTq-4 on Dundas, which has an early component dating between 5,500-5,300 cal BP could date to this period (Martindale et al. 2010). However, the oldest component has not been securely related to any house features (Ruggles 2007; Martindale et al. 2010). It should also be noted genetic studies from the burials found on Lucy Island, has not only demonstrated them to be directly related to modern Tsimshian populations, but have also shown that the individuals were closely related each other (Cui et al. 2013). Between the Lucy Island burials and those at Blue Jackets, this period does see a continuation of evidence that is showing increasing attachment to place and perhaps early indications of territoriality.

Settlement Pattern Conclusions

Table 9 below outlines the general trends of settlement and mobility patterns through time as described in the analysis section. As a general summary, we can break down settlement patterns into four major trends.

Table 9: Summary of settlement pattern changes through time.



	Settlement Pattern Trends			
Age CalBP	**Site Location**	**Types of sites**	**Occupation Type**	**Mobility Type**
11,000	Bays/estuaries, and riverine environments proximal to ocean. Emphasis on access to generalized, high diversity diets	Base camps with little site investment and generalized, usually ephemeral lithic scatters, light shell middens	Consistent revisitation at some sites (E.g. Richardson Island) but overall short term occupations	Generalized foraging. Haida appears to have a more organized settlement pattern and overall less mobility than on AK
10,800				
10,600				
10,400				
10,200				
10,000				
9,800				
9,600				
9,400				
9,200				
9,000	Isolated shell middens and possible logistic camps	Possible specialized shell middencamps at Lucy/Dundas Islands		Possible low-level logistic mobility mixed with generalized foraging
8,800				
8,600				
8,400				
8,200				
8,000	Increasing size and abundance of shell middens		Short term, but more consistent re-use of sites	
7,800				
7,600		Large shell middens present		
7,400				
7,200				
7,000		Permanent structures appear large shell middens become more common	Semi-sedentary behavior. Seasonal and year-round occupation of sites. Possible logistic sites on Lucy/Dundas Islands increase in abundance	Higher levels of logistic mobility, not classical collector though
6,800				
6,600				
6,400				
6,200				
6,000		Increasing abundance of permanent strcutures		
5,800				
5,600				Increasing logistic orientation. Still not still not full-scale collectors
5,400		Formal burials and cemetaries	Increasing attachment to space, possible family level ownership	
5,200				
5,000				

1. As evidenced by sites such as Kilgii Gwaay and Richardson Island, early peoples are practicing high levels of residential mobility but are tethered to certain locales and appear to be at least loosely organized in a logistic fashion. Thus re-use of locations and some level of tethered or logistic mobility is in use throughout the early Holocene on the North Coast.
2. The types of locales utilized remained remarkably consistent through time, with people positioning themselves within protected bays, estuaries and riverine locations that maximized access to a diverse set of resources. The possible exception to this is the middens and structure at Lucy Island, whose isolation makes it currently somewhat distinctive along the North Coast. While the use of these

kinds of locales may seem trivial, given that they are expected to be used, it should be noted that after 5,000 cal BP settlement patterns become very different in many places across the Northwest Coast (Maschner 1997; Q. Mackie 2003; Martindale and Supernant 2009; A. Mackie and Acheson 2005), with people emphasizing very different kinds of locations, such as long linear shorelines and defensible positions. Thus, it is important to highlight that sedentism on the North coast is not related to settlement pattern change.

3. After 8,000 cal BP there is an increase in size and abundance of shell midden sites throughout the area especially on the Dundas and Lucy Islands. This trend seems to continue through the Holocene in all of the sub-regions.
4. After 7,000 cal BP we see the proliferation of more permanent structures (e.g. GdTq-3) and much higher investment in place. The caching and storage features common at the Cohoe Creek site are especially significant as they not only point to long-term planning, and increased attachment to space, but also demonstrates that people were using substantial portions of their time at Cohoe Creek to gear up for later subsistence activities. As highlighted in section 2.2 above, this suggests that specialized and complex subsistence pursuits were taking place, and overall further corroborates a logistically organized seasonal round for people at Cohoe Creek. Along with the appearance of fish weirs, the burials at Lucy Island and at Blue Jackets may also be significant in showing the evolution of increasing attachment, investment and/or ownership of place during this time (Schulting 1995: 14-18).

CHAPTER 5: DISCUSSION

I now return to addressing the questions posed at the beginning of this thesis. The first of these questions was; given the analyses presented here which of the hypotheses put forward best fits with the data. I then explore what other statements *can* be said about the timing, nature and causes for the development of logistically organized mobility on the North Coast. In order to best answer these questions the following discussion is divided into three parts; (i) Can any changes in mobility patterns be observed between 11,000 and 5,000 cal BP on the North Coast; and what were they?; (ii) of the three hypotheses presented here, which (if any) best matches the available data?, and; (iii) given the limitations, ambiguity and sparseness of the record for this period what can we confidently say about the development of logistic mobility?

I begin by asking; can any changes in mobility patterns be observed between 11,000 and 5,000 cal BP on the North Coast; and what were the changes, if any?

Given some leeway in interpreting the results, mobility patterns on the North Coast between 11,000 and 7,000 cal BP appear to closely adhere to what we would expect for aquatic hunter-gatherers utilizing a loosely logistical or possibly tethered mobility system and had relatively high levels of residential mobility. Subsistence focus was clearly on marine and riverine resources, though supplemented by terrestrial resources (i.e. black bear and caribou). The technological data for this time also indicates a broad spectrum economy with little evidence for meaningful resource specialization (though Dundas Island sites remain an enigma in this regard) and no apparent investments in permanent structures or substantial site furniture. Furthermore, as expected for aquatic hunter-gatherers, the location of many sites (e.g. Richardson Island and Lucy Island) along with their routine re-use over very long periods of time, suggest a very structured and planned use of the landscape

I argue, that by at least 7,000 cal BP with the appearance of the permanent structures (and possible village) at GdTq-3, that we see the adoption of an aquatic based, logistically dominated mobility pattern, though probably lacking a full-scale collector pattern. Though I acknowledge that using the appearance of houses as a proxy for logistic mobility can be problematic (see Ames 2000), I believe that the level of investment needed for permanent structures (and likely a whole village) and the possibility that houses at GdTq-3 were inhabited year-round, effectively necessitated that people employed a high level of logistical organization.

While it may be argued that these sites reflect people practicing a tethered or serial foraging strategy, I do not believe this to be the case for the following reasons. To start, the Cohoe Creek , Lucy Island structure and GdTq-3 site are occupied or consistently reoccupied for centuries (if not millennia), moreover Cohoe Creek and possibly GdTq-3 look to be have been occupied for significant portions of the year and possibly for the entire year (Christensen and Stafford 2005: 259; Martindale et al. 2010). The multi-season (if not year-round) occupation of these sites, in combination with their overall longevity, argues against their interpretation as base camps for groups of ‘tethered foragers’ as immediate return subsistence strategies focused on proximally located resources would have presented significant issues for coping with the inherent variance and patchy structure in resource availability in North Pacific climates

As discussed previously, while aquatic resources are *generally* abundant, this abundance exists in dispersed clusters that can vary widely in productivity year-to-year. Thus, sedentism without logistic forays would likely be untenable over multiple seasons, due to the unpredictability in resource abundance for any specific area, much less over hundreds of years as seen in the sites discussed here.

As detailed in section 2.2, the limited usefulness of residential mobility in northern aquatic settings is not due to the absolute abundance of resources in any given spot. Instead it is limited because at any given time, people must be in multiple locations at once to efficiently exploit aquatic resources. Thus, unlike what Chatters (1995) and Prentiss and Chatters (2003) hypothesize for the early appearance of pithouses on the plateau; it appears that people on the North Coast were not ‘lured’ into low residential mobility by super productive ecotones, but instead forced to adopt it. This interpretation is further evidenced very early use of at least semi-logistical strategies in the region. As it seems even during warmer climate regimes, with more productive terrestrial habitats and probably smaller populations, people found logistic strategies necessary for coping with aquatic landscapes. Therefore, it is much more likely that increased sedentism and site investment indicate an elaboration and further commitment to pre-existing organizations rather than an adoption of a completely different mobility system, such as tethered foraging.

Furthermore, as previously discussed the later appearance of tended facilities, such as fish weirs, storage features (at Cohoe Creek) and of formal burials at Lucy Island (and possibly the cemetery at Blue Jackets Creek) indicate a sense of territory with pronounced social and economic attachments to specific places on the landscape

(Schulting 1995: 19). In fact, Binford (2001: 258) has shown that these features are almost universally associated with territorial ownership and intensive use of logistic strategies. This is especially true for mass capture features, such as fish weirs, which were found *only* among people who relied on storage and who almost completely relied on logistic organization. In all, these data along with the duration and seasonality of occupation at these sites are all much more typically associated with people using logistic organization and low residential mobility than those utilizing foraging strategies. Thus by ~7,000 cal BP there is persuasive evidence for a region-wide shift to extensive reliance on logistic mobility.

In reality though, the distinction between people being either 'tethered foragers' or logistically organized may be semantic, as it is often unclear in the literature what being a 'tethered' forager actually is. If tethered foraging is intended to mean logistically organized people who do not practice or rely extensively on storage, then it is perfectly analogous to the kind of mobility I believe is represented by the sites discussed above (though storage features are present at Cohoe Creek). However, if tethered foraging is meant to indicate low residential mobility people who make no (or very little) use of logistic forays, than I believe this is quite different from what is being seen on the North Coast.

5.1: Hypothesis Evaluation

Given the inference that people were largely reliant on logistically organized mobility by at least 7,000 cal BP, how do the various hypotheses discussed previously match up to the data presented here? Below I briefly summarize the key arguments for each hypothesis and then compare them with the data

5.2: Binford's Hypothesis Evaluation:

1. Demographic Predictions: Binford argues that logistic mobility should result from either absolute population growth or from population packing.
    a. Currently, the demographic data does not support the notion that large scale population growth preceded the development of logistic mobility on the North Coast. However, the stabilized population levels post 8,000 cal BP and the noted impoverishment of the terrestrial resource base (Cronin 2010: 218-220; Turunen and Turunen 2003; Banner et al. 1983) in the region may have forced people to rely more heavily on aquatic resources, thus population levels relative to the number of good access points could have dramatically increased the population 'packing' in the region even without an increase in absolute population levels. Therefore, the data does not preclude the possibility that a packing threshold was reached just prior to the adoption of logistic organization.
2. Settlement Pattern Predictions: Here Binford expected that aquatic resources would become a stable resource base as soon as they were available and their subsequent adoption would have inevitably led to at least low-levels of logistic mobility.
    a. Almost all of the early sites known in the region are indeed located near the shore in prime areas to take advantage of aquatic resources. However, as discussed previously, the coastal landscape is the *only* place archaeologists

have systematically surveyed for early Holocene sites. Faunal and isotopic evidence in the region also suggest that people made wide ranging use of aquatic resources, which seemingly confirm the first part Binford's predictions. Evidence for low levels of logistic mobility is also attested to with the Richardson Island and Kilgii Gwaay sites possibly being logistic base camps (Storey 2006; Fedje and Mackie 2005; Fedje et al. 2005) and the early midden sites on Lucy Island arguably representing logistic field camps, which further confirms Binford's expectations. .

