Fall 2021

Intergroup Conflict and the Spread of the Bow and Arrow in the Salish Sea Region

David Hanna
Western Washington University, davidhanna98012@yahoo.com

Intergroup Conflict and the Spread of the Bow and Arrow in the Salish Sea Region

By

David Hanna

Accepted in Partial Completion
of the Requirements for the Degree
Master of Arts

ADVISORY COMMITTEE

Dr. Todd A. Koetje, Chair

Dr. Sarah, K. Campbell

Dr. Daniel L. Boxberger

GRADUATE SCHOOL

David L. Patrick, Dean

Master's Thesis

David Hanna

November 27, 2021

Intergroup Conflict and the Spread of the Bow and Arrow in the Salish Sea Region

A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
Of the Requirements for the Degree
Master of Arts

by
David Hanna
November 2021

Abstract

The bow and arrow is thought to have had a major impact on the introduction of social stratification in the Salish Sea region through increased use of individual hunting, mirroring similar patterns from other parts of North America, as well as being introduced in the Salish Sea region roughly contemporaneously with a period of increased intergroup violence. While the bow and arrow may primarily have been used as a tool for hunting, it was fully capable of being used as a weapon in intergroup and interpersonal conflict. Many of the features that made it a more effective individual hunting tool over the thrown spear or dart also making it a more efficient weapon against human targets. Given this, the introduction of the bow and arrow to the Salish Sea region had the potential to increase the violence and intensity of intergroup conflict in the Salish Sea region. In a prolonged period of low intensity conflict, the defensibility of a given location from attack would be an important factor in the choice to build at said location. I hypothesized that if the introduction of the bow and arrow to the Salish Sea region was a contributing factor to a period of escalating interpersonal and intergroup conflict, then it could be possible that villages would be built in more and more defensible locations the more prominent the use of the bow and arrow was in the region.

Acknowledgements

First and foremost, I must acknowledge the Coast Salish peoples of the Salish Sea region, without whom I would not have a thesis.

I must acknowledge my committee for their advice and aid throughout this process.

Thank you to Professor Koetje for his aid in the statistical analysis portions of the thesis.

Thank you to Professor Campbell, for the consultation she provided during the initial formulation of my research strategy.

Thank you to Professor Boxberger for his expertise in the cultural anthropology of the Salish sea region.

In addition, Adam Rorabaugh and R. Kyle Bocinsky both provided invaluable consultation and access to research materials, without which I would not have been able to conduct my research.

Last but certainly not least, thank you to Mom and Dad, for believing in me even when I could not believe in myself.

Table of Contents

List of Figures

List of Tables

Chapter One: Conflict and Change in the Salish Sea region

The bow and arrow is thought to have had a major impact on the introduction of social stratification through increased use of individual hunting practices (Angelbeck 2009, Angelbeck and Cameron 2014). , as well as being introduced in the Salish Sea region roughly contemporaneously with a period of increased intergroup violence (Ames and Maschner 1999; Moss and Erlandson 1992.). While the bow and arrow may primarily have been used as a tool for hunting, it was fully capable of being used as a weapon in intergroup and interpersonal conflict. Many of the features that made it a more effective individual hunting tool over the thrown spear or dart also making it a more efficient weapon against human targets.

Given this, the introduction of the bow and arrow to the Salish Sea region had the potential to increase the violence and intensity of intergroup conflict. This could have the potential effect of promoting the waging of intergroup conflict as a means of gaining individual status, in much the same way that the bow and arrow empowered the use of individual hunting practices. In a prolonged period of low intensity conflict, the defensibility of a given location from attack would be an important factor in the choice to build at said location, particularly in the case of the larger winter village sites common in the region. If the introduction of the bow and arrow to the Salish Sea region was a contributing factor to a period of escalating interpersonal and intergroup conflict, then it could be possible that villages would be built in more and more defensible locations the more prominent the use of the bow and arrow was in the region.

I will be examining this through the use of Wolf's theory of modes of power (1990), showing how different actors within the societies of the Salish Sea region exercised agency at the interpersonal, intergroup, and society wide scales. The dataset I am using for this project is the set of dated projectile points assemblages complied by Rorabaugh for use in his dissertation research, paired with their associated archaeological site components. I will be analyzing the relative defensibility of the site components by analysis of key geographic features. I initially intended to do this using Martindale and Supernant's (2009) method, but due to running into difficulties with the specific use of their methodology given the data available to me, I switched to Bocinsky's (2014) method of calculating relative defensibility, which was capable of calculating the defensibility values of an entire area, rather than the component-by-component process of Martindale and Supernant (2009).

Once this data is collected, I compare the relative defensibility values of the site components associated with specific points assemblages and the values of said points on a statistical index created by Rorabaugh (2015) building off the work of Hildebrandt and King (2012), to determine if the points are dart/spear points or arrow points. Comparing the relative defensibility and the proportion of arrow points in the assemblage should allow me to determine if there are any links or correlations between the two datasets.

While there has been study of the changes in projectile points styles believed to signal the introduction of the bow and arrow to the Salish Sea region, in particular establishing the dates of 3500-2500ybp as the hypothesized period of the introduction of the bow and arrow to the Salish Sea region, (Rorabaugh 2015; Rorabaugh and Fulkerson 2015), no analysis has been conducted which pairs the analysis of particular point assemblages and the general spatial positioning of their associated site components. By analyzing the relative defensibility of site components associated with specific projectile point assemblages, any resulting correlations could provide areas for further examination of the data on smaller subdivisions, such as the local geography of the site component combined with the subregion of the broader Salish Sea region. By combining these two analyses, I hope to provide a new perspective on the changes in material culture and the role that tool choice in the face of intergroup conflict potentially had in long-term societal changes in the prehistory of the Salish Sea region.

Understanding the nature of conflict in the precontact Salish Sea region is vital to reconstructing the pressures that impacted changes in the social structures and dynamics of the area. intergroup conflict, particularly the raids that took slaves, impacted social dynamics both within and between groups. Within groups, the practice of intragroup conflict was a means for preeminent political actors to maintain their dominance, both materially and socially (Angelbeck 2009). Between groups, armed conflict could be a cause for and expression of tensions, and the results of the conflict could influence further changes among the combatant groups. The Salish Sea region is an area with a significant oral record of conflicts being conducted (Costello 1895, Angelbeck and Mclay 2011), which has been backed up by the archaeological identification of fortified sites (Angelbeck 2009). The taking of slaves in particular would have had the potential to provide outsized economic benefit to the slave-taker, and increase their position in their community (Donald 1997; Ames 2001). Ethnographic records show that war leaders played an important role in society, and that those who had proven themselves as effective leaders in war were more likely to gain influence in their communities (Hancock 1860 and Costello 1895, in Angelbeck 2009). Due to the lack of a precontact written record in this area, archaeological investigation is one of the primary means through which the changing nature of armed conflict in the area can be determined.

The procedures and activities associated with intergroup conflict are shaped and influenced by the weapons and defensive strategies available to combatant groups. Throughout the rest of North America, archaeological evidence has shown that the introduction of the bow and arrow to a given region can strongly coincide with other material changes that have been linked to changes in social organization and structure for the associated region (Grund 2017; Nichols and Vanpool 2015; Vanpool and O'Brien 2013). Under these models, the adoption of the bow and arrow was a factor contributing to changes in hunting practices in favor of individual hunters over group hunting, which was a contributing factor aiding individual hunters in leveraging their positions to assume places of influence and power in their communities. Much of the research relevant to the spread of the bow and arrow in the Salish Sea region and western North America has been conducted in the Great Basin region and the Columbia Plateau (Ames et al. 2010, Bettinger and Eerkins 1999, Hildebrandt and King 2012, Thomas 1978). This is perhaps unsurprising, given the close geographic proximity of these regions, and the possibility that contact of one form or another was not uncommon between them.

Multiple experimental and ethnographical studies of different projectile point delivery methods have shown the bow and arrow as being both more accurate and quicker to use than the spear thrower, commonly known as the atlatl (Angelbeck and Cameron 2014). While the thrown spear and dart would still have had greater force, meaning they were more effective when attempting to bring down larger animals such as wapiti, this advantage would have been less important against smaller, human-sized targets capable of being felled by arrows. The benefits that the bow and arrow would have had over the spear thrower in hunting also applied to provide increased lethality in intergroup conflict (Angelbeck and Cameron 2014).

While the spear throwers and bows themselves rarely survive to be preserved in the archaeological record, the lithic points that are associated with these technologies are commonly recovered from archaeological sites. Using statistical indices, Hildebrandt and King (2012) have proposed a metric to determine the likelihood that a given projectile point was used with a spear thrower, or a bow and arrow. Rorabaugh (2015) used this index, which only applied to stemmed points, and developed a discriminate function analysis to apply a similar function to unstemmed projectile points, which are much more common in the Salish Sea region. This allows a more thorough analysis of the point assemblages in the Salish Sea region to be conducted.

Lithic points may not themselves have always been used in intergroup conflict. However, their presence in assemblages reflects a baseline familiarity with their associated technology, showing that it is plausible that points may have been specifically designed for intergroup conflict but are less likely to preserve in the archaeological record. For instance, wooden points and bone points designed to pierce armor were also in use, as reflected in the oral and archaeological record elsewhere along the Northwest Coast. (Angelbeck 2009; Buddenhagen 2011a; Lowery 1999). While a compete inventory of lithic, bone, and wooden points would be ideal for tracing the influences of the spread of the bow and arrow on material culture, as lithic points are the only ones that can reliably withstand the formation processes of most site types, the baseline familiarity with bow and arrow technology demonstrated by the presence of lithic points is sufficient for broad generalizations.

While the weapons available to potential combatants are an important aspect of how intergroup conflict is conducted, the environment in which the conflict takes place is equally important, as it will dictate the forms of conflict that are more or less effective. Both the ethnographic and archaeological record indicate that groups in the Salish Sea region based their villages and other sites in defensible locations, and at certain points in time, further modified the landscape using fortification to prevent attacks from outside groups, both local groups and those from elsewhere in the Northwest Coast region (Angelbeck 2009). In periods of time where intergroup conflict was becoming more prevalent, the defensibility of a site location would become more important.

In previous research into intergroup conflict and its effects on the societies of the Salish Sea region, there has been a trend to downplay evidence of physical conflict, and instead suggesting ceremonial combat or fulfillment of some other role in a society (Fisher 1976; Angelbeck 2009). This examination of warfare in the Salish Sea must reject the notion that warfare and the material goods associated with it were wholly or primarily ceremonial. Angelbeck (2009) has examined the ethnographic accounts and compiled numerous instances of groups in the Salish Sea region and elsewhere in the Pacific Northwest taking both offensive and defensive action, instead of merely engaging in ceremonial conflict (Angelbeck 2009; Boas 1889; Elmendorf 1993; Buddenhagen 2011a). While it is entirely plausible that some aspects of material culture associated with intergroup conflict could be used in a ceremonial context, this does not negate the potential association with more direct conflict. This association with conflict can be extended to whole sites and their associated landscapes as well. Attempting to better understand the potential for defensibility that sites and locations possess provides a more detailed picture of the factors that might have been considered in the decision-making processes of combatant groups. The relative defensibility of sites on the Salish Sea and the broader Northwest Coast region was first examined by Martindale and Supernant (2009), They examined several key metrics of a site that contributed to its defensibility, and combined them to provide an overall index for the defensibility of the site. Their method was further refined by Bocinsky (2014), who shifted from a vector-based to a raster-based method of calculation., I have created a raster for the Salish Sea region, showing the relative defensibility, as shown by combining the relative elevation and visibility, of the sites in the region.

I applied the defensibility raster to the sites associated with a set of projectile point assemblages analyzed by Rorabaugh (2015), to identify correlations between the presence of points considered arrow points under Rorabaugh and Hildebrandt and King's methods and the maximum defensibility of the associated sites. These two metrics together will aid in determining to what extent the spread of the bow and arrow in the Salish Sea region played a role in the record of increasing intergroup conflict at the end of the Marpole phase (2500-1000 BP). Changes in the way that intergroup conflicts were waged would have allowed for ambitious individuals to leverage their skill in intergroup conflicts to increase their prestige and wealth in their communities, bypassing the older social networks that would have limited their mobility previously. While intergroup conflict is rarely the primary or singular driver of change as observed in the archaeological record, it can be a catalyst for further social change, as actors within a society react to the effect that the conflict has had on their lived experiences. Conversely, other changes may result in or increase the likelihood of intergroup conflict, and the conflicts thus joined may in turn play a role in shaping the environment that future conflicts are conducted in, thus creating a feedback loop of long-term change. The reactions of individuals to both the background changes and the changes influenced by intergroup conflict would play into their decision-making processes, and impact how their decisions affected the decision-making processes of others, thus spreading the effects of the conflict beyond those directly involved. Even if the bow and arrow was already present in the Salish Sea region as early as the Locarno Beach Phase as suggested by Rorabaugh (2015), wider use of the bow and arrow in the Salish Sea region may have been one factor that fed into a larger set of cultural changes throughout the Marpole Phase, such as increased social stratification and material inequality (Croes and Hackenberger 1988), leading to the beginning of the Gulf of Georgia phase (1500 BP to contact).

Chapter Two: Theories of Conflict in the Pacific Northwest

The archaeological study of conflict is especially vital to understanding the nature of intergroup conflict and associated cultural changes in societies that did not leave behind a written record, such as the inhabitants of the Salish Sea region. The archaeological study of warfare is usually conducted along four lines of inquiry, namely: tracing changes in settlement patterns, looking for signs of violence in human skeletal remains (Cybulski 1999; Lambert 2007), looking for iconography related to violence, and examining the weapons and other tools of conflict (i.e. shields, armor) themselves (Lambert 2002). Lambert also mentions the presence of fortifications and other defensive structures, but their presence can vary depending on the area in question. Given the material constraints of different areas, such as the lack of organic remains in areas that do not have the climate or environment to properly preserve them, the study of certain lines of evidence will be more or less relevant. In addition, different sorts of conflict could lead to different lines of evidence being more or less prominent, such as evidence of scalping or other trophy taking being prominent in areas where performance in conflict was a means for social advancement (Maschner and Reedy-Maschner 2007). While smaller-scale conflicts might have been relatively common, when the conflicts thus undertaken would go beyond the level of small scale disputes between individuals and small groups, it is also possible that certain noteworthy conflicts would enter into the oral record, especially if these conflicts involved groups from across the Salish Sea region (Angelbeck and Mclay 2011).

The ways that a society conducted intergroup conflict would be affected by the other activities undertaken in that society. The peacetime expertise and experiences of individuals and groups would be the first areas of their lived experiences to be turned towards conflict in times of more intense crisis, such as weapons designed for hunting being turned on human targets. In addition, relationships and networks that were formed in other activities could potentially be leveraged to provide mutual defense in times of conflict (Borck et al. 2015). Therefore, any material change that had the potential to affect both the individual experiences and societal relationships of combatant groups, such as the introduction of the bow and arrow, would also have the potential to change the intensity and frequency of intergroup conflict.

Definitions of War and Conflict

When discussing war and other forms of intergroup conflict, it is important to recognize that the term “warfare” has a complicated history when it comes to the description of combat taking place in societies with different levels of formal structural organization and geographic scale (Keeley 1996). While the societies of the Salish Sea region and the broader Northwest Coast region possessed complex social and cultural dynamics, they were not the top-down, organized states that are traditionally depicted as engaging in organized warfare. One of the simplest ways of delineating warfare from other conflicts would be the scale of the conflict, both in terms of the numbers of combatants, and the stakes of the conflict. The common archaeological definition of war is "a state or period of armed hostility existing between politically autonomous communities" (Lambert 2002 209). However, the term ‘warfare’ comes loaded with a broad set of assumptions and interpretations. Warfare is usually taken to imply conflict on a large scale, not only in terms of spatial extent, but also in terms of the number of people involved, often but not always limiting it to state-sized polities fighting each other. This is shown specifically in the literature concerning the Salish Sea region by the routine depiction of small-scale predatory raids, meaning armed action intended to seize goods or captives from rival groups, as the primary form of intergroup conflict (Maschner and Reedy-Maschner 1998). While I will use the terms “Warfare” and “Raiding” when describing behaviors specific to those scales of conflict, I will default to “Intergroup Conflict” otherwise.

The Salish Sea Region Within the Broader Northwest Coast Region

The Salish Sea region is the area of the broader Northwest Coast that consists of the Puget Sound, the Strait of Georgia, the Strait of Juan de Fuca, their associated landforms, and river drainages. This area was and still is populated by groups of people who speak variants of the Coast Salish languages.

Compared to the rest of the broader Northwest Coast region, the inhabitants of the Salish Sea region were long considered by anthropologists and archaeologists to be less materially and societally complex than their neighbors to the north, the Inhabitants of northern Coastal British Columbia, Haida Gwaii and the southern coast of Alaska (Suttles 1987; Haeberlin and Gunter 1930; Barnett 1955; Brown 1873-1876). The archaeological and ethnographic records of these other areas of the Northwest Coast contain many well-documented instances of materials and locations associated with intergroup conflict, (Smith 1907; Suttles 1951; Maschner and Reedy-Maschner 1998; Ames and Maschner 1999).

While there were differences in the material and social cultures between Coast Salish and northern groups, interactions between the groups are ethnohistorically recorded. Most notably for this research, much of the literature that Angelbeck (2009) compiled deals with the Coast Salish response to predatory raids undertaken by groups living in the Northern Northwest Coast region, such as the Haida (Boas 1889; Elmendorf 1993).

Angelbeck's compilation of ethnographic sources filled a void in the literature around conflict in the Salish Sea region. One of the most noteworthy incidents he documents is the leadup to and events of a battle at Maple Bay between a raiding force from the Northern Northwest Coast region, and a coalition of different groups from the Salish Sea region (Angelbeck 2009; Angelbeck and McLay 2011; Elmendorf 1993; Lugrin 1932). This account is noteworthy in that it emphasizes the social connections that were necessary to wage large-scale intergroup conflict, as well as the high level of coordination involved in the execution of battlefield strategies.

The presence of social and material structures in the societies of the Coast Salish similar to those of their northern neighbors mean that while the exact form that the social networks and material cultures associated with large scale intergroup conflict may have differed somewhat from those of the inhabitants of the Northern Northwest Coast region, they were not completely alien to each other. Given this, research concerning the conduct of intergroup conflict in the Northern Northwest Coast region may be worthy of consideration in attempting to reconstruct the practice of intergroup conflict as conducted by the inhabitants of the Salish Sea region.

Ethnographic Accounts of Armed Conflict in the Salish Sea Region

The Northwest Coast is an area that lacks a precontact written record, and thus any direct historical record of warfare or other acts of intergroup conflict beyond oral history and ethnography (Angelbeck and Mclay 2011; Boas 1889; Buddenhagen 2011b; Costello 1895; Curtis 1907-1930; Elmendorf 1993; Haeberlin and Gunter 1930), and the Salish Sea region is no exception to this. Therefore, evidence for armed conflict must be inferred from other sources such as artifacts or iconography of warfare, human remains, or changing patterns of settlement, including defensive landscape modifications such as fortification (Lambert 2002) Recent advances in GIS technology, allow an entire region to be analyzed to gauge its suitability for the construction of defensible sites. This can be synthesized with a deeper analysis of the tools and weapons available to a given society, with the combined effect of providing a rough approximation of where conflict may have taken place, and what weapons were used to conduct it. Ethnographic evidence for conflict in the Salish Sea region is complicated by the fact that much of it was documented during the exposure of the Native peoples to the increased presence of European colonizers throughout the 19th century (Boas 1889; Eells 1976,1985; Gibbs 1855,1877; Curtis 1907-1930; Costello 1895; Hancock 1860, 1927 Suttles 1989; Ray 1938). While this data may a valuable source especially in its accounts of changes in war material used by Native groups, such as the adoption of firearms, it must be remembered that the changes brought by the encroachment of European colonizers were nothing short of apocalyptic to the peoples of the Northwest Coast. This was due not only to the direct actions of the colonizers, such as armed conflict and land appropriation, but also due to the epidemic diseases that they brought with them. These circumstances were like nothing that the groups of the Northwest Coast had ever experienced and would have impacted their reactions to armed intergroup conflict.

While there had been earlier contacts on the outer Pacific Coast by both the Spanish and the British, most notably Captain James's Cook's 1775 contact at Nootka Sound on Vancouver Island, the Spanish were the first Europeans to make organized and documented contact with the inhabitants of the Salish Sea region, beginning in 1790 with the arrival of the Quimper expedition (Wagner 1933), followed shortly thereafter by the Eliza Expedition of 1791 and the Galiano-Valdes expedition of 1792 (Wagner 1933). However, it must also be noted that the fur trade was already well-established in the Salish Sea region prior to these expeditions, and their charting of the area only served to formalize what had been a reality for quite some time.

The Spanish expeditions reported that the native inhabitants of the Salish Sea were generally friendly but showed capacity for violence in both the interpersonal and intergroup level in their interactions with them. Quimper reported the wearing of armor among some groups in the San Juan islands but was not witness to any inter-tribe violence personally (Wagner 1933). He described all the groups he encountered as warlike and treacherous, perhaps spurred on by violent incidents between his crew and groups of native men.

Eliza seconded Quimper's characterization of the native groups of the Strait of Juan de Fuca as 'daring and warlike', and the Galiano-Valdes expedition reported encountering parties of warriors with iron tipped arrows (Wagner 1933), although these encounters were generally friendly. While there was some description of the houses and behaviors of the natives of the Salish Sea region, there was no systematic examination of defenses such as fortifications.

The Spanish were joined in the region by the 1791 expedition of George Vancouver. As Britain and Spain were not at war at the time, Vancouver's interactions with the Galiano Valdes expedition were friendly, and they partially collaborated in the exploration of the region, aiding each other in the charting of Vancouver Island (Vancouver 1798). Vancouver's recorded interactions with the native peoples of the Salish Sea region primarily focused on their immediate interactions with his expedition, rather than any detailed ethnographic study like would be conducted later. Even so, he reported that while the groups of the region were generally friendly to himself and his crew, the bow and arrow, along with other weapons such as clubs, were universally present. An incident between his crew and a party of native men very nearly escalated to violence, only being defused with the firing of a swivel gun. Vancouver described a village with a fortified component north of the Fraser Delta, in the Strait of Georgia (Vancouver 1798), but as the village was abandoned there was no description of the activities which may have necessitated the fortification.

American observers entered the region more and more after the settling of the boundary between the American and British claims in the region, especially with the founding of Seattle and the growth of euroamerican settlement in the region. The Wilkes expedition of the early 1840s was one of the first such groups of observers to take an active interest in the fortifications of the peoples of the Salish Sea region, recording fortifications on Whidbey Island (Miller 2011).

George Gibbs was a prolific writer who documented many stories and reports of the peoples of the Salish Sea region, plus the accounts of British and American settlers and his own observations.

Gibbs reported that the presence of trench embankment sites and other fortifications was common knowledge among many of the British and American setters of the northwest coast region. However, Gibbs does not go into any detail regarding the exact locations of these embankments, nor does he partake in any assessment of their use as pertaining to intergroup conflict.

Even more than this, Gibbs was able to provide direct documentation of intergroup violence taking place between different Coast Salish groups. Gibbs in particular showed differences between how conflict was prosecuted among the different groups of the Salish Sea region, compared to the conflict between a cost Salish group and a group from the outside, such as the Haida. As an example of different approaches in conflict with neighbors, Gibbs (1877) reports that it was customary for neighboring groups that were about to engage in conflict to meet at a specified location and on a specified day, and first attempt to solve the conflict through peaceful means. Only if this failed was violence resorted to.

As one of the first anthropologists to enter rigorous academic study of the groups of the Salish Sea region, Franz Boas brought his views on the origins of conflict in 'primitive' societies to his observations of the Salish Sea region. Boas considered armed conflict to be something taking place on all levels of societal complexity, and he drew a major distinction between the societies that he viewed as being incapable of large-scale peaceful organization and coexistence, such as the 'bushmen' of South Africa and the 'Indians' of south America, and the societies that were able to create a cohesive political and social unit in the face of conflict, such as the Zulu and the Iroquois (Boas 1912). He further extended this notion to the various racial and national identities of his day, claiming that it was the same base impulse that drove conflict at all levels of social organization Boas believed that war would be abolished once a political unit became large enough to encompass all the people of the world, the collective identity provided by such an identity giving cohesion to previously warring groups.

Given the demonstrated capacity for the peoples of the Salish Sea region to engage in coordination of both peaceful and violence activates across multi-village lines, Boas would have likely placed them in a category with the Zulu and Iroquois, rather than the 'less developed' peoples. It should go without saying that these interpretations of the way that conflict was conducted in these societies were heavily influenced by the so-called 'scientific' racism of the 18th and 19th centuries, and would have little actual bearing on the actual social organization of the peoples thus described. Much of the later archaeological work in the region has been in part based on the reconstructions of society gained from the understanding of these ethnographic works and others like them. While there cannot be assumed to be a perfect overlap in structure and behavior between the societies described ethnographically and their ancestors described archaeologically, there are enough similarities that basic comparisons can be made, especially in the case of the Gulf of Georgia phase, the period immediately preceding contact.

Due to the importance of the Salish Sea and its associated waters to the lifeways of the inhabitants of the region, it should come as no surprise that the peoples of the Salish Sea region were capable of prosecuting conflicts with groups across the region using the power projection capabilities offered by war canoes and other boats, allowing them to participate in conflicts far outside their own home waters. The canoes that the inhabitants of the Salish Sea region used were smaller and more compact than the larger canoes that groups such as the Haida used to travel to the Salish Sea region. This gave them the ability to maneuver more freely in confined strait and bays, and opened up the possibility of outmaneuvering and ambushing attackers from outside the Salish Sea region, as demonstrated by the Coast Salish accounts of the battle at Maple Bay (Angelbeck and Mclay 2011; Elmendorf 1993; Lugrin 1932).While there are ethnographic accounts that relay stories of fending off attacks from groups located in Northern British Columbia and on Haida Gwaii (Angelbeck and Mclay 2011; Elmendorf 1993; Lugrin 1932), and of conflicts among themselves (Angelbeck 2009; Costello 1895; Curtis 1907-1930), there are no known records of the peoples of the Salish Sea region taking the fight to raiders from outside their region, although Boas (1889) does report a retaliatory attack on a village in northern Vancouver Island that had been taken over by the Lekwiltok.

Ethnographic evidence suggests that the peoples of the Salish Sea region did not use complex military hierarchies in their conflicts. There were war leaders, and warriors that followed them. Any further organization was apparently ad hoc and was usually only found in situations of cooperation between tribes, villages, or other coresidential units (Angelbeck 2009; Angelbeck and Mclay 2011; Costello 1895; Elmendorf 1993; Lugrin 1932, Eels 1976, 1985). The war leaders needed to be seen as brave and skilled in combat for their warriors to be willing to follow them, as the lack of an overarching, military hierarchy meant that those in subordinate positions were not formally bound to follow their leaders, and leaders had to maintain their positions through their achievements and force of personality, as shown from oral histories of conflicts conducted by the inhabitants of the Salish Sea region (Angelbeck 2009; Costello 1895; Elmendorf 1993; Lugrin 1932).

While projectile weapons such as the thrown spear or dart and the bow and arrow were important weapons in the precontact Salish Sea region, they were not the only weapons used. Ethnographic and archaeological evidence from the rest of the greater Northwest Coast region shows that war clubs were used as well, made of both stone and wood. In addition to this, the wealthiest and most powerful fighters had access to slat armor made of wood, and also armors made of stone (Jones 2004). These weapons and armor were associated with specialists in conflict and were a mark of prestige for their users (Fisher 1976).

In response to threats of conflict from both their neighboring groups and outside aggressors, the peoples of the Salish Sea region constructed fortified villages, refuge sites, and lookout sites, which were all capable of being used in a coordinated manner by defenders. Lookout sites would be used to ensure defenders would receive enough warning of attackers to take shelter or prepare to repel the attackers(Moss and Erlandson 1992; Maschner and Reedy-Maschner 1998; Angelbeck 2009; Keddie 2006). The fortifications tended to be constructed as either palisade walls, or as trench embankments. refuge sites were constructed with many of the same materials but were often constructed some distance from the main site with an emphasis on being unobtrusive (Angelbeck 2009). The type of fortification used would depend on the environment. The inhabitants of the Fraser River canyon used their surroundings to create rock fortifications that protected their villages and fishing areas (Carlson 1997; Schaepe 2006). Whether trench embankments or stockades, the construction of fortifications was specialist knowledge. Suttles (1949) reports that the Lummi hired an expert from the Samish Tribe to construct a fortification (Angelbeck 2009). This could be an indication that defensive strategies differed within the Salish Sea region; if the construction of a fort was routine for the Lummi, they would already have the institutional experience necessary for building one. On the other hand, specialists could have been lost due to epidemic diseases and other contact-related social upheavals that resulted in large reductions in native populations. While earlier locations could have been returned to, the encroaching presence of Euro-American colonizers could put previously viable locations out of reach.

Prospective attackers would also have to consider the local topography of their target. The primary goal of predatory raids would have been the seizure of goods and captives (Donald 1997; Ames 2001) and transporting these overland for an extended period would have been quite tiring. This would have opened the possibility of counterattack by the defenders, something only magnified by travelling over difficult terrain such as a large bluff or cliff.

