

A PREDICTIVE MODEL OF THE WIYOT CULTURAL AREA
IN NORTHWEST COASTAL CALIFORNIA
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ABSTRACT

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The focus of this thesis is a Geographic Information System (GIS) based predictive modeling process with results as applied to the Wiyot Cultural Area in Humboldt County, California. Predictive models aim to identify patterns that demonstrate a range of human activities, especially economic maximization and cognitive cultural decisions. This model relied on secondary document analysis in order to recreate the prehistoric environ and identify site type and use areas including historic maps, oral history, ethnographic documents and archaeological site records. Logistic regression was employed to discriminate significance values among the variables derived from the document analysis, selecting the strongest environmental and cultural variables for the modeling process. Topographic setting, distance to prairies, and distance to navigable waterways were selected as variables significant at the 0.05 level. Distance to freshwater, elevation, and vegetation setting did not meet the criteria for significance and were excluded. A relative probability map was produced which indicated both site and non-site locations within the study area. Internal and statistical testing showed that although only three variables were employed, the model exhibited a 66% predictive success rate with a 71% increase in performance over random guessing.

The goal is for this model to be employed as a management, planning, and research tool for the Humboldt area. It is to be used as a voice of empowerment for indigenous peoples in their efforts to preserve prehistoric sites and sacred spaces on lands that encompass their traditional cultural area, but are officially owned or managed by non-tribal entities.

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Special thanks to my graduate peers Sara Keeble, Brian Huggett, Jason Brown, and Chantall Royer. I state implicitly you each contributed to my success as there are parts of this I could not have gotten through without your technical contributions to (and emotional support for) my work. For math consultations, I am grateful to Rob Van Kirk and Chris Dugaw; your generosity saved my sanity.

To the Wiyot Tribe of Table Bluff, thank you for entering into this relationship with me; I complete this work for the benefit of all people in Wiyot country. Also to Karin Anderson for teaching me how to read a compass, starting me in so many right directions.

Lastly but chiefly I am most thankful to my husband Tommy, my daughter Veda, and my mom Mary, who endured this process alongside me. Your faith in this venture, your love, and your support of all kinds has propelled me through this entire process. Thank You for believing in me.

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INTRODUCTION

My focus in this thesis was to develop a predictive model of cultural sensitivity and validate the results in the Wiyot Cultural area in Humboldt County, California. Predictive models aim to identify patterns that demonstrate economic or cognitive cultural processes such as minimum-maximum populations, socially related territories, cultural diasporas (Gusev *et al.* 1999; Kvamme 1999), travel and maritime access (Madry and Crumley 1990), and intensity of occupation (Lookabill 1998). Predictive modeling contributes to understanding land use patterns employed by prehistoric hunter-gatherer peoples.

A GIS based predictive model can store, analyze, and convey data with many parameters. For this model I relied on secondary document analysis to recreate the prehistoric environ and identify site type and use areas. Available data for site locations and use types included historic maps, oral histories, ethnographic documents and archaeological site records. These documents provided information about environmental and cultural characteristics observed over the study area. My study confirms the value of ethnographic literature and the archaeological record to contribute to current studies and community planning with regard to cultural resources and modern identities, and also addresses some challenges of working with these kinds of records and documents.

Examination of epistemological methods that produced these records acknowledges that archaeological and ethnographic documentation have interpretive and data accuracy issues (Clifford 1998; Dalla Bona 1994; Duncan and Beckman 2000 in

Ebert 2000). Movements by indigenous communities to reclaim and recontextualize the written record are healing cultural identities often misrepresented, broken, and disjunctured via political, environmental, racial, religious, and economic agendas (Churchill 2004). Engaging multi-versal beliefs and non-linear modes of interpretation promote a broader culture scope aiming to share knowledge and power between entities based in cultural resource preservation.

The GIS environment is an important tool for rapid communication and empowerment. It is a tool that translates ideology, fact, and belief systems into maps and data. This serves as a voice of empowerment for indigenous peoples in their efforts to preserve prehistoric sites and sacred spaces on lands encompassing their traditional cultural area, but officially owned or managed by non-tribal entities. Giving voice to indigenous communities contributes to research which guides the policies that shape cultural resources laws and management at both the local and national levels.

My goal is that this model will be employed as a management, planning, and research tool for the Humboldt area. The model showed promising results in its potential to aid the early stages of land planning processes. Internal and statistical testing showed the model provides a sound foundation which can be improved upon. The model identified some trends in settlement patterning and land use in the Wiyot cultural area.

To understand the ethnographic and archaeological literature of the region, it was important to understand the context in which this body of work was generated. This required a review of literature concerned with the formation of anthropology and archaeology as formal disciplines (Devine 1994; Ferguson 1996; Fowler 1986; Gruber

1986; Heizer 1965; Kronfeldner 2008; Lekson 1988; Levine 2003;1986; McGuire 1992; Meskell *et al.* 1998; Murray and Evans 2008; Newman 1996; Patterson 1986; Stewart 1961;Trigger 2006; 1989; 1980; Willey 1980; Willey and Sabloff 1993) and changes in latter 20th century archeology and ethnographic practices (Arnold 1993; Barnard 2000; Bielawski 1989; Ferguson 1996; Fixico 1997; Frison 1989; Fowler 1986; Geertz 1973; Hymes 1974; Keeley 1980; Kuznar 1996; Neuman and Sandborn 2001; Wiley and Sabloff 1980; Wilmer 1993; Zimmerman 1989).

In response to past anthropological methods and the resulting documentation of cultural histories, both indigenous and academic reviews discuss the reclamation of identities (Battiste 2000; Behrendt 2004; Berkes 1999; Cheek 1984; Churchill 2004; Fagan 1995; Findlay 2000; Henderson 2000; Hingangaroa-Smith 2000; LaPlant 2008; Nichols 1989; Purdy 1988; Rubertone 1992; Smith 1999; Trigger 1980; Wylie 1992) the re-contextualization and criticism of past histories by both indigenous and anthropological researchers (Ahler 1994; Barnard 2000; Bielawski 1989; Blancke and Slow Turtle 1990; Condori 1989; Crapanzano 2005; Devine 1994; Fagan 1984; Ferguson 1996; Echo-Hawk 1993; Fixico 1997; Fowler 1986; Geertz 1973; Handsman 1989; Holland 1990; Hymes 1974; Jamieson 1994; Kuznar 1996; Males 1989; Rappaport 1989; Riding 1992; Wylie 1992; Zimmerman 1995, 2003) and the resulting environment of consultation between the archaeological and indigenous communities (Adams 1989; Buikstra 1981; Burney 1994; Colwell-Chanthaphonh and Ferguson 2006; Ferguson 1996; Johnson 1973; Klesert 1990; Lynott 2003; McManamon 1991; McGimsey and Davis 1977; McManamon 1994; Scarre and Scarre 2006; Sprague 1974; Ubelaker 1989;

Zimmerman 2003). A discussion of cultural resource management today highlights the present state of practices where these fields currently intersect (Anyon 1995; Barrios 1993; Bielawski 1989; Deloria 1992; Ferguson 1996; Klesert 1992; Reid 1992; Schwab 1992; Sullivan and Hawkins 1994; Zimmerman 2003).

Additionally, a review of the practice of ethnography itself allowed for a better contextual understanding of the written record, the position of the authors, and their contributions to the study area (Clifford 1988, 1998; Beckman in Ebert 2000; Crapanzano 2005; Dalla Bona 1994; Duncian and Geertz 1988; Hastrup 1992, 1995; Mauss 1924; Rabbinow 1986). The literature regarding coastal cultures in the area had a few early contributors (Gibbs 1853; Powers 1872; Thompson 1916), but most documents were generated in the early part of the 20th Century (Berman 1986; Drucker 1937; Goddard 1902, 1904, 1905, 1914a, 1914b; Harrington 1932; Kroeber 1925; Kroeber and Nomland 1936; Waterman 1920), with a few more works published between 1957 and 1996 (Bright 1957; Elsasser 1965; Golla 1979; Heizer 1965; Teeter 1964). Recent archeological publications on the area were reviewed as well (Chartkoff and Chartkoff 1984; Eidsness 1988, 1993; Fredrickson 2007; Moratto 1984).

Themes regarding the modeling environment included the theory of predictive modeling (Bang-Andersen 1996; Church *et al.* 2000; Ebert 2004; Ford *et al.* 2009; Gaffney *et al.* 1996; Gregory and Healy 2007; Gusev *et al.* 1999; Keene 2004; Keegan 1986; Kohler and Parker 1986; Llobera 2000; Lookabill 1998; Maschner 1992; Maschner and Stein 1995; Madry and Crumley 1990; Savage 1990; Zubrow 1990), methods of working with available data (Bang-Andersen 1996; Butzer 1982; Ford *et al.* 2009; Gusev

et al. 1999; Lookabill 1998; Maschner and Stein 1995; Madry and Crumley 1990), the transformation of hard copy and digital data into the GIS environment (Bang-Andersen 1996; Bell and Neuman 1997; Faught 2004; Ford *et al.* 2009; Ebert 2004; Hageman and Bennet 2000; Kvamme 1992; Llobera 1996) and methods of testing the strength of a model (Connolly and Lake 2006; Wheatley and Gillings 2002).

Archaeology and Ethnography from Nacent Anthropology

The written record is a powerful entity, thus the body of ethnographic and archaeological data has been used for many purposes since their formalization. Although many archeological discoveries and ethnographic monographs illuminate our collective past, early documentation of these discoveries were influenced by socio-cultural presumptions, political agendas, and emergent theories. Archaeology, born at the intersection of natural and social sciences, struggled to define the discipline and its processes.

Early Archaeology History

Archaeology, particularly in the western professional and systematic definition, had its beginnings in the early 17th century, primarily in European and Scandinavian countries (Trigger 2006; Levine 1986). Couched as a way to investigate the history of the civilized world, archaeological practices were sometimes governed by imperialistic or colonial imperatives, subsequently providing justification for present western hegemony through their interpretation of the past and the exploitation of cultural patrimony (Ferguson 1996; Devine 1994; Trigger 2006; Levine 1986). This “data” was often used to

re-affirm European origins and construct a “superior western identity”, reinforcing the idea of light-skinned superiority over “savages” as well as racial, genetic, and nationalistic divisions (Arnold 2008; Gruber 1986; Patterson 1986; Trigger 1989; Ferguson 1996; Levine 1986; Meskell *et al.* 1998; Murray and Evans 2008; Trigger 2006). In a colonial and imperialistic sense, ethnographic information was used as a way to emphasize the “Other” and dehumanize conquered persons (Asad 1973; Trigger 1989). The discipline was also used to advance religious agendas and imperatives, searching to confirm Biblical or religious events through archaeological explorations in Mesopotamian and African lands (Trigger 2006).

As European and American exploration began in the Americas, some systematic procedures were being embraced by archeology. These early signs of professional methodology were fashioned after those found in the biological sciences (Barnard 2000). This was evident in the methods and notes associated with mid 18th century surveys of American Indians in North America (Barnard 2000). Despite the growing body of archaeological evidence, interpretive assertions regarding new world inhabitants still supported a legacy of colonial preference over an inferior “race”, cultural and gender bias in interpretation, and the loss of cultural patrimony to predominantly western institutions (Blakeslee 1987; Fowler 1986; Lekson 1988; McGuire 1992; Trigger 1980, 1989; Willey 1980). The scientific community asserted that rich cultural traditions they encountered archaeologically, such as the Cahokia Mounds or Southwestern Pueblo architecture, could not have been propagated by the “inferior” native populations of the Americas (Ferguson 1996; Levine 1986; Trigger 1984, 2006).

However, in examining historic literature, understanding the context in which events were recorded is key to understanding underlying sentiments and meanings in the written record. The general impression that all archaeological endeavors were driven by colonial domination is refuted by Asad (1973). He warns consumers of anthropological literature to acknowledge that these works are from a different time and exemplify the existence of “older, traditional theoretical frameworks” with inadequacies that can be corrected (Asad 1973).

