EXPLORING THE CONSISTENCY OF ARCHAEOLOGICAL SITE LOCATIONS IN THE PRINCE OF WALES AREA IN SOUTHEAST ALASKA OVER THE LAST 5000 YEARS

Kelly Monteleone
University of Calgary, Department of Anthropology and Archaeology, 2500 University Drive NW, Calgary, AB; kelly.monteleone@ucalgary.ca

ABSTRACT

The sites where people chose to live, hunt, and gather for the last 5000 radiocarbon years before present in Southeast Alaska are consistently located based on statistical analysis. GIS analysis is used to quantify parameters related to site location, including slope, aspect, distance from water, coastal sinuosity, and distance from known archaeological sites. A grouped ANOVA allowed for comparison among site locations using four regional cultural chronologies. These statistics indicate consistency in site locations; this implies there was cross-cultural consistency for the last 5000 years in the study region, Prince of Wales Island in the Alexander Archipelago, Alaska. Site location, therefore, cannot be used to identify cultural phases in the Alexander Archipelago.

Advances in geographic information systems (GIS) have presented new opportunities for site location analysis. Site location analysis facilitates comparison of where people chose to live, hunt, and gather within and between regions and temporal groups. Consistency in site location through time is the archaeological expression of choices past people made about where to live, hunt, or gather. This analysis of GIS data provides a unique opportunity to test and compare existing chronologies, specifically chronologies developed for the northern Northwest Coast (NWC) of North America. This paper statistically tests the consistency of known site locations along the northern NWC over the past 5000 radiocarbon years. Archaeologists make assumptions about site locations, such as distance from potable water, flat land surface, and accessibility of resources. These assumptions are collated with artifact typologies into cultural chronologies. However, these assumptions create descriptive tautologies that need to be tested. The study region provides a "limited set" to test these assumptions about site location and their effects on chronologies (Bettinger et al. 2015). This paper statistically validates the chronologies in their descriptions of the variability within this "limited set" or study region.

STUDY REGION

The study region is the southwestern corner of the Alexander Archipelago in Southeast Alaska, located in the Northern NWC (Fig. 1) and comprising an area of approximately 40,520 km^2. This region has been investigated by the Gateway to the Americas projects (NSF OPP #0703980 and 1108367) since 2009. Southeast Alaska extends from Icy Bay in the north to Dixon Entrance and the international border between the United States and Canada in the south. The region is composed of a narrow strip of mainland mountain ranges and over 10,000 islands, the largest of which is Prince of Wales (POWI) (Fig. 1) (Carlson 2007; MacDonald and Cook 2009; O'Clair et al. 1992:11).

Shorelines of Southeast Alaska are highly sinuous (having many curves or turns) and indented with numerous embayments and coves, including estuaries (Lee 2007; Moss 1998). During the last glacial maximum, which