Alternative Explanations for Evidence of Conflict

The societies of northern British Columbia and southern Alaska have been the source for studies of conflict in the past (Ames and Maschner 1999; Maschner and Reedy-Maschner 1998; Lambert 2002), but the Salish Sea region specifically has been somewhat neglected, usually receiving only cursory mention as part of an overview of the PNW region as a whole. Even in studies in which the Salish Sea region is included, most of the research, and therefore the majority of evidence of conflict has been found in the Gulf Islands and Strait of Georgia regions of British Columbia. Conflict in the Puget Sound region is barely touched on at all, effectively it is the neglected subregion of a neglected region. Where conflict has been studied in the Salish Sea region, it is usually only mentioned in passing. This examination of warfare in the Salish Sea must reject the notion that warfare and the material goods associated with it were wholly or primarily ceremonial (Angelbeck 2009). The oral record is full of instances of groups in the Salish Sea region taking both offensive and defensive action, in addition to engaging in ceremonial conflict. Angelbeck believes that this blindness to the potential defensive utility of features in the Salish Sea region may have led to the current lack of archaeological information about defensive features, Angelbeck cites Fisher (1976) as an example of this, where firearms were interpreted as being acquired in the Salish Sea region for emotional reasons, serving as phallic symbols. Firearms would not have been easy to acquire in the mid-19th century, and while there may have been some desire to show prosperity through purchasing firearms, it would be difficult to justify acquiring them if they did not also serve some other purpose (Angelbeck 2009). Angelbeck cites Buxton (1969) as an example of the attitudes taken towards potential defensive features. Buxton interpreted site features that could be defensive structures as fish drying areas instead, despite the fact that they are well away from any body of water (Angelbeck 2009). Perhaps fitting with the earlier interpretation of the native inhabitants of the Salish Sea region as ‘peaceful”, these researchers seem almost unwilling to show things as being primarily used in violence even when it would be the simplest explanation. In addition, the presence of lookout sites and trench embankments (Moss and Erlandson 1992; Angelbeck 2009) makes it unlikely that war was merely ceremonial.

Modes of Power and Intergroup Conflict

The study of intergroup conflict plays into other studies regarding the exercise of individual and societal power, and how different individuals negotiate their structures in order to gain power and security for themselves and their groups. This power could be physical power, such as gaining access to important resources through victory in intergroup conflict, and/or societal power gained through the prestige of a leadership position in a successful conflict (Angelbeck 2009; Ferguson 1983). Wolf (1990) delineates four specific modes of power than can be applied to the relations of individuals, groups, and whole societies. Individual power refers to the concept of power as an attribute of a person. Interpersonal power is the influence that individuals can exert over each other, Organizational power is the ability to influence and control others in a social setting, and structural power is the ability to create and destroy structures, dictating the societies that other individuals would be exercising their power in (Wolf 1990). It is important to note that structural power of this sort is not tied to any one society or system, and instead refers to the environment in which those societies develop. Each of these modes of power builds upon the other, where they can all become components of the whole of the individual's interaction with power in their culture and society (Wolf 1990). Angelbeck (2009), uses Wolf's modes of power, integrated with practice theory, and examines the intergroup conflicts of the peoples of the Salish Sea region through the lens of interpreting the society as an anarchic one, where power was not exercised on structured statelike lines, but instead through the interactions of influential groups and individuals. Conflicts could be both escalated and deescalated by combatant individuals and polities, and both larger 'wars' and smaller 'raids' could be part of the expression of overarching long-term intergroup conflicts. This escalation and de-escalation would take the form of conflict moving through different modes of power. Descriptions of historic intergroup conflict in the Salish Sea region include examples of combatants exercising each mode of power to benefit themselves and their groups. An individual could rally support in their community to solve a personal grudge, or remain invested in a conflict that the rest of their society had moved on from.

In the context of intergroup conflict, individual power could be expressed by demonstrating skill at fighting, or proficiency in other skills, as well as gaining possession of weapons. An individual's use of the bow and arrow to distinguish themselves in individual hunting could be a means of demonstrating skill in gathering food, while also implicitly showing that the hunter would be effective in using their skills in times of intergroup conflict (Angelbeck and Cameron 2014). By doing this, a hunter would demonstrate themselves to be a reliable member of the community in times of peace and times of conflict.

Interpersonal power would apply when combatants were showing leadership in small group conflict by managing and leading other combatants (Angelbeck 2009). This would be relatively informal, based on the relationships between individuals on a personal level rather than any broader structure. An experienced hunter taking up a mentor position to younger hunters in their community might be seen by the other people in the community as a potential leader in a conflict situation. This would be due to the hunter exercising modes of both personal power, due to the hunter's skill with the bow and arrow (Angelbeck 2009; Angelbeck and Cameron 2014), and interpersonal power, because of their personal relationships with other hunters in the community. Organizational power could be exercised in the maintenance of links with other groups, leading larger groups and establishing large scale alliance systems. Structural power is the ability to determine the relations between wider groups, setting the patterns of raiding and resource-based conflict that those with less power would have had to interact with (Angelbeck 2009). The more individual power one had, the easier it would be to gain interpersonal power, and so on up the scale. This is not to say that one level of power was a guarantee of gaining another, but it would be much easier, and disadvantage those that did not already have it. Individuals and groups could act in ways that exercised and reinforced more than one mode of power at a time, such as a warrior taking up a leadership position in his tribe's armed conflict against another tribe. A successful conclusion of the conflict could increase the status of the warrior among his community and increase the standing of the community among its neighbors (Angelbeck 2009). An ethnographic example of this phenomenon can be found in the case of Chief Sealth, who Costello (1895) describes as having gained much prominence in the Salish Sea region as a result of successful leadership in conflict, further capitalizing on his position by using his oratory skill to gain even more prestige and power.

As another example of the ways that different modes of power were exercised together, high-status family groups collaborated with others in their kin group as well as their neighbors and those with whom they had marriage ties in the collective maintenance of status through intermarriage, trade, and potlatching (Angelbeck 2009, Elmendorf 1971). If a group of households potlatched with each other, not only would they recoup some of their own losses from their potlach with what they received from other potlaches, but it would also show the other groups in their community whom they invited that they were both wealthy and influential. A long-term good relationship could benefit both groups involved immensely. However, the existence of such relationships between powerful individuals and groups could make it difficult for newcomers, either families or individuals, to break into these same levels of wealth and influence. Just as the bow and arrow would have been used in more than one capacity, the social networks built around ceremonial and kin ties in the Salish Sea region could have also been used for the purpose of defense. Ceremonial and kin ties that were developed and maintained by prominent groups could have been drawn upon for mutual defense (Borck et al. 2015), and to maintain the prominence of the groups. Status was a resource all its own. In the anarchic society of the Salish Sea, maintaining status would have been essential to provide the means to avoid or succeed in intergroup conflict.

Resources and Status: Differing Interpretations of the Causes of Intergroup Conflict

In the late 20th century, the time in which most of the relevant literature on conflict in the Northwest was written, the two main theoretical frameworks used in the archaeological study of conflict in the Salish Sea region were a resource-based framework and a status-based framework (Ferguson 1983, 1984; Maschner and Reedy-Maschner 1998). The resource-based framework, as championed by Ferguson (1983, 1984), took the position that conflict in the broader Pacific Northwest region was driven by the need to accumulate resources, such as food or land. While this no doubt played a role in many conflicts, Ferguson stated that it was the only reason that war was conducted, as he believed that people would be unwilling to fight and die if they did not directly benefit from their efforts in the conflict (Ferguson 1984). Fitting with this model, Ferguson believed that conflict in the prehistoric Northwest Coast region was heavily linked to the distribution of important resources. Food sources, such as valuable salmon runs, were one such resource, as were slaves and access to trade routes (Donald 1997; Ames 2001; Ferguson 1984). Another resource was access to more sheltered locations that would not be devastated by the storms and tsunamis that rolled in from the Pacific. Weapons themselves could be a resource as well. While the acquisition of firearms during the early years of the fur trade had implications for their owner's expression of status, their combat utility was also a factor in their desirability. Early Euroamerican observers noted that the vast majority of money gained from the fur trade was spent on the acquisition of new weapons (Ferguson 1983,1984). This view of war and conflict being driven by resources has been echoed with scholarship examining the oral histories of the Tsimshian people through the lens of military history, where it was found that many of their conflicts had resources as a base motivation, although most also had other cultural motivators (Buddenhagen 2011a).

Ferguson also makes that case that the prospect of war as a deterrent was key for resource distribution (Ferguson 1983). If one village or group was perceived as holding too much power, the other villages might band together to raid it. Therefore, to avoid the potential loss of resources, and the taking of villagers as slaves, the households of the prosperous village would hold potlaches with both their neighbors and relations from across the region, thereby both taking the target off their backs and reinforcing ties with their surrounding communities. This was combined with intermarriage to build relationships with both near and far communities. The expectation was, however, that the village who hosted a potlach would also be invited to other potlaches, where they would be rewarded handsomely, thus starting the cycle anew. This cycle feeds into the other cycles and systems governing societies and environments in the Northwest. In the resource model, understanding this interlocking set of systems is key to gaining a better understanding of war and cultural change.

Ferguson's overemphasis of the direct conflict value of weapons disregards both the multiple functions of most types of weapons in use in the Salish Sea region, and the broader social context associated with their use. Rifles that can kill people can just as easily be used for hunting, and one group's acquisition of them may lead to an arms race, with tribes buying weapons simply to defend themselves against tribes with more weapons. In addition, many of these articles of war, such as iron blades and the slat armor found in Alaska, were as much status symbols as they were weapons. In that sense, maintaining social bonds was just as important as material gain when conflict and seeking arms were concerned.

Conversely, Maschner and Reedy-Maschner believed that humans have an inbuilt tendency to seek status and are willing to resort to violence in order to achieve it. They singled out males as being status prone, citing the behavior of primates (Maschner and Reedy-Maschner 1998) and state that the more young men without existing sources for status a society has, the more likely that it is to be violent, as there will be more men competing with one another for status who do not have access to the traditional structures used non-violently to gain status, such as kin ties or ceremonial relationships. Using similar criteria to those that would later be used by Lambert (2002), Maschner examined the lines of archaeological evidence for warfare as they occur in the Northwest Coast region through time. The most noteworthy change that he observed was between 1000 and 1500 CE. During this time, there was a large shift in the organization of society, with smaller settlements and groups coalescing into larger polities (Maschner 1991, 1997). Maschner thought that the condensation of groups into larger settlements was a cause for violence, as in his framework it would result in a surplus of young males who would seek status. Success in conflict would be one of the most effective ways of seeking status (Angelbeck 2009), as successful groups would remember those who helped.

One of the most recent predominant interpretations of intergroup conflict frames conflict as another means of establishing and reinforcing social ties among combatant groups. This examination of the effects of conflict is relevant to the study of conflict in the Northwest because it incorporates the study of those affected without being active combatants. It is also useful in integrating the study of armed conflict with the study of how individuals interact with other systems of power, and the role of status in intergroup conflict (Angelbeck 2009; Angelbeck and Cameron 2014; Grund 2017).

Theoretical examinations of intergroup conflict must consider the scales of conflict when they measure the impact on a society. Along the Northwest Coast, the most common type of group that would have conducted conflict would be the village or settlement group, and oral records show that conflict was conducted extensively at this level (Lambert 2002). The peoples of the Salish Sea region lived in an anarchic system, where those who were not slaves or otherwise bonded followed their leaders only due to the prestige and charisma of those leaders (Angelbeck 2016), rather than because of any state or statelike structure. Material wealth, often shown by the ownership of slaves (Donald 1997), possession of certain coppers or the regular holding of potlaches, was one such means of showing prestige (Suttles 1987), and victorious performance in both interpersonal violence and intergroup conflict was another (Angelbeck 2016; Buddenhagen 2011a). The collective defenses of the Salish Sea region were based on collaborations between prominent households and could be broken if there was a falling out among these households (Angelbeck 2016).

One way to integrate these resource and status-based frameworks for the origins of intergroup conflict is to recognize that status itself could be a resource. Prominent lineages had more access to certain material resources and would be more likely to have the means to hold potlaches and other ceremonies with other high-status groups and individuals. Among the Tsimshian of the North and Central coast of British Columbia, a prominent person's deeds and the resulting prestige would continue to be associated with their family line after the individual's death (Buddenhagen 2011a). In the more anarchic social organization of the Salish Sea region, the status of individuals as expressed through their influence, their household, and kin-networks could be leveraged to provide an outsized impact.

According to Clausewitz, "War is a continuation of policy by other means" (Clausewitz 1832 1.24), and this definition would no doubt have applied to the ancestral Coast Salish as well. If ambitious individuals could not get influence and prestige through peaceful means or were not born into a kin-group that would aid in their acquisition of status, intergroup conflict would provide a vector for social advancement. While access to resources might have been a cause for intergroup conflict, if a given warrior or war party leader was known to be the one who had gained access to a valuable resource for the tribe, the war party leader might gain a great deal of prestige and renown within that community.

Intermarriage was a means for resources to be shared across kin lines (Angelbeck 2009). However, these marriage ties were only accessible to those from a suitably prestigious family group, and would be much less accessible to someone from outside these groups. By resorting to warfare, ambitious warriors could bypass these traditional means of gaining power and prestige, and gain access to the resources of the elite (Angelbeck 2009). Both intangible status and tangible resources could be sought through participating in intergroup conflict, so any discussion of intergroup conflict in the Salish Sea region must consider both to be valid causes of conflict.

Conflict and Social Stratification

The level of social stratification in a past society without written records and the forms that inequality took must be traced indirectly using archaeological proxies. The Northwest Coast region has been an area of interest for those studying inequality for decades, as the complex material culture and status focused society provided ample opportunities for research, and the Northwest Coast region was relatively unique in that it was a highly materially complex society that did not rely on large scale agriculture (Ames 1994, 2010). Elsewhere in North America, the introduction of the bow and arrow has been linked to increases in inequality and social stratification (Kennet et al. 2013; Bettinger 2013; Grund 2017; Nichols and Vanpool 2015; Reed and Geib 2013), and this increase of social stratification has also been identified in the Northwest (Angelbeck and Cameron 2014).

Kennet et al. (2013) showed a similar pattern of increase in social stratification when the bow and arrow was introduced in coastal California. They hypothesized that these changes were exacerbated by shifts in regional climate, and that while the bow and arrow did not immediately trigger an increase in warfare, it acted as another destabilizing factor during a period where the cultural and social dynamics of the area were already in flux. They also highlight the importance that the bow and arrow may have played in the enforcement of intragroup social dynamics. Those who had access to the bow and arrow would have been more able to enforce their agendas on others in their groups, and the bow and arrow would allow more swift enforcement of custom and preventing what Kennet et al. (2013) term "social parasites" from harming resources relied on by the whole of the group. Kennet et al. (2013) also linked this change to the bow and arrow with a general increase in signs of violence on skeletal remains in their area of study, corroborating information shown by Lambert (1994, 2007). Similar increases of skeletal signs of violence have been identified in the Prince Rupert Harbor area of the BC Coast (Cybulski 1978, 1999).

While the resource-focused aspects of warfare have often been stressed in Northwest Coast scholarship (Ferguson 1983,1984), it should be remembered that there was also a large social benefit for successful raiders, and they would gain power and influence in their communities (Maschner and Reedy-Maschner 2007). Hunting groups could function as social networks, but if someone was able to kill prey efficiently on their own, such as by using a bow and arrow, the influence of the group relative to the individual would be lessened. It is also noteworthy that the bow and arrow arguably requires less skill to use than the atlatl, and an individual who become proficient in the use of the bow and arrow would have potentially more time and energy to devote to other areas of social advancement(Angelbeck and Cameron 2014), rather than hunting or gaining proficiency with their chosen weapon. This could have a compounding effect, meaning that those who took advantage of the opportunities offered by the use of the bow and arrow could have pulled farther and farther ahead of their rivals in the acquisition of resources and status (Angelbeck and Cameron 2014).

Hunting, Fishing, and the Tools of Conflict

When people of a given cultural background engage in intergroup conflict, the tools they rely on and the skills they have developed in other activities will influence the tools and strategies chosen to conduct conflict. Although projectile weapons would have been used in conflicts with other human groups, the primary use of the technology would be for the hunting of both terrestrial and marine game, although larger marine game would likely have been hunted using spears and harpoons rather than the bow and arrow. The significance of certain food resources in a given region would influence the use of tools associated with the resource. This would have the further effect of linking the choices of hunting tools and the choices of tools related to intergroup conflict. While there would be tools such as armor that would be useful in conflict without having a similar utility for hunting (Jones 2004), those would usually be owned only by specialists or those of sufficient social status to afford them, while tools with roles in both hunting and conflict would be more common. This is reflected by the bow and arrow being an active tool in conflict across North America, while tools such as armor are relatively less common (Jones 2004). Projectile points are one such type of multiuse tool, and as there is an extensive record of projectile points in the Salish Sea region (Croes et al. 2008; Carlson and Magne 2008; Rorabaugh 2015) it stands to reason that projectile points and their associated projectiles would have been available for use in intergroup conflict.

Salmon is one of the most important food resources in the Northwest, because of the regular and predictable seasonal nature of salmon migrations. Thus, bountiful salmon runs will acquire strategic importance. The regular locations of these salmon runs allows for and encourages a more sedentary lifestyle than is common in other areas, such as on the Plains or in the Great Basin. This reliable seasonal resource would mean that groups would have a set of fixed locations they returned to, something that potential attackers would keep in mind while planning offensive efforts against them. While exact particulars varied across the Northwest, in general there was a certain degree of collective ownership of the salmon runs, with different groups trusting each other to share the run responsibly. Collective ownership was built on a network of kin ties and obligations. Failing to meet these obligations could be the impetus for both intragroup and intergroup disputes which had the potential to result in either violence or the expulsion of the offenders from the group.

Mass organized salmon fishing was conducted on the village scale and included elements of religious and cultural ceremony within its broader purpose as a vital food gathering operation (Suttles 1951). Because salmon fishing was a joint effort there was less opportunity for individuals or smaller groups to advance themselves over others through their participation in these events, although those who had key roles in the salmon harvest might have had other prominent roles in society. Catching salmon might have been a more important food source but hunting for terrestrial game offered more of an opportunity for advancement of the individual. Barring the personal leadership skills that would be helpful in coordinating a group activity, I argue that being an expert or leader in the coordination of salmon fishing would not be something that would set apart an individual from the rest of their community when it came to the conducting of intergroup conflict, due to the relatively few overlapping skills.

Salmon fishing in the style of the Coast Salish certainly required expertise and skill, but there would be little to no overlap of skills on the individual level between salmon fishing and intergroup conflict, barring the level of physical fitness required to fish successfully. In times of intergroup conflict, someone who was skilled at salmon fishing through the weir methods commonly practiced in the Salish Sea region would not have any major advantages in experience and skillset over someone who was not, assuming roughly the same physical fitness. This could be a potential point of difference between the Coast Salish and groups from the Olympic Peninsula and northern coastal B.C. such as the Makah and the Tsimshian, who would have had a lot more individual significance tied into the performance of halibut fishers and marine mammal hunters (Suttles 1987, 1989). Those occupations would have been conducted on a smaller personal scale with more opportunity for personal distinction (Angelbeck and Cameron 2014). While the peoples of the Salish Sea region did not have warrior societies like those found in northern groups such as the Tsimshian and the Haida, the experience they had gained from the large-scale coordination of activities such as mass salmon fishing would have had applicable uses in the course of an intergroup conflict. Marshalling those resources would have been yet another example of modes of power being exercised in a context of intergroup conflict.

Technological and Social Change

Prior to the introduction of the bow and arrow, the most prevalent ranged weapon used by the inhabitants of the Salish Sea region would be the spear or dart, thrown with the aid of an atlatl. One of the points that Angelbeck and Cameron (2014) make is that a bow requires less space to effectively use than an atlatl and dart (Yu 2006; Whittaker 2010). While the heavier and more forcefully penetrating points used on thrown spears or darts may have been more effective on larger marine and terrestrial game, arrow points would have been sufficient to deal with human sized threats. Additionally, it would be possible to carry more arrows than darts or spears, and thus combatants armed with bows and arrows would have been able to sustain an engagement for longer than those using thrown spears and darts. Bows and arrows are thus easier to use in large groups in defensive situations, and in close quarters. These two factors Illustrate that the bow and arrow was a more effective weapon against other people. In a conflict where one side was armed with bows and arrows and the other was armed with spears and darts, the group using bows would have an advantage, assuming there were no other mitigating factors. The arrow users would have more individual opportunities to injure or kill their spear-armed opponents in ranged combat, meaning that they might have dispatched them before the need to engage in close combat.

Whether or not the bow and arrow had a greater accurate range than the atlatl is an area of some contention (Hughes 1998). While experimental research conducted by Hutchings and Brüchert (1997) appeared to show a higher maximum range for thrown spears and darts due to a higher velocity, this was disputed by Whittaker et al. (2017), who demonstrated that Hutchings and Brüchert's conclusions on the maximum velocity of atlatl points relied heavily on statistical outliers that assumed an Olympian-level athletic ability on the part of their users. Whittaker et al.'s compiled data showed that arrow points were capable of much higher velocity due to their smaller mass and size, meaning that they could be loosed farther than a dart or spear could be thrown. Experimental archaeology has shown that arrows loosed from a bow have a much flatter trajectory than darts or spears thrown using an atlatl (Tomka 2013), meaning that their flight would have been more predictable, leading to greater potential accuracy. Greater precision would have been especially useful in intergroup conflict, as the profiles of humans are smaller than those of most large game animals. If both weapon systems were being used at roughly the same range, as some ethnographic analysis from Australia, where both technologies were used concurrently has shown (Cundy 1989), those using the bow and arrow would have been able to loose more arrows, in a potentially more accurate manner, and from a stationary position, as opposed to the running start required for best results with thrown projectiles.

In a period of protracted intergroup conflict, the transition to the bow and arrow would have had the potential to be quite rapid, as any groups that survived an encounter with it would be quick to see the advantages. Another aspect of the bow and arrow is that it is much easier for a hunter to hunt alone, as extra arrows are easier to carry than extra spears. This could contribute to the stratification of a society (Grund 2017) by allowing for individual hunters to gain more prestige and influence by making individual hunting more feasible, even if it was usually only practiced against smaller animals such as deer (Angelbeck and Cameron 2014). In order to visualize the spread of the bow and arrow, Angelbeck and Cameron compiled 49 dated faunal assemblages from sites throughout the Salish Sea region dated from 8400 to 675 BP. While larger animals such as elk would be more efficiently hunted with a thrown dart, smaller animals such as whitetail deer could be taken effectively with the bow and arrow. Angelbeck and Cameron believed that assemblages showing an increase over time in the remains of smaller artiodactyls such as deer that could be efficiently hunted with the bow and arrow marked the introduction of the bow and arrow to an area, as well as the increasing prevalence of individual hunting practices that could be undertaken with the bow and arrow (Angelbeck and Cameron 2014). Angelbeck's invocation of Faust in the title of his 2014 paper with Cameron is very telling, as while the organization into larger social groups may have been necessary for defense (Borck et al. 2015), it also led to a greater stratification of society and the loss of relative status for some of those that relied on the larger group for mutual defense.

Escalation and De-escalation of Conflict

War differs from other conflicts by the scale over time, and the number of combatants. A large-scale war might not last as long as a period of protracted raiding, as the potential casualties incurred could have devastating consequences for the combatant parties. Angelbeck (2009) reports a case where one of the wives of a Snoqualmie chief was kidnapped by the Snohomish, and that chief began preparations to attack her captors (Hancock 1860, 1927). However, once the armed party encountered her captors, the situation was resolved by him simply paying them a ransom and having his wife returned to him. The two chiefs then simply acted as if the disagreement had never happened. While this incident was the result of an act of raiding, as part of a wider pattern of raiding, had it been handled poorly it could have escalated into a much broader conflict between the two groups. As Angelbeck (2009) says, these conflicts rarely escalate into larger patterns of violence. Conflicts were short, not often escalated beyond the initial incident. If both local groups exhausted themselves in intensive feuding with each other, it would potentially leave them far more vulnerable to attack from either a local third party Salish group, or from an outside attacker, as demonstrated in the events leading up to the battle at Maple Bay, where a village was attacked by the Leikwiltok while the warriors of the village were raiding another village in the Salish Sea region (Angelbeck 2009, Elmendorf 1993, Lugrin 1932). The threat of the Leikwiltok from the north was matched in later years by the threat posed by the British and U.S. Governments in the south and east. Arnett (1999) describes an example of these coordinated alliances of Coast Salish people reacting to the British attack on one of the settlements, showing how strategies designed to cope with incursions from similarly armed opponents could be adapted in the face of bombardment from a British gunboat. In this environment, it would make sense to ward off any unnecessary conflict or at least any conflict that was more trouble than it was worth. To return to the earlier example of the Snoqualmie and the Snohomish, while the Snoqualmie chief probably would rather not have had to pay a ransom, and very likely would have been able to free his wife by force of arms, as his war party much outnumbered the Snohomish. It is almost certain, however, that some number of his war party would have been killed or seriously injured in the attempt. The cost of the ransom was probably not worth the loss of wealth, production, and respect that would have resulted from escalation. In many ways, this is similar to the concept of “Mutually Assured Destruction” which entered into strategic thought in the Cold War. Just as two nuclear armed superpowers would both have the power to obliterate each other, two groups in the Salish Sea region that invested too many lives and resources into a conflict could find themselves irreparably harmed. In the status based and anarchic system described by Angelbeck, a leader being responsible, even indirectly, for the deaths of those who had chosen to follow them into conflict could lead to that leader losing the favor of the relatives of those that died.

Another reason for de-escalation would have been that serious injuries or death could have the potential to enflame opposition among either tribe, as the relatives of those killed would not be particularly willing to let their relative’s killers get away without consequence. This could lead into a protracted feud which would negatively impact both tribes and leave them open to outside attack. In the case of raiding between different Coast Salish groups, the fact that many villages were linked by kin-networks would also have played a role in de-escalation, as some in these violent acts would be killing their relatives, albeit somewhat distant. Revenge attacks were often targeted at specific households, while raids for slaves and loot might target an entire village (Donald 1997; Ames 2001; Angelbeck 2009). Individual households could opt out of aiding the others in their community, but this might cause troubles down the line (Angelbeck 2009). Oral testimony shows that the tribes of the Salish Sea had a very long memory for events (Angelbeck and McLay 2011; Bruseth 1977; Elmendorf 1993; Lugrin 1932; Samson 1972) and this oral record was likely even more extensive prior to contact.

Projectile Point Analysis

Analysis of projectile points has been one of the most important aspects of archaeological research for decades (Rogers 1940), and the Salish Sea region is no exception to this. Traditionally, archaeologists have tied different types of projectile points to distinctive cultural groups or phases. By tracking the relative frequency of projectile points in different stratigraphic contexts, they were able to associate these phases with artifacts that could be more easily dated (Bettinger and Eerkens 1999). The adoption of the bow and arrow elsewhere in North America has been studied extensively (Morrisey 2009; Bettinger 2013; Kennet et al. 2013; Grund 2017; Nichols and Vanpool 2015; Reed and Geib 2013), and these methods can be applied to the Salish Sea region easily. The projectile point sequences of the Puget Sound and wider Salish Sea region have been relatively well-documented (Croes et al. 2008; Carlson and Magne 2008; Rorabaugh 2015), and I was able to use this documentation to aid in my research.

Stone arming points for projectile weapons are an important portion of the archaeological record that pertains to intergroup conflict, as they are the weapon type that is most likely to survive in the archaeological record. Drastic changes in projectile point types that go beyond mere stylistic variation could reflect larger changes in how projectile points were used in both hunting and intergroup conflict.

One potential bias of the study of projectile points pertaining to intergroup conflict is that lithic points, usually the primary type of point studied in this manner, are not the only sorts of points used in the making of projectiles. In the Pacific Northwest, bone projectiles were very common, as they could be used as harpoons which were important for hunting large fish and marine mammals (Erlandson et al. 2011, Erlandson and Deslauriers 2008, Moss and Losev 2011). However, bone projectiles were fully capable of being used against terrestrial targets (Allen et al. 2016) and were often the preferred type of point to use against armored targets due to having the capacity for higher penetration and being less likely to fracture on impact (Lowery 1999). Wooden points were also used, and archaeologists have conducted tests to determine the relative penetration power of each (Waguespack et al. 2099, Salem and Churchill 2016). It has been found that while wooden points can penetrate farther, they are not nearly as destructive as lithic points, and thus lithic points can be more immediately lethal. Experiments have also been done on animal targets, to see how arrow and dart points might perform differently (Odell and Cowan 1986). Combatants could use different types of arrow with their bows, and the spread of stone points appropriate for the bow shows that bow technology would have been available for defense. While bone points such as harpoons might have been used in different ways than stone points, skills gained from using stone points could be carried over to the use of bone and wooden points, and vice versa. While bone and wooden arrow points may have had more of a presence in armed conflict than lithic points (Lowery 1999), the spread of lithic arrow points, as a proxy for the spread of bow and arrow technology as a whole can still be used as a measurement for how projectile points could be used in armed conflict.

In order to draw any conclusions based on the nature of projectile points, it is first necessary to determine whether a projectile point was mounted to an arrow or a thrown spear or dart (Thomas 1978, 1981; Rorabaugh and Fulkerson 2015). One of the most common ways that this is done is by comparing points to ethnographic museum specimens (Thomas 1978), but one of the other ways that this is done is by comparing the fracture patterns of the artifacts, which can also determine if a given point was used for an arrow, or for a dart thrown with a spear-thrower (Iovita et al. 2016). However, this method has been critiqued as lacking specificity in the criteria used to separate the two types of points (Hutchings 2016), in addition to the fact that fractures at specific locations could just as easily have been caused by other damage to the point, such as being dropped or being used as a thrusting point. Another method for Identifying darts versus arrows is to compare the weight and dimensions of each point, with points being assigned as either probable arrow or probable dart depending on how they compared to set thresholds established by point typologies modeled after museum specimens (Thomas 1978, 1981; Ames et al. 2010; Okumura and Araujo 2015; Erlandson et al. 2014).