The early half of the 19th century brought many changes to the discipline, both refining and dividing historical disciplines (Levine 2003). As professional organizations such as the Society for American Archaeology (SAA) and the Register of Professional Archaeologists (RPA) had not yet been conceived, the profession consisted still of both academics and enthusiasts. American and European Antiquarian Societies, which embodied a wide range of people and interests, were distinguished from “professional” historians and archaeologists by their lack of formalized University education (Levine 2003). The latter group of “professionals” consisted almost exclusively of white men of middle or upper class privilege (Levine 1986). Thus it was a time of processual beginnings without theoretical constrictions, meaning that a framework of acceptable measures and methods was beginning to emerge and be embraced by those aiming to be scientific or academically rigorous. In essence, one need not have a research angle, nor a great deal of formalized training to collect data, but had to be somewhat recognized and sanctioned by an “authoritarian entity”. In later years, the SAA and the RPA as well as the United States Secretary of the Interior would set standards and define who could hold

title and practice sanctioned, institutionalized archaeology based on education and experience (Patterson 1986)

This transitional period did promote professional standards and bring about public awareness of cultural histories. Universities began cultivating professional standards as well, calling for peer review, publication of findings, and an epistemological basis for research and explanations going beyond natural selection and primitive development theories (Murray and Evans 2008; Patterson 1986; Trigger 2006). Additionally, the U.S. government began targeting those who traded and sold Indian relics on the free market with the passing of An Act for the Preservation of American Antiquities Act in 1906 (16 USC 431-433) in an effort to curb looting and exploitation of Native American artifacts. Lastly, popular literature was spreading more archaeology and ethnography to the masses, still focused largely on the monumental, absurd, and romantic notions of exotic culture (Murray and Evans 2008).

A paradigm shift was evident at the turn of the 19th century as theory was now leaning away from biological and linear-evolution theories towards a cultural-historic basis of documentation and interpretation that was regionally or culturally specific (Trigger 1980, 1989; Willey 1980). This change in theoretical direction began to support the body of irrefutable data that had been collected to date in the America's resulting, finally, in the recognition of indigenous cultural florescence, and continuity, on the American continents (Trigger 1980, 1989; Willey 1980; Willey and Sabloff 1993).

Institutionally at the beginning of the 19th century, the incipient discipline of anthropology began to receive generous philanthropic and university support and

advanced degrees specifically in anthropology became available (Patterson 1986; Stewart 1961; Heizer 1965). The next few decades of theoretical concerns focused primarily on classification and descriptive methods (Wiley and Sabloff 1980). Much research was framed under the Functionalist school of thought exemplified by Levi-Strauss, Malinowski, Radcliffe-Brown, Durkheim, and Mauss, or Structuralist as exemplified by Levi-Strauss, Foucault, Hawkes, and Lacan. These schools of thought focused on the place of the individual and its constraints within society, or societal structures as a whole respectively (Bohannon & Glazer 1988). Later, cultural relativism was emphasized and in the forefront of discussion, manifesting in the traditions of Boas and Malinowski (Barnard 2000). Because of their universality, applicable to any level or type of society, these theoretical frameworks combined to further refute the racism found in 18th century eugenics and colonially inspired anthropology (Newman 1996). Chronological and temporal schemes for cultural areas were emerging as important research topics and would remain strong through the century (Wiley and Sabloff 1980; Barnard 2000). It was also at this time that the sub-disciplines of archaeology and ethnography were becoming distinctive, their self-identification signaling divergence in both practice and theory (Kronfeldner 2008).

Professional Growth in the 20th Century

Fully emergent by the 20th Century was the “ethnographer”, institutionally ordained to be the interface between native societies, academic institutions, and the public at large. Ethnographers were poised to connect with indigenous peoples through

the observation and documentation of “other” living cultures. There was an academic urgency to “capture” these vanishing societies in documentation, as they were likely “too weak to maintain their identity in the face of capitalism and modernization” (Patterson 1986). Demonstrations of these ‘living savages’ were notable at public venues such as the University of California Berkeley where one could watch a Yuki Indian named Ishi make projectile points (Kroeber and Kroeber 1961). Ethnography grew as a popular literature genre as well, evidenced by the success of such publications as *Coming of Age in Samoa* by Margaret Mead (1928).

Simultaneously at that time, archaeological praxis moved away from biologically based narratives to regionally and contextually specific cultural studies (Barnard 2000). Up to the 1930’s this was largely visible in the form of accessing monumental sites, primarily through institutional alignments between state bureaucracies and powerful foreign governments. According to Ferguson (1996) and Patterson (1986) this continued a reinforcement of the social inequality in these countries by emphasizing the highly visible stone complexes and city centers (aristocracy) and ignoring the complexity of the remaining social structure such as slave’s quarters and outlying agricultural contributors. Museum professionals were still enmeshed with both disciplines, as all three required the maintenance, interpretation, and storage of artifacts.

The 1930s to the 1960s noted a shift in the over-arching process of archaeology and ethnographic work in the United States. Both disciplines, under the umbrella of anthropology, enjoyed funding from The Smithsonian, academic institutions, New Deal programs, and the Work Progress Administration (WPA) Projects (Neuman and Sanford

200; Yellen and Green 1985). Historic preservation as a sense of civic duty was gaining momentum, manifested in the passing of The Historic Sites Act of 1935 by the U.S. Congress (Newman and Sanford 2001). This period emphasized Classificatory–Historical processes and is associated with such researchers as Rouse, Taylor, Radcliffe-Brown, Wiley, and Steward (Wiley and Sabloff 1980).

At that time, archaeologists became increasingly critical of their own discipline. Criticisms included citing sloppy fieldwork in the face of project deadlines, excavation for excavations sake and not for research, and a lack of analysis and publication (Neuman and Sanford 2001; 9). Researchers moved towards a period of theory based explanations of societal changes, past cultural adaptations, and the power of individual agency. Socially, they were becoming more aware of the indigenous presence in the field. This went very much in hand with the burgeoning social and environmental movements of the 1960's and 1970's; the separate disciplines of archaeology and ethnography were about to find themselves to be very close bedfellows once again.

Fundamental Changes in Practice

The Processual or New Archeology of the 1960's and 1970's was a response not only to legislation, but to the internal and external criticisms of the archaeological field. Internal issues were concerned with theory, cultural affiliations, and comparative processes while external critiques came from the social movements of the day. Theory at this time emphasized the scientific approach with the added goal of getting beyond artifacts and attempting to delve into the lives of the people of the past (Kuznar 1996).

This processual mode of research is discussed in the works of Binford (1967, 1977, 1982), Binford and Sabloff (1982), Fritz and Plogg (1970), Shiffer (1976), and Watson, Leblanc and Redman (1971, 1984) and emphasizes Middle Range Theory.

One of the central tenets of this mode of research is that the archaeological evidence is immutable (in that if it was properly recovered, it cannot be fabricated) and all claims must be checked against the evidence (Kuznar 1996). Aiming to be scientifically defensible, one of the manifestations of this practice was experimental archaeology which aims to replicate prehistoric activities to confirm the assessment of cultural residue (Frison 1989; Keeley 1980; Arnold 1993). Ethnography retained a vital role in this period of archaeology as ethno-historic monographs and living descendants were helpful in deciphering symbology, cultural affiliation, meaning and process in conjunction with archaeological contexts (Seigel and Roe 1986; Stiles 1977; Wiley and Sabloff 1980).

Externally, cultural identity was a contentious topic not only in archaeological circles but in the U.S. in general (Churchill 2004; LaPLant 2008; Wilmer 1993). With the passage of the National Historic Preservation Act of 1966 (P.L. 74-292, NHPA), The Archaeological Resource Protection Act of 1979, and the Native American Graves and Repatriation Act (P.L. 101-601 NAGPRA), archaeology changed at a fundamental level as *federally mandated* contract archaeology was thrust into the rising tide of social issues that included cultural identity and environmental concerns (Ferguson 1996; Neuman and Sandborn 2001). Native Americans had begun to protest both ethnographic portrayals and archeological research, especially regarding burials (Ferguson 1996). Internationally,

indigenous people were recognizing and protesting the destruction of their social systems and customs in the face of modernity and reclaiming their cultural and land rights (Wilmer 1993). By the 1980's, legislation, Indigenous peoples, tribes, environmental planners, government administrators, academics and archaeologists were all enmeshed; they had to find ways to work together in order to move forward in any sense.

A Response to the History of (Mis)Interpretation: Reclamation, Recontextualization, and Consultation

From the 1980's to the present, great strides have been made with regard to indigenous rights in both archaeology and ethnography. However, cultural identity is a global issue engaged in a fundamental debate outside of academia. Because of multi-versal beliefs, approaches to Native American and aboriginal epistemology and ontology are non-traditional in the western sense (Churchill 2004; Findlay 2000; Henderson 2000; Smith 1999). Not only does this place Native American and aboriginal research, education, and methods at odds with the western academic world (LaPlant 2008), but it places these communities at odds with the western structures they inhabit in their daily lives.

Although it is not easy, some communities of differing identities have come together to seek an understanding of each other and find solutions in sharing of knowledge and power. Ecological and archaeological studies are embracing tribal knowledge (Berkes 1999) and exploring solutions that will help protect the natural and cultural environment. More importantly, the social atmosphere is encouraging "both

sides” to work together to find respectful ways to move forward, both into the future and into the past, with new respect for indigenous identities.

Reclamation of Indigenous Identity

There is movement on a global scale to reclaim indigenous identities that have been misrepresented, broken, and disjunctured through political, environmental, racial, religious, and economic agendas (Churchill 2004). People who self-identify as indigenous or aboriginal people of a region engage many tactics to reclaim their heritage in many conceptual and real forms. This is reflected by the number of organizations, both formal and grass-roots, representing people who feel the impact of colonial and imperial politics has jeopardized and compromised their culture (Findlay 2000). These groups advocate for themselves through cultural consciousness, resistance, and transformative praxis (Findlay 2000). These practices strive towards autonomy, self-determination, and empowerment (Henderson 2000; Smith 1999; Churchill 2004) and are most currently recognized through the reclamation of language and cultural education (Greymorning 2004; Smith 2005).

A re-engagement of the aboriginal consciousness is a goal for many native societies. This can mean re-aligning concepts of community, space, worldviews, identity, ecology, gender, sacredness, and awareness (Henderson 2000). Engaging these concepts requires different arenas, including both legal means and non-traditional tactics. The process is oft termed cultural revitalization but according to Maori author Linda Tuhiwai Te Rina Smith (2005), that term itself implies a culture that needs rescuing. Despite the

context they were collected in, ethnographic and archaeological texts are continually being utilized by Native researchers to regain knowledge about their past, especially in cases where continuity has been disrupted (Purdy 1988; Rubertone 1992; Trigger 1980; Wylie 1992).

To reclaim identity, some native communities must shed the structures and labels in which they have become entrenched and disenfranchised (Henderson 2000). This concept is supported in the writings of Brazilian legal scholar Roberto Unger (1987) who works to empower indigenous peoples by constructing post-colonial critical theory comparing aboriginal and European cultures. He emphasizes especially the failed polarities of Euro-centric thought such as savage vs. civilized, individual vs. communal, light skin vs. dark skin as examples of the dualisms that serve to keep people separated (Henderson 2000). Another action includes the discarding of western labels such as “oppressed, minority, subordinated, and exploited” and no longer employing them because they were a western construct to begin with (Hingangaroa-Smith 2000). The removal of such labels is construed as a positive and proactive act rather than embracing victimization (Hingangaroa-Smith 2000; Behrendt 2004).

This concept of re-structure is also welcomed in actions from those outside of a cultural identity who wish to be a part of the solution, including academics or public officials. This requires the external participants (academics, governments) to engage the community as a whole and as a partner, not just as passive recipients of what can be attained through engagement with the formalized structures of a larger society (Hingangaroa-Smith 2000). It also requires that the external structure honor the validity

of research done from within by members of a self-identified group, regardless of formal education (Smith 2000).

Acknowledgement of the limitations and contributions of popular social structure is required most in the realm of education. Community-based education has been highly effective in building language and identity especially where elders or speakers of the active language engage younger generations not only in teaching language, but in teaching cultural skills which can only be valued in a truly cultural context (Batiste 2000; Smith 1999; Henderson 2000). Cross-generation activities build relationships and reinforce sentiments that form the foundation of a community identity and serve to promote ownership of that identity (Battiste 2000, Smith 2000).