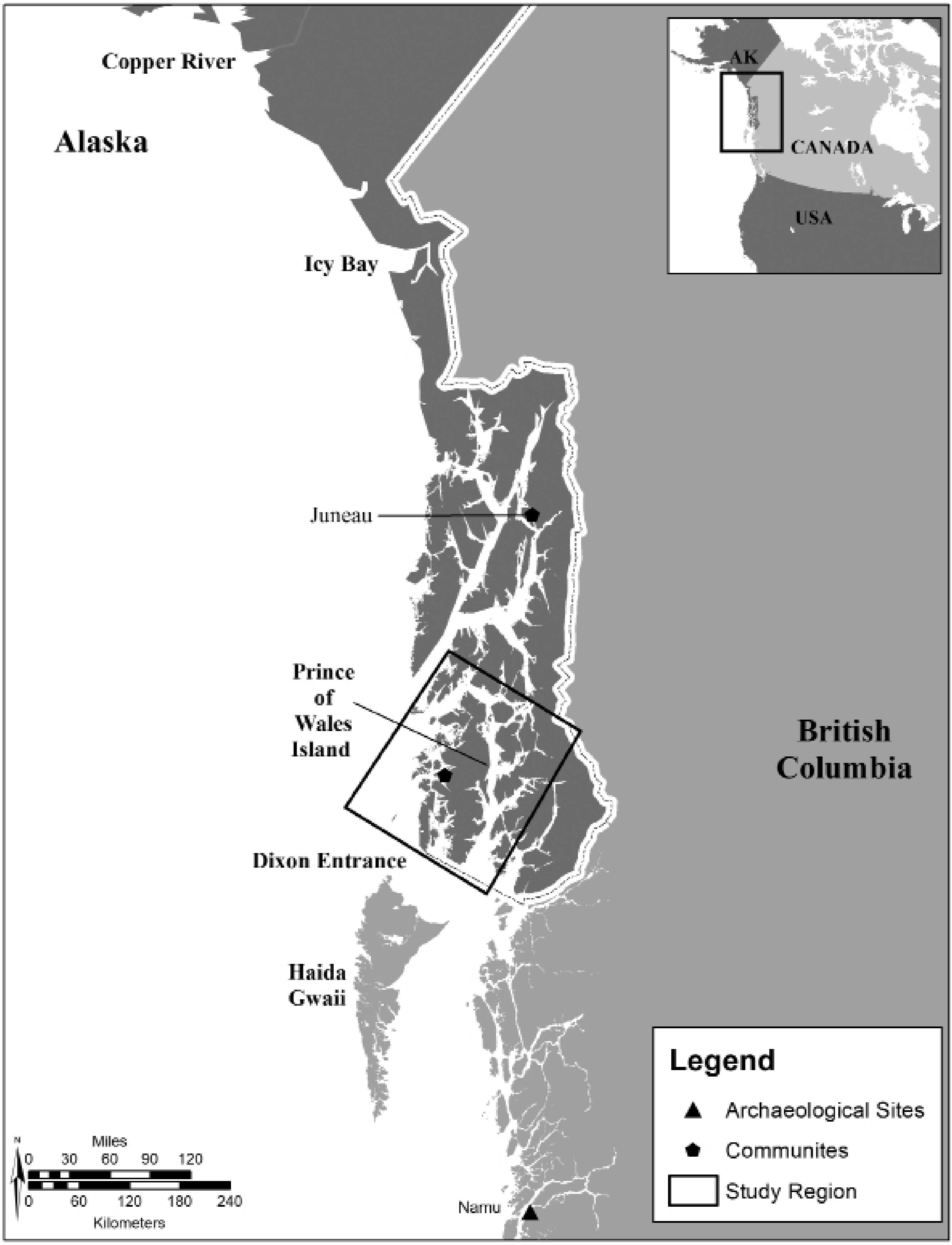

Figure 1: Map of study region

peaked between 21,000 and 26,000 years ago (Blaise et al. 1990:282; Peltier and Fairbanks 2006:3326), glaciers covered much of the region and extended onto the continental shelf in lobes (Carrara et al. 2003, 2007). The landscape of Southeast Alaska is characterized by fjords and drowned valleys adjacent to the continental shelf, which was flooded by post-Pleistocene sea-level rise. Sea levels stabilized approximately 5000 years ago with only minor fluctuations since then (Carlson and Baichtal 2015). The environment is dominated by both fresh and saltwater: ocean, rivers, bays, straits, and abundant rainfall. The region is a temperate rainforest characterized by western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), and yellow and Western red cedar (*Chamaecyparis nootkatensis* and *Thuja plicata*) (MacDonald and Cook 2009:26; O'Clair et al. 1992). Faunal and floral resources tend to concentrate in the intertidal and coastal zones, at the interface between the land and sea (Moss 1998:91).

The NWC culture area is defined by distinctive woodworking technology, twined basketry decorated with false embroidery or overlay, basketry hats, intensive salmon harvesting, permanent villages or towns, and social stratification with hereditary slavery (Suttles 1990:4; Moss 1992). The precise boundaries of the culture area are not agreed upon for the NWC, though it is described as a distinct ecological region based on the availability of salmon (Ames and Maschner 1999; Carlson 1998:26; Drucker 1955; Kroeber 1939; Moss 2011:9; Wissler 1914). The focus of this research is on the northern NWC, which extends from the Copper River in the north to the southern end of Haida Gwaii and the central British Columbian coast as far south as Namu. Namu is a transitional site between the central and northern subdivisions (Ames and Maschner 1999).

In addition to cultural resource surveys and work conducted by the U.S. National Forest Service, there have been a few archaeological research projects within the study region. Maschner (1992) conducted surveys on Kuiu Island, just north of POWI, investigating the origins of political complexity. His research influences the parameters used in this analysis. Carlson and Baichtal (2015) have spent many years identifying archaeological sites prior to 5000 years ago when sea levels were above modern levels. The Gateway to the Americas I and II projects have focused on identifying archaeological sites in areas that are now submerged by sea-level rise using a land-use model. Though four years of survey did not identify any submerged archaeological sites, accompanying terrestrial survey supported the development and testing of the land-use model though the identification of 12 archaeological sites within high potential areas (Dixon and Monteleone 2014; Monteleone 2013; Monteleone et al. 2014).

THEORY

Human behavioral ecology (HBE) provides a theoretical platform upon which to conduct site locational analysis. Decisions people made were based on underlying logic to sustain the "group" or social system. At the scale of the archaeological record, these unconscious or conscious decisions to maintain homeostasis (or conscious decision to disrupt homeostasis) are what are discernable. The units of analysis are at the levels of group, social system or society, even though the aim is investigating how choices affect individuals' survival and reproductive success (Bettinger et al. 2015; Bird and Codding 2008:396; Johnson 1977:479; Kantner 2008:61). This means that HBE's goal of determining how ecological and social dynamics affect behavioral decisions within and between groups is expressed through the archaeological site locations dispersed throughout the study region.

A landscape is an *ecosystem* where humans interact with other species and the environment (Jochim 1981:4), thus setting the scale of analysis for using HBE to investigate the study region's archaeological site locations as a limited set. This is often termed "landscape ecology" (Anschuetz et al. 2001; Bender 2002; Casey 2008; Kantner 2008; Rossignol and Wandsnider 1992). A limited set is a specific dataset used to test general theory or assumptions, a middle-range theory or method (Bettinger et al. 2015).

Landscape archaeology is protean. It provides a conceptual framework to address all contexts of past human behavior and goes beyond an "environmental" approach. It is focused on things that locate humans spatially (David and Thomas 2008:38). Landscape archaeology is about place as a basic unit of lived experience (Casey 2008:44). Decision-making processes make hunter-gatherer subsistence economies perfectly suited to landscape and GIS studies as their main focus is on food procurement (Boaz and Uleberg 2000).