3. Technological Predictions: Binford suggested that technological changes to more specialized and complex tools should be expected to coincide with increasing levels of logistic mobility.
    a. Because no analyses regarding technology change as it related to mobility have been completed and because data is effectively only available from Haida Gwaii; at present, this expectation cannot be accurately evaluated. However, the currently available data suggests that large-scale changes to tool-kits did not take place until almost 1,000 years after the first evidence for significant increases to logistic organization at GdTq-3. This is also true of for the oldest curated, site-facilities, such as the Mitkoff Island fish weir dated to 5,600 cal BP. Thus, the available data does not support this expectation.
4. Environmental Predictions: Binford made no specific predictions regarding the role of the environment in the adoption of logistic mobility among aquatically oriented hunter-gatherers. However, he did suggest that any environmental change which creates disparity in the relative productivity between aquatic and terrestrial

resources should increase the level of logistic organization. He also argued that once logistic mobility was the primary mobility strategy, environmental change should *have no* effect on mobility strategies in aquatic environments (Binford 2001: 279, 366, 369).

  a. Given that evidence for increased levels of logistic mobility appeared shortly after the impoverishment of the terrestrial environment, I feel that Binford's expectations are well corroborated by the data. The fact that logistic organization continued and proliferated throughout the rest of the Holocene despite further environmental changes and the recovery of terrestrial productivity, also supports Binford's expectations.

5.3: Ames' Hypothesis Evaluation:

1. Demographic Predictions: While Ames does not make any specific demographic predictions, he does argue that there is a minimal population threshold necessary to practice logistic organization. Once this minimal level is reached, Ames argues that the fixation of logistic strategies is related to the ratio between access to resources and population levels, where the more disjointed and rare resource patches are, the smaller the populations necessary to force logistic organization would be. With this in mind we should expect to see a rise in population levels or a change in resource availability.
    a. The evidence does suggest that there may have been slightly higher population levels during the advent of logistic mobility compared to earlier

    periods and population levels were also much less variable during this time. Neither of these findings contradict Ames; predictions.

2. Settlement Pattern predictions: Because Ames focuses on the importance of continuity on the North Coast, he suggests we should expect to see an increasing proliferation of redundant sites across the landscape. While new kinds may be added, we should not see a sudden drop off of any older types.
    a. As mentioned above, almost all of the early evidence suggests an aquatically oriented population making extensive use of boats and a wide variety of marine and riverine resources. There is also a remarkable continuity in site location and function through time. Even the appearance of the permanent structures coincides with the types of locations already in use for thousands of years. The available faunal evidence also suggests that resource extraction was the same despite the residential shift. Overall, Ames' predictions are well supported by this data. However, as with the technological data, no systematic study of settlement patterns have been completed for this region, so this support should be seen as tentative.
3. Technological Predictions: Ames' suggested that we should see continuity in technological traditions, though increased levels of technological specialization and complexity should coincide with increasing logistic mobility.
    a. As mentioned above, there is enough evidence to accurately evaluate technological shifts as they relate to mobility in the region. With that said, Fedje and Mackie (2005), Fedje, Magne and Christensen (2005) and Storey (2008) claim that there is no apparent discontinuity in tool-kit assemblages

between early sites and later ones. It should be noted though that the increase in tool complexity seen at Cohoe Creek and Blue Jackets Creek is consistent with Ames' predictions.

4. Environmental Predictions: Similar to Binford's in many respects, Ames environmental predictions differ in emphasis more than kind. Ames stresses that disjuncture (and therefore anything that increases creates disjunction) in the spatio-temporal access to resources will push people towards more logistically oriented strategies. While Binford acknowledges this as an important point, aquatic resources were often assumed to already be disjointed, so he seems to have placed more emphasis on differences in the relative productivity between terrestrial and aquatic resources.
    a. The specific distribution of resources or changes therein cannot be addressed with the currently available data. Therefore, while the data does not contradict Ames' prediction it does not necessarily support it either. However, because northern latitudes generally, already have poor terrestrial productivity, any increases in population levels may have pushed people past a threshold whereby residential groups could no longer support themselves through exploiting terrestrial resources, and thus were forced to focus more and more on aquatic resources. This, in combination with the fact that access to aquatic resources is usually more spatially constrained than terrestrial ones, would have effectively created a disjuncture of resource availability by limiting locations for residential moves. Thus, access to resources would have declined relative to the number of people taking them.

5.4: Prentiss and Chatters' Hypothesis Evaluation:

1. Demographic Predictions: They argue that a punctuated population collapse in the region should open up niches for collectors to inhabit. We should see the region where collectors came from maintain population levels though.
    a. There is a major population collapse between 8,800-8,300 cal BP and evidence for some degree of logistic organization does appear after this collapse. However, populations across the region rebound well before the first evidence of logistic organization and logistic organization does not appear until ~1,400-1,000 years after the population collapse. Every sub-region tested also experienced this population collapse at the same time, meaning that there is no evidence that a pre-existing collector strategy survived and then spread throughout the region. This does not mean that the region was not filled by people who developed logistic strategies outside of the North Coast area. However, this is unlikely, as genetic evidence (Cui et al. 2013; Cybulski 2001) shows that three different genetic lines from outside the North Coast would have had to independently inhabit Haida Gwaii, Southeast Alaska and the Dundas/PRH area immediately afterwards. Overall, the available data does not support these predictions and in many ways directly contradicts them.
2. Settlement Pattern Predictions: Prentiss and Chatters argue that logistic oriented settlement patterns should closely match wherever they originated and be fundamentally different from those preceding them. Prentiss (2009) further argues that settlement pattern change should be a punctuated event, and the origin of

logistic mobility should be in places that are isolated with abundant resource availability.

a. Because there has not been a systematic evaluation of settlement patterns on the North Coast, especially one that details the similarities and differences between regions. For the time period in question, these predictions cannot be definitively refuted or supported. However, the available data does not support their hypotheses. There are no apparent abrupt changes in settlement patterns in any of the regions and settlement patterns across all of the sub-regions have many similarities from very early on. Moreover, sites with the earliest evidence for strong logistic organization on Haida Gwaii (Cohoe Creek) and on the Dundas Islands (GdTq-3) are positioned in the exact kinds of locales as earlier sites. When combined with the overall continuity in site-location, this suggests that high levels of logistic mobility did not spread from a single origin. Instead, I argue that this evidence points to largely independent and in-situ developments of logistic organization. In general support of Prentiss (2009), however, it can be argued that Haida Gwaii and the Dundas Islands represent ‘isolated’ locales with have abundant resources. As well, possible support for Prentiss’ and Chatters’ hypothesis may exist in Southeast Alaska. There is no evidence of permanent structures or intensive logistic organization within the Southeast Alaska region for my study period, thus it is difficult to say that the later appearance of more sedentary living and logistic organization seen in Southeast Alaska did not result from people moving in from the south.

3. Technological Predictions: Prentiss and Chatters argue that the technological tradition that spreads with logistic mobility should be consistent with its place of origin.
    a. As with others research hypotheses. However, the available data tends to paint a picture of continuity and in-situ development instead of sudden replacement or significant borrowing. In fact the only evidence for major technological change comes from the replacement of bifaces by microblades, but this process begins well before the aforementioned population collapse, or any evidence of strong logistic behavior. However, this data is almost entirely from Haida Gwaii, so if logistic mobility originated there, it would only make sense that technology there would be internally consistent. To date though, there is not enough comparable data from the other sub-regions to make any firm conclusions about technological diffusion/replacement. It should also be noted that even if there was a historical, ancestral relationship between technologies, these would be incredibly difficult to link due to the very different raw material constraints between the sub-regions (especially between Southeast Alaska and the Dundas/Lucy Islands).
4. Environmental Predictions: To facilitate the spread of logistic strategies Prentiss and Chatters argue that pre-existing foraging strategies must have become untenable, probably due to severe environmental change.
    a. There is evidence of a severe cold-snap at ~8,500 cal BP that also may be responsible for the dramatic impoverishment of the terrestrial environment and broadly coincides with the population collapse that began ~500 years

earlier. Since logistic strategies only appear after this event, climate change could be said to support Prentiss and Chatters' prediction. However, the earliest evidence of mobility strategy change does not happen for ~1,000 years after the end of the cold-snap. Therefore, while environmental change could be related to the adoption of logistic mobility, it does not appear to be related to a region-wide replacement of mobility strategies. Altogether then, there is only weak support for this argument.

5.5: Hypothesis Evaluation Summary and Discussion

Overall, Binford's and Ames' predictions are more congruent with the data presented here than are Prentiss and Chatters'. However, our ability to precisely evaluate these hypotheses is hindered by the limited available data and analyses. This is especially true for the technological data, which is severely lacking. Most technological studies have focused on metric descriptions and intra-site comparisons, or are too focused on a very narrow range of tool classes (i.e. microblade core reduction sequences) to be useful for region-wide questions regarding mobility strategies. The dearth of technological data for long periods of time and for entire regions is particularly problematic. Frustratingly, there is no easy solution to this comparative analysis problem, as outside of Haida Gwaii, there simply is no material to study, due to the lack of sizeable excavations within Southeast Alaska and the Dundas/PRH area.

Furthermore, while predictions derived from Ames' and Binford's hypotheses better match the available data, the analyses presented here do not *confirm* their hypotheses as much as it does not contradict them. However, the analysis presented here provides minimal support for the macro-evolutionary hypothesis of Prentiss and Chatters (2003, also see Prentiss et al. 2014). There is little evidence of a punctuated event, change over time is relatively slow and shows clear evolution from antecedents. I would argue that there is no evidence of any top down 'selection' from environmental or outside social forces (e.g. population replacement or competition) that led to the development of logistic mobility.

5.6: The Evolution of Logistic Mobility and Organizations on the North Coast

As described in the preceding sections, each line of data is highly problematic for making inferences in regards to the evolution of mobility patterns on the Northern Coast. To date, differences in research focus, sampling intensity, and understanding of sea-level changes have led to largely biased and often difficult to compare data sets between the sub-regions of this area. However, I do not mean to suggest that nothing can be said because of these problems, only that the data in its current state greatly inhibits a more detailed understanding of the North Coast. Indeed, while each individual dataset may be problematic, the fact that *all* of archaeological data points to little substantial change in either population levels, subsistence, technology or settlement strategies between 11,000 and 5,000 cal BP is significant in itself. Therefore, taking the demographic analysis at face value; given so little change, how can we best explain the advent of sedentary and logistically reliant behavior? However, as discussed in chapter 4, I believe that population levels grew more than is currently seen.

I believe that the most parsimonious explanation comes from using a combination of Ames and Binford’s ideas. Basically, it seems that population packing brought on by the impoverishment of the terrestrial landscape, caused by the region wide expansion of bog and mire systems, pushed people further onto an aquatic landscape, which was already limited in suitable residential locations. Therefore, not only was residential mobility becoming less effective (due to loss of terrestrial resources and patchy structure of aquatic ones), it was also becoming less possible at the same time, due to the more circumscribed space for accessing aquatic biomes. If true, this may explain why the earliest appearance of sedentism and houses are on the Dundas Islands, as their already marginal terrestrial resources would have forced this switch earlier than other places.

Extrapolating this further, the apparent lag in the appearance of these features between Southeast Alaska and Dundas and Haida may suggest that terrestrial productivity in Alaska did not suffer as much during this time period. Meaning that population packing took longer to occur and the need to fully adopt aquatic resources and subsequent logistic organization would have been slowed. It is important to note though that this lag is most likely exaggerated by the lack of research in Southeast Alaska compared to these other regions. This is partially evidenced by the earliest known appearance of fish weirs in Aslaka dating to ~5,600 cal BP, which is similar in age to components at Cohoe Creek and the later house date at Lucy Island. Using ethnographic data, Binford (2001) strongly correlated features such as these to storage and sedentism. Therefore, it seems very possible that similar sites to Cohoe Creek and GdTq-3 existed at least by at least 5,600 cal BP, but are as of yet undiscovered in Southeast Alaska.