Where culturally based education programs are supported by indigenous communities, there has sometimes been resistance from the state. In New Zealand the government has objected to children attending “unlicensed schools” and having teachers that aren’t accredited. But in a stance of resistance and support of indigenous-community based curriculum, one Maori community’s sentiment is that the government can help (*get in the canoe with us*) or they can be left behind. This particular community feels that this move is in the best interest of their children and their culture *together* (Batiste 2000; Smith 2002). Legislation is another avenue with which to acknowledge the viability and usefulness of community teaching and also to advocate the teaching of a broader cultural history within the public schools (Battiste 2000).

Recontextualization

Another form of reclamation is re-contextualization of the past. For anthropologists, this meant revisiting the literature of the past while acknowledging the political, academic, and cultural frameworks in which these works were produced. For indigenous people, it meant a re-vision of the literature, sometimes replacing it with literature that is grounded in their own cultural histories and viewpoints (Greymorning 2004; Hingaroa-Smith 2000; Smith 2000, 1999; Wilmer 1993).

Voices of indigenous peoples combined with the growing social enlightenment of the 1970's ushered in new "ways of seeing" the past, present and future (Fowler 1986; Bielawski 1989). Anthropologists and archaeologists introduced additional theoretical frameworks to address and convey the "cultures of others". In ethnographic writing, Post-modern, Feminist, and Marxists standpoints are responsive to the post-colonial interpretations of native cultures. The core of these movements are represented in the works of several authors; Clifford 1986; Fox 1991; Marcus 1994; Marcus and Fisher 1986; Marcus and Cushman 1982; Rabinow 1977; Said 1978; Tyler 1986, 1991; Vincent 1991; and Kuznar 1996 (Asad 1973).

Although these epistemological standpoints differ in their origins, they hold several tenets in common including: an anti-science stance; a pervasive colonial critique; and are eminently concerned with the crisis of representation and ethnographic authority (Geertz 1973; Hymes 1974; Kuznar 1996). According to Barnard (2000) each of these theoretical views contain complex ideas that are peripherally influenced by and related to each other, reflecting the inextricable relationship of many systems within one. The

notable commonality of these theoretical standpoints is their aim to situate the voice of the writer in an explicitly subjective context and positionality. This intentional situating, places the observed and the resulting cultural documentation in a still subjective, but stated, frame of reference for the reader (Hodder 1999).

These frameworks promote reflexive practices and the acceptance of multiple, simultaneous paradigms which has a positive effect on the relationship between native and non-native organizations. By affirming simultaneous multiple perspectives (Bielawski 1989; Zimmerman 1989) and the political nature of archaeology (Wylie 1992; Handsman 1989) both sides agree that each views the past differently, but share in the stewardship of knowledge. For example, Zimmerman (1995) and Anyon (1991) discuss how concepts of time, politics, and construction of the past in a *linear* framework differs greatly from traditions that perceive time differently, possibly in a spatial framework instead (Rappaport 1989). Zimmerman (1995, 2003) concludes that simultaneously sharing, and honoring as valid, these competing visions of the past is a power-sharing solution.

Production of ethnographic and archaeological literature today comes from both native and non-native members of communities, but there are still contentions between producers and consumers of ethnographic literature. By telling the story of native people *now*, as present inhabitants of their lands, some view indigenous and non-native ethnographers as assisting in the legitimization of the native speaker. Current scholars are using a number of cross-disciplinary methods including development of cross-cultural backgrounds, analyzing oral traditions, and studying symbolic,

metaphorical, and environmental relationships of tribes to recontextualize the past (Fixico 1997). As most historical texts are fragmented, complicated, and highly contextualized, Fixico (1997) suggests questioning everything (sources, context, and author) and paying attention to the details found within the other disciplines.

There are additional criticisms leveled at the current documentarian community. For instance Crapanzano (2005) argues that common practices and terms in ethnographic works, like the use of informants or terming someone an informant, still speaks to the objectification of another person. Other practices that may be offensive include giving “white” names to locations that already have a name in an oral tradition (Condori 1989), using archaeology to construct nationalistic identities (Condori 1989; Holland 1990; Males 1989), and using the term prehistory which implies that there was not a maintained history among the native people until Europeans arrived (Condori 1989; Echo-Hawk 1993). An extreme solution to the ever sensitive reburial question is proffered by Riding (1992) who proposes not only that repatriation occur but that all data collected from “immoral studies” should be removed from all reference works. However, the retention of “immoral research” is an opportunity to open up a dialogue on such events in order to move towards best practices and improved ethics (Zalarvis-Chase 2010)

Consultation

The criticism levied at the archaeological community in the 1970s did not go unheeded. American archaeological professionals looked critically within and without for solutions (Reid 1992). To consider actions and solutions on both sides, a dialogue was

needed (Scarre and Scarre 2006). This is formally termed consultation. Consultation became a key practice in bettering relationships between Native Americans and other formal and self-identified entities. These entities can range from city, state, and national management agencies to groups dealing with community identities, ecology, and politics centered on land use issues. Both the Archaeological Resources Protection Act of 1979 and NAGRPA directly demand consultation with Native American communities where burial, remains, and cultural affiliation are concerned (Burney 1994; Klesert 1990; McManamon 1994; Ferguson 1996; Buikstra 1981; Ubelaker 1989). Although not mandated on all projects, consultation is considered a best ethical practice.

The professional organization, the Society for American Archaeology (SAA), recognized the need for change and encouraged archaeologists to communicate and increase their participation with Native American entities (Adams 1989; Johnson 1973; McGimsey and Davis 1977; Sprague 1974). Since the 1970's the SAA has formed Native American liaison committees, defined the responsibilities of archaeologists to Native American groups, prepared guidelines to address reburial and repatriation with non-Federally recognized groups, and formed outreach and public education programs for both the public and Native American communities in efforts to work together (Ahler 1994; Blancke and Slow Turtle 1990; Devine 1994; Fagan 1984; Ferguson 1996; Jamieson 1994; McManamon 1991).

Ethical Archaeology

Ethical issues are addressed in both project driven and academic research. Zimmerman (2003) states that we have an ethical duty not only to the archaeological record but more importantly to our students, colleagues, employees, and the diverse communities of the world, to be transparent in our work and communications. Scarre and Scarre (2006) define being “ethical” as being willing and able to explain your positions and methods transparently under critical appraisal. Lynott (2003) defines ethics as guidelines to assist professionals in meeting specialized needs of the profession while Colwell-Chanthaphonh and Ferguson (2006) frame ethics as a basis for obligations to both the living and dead communities we serve. Only recently have ethics have been formalized as part of professional training in ethnography, archaeology, and museum realms, recognizing a need to continue identifying the broad scope of issues to be addressed (Lynott 2003).

Cultural Resource Management Today

Today most non-academic archaeology is known as Cultural Resource Management or contract archaeology, much mandated by federal and state law (Zimmerman 2003; Ferguson 1996). Although some argue that this resulted in commoditization of archaeology and ethnography, archaeological law and the practice of archeology outside of academia enabled protection of many Native American and pan-cultural historic sites while providing for a broader power-sharing base (Ferguson 1996).

As Native American entities engage archaeological situations, the methods of resolution vary. Some tribes choose to engage in archaeological programs while others want as little to do with archaeology as possible. In my personal experience, I find this varies for each tribe and is subject to change as tribal communities change. Two activities that promote meaningful, working relationships between Native Americans and management agencies are attendance and participation at regional, state, national, professional, and tribal meetings (Barrios 1993; Deloria 1992; Reid 1992; Schwab 1992), and also tribal consulting with archaeologists in CRM or land management positions (Bielawski 1989; Ferguson 1996; Sullivan and Hawkins 1994). These venues offer an opportunity to discuss current issues and move toward resolution of conceptual matters between the entities. In 1992, an amendment to NHPA strengthened the role of tribes by allowing for Tribal Historic Preservation Officers and tribal stewardship of sites within their property boundaries. Consequently, many tribes now operate their own CRM facilities which provides on-the-job training as well as economic opportunities for their own community members (Anyon 1995; Ferguson 1984; Klesert 1992).

My own experience as an archaeologist, working for both the National Forest Service and for private consulting firms, is that tribes regularly work with non-native archaeologists in field and laboratory settings, especially those within a tribe's specific cultural area. The result is that tribes have more direct involvement in archaeological collaboration, research, and heritage protection than ever before. It is through creative solutions and communication that the cultural and legal obligations of each side can be met.

The Modeling of Cultural Processes

For this thesis I examined ethnographic and archaeological accounts of the region. In examining epistemological methods I acknowledge that archaeological and ethnographic documentation have interpretive and data accuracy issues (Clifford 1988; Dalla Bona 1994; Duncan and Beckman in Ebert 2000). Clifford (1988) states that writing culture is an artful practice, manifested as text derived from experience and observation requiring the viewer to interpret actions, and then re-interpret those actions into words that can be contextually absorbed and understood by those of another culture. Ethnographies surpass the notion of general literature and are granted status as fact or truth within the academic community and society at large (Clifford 1998; Hastrup 1992, 1995; Crapanzano 2005; Rabinow (1986): Geertz 1988).

Culture is not only documented through ethnography, but the process and experience of developing ethnography is often included (Crapanzano 2005; Hastrup 1995). There is the writer, and there is the informant who is of the culture being observed. It is through these informants that the acculturated and shared knowledge of a people or an area is acquired by the researcher. Through multiple methods, including discussion and observation, the researcher attempts to convey the complexity, roles, values and purpose of social, economic and religious structures within the observed society; a composition of “total social facts” (Mauss 1924). In the case of many indigenous societies, the western writers who authored ethnographies presented a view of these societies through their own lens. However the authority to represent a culture or community is still a contentious debate in anthropology (Kuznar 1997). This is an issue

that many indigenous groups wrestle with today as they try to reconcile historic records with their own accounts of past events.

There is variation in modern archeological data which in my opinion results from the nature of the approach to data collection and associated financing. Results are either framed with a particular project goal in mind and/or limited to the project scope. Scope can be mandated by federal or state laws regarding permitting and development or by academic design. Although these parameters limit the data collected and may abbreviate the documentation in some manner, this information is still useful in a mixed methods approach to modeling.

Despite the challenges of interpretation, modeling environments are enriched by the application of ethnographic information to the spatial environment (Gillings 1997; Griffin 2000; 1996; Zubrow 1990). By perusing a large body of archeology site and ethnographic research records, a broad picture will emerge. The challenge is to qualitatively select information in these disciplines that appears credible and consistent enough to inform multiple aspects of the model.

Ethnographic contributions on North Coastal California

From the turn of the century to 1936, contributions to the ethnographic literature of the tribes of Northwest Coast of California were plentiful. As Berman (1986) points out, a review of the ethnographic material reflects the background and social tenor of the authors as well as their subject matter. Early accounts of the Humboldt Bay region were captured by a wide range of people including white interpreter George Gibbs *Journal*

(1853) and *Observations* (1853), white journalist Stephen Powers *Overland Monthly* articles (1872), and Yurok Indian author Lucy Thompson *To the American Indian* (1916) (Berman 1986).

After 1880, most major contributions to the early ethnography of the Northcoast were published under the auspices of the University of California and examined many aspects of indigenous society, religion, and language (Berman 1986). Notable authors for the northcoast region include Goddard's (1902, 1904, 1905, 1914a, 1914b) work on the ethnography and linguistics of the Chilula and Hoopa, Waterman's (1920) works on Yurok geography Drucker (1937) on the Tolowa, and Reichard (1925) on Wiyot linguistics. Harrington (1932) is also a notable author of this time for his works on the Karuk but was not affiliated with the University of California (Berman 1986).

The 1950s and 1960s literature reflect a renewed interest in native languages and an overview of coastal archaeology. Publications on linguistics include *Karok Language*¹ (Bright 1957), *Yurok Language* (Robins 1958), and *Wiyot Language* (Teeter 1964). Humboldt State University Professor Victor Golla contributed *Hupa Grammar* (1979). Elsasser (1965) contributed "The Archaeology of the North Coast of California while Heizer (1965) took a comparative look at data compiled separately by ethnographer L.L.