CULTURAL CHRONOLOGIES

Considering the linear extent of the culture area, the unity in the cultural chronology for the NWC is either an amazing historical fact, or a coincidence of archaeological research. Most researchers agree that by 5000 years ago, the culturally distinctive pattern of the NWC was "emerging" (Ames and Maschner 1999:87; Fedje and Mackie 2005:156; Fladmark 1982:103; Matson and Coupland 1995:9). Others, such as Carlson (1998) suggest there is evidence for a developed NWC culture type as early as 7000 years ago based on the deep stratigraphic record from Namu on the central British Columbia (BC) coast. Based on the consensus in the literature, the ethnographically described NWC culture type has persisted throughout the region since at least 5000 years ago. This may mark a transition to this distinctive culture type or a continuation. For this paper, the date 5000 BP marks both a chronological break and a change in the abundance of the archaeological record, since there are limited archaeological sites prior to 5000 BP for statistical analysis. The stabilization of sea levels is partially the reason for the break 5000 years ago. It is possible that there was a significant cultural change at that time. More likely, archaeological sites prior to 5000 years ago are more difficult to locate because they are associated with past coastlines that are either submerged (prior to 9200 years ago) or in the rainforest (from 9200 to 5000 years ago) and therefore difficult to identify (Carlson and Baichtal 2015; Dixon and Monteleone 2014; Monteleone 2013; Monteleone et al. 2014).

Archaeologists have developed numerous chronologies for the northern NWC to categorize cultural change and variability into units for analysis. Table 1 includes four chronologies for the northern NWC (Moss 2004:181). Fedje and Mackie's (2005) chronology incorporates different aspects of the older chronologies such as Fladmark's (1982:103) and includes location-specific chronologies such as those described by Burley (1980) for the lower mainland of BC and Carlson (1979) for the central BC coast. In this paper, the focus is on a small area in Southeast Alaska. These location-specific chronologies add noise or extraneous information to this analysis. This makes Fedje and Mackie's chronology unique as it acts as a link to earlier chronologies and to the more developed chronologies of the Fraser River Valley (Borden 1975; Matson and Coupland 1995).

There are a number of similarities between the four chronologies being reviewed in this analysis. All four chronologies identify a change at approximately 5000 ^{14}C years BP, except for Davis (1990) for whom the Paleomarine period begins at 6000 BP. Davis' extra 1000 years means that additional sites needed to be included in Davis' (1990) Transition Group. Moss (1998) uses environmental, rather than archaeological, parameters to divide the Holocene into early, middle, and late periods. All of the chronologies

Table 1: Cultural chronologies for the northern Northwest Coast. These chronologies were combined into groups (see Table 2) for further analysis.

Time (^{14}C years BP)	Davis (1990)	Ames & Maschner (1999)	Moss (1998)	Fedje & Mackie (2005)	
AD 2000	Late Developmental	Late Pacific	Late	The Developmental Stage	Late
1000 BP					
1500 BP					
2000 BP	Middle Developmental	Middle Pacific	Middle		Middle (Marpole)
2500 BP					
3000 BP	Early Developmental				Transitional (Locarno Beach)
3500 BP		Early Pacific			
4000 BP					Early (Charles)
5000 BP	Transitional				
6000 BP		Archaic	Early	The Lithic Stage	Early Coastal Biface Tradition & NWC Microblade Tradition
7000 BP	Paleomarine				
8000 BP					
9000 BP					
10,000 BP					
11,000 BP					

recognize the continuity of NWC cultures through time. This paper tests that continuity in terms of site location.

In this article, I categorize sites into nine temporal groupings (Table 2) based on the four established chronologies in Table 1. The category names are used in all subsequent tables. This analysis specifically focuses on the last 5000 years; however, Davis' (1990) Transitional period spans from 4000 to 6000 radiocarbon years BP and the corresponding sites are included in this analysis. There are only 14 sites older than 6000 BP in the archaeological site database provided in January 2009 by the Alaska SHPO office.

ARCHAEOLOGICAL SITE LOCATION DATA

Archaeological site information was collected from the Alaska Heritage Resources Survey (AHRS) database maintained by the Alaska SHPO's office in January 2009 as part of the Gateway to the Americas I project and the author's dissertation research (Monteleone 2013). The data encompasses all non-historic sites south of Juneau, Alaska. In total, there are 903 known archaeological sites within the study region (Fig. 2). Only 316 of these sites are dated and, therefore, are included in the statistical tests. Additional radiocarbon dates were obtained from published sources and the Canadian Archaeological Radiocarbon Database (canadianarchaeology.ca).

The archaeological site data included site name, number, a description (often minimal), location description, locational information (geographic coordinates), and a date. The site name, description, and location information were used to create "site types." Each of 903 sites were assigned to only one site type. All archaeological site types found in Southeast Alaska were incorporated in the modeling process and statistical analysis. Table 3 lists the nine identified site types and their frequencies in the study region. Site type was manually classified based mainly on the "type" field and site name provided by the Alaska SHPO office. The habitation (HB) site type includes sites described as forts, house depressions, and caves or rockshelters. Sites that were identified as burials or were only comprised of human remains were classified as the human remains (HR) site type. The lithic (LITH) site type was used for rock alignments and lithic scatters. Petroglyphs and picto-

Table 2: Chronologies grouped for statistical analysis. There are a total of 905 unique sites. Sites can be included in multiple groups because a site can span multiple time periods and be grouped differently depending on the chronology.