The difference between darts and arrows has particular importance in archaeology, as it aids in determining when exactly the introduction of the bow and arrow took place (Blitz 1988, Maschner and Mason 2013). Studies have been conducted across North America, with the result that a common standard of arrow/dart identification has emerged (Ames et al. 2010, Erlandson et al. 2014, Roth et al. 2011). Hildebrandt and King (2012)'s examination was geared towards the analysis of stemmed points, and it is this analysis that forms the basis of Rorabaugh's analysis of points compiled from sites throughout the Salish Sea region (Rorabaugh 2015), and he further expands on this by developing a DFA that would allow him to measure stemmed points in the same manner. Rorabaugh and Fulkerson (2015) were the first to apply this in the Salish Sea Region, giving a date of 3500 BP as the initial period of introduction of the bow and arrow, and 2500 BP as the period in which the bow and arrow fully eclipsed the thrown projectile in the Salish Sea region. They argue for a period of roughly 1000 years in which the two point types were used in roughly equal proportion, with arrow points steadily growing more common without completely dominating assemblages.

Analysis of Fortifications and Intergroup Cooperation

Fortification networks would be an important resource for groups engaged in protracted intergroup conflict, as they would aid in the defense of important areas and resources. However, fortifications and other such defenses would not be easy or simple to build and could potentially require the coordination of multiple communities in order to properly implement them, depending on their size and complexity. Analyzing the relationships of fortifications to multiple associated communities could provide an insight into how protracted intergroup conflict impacted the dynamics between those groups. The Fraser River

Canyon has an oral record of conflict, and a series of fortifications have been found in the area, which are believed to be interconnected (Schape 2006). Oral tradition collected from the Fraser River area speaks of warriors and war leaders, although it is unclear exactly how much of this can be applied to other geographic areas of the Salish Sea. Access to the watershed and the salmon fisheries was limited by control of the lower Fraser River Canyon. The Canyon is noted by Schaepe as being at a unique confluence of reliable resources, making it a possible target for competition; something worth killing over, and thus something worth protecting. In addition, the Canyon is very narrow, with steep hills and rapid flowing water, meaning that there are defensible locations suitable for fortification. This example of fortification would be a rejection of the assumption that intergroup conflict carried out in the Salish Sea and greater Northwest Coast area was solely predatory raiding, and that protracted conflict over reliable long-term access to resources was also a factor in the calculus of war.

Schaepe argues that some of the Fraser River fortified sites he identified were used as a network of lookouts to warn for incoming raids, suggesting cooperation among multiple Stó:lō villages. If one family group was injured, the ramifications would spill over and impact the collective security of the rest. Schaepe further argues that coordination of a canyon-wide defense system would demonstrate that groups were willing to cooperate on defense at a very high level, even with groups that they might feud with in other situations. This level of intergroup coordination is beyond that commonly thought to exist among groups in the region.

While the societies of the Northwest Coast were stratified, they were also decentralized, and Angelbeck (2009) argues that an anarchic framework might be the best lens with which to view them. An anarchic model suggests that in the absence of a unifying body such as a legislature or over-chief, people would have relied on mutual aid to coordinate for larger projects, such as the construction of fortifications and other parts of a defensive network. Individual households would collaborate at different levels for different tasks, such as the harvest of salmon. However, kinship ties were a way for different groups to connect, and they were often used in the coordination of defenses (Angelbeck 2009). Schaepe (2006) showed a network of rock fortifications, which could have been used in a coordinated manner by the inhabitants of the Fraser River Canyon to spot and defend against attackers. Under Angelbeck's model, individual households and villages could opt out of aiding the others in their broader community, but this might cause troubles down the line (Angelbeck 2009). If the individual households did not provide aid when requested, they might be less likely to receive aid from their neighbors in return.

In terms of archaeological evidence, Angelbeck notes evidence for defense on more than one scale. Sometimes individual longhouses would be fortified, and sometimes smaller groups within larger settlements would be fortified. Together this demonstrates another expression of the different modes of power as described by Wolf (1990) and Angelbeck (2009), where those with more individual and societal power were able to use it to tangibly protect themselves. The process of fortifying a location could function as an expression and reinforcement of social bonds and structures (Angelbeck 2009). Commanding the labor and capital necessary for the construction of significant defensive landscape modification would have been a means of demonstrating the power of those who had commissioned or mandated their construction. In addition, those who cooperated in the building of such fortifications had the potential to reinforce social bonds with each other. Angelbeck asserts that when fortifications were linked by lines of sight and access, that this was a sign of coordinated action by different groups. Given that fortifications like those described could hardly have been constructed without the knowledge of neighboring groups, there had to have been at least some acceptance of the idea of fortification in the area, even if this did not extend to active cooperation.

Fortification and Defensibility

The fortification of strategically important areas shows that there is a willingness to fight in order to defend a given location, as opposed to fleeing the area. Of the lines of archaeological evidence for intergroup conflict mentioned by Lambert (2002), fortification is one of the easier to locate in the archaeological record. In areas where skeletons or weapons do not preserve or there is a lack of iconography related to conflict, fortifications can often be the most readily apparent evidence found of conflict. Fortification is one of the most detectable lines of archaeological evidence for conflict, it is an important vector for archaeological study in the Pacific Northwest, where some of the other types of evidence can be lacking, due to the local environment not being conducive to their recovery or their absence from the cultures in question. There are strong ethnographic records of fortification throughout the historical period (Maschner and Reedy-Maschner 1998; Moss and Erlandson 1992; Angelbeck 2009). Martindale and Supernant (2009) conducted one of the first research projects to quantitatively analyze the defensibility of archaeological sites. They devised a set of parameters to apply to all archaeological sites: size, visibility, elevation and sight lines. A set of archaeological sites in the Pacific Northwest region, chosen to provide a broad spectrum of site types, were assessed using these metrics, and the results showed the relative 'defensibility' of these sites. All of these metrics measure qualities that the builders of a fortified site would have had to consider when planning the location of their fortification.

The approach taken by Martindale and Supernant has been applied to Napoleonic era fortifications in Portugal (Gonçalves et al. 2016). Sakaguchi Et. al (2010) used similar criteria to rank sites in the Fraser River canyon, an area where Schape (2006) identified a complex network of defenses that were linked together by line of sight. Sakaguchi et al. (2010) also incorporated foliage coverage into their model, with clear cut land having different values than old growth forest, for example. GIS was used to plot paths of travel, and to simulate viewsheds, which demonstrate what those using the site would have been able to observe. Referencing Martindale and Supernant (2009), a similar model was applied by McCool (2017) to fortified sites in Peru. In that case, extra emphasis was placed on the steepness of the slopes leading to the hillforts, to show how accessibility would be limited by the unique variation of the local geography. This shows how Martindale and Supernant's method can be applied outside of the area in which it was first devised. Bocinsky (2014) presented an adaptation of Martindale and Supernant's model for the Salish Sea area, making it viable for multidirectional application in a GIS raster format.

The networks of lookouts and fortifications constructed in the Salish Sea region would have had to have been flexible, able to respond to both local and remote threats. Ethnographic data collected by Carlson (2001), as relayed in Angelbeck (2009), indicates that these fortifications would have been used roughly equally to defend against raiders from far away, such as the Leikwiltok, and the closer neighbors of the tribe. The techniques used to confront these threats might vary depending on the source of the attack, but the strategies that were developed could be effectively based in part on the use of these defensive landscape modifications. This could reflect two different 'types' of conflict that were conducted, and potentially two different sets of motivations for conflict. The first is the defense against raiders from an outside source. The motivation in this case is straightforward, preventing the loss of property or the taking of group members as slaves by raiders. The second application of conflict is expressed in warfare or intergroup violence as an extension of other intergroup relations with their local neighbors. However, it is important to keep in mind that there was no hard and fast division between these models of conflict. For example, neighbors could engage in raiding behavior, as demonstrated in Angelbeck's anecdote of the kidnapped wife of the chief ((Hancock 1860, 1927), in Angelbeck 2009).

While the analysis of defensibility and the analysis of projectile points on their own are both worthwhile fields of inquiry, combining them will lead to a more thorough examination of the state of warfare in the Salish Sea region. The more factors that are considered in archaeological analysis, the more complete the picture of the environment in which the inhabitants of the Salish Sea region made decisions related to conflict and defense, on the individual, household, and village levels. Decisions related to defense would have taken both the tools available to the defenders and their local geographical circumstances into account, and formulated solutions that addressed them.

Chapter Three: Analysis of Site Defensibility

In order to determine if the widespread adoption of the bow and arrow coincided with changes in site defensibility in the Salish Sea region, each of these variables need to be measured independently, so that correlation analysis can be conducted.

I started my measurements of site defensibility using the methods relayed by Martindale and Supernant (2009), taking hand measurements of the size, visibility, accessibility, and relative elevation of the selected sites, although I substituted GIS Hillshade (ArcGiS World Hillshade 2018) for topographical maps, in order to synthesize a value for defensibility. However, I encountered difficulties in replicating Martindale and Supernant (2009)'s methods due both to ambiguities in their description, and due to errors of calculation and interpretation that come from hand-measuring sites. Therefore, I switched to using the raster-based calculations of defensibility laid out in Bocinsky (2014). Bocinsky had noted many of the same problems in replicating Martindale and Supernant's methods, and the raster method not only eliminated a potential source of error, it allowed me to calculate the defensibility of all of the sites in my area of study simultaneously though the execution of a single program.

Predictive Models of Site Location

Predictive models for analyzing site layouts and locations can be applied in order to learn more about the nature of intergroup conflict in the Salish Sea region. Two examples of the use of predictive models, one applied to site location and the other to defensibility can be found in Maschner and Stein (1995) and Martindale and Supernant (2009). Both papers use GIS to analyze sites and determine what sorts of location are favored for fortification, or for settlement under certain environmental conditions. Maschner and Stein (1995) focused on all aspects of settlement in a small area in southern Alaska. They selected a wide variety of parameters to use for the model, such as island size, quality slope and exposure of the beach, and distance to sources of fresh water. These were compared to other sites already found in the area and the parameters were weighted according to how existing sites were constructed and placed. They were able to make generalizations from this, such as that the natives of the area preferred to build their villages on a south-facing beach as opposed to a north-facing one, to avoid cold winter winds. Martindale and Supernant (2009) focused specifically on conflict, and what made a given site defensible, and how common such defensible sites were, measuring many different site types as a proof of concept. They measured variables focused on aspects of defensibility, such as visibility, accessibility, and elevation. These factors would be valuable even in a site that did not need to be defended, but they would be weighted differently.

While the aforementioned models can lead to interesting and useful comparisons, they should not be applied uncritically. The unique circumstances and lifeways of the groups being studied must be considered when applying a program or procedure in a geographic environment that drastically differs from the environment it was first developed in. An example of this is a model developed for the study of a high and arid area being applied to an area with regular seasonal flooding. Maschner and Stein (1995) tailored their model for their area of study, and future uses of the same methods must account for potential irregularities caused by variations in the geographic region in which they are used. In particular, Maschner and Stein (1995) noted that the model they used might not be appropriate for use in areas with extensive fjords, as those produce errors and show up oddly in the model.

In regions where different village groups would have had relatively high levels of contact with one another, it can be acceptable to examine different subgroups of sites as one overarching set. This is appropriate in the Salish Sea region, as the abundance of waterways meant that long distance contact, both peaceful and violent, was feasible and regularly engaged in (Angelbeck 2009; Rorabaugh 2015).

Martindale and Supernant (2009)'s Analysis of Site Defensibility

In their pioneering study of site defensibility, Martindale and Supernant (2009) identified four variables contributing to the overall defensibility of a site and devised proxy measures for those variables that could be applied to maps, and also suggested how to weight and combine these four measures for an overall estimate of site defensibility. These factors are site size, elevation above sea-level, the sightlines of the site, and, the accessibility of the site. While initially I planned to follow Martindale and Supernant's methods, I ended up switching to Bocinsky's raster-based measurement of defensibility. However, the variables and calculations that Martindale and Supernant identified and utilized in their research informed much of my own research process, so I will provide a brief explanation of their processes and factors. The reasoning behind their choice of variables and their means of measuring them is sound, but some aspects were poorly explained or were difficult to replicate.

Factor 1: Site Area in Square Meters. While a larger site might be harder to defend due to having more potential avenues for approach and more places that defenders would have to allocate their attention, the assumption with a larger site is that there will also be more people available to defend it. Therefore, in Martindale and Supernant (2009)'s defensibility index, defensibility goes up as site size increases. Area was added into their index by dividing the area of the site as measured in square meters by one million square meters, representing the largest known site in the Pacific Northwest. I used the standard regional site forms to estimate site area, as per Martindale and Supernant (2009). While site forms are imperfect, they provide a uniform set of standard measurement estimates.

Factor 2: Site Approach Slope. The elevation of a site relative to its local environment is a limiting factor in how attackers can approach the site, and impacts how much energy must be expended prior to arriving at their target. Prominent elevation can also be useful in establishing lines of sight, as can be seen by the use of lookout sites throughout the Salish Sea region.

They measured they measured the site approach slope, which was referred to in their calculation as 'elevation' by taking the approach slope as created by comparing the height of the site and the surrounding area. I followed their method, calculating the approach slope using the highest portion of the site and the nearest body of water, such as the ocean or a large river such as the Skagit, as this would be the most likely vector of attack. The approach slope is the angle formed between the closest body of water and the highest elevation in the site. Crucially, the calculations for Martindale and Supernant's defensibility index only calls for one approach slope to be calculated, rather than taking into account the broader geography of the site. This means that the resulting calculation would have the potential to be skewed in favor of one particularly dominant land feature associated with the site, such as a cliff or ravine, rather than take into account multiple potential avenues of approach for a site.

Factor 3: Arc of Visibility. In a potential conflict situation, the more information available to combatants, the better position they are in to make decisions about how they should conduct the conflict. Locations that offer long lines of sight over most of their circumference would have allowed more forewarning about attackers, enabling the defenders to react quickly and either repel the attack or flee to safety.

Martindale and Supernant calculated "Arc of visibility" using two measures:

1.) the portion of the site circumference, measured in degrees, for which direct lines of sight from the site were greater than 100 Meters

2.) the portion of the site circumference, also in degrees, by which the site could be approached on foot or by water.

"Arc of Visibility" is simply the ratio of 1 over 2.

Martindale and Supernant assumed that any sightlines over land would have been obstructed due to the heavy vegetation of the forests of the Salish Sea region. Therefore, this was effectively measuring the proportion of the site's circumference that fronted the ocean or another large body of water. Presumably, this value or proportion would be adjusted when studying the defensibility of another region.

Factor 4: Modified Site Accessibility. Martindale and Supernant included modified accessibility in their index to measure the extent to which a site's inhabitants modified the environment to obstruct the movements of attackers. Accessibility was measured in the same way as visibility, calculating the degrees of accessibility of the site as a subset of degrees of approach. In effect, the smaller a fraction of the degrees of approach that were still accessible, the higher the defensibility value gained from accessibility. Calling the value 'accessibility' seems like a misnomer, as it is measuring the inverse of accessibility. Accessibility was the metric for which I had to use the most individual discretion with during my measurement of sites, as there was no clear definition given for what level of landscape modification would be necessary for travel to be considered restricted using their model. Measuring the accessibility and approachability of a certain site is not just measuring the ability of someone to approach the site, regardless of condition, but rather the ability of a raiding party to access that site and still attack it in good condition. An experienced hiker may well be able to scale the hills overlooking a site surrounded by bluffs and use them to approach the site, for example, but it is unlikely that a party of raiders would be in any condition to mount a serious raid or assault on the site once they arrived using that same route.

Bocinsky (2014)'s Analysis of Site Defensibility

Martindale and Supernant's (2009) model was a good starting point, but it is not without flaws. The largest of these shortcomings is that the index only measures the approach slope of a site as it pertains to one vector. This potentially skewed the overall value in favor of a single approach slope even if that slope was not representative of the majority of the site, especially if the single approach vector passes through a lower portion of the site on the way to a high point. In addition, their use of the size of the site and the presence or absence of structures designed to inhibit accessibility as two of their factors means that the reliability of their measurements could vary depending on how completely a site was excavated and documented. In an area such as the Salish Sea where the much of the archaeological investigation is reactive investigation in the context of Cultural Resource Management, this would mean that there would be very little in the way of the highly documented and broadly excavated sites that would be necessary for this method to be an effective or representative sampling.

Martindale and Supernant (2009) hand measured their sample of sites using topographical maps. Hand measurement is better than no measurement, but replicating hand measurement means that measurements are opened up to individual error, and when this is compounded it can lead to greater problems with the compiled measurements. Due to the well documented records of fortification in the Prince Rupert Harbor area, on the Alaska/ BC border, Cookson (2013) was able to more accurately use Martindale and Supernant's methods in conjunction with the rest of his research because more effective documentation of sites meant there were fewer areas of ambiguity in the measurement of relative site accessibility.

Because of these shortcomings, I switched to Bocinsky's (2014) methodology to measure the defensibility of site locations. Bocinsky used a raster, a grid of cells with each cell being given a value. He used the elevation of the cells of the Japan Aerospace Exploration Agency's ALOS 30m DEM (JAXA

AW3D30 2019), and the relationships between those cells and the 24 cells at a Moore radius of 3 around them. The relative elevation of a cell was calculated as the mean of the 24 angles created using the formula: [(ARCTAN)*(change in elevation/distance)] for each cell. The relative visibility of the cell was calculated from the number of cells at a Moore radius of 3 to the focal cell which were visible unobstructed to the focal cell, divided by the total number of cells, in this case 24. (see figs 3.1 and 3.2 below) Once Bocinsky's method determined the values of relative elevation and relative visibility, these values are added together to create the value of defensibility for the individual cell. His defensibility index for a site is the maximum combined score given for elevation and relative visibility out of all of the grid cells which include portions of the site. Site boundaries are determined by shapefiles gained from the British Columbia's RAAD database in the case of the sites located in British Columbia, and drawn by myself based on the shapefiles from the Washington State WISAARD database in the case of sites located in Washington State.

Bocinsky's method for measuring defensibility dispensed with two of the factors deemed important by Martindale and Supernant (2009), size and accessibility. The rasters created through his calculations only contained relative elevation and relative visibility. These are much less reliant on the presence or absence of accurate archaeological excavation of a given site and can thus be applied over a much broader spectrum of sites with more potential for a uniform standard of accuracy. While the level of completion of an archaeological survey would still impact the known boundaries of a given site, the measurements created using Bocinsky's method do not change depending on the presence or absence of archaeological sites in the area, meaning that if a partial site is measured, the defensibility of that partial site is measured accurately, and would not change if new areas of the site are found.

Bocinsky measured the elevation of the raster squares as they related to all the 8 squares surrounding them as well as the two layers of tiles beyond them. When measuring elevation and visibility, Bocinsky used the 24 tiles within a Moore radius of 3 to the focal tile. This roughly approximated the radius of 100 meters as used by Martindale and Supernant, to the extent that it could be matched using a 30m Digital Elevation Map. The intervening tiles were used to measure the obstruction of sightlines by intervening elevation when approaching the 24 cells at a Moore radius of 3 to the focal cell (see Figure 3.1), combining the measurements of each of the 24 cells into a single mean. This enabled the raster to record a more accurate representation of the site as it was situated in the surrounding area. While the size of the site is no longer directly used in Bocinsky's methods, the larger a site is, the more cells from the raster it would take up, and thus the more measurements for defensibility that the maximum defensibility of the site can be selected from, meaning that the area of the site still indirectly impacts the score of relative defensibility.

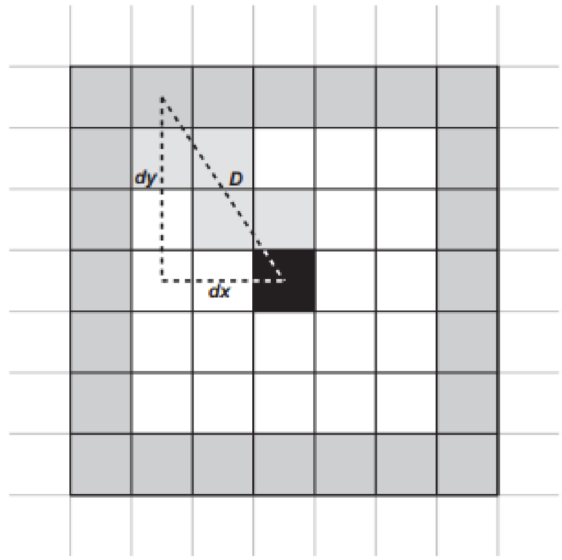


Fig. 1. Plan-view of distance calculation on a grid. The defensiveness index is calculated for the focal cell (black). Dark gray cells are at a Moore distance r_3 from the focal cell. Light gray cells are potentially intersected by the line-of-sight between the focal cell and the r_3 cell.

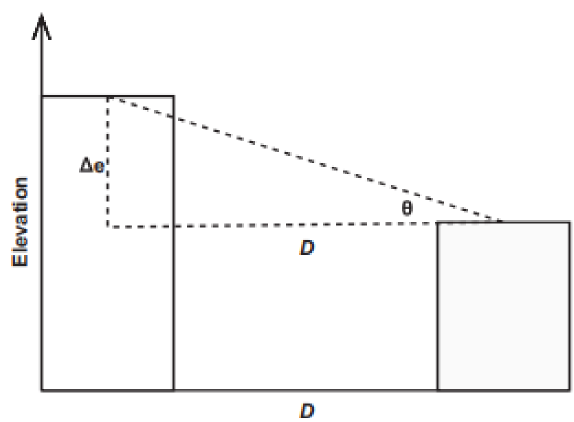


Fig. 2. Profile of elevation calculation between two cells. The cell centers are a distance D from each other, have a difference in elevation of Δe. The angle of elevation formed by a right triangle with edge-lengths D and Δe is given by θ.

Figure 3.1. Elevation calculation in Bocinsky's method, from Bocinsky 2014 Figs. 1 and 2: showing the tiles at a Moore radius of three from the focal tile, and the measurement of elevation for a single pair of tiles.

I agree with Bocinsky on not directly using size or accessibility as metrics. While both would be factors that would have been considered in the selection of a defensive location and the construction of a defensive site in intergroup conflict, the proper use of them relies on the sites being evaluated having already been thoroughly archaeologically investigated. While including these metrics may be worthwhile when examining well documented sites such as Ozette, this would also mean that the information thus gathered could only be compared with any real academic rigor to other sites that have well documented defensive or obstructing structures or have a clear reason why such structures should not be assumed to be in place. As there are only a handful of such sites in the Salish Sea region, this would be drastically limiting in the areas where this research could produce replicable results.

Out of all of the sites with point assemblages that were documented by Rorabaugh, only one of them, DgRv 1, had any documented fortification, in the form of a trench embankment (Angelbeck 2009). The site at Semiahmoo spit is another site where potential defensive landscape modification has been noted, but there has been no official documentation of this feature.

The archaeological record of constructed fortifications and landscape modifications such as ditches in the Puget Sound region, or other areas of the Salish Sea region south of the WA-BC border is biased and incomplete due to inconsistent study and recording. This may be in part due to the heavy development of the shoreline compared to the relatively undeveloped shorelines in British Columbia and Alaska. In areas where the shore was not developed post-contact, the shore fortifications of sites would have been better preserved, and more likely to be available for archaeological investigation, as shown by Angelbeck (2009), providing examples of sites in the Gulf Islands that have not been built over, and show a much clearer record of trench embankment.

Another reason behind the lack of data on fortifications in this area might be the focus on the central areas of sites in archaeological research, as opposed to their peripheries. For example, Grabert, Cressman, and Wolverton (1978), investigated only a small, centrally located portion of 45WH17, the Semiahmoo spit site, rather than the perimeter of the site, which might have had more defensive landscape modification. This is a reflection of the fact that most of the archaeological research in the U.S. Pacific Northwest is related to Cultural Resources Management in the face of encroaching development, compared to the much larger academic infrastructure in place in British Columbia, which allows for more academic projects to be undertaken (Springer and Lepofsky 2019), and in areas that are relatively free from post-contact land modification. This means that large portions of sites are rarely excavated south of the Canada and U.S. border, which means that larger landscape modifications such as fortifications are less likely to be found, and the full size of sites is potentially difficult to determine. In addition, many sites that have an ethnographic record of fortifications or other landscape modification have been built over, making attempts to locate potential fortifications using LiDAR difficult if not impossible. The sites in the Gulf Islands as described by Angelbeck (2009) are in areas with very little construction, meaning that there was less chance for features to be built over, and they were visible using LiDAR.

In order to examine the peripheries of a site, the site's dimensions must already be known, which may be difficult to determine in the face of transformational processes such as erosion or sediment deposition, as well as land modification prior to the site becoming of archaeological interest. It may also be the case that the periphery of sites are areas where less activity was conducted, and where deposits were more vulnerable to transformational processes.

Of all the factors in Martindale and Supernant's (2009) defensibility index, approach slope is the one that could have used the most clarification. While the process of the measurement of angles was straightforward, they did not discuss how to measure approach slope for sites that had more than one approach vector, such as a site on a hill that sloped at different angles at different parts of its circumference. Under their method, the approach slope of the site would only be calculated from one point, even if it only applied to a portion of the site. When I was using this method, I chose to measure the approach slope from the site to the nearest large body of water connected to the ocean, as this would likely be a potential avenue of approach for attackers arriving by boat. At landlocked sites, I took the approach slope from the lowest point on the 100m perimeter, as determined through the GIS heightmap (ArcGiS World Hillshade 2018).

Bocinsky's shift to a raster system was immensely helpful in eliminating the ambiguities in this part of the measurements. His method measures all 24 cells at a Moore radius of 3 from the focal cell, representing a roughly 100 degree radius in the case of a 30 meter Digital Elevation Map. This system is omnidirectional, and when it combines the measurements of multiple cells it is capable of accounting for all the elevation differences involved in a particular site. Therefore, multiple sites can be measured consistently, under the same circumstances. If the limits of more than one site are defined in a given region, as was the case in my research, then multiple sites can be measured at once, as the relative defensibility ratings of the underlying raster do not vary based on the limits of the individual site

Table 3.1. The Metrics of Defensibility as Measured by Martindale and Supernant (2009) and Bocinsky 2014

	Martindale and Supernant	Bocinsky
Size	Area was added into the index by dividing the square meterage of the site by one million square meters, representing the largest known site in the Pacific Northwest.	Not directly measured, the size of the site influences the available cells to draw measurements from
Elevation	Elevation is measured by taking the approach slope, the angle created by comparing the height of the site and the surrounding area, combined with the distance it would take to reach that point.	Multidirectional, measured using the equation ((average approach slope change of the 24 cells at a Moore radius of 3 to the focal cell)+90 degrees)/180 degrees
Visibility	The visibility of the site was measured using the degrees of visibility meeting or exceeding 100 meters around the site and dividing them by the degrees of approach.	Multidirectional, measures the number of the cells at a Moore radius of 3 to the focal cell visible from the focal cell that are unobstructed by intervening cells/the number of all cells being measured (24)
Accessibility	Accessibility is measured in the same way as visibility, calculating the degrees of accessibility of the site as a subset of those degrees of approach.	Not measured, as this measures modification of the landscape rather than the landscape itself
Degrees of approach	Degrees of approach are not part of the final formula, but are important for the calculation of Visibility and Accessibility	Not used

Comparison of Methods; The Case of 45-WH-17

A potential example of the sorts of landscape modification that could have been used to improve the defensibility of a location is provided by the remains of what is potentially a trench embankment site at 45-WH-17, Semiahmoo spit. The Site of WH-17 consists of a shell midden spreading across the base of the spit. The feature that potentially could be trench embankment runs along the northwestern shore of the spit, which is the side that is facing the Strait of Georgia, the main waterway attackers would have needed to use to approach the site. In 2019, I travelled to WH-17 with Professor Sarah Campbell, in order to document the presence of a land feature at the site that Professor Campbell believed to be the remains of a trench embankment. My observations with Dr. Campbell showed that there were clear remains of a ditch. While Professor Campbell was convicted of the nature of the feature as a trench embankment, I am somewhat less convinced due to the built over nature of this portion of the spit. Grabert et al. (1978: 174) did document the presence of historical features to the north of the area they excavated. It is possible that this feature is a product of historical land use, or otherwise dates from the very end of the Gulf of Georgia phase. However, as the ditch has not been dated this could not be determined for certain, and a modern trench would also reveal the midden. It is possible that this trench could be the remains of a later stockade such as the one described by Suttles (1951),in which case it would be an example of a fortification. This feature is also visible from LiDAR images of the site taken from the Washington State DNR North Puget Sound 2017 LiDAR (https://lidarportal.dnr.wa.gov/ 2017, accessed 2019), showing the feature extending north of the area excavated by Grabert et al. (1978). See Figure 3.2, below.

Figure 3.2. LiDAR image of the site 45-WH-17, taken from the Washington State Department of Natural Resources North Puget Sound 2017 DTM Hillshade(https://lidarportal.dnr.wa.gov/ 2017, accessed 2019). The limits of the potential trench embankment are denoted by the blue bracket.

Given that there has been no dating of this feature, it is unknown whether it was present during the period the site was occupied. Regardless, it can be used to illustrate measurement of site defensibility according to Martindale and Supernant (2009). It is worth noting that Semiahmoo Spit is immediately adjoined to the south by a steep slope and bluff. t would not be out of the question that this area would have been an appropriate location for a refuge site or a series of lookout positions, fitting the patterns of the ethnographic and archaeological information compiled by Angelbeck (2009).