¹ At the time Bright published, an acceptable spelling for this tribe was Karok. Modern tribal preference for spelling is Karuk.

Loud (1918), and the notorious amateur archaeologist Dr.H.H. Stuart from the infamous Indian Island site known as the village of Tolowat (CA-Hum 67).

In recent years, comprehensive overviews of the region and its people have been published by several California archaeologists including Eidsness (1988, 1993), Moratto (1984), Fredrickson (2007), and Chartkoff and Chartkoff (1984). Extensive modern documentation of the study area has been generated by the Cultural Resources Facility at Humboldt State University, with contributions by Roscoe and by Rohde (Berman, personal communication 2010). The information housed at the Humboldt State Cultural Resources Facility ranges from technical and analytical archaeological reports and archival maps, to oral histories of the area.

No discussion of California of Northcoast ethnography would be complete without acknowledging the contributions by, and critique of, Alfred Kroeber a professor of Anthropology at the University of California Berkeley. Kroeber was the epitome of the white, privileged, and privately educated scholar anthropologist of his time (Steward 1961). Steeped in the Boasian tradition, he was in conversation with premier anthropologists and ethnographers of his day including Malinowski, Radcliffe-Brown, Lowie, Sapir, Barrows, and Spier (Stewart 1961).

Like many works in anthropology and ethnography, Kroeber's extensive publications (1896-1961), of which there are over 230 on numerous tribes including the Wiyot, are often criticized as being subjective and intuitive (Stewart 1961). An additional criticism of Kroeber was his collecting of artifacts for the University of California at Berkeley (Steward 1960). At the turn of the century, museums were intent on amassing

“exotic and native” objects to fill their museums. Few were more voracious about collecting than Pheobe Hearst (1842-1919), a University of California Berkeley Regent and the main benefactress to the Anthropology Department at Berkeley where Kroeber worked (Steward 1961).

Steward (1961), a student and colleague of Kroeber’s, defends Kroeber’s methods stating that he approached cultures in a holistic manner believing that “each cultural pattern or configuration is unique, different from all others, comprehensible in terms only of itself” (Steward 1961:1049). This means he opposed the generalization and reductionist theories of the 1800’s, and ethnographic interpretations which dissected the absurd or colorful parts of other cultures, effectively separating them from their meanings and cultural contexts (Steward 1961). Kroeber was both loved and hated. But it is this holistic approach that influenced an unconventional, unprivileged student of Kroeber’s, that being Llewellyn Loud.

Llewellyn Loud

Ethnography and Archaeology of the Wiyot Territory by L.L. Loud (1918) is the premier work on Wiyot socio-geography. Loud’s monograph aimed to be a culturally informed geography of the Wiyot area that provides a well-rounded picture of Wiyot life-ways, post-contact history, and social relationships. Although weak in his analysis of language and religion, his primary strength is in his illustration of the cultural geography which relates land use to the inhabitants in a practical manner.

In 1905 Loud enrolled as a student at Berkeley (Heizer 1970). He never worked towards a degree but rather took classes that interested him in geography, anthropology, and natural sciences (Heizer 1970). Loud was never a formally trained ethnographer but while employed at the Museum of Anthropology at Berkeley he was a museum curator, guard, janitor, and unofficial field archaeologist when Kroeber needed him. A commentary by Heizer (1970) states that Kroeber considered Loud difficult at times, even exasperating but respected him in spite of these characteristics. Though unconventional in both his education and rapport within academia, Loud delivered a respectable monograph on the Wiyot area (Kroeber 1946).

Informing on Cultural Processes

Because archaeological models are situated in a physical landscape, they address spatial and environmental questions while aiming to inform on the results of cultural processes such as minimum-maximum populations, socially related territories, cultural diasporas, differences in defensive vs. exploitative assets and traits (Gusev *et al.* 1999; Kvamme 1999), travel and maritime access (Madry and Crumley 1990), and intensity of occupation (Lookabill 1998). Informing research questions can also require that input variables relate to types of activity sites (Ford *et al.* 2009); those generally being base camps (perm or semi-permanent villages), extraction and processing sites (quarries, shell beds, acorns), transitory, or special purpose sites (prayer seats, ceremonial, petro/pictograph sites) (Bang-Andersen 1996).

Modeling the Wiyot Cultural Area

With these parameters in mind I explored the relationship between archaeological location preferences in regard to cultural and environmental factors in the Wiyot region of northern coastal California. The supposition of this model is that these culturally selected activity spaces will have a spatial signature, encoded as environmental and cultural variables, and will reveal a pattern of locality that differentiates from background conditions of the general environment. In other words, the spatial signature of a random point on the landscape will differ from the signature at a location that was selected for a particular culturally related activity (Maschner and Stein 1995). To compare these two groups, a body of archaeological and ethnographic data relevant to the Humboldt region was examined against the overall landscape.

When comparing data from archeological and ethnographic records, two observations were apparent. First, older archaeological records were less detailed in regard to environmental description, site-type, actual location, and artifact descriptions or identification such as materials or typology. The opposite was found in older ethnographic material where, for instance, plant names and harvesting areas were explicit topics of documentation, complete with names, locations and potential uses. Archaeological site records from the last 30 years showed a marked increased in locational accuracy more detailed descriptions, reflective of both an improved interdisciplinary practice and professional standards. For instance, of the first 200 archaeological site records examined, the earlier records (1918 to 1970) hardly mention the vegetative environment. More recent archaeological site records (1970-2004) not only

note the vegetative environment, but up to eleven individual plant species were noted for one site.

The second difference in site document consistency related to the reason for its creation. Of the 400 site records examined, approximately 75% of them were project driven records, generated as a result of parcel development, road maintenance, timber operations, or required maintenance on state and federal lands. Because a majority of these site documents were initiated by development and timber harvesting they reflect two targeted environments not necessarily representative of the landscape as a whole. Therefore it is possible these locations do not reflect the entire range of sites or activities associated with the Wiyot culture group or their neighbors. In contrast, the ethnographic data, which was academically driven, aimed to cover and reflect a wide range of cultural activities. Recognition of data limitations is acknowledged. Limitations of sample based representational modeling are inherent due to sites destroyed and altered by human activities, erosion, deposition by natural or artificial means, or simply missed during survey activities (Kvamme 1999; Hammer 1993; Hobbs and Hudak 2002).

Noting patterns of divergence and differentiation between archaeological site records and ethnographic literature does not preclude their usefulness. In fact they are complementary, one filling in where the other lacks information. Between these two types of sources, information will overlap substantially enough for incorporation into the model.

Cultural Themes for the Wiyot Area

Although no particular section of Loud's monograph is exhaustive, he compiled a broad range of information for his assignment. Much of this was considered for inclusion as map layers for this thesis. These themes were examined for their potential to be translated into cultural variables within the model, meaning they reflected a concept or activity central to Wiyot indigenous life. Ideally, these would be differentiated from, but not necessarily exclusive of, environmental variables such as specific topography or vegetative surroundings. Information with potential for analysis included Loud's map (1918) of the boundary and extent of Wiyot language and villages, his comments on the importance of maritime travel for the Wiyot, his descriptions of particular site locations and their uses, and his descriptions of the natural environment in relation to the Wiyot.

According to Loud (1918), the world of the Wiyot was highly dependent on redwood dugout canoes. A canoe provided access not only to resources such as shellfish, sea mammals, and birds, but was an important mode of rapid transport from village to village. As roads were rough and minimal, Loud (1918) tells of his difficulty in traversing the region and around the bay by foot or horseback due to dense briars and underbrush. But he also wrote that all major Wiyot villages around the bay he visited were accessible by canoe, many were situated at the tips of ridges reaching into the marshes, and he likely would have visited more archaeological sites had he traveled by boat instead of foot (Loud 1918: 275). A topical examination of the Wiyot region in relationship to site placement shows that not *all* Wiyot sites were on the water's edge, however the overall preference of permanent settlements was near a navigable waterway (Loud 1918; Mills

1950; Nomland and Kroeber 1936). It is interesting to note that although both the Eel and Mad Rivers are navigable by canoe for some miles outside of Wiyot territory, the settlements identified as Wiyot (Loud 1918; Nomland and Kroeber 1936; Elsasser 1978) drop off significantly where the wide river valleys begin to narrow, and the mountains close in.

Loud (1918) also states as well the importance of prairies to the Wiyot, not only for vegetation resources, but for the game they harbored. Additionally, he delineated major prairies on his map (Loud 1918). Loud noted that the maintenance of a number of trails from the coast to the inland prairies were evidence of the importance of these places to the Wiyot people. Through oral histories of the northern California tribes we are told that fire was an integral part of traditional maintenance of the prairie lands (Kliejunas 2005; Redwood National and State Parks Fire Management Plan 2005). Although many of these prairies are maintained as ranchland today some are managed for traditional cultural uses through the use of prescribed fire. As cultural variables, both prairies and navigational routes would contribute to the modeling of this region.

Predictive Modeling in an Archeological Context

Predictive modeling has become a popular tool in archaeology because of its ability to aid in the managing, planning, and research of archaeology data and sites within a spatial context (Dalla Bona 2000; Duncan and Beckman 2000; Kvamme 1999, 1992). Although the initial digitization of archival data into a Geographic Information System (GIS) environment is time consuming and expensive, the bulk of it is often a one-time

expenditure with future documentation being budgeted into routine data maintenance (Connolly and Lake 2006; Gregory and Healy 2007).

As a planning tool, the ability to incorporate archaeological considerations into the early stages of land based projects is increasingly accepted as an important planning mechanism which helps avoid or mitigate unwelcome circumstances (Duncan and Beckman 2000; Kvamme 1999). The most common models used for planning are descriptive models (passive) that describe what is now, and prescriptive models (active) which examine what might be (DeMeers 2002).

In taking GIS to an analytical level there has been a broad engagement in predictive archaeological modeling. Kvamme (1999) and Hammer (1993) define predictive models as descriptive and explanatory statements of multivariate and spatial patterning of archaeology sites. The premise of modeling is that the spatial distribution of cultural remains is the result of human decision making and activities within the possibilities, conditions, and limitations set forth by the surroundings (Duncan and Beckman 2000;33, Wheatley and Gillings 2002).

Most predictive models begin with a pattern recognition and classification approach and are followed up with a quantifiable statistical analysis (Llobera 2003; Wheatley and Gillings 2002; Kvamme 1992). Statistical tests are good measures of strength in modeling and play a confirmatory role in the analysis. Because researchers may see patterns that they think exist in a data set, statistical methods are useful to inform or uncover relationships that were misperceived or overlooked (Kvamme 1999). Two statistical methods often employed are multi-variate or logistic regression functions,

which provide a means of identifying the strongest variables within a model (Connolly and Lake 2006; Kvamme 1999). As a statistical tool, logistic regression is appropriate for non-parametric data with varying scales (nominal, interval, ratio) and has the added advantage of binary presence/absence output or relative probability which predicts values for non-sites as well as sites (Connolly and Lake 2006; Wheatley and Gillings 2002). The model developed in this study area meets the assumptions for probabilistic logistic regression in that it is a large sample of non-parametric data with an equal number of non-sites for comparison (Wheatley and Gilling 2002).

Archaeologists engage predictive models from different theoretical standpoints. Two of the most common are optimal foraging theory and evolutionary-cognitive psychology (Maschner 1992). Optimal foraging theory supports modeling of archaeology sites, which follow a pattern often linked to site type and the specific selection of environmental conditions in order to fulfill a particular purpose for the user (Kvamme 1992; Maschner 1992). However, there are studies that claim to reflect a cognitive choice in site locality in order to maximize economic or defensive strategies or minimize conflict (Forsythe 2007; Gusev *et al.* 1999; Maschner 1992). These models reflect the supposition that people had cognitive preferences independent of base utility or necessity (Gaffney *et al.* 1996; Hammer 1993; Maschner 1992) and that some site patterns or impacts to a landscape are the results of personal choice and cultural decisions (Zubrow 1990; Braje 2007).