Reference	Chronological Period	Group	rcybp	Number of sites
Davis (1990)	Late Developmental	Late (all)	modern–1500 BP	84
Ames and Maschner (1999)	Late Pacific			
Moss 1998	Late			
Fedje and Mackie (2005)	Late			
Moss 1998	Middle	Moss (Middle)	1500–5000 BP	86
Ames and Maschner (1999)	Middle Pacific	Ames (Middle)	1500–3000 BP	74
Ames and Maschner (1999)	Early Pacific	Ames (Early)	3000–5000 BP	24
Davis (1990)	Early Developmental	Davis (Early)	2500–3000 BP	43
Davis (1990)	Transitional	Davis (transitional)	4000–6000 BP	15
Davis (1990)	Middle Developmental	Davis & Fedje (Middle)	1500–2500 BP	56
Fedje and Mackie (2005)	Middle (Marpole)			
Fedje and Mackie (2005)	Transitional (Locarno Beach)	Fedje (Transitional)	2500–3500 BP	37
Fedje and Mackie (2005)	Early (Charles)	Fedje (Early)	3500–5000 BP	14
			5000–6000 BP	6
			older than 6000 BP	14
			Total	453
			Unique	316

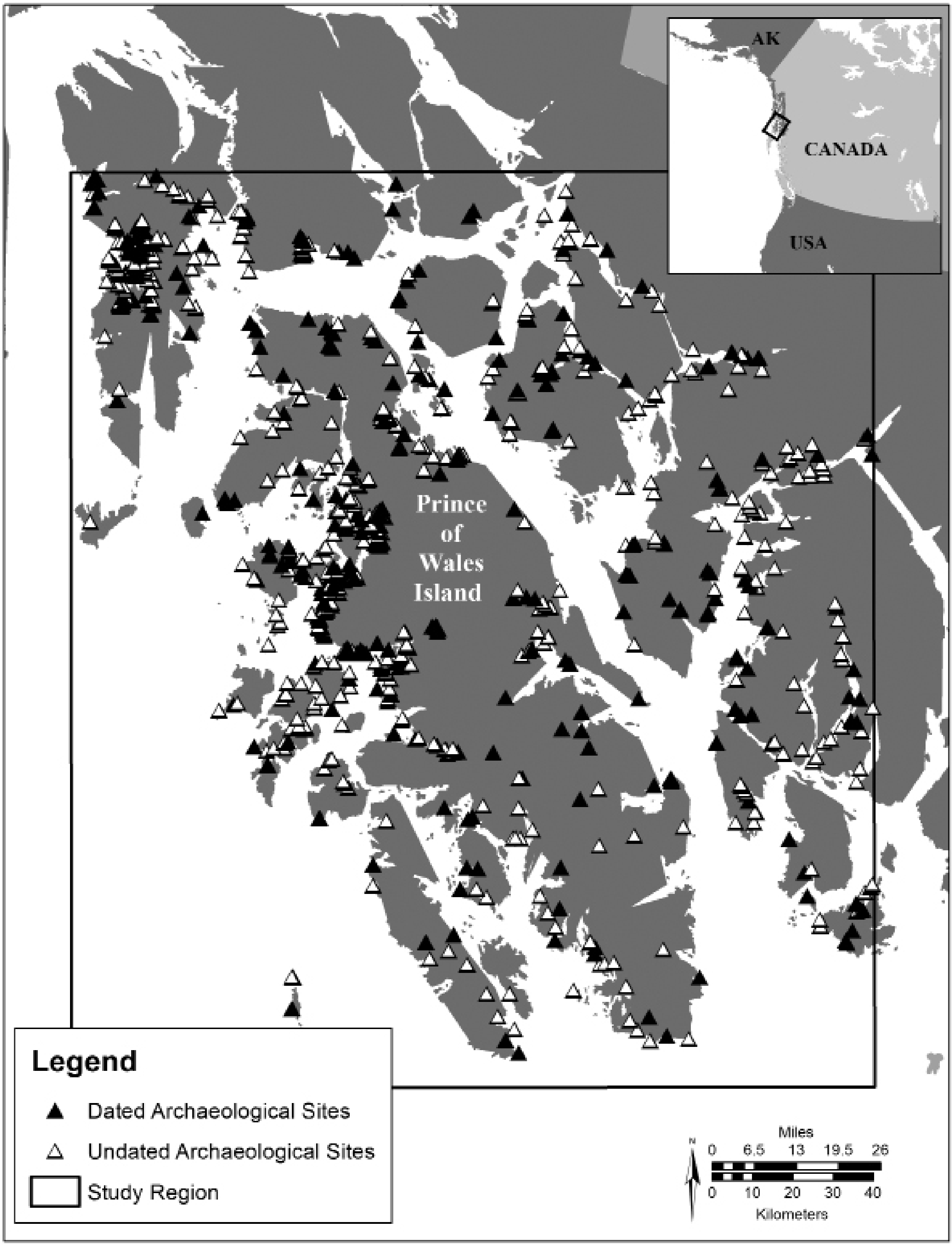

Figure 2: Map of known archaeological sites. Black triangles are sites that have dates and are included in this study.