As people became increasingly reliant on the aquatic landscape, it is quite possible that the wholesale adoption of sedentism and logistic reliance happened extremely quickly. Not only would these traits have been highly effective in these environments, but the fact that people in the region had already been exploiting all kinds of aquatic resources and using some logistic organization, meant that sedentism and logistic organization would have simply been extensions to pre-existing lifeways. As discussed above, the long-term use of boats in the region would have further facilitated this transition by making increasing use of logistic forays relatively easy.

The lack of change in subsistence pursuits, demography and technology coinciding with the appearance of logistically reliant strategies, indicates that mobility pattern change happened *prior* to and were not caused by population growth. Had mobility pattern change been a response to absolute population growth it seems likely that we would see technological changes or changes in the faunal data that reflected intensification of resources or an expansion of diet breadth, neither of which are currently seen (Binford 2001; Fitzhugh 2004). However, following Ames (1985, 2004), I hypothesize that the continued investment, elaboration and proliferation of these strategies is directly related to population growth following their initial adoption. Whereby, social and organizational stresses brought on by growing populations would have led to the intensification of existing logistic strategies.

This scenario would also help explain why we do not see increasing numbers of sites such as Cohoe Creek and GdTq-3 after they appear. Because, if they did not arise out of a response to absolute population growth, there is no reason for people to splinter off and create houses elsewhere, as moving elsewhere would have done nothing to solve resource distribution issues. Furthermore, as Ames (1985, 1996, and 2004) argues, logistic organization *requires* larger populations than foraging strategies. Thus, splintering and the creation of new houses/villages would have been greatly constrained until certain population thresholds were reached. After which, elaboration and increased complexity of logistic organization would have been the only way to handle new stresses arising from growing populations. Along these same lines, the appearance of tended facilities may indicate such a response to growing populations. While the later presence of burials as symbolic markers of territory and attachment to place may not have been necessary until population levels reached a point where the overlapping of social space became an actual concern and worked to reify concepts of ownership.

Interestingly, Fitzhugh (1995, 2002, and 2004) reached a similar conclusion based on his research in the Kodiak Islands, noting the same patterns of site-use and settlement pattern changes as people made more and more use of aquatic resources. However, because Fitzhugh's study focused on time periods much later than mine within a much smaller area, and used much more fine grained data, making a direct comparison between our results difficult. However, regardless of direct comparability, it is noteworthy that the behavior or aquatic hunter-gatherers between different cultural, environmental and temporal contexts are quite consistent.

CHAPTER 6: CONCLUSIONS

Using previously published technological, environmental and settlement pattern data in combination with novel demographic analysis, this study set out to better understand the historical development of logistic organization on the North Coast between 11,000-5,000 cal BP. In order to do this, available data was systematically evaluated and compared to various hypotheses that have attempted to explain the causal mechanisms behind the appearance and spread of logistic mobility. Secondarily, the goal of this study was to highlight the biggest gaps in the data sets and explore how to better conceptualize aquatic hunter-gatherers within the forager-collector spectrum.

Sites such as Kilgii Gwaay, Richardson Island, Lucy Island and possibly Far West point, demonstrate that highly structured and seasonal patterns of mobility were utilized by 11,000 cal BP. Furthermore, features, artifact assemblages, location and fauna at these sites suggest that people were making use of logistical movements to procure resources (though residential mobility remained high). Intensification of logistic organization and use of aquatic resources is indicated by ~7,000 cal BP on Dundas Islands, and possibly and at least by 6,300 cal BP Haida Gwaii at the Cohoe Creek site.

Analysis of settlement patterns indicates that types of locations used remained unchanged throughout the early and middle Holocene. Technologically, while we do see various changes, i.e. development of microblades and later bipolar flaking with more complex organic tools, these changes happen long before (microblades ~9,000 cal BP) and after (bipolar and more complex organic tools between 5,000-6,000 cal BP) the appearance of sedentary living and extensive logistic organization (~7,000-6,500 cal BP).

Available dietary evidence also suggests no minimal changes took place during this time. Demographically, while volatile, the overall average population levels remain stable throughout the study period, with a significant decrease in variability following ~8,400 cal BP. However, as mentioned above, there is reason to believe that ongoing work will reveal that populations following ~8,000-7,000 cal BP probably grew much more than is currently seen. Environmentally, warming and cooling episodes seem to have little direct correlation with any evidence for mobility pattern changes, with a possible exception being the bog/mire expansion and impoverishment of terrestrial productivity across much of the study area after 8,000 cal BP, which may have been a critical force in the intensification of aquatic resources and logistic mobility (and also may relate to the increase in midden size/density on the Dundas Islands during this time).

Therefore it seems that the shift to low residential mobility and increasing reliance on logistical organization may have happened independently of any change to settlement pattern, technology, demography or diet. Thus it is likely that mobility changes were brought on by internal social pressures in the form of organizational stress that resulted from a changing resource structure. More specifically, I argue here that decreased terrestrial productivity forced people to utilize already limited aquatic areas even more than they had already had been as seasonal or permanent use of the terrestrial environment would have been greatly constrained. Therefore, as residential mobility became more untenable as a solution to resource availability, the only recourse would have been to intensify the use of logistic mobility. Furthermore, as discussed in section 2.2 movements along a coastal landscape does little to change resource availability; there would have been little incentive to move, thus, sedentism and the increased use of logistic mobility. In this way, while environmental changes and distribution of aquatic resources may have been the ultimate causal mechanism, the proximal cause of sedentism and logistic mobility would have been the intensified social stresses inherent in organizing tasks among groups who could no longer use residential mobility as an effective tool.

With this in mind, I return to exploring how archaeologists should conceptualize aquatic hunter-gatherers within the forager-collector framework. It is important to highlight here that this research largely corroborates the general expectations for aquatic hunter-gatherers set forth by authors such as Yesner (1980), Binford (1990; 2001) and Ames (2002), despite the fact that much of their work was based upon ethnographic data. This demonstrates that certain qualities of managing access to aquatic resources are so intrinsic that basic organizational principals are extremely difficult to overcome even as technology and social structures change.

With this in mind, I suggest, as do these authors, that we should *not* expect aquatic hunter-gatherers to organize themselves in entirely analogous ways to terrestrial ones. This research also suggests that mobility among aquatic hunter-gatherers may be best thought of as a gradation within logistic organization. Therefore, in corroborating the thoughts of the authors mentioned above these results further stress that archaeologists are in considerable need of refining empirical expectations and theory for mobility patterns among aquatic hunter-gatherers. Until this is done, we will be left with subjective and often uninformative qualifications such as ‘low’ and ‘high’ amounts of logistical organization. Moreover, better detailing this gradation may reveal a litany of mobility strategies that are undocumented or poorly understood which in turn may shed light on how and why cultures took different trajectories in adapting to the interplay between resource access and internal social forces.

However, going back to the hypotheses discussed and evaluated earlier, the above discussion should make it clear that we can actually say *very* little about the causal mechanisms of logistic organization on the North Coast, much less accurately test hypotheses that rely on a complex interaction of variables. Even when combining all of the sub-regions, the quality of data and availability of regional analyses is quite poor and this problem is only exacerbated when looking at the sub-regions individually. This not only means that the model, presented above, for the advent of logistic reliance is likely to change, but also that many of our theories regarding the evolution of social and economic structures on the NWC may need to be re-evaluated. Especially as a better region-wide understanding of sea level histories have allowed archaeologists (for the first time) to specifically target early and middle Holocene sites (See McLaren 2008; Carlson 2012; Letham et al. 2015). Despite this, the demographic analysis presented here is the most robust of its kind and utilizes unprecedented amounts of data for this time period and region. Therefore, while changes to this demographic picture are certain, the general patterns uncovered here likely reflect real and critical trends in population histories for the region.

Besides the regional synthesis of previously available data and analyses, this thesis also provides unique and significant contributions to our understanding of the period between 11,000-5,000 cal BP on the North Coast. The dates taken from the GdTq-3 site as part of this research, which is currently the oldest known site of its kind in the region and has pushed back the appearance of permanent structures (also likely villages) to almost 7,000 cal BP.

While this is significant in itself, pushing back the appearance of archaeological features, without drawing in context from other data does little to advance theory regarding the evolution of mobility strategies, which highlights perhaps the most substantial and novel contribution of this research, which is the demographic analyses. This analysis showed that while overall population levels may not have grown significantly during much of the early and middle Holocene, there is evidence that population volatility decreased significantly after ~8,400 cal BP, which suggests that population pressure was not responsible for the decrease in residential mobility and intensification of logistic organization seen later. This also suggests that population volatility may play a larger role in mobility patterns than previously discussed by archaeologists. It also begs the question about how and why populations suddenly stabilized and whether or not it is simply a pattern born from eustatic sea-level change stopping around this same time. A thorough investigation that systematically analyzes changes in size, density and occupation length between sites dating before and after ~8,400 cal BP could shed light on this issue in the future, as will more sampling effort focused on shorelines that date between 8,000 and 6,000 cal BP.

The demographic analyses presented above also uncovered evidence for a region-wide, massive population collapse, which to my knowledge has never been observed in North Coast data. However, the causes and effects of this collapse are not yet understood and require future work. Though it’s possible temporal correlation with a world-wide cold spike is suggestive of a causal relationship between the two. The demographic data was by far the most robust set of data available for the region. It was the most evenly sampled data, had the largest sample size and in aggregate was less prone to individual researcher bias or intellectual focus. These advantages come from the comparatively little effort it takes to date a site compared to excavations or site-level analysis of features and artifact assemblages. While not perfect, and subject to its own limitations, the demographic analysis presented above highlights the exceptional utility of using ^{14}C dates as data. At a regional level we can explore trends in settlement patterns, population histories, and changes to intensity or longevity to site use. These methods also allow us to compare relationships and patterning between any of these variables on scales that would have otherwise been prohibitively cumbersome. In other words, even if not used directly as a population proxy, these methods are extremely useful as a tool for pattern recognition and for generating questions.

Future Work

The major goal of this research was to highlight what we can actually say about mobility patterns on the North Coast prior to 5,000 cal BP. However, the secondary goal was to use this research as a way to illustrate where our largest gaps in understanding are and what kind of data can be used to answer them. The following suggestions of future work are done with this in mind.

Overall, it should be emphasized that more data is needed from individual sites if we are to better assess the nuances in mobility strategies between regions and understand how sub-regionally specific environmental, demographic and social variables influenced the adoption and evolution of logistically organized mobility and how these strategies may have differed between regions . To date, sites dating to the period covered here have largely been uncovered through paleo-shoreline surveys that have focused on site discovery, but have forgone excavations due to financial limitations and the individual goals of researchers. While this work is what made this thesis possible and is paramount for the demographic analyses, without contextualizing the dates of these sites with more detailed data, there are severe limits to the inferences we can draw from them. This issue is especially problematic in Southeast Alaska, where, anecdotally speaking, I feel that we may be seeing a very different mobility pattern than seen in Haida Gwaii or the Dundas regions. I believe that populations within Southeast Alaska were much more mobile and riverine focused, while making more extensive use of terrestrial resources.