Although there are homogeneous environments found throughout the world, it is evident that each geographic area under study has unique qualities. Compounding

geography with unique cultural traits, no two places, or models, are the same. Therefore, one must consider not only environmental geography but cultural geography to develop a sound model; meaning each case study and region will present its own set of cultural and environmental variables to be tested within a modeling environment.

The modeling assumption is that human behavior across the landscape is not random, and therefore exhibits different patterns or signatures than randomly selected places within a landscape (Ebert *et al.* 2004; Hammer 1993; Kvamme 1992). Pattern recognition and classification are a common starting point in support of this assumption. There is also agreement on a number of consistent variables, predominantly environmental, that can be applied to many modeling environments with informative results (Kvamme 1992). Accordingly, early modeling methods included attempts to characterize the cultural landscape by delineating simple environmental variables. More recently, models have been developed further to incorporate cultural explanations and avoid interpretation solely through the narrow lens of environmental determinism (Gaffney and Watson 1996; Ebert 2006; Wheatley and Gillings 2002).

The sample or data set utilized to derive the model determines the types of sites and activities that can be examined and the kinds of analysis that can be derived (Wheatley and Gillings 2002; Ebert 2000). It therefore follows that one must use culturally related variables in order to examine cultural activity. For instance, plotting pottery patterns (via décor, materials, function, quantity, and condition) could deliver patterns related to manufacture, processing, trade, dispersal, and disposal. Elements of the pottery reflect the cultural norms of the society related to the artifact. Thus results

produced from a model will be relative only to the region and culture from which they were derived (Kvamme 1992)

According to Ebert *et al.* (2004) all models are composed of three elements; the available body of knowledge or data, methods of transformation, and explanations of the predictions themselves. Two model frameworks have evolved: the inductive and the deductive model. The inductive model utilizes specific information to build a generalized model while the deductive model moves from generalized to specific conclusions (DeMeers 2002). Both approaches include a desired dependent variable, in this case archaeology sites, and a set of independent variables which are combinations of environmental and/or culturally derived characteristics (Hobbs and Hudak 2002).

Inductive Modeling

Inductive models are devices that make use of existing knowledge to explore and define existing patterns. These are often termed intuitive (Ebert 2004; Gaffney *et al.* 1996), associative (Kohler and Parker 1986), correlative (Church *et al.* 2000; Ebert 2004) or descriptive models (Hammer 1993). Although it cannot be denied that settlement patterns are influenced by geographic and environmental conditions, Maschner (1995) argues that they should not be the sole consideration in the formulation of a predictive model.

Criticisms of the inductive method are often focused on over-weighting environmental considerations and the overtly simplistic model itself (Maschner 1992; Keene 2004; Keegan 1986). This is termed environmental-determinism or a cultural-

ecological point of view, and is rejected by some academics as a stand-alone theory (Ebert 2004; Gusev *et al.* 1999; Kvamme 1999). However, Kvamme (1999) and DeMeers (2002) also defend the use of data-grounded theory because much insight to can be gained from looking at raw patterns and data (Glasser and Strauss; Charmaz 2006).

An additional criticism of modeling is the reliance on mathematical functions to process the data and inform the results (Llobera 2000). Functions such as thiesien polygons and nearest neighbor, which measure geographical areas or distances within or between sites, are informative. But they must be used in conjunction with a hypothetical framework that relates to some aspect integral to the model. Otherwise it is a just a subjective measurement that doesn't address cultural choice at all (Llobera 2000; Zubrow 1990). Additionally, Ebert (2004) states that this approach and the statistics related to these functions are weak because they relate the variable to the land unit rather than to the human intentions that created the site and therefore explain only explain limited facets of site selection and location change.

Inductive methods use existing data, but on occasion a paucity of certain *types* of site data necessary to construct the models parameters, thus calling for another approach (Schuppert and Dix 2000; Lookabill 1998; Zubrow 1990). For several hundred years, most archaeology had focused on high profile sites such as major stone complexes and agricultural settlements. Sites that left little trace or were not monumental were marginalized or overlooked, such as slave quarters or plant gathering areas (Lookabill 1998). This situation is being remedied as archaeologists broaden the scope of societal inclusion in research and engage with ethnographic data describing activities or areas of

use previously ignored. Thus examination of the spaces “in between” the monumental places is proving to be extremely informative of social landscapes of the past (Llobera 1996).

Inductive models have been successful when studying early levels of societal development. Inductive models based on optimal foraging theory have work especially well for mobile hunter-gatherer and small band level societies. However the explanatory power of an ecologically based model decreases as cultural complexity increases (Griffin and Churchill 2000; Maschner 1992). Often, complex societies are more economically oriented and able to manipulate their environmental surrounding, resulting in an increased scale of resource extraction and distribution networks (Griffin and Churchill 2000; Maschner 1992). To address increased cultural complexity and cognitive choices in past societies, it is suggested that one use a deductive model.

Deductive Models

Deductive models are the more arduous to produce of the two models but can stretch the known bound of GIS use in archaeology further into the theoretical realm (Ebert 2004; DeMeers 2002). These models emphasize holistic landscape archaeology as an integrative paradigm for studying past cultural systems (Savage 1990). They aim to explore cognitive or socio-cultural decisions (Gaffney *et al.* 1996), seek to explain site variability both spatially and temporally, and locate catalysts for social change within the archaeological record from an *a priori* theoretical standpoint (Hammer 1993; Maschner 1992).

Ebert (2004) states that to successfully incorporate cultural variables we need to expand our views to include social considerations which fall outside economy and consider as well institutions and group dynamics. An example would be a shift in site locations that reflect a retreat from primarily economic maximization to an increase in political maximization. However, this is difficult because proof of cognitive evolution is not easy to recognize, much less prove, within the archaeological record (Bridgeman 2002). It is suggested that improvements lay in using a culturally based hypothesis. This means incorporating variables derived from ethnographically based data and belief systems into the model (Butzer 1982; Gusev *et al.* 1999; Gaffney *et al.* 1996; Newell and Constandse-Westermann 1996).

To be clear, each kind of model does have its uses and benefits. Gillings (1997) and Zubrow (1994) advocate a model that incorporates aspects of both inductive and deductive models in order to reflect the integration of both environment and culture. An inductive model grounds the data within a geographical and environmental framework, but is improved upon with the incorporation of culturally based variables to reflect cognitive human behavior. Using socio-anthropological, archaeological, and environmental information produces a reflexive, experiential, and phenomenologically based model of a human influenced landscape rather than a reductionist model reflecting a binary opposition between culture and nature (Llobera 1996; Gillings 1997).

Data Acquisition and Transformance into GIS

Data integrity and acquisition is a paramount consideration and challenge for GIS applications in a modeling environment. The selection process should be explicit about data utilized, what is derived from the data, validations of class and division choices, how variables are used, and appropriateness to the type of statistics applied. Subsequently, one must also decide if raster, vector, or a combination of layers is appropriate for model building.

Preliminary Data Considerations

Data is first given a preliminary assessment to determine its potential usefulness. For the continental U.S., raster layers depicting the physical environment are relatively easy to acquire. National and state agencies, including the U.S. Forest Service and CALATLAS, regularly produce or archive remotely sensed imagery and agency derived data that captures a level of detail suitable to many models. The cost of commercial satellite and aerial data is often prohibitive on a project level and publicly funded, government generated, and free, land base data is often sufficient for modeling purposes.

Three considerations in the representation of data for modeling include resolution, measurement, and interval (Connolly and Lake 2006; Allen 1990). Resolution is a component that is fixed during the data capture. For example, the pixel size of an image during data capture is fixed. Measurement and interval are left up to the data interpreter. How they are conveyed influences not only how data is framed, but also plays a significant role in the calculation of results.

Llobera (1996) purports that space, defined by measured and interval, becomes an active agent instead of a passive construct on the landscape. Therefore it must be criticized as acutely as other parameters. For instance, to accurately use the geological variables of slope, aspect, elevation, and landform, one must experiment with interval to determine what combination will most accurately portray their regional data. Changing measurement and interval assists in retaining detail, which improves the reflection of the environment and provides a stronger validation of the resulting analysis. Conversely, measurement and interval can obfuscate data to the point of gross generalization (Ford *et al.* 2009; Ebert 2004; Kvamme 1992).

Environmental Data

The primary layers acquired for this model addressed topographic, vegetal, hydrological, cultural, and archaeological themes. Topographic variables of slope, aspect, and elevation are commonly used in a probability study and often contribute to the derivation of secondary themes (Ebert 2004; Hageman and Bennet 2000; Kvamme 1992). One may also add soil to this litany if we are looking at agricultural societies and soil fertility or drainage characteristics in regard to permanent dwelling locations.

Water is highly influential because of the impact it has on societal interaction, travel, and subsistence procurement and must be considered in both a cultural and resource context. Riverine, lagoon, island, and estuarine zones are important resource areas (Bang-Andersen 1996; Faught 2004) and harbor a wide variety of site types (Bell and Neuman 1997), making them a multi-faceted parameter to examine. Although water

is paramount to survival, many models have over-weighted water rich sites. These models may ignore moderate water sites that would be within a day's walk, or distant locations that are accessible with water transport technologies such as those utilized in the high deserts and plains (Bange-Andersen 1996).

Historic vegetation cover is a very difficult parameter to recreate. Land development, agricultural practices, and cultivation of exotic species have radically altered the vegetation of North America. However, in certain models this can still be useful for an analysis, even if scale and level of generalization are broad (Maschner 1995)

CONCEPTUAL FRAMEWORK

This section presents my conceptual framework to illustrate the relationships, concepts, and theories underlying my research in this thesis. A conceptual framework is valuable because it details and communicates a theoretical model. In this thesis I examine cultural resource predictive modeling process as a move towards supporting implementation of cultural resource law by supporting formal Native American consultation and indigenous empowerment. This predictive model is intended as a practical tool to aid these areas of interest.

How cultural and archaeological knowledge is stored, processed, presented, and shared affects how cultural resources are managed in a legal framework. Using a grounded theory lens (Glasser and Strauss; Charmaz 2006) this model incorporates historic information to create a predictive model of archaeological sensitivity of the Humboldt Bay area and a portion of the surrounding region. Figure 1 demonstrates how a GIS based predictive model becomes a tool for tribal voices and assists with communication and consultation efforts between the tribe and other managing agencies. Tribal consultation engages bilateral participation in the decision making process which in turn informs national law on heritage resources.

Literature on prehistoric life-ways has, at times, been grossly generalized when anthropologists were searching for over-arching, universal explanations of cultural structures (Clifford 1998). In actuality, ethnographic material and tribal knowledge is broad ranging, culturally specific, and often qualitative in nature (Ferguson 1996). The

available data used in this model was gathered by people with an interest in culture and geography. It was examined in its basic forms, and in turn, informed my choice of potential variables for the modeling process.