As measured using Martindale and Supernant's (2009) technique, the site has a relatively open sightline, except for the large bluff to the south obstructing view from that direction. The site is approachable from all directions, including the south, so there is very little in the way of natural defensibility afforded by the location of the site. While the inner portion of the spit would not have needed to be defended against attack from the broader Salish sea region, it would still have been vulnerable to attackers coming from within Drayton harbor. However, the presence of a potential defensive modification in the form of a trench embankment would have a major impact on the defensibility of the site, by limiting the potential approach of attackers to specific portions of the site, doubly so when attacking from outside the harbor. Although it is difficult to determine the full extent of the landscape modification, if we assume that it covered a roughly 90 degree arc of the site, it would have the effect of cutting off direct access to the site from that direction, even if attackers could still approach the site from that direction and circle around on another angle of attack. Once all of the factors have been measured, the values for site area, site elevation, site visibility and site accessibility are added together, and the resulting number is the value according to Martindale and Supernant's defensibility index, as shown below (Table 3.2).

Table 3.2. Elements of Site defensibility measurement following Martindale & Supernant (2009), assuming no modification and the presence of a modification obstructing access to 90 degrees of 45-WH-17.

	Defensibility Index	site area in m2, / 1,000,000	Site elevation as calculated / 90 degrees	Degrees of visibility / degrees of approach	Limits to Accessibility	Angles of approach	Degrees of Visibility	Angles of access Through modifications, if present	arc of the site not approachable	approachable arc not accessible
45WH17 unmodified	0.890	0.24	0.033	0.617	0	360	222	360	0	0
45WH17 modified	1.015	0.24	0.033	0.617	0.125	360	222	270	0	0.25

In contrast, Bocinsky's method measures the elevation and obstruction of the 24 cells at a Moore radius of 3 from the focal cells. The elevation and obstruction values are combined for each of the focal tiles, measuring each tile's defensibility relative to their surroundings. These are displayed as a raster on the underlying 30 m sq grid. However, the raster generated using Bocinsky's (2014) methods, as shown below (Figure 3.3), is not a high enough resolution to show any of the land features of the site, except in broad generalities.

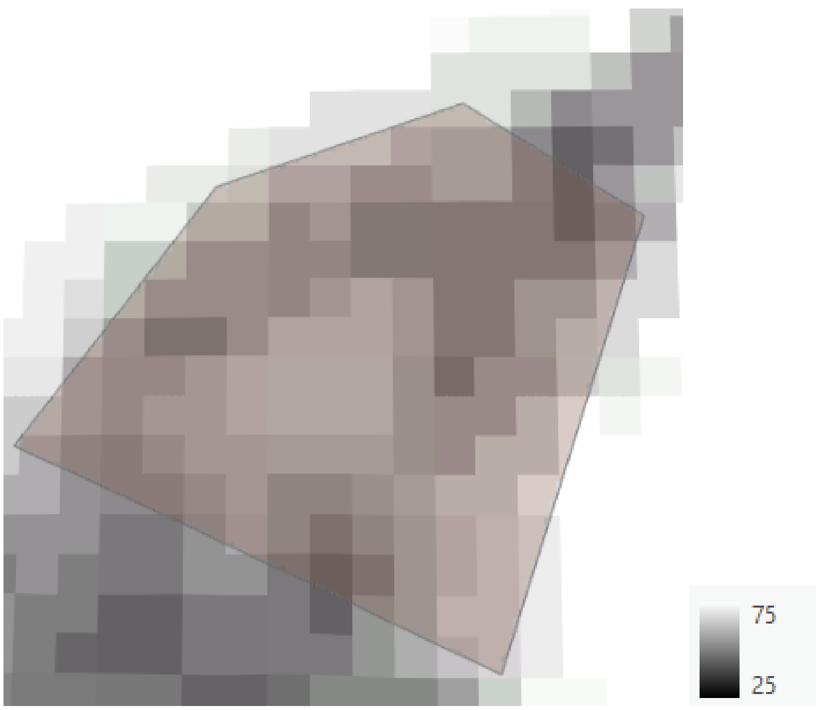


Figure 3.3. The relative defensibility raster covering 45-WH-17 generated by Bocinsky's (2014) methods. The maximum value generated was 66, the average value was 52. Lighter cells are high values, darker are low values.

Therefore, while Bocinsky's method excels at the measurement of broad geographical areas, which is why I found it ideal for the purposes of my research, Martindale and Supernant's (2009) method could potentially be of great utility in areas where there is a more intact record of site features, such as the sites listed in Angelbeck (2009) with documented and dated trench embankments and other defensive landscape modifications.

Limitations of the Measurement of Defensibility.

There are aspects of a local landscape not included in a purely quantitative measurement of the immediate physical location of the site, but which should still be considered in the analysis of site defensibility. These can be both features of the landscape itself and features of other contemporaneous sites in the area. The first of these factors would be the presence of other settlements engaged in mutual defense against a common threat. If a given settlement was close to another settlement that could be relied upon to aid in defense the defensibility of the route to that site would be much less of a priority compared to other factors, such as access to food resources. Conversely, if a given site was in an isolated area far from any allies, there would be more impetus to prioritize defensibility in all directions. The second of these factors would be whether a given location was the only one on an island with a usable beach. This could also apply to the site location compared to other marine routes. If a site was situated on the only access route between two islands, it would have more reason to secure itself through fortification, both to protect against raiding, and to project power over the marine route. The third factor is the presence of local geographical features that would restrict easy access to the site that were situated outside of the site perimeter. For example, A site could be in an open valley that had only one point of easy entrance or exit, but if it was far enough away, the measurement process would potentially underrate the defensiveness of the site. However, the use of Bocinsky's process establishes a baseline for the analysis of defensibility that can be supplemented with contextual information for sites outside of the norm, while still providing a robust method to broadly analyze large areas. In contrast, a project using Martindale and Supernant's (2009) method would only be at its most effective in the case of sites where defensive landscape modification had been documented, or the site had been documented to such an extent that the absence of such fortifications could be reasonably supposed. If this could not be established, Martindale and Supernant's method could only be used by disregarding one of its four measuring values, negatively effecting the accuracy of the measurements.

Chapter Four: Analyzing Darts and Arrows

In order to determine the validity of my hypothesis that changes in projectile point assemblages could be correlated with changes in site defensibility, it was necessary to obtain a set of dated and measured assemblages of projectile points. The most effective available sample of points were the assemblages used by Rorabaugh for his (2015) dissertation research. The assemblages came from sites throughout the Salish Sea region and were from a broad chronological timeframe (See appendix Tables 1 and 2), which would hopefully aid in showing the broad trends of change over time in the Salish Sea region. In addition, some sites had point assemblages dating from different phases. This is particularly useful in investigating how the environmental and other factors affected the inhabitant's choices in projectile points over time. Given that this dataset plays such an important role in my own research, it is important to provide a thorough analysis of the aspects of the aggregated points that may reflect on my own analysis

The Dataset of Projectile Points Used by Rorabaugh (2015)

The dataset of projectile points used by Rorabaugh (2015) provided a series of sites throughout the Salish Sea region with well documented projectile point assemblages. As his work was focused on the geographical and chronological spread of lithic craft traditions including projectile points, his dataset was a natural fit for the examination of the of the spread of the bow and arrow through the analysis of projectile points. Rorabaugh had already measured an assemblage of projectile points, using a method derived by Hildebrandt and King (2012) for the stemmed points, and using those results created a discriminate function analysis which he applied to the unstemmed points in the dataset. The indices and functional categories that this process created made it possible to estimate whether a given point was a dart or an arrow. I use the functional categories of arrow and spear/dart point established by

Rorabaugh's Discriminant Function Analysis (DFA) in my analysis of site defensibility and the associated projectile point assemblages for this reason.

The one area that could have used more discussion is the presence of fletched dart points prior to the date of the bow and arrow stated by Rorabaugh. Arrow points are especially similar to fletched dart points in their construction (Hughes 1998), to the effect that there can be misidentification between the two point types. If the points analyzed by Rorabaugh were taken on their face value as arrow points, it would indicate the presence of the bow and arrow in the Salish Sea region prior to 3500ybp. While Rorabaugh's explanation of fletched darts in certainly possible, the fact that this is something that needs to be explained at all means that it is a weak point of the classification. Even if the base measurements of the index remained the same, comparing the older points with documented fletched dart point might be a way that to establish a more effective means of differentiating the two types of small points, such as the discovery of an intact arrow or fletched dart from the period in question at a wet site, allowing more secure analysis of these point types to be conducted.

Rorabaugh obtained this set of projectile point data through the examination of projectile points from research collections located at Washington State University, Simon Fraser University, the University of British Columbia, Western Washington University, the Burke Museum, and Royal British Columbia Museum. This represents a catalog of many of the largest sites of the Salish Sea region. Notably, not all of the lithics analyzed by Rorabaugh could be functionally categorized, as some lacked the features that allowed them to be measured according to his methods, due to their fragmentary nature. In my exploration of this dataset, I will only be referring to the points, both stemmed and unstemmed, that received a functional category through Rorabaugh's DFA.

Rorabaugh analyzed points from 113 components in 49 separate archaeological sites. Seventeen of these components were larger residential site components, and 96 were smaller components associated with specific activities. Rorabaugh aggregated point data from both single-phase and multiphase sites, (see Table 3 of the Appendix). While there are points in the assemblage from site components as early as 6000 ybp, the majority are from sites of the Locarno Beach, Marpole, and Gulf of Georgia Phases (3500 to 500YBP). Rorabaugh tried to include other assemblages, but could not because of time constraints. Given similar time constraints, including the COVID-19 pandemic shutdowns, I was unable to measure other point assemblages personally.

From the assemblages he analyzed, Rorabaugh found 2130 points that could be assigned a functional category according to his DFA (see Table 1 of the Appendix). The mean number of points per site component is 65.9, the median is 4.0. In practice, this means that the aggregated assemblages are a mix of a few large components with many projectile points, and many smaller components with fewer points.

Rorabaugh divided the assemblages he examined into five geographic regions, Puget Sound, Northwest Washington, The San Juan Islands, the Gulf Islands and the Fraser River Delta. I am retaining these regional categories to show areas of potential variation within the subregions of the broader Salish Sea region. Due to the nature of the previous archaeological work conducted in the Salish Sea region, there are some gaps due to sampling (see Table 4.1). There are few point assemblages from inland river valleys, meaning that the data is biased towards coastal areas. Mainland Washington north of Puget Sound is another area with fewer numbers of smaller assemblages. The assemblages cover the five main cultural periods of the Salish Sea region. Comparatively, there are relatively few points from earlier phases, such as the Charles, compared to the Marpole and Gulf of Georgia phases (see Table 4.2). The Archaic phase is effectively a nonentity, with only one assemblage of four points. While this may be expected given the relative scarcity of earlier sites, a more robust collection of earlier points could have aided in establishing the tool-using environment that existed prior to the introduction of the bow and arrow. This is especially unfortunate given that Rorabaugh placed the initial introduction of the bow and arrow in the 3500ybp interval, a period that had comparatively few projectile points in the assemblages that he analyzed.

This sampling problem may have come about primarily due to the fact that Rorabaugh used museum collections as of 2015 when he was conducting his research. While he tried to be as representative as he could be in the points he used, it is perhaps inevitable that some collections may have fallen through the proverbial cracks when he was conducting his analysis, such as the many points found in the region that cannot be associated directly to a provenanced and dated site component. In addition to this, it is important to remember that the stone points being measured are only part of the overall point types being used in the region. Points in the Salish Sea region made of bone or wood, would have been much less likely to preserve outside of wet sites. The dataset that Rorabaugh compiled did not contain any organic points, as his research was focused on the transmission of lithic crafting knowledge. He however notes that bone arrow points are commonly considered to have been introduced contemporaneously with ground-stone lithic points, citing documentation of the introduction of ground points in the archaeological record, which is contemporaneous with changes in point styles believed to mark the introduction of the bow and arrow to the Salish Sea region (Angelbeck and Cameron 2014, C. Ames 2009, Pratt 1992, Rorabaugh 2015). However, only some arrow points were constructed using the grinding method, and chipped points would remain the majority throughout the Salish Sea region. Ground points would remain in the minority regardless of whether arrow points or dart points were more common in the phase. As was the case with the introduction of the bow and arrow, ground points never fully replaced chipped points or vice versa (see Table 4.4).

Table 4.1. Count of points utilized by Rorabaugh (2015) using his temporal and geographic divisions.

Years BP	Fraser Delta	Gulf Islands	NW Washington	Puget Sound	San Juan Islands	Grand Total
500	3	79		33	44	159
1000	63	21	21	11	126	242
1500	13	55	1	81	276	426
2000	215	69	30	96	103	513
2500	257		2	166		425
3000	78	111	2		17	208
3500	32	62		16		110
4000	11					11
4500	1	15				16
5000			16			16
6000	4					4
Grand Total	**677**	**412**	**72**	**403**	**566**	**2130**

Table 4.2. points in the assemblages analyzed by Rorabaugh, organized by cultural phase and 500ybp interval.

Row Labels	Archaic	Charles	Locarno Beach	Marpole	Gulf of Georgia	Grand Total
500					159	159
1000					242	242
1500				426		426
2000				513		513
2500			27	398		425
3000			204	4		208
3500			110			110
4000		11				11
4500		16				16
5000		16				16
6000	4					4
Grand Total	**4**	**43**	**341**	**1341**	**401**	**2130**

Points could be constructed both by being struck or chipped or by the ground-stone method used in many other lithic crafts in the Salish Sea region (see Table 4.3) (Suttles 1990). While the dataset analyzed by Rorabaugh includes points constructed from eleven different materials, the three most common by a wide margin are cryptocrystalline silicate (CCS), crystalline volcanic rock, (CVR), and metamorphic rock (see Table 4.4). Different point materials were used in different construction methods (see Table 4.5).

The CCS points were chipped exclusively while CVR points could be ground or chipped, most commonly chipped. Metamorphic points were the only ones that were predominantly ground. Given all of this variation, and the fact that both chipped and ground points could be considered arrows and darts across the period of study, it seems inappropriate to assume that any changes in projectile point measurements carry over one-to-one with changes in material type or construction style.

Table 4.3. *Count of points in the assemblages used by Rorabaugh, showing both construction style and functional category by his assigned 500ybp intervals.*

500ybp interval	**Functional Category**		
Chipped versus Ground	**Arrow**	**Dart/Spear**	**Grand Total**
500	**76**	**83**	**159**
Chipped	68	78	146
Ground	8	5	13
1000	**123**	**119**	**242**
Chipped	92	100	192
Ground	31	19	50
1500	**148**	**278**	**426**
Chipped	136	274	410
Ground	12	4	16
2000	**179**	**334**	**513**
Chipped	148	292	440
Ground	31	42	73
2500	**186**	**239**	**425**
Both		1	1
Chipped	161	213	374
Ground	25	25	50
3000	**90**	**118**	**208**
Chipped	72	103	175
Ground	18	15	33
3500	**34**	**76**	**110**
Chipped	23	55	78
Ground	11	21	32
4000	**3**	**8**	**11**
Chipped	1	7	8
Ground	2	1	3
4500	**1**	**15**	**16**
Chipped		6	6
Ground	1	9	10
5000	**7**	**9**	**16**
Chipped	7	9	16
6000		**4**	**4**
Chipped		4	4
Grand Total	**847**	**1283**	**2130**

Table 4.4. Points in the assemblages analyzed by Rorabaugh, organized by material type and 500ybp interval.

	CCS	CVR	MR	Obsidian	Other	Total
500	18	125	13	2	1	159
1000	14	211	16		1	242
1500	29	379	11	1	6	426
2000	78	367	57	4	7	513
2500	97	307	10	4	7	425
3000	9	187	9	1	2	208
3500	18	73	18		1	110
4000	1	7	3			11
4500	1	6	9			16
5000	3	13				16
6000		4				4
Total	**268**	**1679**	**146**	**12**	**25**	**2130**

Table 4.5. Material type and construction method of points analyzed by Rorabaugh (2015)

Material Type	**Chipped and Ground**	**Chipped**	**Ground**	**Grand Total**
CCS		267		267
Conglomerate		1		1
CVR	1	1531	134	1666
MR		2	144	146
Obsidian		11		11
Petrified Wood		9		9
Quartz		8		8
Quartz crystal		1		1
Quartzite		1		1
Sandstone		1		1
Silicified Mudstone		3		3

The Introduction of the Bow and Arrow in Other Regions.

The Great Basin region is an area where the bow and arrow is believed to be relatively late coming, as Bettinger and Eerkens (1999) claim that it was introduced to the region as late as 1350ybp, far after even the latest estimate of the bow and arrow being introduced to the Salish Sea region. They used measurements of different point features to assign points to typologies and used those typologies to determine if a point was a dart or an arrow point. This follows work done by Thomas (1978), which is the foundation to much of the projectile point literature in the American West, Hildebrandt and king (2012) included. While there are debates about exactly how reliable the point typologies are in the Great Basin region, Thomas (2013) defended them, saying that they were especially useful in tracking the influence of the climate on human behaviors. Conversely, Smith et al. (2013) stated that the typologies used in the Great Basin region, were potentially flawed, due to points considered to be in different typological categories having been deposited at the same time. However, this conclusion has been disputed (Hockett et al. 2014, Smith et al. 2014). Despite this controversy, the introduction of the bow and arrow to the region still seems to be estimated at roughly the timeframe proposed by Bettinger and Eerkins (1999).

The Columbia Plateau region is an area where the bow and arrow is considered to have been introduced relatively early. Chatters (2004) documented the ways that the introduction of the bow and arrow shaped the formation of village sites across the plateau in a more defensive direction, giving approximately 2500bp as the date this began. Ames et al.(2010) state that many of the current models for the introduction of the bow and arrow to the Columbia Plateau region and the western portion of North America as a whole are too recent. They argue for 8000ybp as an effective introduction date for the bow and arrow, with 4500ybp being the time where it truly began to become more prominent. Ames et al.'s push for an earlier introduction date for the bow and arrow shows that even as the introduction date for the bow and arrow is up for debate in the Salish Sea region, the same can be said for other regions across western North America.

In contrast to the predominant approach of using an index to categorize points, Erlandson et al. (2014) urged caution in the use of indices to classify projectile points, and said that they should not be used universally. They provided evidence of points from California's Channel Islands which are believed to be dart points, but are small enough to have the index values of arrow points. The issue of fletched small dart points being potentially mistaken for arrow points or vice versa is an issue that has the potential to severely jeopardize the use of any index such as this, unless it is properly accounted for.

Hildebrandt and King (2012)'s Stemmed Dart-Arrow Index.

Hildebrandt and King (2012) use points from assemblages in the Great Basin Region, combining research conducted in that region's projectile points from museum collections with documented confirmation of dart or arrow-usage such as being found dry-preserved with wood intact (Thomas 1978). In trying to establish the use category of heavily retouched points, Hildebrandt & King (2012) found that length, shoulder angle, and base width were too variable to be useful, whereas neck width and maximum thickness were better predictors, based on experimental work conducted by themselves and by Flenniken and Raymond (1986), which showed that these attributes were the least vulnerable to the stresses of use. They analyzed points before and after they suffered damage and retouch in order to establish this pattern, using points that they constructed in the style of points from their area of study and took them through similar patterns of damage and retouching as seen in the archaeological record. Their index, consisting of neck width and maximum thickness added together, was used to create a dart and arrow index (see Figure 4.1)

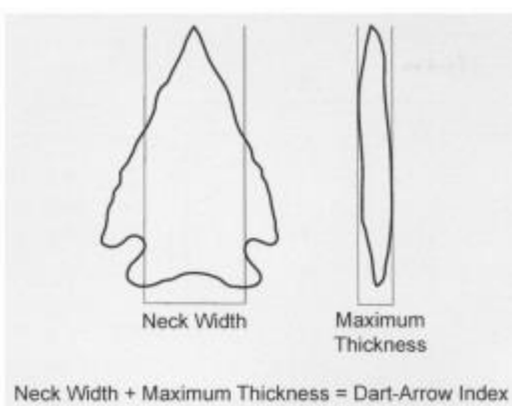


Figure 4.1. Neck Width and Maximum Thickness of a Hypothetical Stemmed Projectile point. Taken from Figure 1 of Hildebrandt and King (2012).

However, Hildebrandt and King's (2012) measurement can only be used on stemmed points as unstemmed points do not have a neck that can be measured. While this is less of a problem in areas such as the Great Basin, where many points are stemmed, the Salish Sea region is an area where most projectile points are unstemmed, and thus cannot be measured on Hildebrandt and King's index. Rorabaugh used the stemmed dart-arrow index developed by Hildebrandt and King as the basis of his own research into the properties of unstemmed projectile points (2015).

Rorabaugh's (2015) Analysis of Stemmed and Unstemmed Projectile Points in the Salish Sea Region.

Rorabaugh based his calculations on measurements of stemmed points from 49 sites in the Salish Sea region. He used these measurements to create a discriminate function analysis, in order to determine what features of unstemmed points would be the best determinant of whether a point was an arrow or a dart, in the same way that the neck width and maximum thickness functioned in Hildebrandt and King's (2012) method.

Rorabaugh did this by using characteristics of the stemmed points which were shared by the unstemmed points: maximum thickness, width and length, blade width and length, and haft width and length. Through his discriminant function analysis, Rorabaugh found that the most important metrics for classifying an unstemmed point as a dart or an arrow armature were maximum thickness, blade width and haft width (See Figure 4.2).

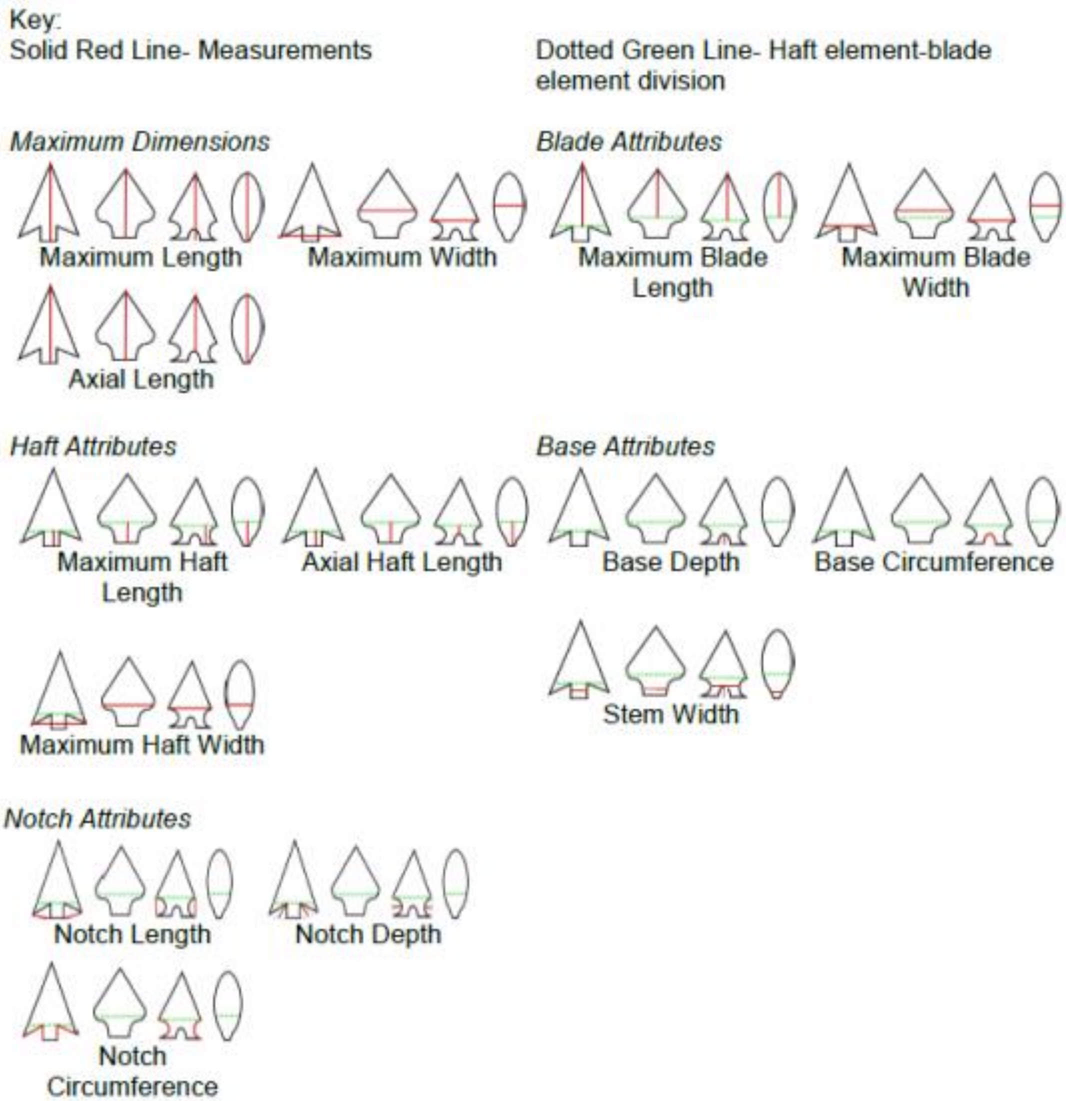


Figure 4.2, example projectile point measurements. Taken from Figure 6.2 of Rorabaugh (2015)

All of these would logically have an impact on the overall weight and mass of the projectile point and would thus influence whether it could be more effectively used on an arrow or a thrown projectile. Using discriminant function analysis, Rorabaugh was able to determine the dividing threshold for a new set of functional categories, which he labeled Darts/Spearpoints and Arrows containing both stemmed and unstemmed points. It is this category system that I will use in my analysis.

Limitation and Biases of the Dataset.

One of the largest limitations of this dataset is that it does not record any of the bone projectile points found alongside lithic points, or in other site components in the Salish Sea region, even though such points are known archaeologically and ethnographically (Suttles 1987, Angelbeck 2009). This is to be expected given that Rorabaugh was investigating a different research question specifically related to lithic crafts, and he can hardly be faulted for not tailoring his research process to specifically suit my questions.

Rorabaugh divided the points that he analyzed into five geographic subregions of the broader Salish Sea region. Perhaps inevitably, there is some variation in the number of points analyzed from each subregion. The Fraser delta was the subregion with the most points to be analyzed, perhaps to be expected given the long record of archaeological sites in the region, including those that would give their names to the Locarno Beach and Marpole phases. The Gulf islands, San Juan islands, and Puget Sound subregions all have relatively similar numbers of points, although somewhat varying in chronological distribution. Northwest Washington is the subregion with by far the fewest points, having less than a quarter of the points of the next smallest subregion. This is far and away the area that would have benefited the most from a larger sample in the dataset assembled by Rorabaugh. The Northwest Washington sample is so small that I question the validity of analyzing it on the same level as the other subregions in this dataset. Throughout my analysis, I will be including the Northwest Washington site components with the Fraser Delta, and analyzing the two island subregions together, due to their geographic proximity.

Rorabaugh also did not document the presence or absence of any organic points in the assemblages that he investigated. While it would have been helpful if Rorabaugh provided a brief overview of the styles of bone points that were used alongside the lithic tools of different phases, this is perhaps to be expected given they are not directly related to his research questions. I did not conduct an analysis of bone points in my research process due to time and scope limitations, and I am sure that the same applied for Rorabaugh. At present, there is no similar set of metrics that are used to differentiate organic darts and arrows from each other in the similar style of Hildebrandt and King (2012)'s methods, so the users of bone points must be assumed to have access to the same methods of delivery, alongside others such as harpoon technology, as their contemporaries using lithic points. Presenting bone points alongside lithic points without an analogous means of differentiating them would mean that the accuracy of the analysis would have been questionable. Consciously limiting to lithic points kept the scope of the project manageable, and also avoided the need to determine if sites with only one of the two material types could be investigated, or only those with bone and lithic points.

Chapter Five: Analysis of Results

In order to determine if the introduction of the bow and arrow to the Salish Sea region correlated with an increase in the relative defensibility of areas of activity recorded in the archaeological record, I will examine the correlation of the metrics of average and maximum relative site defensibility versus two different metrics from the projectile point assemblages. The first of these is the average score on the unstemmed dart arrow index created by Rorabaugh's (2015) Discriminate Function Analysis (DFA). The second metric is the proportion of arrow points in a given assemblage.

The first relationship will show the relative influence of arrow points on the toolmaking style of the wider era and phase. Using Rorabaugh's index, points below a certain combined threshold of measurements were classified as arrow points, and a low average on the dart and arrow index for an assemblage shows that even those who used points that the index would classify as darts would have had a familiarity with the construction of points that could be classified as arrows.

The second will show the prevalence of the specific use of arrow points. When this measurement is combined with dart / arrow index score of the point assemblage, it will provide a more complete examination of the introduction of the bow and arrow by showing the use of arrow style points and the influence of arrow style points on the overall toolmaking styles of the relevant periods.

Synthesis of Data

Mine is the first research in the Salish Sea region to directly examine the association of these variables through statistical analysis and how they relate to intergroup conflict. The relationships between these four metrics will be used to address two different aspects of the introduction of the bow and arrow as it pertains to site defensibility.