With this in mind, I also highlight the need to specifically excavate sites dating between 8,000 and 6,000 cal BP, in order to better understand the region-wide transition to more sedentary living. At the moment, this transition is inferred only by the appearance of permanent structures and very preliminary seasonality analyses. Without more detailed subsistence, technological and site formation data, little more can be made of this event or its connections with social or environmental factors. Moreover, efforts to investigate or even locate sites on the interior need to be taken as a complete understanding of this transition may remain elusive if data from interior regions stays as negligible as it is today.

The population collapse lasting between ~8,800 and 8,400 cal BP also requires further investigation. There is some circularity in using ^{14}C data to track this event, due to the linkage between global environmental changes and ^{14}C production, which means that other lines of evidence outside of ^{14}C dating need to be used to corroborate this event.

The implication of this collapse and the exceedingly fast recovery from it, hold massive potential for elucidating a possibly extraordinary and widely shared event throughout the entire region's history.

Lastly, this thesis research has brought attention to the importance of using **calibrated** ^{14}C dates, instead of simply using the raw ^{14}C date, when discussing the timing and temporal relationship between events. This issue is pervasive in literature from the North coast and poses serious problems for analysis. As discussed in section 3.1 uncalibrated ^{14}C dates are not actually dates, they are ratios regarding the amount of ^{14}C in an object. Therefore, when we say "radiocarbon years before present" we are not actually specifying any amount of time, as "radiocarbon" years are *not* years. A radiocarbon year is not a standard measurement, as each individual radiocarbon year represents a different amount of time (i.e. an object five radiocarbon years older is not five calendar years older, and how much older an object is changes through time). This means that, at best, uncalibrated ^{14}C dates can be used to represent an ordinal order of events. For a more detailed illustration of this problem see appendix IV.

Further adding to this issue is that uncalibrated ^{14}C dates are not comparable to dates coming from other dating techniques. For example, 'years BP' from luminescence, ice-core, tree ring or obsidian dates are not equivalent to an uncalibrated radiocarbon date; they are scaled to calendar years and therefore comparable only to calibrated ^{14}C dates.

The problems that result from the lack of calibration are not trivial and can result in dramatic misinterpretations or inability to see patterning in temporal data. An example of this is the population gap discovered in this research. Part of the reason this gap has not been discovered before may have been because it does not exist in terms of uncalibrated dates (see figure-17 below) and much of the literature for the North coast uses uncalibrated dates when discussing the chronology of events. Outside of this gap, literature review for this thesis also revealed many examples where confusion or inappropriate inferences in regards to the timing and tempo of archaeological and paleo-environmental events and their correlation had resulted from the use of uncalibrated dates. The inconsistent, or lack of acknowledgement in using uncalibrated or calibrated dates has also led to some confusion where calibrated (or calendar scale) data is compared to uncalibrated.

There are critical problems in the use of uncalibrated dates, and this discussion has not even included the extra problems coming from using uncalibrated marine dates and their comparability issues. There is also little reason to use uncalibrated dates, as calibration software is free (though sometimes tricky) and widely available. Furthermore, while dates older than 10,000 BP were initially problematic to calibrate due to a lack of calibration data for this time period, this issue has mostly been resolved with the last few iterations of the IntCal curve (See Reimer et al. 2013).

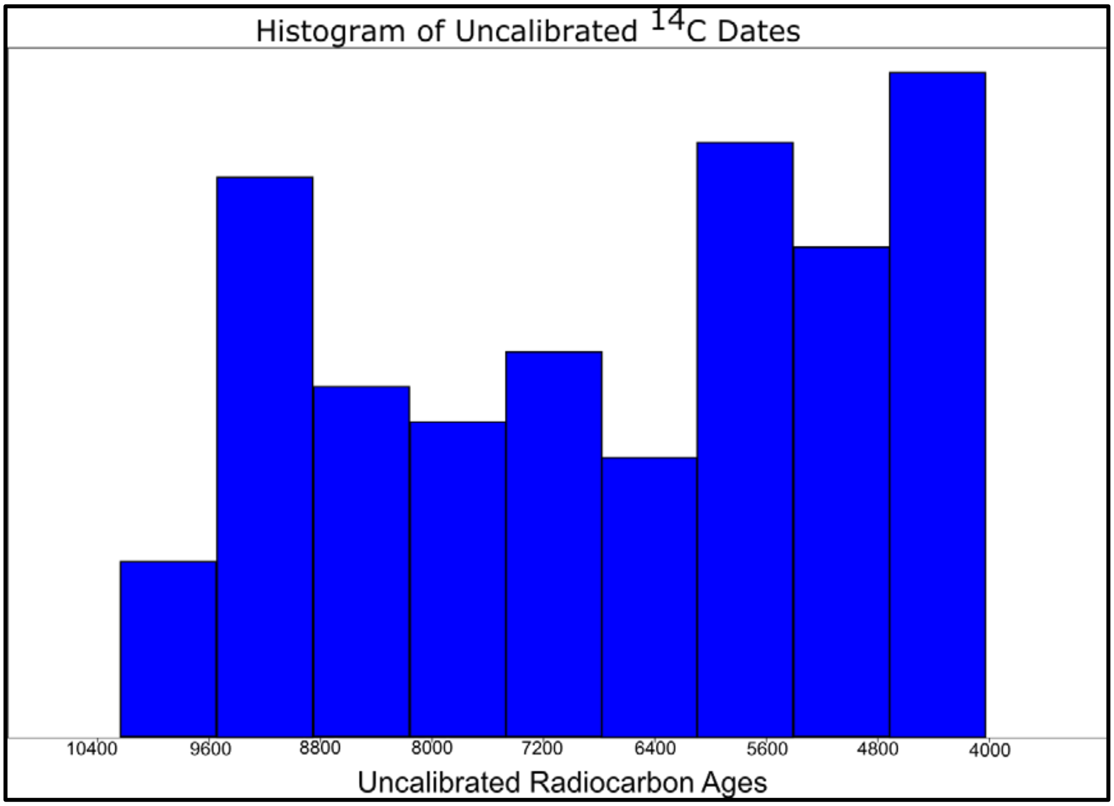


Figure 17: Histogram showing frequency of uncalibrated dates from the North Coast study region, through time. Note that the gap in the histogram is much less severe than observed in the SPD made from calibrated dates.

Altogether then, with the extensive list of caveats and need for more research in mind. There does not appear to be any straightforward connection between mobility change and any of the variables discussed throughout this thesis. While a more direct relationship may be revealed with more data, I believe that this research indicates that there are no meaningful (at a population level) organizational, technological or population barriers, which prohibit the development of sedentism and logistic mobility. Instead, it seems all that is needed is a lack of mobility options. Whereby, as Ames' hypothesizes, the demands of organized labor drive its own complexification. Therefore, as proposed by Scarborough and Burnside (2010) changes to labor organization that increase efficiency of pursuits may be more easily accomplished and more effective than is currently conceptualized by archaeologists.

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Appendix A: Terrestrial ^{14}C Dates Used Throughout Thesis

Site Name	Site Number**	Location Code	Lab #	Conventional Age	STD	Calibrated Age Range*	Material
Rosie's Rockshelter	CRG236	AK	WSU-3238	4150	80	4850-4445	charcoal
Wolf's Lair	CRG381	AK	Beta-74861	4440	60	5288-4872	wood
Wolf's Lair	CRG381	AK	Beta-_75463	4360	70	5280-4828	wood
Wolf's Lair	CRG381	AK	Beta-_75462	4120	70	4835-4441	wood
Ground Hog Bay 2	JUN037	AK	WSU-_412	10800	800	15065-10519	charcoal
Ground Hog Bay 2	JUN037	AK	SI-2112	9220	80	10578-10234	charcoal
Ground Hog Bay 2	JUN037	AK	I-__6304	9130	130	10656-9914	charcoal
Ground Hog Bay 2	JUN037	AK	I-__7057	8880	125	10236-9565	charcoal
Ground Hog Bay 2	JUN037	AK	I-__6395	8230	130	9520-8783	charcoal
Ground Hog Bay 2	JUN037	AK	I-__7058	7545	185	8858-7966	charcoal
Ground Hog Bay 2	JUN037	AK	SI-2106	6755	110	7826-7433	charcoal
Ground Hog Bay 2	JUN037	AK	SI-2107	5770	95	6790-6323	charcoal
Ground Hog Bay 2	JUN037	AK	SI-2105	5360	90	6300-5937	charcoal
Ground Hog Bay 2	JUN037	AK	SI-2109	4180	65	4850-4530	charcoal
Ground Hog Bay 2	JUN037	AK	I-__7056	4155	95	4864-4427	charcoal
Coffman Cove	PET067	AK	SI-4478	4105	75	4829-4437	charcoal
Coffman Cove	PET067	AK	SI-4475	4100	75	4827-4437	charcoal
On Your Knees Cave	PET408	AK	CAMS-_43990	9210	50	10506-10248	charcoal
On Your Knees Cave	PET408	AK	CAMS-_43989	9150	50	10486-10225	charcoal
On Your Knees Cave	PET408	AK	CAMS-_43991	8760	50	10115-9555	charcoal
On Your Knees Cave	PET408	AK	CAMS-31069	5210	60	6182-5768	deer bone
Lake Eva	SIT170	AK	SI-5576	5780	90	6793-6354	charcoal
Lake Eva	SIT170	AK	SI-5578	5520	100	6533-6011	charcoal
Lake Eva	SIT170	AK	SI-5580	5500	70	6445-6125	charcoal

Kanalku Coal Claim Weir	SIT329	AK	Beta-_46336	5550	50	6438-6279	wood
-	SUM042	AK	Beta-_13923	4240	80	5029-4530	charcoal
Hidden Falls	XPA119	AK	SI-4360	10345	95	12530-11825	wood
Hidden Falls	XPA119	AK	SI-4354	10075	75	11978-11320	wood
Hidden Falls	XPA119	AK	SI-4352	10005	75	11805-11246	wood
Hidden Falls	XPA119	AK	SI-3776	9860	75	11609-11165	wood
Hidden Falls	XPA119	AK	SI-4359	9690	70	11235-10785	wood
Hidden Falls	XPA119	AK	SI-3778	9410	70	11068-10425	wood
Hidden Falls	XPA119	AK	SI-4355	9405	75	11069-10412	wood
Hidden Falls	XPA119	AK	SI-4358	9290	70	10660-10264	wood
Hidden Falls	XPA119	AK	SI-4353	9080	70	10491-9953	wood
Hidden Falls	XPA119	AK	Beta-__7440	9060	230	11058-9543	charcoal
Hidden Falls	XPA119	AK	SI-4356	8750	65	10125-9546	wood
Hidden Falls	XPA119	AK	SI-4357	8640	70	9885-9495	wood
Hidden Falls	XPA119	AK	SI-4340	7900	90	9007-8541	wood
Hidden Falls	XPA119	AK	SI-3777	7175	155	8321-7701	wood
Hidden Falls	XPA119	AK	Beta-__7442	4620	110	5589-4976	charcoal
Thorne River	CRG-177	AK	WSU-3618	7650	160	8978-8168	Charcoal
Thorne River	CRG-177	AK	WSU-3679	7560	90	8540-8189	Charcoal
Thorne River	CRG-177	AK	WSU-3681	7440	90	8403-8046	Charcoal
Chuck Lake	CRG237	AK	WSU-3241	8220	125	9494-8780	Charcoal
Chuck Lake	CRG237	AK	WSU-3242	7360	270	8931-7657	Charcoal
Logjam Creek Falls	CRG-578	AK	Beta-264553	5160	40	5995-5755	Charcoal
Rice Creek	CRG-592	AK	Beta-264554	9090	50	10396-10182	Charcoal
Rice Creek	CRG-592	AK	Beta-264580	8330	50	9473-9142	charcoal
Rice Creek	CRG-592	AK	Beta-264579	6100	50	7159-6805	charcoal
Canoe Point	CRG-595	AK	Beta-268998	8220	50	9397-9025	Charcoal
Canoe Point	CRG-595	AK	Beta-268997	8130	50	9255-8992	Charcoal
Canoe Point	CRG-595	AK	Beta-264080	7240	50	8167-7970	Charcoal
Canoe Point	CRG-595	AK	Beta-268996	7190	50	8159-7936	Charcoal
Staney Creek	CRG-600	AK	Beta-269000	6890	40	7831-7656	charcoal
Staney Creek	CRG-600	AK	Beta-269001	6840	40	7757-7591	charcoal
Staney Creek	CRG-600	AK	Beta-268999	6350	40	7415-7174	charcoal
Staney Creek	CRG-600	AK	Beta-269003	6100	40	7158-6861	charcoal
Staney Creek	CRG-600	AK	Beta-269002	4530	40	5314-5046	charcoal
Falls Creek	CRG-603	AK	Beta-283337	7030	40	7954-7763	charcoal
Falls Creek	CRG-603	AK	Beta-283338	6860	40	7787-7615	charcoal
Falls Creek	CRG-603	AK	Beta-283339	6840	40	7757-7591	Charcoal
Cape Pole	CRG-606	AK	Beta-283011	7250	40	8167-7983	charcoal