graphs were classified as religious (REL) sites though the term may not be applicable to all of the sites. A subsistence (SUB) site contains evidence of food procurement, including archaeological features such as shell middens or other midden features, fish weirs or traps, and faunal remains. The transportation (TRAN) site type includes canoe landings, runs, and skids. Traditional use (TU) sites are usually more recent sites that are typified by culturally modified trees (CMTs) or trees stripped of bark, aboriginally logged, or modified to mark a trail. The mixed use (MIX) site type includes any two or more of the above listed site types. The unknown (UNK) site type was used when there was no AHRS site description. For example, 49-PET-408, On Your Knees Cave, is identified in the AHRS database as "Site, Cave, Human remains, Faunal remains" and is classified as MIX as there were human remains and other archaeological materials, including fauna, recovered from the site.

Many of the archaeological sites included in this analysis were recorded before handheld GPS and were digitized from paper maps when GIS became the archival medium of choice. This process often introduces locational or "validation" errors. Validation errors are introduced when incorrect data is inputted into a model or program, such as incorrect coordinates. For example, if a site was originally located and mapped on a flat beach, but the location description indicates it was 100 m to the east on a hill side, the site would appear sloped, rather than flat. Minimal site location bias is expected because the unit of analysis is 100 m^2 areas (10 by 10 m cell resolution), which will negate some of the locational errors.

Table 3: Site type frequency for study region.

Site Type		AHRS sites	Used in Analysis
Habitation	HB	31	9
Human Remains	HR	7	1
Lithic	LITH	10	7
Mixed (2 or more types)	MIX	222	149
Religious	REL	73	2
Subsistence	SUB	341	132
Traditional Use	TU	9	1
Transporation	TRAN	28	0
Unknown	UNK	182	15
Total		903	316

Kvamme (2006) recommends using a single site type for analysis, especially for site location modeling. Due to small sample size, all site types were incorporated into the analysis presented here. Requiring a minimum sample of 20 site locations per site type would eliminate lithic, traditional use, human remains, and historic types from the analysis, as each type has less than 20 sites. A minimum sample of 100 site locations per type would restrict analysis to only subsistence, mixed and unknown site types. Each of the 316 sites were characterized by a series of commonly used parameters.

ANALYSIS PARAMETERS

Parameters were chosen based on research done in the region (Carlson and Baichtal 2015; Maschner 1992), archaeological predictive models (Hamilton and Lacombe 1994; van Leusen et al. 2005), and available data. The parameters used in this analysis were slope; aspect; sinuosity; and distance from known archaeological sites, lakes, coast, and tributary junctions. I explain the values for each parameter using as an example On Your Knees Cave (49-PET-408) in the northwest corner of Prince of Wales Island. This is a cave site with archaeologically associated dates ranging from 1990 ± 95 (AA-21568) to 10300 ± 50 (CAMS-42381) radiocarbon years before present. This site also contains Pleistocene mammal remains that predate the human use of the cave. Because of the range in dates, the cave is included in seven of the nine chronological groups. Due to the potential for multiple occupations, each radiocarbon date counts as a single entry.

All of the parameters, except distance from archaeological sites, were derived from the digital elevation models (DEM) generated for the Gateway to the Americas II project and the author's dissertation (Monteleone 2013). All of the "distance from" parameters use multiple buffers to determine a ranked value, similar to concentric circles expanding from a site. This means that a location is classified into a distance category, not measured individually to the nearest point. This is because the data was derived for the land-use model used to help select survey locations for the Gateway to the Americas I and II projects. Modern coastline and sea levels were used for all distance measurements as they have not changed significantly over the last 5000 years. All seven parameters were calculated using the "identify feature" in either GRASS GIS or ArcGIS; this feature characterizes the archaeological site's point location "on top" of a raster layer describing each parameter. For example, a dot or point on a map over an eastern aspect would produce a result of "east." Slope, aspect, sinuosity and distance from parameters of the known site locations for the last 5000 years were derived from GIS analysis.

Two attributes commonly used in site description are slope and aspect. Slope is the change in elevation over a specified distance (rise over run). In a GIS, it is the difference in elevation from one 5 m^2 cell to the adjacent cell. Slope has an average of 7.7° and a median of 4°, essentially a slight or moderately flat slope. On Your Knees Cave has a slope of 4° (moderately flat). This is somewhat deceptive because the site is located on a steep hill; however, this value indicates that the location is flat in a small area within a steeper area.

Aspect is the cardinal orientation of the landform. Aspect is derived from the 5 m^2 area where the site is located. Ideally, this parameter would identify the aspect of the site, but unfortunately, the landscape is often what is characterized. The average aspect is 153° or south-southeast. The median is 170° or approximately south. Maschner (1992) characterized 150 archaeological sites spanning the last 4500 years, located on Kuiu Island, just north of the study region, as generally having southerly exposures. The slope and aspect averages fit with Maschner's (1992) analysis. The aspect for On Your Knees Cave is 300° or west-northwest overlooking Sumner Strait.