Temporal Subdivision and Comparison. I will also compare the relative site defensibility of a sample of sites to the composition of point assemblages through three different cultural phases. Sites that have more than one component will be counted in their first occupation-phase. This will show when or if the inhabitants of sites with certain levels of defensibility chose to utilize the bow and arrow in their toolmaking and defensive strategies. When I am analyzing point assemblages without considering site defensibility, I will analyze the point totals from all phases. I have chosen to use Rorabaugh's (2015) division of site components and point assemblages into 500 year intervals formed by rounding the calibrated radiocarbon date of the associated site component to the closest of these intervals. This means that the points, assemblages, and components in the 2000bp category, for example, have calibrated date averages from 2250 to 1750 bp. The 2500 bp category has assemblages from both the Locarno Beach and Marpole phases, and the 1500bp category has points from both the Marpole and Gulf of Georgia phases, all other categories are exclusive to a single phase (see Table 5.1).

Table 5.1. Count of site components by cultural phase and 500 year interval.

Years BP	**Archaic**	**Charles**	**Gulf of Georgia**	**Locarno Beach**	**Marpole**
500			7		
1000			14		
1500			1		9
2000					22
2500				1	5
3000				5	
3500				5	
4000		2			
4500		3			
5000		1			
6000	1				

It is also worth noting that the earlier sites tend to have much smaller numbers of points than the later sites (see Tables 5.2 and 5.3), meaning that measurements of one point can have disproportionate impact on the overall index value or proportion of the assemblage, potentially indicating that results from earlier periods should be less relied upon in interpretation than those from later periods.

Table 5.2. Count of projectile points in the assemblages analyzed by Rorabaugh (2015) by 500 year interval.

YBP increment	Number of Points
500	156
1000	237
1500	417
2000	504
2500	418
3000	208
3500	110
4000	11
4500	16
5000	16
6000	4

Table 5.3. Count of projectile points in the assemblages analyzed by Rorabaugh by cultural phase.

	Archaic	Charles	Locarno Beach	Marpole	Gulf of Georgia
Number of Points	**4**	**43**	**339**	**1313**	**398**

Landform and Subregional Comparison. I will also compare the defensibility and point assemblages of sites situated on different types of landform: mainland coastal, island, and mainland inland (see Table 5.4). By doing this, I will be able to show how different groups with different landforms and resources available to them utilized their resources for defense. This may also show how the different pressures of defensibility and material culture impacted the size of projectile points in different areas.

Table 5.4. The number of points and site components for each of the local geography types by the 500-year intervals used by Rorabaugh. Number in parentheses is the number of site components.

Years BP	***Island***	***Mainland Coastal***	***Mainland Inland***	***Mainland River***
500	*124 (5)*	*3 (1)*		*29 (1)*
1000	*142 (6)*	*81 (6)*		*14 (2)*
1500	*322 (5)*	*17 (3)*		*78 (2)*
2000	*172 (10)*	*58 (7)*	*91 (1)*	*183 (4)*
2500		*238 (4)*	*166 (1)*	*14 (1)*
3000	*128 (3)*	*80 (2)*		
3500	*62 (2)*	*48 (3)*		
4000				*11 (2)*
4500	*15 (2)*	*1 (1)*		
5000				*16 (1)*
6000				*4 (1)*

In addition to the above, I will compare the differences in defensibility and point assemblages for the different subregions of the Salish Sea region, merging the Gulf and San Juan Islands into the broader Islands subregion, and the NW Washington and Fraser Delta subregions into the broader Northern Mainland subregion (see Table 5.5).

Table 5.5 The number of points by merged region in-500-year intervals used by Rorabaugh. The Rest of the Salish Sea referred to elsewhere combines the Northern Mainland and Island categories. The number in parentheses is the number of site components.

Years BP	***Islands***	***Northern Mainland***	***Puget Sound***
500	*120 (4)*	*3 (1)*	*33 (2)*
1000	*142 (6)*	*84 (7)*	*11 (1)*
1500	*322 (5)*	*14 (3)*	*81 (2)*
2000	*172 (10)*	*236 (10)*	*96 (2)*
2500		*252 (5)*	*166 (1)*
3000	*128 (3)*	*80 (2)*	
3500	*62 (2)*	*32 (2)*	*16 (1)*
4000		*11 (2)*	
4500	*15 (2)*	*1 (1)*	
5000		*16 (1)*	
6000		*4 (1)*	

Generation of Results

As discussed in Chapter 4, I used the sample of measured projectile points from 77 different assemblages drawn from 44 different sites throughout the Salish Sea region used by Adam Rorabaugh for his (2012) research. I also generated a raster for the defensibility of the Salish Sea region, and applied shapefiles gained from the British Columbia's RAAD database in the case of the BC sites (https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/archaeology/systems/raad), and drawn by myself based on the shapefiles from the Washington State WISAARD database (https://wisaard.dahp.wa.gov/) (see Figure 5.1).

This raster was created using Bocinsky's (2014) methods (see below). I took the maximum and average values for defensibility calculated from the raster cells within the different shapefiles and correlated those against:

1.) the proportion of points that could be classified as arrows using Rorabaugh's DFA, and,

2.) the average value on Rorabaugh's dart/arrow index, from all of the points of a given site component.

This data was investigated without placing it chronologically, meaning that while the proportion of arrow points may be correlated with site defensibility in a similar manner to expectations (see below), it does not directly show whether the introduction of the bow and arrow to the Salish Sea region led to an increase in site defensibility.

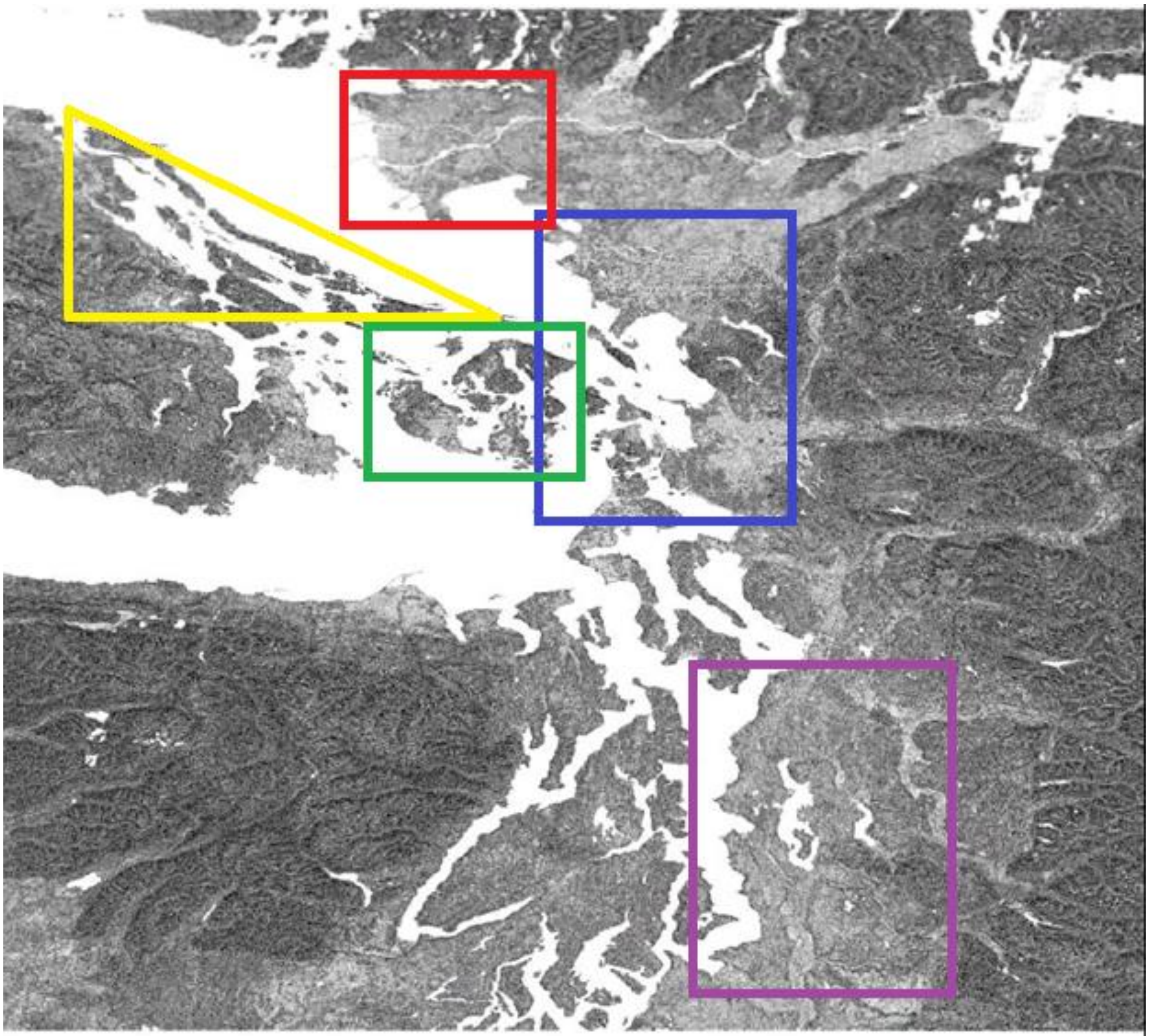


Figure 5.1. The defensibility raster generated for the Salish Sea Region. The lighter the raster tile, the more defensible the location. The colored shapes indicate the rough locations of the site components in question. Red shows the Fraser Delta area sites, Yellow shows the Gulf Islands sites, Green shows the San Juan Islands sites, Blue shows the Northwest Washington sites, and Purple shows the Puget Sound area sites.

Initial Expectations. I had four primary expectations when I began this research.

1. As per arguments by Angelbeck (2009), Angelbeck and Cameron (2014), and Rorabaugh and Fulkerson (2015), site defensibility would increase along with the relative proportion of arrows and the average index value of projectile point assemblages. As my research evolved, this expectation was refined down to expecting that the defensibility values of the sites would

increase along with the introduction of the bow and arrow to the Salish Sea region, as expressed by the correlations between the proportion of points considered arrows in Rorabaugh's DFA and the average value of the overall assemblage on the dart/arrow index against the average and maximum defensibility of their associated sites as measured using Bocinsky's (2014) raster method.

2. The average dart/arrow index value would trend down over time, which would show the relative influence of arrow style points on the toolmaking style of the wider era and phase. A low average on an overall assemblage shows that even those who used points that the index would classify as darts would have had a familiarity with the construction of arrow style points.
3. The average proportion of arrow points would increase over time, showing the increasing use of the bow and arrow in the region.
4. The average and maximum defensibility of the associated sites would also increase over time due, presumably, to the introduction of the arrow, but perhaps from other causes as well.
5. This defensibility increase would occur coincident in time with or after any substantial increase in arrow points or decrease in the Dart/Arrow index

***Results Compared to Expectations*.** In contrast to my expectations, I found that there is a slight positive correlation between the maximum defensibility of a given site and the proportion of arrow points, and a slight negative correlation between the maximum defensibility of a site and the average dart/arrow index value of the site (see Table 5.6). The higher the defensibility value of the most defensible portion of the site was, the higher the proportion of points that could be considered arrows, and the more arrow-like the average index value of the aggregated points. The more defensible the most defensible portion of the site was, the smaller the points were using Rorabaugh's (2015) methods.

The arrow proportion and the dart/arrow index were not significantly correlated with the average site defensibility values, and the averages were not strong measurements to begin with , so I will not be discussing them going forward.

Table 5.6. Correlation and Statistical Significance of Defensibility and Point Indices.

	Max Defensibility Vs Arrow Proportion	Average Defensibility vs Arrow Proportion	Max Defensibility Vs Average Index Value	Average Defensibility Vs Average Index Value
Correlation Coefficient (r)	0.22	0.140	-0.204	-0.157
T value	1.938	1.217	-1.809	-1.37
Statistical significance	0.028	0.114	0.037	0.087

As I had initially expected, the correlations show that the average and maximum defensibility of a site are correlated positively with the proportion of arrow points, and negatively with the average value of points from Rorabaugh's DFA. In other words, the higher the defensibility, the higher proportion of arrow points, and the smaller the points tended to be on the most significant factors used in Rorabaugh's DFA, namely maximum thickness, blade width and haft width. However, the average defensibility gave much weaker correlations and less statistically significant results than the maximum defensibility. Maximum site defensibility and proportion of arrow points are the variables that had the strongest and most statistically significant correlation to each other, with a positive correlation of 0.22 and a statistical significance of 0.028. Therefore, I will be basing my further analysis around the relationship between these variables. While the other correlations might gain strength and significance when examined with a larger dataset, given this sample their relationships are not statistically significant at the 0.05 level of significance. It is understandable that the average index value and the average proportion of arrows would have similar strength and significance of correlation to maximum defensibility, albeit one being a positive correlation and the other a negative one. The smaller the average index value of an assemblage, the higher the proportion of points that would be classified as arrows.

The relationship between the average on the dart-arrow index and the maximum site defensibility, is much stronger and more statistically significant than the measurements involving the average defensibility. However, I have also noted that the average on the index is also very strongly and significantly negatively correlated with the proportion of arrows ($r = -0.69$, $T = -8.22$, $p < .001$). Given this, it can reasonably be assumed that examinations of the arrow proportion by site and the average value on the dart-arrow index would reflect roughly similar changes and trends. Therefore, I will be using proportion of arrows as the basis for the rest of my analysis, as it is simpler to measure one value rather than two, enabling me to conduct a deeper analysis. While I have attempted to document specific variables where relevant, see Table a.1 of the appendix for a full list of all site components and their relevant data. While both plots (Figure 5.2 a,b) show the data behaving similarly to how the correlation coefficients would suggest, the comparison of proportion of arrows and maximum defensibility shows that there are many sites that do not have any arrows at all. As both arrow and dart points have index values, the plot for the average index value lacks thoe outliers caused by the components with no arrow points, or only arrow points (Figure 5.2 a and b). As obvious outliers have the potential to effect the r values, further analysis may also separate out the site components with 10 or more projectile points, in order to see how the larger sites differ from the overall dataset.

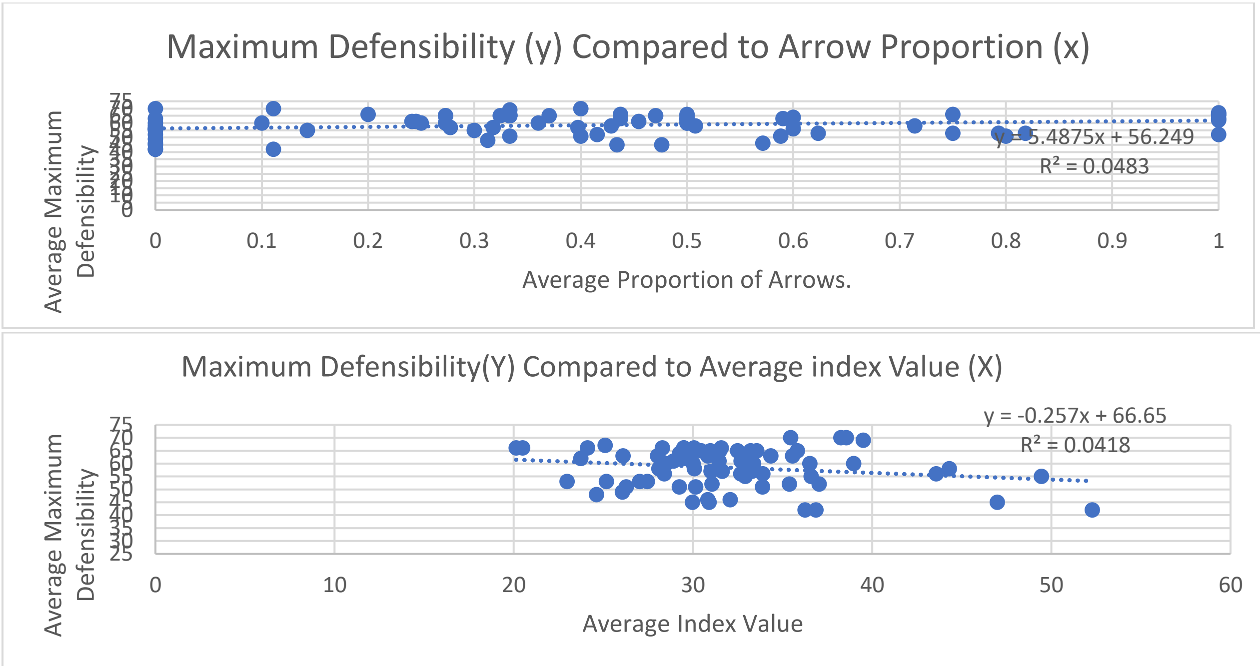


Figure 5.2 a and b. scatter plots of the average maximum defensibility compared against both the proportion of arrows and the average index value for all site components in the dataset.

Chronological Comparisons of the Data. When I examine the data chronologically, I use the same 500-year intervals that Rorabaugh used throughout his analysis of the points, to enable easier comparison of the datasets.

When the proportion of arrows is plotted against the average maximum defensibility over the 500-year intervals used by Rorabaugh, there is no clear single trend of increasing maximum defensibility corresponding to the increase in proportion of arrows. Instead, there are increases and decreases throughout the period of study, some of which coincide with changes in overall arrow proportion (See Figure 5.3).

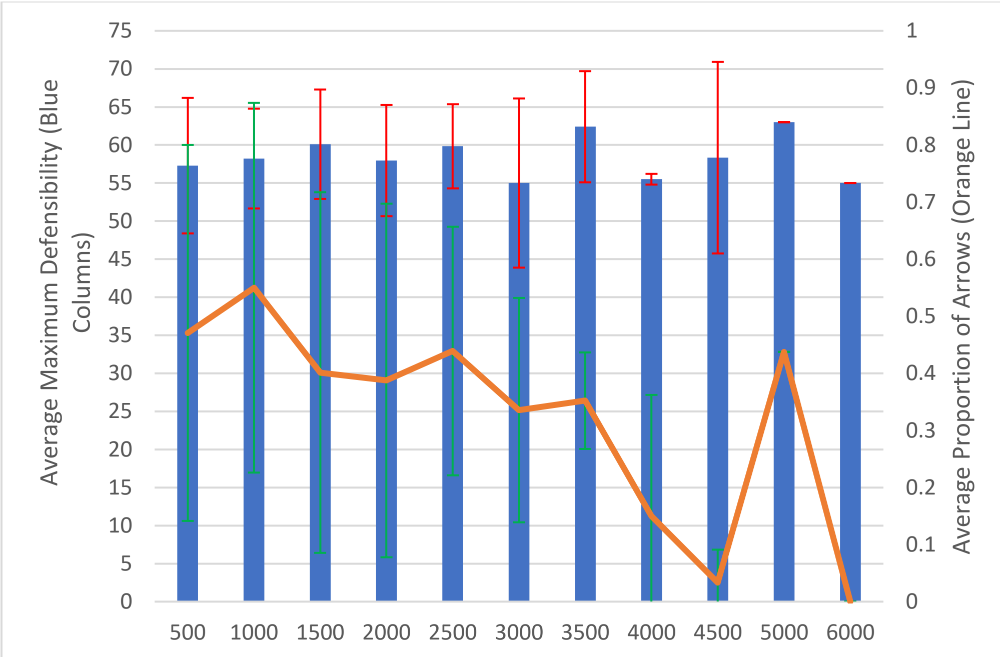


Figure 5.3. average proportion of arrows (orange line), and average maximum defensibility (Blue columns),for all site components in the dataset, by 500-year interval. Error bars are 1 standard deviation for both average arrow proportion and average maximum defensibility.

While the arrow proportion data does show dramatic changes from 6000 to 5000 BP, this is most likely due to the relatively small sample size of both points and sites available from those periods (see Table 5.5) The correlation between average maximum defensibility and average proportion of arrows was still significant when the sites from 4500bp and later were tested (r=0.214,T=1.858, p<.05). In order to measure the impact that outlier sites with relatively few points could have on the aggregated means of the time categories, I filtered out all site components with less than 10 projectile points, and analyzed the trends again (See Figure 5.4). When this was done, all but one of the site components that had only dart or arrow points had been filtered out, meaning that the disproportionate impact of one-or-two-point assemblages was negated. Once the sites with ten or more projectile points were analyzed over time, the direction of change in the average proportion of arrows and average max defensibility still matched each other in 4 out of the 9 transitions between time increments, such as in the 1500ybp-1000ybp period, but this is a clear difference from the matching trend shown from 4000-1500ybp (See Figure 5.3.)

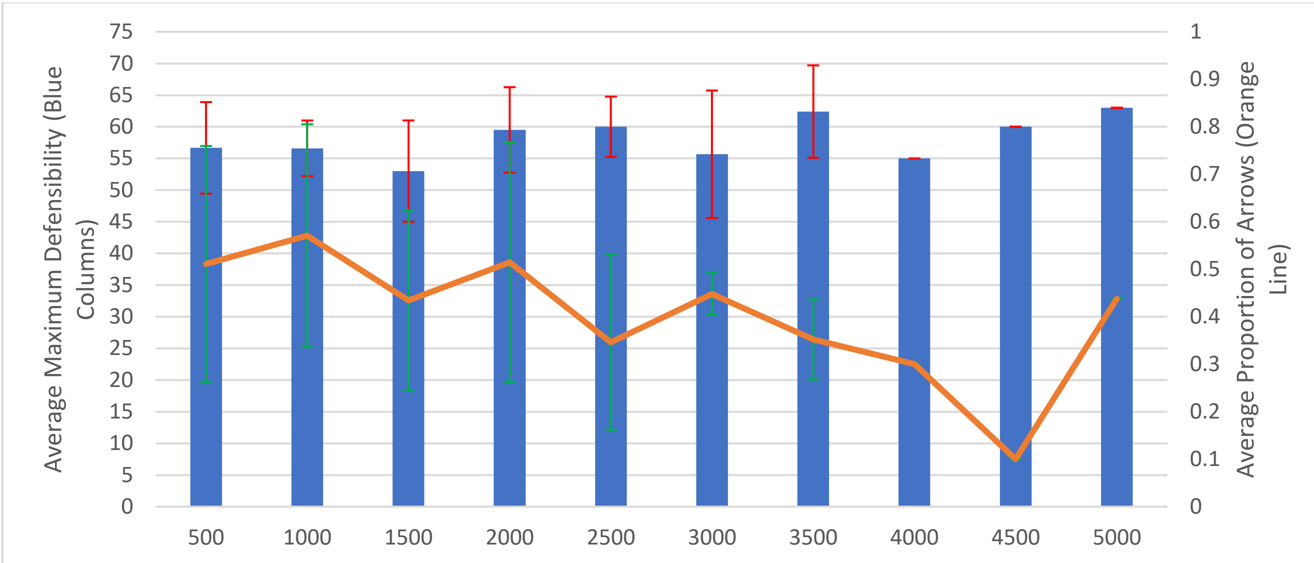


Figure 5.4. *average proportion of arrows (orange line), and average maximum defensibility (Blue columns),for all site components with 10 or more points, by 500-year interval. Error bars are 1 standard deviation for both average arrow proportion and average maximum defensibility.*

Analysis by Cultural Phase. When the relationships between the average proportion of arrows and the average maximum defensibility were graphed according to the cultural phase of the site component, it initially showed that all phases had a positive association between the proportion of arrows and the maximum defensibility. However, many of these sites had a very small number of projectile points, and adding them alongside the data from much larger site components with more points could potentially skew any correlations. n this section I explore the detailed patterns by cultural phase underlying the larger scale patterns noted above. In Figure 5.5 a-d, I show the raw regression relationships, and then the data filtered to remove extreme outliers (assemblages with less than 10 points) in the arrow proportion measure (Figure 5.6 a-d), and summarized in Table 5.7. As can be seen, this changes the relationships substantially. Below I discuss the results in each cultural phase.

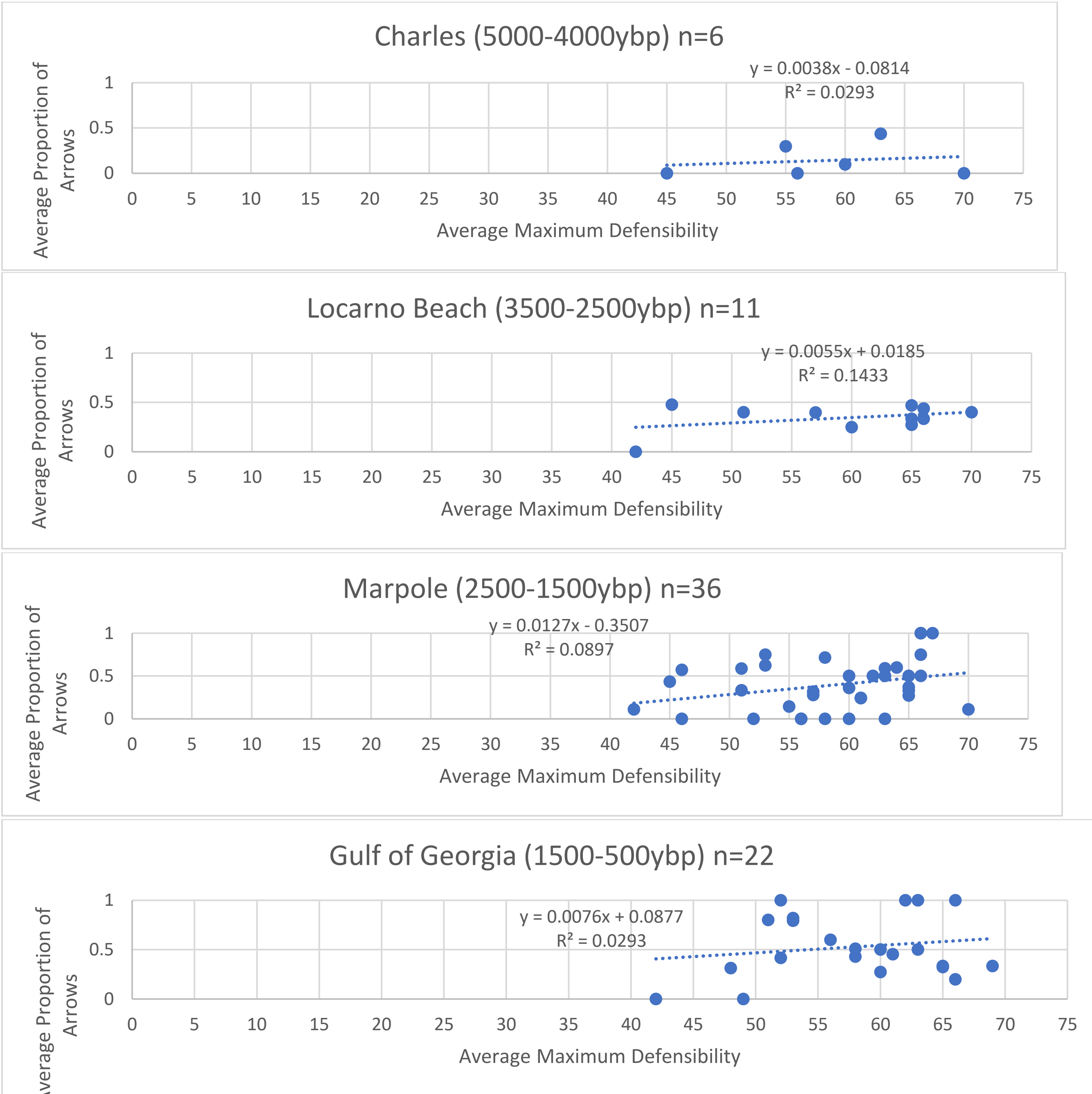


Figure 5.5 a through d. Linear regressions of average maximum defensibility (x) and the proportion of arrows (y), through the four main cultural phases studied.

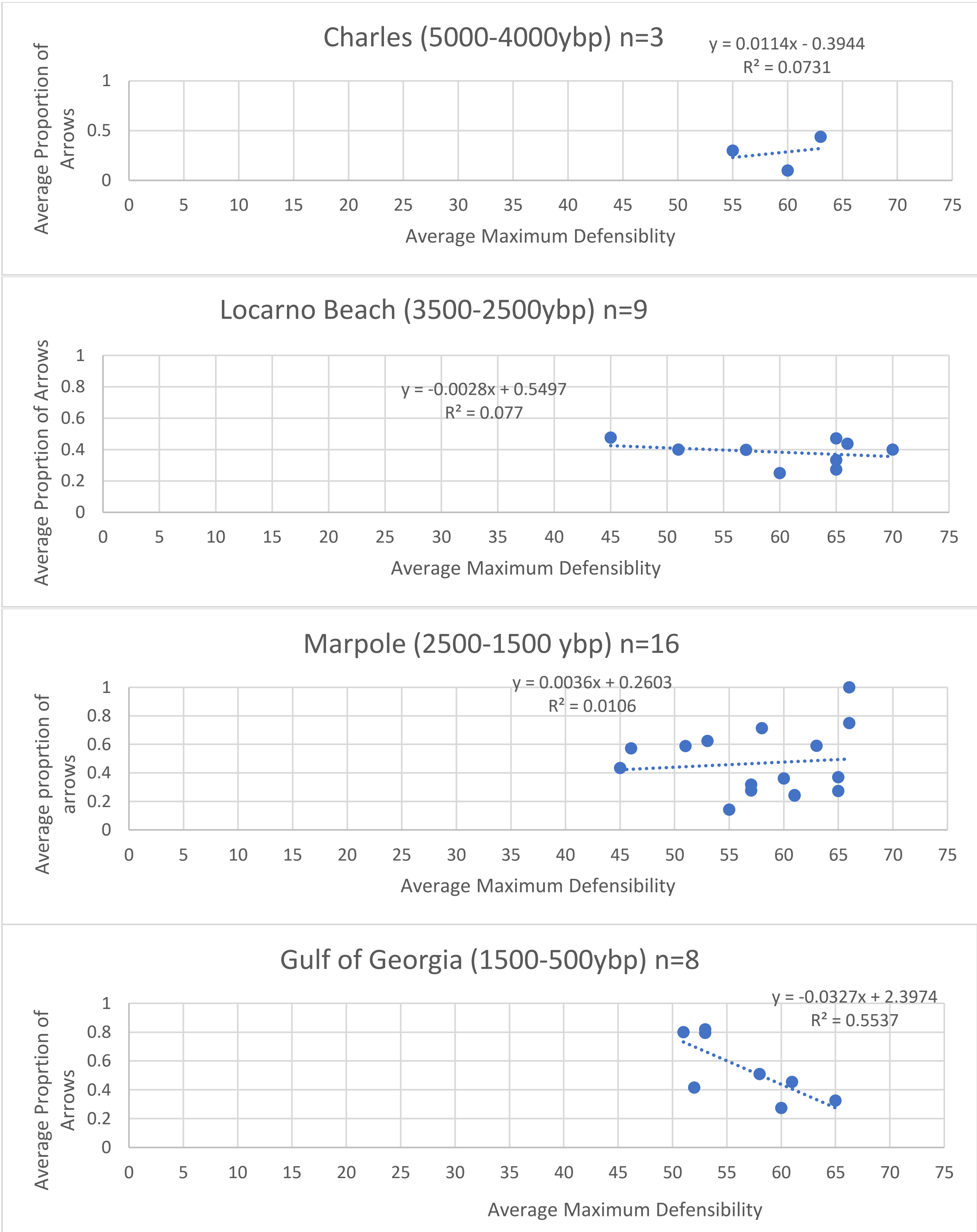


Figure 5.6. a through d. Linear regressions of average maximum defensibility (x) and the proportion of arrows (y), through the four main cultural phases studied, showing only site components with 10 or more projectile points.