Cape Pole	CRG-606	AK	Beta-283013	6390	40	7420-7260	Charcoal
Cape Pole	CRG-606	AK	Beta-283012	5570	40	6435-6291	Charcoal
Cape Pole Easy 12m	CRG-609	AK	Beta-283016	5760	40	6659-6454	Charcoal
Cape Pole Easy 12m	CRG-609	AK	Beta-283017	5590	40	6443-6299	Charcoal
Cape Pole 30m	CRG-610	AK	Beta-283015	5130	40	5986-5749	Charcoal
Rice Creek 2	CRG-611	AK	Beta-286823	8660	40	9697-9539	Charcoal
Cape Pole 12m	CRG-612	AK	Beta-283347	4170	40	4835-4578	Charcoal
Cape Pole 12m	CRG-612	AK	Beta-283346	4100	40	4820-4446	Charcoal
Warm Chuck	CRG-669	AK	Beta 337147	7110	50	8016-7841	Charcoal
Black Beauty	CRG-670	AK	Beta 337149	8080	40	9128-8780	charcoal
Black Beauty	CRG-670	AK	Beta 338254	8060	40	9089-8775	charcoal
Black Beauty	CRG-670	AK	Beta 337148	5570	30	6406-6301	charcoal
Sunny Cove	CRG-708	AK	Beta 357144	8400	40	9502-9304	Charcoal
Trout Creek	PET650	AK	Beta-288260	9130	40	10407-10222	Charcoal
Trout Creek	PET650	AK	Beta-286822	8980	40	10234-9930	Charcoal
Trout Creek	PET650	AK	Beta-288621	8900	40	10190-9896	Charcoal
Trout Creek	PET650	AK	Beta-288619	8860	40	10165-9774	Charcoal
Trout Creek	PET650	AK	Beta-264082	8730	50	9890-9554	Charcoal
Trout Creek 18m	PET-650	AK	Beta 288621	8900	40	10190-9896	Charcoal
Trout Creek 18m	PET-650	AK	Beta 286821	8840	40	10156-9710	Charcoal
Trout Creek 18m	PET-650	AK	Beta 264082	8730	50	9890-9554	Charcoal
	GcTq-2	D	UCIAMS 28009	6930	20	7823-7689	Charcoal
Far West Point	GcTr-6	D	UCIAMS 28008	9690	30	11204-10885	Charcoal
Far West Point	GcTr-6	D	UCIAMS 30930	6940	20	7829-7698	Charcoal
Far West Point	GcTr-6	D	UCIAMS 21984	6925	50	7920-7667	Charcoal
Far West Point	GcTr-6	D	TO-13292	6800	60	7784-7566	Charcoal
Far West Point	GcTr-6	D	UCIAMS 30931	6490	20	7440-7326	Charcoal
Far West Point	GcTr-6	D	UCIAMS 30932	6185	20	7165-7006	Charcoal
	GdTq-3	D	D-AMS 007908	5928	30	6845-6670	Charcoal

Kilgii Gwaay	FaTs (1325T)	HG	CAMS-76670	9850	40	11326-11199	charcoal
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-70704	9460	50	11068-10568	caribou bone
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-76666	9430	50	11057-10515	charcoal
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-77248	9410	50	10757-10511	charcoal
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-79684	9340	40	10680-10427	charcoal
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-79682	9260	40	10562-10290	charcoal
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-76668	9230	50	10545-10251	charcoal
Sedgewick Bay	FbTv-(791T)	HG	CAMS-10597	8080	60	9248-8729	plant remains
Poole Inlet West	FcTt-(1359T)	HG	CAMS-26261	8270	60	9435-9034	charcoal
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 9968	9900	90	11711-11180	charcoal
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 8382	9840	100	11709-10873	charcoal
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 9984	9810	190	11968-10685	bone
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10844	9750	70	11307-10795	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10855	9720	70	11252-10788	bone
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10600	9580	200	11591-10268	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10847	9430	100	11104-10404	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 9986	9410	60	11061-10439	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10846	9320	60	10692-10298	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10599	9280	60	10649-10264	wood
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 8381	9240	60	10560-10254	plant remains
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 8380	9150	60	10495-10218	plant remains
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 9987	9150	100	10645-9975	charcoal
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 4113	9100	90	10520-9938	plant remains
Arrow Creek 2	FcTv-(925T)	HG	CAMS- 8377	9010	160	10560-9632	charcoal

Arrow Creek 2	FcTv-(925T)	HG	CAMS- 4114	8890	70	10202-9737	wood
Arrow Creek 1	FcTv-(925T)	HG	CAMS-33909	8880	50	10182-9779	charcoal
Arrow Creek 1	FcTv-(925T)	HG	TO- 2622	8200	80	9407-9004	charcoal
Arrow Creek 1	FcTv-(925T)	HG	TO- 2623	8200	90	9439-8990	charcoal
Arrow Creek 1	FcTv-(925T)	HG	CAMS-33908	8150	60	9288-8992	charcoal
Arrow Creek 1	FcTv-(925T)	HG	CAMS-33906	7410	60	8374-8050	charcoal
Arrow Creek 1	FcTv-(925T)	HG	CAMS-33907	7000	50	7939-7711	charcoal
Arrow Creek 1	FcTv-(925T)	HG	CAMS- 4111	5650	70	6628-6301	charcoal
Arrow Creek 1	FcTv-(925T)	HG	CAMS- 4112	5650	70	6628-6301	charcoal
Lyell Bay East	FdTv-(1355T)	HG	CAMS-33913	8810	60	10158-9632	charcoal
Lyell Bay East	FdTv-(1355T)	HG	CAMS-33912	8610	60	9731-9486	charcoal
Lyell Bay East	FdTv-(1355T)	HG	CAMS-26257	7540	50	8423-8205	charcoal
Lyell Bay East	FdTv-(1355T)	HG	CAMS-33911	5350	60	6281-5993	charcoal
Lyell Bay East	FdTv-(1355T)	HG	CAMS-33910	5030	40	5896-5661	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-42481	9070	50	10378-10170	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-33917	8450	60	9541-9309	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-42480	8230	50	9400-9029	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-33916	8170	60	9294-8999	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-26256	8110	60	9269-8780	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-33915	8060	60	9132-8660	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-33914	7940	60	8992-8610	charcoal
Lyell Bay South	FdTv-(1355T)	HG	CAMS-26255	6630	60	7591-7429	charcoal
Dodge Point	FeTu-(1131T)	HG	CAMS- 9979	5490	80	6449-6020	charcoal
Echo Bay	FeTw-(1127T)	HG	CAMS- 9977	8580	60	9682-9475	wood

Richardson Island	FeTw-(1127T)	HG	CAMS-39877	9590	50	11145-10742	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-39875	9290	50	10648-10286	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-39876	9290	50	10648-10286	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26270	9220	60	10552-10245	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26269	9160	60	10496-10226	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26268	9080	60	10476-10158	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-16202	9010	60	10257-9918	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26266	8980	60	10241-9915	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26267	8960	60	10233-9910	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS- 9975	8850	60	10173-9705	wood
Richardson Island	FeTw-(1127T)	HG	CAMS-26264	8850	60	10173-9705	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-16201	8750	60	10119-9547	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26265	8700	60	9888-9543	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-16200	8690	70	9901-9536	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26263	8640	50	9732-9527	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS- 9974	8550	70	9680-9437	plant remains
Richardson Island	FeTw-(1127T)	HG	CAMS-16199	8490	70	9560-9307	charcoal
Richardson Island	FeTw-(1127T)	HG	CAMS-26262	8470	60	9547-9320	charcoal
Kasta	FgTw-4	HG	S- 677	6010	100	7161-6652	charcoal
Kasta	FgTw-4	HG	GaK-3511	5420	100	6403-5950	charcoal
Lawn Point	FiTx-3	HG	S- 679	7400	140	8451-7952	charcoal
Lawn Point	FiTx-3	HG	GaK-3272	7050	110	8154-7666	charcoal
Lawn Point	FiTx-3	HG	GaK-3271	5750	110	6785-6311	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-54599	6980	50	7932-7696	charcoal
Cohoe Creek	FjUb- 10	HG	Beta-25179	6150	70	7248-6861	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50948	5680	100	6714-6289	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50956	5590	50	6468-6292	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50952	5380	40	6284-6009	charcoal