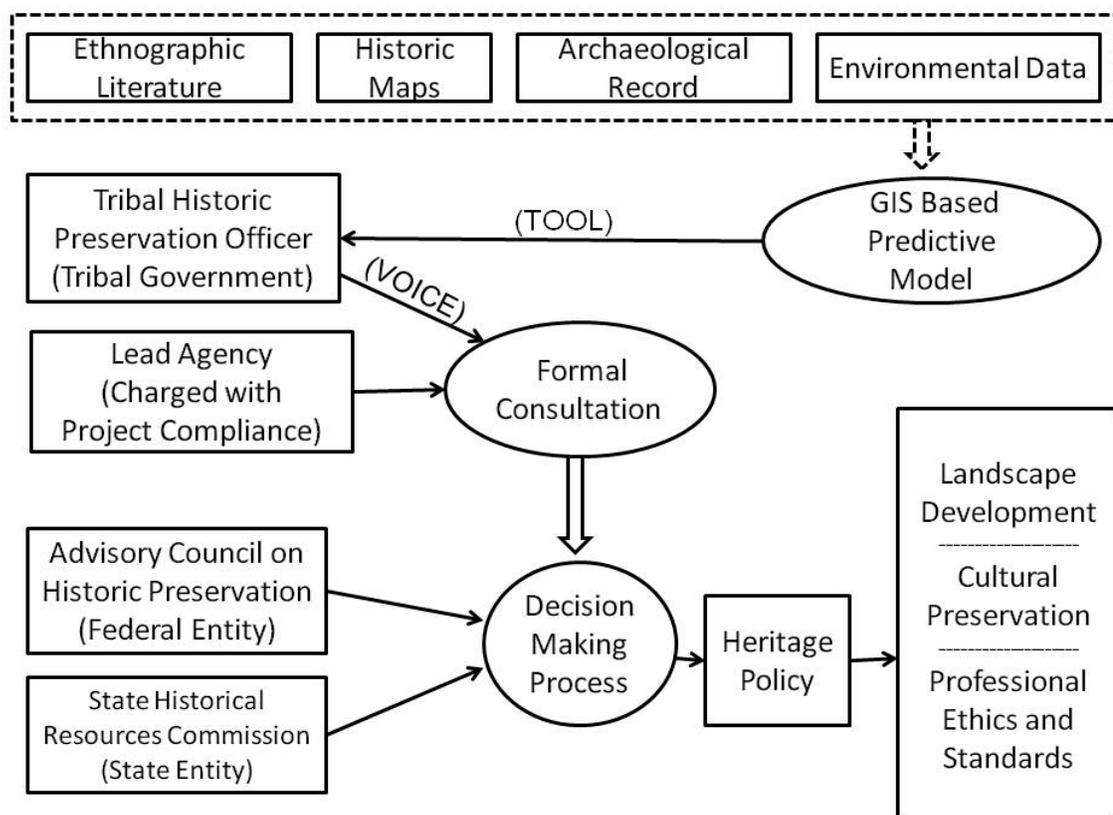


Figure 1. Flowchart illustrating how data input to a GIS become a useful tool in formal government to government consultation, which contributes to both project outcomes and heritage resource law at state and federal levels.

This model employed a variety of historic records. Using only one type of record would have created a narrow view of the environmental and cultural context of the Wiyot area. By employing data rooted in diverse epistemologies, including academic and tribal knowledge, a multi-faceted view of the historic landscape was created. While each kind

of knowledge generation is translating, transferring, or perpetuating cultural knowledge, there are significant differences in the methods used to gather and format information.

Berkes (1999) frames *traditional knowledge* as cultural continuity transmitted in the form of social attitudes, beliefs, principles, and convictions of behavior and practice derived from historical experience (Berkes 1990:3). Traditional knowledge is often privileged information given to certain persons in certain contexts (Peppion 2008). Ethnographic material in the academic sense has been collected by someone outside the culture of interest and can sometimes be noted as unequal exchanges because of the subjectivity of the writers (Clifford 1988).

Traditional or ethnographic knowledge is not always freely shared with the academic or planning community. Even when indigenous knowledge is shared, LaPlant (2008) states that the “authority” to research, share, impart, or claim communal knowledge brings about the question of identity in asking exactly “who” is the community, and therefore “who” is allowed to share that knowledge (Berkes 1999; LaPlant 2008). This is followed up by the question of *what kinds of knowledge* are shared with external communities or divulged by sanctioned individuals. Unlike a federal or state mandated project, tribally generated records of any type (archaeological, basket resource procurement, medicine making) are not required to be furnished to the Archaeological Information Centers within the State of California *unless* they have been funded by federal entities (Section 106 NHPA). Even then, the degree of disclosure is negotiable. An example of this would be a sacred space in which a tribe may delineate

the physical boundaries of the site without stating the particular activity that takes place there.

Much of the historic ethnographic material gathered on the Wiyot ancestral territory is being revisited by the current Wiyot community and utilized to revitalize or revise language, religious ceremonies, and to establish areas of concern within their traditional cultural territory (Berman 1996; Rouvier, personal communication 2009). As the tribe has found such records useful in understanding their history, so I as an archaeologist have relied on these early ethnographic records in my thesis work.

Historic Maps

Historic maps were critical to recreating the peri-contact environment of Humboldt Bay. Maps are intended to mirror reality, but they are merely symbolic representations of space (Jeon 2008; Kvamme 1999; Steinberg and Steinberg 2006; Wood 1994). Since representation is a product of perceptions which are culturally informed, a map which depicts a geographic space made by one person may be very different from the map created by another from the same place (Gillespie 2010).

Maps also reflect the biases or single voice of their creators through content inclusion or omission (Stephens 2002; Wood 1994; Jeon 2008). Harley (1988) states that map elements, such as nations and empires, are not natural features of the landscape; they are human constructs (culture) that have been imposed over the centuries. Thus nationalistic ideas, political agendas, power holders, and important icons of a personal or community identity are reflected in the choices of map symbology (Stephens 2002; Jeon

2008; Gillespie 2010). In addition, according to Peterson (2002) most of our modern population is map-illiterate and have trouble visualizing spaces beyond their own experience. Thus map-illiteracy contributes to a person's ability to be further manipulated by mapping biases.

A solution that facilitates the inclusion of multiple voices and indigenous empowerment in representation is participatory mapping. Participatory mapping is a research method that combines the tools of geography with the geographical knowledge of local residents (Close and Hall 2005; Chapin *et al.* 2004; Brady 2009) and is taking place in indigenous, academic, and other mainstream communities. This methodological approach is grounded in the concept that expert knowledge of a space is held by those who inhabit that space (Brady 2009; Chapin *et al.* 2005; Steinberg and Steinberg 2008). One of the unique aspects of this kind of mapping is that it is supported by self-identified members of a community (Steinberg Personal Communication 2009). Although ethnographers like Loud, Kroeber, Goddard, and Merriam made maps which were informed by members of indigenous communities, their experience differs from participatory mapping in that it is unlikely that the entire community sanctioned the documentation or interpretation of their culture. For these reasons it was important to recognize the context, purpose, and time of publication for each map that was consulted for this project.

Archaeological Records

In the State of California, access to archaeological records is restricted in order to protect both the physical and sometime the spiritual integrity of a site (General Authorities Act of 1976 P.L. 94-458; 90 Stat. 1939). Records are housed in a variety of repositories including tribal offices, National and State Parks offices, historic societies, academic institutions, utility companies with large land holdings, and in the offices of private contractors. Access to each repository varies, depending on the record holder and the position of the person requesting access (California Historical Resources Information System).

Source and context critique is also appropriate when examining archaeological site records of a region. The California Department of Parks and Recreation Form Series 523 is a collection of forms through which a variety of physically observable heritage resources are recorded in a standardized format (California Office of Historic Preservation 2010). The theoretical concept of “text-aided archaeology” tells us that although these are “standardized” forms, the participant’s literal observations, education, professional field, chronological time of observation, and level of interest influence the tone and quality in which these forms are completed (Fagan 1991). These individual characteristics are reflected in the breadth, depth, and accuracy of the statements contained within the records. Though varied, the records for this model were cohesive enough to be evaluated for patterns of information that could contribute to interpretive or thematic analysis within the GIS environment. Archaeological records used for this study were housed at the Cultural Resources Facility at Humboldt State University in Arcata,

California, and at the Wiyot Tribe at Table Bluff. These records offered both qualitative and quantitative information for the modeling process.

Geographic Information Systems as an Empowerment Tool

GIS has the ability to relate spatial data from any number of cultural, historical, or environmental attributes (Chapin *et al.* 1998; Gregory and Healy 2007). Combining analysis and visualization, GIS use is expanding in a number of social science and social justice applications including indigenous mapping, environmental and ecological justice, access to health care, land use, and social and political policy to name a few (Chapin *et al.* 1988; Steinberg and Steinberg 2006). In the context of tribal consultation, the Wiyot Tribe at Table Bluff needed GIS technology which created a reciprocal opportunity for my research.

As a picture conveys a thousand words, GIS is a powerful visual accompaniment and can be a tool of empowerment. GIS illustrates both broad and specific relationships of place, space, and people (Steinberg and Steinberg 2008), enabling voices to be heard in ways not always represented well in other formats. The Wiyot at Table Bluff now have a functioning management tool in a digital interface to aid in their consultation and cultural resource management duties. This base could eventually be expanded to encompass other traditional cultural properties such as gathering sites for plant and animal resources.

There is a history in academia of scholars gathering cultural knowledge and using it as a means to an end that benefits only academia or themselves (Hingaroa –Smith

2000). Having lived in Humboldt County since the age of ten, I wanted to engage a thesis that would be mutually beneficial to my education and my community. Researching with permission of the people affiliated with the traditional cultural area was an important ethical cornerstone; a way to honor the ownership of that information. In agreement with the tribal council, I was given access to the tribe's records in order to set up and populate the base, environmental, and cultural GIS layers for the Tribal Historic Preservation Officer. In return, I was allowed to use this data to conduct my research.

National Policy

Although GIS can be an effective tool for tribal empowerment, tribal voices first need to be included during discussion on state and national policy. Federal and state laws mandate formal consultation with Native American entities as a part of the certain process to protect cultural resources. Applicable Federal laws include The National Historic Preservation Act (NHPA, 1966, 36 CFR 800.16(1)), the National Environmental Policy Act (NEPA), Presidential Executive Order 13007 regarding "Indian Sacred Sites", and the Archaeological Resources Protection Act (ARPA). In addition to Federal law, California state law includes a variety of provisions that require consultation in order to promote the protection and preservation of Native American cultural places. These include Public Resources Code 5097.2, The California Environmental Quality Act (CEQA), California Executive Order W-26-92, and California Government Code 65352.4., also known as Senate Bill 18 (SB18).

Senate Bill 18 in particular mandated that city and county planners were to engage in meaningful consult with California Native American tribes in order to aid in the protection of traditional cultural places (“cultural places”) through local land use permitting processes. *Meaningful* consultation is defined as

“...the meaningful and timely process of seeking, discussing, and considering carefully, the views of others, in a manner that is cognizant of all parties’ cultural values and, where feasible, seeking agreement. Consultation between government agencies and Native American tribes shall be conducted in a way that is mutually respectful of each party’s sovereignty. Consultation shall also recognize the tribes’ potential needs for confidentiality (California Government Code §65352.4)”

For all parties involved, consultation efforts and communications should be made as easy as possible. All projects involving land use require maps, a visual tool which can be stored in a GIS environment. Since GIS is a map tool that is commonly used by state and county governments to delineate the boundaries of projects, GIS files can be sent with consultation requests regarding land management projects. A digital comparison or overlay of the proposed project file within the tribal GIS can rapidly inform the tribe and other stakeholders of concerns within or near a proposed project area. This enables all parties to respond faster to project concerns and deadlines.

This process itself is not new, but it is possible that more widespread use of, and access to, GIS based information will not only make this process faster, but more cost effective for all parties. On a local and state level, timely communication serves

tribes, planners, and permittees in moving forward while protecting heritage resources. At a national level, the communication potential of GIS based archaeology is an informed, powerful visual voice for tribal entities and cultural resource managers participating in the policy making process (Merchand and Winchell 1992; Smith 2008)

METHODS

A multiple-methods approach was employed consisting of an analysis of historic maps, ethnographic material, archeological records, and environmental changes. I chose a multiple methods approach to provide a holistic perspective grounded in multiple data-types.

GIS and Data Interface

In the modeling environment, decisions regarding representation of the study area in digital format will vary greatly depending on the geographic information available. While available data limits the kinds of analysis that can be performed, it is common that funding and time constraints prohibit the collection of new data that has been field verified by the modeler.

All sources of modeled information were processed with ESRI ArcMap 9.3.1 (ESRI, Redlands, CA). Ethnographic accounts, ethnographic maps, archaeological records, historic maps, and public GIS data sources were used to derive topography, hydrology, vegetation, and cultural representation within the study area. Both vector and raster outputs were created. Raster cell size for the model was 120 meters x 120 meters with a total of 1,859,194 raster cells in the study area.

Figure 2 illustrates the distillation process which led to the final map layers. Original data is gathered and brought into the GIS environment for initial assessment.