Table 5.7. The Correlation Between Arrow Proportion and Maximum Defensibility by Cultural Phase, measuring Sites with 10 or more points.

	R	T Value	Statistical Significance
Overall	-0.167	0.990	0.164
Charles	0.270	0.281	0.399
Locarno Beach	-0.278	0.764	0.232
Marpole	0.141	0.512	0.308
Gulf of Georgia	-0.744	2.729	0.013

The Gulf of Georgia phase is the only phase in which there is a significant relationship between the proportion of arrows and the maximum defensibility, and in this case it is a very sharply negative correlation. The more defensible a site was, the smaller the proportion of arrow points in the related assemblages. As this is the phase that differs from the others, it deserves a closer examination

Comparison of Marpole and Gulf of Georgia

When comparing the maximum defensibilities of the site components with 10 or more projectile points from the Marpole and Gulf of Georgia phases, a t-test reveals that they are not significantly different at a <.05 level. (t= 0.5332, n=24, p=0.3)

There is also no significant difference between the arrow proportions of the two phases (t= -0.799, N=24 p=.216). This would seem to indicate that the Gulf of Georgia's significant relationship between arrow proportions and defensibility comes from a different underlying cause than the existence of the bow and arrow in the Salish Sea region, as the bow and arrow would already have been used in the region for generations.

The difference in behavior that might best account for the changes between the two periods is the growth of large multifamily settlements in the beginning of the Gulf of Georgia phase, along with an overall increase in population (Angelbeck 2009, Croes and Hackenberger 1988). If the inhabitants of the Salish Sea region were living in larger settlements, they would have had larger groups with which to defend themselves. One possible consequence of this change is that the individual choice of weapon was less of a factor in the conflict performance of the overall group. Something interesting to note is that the introduction of the bow and arrow to the Salish Sea region seems to have occurred independently of the adoption of a more materially complex society in the Salish Sea region during the Marpole phase (Clark 2013). The bow and arrow had no significant correlation to defensibility during this period (See Table 5.7), and there was no single linear trend of proportions of arrows during this period (See Figures 5.3, 5.4). That the use of the bow and arrow seems to have been relatively constant during a period where so many other cultural elements changed, is certainly worth noting.

The Gulf of Georgia phase had an exceptionally high negative correlation between the site arrow proportion and the site maximum defensibility. The R squared value suggested that over 50 percent of the decrease in arrow proportion could be accounted for by the increase in maximum defensibility. In addition to this, the Gulf of Georgia phase is the only phase in which there is a significant relationship between the proportion of arrows at a site, and the average maximum defensibility. This is a clear contrast to the sites from other phases, and could be representing the effects of some as of yet unknown phenomena. When comparing the site components with ten or more projectile points against the other sites from that period, two things are immediately notable. As there was only one site component from the 1500ybp interval that was part of the Gulf of Georgia phase, and this component had less than 10 projectile points associated with it (See Table 5.8), the measured components are all within the 1000ybp and 500ybp intervals. This means that there are no site components from the immediate transition from the Marpole to Gulf of Georgia phase, only from later periods.

Table 5.8. The site components from the Gulf of Georgia phase, showing their 500ybp time increment and if they had 10 or more projectile points.

500ybp interval	Less than Ten Points	Ten or More Points
500	4	3
1000	9	5
1500	1	

In addition to this, all of the components from the northwest Washington subregion had less than 10 projectile points, meaning that sites from this region were not measured in this analysis. The majority of the site components measured in this period were Island subregion sites (See Table 5.9), located in San Juan and Gulf Islands (See Table 5.10), areas where the average arrow proportions in assemblages are lower than those in the Puget Sound subregion (See Table 5.11). Perhaps, due in part to a higher reliance on marine resources compared to terrestrial hunting, which is one of the main areas where the bow and arrow replaced the thrown spear or dart.

Table 5.9. The site components from the Gulf of Georgia phase, showing their local landform type and if they had 10 or more projectile points.

Site Landform Type	Less than Ten Points	Ten or More Points
Island	7	5
Mainland Coastal	6	1
Mainland River	1	2

Table 5.10. The site components from the Gulf of Georgia phase, showing their geographic location by subregion and merged region, and if they had 10 or more projectile points.

Merged Regions and Subregions	Less than Ten Points	Ten or More Points
Islands	**6**	**5**
Gulf Islands	4	2
San Juan Islands	2	3
Northern Mainland	**7**	**1**
Fraser Valley	1	1
NW Washington	6	
Puget Sound	**1**	**2**

Table 5.11. Average arrow proportion and average maximum defensibility of site components from the Gulf of Georgia phase with 10 or more projectile points, divided by subregion.

Subregion	**Average of Max Defensibility of the site**	**Average of Proportion of points considered arrows**
Fraser Valley	58 (Single Site) (N=1)	0.508 (Single Site)
Gulf Islands	51.5 (stdev 0.7) (N=2)	0.608 (stdev 0.27)
Puget Sound	53 (stdev 0) (N=2)	0.806 (stdev 0.02)
San Juan Islands	62 (stdev 2.65) (N=3)	0.351 stdev 0.09)

Given the increase in population of the overall Salish Sea region during the Gulf of Georgia Phase (Croes and Hackenberger 1988), there would have been extra pressure placed on competition for food resources, and thus local reliance on points best suited to food gathering. Conversely, this could also reflect a local change to the primary use of bone points for arrows, meaning that the analysis of only lithic points would not be able to show the entire spectrum of tool-usage in this period. Further analysis of this period would be best done comparing both lithic and bone assemblages at the same time, in order to determine if there are gaps in one dataset that can be explained by the other.

Geographic Analysis of Point Distribution

As noted above, I analyzed the distribution of point types according to division between the local landform type of the site, and the subregion of the broader Salish Sea region that the site was associated with. By comparing the local site landform type, I hoped to determine if there was a pattern in the types of points that could be associated with specific landforms, possibly due to the different activities conducted in different areas, such as terrestrial hunting at inland sites or the hunting of marine mammals at coastal or island sites. In examining subregions, I hoped to potentially gain greater insight in how different groups across the Salish Sea region related their choices in projectile points to the multiple landform types of their local environment.

Proportion of Arrows by Local Site Geography. The most notable changes when examining point proportions by site geography are that mainland river sites show-a substantial increase after 1500 BP (see Figure 5.7 a and b). Mainland coastal sites showed a roughly constant proportion of arrow points throughout the periods in which they are documented, with a few outliers. Mainland inland sites show a substantial increase after 2500, and then disappear from the data set entirely. This could simply be a reflection of the available sites in the area, as these two sites, SN100 and the Marymoor park sites, are the only sites in the dataset used by Rorabaugh that are a significant distance away from the somewhat open waters of the Salish Sea region.

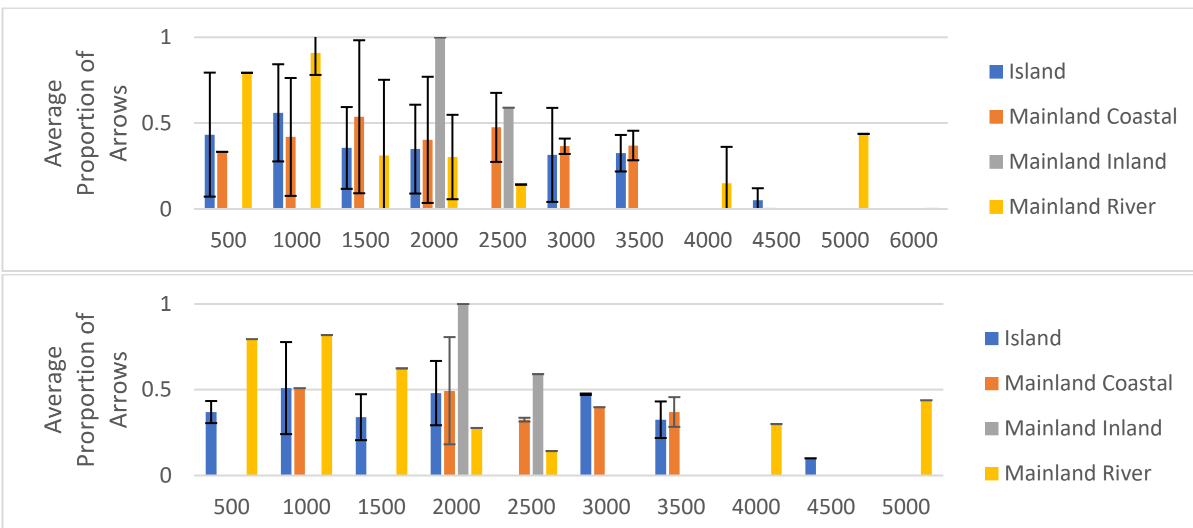


Figure 5.7a and b. *Average proportion of arrow points over time by the local geography of the site, expressed in 500ybp intervals, both the whole of the dataset (a) and the sites with 10 or more points (b). Error bars are 1 standard deviation.*

The only major outlier to the trend of arrow points increasing across the period of study is the presence of points assigned as arrows prior to the hypothesized introduction of the bow and arrow to the Salish Sea region at 3500 (Rorabaugh and Fulkerson 2015). Rorabaugh claimed these points to be fletched darts (Angelbeck and Cameron 2014; Hughes 1998), citing Hughes' (1998) assertion that fletched darts could use smaller heads, and thus be included as arrow points when using an index that does not account for this. Given this, it is understandable to assume that the earlier points in the assemblage are fletched darts, although this is one of the areas where a further refinement of the index would be most welcomed. Rorabaugh's reference to Hughes (1998) may well be appropriate, although the very fact that this is something that, absent of any other information, would mean that the measurement method could only be effectively used in an area with a long record of ethnographically or wet-site associated point types with clear differentiation between arrows and fletched darts or other transitional technologies. As this assumption has been imbedded in the data collected by Rorabaugh, I have carried forward using it in my analysis, but this is something that I really believe needs to be more thoroughly discussed.

In any case, disproportionately small sample sizes from this period mean that this is a discussion of 11 projectile points from 3 site components. It is unlikely that a feasibly large sample size could be compiled to differentiate fletched darts from arrows given currently known point assemblages. While this data does show dramatic changes from 6000 to 5000 BP, this is most likely due to the relatively small sample size of both points and sites available from those periods, as mentioned earlier (see Table 5.2).

I ran an ANOVA test for the average proportion of arrows by local site geography. The ANOVA test for this information returned a p value well in excess of 0.05,(see Table 5.12) meaning that overall variation in the proportion of arrows by local site geography was not statistically significant. This supported by another test of the data, which discounted the data of the Mainland Inland sites, and the sites from prior to 3500bp, and further reinforced by the testing of the filtered components with 10 or more points (See Table 5.13 a and b). All yielded no significant relationships.

Table 5.12. The means, standard deviations and errors, and ANOVA test results for the average proportion of arrows by site local geography.

	N	Mean	SD	SE	
Island	33	0.379	0.272	0.047	
Mainland Coastal	27	0.408	0.290	0.056	
Mainland Inland	2	0.795	0.290	0.205	
Mainland River	14	0.380	0.341	0.091	
ANOVA Summary	DF	SS	MS	F	P
Between	3	0.335	0.112	1.306	0.279
Within	72	6.148	0.085		
Total	75	6.483			

Table 5.13 a and b. ANOVA test of the filtered data from Table 5.6, both the whole dataset (a) and the components with 10 or more points (b).

	N	Mean	STDev	Stderror	
Island	31	0.4	0.267	0.048	
Mainland Coastal	26	0.424	0.283	0.056	
Mainland River	10	0.459	0.357	0.113	
ANOVA Analysis	DF	SS	MS	F	P
Between	2	0.028	0.014	0.168	0.846
Within	64	5.295	0.083		
Total	66	5.323			

	N	Mean	STDev	Stderror	
Island	17	0.437	0.165	0.04	
Mainland Coastal	9	0.406	0.139	0.046	
Mainland River	5	0.531	0.306	0.137	
ANOVA Analysis	DF	SS	MS	F	P
Between	2	0.052	0.026	0.751	0.481
Within	28	0.965	0.035		
Total	30	1.017			

These results are perhaps unsurprising, given that different groups would use sites in more than one area of local geography, meaning that the tool technologies of a given group would have the potential to be distributed across an area covering multiple landform types. A more effective use of this method might be in the analysis of vastly different geographic areas, such as the Columbia Plateau compared to the Salish Sea region.

I ran a series of regressions between the projectile point counts and the arrow proportions by cultural phase to examine the effect of sample size on arrow proportion. In the Charles and Locarno Beach phases, the average proportion of arrows increased with sample size, while the average proportion of arrows decreased with sample size in the Marpole and Gulf of Georgia phases (Table 5.14).

Table 5.14. *Regression results between the number of projectile points associated with a site component and the proportion of arrow points at that component, separated by cultural phase.*

Cultural Phase	Linear regression results of sites with >=10 points
Charles	$\hat{y} = 0.03958X - 0.19583$ (n=3)
Locarno Beach	$\hat{y} = 0.00038X + 0.36789$ (n= 9)
Marpole	$\hat{y} = -0.00056X + 0.51223$ (n= 16)
Gulf of Georgia	$\hat{y} = -0.00232X + 0.6491$ (n= 8)

In the case of the Charles phase This could simply be a reflection of the relatively small amount of both points and site components in the Charles phase, as the filtering of sites with less than ten points halved the available number of sites to analyze, and all of the filtered out sites lacked 'arrow' or alleged fletched dart points (Table 5.15).

Table 5.15. Site components from the Charles phase, with the number of projectile points and the proportion of arrow point value.

Site component	Number of Points	Proportion of points considered arrows
45WH34-1	16	0.4375
DeRt2-2	10	0.1
DfRu8-1	5	0
DgRr1-1	1	0
DgRr2-2	1	0
DgRr6-2	10	0.3

Regardless, this shows that the projectile points of the Charles phase warrant further study, in order to determine the validity of claims that the small points represented are in fact fletched dart points, or if the projectile point timeline needs to be reassessed. If these points are in fact arrow points, their almost complete absence after 5000 and before 3500ybp needs to be addressed. In doing so, it must be kept in mind that lithic points were only one of the forms of point technology used in the Salish Sea region, and it is possible that any gapes in the lithic record could potentially be explained by the adoption of a corresponding set of bone points. Regardless, further dated lithic points would be quite useful in providing greater context.

Proportion of Arrows by Merged Region*.* I chose to merge the Gulf Island sites and the San Juan islands sites into one larger group, as well as the Fraser delta sites and the Northwest Washington sites into one larger group, due to the geographical proximity and similarity of the regions, combined with the relatively small sample sizes for some of these regions, Northwest Washington in particular (see Table 5.5). By doing this, I hoped to provide a more comprehensive analysis of the regions. Sites from the Puget Sound have a higher proportion of arrows, than do sites from other regions. However, there are still more points overall from the sites in other regions (see Table 5.5). The other regions, while there are occasional increases in the average arrow proportion, never reach the same level as the percentages from the Puget Sound Region (Figure 5.8).

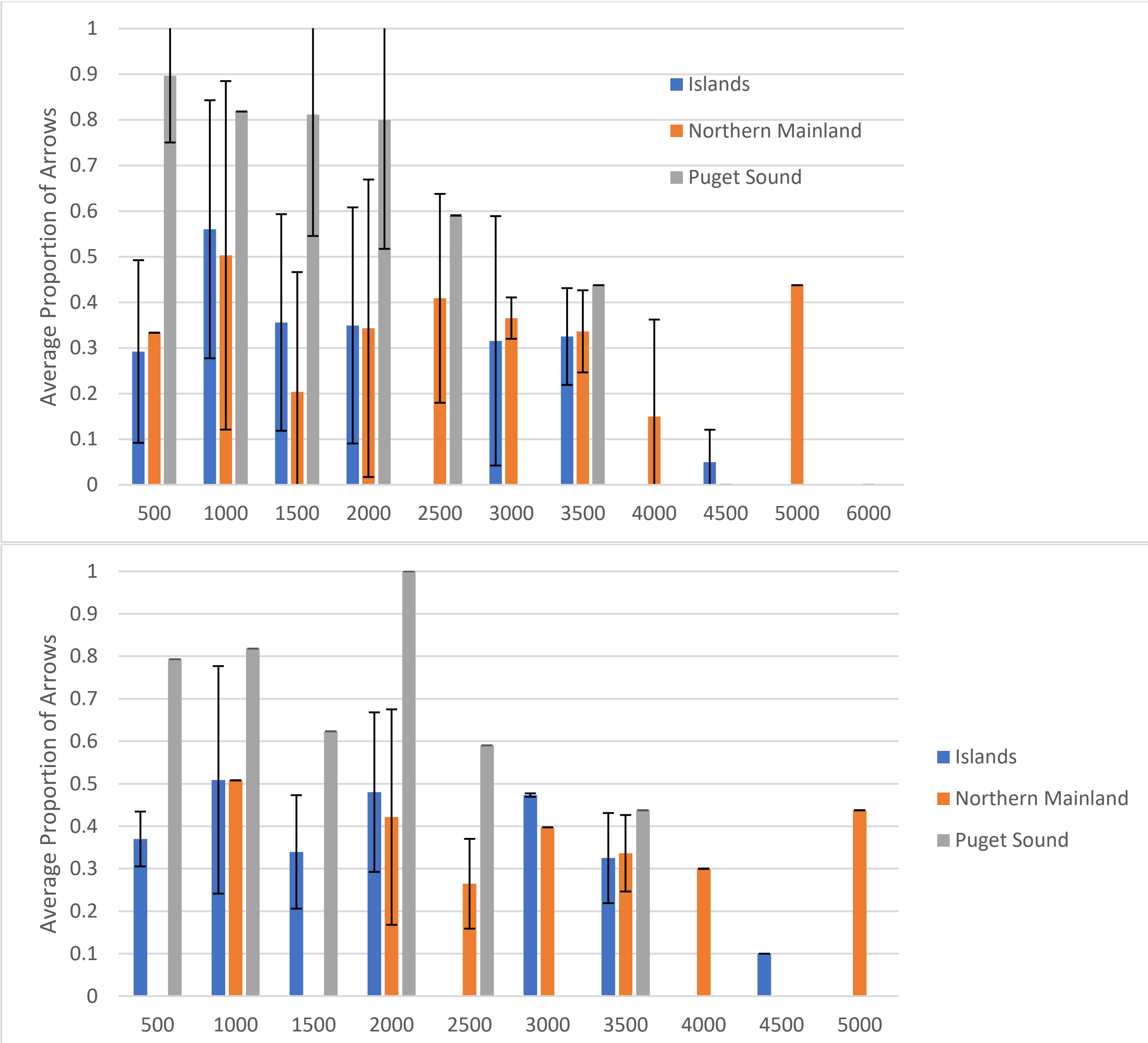


Figure 5.8 a and b. *Average arrow proportion by time and region: all phases. both the whole of the dataset (a) and the sites with 10 or more points (b). Error bars are 1 standard deviation.*

The difference in point proportions is even more noticeable when comparing the Puget Sound region to the rest of the Salish Sea region in aggregate (Rest Of the Salish Sea: ROSS)(Figure 5.9a and b). While there was some variance in the values of the ROSS throughout the period of study, the ROSS arrow proportions never exceed those of the Puget Sound subregion. A t-test between the regions was significant at a 0.05 level (t=4.39. N=76 *p*=<.001). I tested two more times, testing first only the means from 3500bp and onward, the periods in which I have data from both areas, and then from 2500bp and onward, the period in which I have an uninterrupted series of data from both areas.

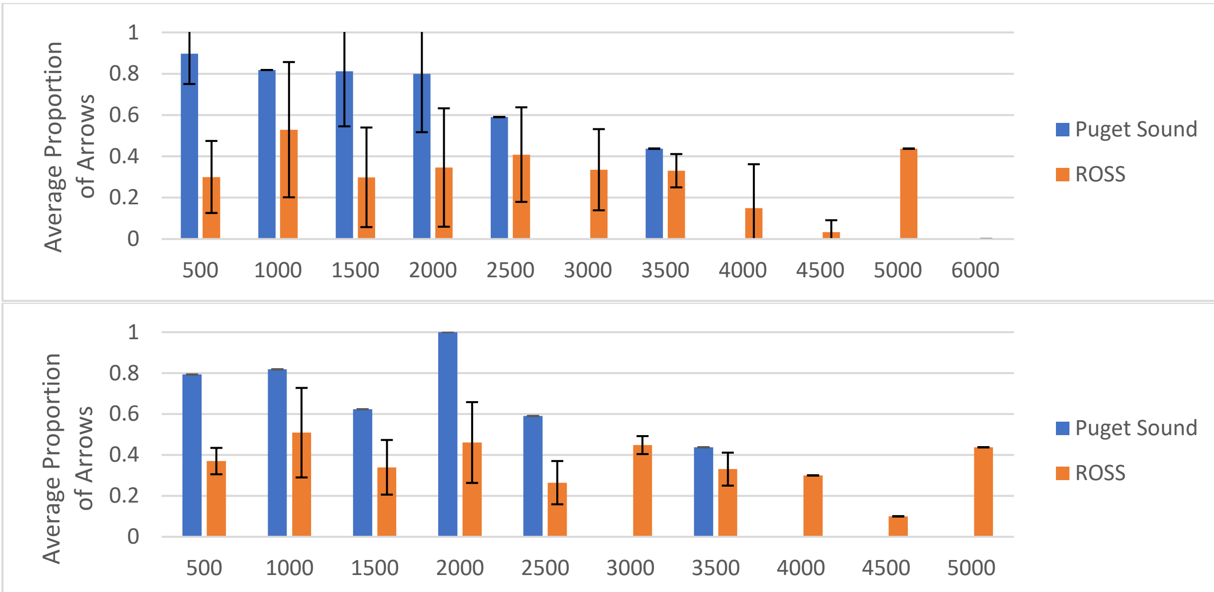


Figure 5.9 a and b. *Puget Sound and ROSS Arrow proportions: all phases, both the whole of the dataset (a) and the sites with 10 or more points (b). Error bars are 1 standard deviation.*

The results for the 3500bp test were (*t=4.125, n=67 p- <.001)* The results for the 2500bp test were (*t*= 4.023, n=57 *p*=<.001). Both results were significant at .05, indicating among other things that this difference was not due to a difference in sample sizes among the subregional datasets. In addition, when the whole dataset was tested again after filtering out the components with less than 10 projectile points, it remained significant (*t*= 4.105, N=36, *p*=<.001). this significance remained when filtering out the sites from prior to 3500ybp (*t*=3.933, N=33, *p*=<.001) and 2500ybp (*t*=3.835 N=25 *p*=<.001) These results indicate that there is a clear and significant regional difference between the Puget Sound and the other combined subregions of the Salish Sea region.

Arrow Proportions by Cultural Phase. I conducted pairwise t-tests of each of the main cultural phases represented in the dataset, the Charles, Locarno Beach, Marpole, and Gulf of Georgia phases, in order to determine if there was a significant difference in the projectile points of the three phases (Tables 5.16 and 5.17).

Table 5.16. T-tests comparing the proportion arrow for the site components of the main cultural phases of study.

Phase and years BP	Charles and Locarno Beach	Locarno Beach and Marpole	Marpole and Gulf of Georgia
t-test results	t=-2.59 n=17 p=.01	t=-0.56 n=47 p=.29	t=-1.60 n=58 p=.058

Table 5.17. T-tests comparing the proportion of arrows for the ROSS site components of the main cultural phases of study.

Phase and years BP ROSS	Charles (5000-4000) and Locarno Beach (3500-2500)	Locarno Beach (3500-2500) and Marpole (2500-1500)	Marpole(2500-1500) and Gulf of Georgia(1500-500)
t-test results	t=-2.38 n=14 p=.016	t=-0.033 n=39 p= .49	t=-1.67 n=48 p= .051

The only t-test which showed a significant difference in proportion of arrows was the test between the Charles and Locarno Beach Phases (See Table 5.15). This corroborates Rorabaugh and Fulkerson's (2015) date of 3500bp as the introduction of the bow and arrow to the Salish Sea region. However, due to the very small sample size of points and site components in the Charles phase it is uncertain exactly how strongly this conclusion should be supported.

Given the previously noted difference in the Puget Sound subregion compared to the ROSS, I performed these t-tests again, filtering out the assemblages from the Puget Sound subregion (see Table 5.16).

While the results do support Rorabaugh's conclusion of the introduction of the bow and arrow taking place roughly in 3500bp, it also may call into question exactly how much the data from the Charles phase can be relied on. The relationship between the Charles and the later phases is being extrapolated from a small handful of points compared to the later phases. While this relationship might hold up given the inclusion of further points in the dataset, it also might produce results similar to later phases. The lack of dated pre-3500bp points among the compiled points from the Puget Sound subregion in particular is quite troubling given the dramatic difference in the proportion of arrows in the assemblages. Documentation of earlier sites and assemblages would be very welcome in determining if the subregional differences in projectile point usage were also prevalent prior to the introduction of the bow and arrow to the broader Salish Sea region.

Analysis of Site Defensibility

Much like with the projectile point assemblages, I analyzed the relative site defensibility by both the local site landform type, and the specific subregion of the Salish Sea region that site was associated with. One additional complication with the measurement of site defensibility is that sites could have multiple periods of occupation, potentially skewing the weight of averages over time in their favor. As the points associated with a site could change while the defensibility of the site did not, it was worthwhile to analyze sites both in aggregate and only examining their first component, so as to better see the effects of multicomponent sites.

Analysis of the Defensibility of the Site First Occupation Periods. The previous analysis of the data was undertaken without regard for the effect that sites with multiple phases of occupation; i.e. multiple point scores against a single set of defensibility values would have on the overall correlation. Multiple point assemblages would be compared against a single defensibility values, despite the possibility that human modification of the site during its periods of occupation, such as the addition of trench embankments, would have changed the overall defensibility of the site, something that would not be accounted for under Bocinsky's (2014) method as it would not directly impact the elevation or sightlines of the site. Therefore, I narrowed down the dataset to include only the point assemblages that were the oldest recorded for the site. This would have the effect of showing the material culture that was in use during the first occupation of the site, and if/how the material culture of the time impacted the choice of location for settlements. Examining only the earliest component eliminated 33 components from the dataset, leaving 43 components to compare (Figure 5.10). One of the clearest patterns in this data is that the removal of later components removes some of the site components that have the largest impact on the overall proportion of arrows for their given 500 year interval. For the 500bp, 1000bp, and 1500bp categories, more sites are removed from the dataset than are retained.

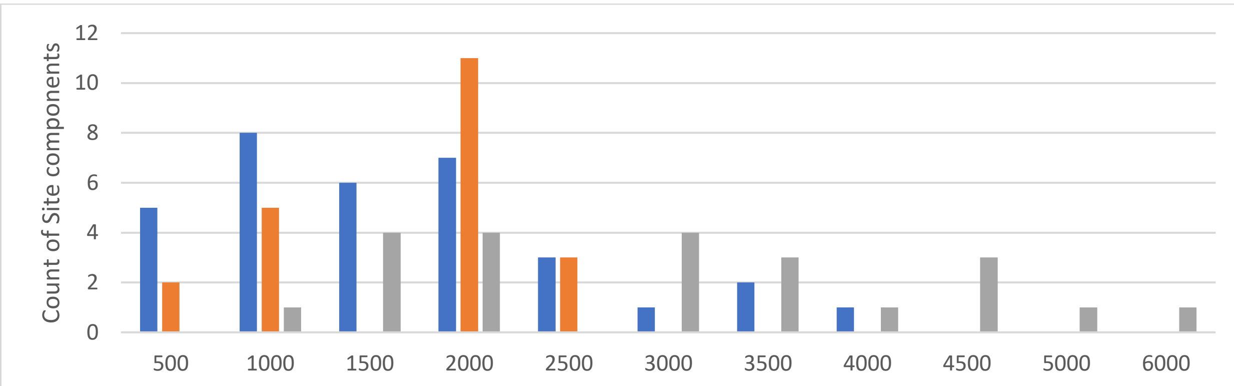


Figure 5.10.
Counts of single vs multicomponent sites by 500-year interval
Orange = singe-phase sites, Gray = first phases of multicomponent sites, Blue = subsequent phases of multicomponent sites

This means that the analysis of defensibility of later phases has the potential to be skewed by outliers more easily than the earlier phases, due to fewer sites being analyzed. This would also imply that outside of direct correlations, proportion of arrows and average maximum defensibility are best analyzed in two different ways. Analyzing components of the first occupation period only for a given site works for defensibility, because the defensibility will not change over subsequent components. Conversely, the proportion of arrows will change, and thus all assemblages could be included without potentially skewing the data.