Cohoe Creek	FjUb- 10	HG	CAMS-19017	5370	70	6295-5955	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16204	5320	60	6274-5943	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50960	5290	40	6187-5943	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50962	5260	40	6180-5928	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50950	5230	40	6177-5912	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50954	5090	50	5935-5715	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16207	5000	70	5899-5609	charcoal
Cohoe Creek	FjUb- 10	HG	RIDDL-1227	4990	110	5987-5482	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16206	4970	60	5891-5596	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-50958	4930	40	5735-5594	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16205	4900	80	5891-5470	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16209	4420	60	5285-4860	charcoal
Cohoe Creek	FjUb- 10	HG	CAMS-16208	4390	70	5284-4842	charcoal
Strathdang Kwun High	FkUb- 16	HG	CAMS-19023	5740	60	6667-6407	charcoal
Strathdang Kwun High	FkUb- 16	HG	CAMS-19019	5330	60	6276-5949	charcoal
Strathdang Kwun High	FkUb- 16	HG	CAMS-16203	4520	60	5437-4972	charcoal
Skoglund's Landing	FlUa- 1	HG	GX-1696	4165	130	5045-4297	charcoal
Bluejackets Creek	FlUa- 4	HG	GaK-5093	5260	440	7156-4986	charcoal
Bluejackets Creek	FlUa- 4	HG	GSC-1554	4290	130	5290-4526	charcoal
Bluejackets Creek	FlUa- 4	HG	S- 676	4160	120	5038-4305	charcoal
Bluejackets Creek	FlUa- 4	HG	S-2776	4160	140	5212-4250	charcoal
Bluejackets Creek	FlUa- 4	HG	S- 936	4150	90	4857-4437	charcoal
Ridley Island	GbTn-19	PRH	S-1672	4890	80	5891-5335	charcoal
Ridley Island	GbTn-19	PRH	S-1671	4610	60	5574-5053	charcoal
Dodge Island	GbTo-18	PRH	S-1410	5555	140	6658-6003	charcoal
Dodge Island	GbTo-18	PRH	S-1409	4875	125	5900-5324	charcoal
Dodge Island	GbTo-18	PRH	GaK-1879	4790	100	5729-5311	charcoal
Dodge Island	GbTo-18	PRH	GaK-1880	4130	90	4845-4435	charcoal
Boardwalk	GbTo-31	PRH	S- 752	4230	220	5449-4157	charcoal
Lachane	GbTo-33	PRH	S- 843	4630	105	5589-4982	charcoal
Lachane	GbTo-33	PRH	S-1148	4455	80	5302-4871	charcoal
Kitandach	GbTo-34	PRH	S- 924	4970	100	5924-5483	charcoal
Kitandach	GbTo-34	PRH	S- 927	4460	120	5463-4831	charcoal
Kitandach	GbTo-34	PRH	SUERC-44466	4218	29	4853-4645	charcoal

Kitandach	GbTo-34	PRH	SUERC-44475	4216	27	4851-4646	charcoal
Kitandach	GbTo-34	PRH	SUERC-44468	4182	27	4836-4620	charcoal
Kitandach	GbTo-34	PRH	SUERC-44470	4176	27	4833-4616	charcoal
Kitandach	GbTo-34	PRH	S-1408	4100	140	4968-4162	charcoal
Paul Mason	GdTc-16	PRH	SFU- 259	5050	140	6181-5485	charcoal
Paul Mason	GdTc-16	PRH	S-2336	4745	195	5908-4892	charcoal
Paul Mason	GdTc-16	PRH	S-2337	4655	130	5644-4971	charcoal
Paul Mason	GdTc-16	PRH	S-2334	4395	130	5447-4624	charcoal
Paul Mason	GdTc-16	PRH	SFU- 261	4350	320	5738-4090	charcoal
Paul Mason	GdTc-16	PRH	WSU-2923	4280	95	5271-4530	charcoal
Paul Mason	GdTc-16	PRH	SFU- 258	4270	200	5454-4291	charcoal
Paul Mason	GdTc-16	PRH	SFU- 257	4250	100	5260-4447	charcoal
	T416-1	PRH	D-AMS 007904	6211	28	7242-7008	Charcoal
	T416-1	PRH	D-AMS 007903	4504	30	5299-5046	Charcoal

*Calibrated at 2-Sigma (95%) range using OxCal 4.2 and IntCal13 Calibration Curve. In the case of multiple intercepts, the highest probability range is represented here.

** Some site numbers for Haida Gwaii such as FdTv-(1355T) do not have typical Borden numbers because they are not registered with the national heritage database in Canada, due to the wishes of the Haida First Nations. Therefore, while the FdTv does represent the general Borden block where the site is located, the numbering that follows is the Haida Gwaii Park Service internal numbering system for sites and does not represent the locality of the site. The site number T416-1 is a temporary site number and is awaiting an official designation.

Appendix B: Marine ^{14}C Dates Used Throughout Thesis

Site Name	Site Number	Location Code*	Lab #	Conventional Age	STD	Calibrated Age Range**	Material
Thorne River	CRG177	AK	WSU-3618	7650	160	7924-7290	marine shell
Rosie's Rockshelter	CRG236	AK	WSU-3234	4460	100	4225-3588	marine shell
Rosie's Rockshelter	CRG236	AK	WSU-3236	4230	140	4008-3228	marine shell
Chuck Lake 1	CRG237	AK	WSU-3243	8180	130	8383-7817	marine shell
Chuck Lake 2	CRG237	AK	WSU-3245	5140	90	5169-4499	marine shell
Chuck Lake 3	CRG237	AK	WSU-3244	5240	90	5273-4674	marine shell
On Your Knees Cave	PET408	AK	CAMS-_42381	10300	50	9825-9245	bone
On Your Knees Cave	PET408	AK	CAMS-_32038	9880	50	9562-9024	Human bone

On Your Knees Cave	PET408	AK	CAMS-_29873	9730	60	9428-8926	Human bone
Chuck Lake	CRG-237	AK	WSU-3243	8180	130	8383-7817	marine shell
	GcTq-4	D	Beta 215178	6830	70	7261-6802	Marine shell
	GcTq-4	D	Beta 215179	5290	40	5562-5123	Marine shell
	GcTq-5	D	TO 13600	8829	60	9411-8973	Marine shell
	GcTq-5	D	TO 13599	4620	50	4770-4227	Marine shell
	GcTr-3	D	Beta 215176	4440	50	4442-3965	Marine shell
Far West Point	GcTr-6	D	UCIAMS 21881	7510	20	7841-7556	Marine shell
Far West Point	GcTr-6	D	UCIAMS 31730	7300	30	7644-7380	Whale bone
Far West Point	GcTr-6	D	Poz 30563	7005	44	7413-7057	Marine shell
Far West Point	GcTr-6	D	Poz 30562	6900	43	7306-6928	Marine shell
	GcTr-8	D	TO-13289	7000	60	7415-7020	Marine shell
	GcTr-8	D	XA 5803	6306	31	6616-6281	Marine shell
	GcTr-8	D	XA 5804	6192	36	6496-6166	Marine shell
	GdTq-1	D	TO 13593	6190	70	6555-6102	Marine shell
	GdTq-1	D	TO 13594	5140	70	5400-4865	Marine shell
	GdTq-1	D	Beta 215174	4780	40	4845-4447	Marine shell
	GdTq-1	D	TO 13595	4640	70	4790-4235	Marine shell
	GdTq-3	D	Beta 215180	6890	50	7303-6907	Marine shell
	GdTq-3	D	Poz 27700	6600	50	6989-6558	Marine shell
	GdTq-3	D	Poz 30561	6540	41	6899-6494	Marine shell
	GdTq-3	D	D-AMS 008142	6474	29	6804-6432	Marine shell

	GdTq-3	D	Poz 30560	6435	42	6772-6391	Marine shell
	GdTq-3	D	D-AMS 008141	5990	29	6265-5934	Marine shell
	GdTq-3	D	Poz 30559	5821	38	6140-5720	Marine shell
	GdTq-3	D	Poz 25879	5537	38	5825-5445	Marine shell
	GdTq-3	D	Beta 215183	5230	60	5505-4978	Marine shell
Lucy Island	GbTp-1	D2	Beta 345573	8680	40	9231-8715	Marine Shell
Lucy Island	GbTp-1	D2	Beta 345571	7800	40	8154-7810	Marine Shell
Lucy Island	GbTp-1	D2	Beta 292552	7500	40	7851-7534	Marine Shell
Lucy Island	GbTp-1	D2	Beta 292555	7220	40	7573-7284	Marine Shell
Lucy Island	GbTp-1	D2	Beta 292551	6910	40	7311-6940	marine shell
Lucy Island	GbTp-1	D2	Beta 292554	6900	40	7304-6931	marine shell
Lucy Island	GbTp-1	D2	Beta 292553	6230	40	6541-6196	marine shell
Lucy Island	GbTp-1	D2	Beta 292550	6220	40	6529-6185	marine shell
Lucy Island	GbTp-1	D2	Beta 317343	5710	40	5952-5602	Human bone
Lucy Island	GbTp-1	D2	Beta 345575	5560	40	5841-5467	marine Shell
Lucy Island	GbTp-1	D2	Beta 345577	5500	30	5745-5362	marine Shell
Lucy Island	GbTp-1	D2	Beta 345570	5440	30	5648-5314	marine Shell
Lucy Island	GbTp-1	D2	Beta 294715	5330	40	5580-5223	Human bone
Lucy Island	GbTp-1	D2	Beta 292549	5290	40	5562-5123	Marine Shell
Lucy Island	GbTp-1	D2	Beta 345572	4960	30	5193-4710	Marine Shell
Lucy Island	GbTp-1	D2	Beta 345574	4950	30	5186-4688	Marine Shell
Lucy Island	GbTp-1	D2	Beta 345576	4780	30	4845-4450	Marine Shell

Kilgii Gwaay	FaTs (1325T)	HG	CAMS-76669	10140	40	11035-10647	marine shell
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-76667	10040	50	10919-10514	marine shell
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-79683	10040	40	10900-10528	marine shell
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-79681	10020	50	10890-10492	marine shell
Kilgii Gwaay	FaTs (1325T)	HG	CAMS-79685	9270	40	9881-9524	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10853	10020	60	10920-10479	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-9969	9970	70	10864-10370	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10856	9930	60	10756-10330	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10845	9900	70	10717-10266	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-8376	9870	60	10661-10259	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-8373	9860	70	10662-10240	marine shell
Arrow Creek 2	FcTv-(925T)	HG	CAMS-10848	10030	100	11025-10405	marine shell
Echo Bay	FeTw-(1127T)	HG	CAMS-9978	9640	70	10461-9959	marine shell
Echo Bay	FeTw-(1127T)	HG	CAMS-14438	9270	100	10075-9472	sea otter bone
Richardson Island	FeTw-(1127T)	HG	CAMS-16953	9390	100	10160-9560	marine shell
Richardson Island	FeTw-(1127T)	HG	CAMS-10854	9250	60	9899-9487	marine shell
Richardson Island	FeTw-(1127T)	HG	CAMS-16955	8960	80	9525-9115	marine shell
Richardson Island	FeTw-(1127T)	HG	CAMS-9976	8850	60	9413-9025	marine shell
Richardson Island	FeTw-(1127T)	HG	CAMS-16954	8750	60	9340-8928	marine shell
Richardson Island	FeTw-(1127T)	HG	CAMS-19290	8540	60	9002-8589	whale bone
Cohoe Creek	FjUb- 10	HG	CAMS-50957	6350	40	6660-6368	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-50949	6340	40	6650-6353	marine shell

Cohoe Creek	FjUb- 10	HG	CAMS-50959	6240	40	6533-6268	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-50951	6150	40	6429-6180	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-50961	6020	40	6285-5999	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-50953	6000	40	6274-5988	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-16957	5990	60	6281-5948	marine shell
Cohoe Creek	FjUb- 10	HG	CAMS-50963	5980	50	6270-5955	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-50955	5890	40	6175-5896	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-19018	5790	60	6115-5717	marine shell
Cohoe Creek	FjUb-10	HG	RIDDL-1228	5715	90	6061-5592	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-16958	5650	60	5904-5593	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-16959	5570	50	5861-5551	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-16960	5550	60	5845-5485	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-16962	5020	60	5246-4835	marine shell
Cohoe Creek	FjUb-10	HG	CAMS-16961	4890	70	5111-4579	marine shell
Strathdang Kwun High	FkUb- 16	HG	CAMS-19022	6000	50	6285-5975	marine shell
Strathdang Kwun High	FkUb- 16	HG	CAMS-19024	5990	70	6291-5930	marine shell
Strathdang Kwun High	FkUb- 16	HG	CAMS-19020	5810	60	6142-5741	marine shell
Strathdang Kwun High	FkUb- 16	HG	CAMS-16956	5240	60	5511-5066	marine shell
Bluejackets Creek	FlUa- 4	HG	S-2352	5055	155	5475-4645	Human bone
Bluejackets Creek	FlUa- 4	HG	S-2351	5005	150	5430-4603	Human bone
Bluejackets Creek	FlUa- 4	HG	S-2349	4675	145	4956-4145	Human bone
Garden Island	GbTo-23	PRH	S-1596	6330	80	6711-6260	Human bone