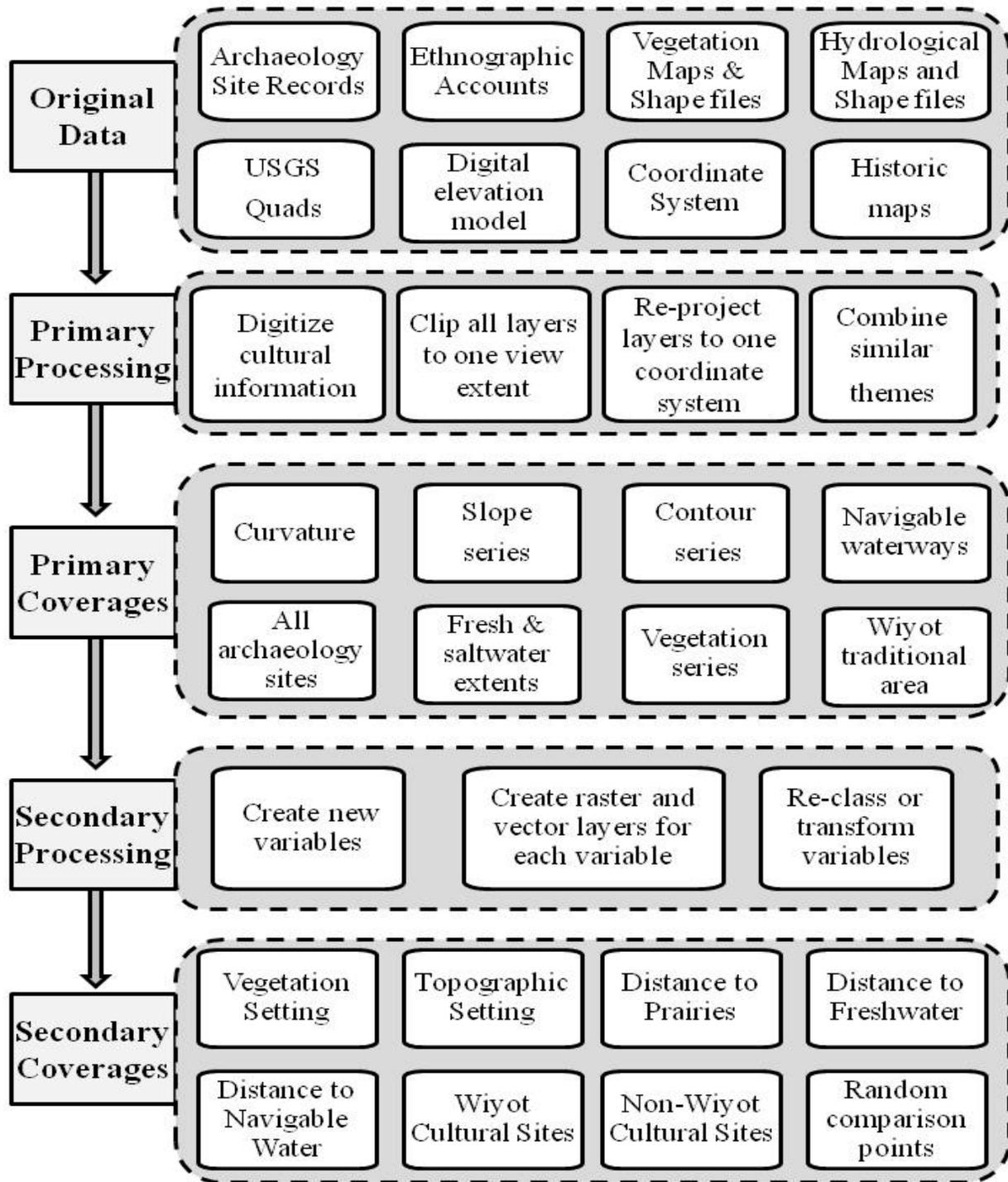


Figure 2. Flowchart illustrating primary data layers, data processing steps, and distillation of the final map layers within the GIS environment (Connolly & Lake 2006) as applied to this model.

Patterns are explored using GIS tools (Primary Processing), resulting in the extraction or definition of themes (Primary Coverages). Primary coverages are then combined or distilled (Secondary Processing) into finalized themes and layers that are relevant to the particular study area (Secondary Coverages). These secondary coverages are utilized for the final analysis.

Study Area – An Environmental Overview

The study area (Figure 3) is located on the north-west coast of California in the County of Humboldt. A little more than 50% of the county (1,353,843 acres of land and 112,593 acres of water) were analyzed in building the model (Zalarvis-Chase 2010). Humboldt County is characterized by rugged mountains, coniferous and hardwood forests, coastlines, and a profusion of water, plant, and animal resources (Redwood National Park 2010).

Geography

Dominating the landscape of north-coastal California is the Pacific Coast mountain range which runs parallel to the Pacific Ocean. Encompassed in this major geographic feature is the Kings Range to the South, the Trinity Range to the East, and the Klamath range to the North (California Spatial Information Library 2003). This dynamic terrain offered many challenges for overland travelers wishing to explore and settle the region. Abrupt bluffs, rocky shores, and mountainous sand dunes hug the coast, occasionally interrupted by wide alluvial deltas of several major rivers (United States Department of Agriculture 2005). Another notable feature of the landscape is Humboldt

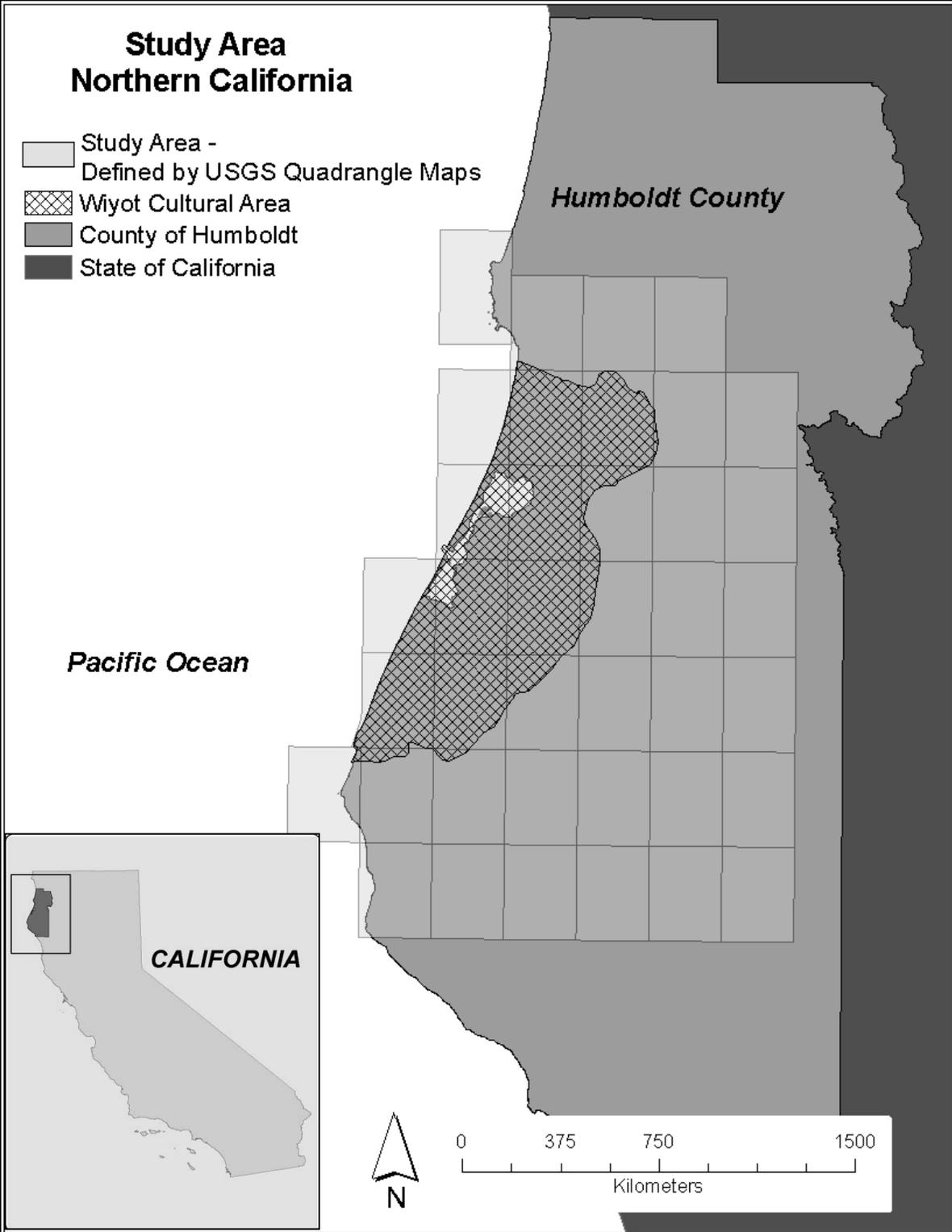


Figure 3. The study area is located on the northcoast of California in Humboldt County.

Bay, the second largest natural bay in California (Humboldt Bay Harbor, Recreation, and Conservation District 2008).

Hydrology

The study area is abundant with natural springs, perennial creeks, and rivers making up seven distinct watersheds (California Spatial Information Library 2003). The low lying coastline harbors a number of lagoons, estuaries, and marshes of both fresh and brackish waters (California Spatial Information Library 2003).

Climate

The climate of the north coast is moist and humid with moderate year- round temperatures, with an average rainfall that often exceeds one meter per year in the direct coastal zone with accompanying temperatures remaining between five and twenty-one degrees Celsius (Western Regional Climate Center 2010). The combination of topography and maritime influences often leaves the immediate coast shrouded in a pleasant and ethereal fog. Inland mountains and high valleys are distinctly different than the coastal belt, exhibiting a greater range of conditions with less average rainfall, temperatures reaching thirty-eight degrees Celsius in the summertime, and snowfall during winter storms (Western Regional Climate Center 2010).

Vegetation

This unique geography and climate have created niches for distinct plant communities. At the coast, the dune forest harbors unique and stalwart species adapted to

the saline and dynamic dune environ. It is dominated by Sitka Spruce (*Picea sitchensis*), hearty shrubs, mosses, and stabilizing plant species including Sand Verbena (*Abronia spp.*), Sand Bur (*Ambrosia chamissonis*), Low Saltbushes (*Atriplex spp.*), Rye Grass (*Elymus mollis*), Bush Lupines (*Lupinus arboreus* and *L. chamissonis*), Mock Heather (*Ericameria ericoides*), Coastal Sagewort (*Artemisia pycnocephala*) (Laspilitas 2010; National Park Service 2010).

Buffered by the dune community, the next immediate inland plant community is the coastal forest which is dependent on coastal fog and the abundant water of the region. Characterized by an overstory of Coast Redwood (*Sequoia sempervirens*) and Doug Fir (*Pseudotsuga menziesii*), these towering forests harbor a unique understory of berries, bulbs, flowers, and tubers all adapted to the very moist and shady setting including California Huckleberry (*Vaccinium ovatum*), Yerba de Selva (*Whipplea modesta*), California rose-bay (*Rhododendron macrophyllum*), Western Sword Fern, (*Polystichum munitum*), Redwood Sorrel (*Oxalis oregona*), Salmon Berry (*Rubus spectabilis*), Thimbleberry, (*Rubus parviflorus*), Wood Rose (*Rosa gymnocarpa*) (Laspilitas 2010; National Park Service 2010).

Like a complicated mosaic the rivers, marshes and estuaries are woven throughout these two communities, creating an interface rich in aquatic plant species that stabilize soils and provide habitat for numerous aquatic and terrestrial species. Saltwater marshes are characterized by Sea Blite (*Suaeda spp.*), Pickleweed (*Salicornia spp.*), Saltbush (*Atriplex spp.* *Frankenia salina*) Salt Grass (*Distichlis spicata*). These marshes often interface with freshwater marshes with plants such as Rushes (*Juncus spp.*), Sedges

(*Carex spp.*), Bulrush (*Scirpus spp.*), Cattail (*Typha spp.*), Spike Rush (*Heleocharis spp.*), along edges are Willows (*Salix spp.*), Cottonwood (*Populus spp.*), Alders (*Alnus spp.*) (Laspilitas 2010; National Park Service 2010).