Analysis by Site Landform Type. I classified site components into categories based on their local geography. These categories were:

1.) Island sites,
2.) mainland coastal sites, defined as being directly adjacent to the Salish Sea,
3.) mainland river sites, sites that bordered a major river but not the Salish Sea, including sites in the Fraser River Delta, and
4.) Inland sites, those with no direct access to a navigable body of water.

One complication found using this data was the very small and incomplete sample sizes involved. There were only 2 mainland inland sites in the whole assemblage, and seven mainland river sites (Table 5.18).

Table 5.18. Sample size of earliest components within my landform categories, as separated by 500 year intervals per Rorabaugh (2015).

	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**	**6000**	**Total**
Island	2	1	3	6		2	1		2			17
Mainland Coastal		5		5	2	2	2		1			17
Mainland Inland				1	1							2
Mainland River			1	3				1		1	1	7

The only interval of time with examples of all four landform categories was 2000 BP, making it difficult to draw broader conclusions from the defensibility data in this manner (Figure 5.11 a and b).

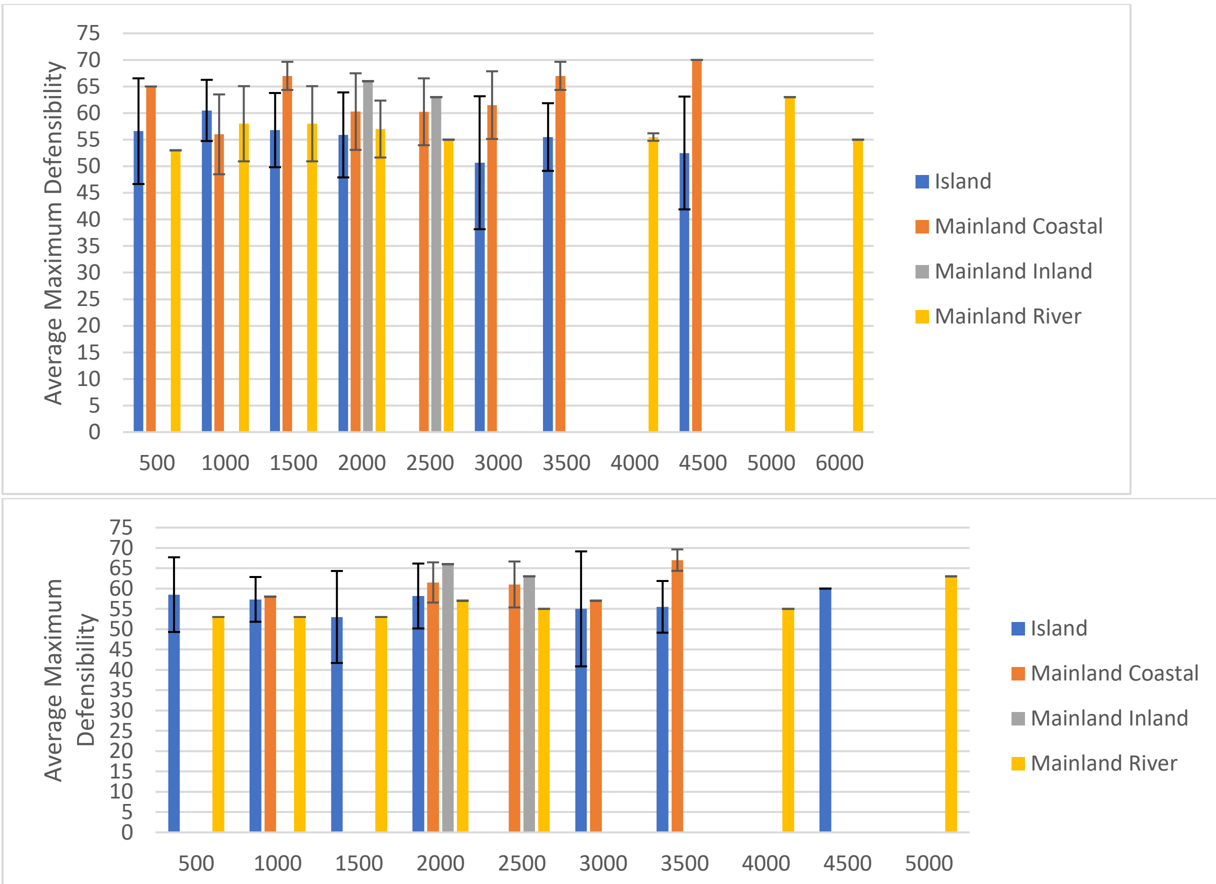


Figure 5.11a and b. Average maximum site defensibility over time by site geography, both the whole of the dataset (a) and the sites with 10 or more points (b). Error bars are 1 standard deviation.

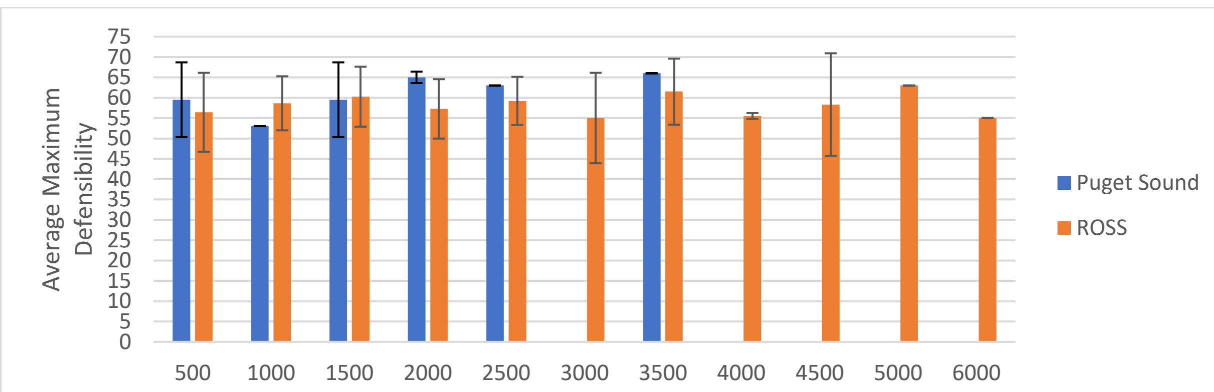
I ran an ANOVA test to see whether the data would show a clear difference in the defensibility of the landforms. This test returned a p value of >0.05, as did a subsequent test of only the components with 10 or more points (see Table 5.19 a and b). This, combined with the issues of sample size, leads me to conclude that there are no clear patterns of change over time due to there being no clear statistically significant differences. This was backed up by my performing another t-test, this one measuring the mainland inland sites compared to all of the other categories (t=. 1.222 n=43 p=.114). This test showed no significant difference between the average maximum defensibility of the mainland inland sites and those bordering a large body of water. One final t-test was conducted between the three categories of mainland site and island sites. The results of this test (t= -0.618 n=43 p= .270) show that there was not a significant difference between island and mainland sites. An ANOVA test of only the 2000bp category components was not possible due to there only being one mainland inland site in this category. While the site in question had a higher defensibility rating than the mean ratings of the other three categories, a larger sample size of Mainland Inland sites could reveal if this is an outlier or not.

Table 5.19 a and b ANOVA test results for the average maximum defensibility as divided by site local geography, both the whole of the first occupation components (a) and the site components with 10 or more points (b).

	N	Mean	STDev	Stderror	
Island	17	57.647	7.905	1.917	
Mainland Coastal	17	59.235	7.504	1.820	
Mainland Inland	2	64.5	2.121	1.5	
Mainland River	7	57	4.865	1.839	
ANOVA Analysis	DF	SS	MS	F	P
Between	3	109.302	36.434	0.694	1.194
Within	39	2047.429	52.498		
Total	42	2156.731			

	N	Mean	STDev	Stderror	
Island	7	58.571	7.367	2.785	
Mainland Coastal	5	60.8	4.324	1.934	
Mainland Inland	2	64.5	2.121	1.5	
Mainland River	3	57.667	5.033	2.906	
ANOVA Analysis	DF	SS	MS	F	P
Between	3	73.378	24.459	0.698	0.570
Within	13	455.680	35.052		
Total	16	529.058			

Defensibility of the Puget Sound subregion versus the ROSS. The Puget Sound subregion appeared to have an average maximum defensibility over time that varied in some ways from ROSS (see Figure 5.12 a and b). this is backed up by a t-test of the components form the first phase of occupation of all sites that showed there was a significant variation in the average maximum defensibility between the two regions (t=1.69948. n=43, p=.049) However, there are no clear patterns of change over time for either the Puget Sound or the ROSS (Figure 5.12 a and b), meaning that this analysis does not show any single linear trend over time.



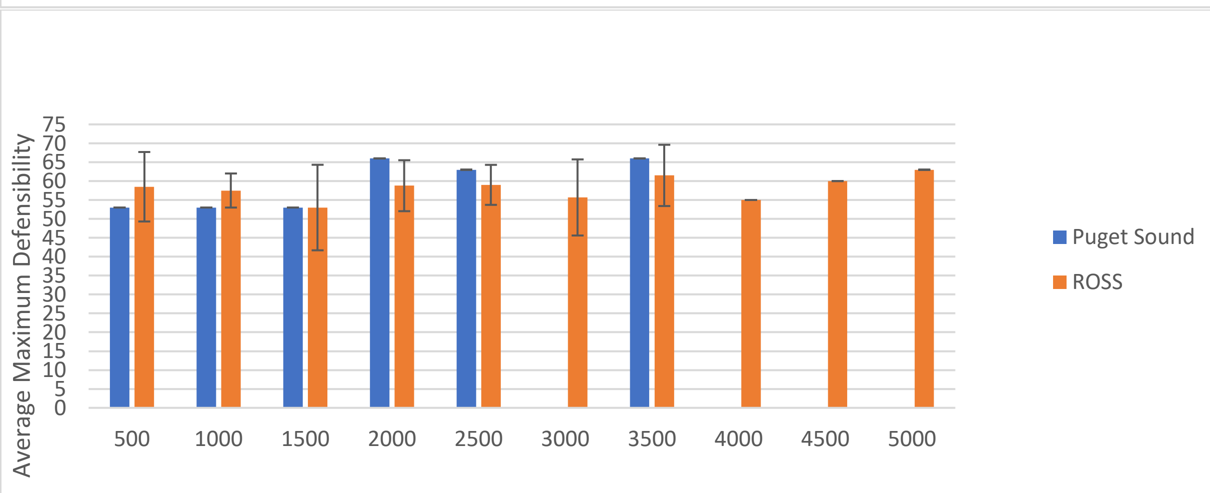


Figure 5.12 a and b. *Average Maximum Site Defensibility over time, comparing the Puget Sound Region against the Rest of The Salish Sea (ROSS) , both the whole of the dataset (a) and the sites with 10 or more points (b). Error bars are 1 standard deviation.*

Given the small sample size of Puget Sound subregion sites (see Table 5.20), these significant differences could simply be reflecting the values of individual outliers rather than a group of sites showing a broader trend. A larger sample of Puget Sound Site components would be very helpful in determining the extent of the variation compared to the ROSS.

Table 5.20. Sample size of earliest components within Rorabaugh's (2015) regions and my merged regions. Rorabaugh's regions are shown as subsets of my three merged regions.

Geographic setting	**Count of site components**
Total ROSS	**37**
Islands	**16**
Gulf Islands	8
San Juan Islands	8
Northern Mainland	**22**
Fraser Valley	12
NW Washington	9
Puget Sound	**6**
Puget Sound	6
Grand Total	**43**

Site Defensibility by Cultural Phase. I examined the defensibility of sites by grouping them according to their earliest occupied phase into the three main cultural phases covering the period of study, the Locarno beach, Marpole, and Gulf of Georgia phases. The Archaic and Charles phases were omitted from the latter study due to low sample size of sites, leaving only the Locarno beach, Marpole and Gulf of Georgia phases. The ANOVA tests showed that there was not a significant variation between the average maximum defensibility of the three periods in study, this was supported by another ANOVA test which only measured the sites with 10 or more points and showed a similar result (see Table 5.21 a and b.)

Table 5.21 a and b. *ANOVA test results for the average maximum defensibility across cultural phases, both the whole of the dataset (a) and the site components with 10 or more points (b).*

	N	Mean	STDev	STDerror	
Locarno Beach	7	58.857	9.371	3.542	
Marpole	22	58.682	6.335	1.351	
Gulf of Georgia	8	57.875	7.809	2.761	
ANOVA Analysis	DF	SS	MS	F	P
Between	2	4.684	2.342	0.044	0.957
Within	34	1796.511	52.839		
Total	36	1801.195			

	N	Mean	STDev	Stderror	
Locarno Beach	9	60.444	8.095	2.698	
Marpole	16	58.063	6.688	1.672	
Gulf of Georgia	8	56.625	5.097	1.802	
ANOVA Analysis	DF	SS	MS	F	P
Between	2	64.6	32.3	0.704	0.503
Within	30	1377.037	45.901		
Total	32	1441.637			

Given this data, it is clear that the average maximum site defensibility did not change in a statistically significant manner across these periods. It is possible that the lack of any major long term change in defensibility could be an indication of either a reliance on landscape modifications such as fortifications which have not been archaeologically preserved, or that a location's defensibility was much less of a priority than other factors such as the location of resources such as salmon runs and clam beds, as well as access to travel routes throughout the region. A certain level of vulnerability in the location of villages and other activity areas may have been an acceptable price to pay in exchange for access to the resources that would have allowed individuals and groups to survive and gain status through means other than conflict.

Chapter Six: Conclusions

While analysis of the aggregated assemblages and site components showed a correlation between high proportions of arrows and high site defensibility (see Table 5.6), this was not the case when only the assemblages with 10 or more projectile points were measured. The t-tests conducted with the point assemblages indicate that the bow and arrow was likely introduced in the Locarno Beach phase (see Table 5.16), while the only phase that showed any significant relationship between proportion of arrows and maximum defensibility was the Gulf of Georgia phase (see Table 5.7), and it was negative. This would seem to indicate that the introduction of the bow and arrow to the Salish Sea region had no direct impact on site defensibility in the Salish Sea region. In addition, analysis showed that there was no meaningful difference in either average maximum defensibility or average proportion of arrows as separated by local site geography (see Tables 5.12 a and b, 5.19 a and b).

Once the site components with less than 10 projectile points were filtered out, the Gulf of Georgia was the only phase with a significant association between defensibility and the average arrow proportion, with high maximum defensibility being strongly associated with low proportions of arrow points from associated assemblages. The increase in defensibility and the decrease in proportion of arrow in the Gulf of Georgia phase could be seen as a reflection of changes in social organization and the increase in regional population of the Gulf of Georgia phase and leading up to ethnographic reports of contact (Croes and Hackenberger 1988, Angelbeck 2009). If more defensible constructions were made in more defensible locations, there would be less of a need to rely heavily on weapons such as the bow and arrow that were more efficient in intergroup conflict. However, as the association in the Gulf of Georgia phase is primarily caused by three site components in the San Juan islands that had high defensibility and low proportions of arrows, this may instead be a reflection of the higher proportion of marine resources that these sites would have access to, and the existing, non-arrow tools used to harvest these resources. It may be worthwhile to conduct a more thorough study of defensibility on a subregional basis, in order to see if there were changes that did not carry over throughout the broader Salish Sea region.

In addition, the drastically differing point proportion results that have been gathered from the Puget Sound as compared to the rest of the Salish Sea region suggests that more emphasis be put on the analysis of the Puget Sound as a subregion when conducting analysis of the Salish Sea as a whole. Previously, analysis of the Puget Sound region has been used as part of a broader analysis of the Salish Sea region as a whole (e.g. Angelbeck (2009), with some exceptions such as individual site reports (Campbell 1981, Chatters 1988, Lewarch et al. 2002,) and the documentation of point sequences such as that conducted by Croes et al. (2008), as well as Carlson and Magne (2008). Much of the data that specifically examines the Puget Sound region on a broader basis is quite old, (Bryan 1955, 1963, Smith 1907), meaning that newer research projects were not included in the subregion-level analysis.

Any further studies of the Salish Sea region that involve the analysis of sites from the geographic subregions mentioned above, such as the Fraser Delta, San Juan Islands, or Puget Sound should follow a similar pattern to Rorabaugh's (2015) research, where the data points from different subregions could be differentiated from each other for the purposes of ascertaining if any major changes in the aggregated data were caused by the disproportionate impact of one subregion in particular, rather than the broader Salish Sea region as a whole. By differentiating the subregions in this manner, it will allow for analysis on both a regional and sub-regional scale, giving more flexibility in the answering of research questions.

The Puget Sound as a unique subregion within the Salish Sea region

The statistically significant difference in point proportions in the Puget Sound subregion compared to the rest of the Salish Sea (see Figure 5.9 a and b) may indicate that the tool use practices of the peoples of the Puget Sound region were different enough from that of their northern neighbors to result in significant differences in their use of projectile points. While this conclusion cannot be definitely assumed to apply for bone and lithic points, if an area has arrow points of one material, it can indicate that the baseline arrow technology was able to be used with point types not directly shown in the archaeological record.

These inter-subregion differences may simply indicate that the bow and arrow was used primarily as a tool for hunting, rather than a weapon against other groups, or that raiding and other forms of intergroup conflict were infrequent enough that site defensibility was not considered a higher priority. However, the predominance of the bow and arrow in the Puget Sound subregion as compared to ROSS may indicate a key difference in how the inhabitants of the Puget Sound subregion conducted themselves in both subsistence hunting and intergroup conflict. In areas where there was a larger framework of societies that could be used for both coordinated hunting and coordinated action during the course of intergroup conflict, there may have been less of an advantage to rely on the bow and arrow. If the Puget Sound region adopted the bow and arrow at a much higher proportional level than the ROSS, this may be an indication that the same sorts of social networks that could be used for hunting and defense were much less relied on than in the rest of the Salish Sea region, even if they were present. The use of the bow and arrow in individual hunting would enable the bypassing of the older group-hunting social networks, and reinforce new ones based around individual prestige shared on kin lines (Angelbeck and Cameron 2014, Rorabaugh 2019).

Angelbeck and Cameron (2014) suggest that the bow and arrow is more suited to individual hunting than the thrown spear or dart, due to its more portable nature and greater accuracy at distance. The bow and arrow is more accurate at range than the thrown spear or dart (Bettinger 2013), which is yet another argument in favor of its use in intergroup conflict. Angelbeck and Cameron (2014) also make the point that the bow and arrow would have been quicker to use than the thrown spear. When both factors are combined, the bow and arrow allow for more rapid acquisition of targets and quicker follow up shots, at longer range than the thrown spear or dart. These advantages allow an individual combatant with a bow and arrow to be more proficient in fighting than an individual using a thrown spear or dart. The differences on the individual level between users of these weapons would have been compounded by the addition of other combatants and would have meant that barring extreme cases it would have been a major error to attempt to engage those armed with bows and arrows while armed with thrown spears or darts. In areas where there were less established groups to aid in the coordination of defense, it would be highly advantageous for individuals and smaller groups to adopt the bow and arrow as their primary ranged weapon in interpersonal and intergroup conflict. The advantages of the bow and arrow over thrown spears and darts would make it a more effective choice of weapon in cases where the user was fighting alone or as part of an outnumbered group.

Areas for Further Research

One of the clearest areas where more research could be done is in the pre-3500 BP projectile point record of the Puget Sound subregion. While the assemblages aggregated by Rorabaugh are as exhaustive as he was able to find and analyze in the course of his research, (Rorabaugh 2015), any future finds of projectile points in the Puget Sound subregion would potentially go a long way in establishing the validity of lumping the subregion into the broader Salish Sea region when discussing the use of the bow and arrow. Another area for further research would be the presence of arrow points prior to Rorabaugh's date for the introduction of the bow and arrow. While Rorabaugh claims that these are fletched dart points, it is certainly something that could use a second look. This is another area in which a larger sample of early projectile points could remove an area of ambiguity.

Tying into the issue of sample size, another clear area for more research is in the holistic examination of both bone and lithic points in the same research project.

While there are potential issues with using the same criteria on tools made from two quite different materials, examination of assemblages in tandem could help to fill in the gaps of one assemblage with the results of another. One major hurdle for this project is that anyone who did this would have to define projectile points and clarify how they will treat harpoon points and other bone points that are different in design than stone points. Improvements in cataloguing software and data processing could make this more feasible in the future.

While Martindale and Supernant's methods may provide more conclusive measurements of defensibility when used on sites that have a robust enough record of excavation to support them, (Martindale and Supernant 2009; Cookson 2013), as they would be able to show how landscape modifications can impact the defensibility of a given site over multiple phases. However, they are of relatively limited use when applied to sites without a comprehensive knowledge of the extent of site features. Bocinsky (2014)'s method is much more effective when examining the entirety of a broader region, and examining sites within this broader regional context.

The use of Bocinsky's process establishes a baseline for the analysis of defensibility that can be supplemented with contextual information for sites outside of the norm. As the defensibility raster extends throughout the Salish Sea region, it would be relatively easy to add more sites and associated point assemblages into the overall dataset. Adding more point assemblages and their associated sites to the existing dataset could make the relationship between the introduction of the bow and arrow and intergroup conflict in the region much clearer. In theory, Bocinsky's method is scalable to work in other areas as well.

WORKS CITED

Digital Sources

The GiS Hillshade Referenced was the ArcGiS World Hillshade, 2018; accessed 2019

Sources: Esri, USGS, Airbus DS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, and the GIS user community

https://www.arcgis.com/home/item.html?id=babedc22ebd64a428b77f7119c2591c3

The LiDAR Hillshade used in this thesis was the Washington State Department of Natural Resources North Puget Sound 2017 DTM Hillshade, found at https://lidarportal.dnr.wa.gov/, accessed 2019

The Digital Elevation Map data used for this paper has been provided by AW3D30 of the Japan Aerospace Exploration Agency (JAXA), accessed 2019

References

Allen, Harry, Michelle C. Langley, and Paul S. C. Taçon.

2016 Bone Projectile Points in Prehistoric Australia: Evidence from Archaeologically Recovered Implements, Ethnography, and Rock Art. Osseous Projectile Weaponry Vertebrate Paleobiology and Paleoanthropology: 209–218

Ames, C.

2009 *From Chipped to Ground: the spatio-temporal systematics of 9000 years of archaeological change in southwest British Columbia.* Unpublished MA Thesis. Department of Anthropology. McGill University

Ames, Kenneth M.

1994 The Northwest Coast: Complex Hunter-Gatherers, Ecology, and Social Evolution. *Annual Review of Anthropology* 23(1): 209–229

2001 Slaves, chiefs and labor on the northern Northwest Coast. *World Archaeology* 33(1): 1–17.

2010 Comments on the Emergence and Persistence of Inequality in Premodern Societies. *Current Anthropology* 51(1): 95–96.

Ames, Kenneth M., Kristen A. Fuld, and Sara Davis.

2010 Dart and Arrow Points on the Columbia Plateau of Western North America. *American Antiquity*75(02): 287–325.

Ames, Kenneth M., and Herbert Maschner

1999 *Peoples of the Northwest Coast: their archaeology and prehistory*. Thames and Hudson, London.

Angelbeck, Bill.

2016 The balance of autonomy and alliance in anarchic societies: the organization of defences in the Coast Salish past. *World Archaeology* 48(1): 51–69.

2009 "They recognize no superior chief": power, practice, anarchism and warfare in the Coast Salish past. Unpublished dissertation.

Angelbeck, Bill, and Ian Cameron.

2014 The Faustian bargain of technological change: Evaluating the socioeconomic effects of the bow and arrow transition in the Coast Salish past. *Journal of Anthropological Archaeology* 36: 93–109.

Angelbeck, Bill, and E. McLay.

2011 The Battle at Maple Bay: The Dynamics of Coast Salish Political Organization through Oral Histories. *Ethnohistory* 58(3): 359–392.

Arnett, Chris.

1999 *The Terror of the Coast: Land Alienation and Colonial War on Vancouver Island and the Gulf Islands, 1849 - 1863*. Talonbooks, Vancouver, B.C.

Barnett, Homer Garner

1955 *The Coast Salish of British Columbia*. University of Oregon Press, Eugene.

Bettinger, Robert L.

2013 Effects of the Bow on Social Organization in Western North America. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 118–123.

Bettinger, Robert L., and Jelmer Eerkens.

1999 Point Typologies, Cultural Transmission, and the Spread of Bow-and-Arrow Technology in the Prehistoric Great Basin. *American Antiquity* 64(02): 231–242.

Blitz, John H.

1988 Adoption of the Bow in Prehistoric North America. *North American Archaeologist* 9(2): 123–145.

Boas, Franz

1889 *Notes on the Snanaimuq*. American Anthropologist 2(4):321–328.

1912 An Anthropologist's View of War. American Association for International Conciliation 52: 1-14.

Bocinsky, R. Kyle

2014 Extrinsic site defensibility and landscape-based archaeological inference: An example from the Northwest Coast. *Journal of Anthropological Archaeology* 35: 164–176.

Borck, Lewis, Barbara J. Mills, Matthew A. Peeples, and Jeffery J. Clark.

2015 Are Social Networks Survival Networks? An Example from the Late Pre-Hispanic US Southwest. *Journal of Archaeological Method and Theory* 22(1): 33–57.

Brown, Robert

1873-1876 *The Races of Mankind: Being a Popular Description of the Characteristics, Manners and Customs of the Principal Varieties of the Human Family*. Vol. 4. 4 vols.. Cassel, Petter, and Galpin, London.

Bruseth, Nels

1977 *Indian Stories and Legends of the Stillaguamish, Sauks, and Allied Tribes*. Arlington

Times Press, Arlington, WA. Originally published 1926.

Bryan, Alan Lyle

1955 An Intensive Archeological Reconnaissance in the Northern Puget Sound Region. Master's thesis. Department of Anthropology, University of Washington, Seattle.

1963 An Archaeological Survey of Northern Puget Sound. Occasional papers of the Idaho University Museum Volume 11, Pocatello

Buddenhagen, Jeremy.

2011a Sixteen Battles in the Military History of the Nine Allied Tsimshian Tribes Tsemsyaenhl-get. Unpublished dissertation.

2011b Coast Salish Trench Embankment Defensive Sites: Evidence for Siege Warfare in the Late Pacific Period.

Buxton, Judith.

1969 Earthworks of Southwestern British Columbia. Master's thesis. Department of Archaeology, University of Calgary, Calgary, Alberta.

Campbell, S.K.,

1981. The Duwamish No. 1 Site: A Lower Puget Sound Shell Midden. Institute for Environmental Studies, Office of Public Archaeology, Research Report 1, University of Washington, Seattle.

Carlson, Keith Thor, editor

1997 *You are Asked to Witness: The Sto:lo in Canada's Pacific Coast History* Sto:lo Heritage Trust, Chilliwack, BC.

Carlson, Keith Thor.

2001 Intercommunity Conflict. In A Sto:lō Coast Salish Historical Atlas, edited by K. T. Carlson, pp. 48–49. Douglas & McIntyre, Vancouver, B.C.

Carlson, R. L. and Magne, M. P. R.

eds. 2008 *Projectile Point Sequences in Northwestern North Americ*a, Archaeology Press. Burnaby, British Columbia.

Chatters JC.

1988. Tualdad Altu (45KI59): A 4th Century Village on the Black River, King Country, Washington. First City Equities, Seattle, Washington.ro

2004. Safety in numbers: the influence of the bow and arrow on village formation on the Columbia Plateau. In: Prentice WC, Kuijt I, editors. *Complex hunter-gatherers: evolution and organization of prehistoric communities on the plateau of northwestern North America*. Salt Lake City: The University of Utah Press. p 67–83.

Clark, Terence Norman

2013 *Rewriting Marpole: the path to cultural complexity in the Gulf of Georgia*. Canadian Museum of Civilization, Gatineau, Québec.

Clausewitz, Carl von

1832 *On War*. Ed. Marie von Brühl.

Cookson, C.

2013. An analysis of site selection behaviours and landscape use in the Prince Rupert Harbour area. Master's thesis. Edmonton: University of Alberta.

Collins, June

1974 *Valley of the Spirits, The Upper Skagit Indians of Western Washington*. Seattle: University of Washington Pres

Costello, J. A.

1986 [1895] *The Siwash: Their Life, Legends, and Tales.* Ye Galleon Press, Fairfield, Washington.

Croes, Dale R. and Steven Hackenberger

1988 Hoko River Archaeological Complex: Modeling Prehistoric Northwest Coast Economic Evolution in Prehistoric Economies of the Pacific Northwest Coast, *Research in Economic Anthropology*, Suppl. 3. Barry Isaac, ed., Greenwich, CT.:JAI Press, 19-85.

Croes, D.R. & Williams, Scott & Ross, L & Collard, Mark & Dennler, C & Varge, B.

2008. The projectile point sequences in the Puget Sound region. Projectile Point Sequences in Northwestern North America. 105-130.

Cundy, B. J.