Kitandach	GbTo-34	PRH	SUERC-44467	4898	29	5032-4597	marine shell
Kitandach	GbTo-34	PRH	SUERC-44469	4886	27	5016-4587	marine shell
Kitandach	GbTo-34	PRH	SUERC-44474	4854	29	4959-4542	marine shell
Kitandach	GbTo-34	PRH	SUERC-44465	4852	27	4955-4543	marine shell
Kitandach	GbTo-34	PRH	OS-108926	4600	30	4684-4216	marine shell
Kitandach	GbTo-34	PRH	OS-108968	4570	25	4605-4166	marine shell
Kitandach	GbTo-34	PRH	OS-108925	4320	30	4275-3838	marine shell
Kitandach	GbTo-34	PRH	OS-109689	4300	20	4235-3825	marine shell
Kitandach	GbTo-34	PRH	SUERC-44456	4242	29	4154-3719	marine shell
	GbTo-59	PRH	OS-108829	4470	25	4478-4056	marine shell
	GbTo-66	PRH	OS-101348	4810	30	4887-4496	marine shell
	GbTo-66	PRH	OS-101352	4780	25	4844-4475	marine shell
	GbTo-66	PRH	OS-101344	4650	40	4775-4296	marine shell
	GbTo-66	PRH	OS-101350	4230	30	4141-3711	marine shell
	GcTn-9	PRH	OS-119878	4250	25	4169-3735	marine shell
	GcTo-27	PRH	OS-101360	4380	25	4366-3926	marine shell
McNichol Creek	GcTo-6	PRH	OS-101646	5780	35	6081-5669	marine shell
McNichol Creek	GcTo-6	PRH	OS-101555	4490	30	4498-4077	marine shell
	T416-1	PRH	D-AMS 007887	6951	46	7371-6982	marine shell
	T627-2	PRH	OS-101563	4860	25	4965-4552	marine shell
	T627-2	PRH	OS-101562	4310	30	4260-3827	marine shell
	GaTp-10	SI	D-AMS 007883	9133	30	9695-9335	marine shell

	GaTp-10	SI	D-AMS 007882	6275	26	6589-6261	marine shell

* AK dates calibrated using Delta_R of 545+-60 (Carlson and Baichtal 2015); Dundas, Lucy and PRH dates calibrated using Delta_R of 288 +-69; Haida Gwaii dates calibrated using Delta_R of 265 +-45 (Southon and Fedje 2003)

**Calibrated at 2-Sigma (95%) range using OxCal 4.2 and Marine13 Calibration Curve. In the case of multiple intercepts, the highest probability range is represented here.

Appendix C: The Importance of Calibrating ^{14}C Dates and Why Combine Them Prior to Calibration

To create 'bins' or weighted averages of multiple ^{14}C dates, the averaging process should be done on the *uncalibrated* dates and then calibrated (Ramsey 2001, 2008, 2009). The reason for this is partially for consistency, as the results will be different depending on whether you average before or after calibration. However, the primary reason to average before calibration is because doing so gives a much more accurate reflection of the true calendar age and associated error for the sample (Weninger et al. 2015). This is because the calibration curve changes the underlying probability distributions of ^{14}C samples in a non-linear way, which introduces chaotic effects to every date being calibrated. Therefore, when you average calibrated dates you are stacking or compounding these effects in the end result. Thus, your average is not just an average of the ^{14}C samples, but also an average of the calibration curve. This is why (CalDate A + CalDate B)*/2 is not equal* to the calibrated age of ^{14}C sample A + ^{14}C sample/2 (Weninger et al. 2015; Ramsey 2009).

Combining dates before calibration alleviates this issue by creating a single date and associated error from the normally distributed isotopic ratios in the ^{14}C samples to calibrate, which in turn means that the effects of the calibration curve are incorporated only once into the final result (Ramsey 2001, 2009). Besides avoiding the compounding effects of the calibration curve, the reason to average beforehand is to make sure the correct effects of the calibration curve are captured in the calibration. Because the calibration curve is not linear, and its effects are not constant (^{14}C ages can stay the same, get older, or younger depending on where in the calibration curve they fall), ^{14}C ages do not have a one-to-one relationship to calibrated calendar ages. As table 10 shows while the ^{14}C dates are evenly spaced at every 60 years, the calibrated ages have very different intervals, changing the relative relationship between dates considerably. The importance of this difference, which demonstrates the importance of calibrating dates, is best illustrated by comparing the span of dates between the two columns. The span of the uncalibrated dates is 240 years, while the calibrated span is almost *half* that at 130 years.

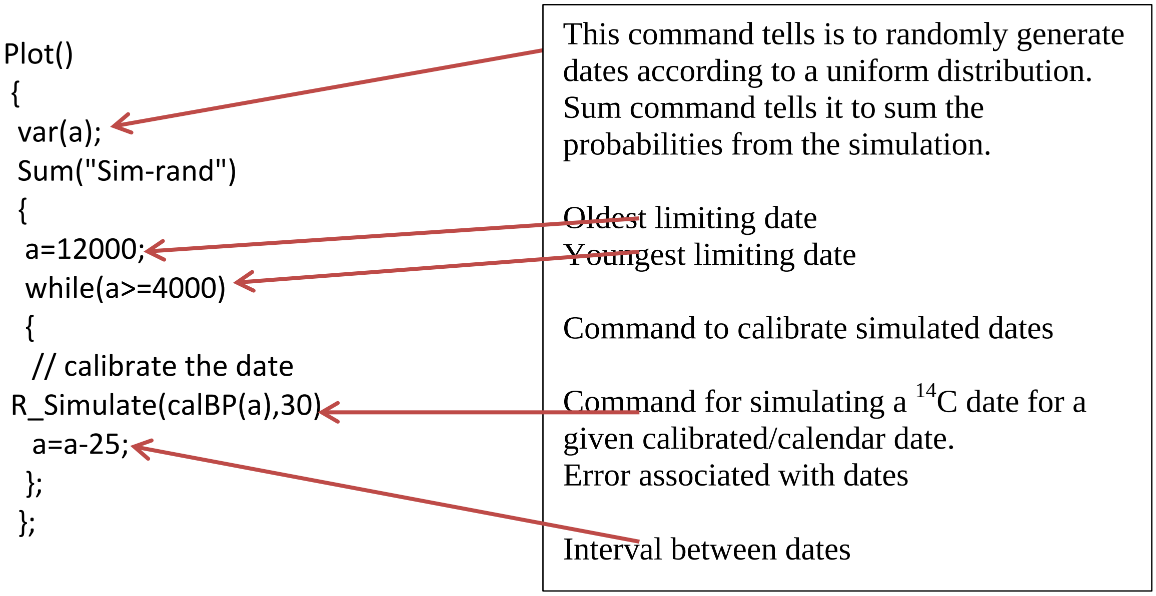
Table 10: comparison of calibrated and uncalibrated age spans

Sample #	14C Age	STD	Cal Age	STD
1	500	50	552	50
2	560	50	581	49
3	620	50	602	43
4	680	50	622	53
5	740	50	685	37

Because of the curve's fluctuations, not all ^{14}C years represent the same amount of time and the only way to capture the accurate relationship between ^{14}C time and calendar time is to make sure the right atmospheric fluctuations are accounted for in the averaging process and averaging prior to calibration assures we do this (see Weninger et al. 2015 for more discussion). This does not mean that calibrated results will not be similar, only that there is no way to know until calibration is complete. It should also be noted that this discussion does not even take into account how to average calibrated dates when there are multiple high-probability calibrated ranges or how to weight different lengths of calibrated ages with one another.

Appendix D: Creating Control Samples with OxCal

Using OxCal version 4.2, the code below was used to simulate a 'control sample' from which to compare the actual SPDs. This code creates a series of randomly generated ^{14}C dates, in systematic intervals with a randomly generated error for the period between 11,000 and 4,000 cal BP. It then calibrates each of these simulated dates and sums them together to create an SPD. This was done twice, once using the terrestrial curve and a second time using the marine curve (Intcal13 and Marine13 respectively). The coding for using the marine curve is the same but options are set to use the marine instead of the default terrestrial curve. Copying and pasting this code directly into OxCal will allow someone to create their own control samples. The picture to the right of the code gives a quick description of what each part of the coding is doing. A similar process can be done using the "Make Set" function on CalPal software (Weninger 2015), which is available, for free, upon request from Dr. Weninger.



```
Plot()
 {
  var(a);
  Sum("Sim-rand")
  {
   a=12000;
   while(a>=4000)
   {
    // calibrate the date
 R_Simulate(calBP(a),30)
    a=a-25;
   };
  };
```

This command tells is to randomly generate dates according to a uniform distribution. Sum command tells it to sum the probabilities from the simulation.

Oldest limiting date
Youngest limiting date

Command to calibrate simulated dates

Command for simulating a ^{14}C date for a given calibrated/calendar date.
Error associated with dates

Interval between dates

Appendix E: Illustrative Example Showing the Effects of Using a Rolling Mean

The figure below is an illustrative example of the effects of using a rolling mean or moving average. Note how it smooths away many of the exaggerated spikes and dips, which are usually a product of the calibration curve. It is also important to note that using a moving average does move certain events in time slightly. However, this movement should not be understood as a tradeoff between reducing noise and precision, as the timing of events in the pre-MA graph are not more 'correct'. The timing and spikiness of events is a product of both the real timing of events and the shape of the calibration curve, thus the moving of events that happens during the smoothing process may both better reflect the actual timing of events and eliminate noisy variations.

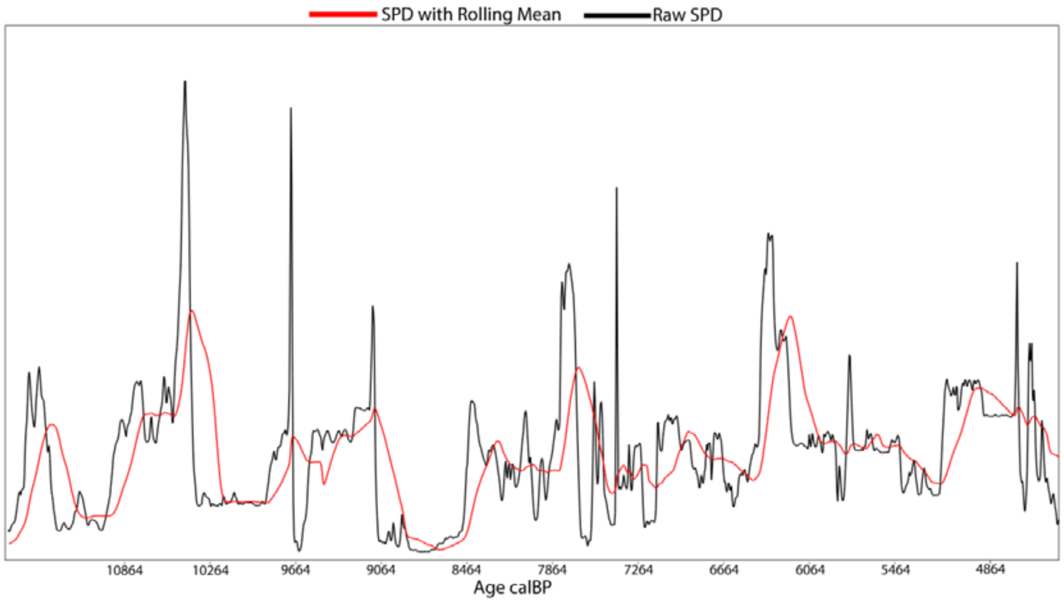


Figure 18: Showing effects of using a rolling mean to smooth data. Note: this is an illustrative example and timing of events may differ slightly compared to the other SPD figures.