Distance from fresh water is very important for human settlements (Erlandson et al. 2008; Mandel and Simmons 2001). This area is a temperate rainforest, so sources of potable water are abundant. This parameter was calculated from a DEM with a resolution of 10 m^2 using buffered distance categories of 100, 500, 1000, 2000, and 3000 m from water sources. Water sources include rivers and streams, tributary junctions between rivers, streams and/or lakes. Distances from water sources were calculated using the basin fill module in ArcGIS; essentially these are low points on the landscape that could have been, and likely were, lakes, marshes or wetland environments. The median distance from sites to potable water sources is 418 m. As these features are simple points (tributary junctions), lines (streams), and polygons (lakes), archaeological sites are not expected adjacent to but rather within a short distance of the GIS element. For example, a tributary junction for two streams is a single point, but the width of the actual streams may be several hundred meters. Hence, a median distance of known archaeological sites of 418 m away from water is explained by a combination of wide rivers, adjacent marshlands, and changing environments over the last 5000 years. On Your Knees Cave is categorized as a site 2000 m from a source of fresh water.

Using the concept of home range (Brown 1995), distance from one known archaeological site to another was used as a parameter to increase the weight for areas known to contain sites. Twenty-five percent of the known sites in the study region are within 70 m of another site and 50% of the sites are within 416 m of another known site. On Your Knees Cave does not have a known site within 3000 m.

In this article, sinuosity was calculated as the average of the length along the coast divided by the linear length of a line segment for each line section (Fig. 3). This parameter is often used to describe the shape of rivers where the ratio is the channel length to the downvalley length of the river (Leopold and Wolman 1957; Petrovszki et al. 2012; Schumm 1963; Timár 2003). Sinuosity reflects the amount of coastline available from a site location. Greater sinuosity can indicate increased resource availability within a specified distance (Mackie and Sumpter 2005). On Your Knees Cave has a sinuosity value of 4.0, as it is located 389 m from the coast. This sinuosity value is a moderate one and indicates that the coast is mostly straight but has some undulations. For this analysis, sinuosity was derived from an automated process (or program) created using a python script that measures the shape of the coast for each point along a coastline within a three kilometer diameter area or buffer. The results ranged from 0 to 87.0. The points are located 50 m apart along the entire coastline (Monteleone 2013). The mean distance of recorded archaeological sites from the coast is 676 m. However, 50% of the sites are less than 182 m from the coast (essentially on the beach) and 75% are less than 550 m from the shore. The mean sinuosity value for the modern coast is 19.0. The mean coastal sinuosity near known archaeological sites is 4.7. The sinuosity value assigned to an archaeological site is that of the closest point along the modern coast. A paired t-test was run between all of the coastal sinuosity values and coastal sinuosity values nearest to known archaeological sites. The sinuosity values are close to a normal distribution; hence, a t-test is valid for the comparison. The null hypothesis is that the mean of the coastal sinuosity and the mean of the coastal sinuosity values nearest to known archaeological sites are the same at a 95% confidence interval. The p-value for the paired t-test is > 0.000 (t is –6.633 and 334 degrees of freedom),

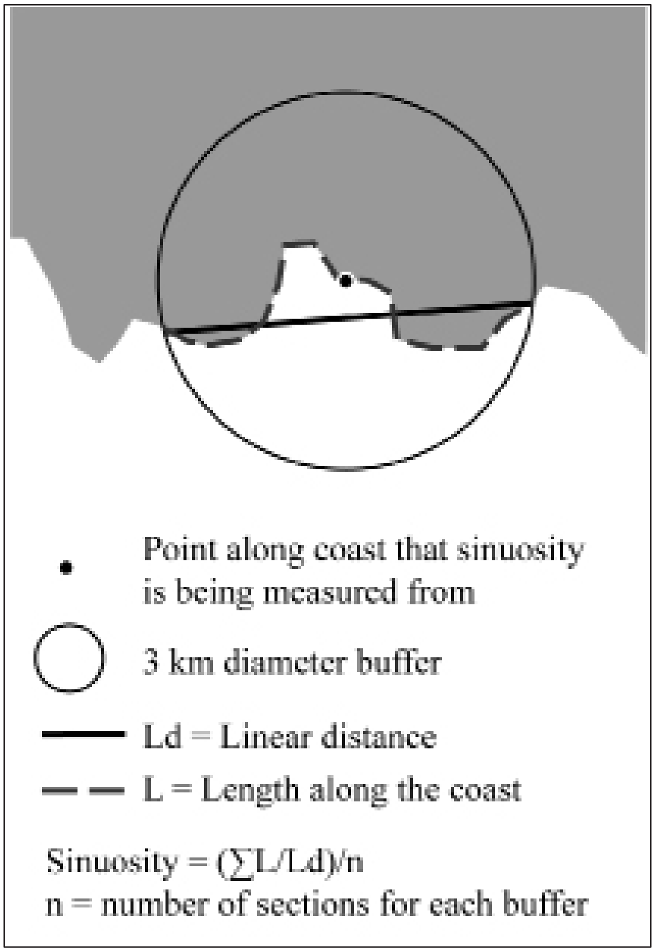

Figure 3: Sinuosity is the average of the length along the coastline divided by the linear length of the line segment within a 3-km buffer diameter around each point along the coast.

indicating that the two sinuosity values are different. The null hypothesis can be rejected, meaning there is a statistically significant difference between mean coast sinuosity and coast sinuosity closest to known archaeological sites; people choose sites that are located in areas where coasts are more sinuous than the average sinuosity for the region. This suggests that people may have selected moderately complex coastlines for land-use and subsistence purposes for the last 5000 years. In effect, people chose to live near coastlines that offered a spectrum of available resources that were intermediate between straight and highly convoluted. The immediate area of the intermediate coastlines includes straight sections and sections with bays, inlets, or estuary-like environments.