1989 *Formal Variation in Australian Spear and Spearthrower Technology*. BAR International Series 546, Oxford.

Curtis, Edward

1907-1930 *The North American Indian*. Ed. Fredrick Hodge. 20 vols.. Plimpton Press, Norwood, MA.

Cybulski, J. S.

1978. Modified human bones and skulls from Prince Rupert Harbour, British Columbia. Canadian Journal of Archaeology. 2, 15–32.

1999. Trauma and warfare at Prince Rupert Harbour. *The Midden* 31: 5–7

Donald, Leland

1997 *Aboriginal slavery on the northwest coast of North America*. University of California Press, Berkeley.

Eells, Myron

1976 [ca. 1874-1907] *Myron Eells and the Puget Sound Indians.* Edited by Robert H. Ruby and John A. Brown. Superior Publishing Company, Seattle.

1985 [ca. 1886-1888*] The Indians of Puget Sound: The Notebooks of Myron Eells*. Edited by George Pierre Castile. University of Washington Press, Seattle.

Elmendorf, William W.

1971 Coast Salish Status Ranking and Intergroup Ties. *Southwestern Journal of Anthropology* 27(4): 353–380.

1993 *Twana Narratives: Native Historical Accounts of a Coast Salish Culture*. UBC Press, Vancouver, B.C

Erlandson, Jon M., Jack L. Watts, and Nicholas P. Jew

2014 Darts, Arrows, and Archaeologists: Distinguishing Dart and Arrow Points in the Archaeological Record. *American Antiquity* 79(01): 162–169

Erlandson, J. M., T. C. Rick, T. J. Braje, M. Casperson, B. Culleton, B. Fulfrost, T. Garcia, D. A. Guthrie, N. Jew, D. J. Kennett, M. L. Moss, L. Reeder, C. Skinner, J. Watts, and L. Willis.

2011 Paleoindian Seafaring, Maritime Technologies, and Coastal Foraging on Californias Channel Islands. *Science* 331(6021): 1181–1185.

Erlandson, J, M Moss, and M Deslauriers.

2008 Life on the edge: early maritime cultures of the Pacific Coast of North America. *Quaternary Science Reviews* 27(23-24): 2232–2245.

Ferguson, R. B.

1983. Warfare and redistributive exchange on the Northwest Coast. In Tooker, E., and Fried, M. (eds.), *The Development of Political Organization in Native North America*, The American Ethnological Society, Washington, DC, pp. 131-147.

1984. A reexamination of the causes of Northwest Coast warfare. In Ferguson, R. B. (ed.), *Warfare, Culture, and Environment*, Academic Press, New York, pp. 267.

Fisher, Robin.

1976 Arms and Men on the Northwest Coast, 1774-1825. *BC Studies* 29:3–18.

Flenniken, J. Jeffrey, and Anan W. Raymond

1986 Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. *American Antiquity* 51:603-61

Gibbs, George

1855 Report ... to Captain Mc'Clellan on the Indian Tribes of the Territory of Washington. Pacific Railroad Report 1 :402-436. 33rd Congress, 2nd Session, *Senate Executive Document*, 78 (Series# 758). [Reprinted Ye Galleon Press, Fairfield, WA, 1972].

1877 Tribes of Western Washington and Northwestern Oregon. Department of the Interior, United States Geographical and Geological Survey of the Rocky Mountain Region, Part II: 157-241, Washington. [Reprinted Northwest Anthropological Research Notes, 31 :95- 188. 1997].

Gonçalves, Alexandre B., José Almeida, and Helena Rua.

2016 Assessment of the Permeability of Historical Defensive Systems: the Case of the Lines of Torres Vedras. *International Journal of Historical Archaeology* 20(2): 229–248.

Grabert G. F., J. A. Cressman, A. Wolverton.

1978 Prehistoric Archaeology at Semiahmoo Spit, Washington. Western Washington University Reports In Archaeology. Bellingham, WA: Western Washington University.

Grund, Brigid Sky.

2017 Behavioral Ecology, Technology, and the Organization of Labor: How a Shift from Spear Thrower to Self Bow Exacerbates Social Disparities. *American Anthropologist* 119(1): 104–119.

Haeberlin, Hermann, and Erna Gunther

1930 The Indians of the Puget Sound. *University of Washington Publications in Anthropology* 4: 1–84.

Hancock, Samuel.

1860 *Trip Across the Plains, From Independence, Mo. To Portland, Oregon*. [Whidby's Island, Wa]. Bound typescript. Pacific Northwest Special Collections, University of Washington, Seattle.

1927 *The Narrative of Samuel Hancock, 1845-1860*. R.M. McBride & Company, New York

Hildebrandt, William R., and Jerome H. King

2012 Distinguishing Between Darts and Arrows in the Archaeological Record: Implications for Technological Change in the American West. *American Antiquity* 77(4): 789–799.

Hockett, Bryan, William R. Hildebrandt, and Jerome H. King

2014 Identifying Dart and Arrow Points in the Great Basin: Comment on Smith Et Al.'s "Points in Time: Direct Radiocarbon Dates on Great Basin Projectile Points". *American Antiquity* 79(3): 561–565.

Hughes, Susan S.

1998 Getting to the point: Evolutionary change in prehistoric weaponry. *Journal of Archaeological Method and Theory* 5(4): 345–408.

Hutchings, W. Karl, and Lorenz W. Brüchert.

1997. Spearthrower Performance: Ethnographic and Experimental Research. *Antiquity* 71 (274): 890–897.

Hutchings, Wallace Karl.

2016 When Is a Point a Projectile? Morphology, Impact Fractures, Scientific Rigor, and the Limits of Inference. *Vertebrate Paleobiology and Paleoanthropology Multidisciplinary Approaches to the Study of Stone Age Weaponry*: 3–12.

Iovita, Radu, Holger Schönekeß, Sabine Gaudzinski-Windheuser, and Frank Jäger.

2016 Identifying Weapon Delivery Systems Using Macrofracture Analysis and Fracture Propagation Velocity: A Controlled Experiment. *Vertebrate Paleobiology and Paleoanthropology Multidisciplinary Approaches to the Study of Stone Age Weaponry*: 13–27.

Jones, David E.

2004 *Native North American armor, shields and fortifications*. University of Texas Press, Austin.

Lambert, Patricia M.

1994 War and peace on the western front: a study of violent conflict and its correlates in prehistoric hunter-gatherer societies of coastal Southern California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara.

2002 The Archaeology of War: A North American Perspective. *Journal of Archaeological Research*10(3): 207–241.

2007 The osteological evidence for indigenous warfare in North America. In: Chacon RJ, Mendoza R, editors. *North American indigenous warfare and ritualized violence.* Tucson: University of Arizona Press. p 202–221.

Lewarch, D.E., Forsman, L.A., Kramer, S.K., Murphy, L.R., Larson, L.L., Iverson, D.R., Dugas, A.E.,

2002. Data Recovery Excavations at the Bay Street Shell Midden (45KP115), Kitsap County, Washington, Limited Technical Report 2002-01, Larson Anthropological/Archaeological Services, Gig Harbor, Washington

Lowery, N. S.

1999 An ethnoarchaeological inquiry into the functional relationship between projectile point and armor technologies of the Northwest Coast. *North American Archaeologist* 20: 47–73.

Lugrin, N. De Bertrand

1932 *Indian Saga: Heroic Tales From the Golden Age of the Indian's Supremacy on the West Coast.* Maclean's Magazine December 15, p. 38

Keddie, Grant

2006 *Aboriginal Defensive Sites: Part 1: Settlements for Unsettling Times, Part 2: Amateur Archaeology Begins, Part 3: Modern Archaeologists Collect Evidence, Part 4: Local Sites are Dated; Final Conclusions.* http://www.royalbcmuseum.bc.ca/Content_Files/Files/AboriginalDefensiveSites article0ct2006.pdf. Accessed August 2021.

Keeley, Lawrence H.

1996 *War Before Civilization: the Myth of the Peaceful Savage*. Oxford Univ. Press, New York.

Kennett, Douglas J., Patricia M. Lambert, John R. Johnson, and Brendan J. Culleton.

2013 Sociopolitical Effects of Bow and Arrow Technology in Prehistoric Coastal California. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 124–132.

Martindale, Andrew, and Kisha Supernant.

2009 Quantifying the defensiveness of defended sites on the Northwest Coast of North America. *Journal of Anthropological Archaeology* 28(2): 191–204.

Maschner, Herbert

1991 The emergence of cultural complexity on the northern Northwest Coast. *Antiquity* 65(249): 924–934.

1997. The evolution of Northwest Coast warfare. In: Martin, D.L., Frayer, D.W. (Eds.), *Troubled Times: Violence and Warfare in the Past, Warfare and Society.* Gordon and Breach, vol. 3, pp. 267–302.

Maschner, Herbert, and Reedy -Maschner, K. L.

1998. Raid, retreat, defend (repeat): The archaeology and ethnohistory of warfare on the North Pacific Rim. *Journal of Anthropological Archaeology* 17: 19-51.

2007 Heads, Women, and the Baubles of Prestige. *The Taking and Displaying of Human Body Parts as Trophies by Amerindians*: 32–44.

Maschner, Herbert, and Owen K. Mason.

2013 The Bow and Arrow in Northern North America. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 133–138.

Maschner, Herbert, and Stein, J. W.

1995. Multivariate approaches to site location on the Northwest Coast of North America. *Antiquity* 69: 61-73.

McCool, Weston C.

2017 Coping With Conflict: Defensive Strategies And Chronic Warfare In The Prehispanic Nazca Region. *Latin American Antiquity* 28(03): 373–393.

Miller, Jay

2011 First Nations Forts, Refuges, and War Lord Champions Around the Salish Sea . *Journal of Northwest Anthropology* 45(1): 71–87.

Morrisey, Gregory E.

2009 *Tools and Change: The Shift from Atlatl to Bow on the British Columbia Plateau*. Unpublished Master's thesis, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.

Moss, Madonna, and Jon Erlandson.

1992 Forts, Refuge Rocks, and Defensive Sites: The Antiquity of Warfare along the North Pacific Coast of North America. *Arctic Anthropology* 29(2).

Moss, Madonna L., and Robert J. Losev.

2011 Native American Use of Seals, Sea Lions, and Sea Otters in Estuaries of Northern Oregon and Southern Washington. *Human Impacts on Seals, Sea Lions, and Sea OttersIntegrating Archaeology and Ecology in the Northeast Pacific*: 167–195.

Nichols, Kerry, and Todd L. Vanpool.

2015 Late Woodland cultural adaptations in the Lower Missouri River Valley: archery, warfare, and the rise of complexity. Unpublished dissertation.

Odell, George H., and Frank Cowan.

1986 Experiments with Spears and Arrows on Animal Targets. *Journal of Field Archaeology* 13(2): 195.

Okumura, Mercedes, and Astolfo G.m. Araujo.

2015 Contributions to the Dart versus Arrow Debate: New Data from Holocene Projectile Points from Southeastern and Southern Brazil. *Anais da Academia Brasileira de Ciências* 87(4): 2349–2373.

Pratt, H.

1992 *The Charles Culture of the Gulf of Georgia: A Reevaluation of the Charles Culture and its Three Sub-phases.* Unpublished Master's thesis, Department of Anthropology and Sociology, University of British Columbia, Vancouver.

Ray, Verne F.

1938 *Lower Chinook Ethnographic Notes*. University of Washington Publications in Anthropology, 7 (2):29-165, Seattle.

Reed, Paul F., and Phil R. Geib.

2013 Sedentism, Social Change, Warfare, and the Bow in the Ancient Pueblo Southwest. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 103–110.

Rogers, Spencer L.

1940 The Aboriginal Bow And Arrow Of North America And Eastern Asia. *American Anthropologist* 42(2): 255–269.

Rorabaugh, Adam N.

2015 Investigating restricted knowledge in lithic craft traditions among the pre-contact Coast Salish of the Pacific northwest coast of North America. Unpublished dissertation

2019 Hunting social networks on the Salish Sea before and after the bow and arrow. *Journal of Archaeological Science: Reports* 23: 822–843.

Rorabaugh, Adam N., and Tiffany J. Fulkerson.

2015 Timing Of The Introduction Of Arrow Technologies In The Salish Sea, Northwest North America. *Lithic Technology* 40(1): 21–39.

Roth, Barbara J., Elizabeth Toney, and Leon Lorentzen

2011 The Advent Of Bow And Arrow Technology In The Mimbres Mogollon Region. *Kiva* 77(1): 87–109

Sakaguchi, Takashi, Jesse Morin, and Ryan Dickie.

2010 Defensibility of large prehistoric sites in the Mid-Fraser region on the Canadian Plateau. *Journal of Archaeological Science* 37(6): 1171–1185.

Salem, Paul E., and Steven E. Churchill.

2016 Penetration, Tissue Damage, and Lethality of Wood- Versus Lithic-Tipped Projectiles. *Vertebrate Paleobiology and Paleoanthropology Multidisciplinary Approaches to the Study of Stone Age Weaponry*: 203–212

Sampson, Chief Martin.

1972 Indians of Skagit County. *Skagit County Historical Society Historical Series* 2, 26, La Conner, WA.

Schaepe, David M.

2006 Rock Fortifications: Archaeological Insights Into Precontact Warfare and Sociopolitical Organization Among the Stó:lō of the Lower Fraser River Canyon, B.C.. *American Antiquity*71(04): 671–705.

Smith, Geoffrey M., Pat Barker, Eugene M. Hattori, Anan Raymond, and Ted Goebel

2013 Points in Time: Direct Radiocarbon Dates on Great Basin Projectile Points. *American Antiquity* 78(3): 580–594.

2014 Identifying Dart and Arrow Points in the Great Basin: A Reply to Hockett Et Al.. *American Antiquity* 79(3): 566–569.

Smith, Harlan I.

1907 Archaeology of the Gulf of Georgia and Puget Sound. The Jesup North Pacific Expedition 2(6); Memoir of the American Museum of Natural History 4(6): 303–441

Springer, Chris, and Dana Lepofsky.

2019 Conflict and Territoriality: An Archaeological Study of Ancestral Northern Coast Salish-Tla'amin Defensiveness in the Salish Sea Region of Southwestern British Columbia. *The Journal of Island and Coastal Archaeology*: 1–25.

Suttles, Wayne.

1949 Field notebooks 4 to 7. Wayne Suttles Papers, 1946-86. Pacific Northwest Special Collections, University of Washington, Seattle..

1951 *Economic life of the Coast Salish of Haro and Rosario Strait*.

1987 *Coast Salish Essays*. University of Washington Press, Seattle.

1989 They Recognize No Superior Chief: The Strait of Juan de Fuca in the 1790s. In *Cultures de la Costa Noroesta de America*, Jose Luis Peset, editor, pp 251-264. Turner, Madrid.

Suttles, Wayne (editor).

1990 *Handbook of North American Indians, volume 7:* Northwest Coast. Smithsonian Institution, Washington, D.C.

Thomas, David Hurst.

1978 Arrowheads and Atlatl Darts: How the Stones Got the Shaft. *American Antiquity* 43(3). Cambridge University Press: 461–472.

1981 How to Classify the Projectile Points from Monitor Valley, Nevada. *Journal of California and Great Basin Anthropology* 3(1): 7–43

2013 Great Basin Projectile Point Typology:Still Relevant?. *Journal of California and Great Basin Anthropology* 33(1): 133–152.

Tomka, Steve A.

2013. The Adoption of the Bow and Arrow: A Model Based on Experimental Performance Characteristics. *American Antiquity* 78 (3): 553–569.

Vancouver, George.

1798. *A voyage of discovery to the North Pacific Ocean, and round the world: in which the coast of north-west America has been carefully examined and accurately surveyed : Undertaken by His Majesty's command, principally with a view to ascertain the existence of any navigable communication between the North Pacific and North Atlantic Oceans, and performed in the years 1790, 1791, 1792, 1793, 1794, and 1795, in the Discovery sloop of war, and armed tender Chatham, under the command of Captain George Vancouver : in three volumes, Vol. I.* : printed for G.G. and J. Robinson ... and J. Edwards. London.

Vanpool, Todd L., and Michael J. Obrien.

2013 Sociopolitical Complexity and the Bow and Arrow in the American Southwest. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 111–117.

Wagner, Henry Raup

1933 *Spanish explorations in the strait of Juan de Fuca*. Fine Arts Press, Santa Ana, California.

Waguespack, Nicole M., Todd A. Surovell, Allen Denoyer, Alice Dallow, Adam Savage, Jamie Hyneman, and Dan Tapster.

2009 Making a point: wood- versus stone-tipped projectiles. *Antiquity* 83(321): 786–800.

Whittaker, J.C.

2010. Weapon trials: the atlatl and experiments in hunting technology. In: Ferguson, J.R. (Ed.), *Designing Experimental Research in Archaeology: Examining Technology Through Production and Use*. University Press of Colorado, Boulder, pp. 195–224.

Whittaker, John C., Devin B. Pettigrew, and Ryan J. Grohsmeyer

2017 Atlatl Dart Velocity: Accurate Measurements and Implications for Paleoindian and Archaic Archaeology. *PaleoAmerica* 3(2): 161–181.

Wolf, Eric R.

1990 Facing Power - Old Insights, New Questions. *American Anthropologist* 92(3): 586–596.

Yu, P.

2006. From Atlatl to Bow and Arrow: Implicating Projectile Technology in Changing Systems of Hunter-Gatherer Mobility. In: Sellet, F., Greaves, R., Yu, P. (Eds.), *Archaeology and Ethnoarchaeology of Mobility.* University Press of Florida, pp. 201–220.

Appendix

Table One

site components	Average defensibility of the site	Max Defensibility of the site	Average bow and arrow value	Percentage of points considered arrows	500y bp Chunks	Component and morphological Period	Site Landform Type	Site Region	Multi-Phase site	First Phase of Occupation	Merged Regions	ROSS	Number of Points
45KI23-1	42	53	27.461298 7	0.623376623	1500	Marpole	Mainland River	Puget Sound	yes	Yes	Puget Sound	Puget Sound	77
45KI23-2	42	53	25.17363636	0.81818181 8	1000	Gulf of Georgia	Mainland River	Puget Sound	yes	No	Puget Sound	Puget Sound	11
45KI23-3	42	53	22.96793103	0.79310344 8	500	Gulf of Georgia	Mainland River	Puget Sound	yes	No	Puget Sound	Puget Sound	29
45KI428-2	52	66	30.051875	0.4375	3500	Locarno Beach	Mainland Coastal	Puget Sound	yes	Yes	Puget Sound	Puget Sound	16
45KI428-4	52	66	24.12	1	1500	Marpole	Mainland Coastal	Puget Sound	yes	No	Puget Sound	Puget Sound	4
45KI437	47	66	20.1275	1	500	Gulf of Georgia	Island	Puget Sound	no	Yes	Puget Sound	Puget Sound	4
45KI59	50.6	64	29.26	0.6	2000	Marpole	Mainland River	Puget Sound	no	Yes	Puget Sound	Puget Sound	5

45KI9-3	52.5	63	28.04204819	0.590361446	2500	Marpole	Mainland Inland	Puget Sound	no	Yes	Puget Sound	Puget Sound	166
45SJ105-1	49.4	56	32.67	0	2000	Marpole	Island	San Juan Islands	yes	Yes	Islands	ROSS	2
45SJ105-2	49.4	56	28.402	0.6	1500	Gulf of Georgia	Island	San Juan Islands	yes	No	Islands	ROSS	5
45SJ1-1	55.8	65	30.96470588	0.470588235	3000	Locarno Beach	Island	San Juan Islands	yes	Yes	Islands	ROSS	17
45SJ1-2	55.8	65	31.49518519	0.37037037	2000	Marpole	Island	San Juan Islands	yes	No	Islands	ROSS	54
45SJ1-3	55.8	65	29.99189189	0.324324324	500	Gulf of Georgia	Island	San Juan Islands	yes	No	Islands	ROSS	37
45SJ185	50.4	60	28.51	0.5	2000	Marpole	Island	San Juan Islands	no	Yes	Islands	ROSS	2
45SJ24-1	41	61	31.45579767	0.245136187	1500	Marpole	Island	San Juan Islands	yes	Yes	Islands	ROSS	257
45SJ24-2	41	61	28.92145455	0.454545455	1000	Gulf of Georgia	Island	San Juan Islands	yes	No	Islands	ROSS	110
45SJ25	41	61	32.69275862	0.24137931	2000	Marpole	Island	San Juan Islands	yes	Yes	Islands	ROSS	29
45SJ254-1	48.9	60	38.968	0	1500	Marpole	Island	San Juan Islands	yes	Yes	Islands	ROSS	5

45SJ254-2	48.9	60	29.99909091	0.272727273	1000	Gulf of Georgia	Island	San Juan Islands	yes	No	Islands	ROSS	11
45SJ280-4	48.3	58	31.47428571	0.428571429	500	Gulf of Georgia	Island	San Juan Islands	no	Yes	Islands	ROSS	4
45SJ2A/B/C	48.7	66	28.295	0.75	2000	Marpole	Island	San Juan Islands	no	Yes	Islands	ROSS	16
45SK37	43.5	48	24.61	0.3125	1000	Gulf of Georgia	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	1
45SK46-2	56.1	66	20.485	0.5	2500	Marpole	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	2
45SK-59A/B-2	44.1	49	26.05714286	0	1000	Gulf of Georgia	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	7
45SK7	47.4	52	35.38666667	1	1000	Gulf of Georgia	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	3
45SN100	56	66	29.49164835	1	2000	Marpole	Mainland Inland	Puget Sound	no	Yes	Puget Sound	Puget Sound	91
45WH1-2	46	58	28.09653846	0.714285714	2000	Marpole	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	26

45WH17-1	52	66	29.485	0.333333333	3000	Locarno Beach	Mainland Coastal	NW Washington	yes	Yes	Northern Mainland	ROSS	2
45WH17-2	52	66	31.586	0.2	1000	Gulf of Georgia	Mainland Coastal	NW Washington	yes	No	Northern Mainland	ROSS	5
45WH34-1	52.3	63	28.020625	0.4375	5000	charles	Mainland River	NW Washington	yes	Yes	Northern Mainland	ROSS	16
45WH34-2	52.3	63	35.56	0	1500	Marpole	Mainland River	NW Washington	yes	No	Northern Mainland	ROSS	1
45WH34-3	52.3	63	26.09	1	1000	Gulf of Georgia	Mainland River	NW Washington	yes	No	Northern Mainland	ROSS	3
45WH48-3	48	67	25.095	1	2000	Marpole	Mainland Coastal	NW Washington	no	Yes	Northern Mainland	ROSS	2
45WH55-1	44	63	30.82	0.5	1000	Gulf of Georgia	Mainland Coastal	NW Washington	yes	Yes	Northern Mainland	ROSS	2
45WH55-2	44	63	34.35	0.5	2000	Marpole	Mainland Coastal	NW Washington	yes	No	Northern Mai	ROSS	2

											nland		
DeRt 1-1	38.8	42	36.248333333	0	3000	Locarno Beach	Island	Gulf Islands	yes	Yes	Islands	ROSS	6
DeRt 1-2	38.8	42	36.864444444	0.11111111	2000	Marpole	Island	Gulf Islands	yes	No	Islands	ROSS	9
DeRt 1-3	38.8	42	52.295	0	500	Gulf of Georgia	Island	Gulf Islands	yes	No	Islands	ROSS	2
DeRt 2-2	48	60	36.529	0.1	4500	charles	Island	Gulf Islands	yes	Yes	Islands	ROSS	10
DeRt 2-3	48	60	33.15038462	0.25	3500	Locarno Beach	Island	Gulf Islands	yes	No	Islands	ROSS	52
DeRt 2-4	48	60	33.378	0.36	2000	Marpole	Island	Gulf Islands	yes	No	Islands	ROSS	25
DeRt 2-5	48	60	28.45	0.5	1000	Gulf of Georgia	Island	Gulf Islands	yes	No	Islands	ROSS	6
DfRu 13-2	43.9	51	30.149	0.4	3500	Locarno Beach	Island	Gulf Islands	yes	Yes	Islands	ROSS	10
DfRu 13-3	43.9	51	29.23882353	0.58823529 4	2000	Marpole	Island	Gulf Islands	yes	No	Islands	ROSS	17
DfRu 13-4	43.9	51	26.267	0.8	1000	Gulf of Georgia	Island	Gulf Islands	yes	No	Islands	ROSS	10
DfRu 8-1	43	45	46.98	0	4500	charles	Island	Gulf Islands	yes	Yes	Islands	ROSS	5
DfRu 8-2	43	45	29.97190476	0.47619047 6	3000	Locarno Beach	Island	Gulf Islands	yes	No	Islands	ROSS	105
DfRu 8-3	43	45	30.9045283	0.43396226 4	1500	Marpole	Island	Gulf Islands	yes	No	Islands	ROSS	53
DgRr 1-1	52.1	70	38.25	0	4500	charles	Mainland Coastal	Fraser Valley	yes	Yes	Northern Mainland	ROSS	1

DgRr 1-2	52.1	70	38.562	0.4	3500	Locarno Beach	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	10
DgRr 1-3	52.1	70	35.45111111	0.11111111	1500	Marpole	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	9
DgRr 2-2	50.1	56	43.57	0	4000	charles	Mainland River	Fraser Valley	yes	Yes	Northern Mainland	ROSS	1
DgRr 2-3	50.1	56	33.895	0	2000	Marpole	Mainland River	Fraser Valley	yes	No	Northern Mainland	ROSS	2
DgRr 6-1	45.9	55	49.44	0	6000	archaic	Mainland River	Fraser Valley	yes	Yes	Northern Mainland	ROSS	4
DgRr 6-2	45.9	55	32.922	0.3	4000	charles	Mainland River	Fraser Valley	yes	No	Northern Mainland	ROSS	10
DgRr 6-3	45.9	55	36.59571429	0.14285714 3	2500	Marpole	Mainland River	Fraser Valley	yes	No	Northern Mainland	ROSS	14
DgRs 1-3	47.2	58	44.315	0	2000	Marpole	Mainland Coastal	Fraser Valley	no	Yes	Northern Mai	ROSS	2

											nland		
DgRs 2-5	49.3	65	33.213333333	0.333333333	2000	Marpole	Mainland Coastal	Fraser Valley	yes	Yes	Northern Mainland	ROSS	3
DgRs 2-6	49.3	65	30.4475	0.5	1500	Marpole	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	4
DgRs 2-8	49.3	65	35.826666667	0.333333333	500	Gulf of Georgia	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	3
DgRv 1	53.9	69	39.51	0.333333333	1000	Gulf of Georgia	Island	Gulf Islands	no	Yes	Islands	ROSS	3
DgRv 2-2	49.3	62	29.59	0.5	1500	Marpole	Island	Gulf Islands	yes	Yes	Islands	ROSS	2
DgRv 2-3	49.3	62	23.735	1	1000	Gulf of Georgia	Island	Gulf Islands	yes	No	Islands	ROSS	2
DgRv 3-1	40.8	46	30.835714429	0.571428571	2000	Marpole	Island	Gulf Islands	no	Yes	Islands	ROSS	14
DgRw 4-1	43.2	52	37.045	0	2000	Marpole	Island	Gulf Islands	yes	Yes	Islands	ROSS	4
DgRw 4-2	43.2	52	31.068896104	0.415584416	500	Gulf of Georgia	Island	Gulf Islands	yes	No	Islands	ROSS	77
DhRs 1-2	51.8	57	33.296994422	0.277456647	2000	Marpole	Mainland River	Fraser Valley	no	Yes	Northern Mainland	ROSS	173
DhRs 19	45.5	51	33.883333333	0.333333333	2000	Marpole	Mainland	Fraser	no	Yes	Northern	ROSS	3

							River	Valley			Mainland		
DhRt 2	56.6	58	30.08396825	0.50793650 8	1000	Gulf of Georgia	Mainland Coastal	Fraser Valley	no	Yes	Northern Mainland	ROSS	63
DhRt 3	55	53	27.0225	0.75	2500	Marpole	Mainland Coastal	Fraser Valley	no	Yes	Northern Mainland	ROSS	4
DhRt 4-1	55.5	57	31.01397436	0.39743589 7	3000	Locarno Beach	Mainland Coastal	Fraser Valley	yes	Yes	Northern Mainland	ROSS	78
DhRt 4-2	55.5	57	31.63004739	0.31753554 5	2500	Marpole	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	211
DhRt 5	43	46	32.07	0	2000	Marpole	Mainland Coastal	Fraser Valley	no	Yes	Northern Mainland	ROSS	1
DhRt 6-1	52.1	65	32.48227273	0.27272727 3	3500	Locarno Beach	Mainland Coastal	Fraser Valley	yes	Yes	Northern Mainland	ROSS	22
DhRt 6-2	52.1	65	30.02	0.33333333 3	2500	Locarno Beach	Mainland Coastal	Fraser Valley	yes	No	Northern Mainland	ROSS	21

DhRt 6-3	52.1	65	33.550909 09	0.272 7272 73	2000	Marpole	Mainland Coastal	Fraser Valley	yes	Yes	Northern Mainland	ROSS	22

Table Two

	no	yes		yes Total	Grand Total
Row Labels	**Single component sites**	**Multicomponent, Subsequent occupation**	**First occupation**		**Grand Total**
500	2	5		5	7
1000	5	8	1	9	14
1500		6	4	10	10
2000	11	6	5	11	22
2500	3	3		3	6
3000		1	4	5	5
3500		2	3	5	5
4000		1	1	2	2
4500			3	3	3
5000			1	1	1
6000			1	1	1
Grand Total	**21**	**32**	**23**	**55**	**76**