Appendix F: Comparison of Sub-regional effects on the overall SPDs.

Comparing compatibility of Marine and Terrestrial samples:

Like other coastal sites across the world, shell middens and other marine sources (e.g. sea-mammals, fish, etc.) make up a major portion of dateable material and site-types available to archaeologists. Therefore, many sites may only have dates from marine sources such as shell fish. Since it is extremely difficult to accurately combine marine dates with terrestrial ones in the creation of SPD's, I use comparative methods to understand their respective patterning. The goal of the following comparisons is to understand if, when and why there are major differences among the SPDs to better understand if there are there significant biases affecting the terrestrial and marine SPDs.

The first comparison (figure-19) is between the overall terrestrial SPD and the overall marine SPD that was created using the most up-to-date Delta_Rs I could find for each sub-region. Note that these two SPDs show remarkable consistency between one another. In fact they have almost the exact same pattern. The only places where any real discrepancies occur is between 9,000-8,400 Cal BP, where the dip in the marine SPD is not as significant. After which, the marine SPD also takes much longer to recover (~7,800 cal BP) than the terrestrial, which recovers around 8,400 Cal BP. At ~5,400 cal BP we also see an inversion between the SPDs where a spike in growth of the marine SPD is opposite a decline in the terrestrial. However, given the discussion of comparability above (see section 3.3), these differences are quite minor and the overall pattern between the two SPDs is very strong.

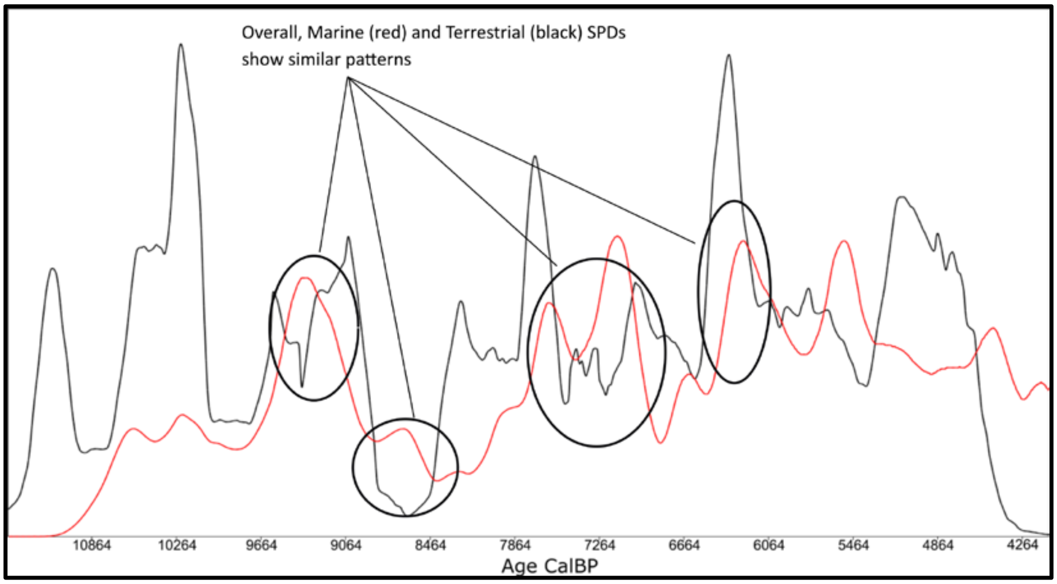


Figure 19: Showing comparison of marine and terrestrial SPDs

Sub-Regional Comparison-Marine:

In this section I compare the overall marine and terrestrial SPDs with SPDs created for each of the sub-regions in order to better understand how each sub-region is effecting the total shape of the SPD. This step also helps identify how certain patterns or timing of events are being overly biased by a single sub-region. Figure-20 below, compares the marine SPDs.

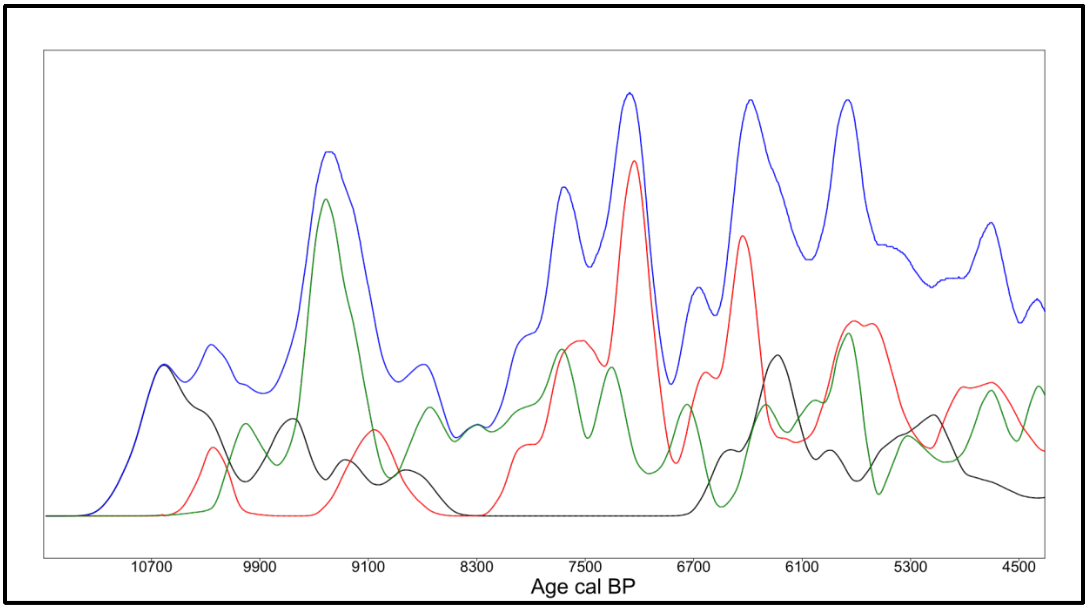


Figure 20: Compares SPD generated for each sub-region to the overall marine SPD. Blue = Whole SPD; Red = Dundas; Green = Alaska and Black = Haida Gwaii. All were done using local corrections

Overall, figure-20 clearly demonstrates that certain peaks in the overall SPD are being driven by a single sub-region. However, most of these peaks correspond to peaks from other regions as well, thus the actual pattern seems fairly robust. Interestingly, Haida Gwaii is conspicuously absent for almost 2,000 years between 8,500 and 6,500 cal BP and then sees a dramatic increase in representation. This feature highlights a point made throughout the thesis, that this time-period has received proportionately little sampling effort until very recently compared to much earlier and later sites. This graph also shows that samples from the Dundas and PRH regions have a much more pronounced signature on the SPD post 7,500 cal BP than either Alaska or Haida Gwaii. This may be an effect of the Dundas/PRH region being much more reliant on shell fish, which is probably true to some extent given the lack of other subsistence resources on the Dundas Islands. However, surveys specifically looking for sites of this age have also been much more prevalent on the Dundas Islands (see McLaren 2008; Martindale et al. 2009, 2010; Letham et al. 2015). In all, while certain sub-regions are more represented in certain time periods than others, such as early Alaska, the lack of Haida Gwaii samples between 8,500-6,500 and a possible overrepresentation of sites from the Dundas Islands following 7,500, the overall marine SPD is being shaped by samples from multiple sub-regions throughout the entire period. Therefore, with the above caveats in mind, I feel that the region-wide SPD is fairly representative of the region as a whole and is not being grossly distorted by any single region.

Sub-regional Comparison of the Terrestrial SPDs

As with the marine comparisons it is important to compare the total terrestrial SPD to the individual sub-regions SPDs, in order to see where and how different sub-regions are disproportionately affecting the shape of the SPD.

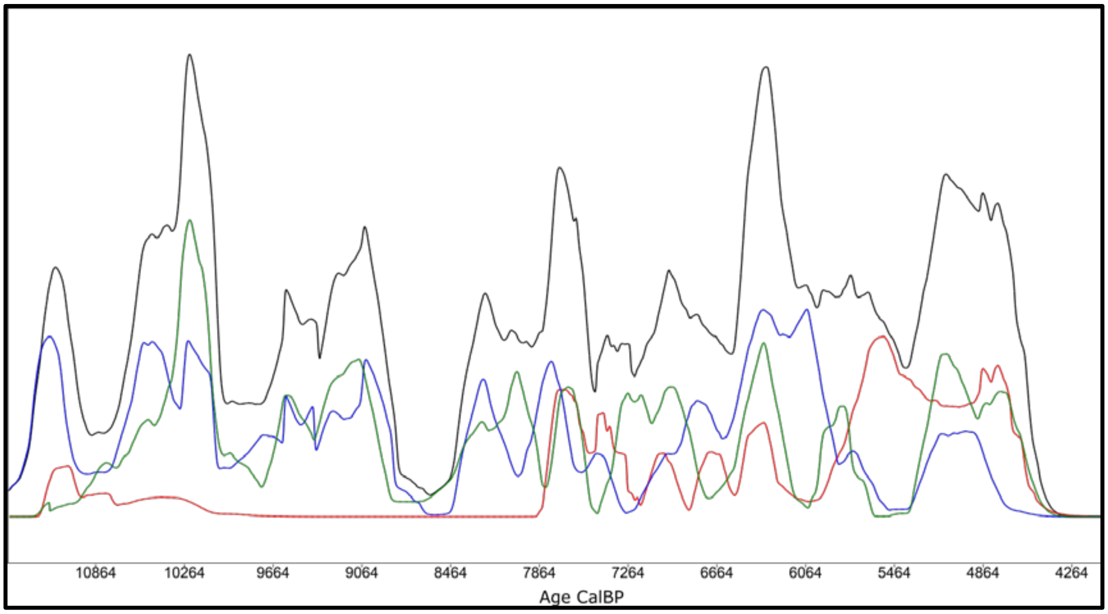


Figure 21: showing SPDs from each sub-region, Haida Gwaii (Blue), Alaska (Green) and Dundas (Red), compared to the whole terrestrial SPD (black). Note, except for early absence of terrestrial dates from Dunas/Lucy area, each sub-region is well represented throughout sequence.

Figure-21 (above) shows that, similar to the marine samples, the early period is much better represented by Haida Gwaii and Alaska than by the Dundas/PRH region. However, this difference is much more pronounced in the terrestrial SPD. This can be explained by the sampling methods so far employed within the Dundas/PRH region where all of the early sites are shell midden sites. Post 8,500 cal BP though; there is relatively even representation within each of the sub-regions. Allowing for expected variation between the regions, the terrestrial SPD is a good representation of the region as a whole and is not being overly biased by any single sub-region. This does not necessarily mean that the shape of the SPDs or trends within it is not affected by research or preservation biases, just that these biases are regionally consistent.