CHANGE IN SITE LOCATION THROUGH TIME

Assumptions about site locations create descriptive tautologies; these assumptions will be tested here using a limited set. The hypothesis being tested is there were no significant changes in site locations over the last 5000 radiocarbon years BP using a one-way ANOVA with groups with a confidence interval of 95% (or an alpha of 0.05). The ANOVA allows for comparison of multiple cultural phases and parameter combinations at once and identifies outliers that do not support the null hypothesis. Paired t-tests can reduce specific parameter combinations that do not meet the null hypothesis, or indicate variability. The paired t-test compares the sample populations of each cultural phase. The analysis was conducted using SPSS 21, the Statistical Package for the Social Sciences .

The ANOVAs compare the mean locations of archaeological sites for each cultural phase identified in Table 2. Table 4 presents the results. Slope is the only parameter for which the null hypothesis can be rejected, i.e., the mean value for slope varied between cultural phases with a confidence interval of 95% (or alpha of 0.05). These results indicate that archaeological site locations over the last 5000 years have not varied significantly in terms of aspect, sinuosity, and distance from known archeological sites, lakes, coast, and tributary junctions. Slope, however, did vary slightly.

Slope was analyzed further using paired t-tests with a confidence interval of 95% (alpha of 0.05) (Table 5). The null hypothesis of the t-test is the same as that for the ANOVA: that mean slope is the same for each cultural period. Only three pairs out of 36 can reject the null hypothesis (in bold in Table 5); therefore, the slope of sites only differed in three comparisons of out 36 possible. The first t-test pair that was below the 95% confidence interval is between the late periods and Fedje and Mackie's (2005) Early Period with a significance value of 0.03. This pair is at each end of the temporal spectrum. The second pair is between Moss's (1998) Middle Period and Ames and Maschner's (1999) Middle Period with a significance value of 0.03. This is possibly because Moss's period extends 2000 years longer than Ames and Maschner's Middle Period. The final pair in which the null hypothesis must be rejected is Fedje and Mackie's (2005) Early Period and Davis' (1990) Transitional Period where the significance value is 0.04. Here Davis' (1990) period extended beyond

Table 4: Results of grouped ANOVA. Null hypothesis is that the different chronological groups are equal at a confidence interval of 95% (or an alpha of 0.05). This means that the null hypothesis cannot be rejected, i.e., that the chronologies are statistically the same except for slope (in bold) as it has a p-value of less than alpha.

ANOVA					
		DF	Mean Square	F	Sig.
Slope	Between Groups	8	397.71	2.32	0.02
	Within Groups	647	171.22		
	Total	655			
Aspect	Between Groups	8	14534.61	1.26	0.26
	Within Groups	647	11510.72		
	Total	655			
Sinuosity	Between Groups	8	2.85	0.31	0.96
	Within Groups	647	9.14		
	Total	655			
Distance to nearest coast	Between Groups	8	363708.29	0.14	1.00
	Within Groups	647	2596802.33		
	Total	655			
Distance to nearest Lake	Between Groups	8	433800.60	1.10	0.36
	Within Groups	647	392862.47		
	Total	655			
Distance to nearest site	Between Groups	8	330406.93	0.42	0.91
	Within Groups	566	778910.03		
	Total	574			
Distance to nearest tributary	Between Groups	8	413809.57	0.59	0.79
	Within Groups	566	707082.86		
	Total	574			

the other chronologies to 6000 years ago, and this might be affecting the results. Despite any assumptions as to why these three combinations are outside the confidence interval of 95%, all t-test values are within the 99% confidence interval or alpha of 0.01. Further analysis with a larger database of dated archaeological sites may relate this difference to site type. For example, culturally modified trees may be located on steeper slopes than habitation sites.

DISCUSSION

The statistical analyses of known archaeological sites in Southeast Alaska indicate that preferences for locations to live, hunt, and gather have not changed significantly in the last 5000 years. The choices people made are reflected by these site locations within the landscape. This statistical analysis confirmed that the locations have remained

Table 5: Results of paired t-tests for slope where the null hypothesis can be rejected. The null hypothesis is that the pairs are equal at a confidence interval of 95% (or an alpha of 0.05). At 99% confidence interval (alpha of 0.01), the null hypothesis cannot be rejected, i.e., even these three pairs are statistically similar.

Paired Samples Correlations				
		n	Correlation	Sig.
Pair 7	Slope of All Late & Slope of Fedje Early	30	0.39	0.03
Pair 10	Slope of Moss Middle & Slope of Ames Middle	101	0.21	0.03
Pair 34	Slope of Davis Transitional & Slope Fedje Early	24	-0.42	0.04

statistically similar for this entire period (except for a few anomalies related to slope). This result, combined with the chronologies themselves, implies continuity in population and culture over the last 5000 years in the analysis area. Cultural phases have traditionally been identified on the basis of material culture and, second, patterns of site location. In this region, while material culture has changed over 5000 years, site locations have remained statistically similar, indicating that people made similar choices through time when selecting locations for hunting, fishing, and gathering. Within a larger framework for cultural chronology, the last 5000 years within the Alexander Archipelago could be grouped into a single cultural stage, as suggested by Fedje and Mackie's (2005) Developmental Stage. The smaller phases are then more nuanced extrapolations from the material culture.

This research is limited by the accuracy of the coordinates provided for each archaeological site. The resolution of 100 m^2 is relatively fine grained and incorporates significant topographic features. Only features smaller than 100 m^2 (a 10-meter cell size) are excluded from this analysis. Issues of location related to coordinate system biases, inaccuracies in global positioning system (GPS) coordinates, and the inevitable errors associated with digitizing may have affected the results of this study; however, the 10-meter cell resolution used for the GIS analysis is intended to minimize these issues.

The consistency of site locations through time does not mean that people lived in the same places for the last 5000 years, but that they made similar choices. Cultural continuity on the NWC is expressed by similar responses to choice, as seen through consistent patterns of decision-making with regard to site location and material culture. The statistical analysis demonstrates that there was continuity in decision-making regarding site location. When past people set up a village or a camp, they selected a location that was about 500 m from a fresh water source. They usually chose sites within 500 m of a coast along a moderately sinuous shoreline, an undulating shoreline with some short, straight stretches. Preferred sites included beaches with good shellfish habitat, for clam gardens, for example (Williams 2006), and/or salmon-bearing stream outlets (Langdon 1977; Mackie and Sumpter 2005). Additionally, a moderately sinuous shoreline is consistent with oral history descriptions of preferred places to pull a canoe onto a beach and to see friends and enemies approach by water (de Laguna 1990). Preference for village locations included: a sheltered bay from which there was a view of the approaches, a sandy beach, proximity to salmon streams, hunting areas, berry patches, clam beds, fresh water, good timber, or special resources (such as deep water for halibut, sealing grounds, or trails to the interior) (de Laguna 1990:206–207). The slope that these people preferred may have varied slightly but was less than 10° and usually less than 5°, i.e. gentle to flat slope.

There were undoubtedly other factors that affected where NWC people chose to live, such as proximity to other resources, social and cultural factors, and weather. The parameters analyzed here—slope, aspect, sinuosity, and distance to the nearest lake, site, tributary, or coastline—can be consistently measured and compared. The other variables influencing decision-making by past people generated additional diversity in archaeological site locations. Nevertheless, the ANOVA and subsequent paired t-tests demonstrate that there was cultural continuity in site location for the last 5000 years within the study region.

There are too few archaeological sites in the region dating to before 5000 radiocarbon years for reliable spatial analysis. Additionally, 5000 years ago is when sea levels stabilized near their modern levels (Carrara et al. 2007) and marks a shift in the material culture of the region. "All large concentrated shell-midden deposits on the Northwest Coastal, from the Aleutian Islands to northern California, post-date 5,000 BP and the vast majority have basal dates around 4,000–4,500 BP" (Fladmark 1982:110). This shift has been recognized in three of the four chronologies discussed above; each identifies a break at 5000 BP. Cultural continuity on the NWC cannot yet be extended further back in time. Several sites utilized prior to 5000 years ago are on elevated marine terraces indicating that land/sea relationships changed as sea levels rose and subsequently fell to modern levels (Carlson and Baichtal 2015; Dixon and Monteleone 2014). Cultural continuity has been argued at Namu (Carlson 1998) for the last 7000 years. Further survey and dating of archaeological sites in the region may challenge this assumption.

CONCLUSION

Oral histories state that the people and cultures of the NWC have occupied Southeast Alaska since "time immemorial" (Central Council n.d.). The results of this analysis are consistent with this statement for at least the last 5000 years. As for the various cultural chronologies that currently exist for the study region, this analysis indicates that grouping the last 5000 years into a single Developmental Stage has some merit, as was originally proposed by Fladmark (1982) and is now part of Fedje and Mackie's (2005) chronology. The variability of this limited set has been quantified and can be and has been used in models to identify areas with high potential for archaeological sites. The results presented here indicate that cultural chronologies should not rely on site location or site location variability as temporal markers . Chronologies based on changes in tool and other artifact types make sense, such as those discussed in Fedje and Mackie (2005).

This analysis demonstrates continuity in preferred site locations, but does not explain why people chose to live, hunt or gather in a particular location. Factors such as a "good" view, protected beach, plant and animal resources, and many other factors that cannot be quantified or reconstructed for the past played important roles in these decisions. This spatial analysis further supports prospective site locationsand the land-use model created to locate archaeological sites within the study region (Monteleone 2013). Carlson and Baichtal's (2015) work in the study region and Fedje et al.'s (2005:163–186) on Haida Gwaii have demonstrated that sites are found in similar locations prior to modern sea level stabilization 5000 years ago. Analyses like that reported here enable archaeologists to locate archaeological sites in landscapes that may not have been previously surveyed by quantifying spatial parameters such as slope, aspect, sinuosity, and distance from fresh water and other resources. Further work will test whether cultural continuity on the NWC can be quantitatively extended back to 7000 years or even farther out onto the continental shelf.

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