Moving inland, the climate supports a drier forest characterized chiefly by Doug Fir (*Pseudotsuga menziesii*), Bigleaf Maple (*Acer macrophyllum*), California Bay (*Umbellularia californica*), Christmas Berry (*Heteromeles arbutifolia*), Coulter Pine (*Pinus coulteri*), Tan-Bark Oak (*Lithocarpus densiflora*), Canyon Live Oak (*Quercus chrysolepis*), Black Oak (*Quercus kelloggii*), Coast Live Oak (*Quercus agrifolia*), Madrone (*Arbutus menziesii*), California Hazelnut (*Corylus californica*), and Coffeeberry (*Rhamnus californica*) (Laspilitas 2010).

Intermixed with all three vegetation zones are open prairies and river valleys which support numerous grasses and plant communities that thrive in the transition zones of these communities (California Spatial Information Library 2003).

Wildlife

The rich environmental resources of Humboldt provide habitat and nutrients for many terrestrial, aquatic, and avian species (Humboldt Bay Harbor Recreation and Conservation District 2008). Sea mammals and whales are present and numerous crustaceans thrive on the rocky coasts, muddy bays, and freshwater streams. Roosevelt elk (*Cervus canadensis roosevelti*), black bears (*Ursus americanus*) and mountain lions (*Puma concolor*) are larger common mammals, while raccoons (*Procyon lotor*), foxes (*Urocyon cinereoargenteus*) and rabbits (*Lepus californicus*) flourish in the brush (Sakai

1996; California Department of Fish and Game 2010). As part of the Pacific Flyway, pelagic birds, marsh, forest, prairie and migratory bird populations are abundant (Humboldt Bay Harbor Recreation and Conservation District 2008). A notable resource of the region is its fishing industry, especially salmon (*Oncorhynchus tshawytscha*) and trout (*Oncorhynchus clarkia*) which have graced the rivers of the northcoast for hundreds of years (Wallace 1983; McEvoy 1986; Most 2006).

All of these elements that compose the natural beauty of the area have been impacted by urban and agricultural development. The dyking of the bayside areas, industrial impacts to the forests, the subsequent erosion from logging and mining, and ranching practices of the last 160 years have radically altered all aspects of the study area. Recreating that pre-contact environ through historical research was the first step to situating the Wiyot in their ancestral territory.

Environmental Layers for analysis

Environmental layers were informed by the literature review and an exploration of the geographic characteristics of the study area. A USGS 10 meter digital elevation model (DEM) of the study area was used to explore primary topographic variables of slope, aspect, elevation, and topography. However, before land parameters could be finalized, the hydrological history of Humboldt Bay had to be addressed.

Hydrology

The center of the Wiyot world, Humboldt Bay, is a dynamic environment influenced by both freshwater and tidal contributions. To understand the influence of this

body of water within the Wiyot interaction sphere, pre-contact representation of the bay was required. One particular model created by Wescott and Kuiper (2006), provided a great deal of guidance in dealing with the maritime representational issues, particularly at the interface of tidal and freshwater environs.

Geo-rectified historic map scans were obtained from the Humboldt Bay Harbor Commission (Laird 2007). These were utilized to delineate the pre-1850 bay entrance, shoreline and slough network of the region, much of which had been altered by development. Additional historic map images were obtained from Humboldt State University and the California Spatial Information Library. These were imported and geo-rectified using the ArcGIS Geo-Referencing tool. Current freshwater source layers were also obtained through the California Spatial Information Library (CASIL).

Three particular challenges were addressed to create the hydrologic layer. First, the study area includes two major river channels that prior to channelization had historically broad, meandering courses (Belcher 1921; Laird 2007). To allow for the maximum extent of a non-modified river system, all historic beds and courses were digitized for both the Mad and Eel Rivers. Second, at the time of contact there was an extensive, tidally influenced slough network connecting Humboldt Bay with numerous freshwater tributaries. The Belcher Atlas series (1921) and Loud's map were geo-rectified and the old slough network was digitized into the hydrology layer (Figure 4).

Lastly, it was necessary to determine where freshwater and salt water influences interacted. A National Wetlands Inventory (NWI) layer was obtained to incorporate salinity information. This aided in delineating freshwater and brackish environments

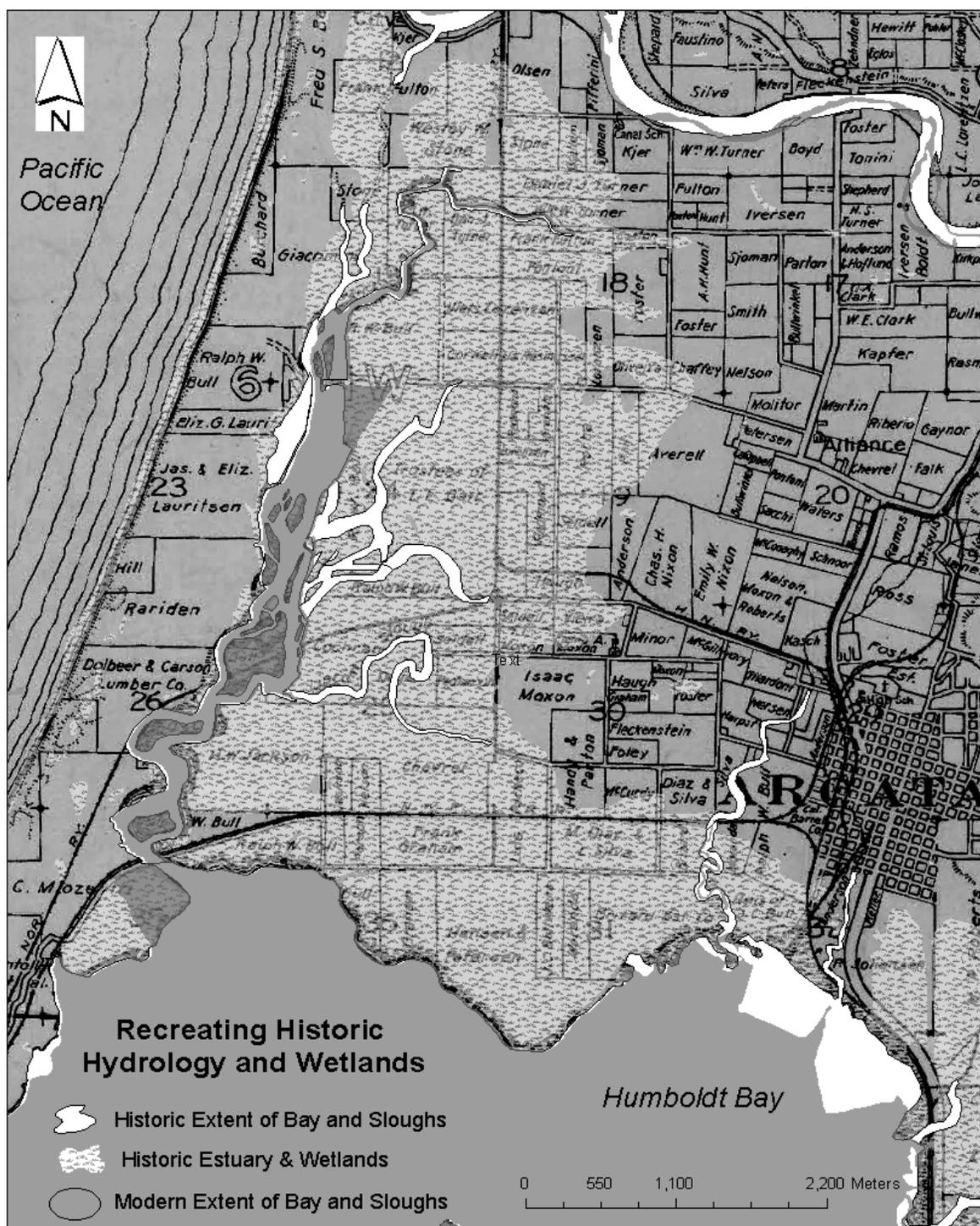


Figure 4. Digital images of historic and modern maps were digitized and overlaid to determine the current and historic extents of the slough networks, Humboldt Bay, estuaries, and wetlands.

within the tidal and estuarine zones. Freshwater springs appeared on topographic maps and in archaeological site records, but were not charted on digital maps obtained from state sources. Therefore, as they were encountered in the archaeological records and on base maps, springs were manually digitized into the water layer. This resulted in providing only a partial representation of the freshwater springs in the study area. However, given the abundance of freshwater in the area, preliminary data exploration indicated that this would not be a critical inadequacy.

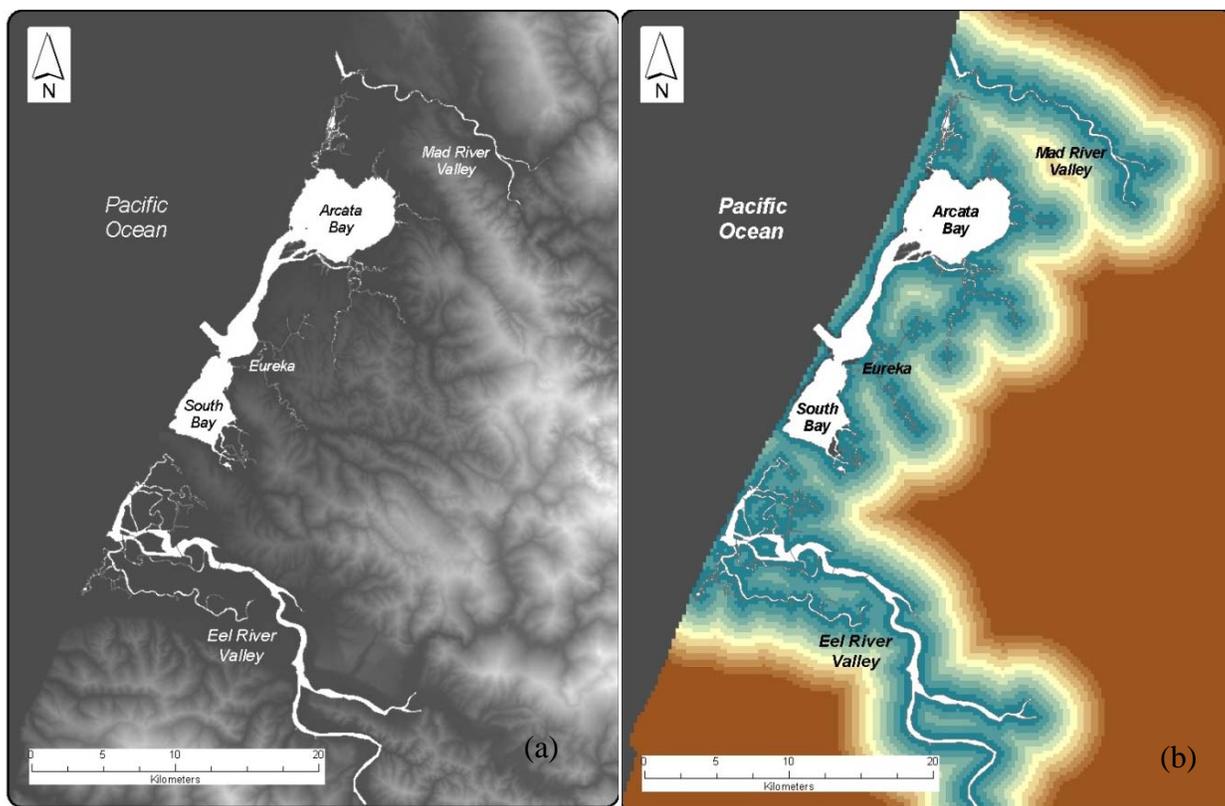


Figure 5. Processing primary hydrologic information produced several layers for analysis including the historic extent of navigable waterways (a) and distance from navigable waterways, illustrated through a series of buffered rings in 500m increments (b).

Raster calculator and vector union functions were performed to combine the multiple shapefiles and networks into a single historic water layer. Both vector and raster

layers were produced and reclassified to represent ocean, deep water tidal channels, estuary and slough networks, and freshwater creeks, lakes, ponds, and springs. The derived hydrological layer could now be placed with the DEM, editing out artificial levees and land use areas while restoring tidal and estuarine flow routes. This layer was used to produce two secondary coverages used in the final analysis. The first was distance from known sites to freshwater. The second was a layer reflecting waterways that were navigable by canoe as seen in Figure 5.

Topography

The study area has an extremely diversified landscape with elevations ranging from minus 1.5 meters below mean sea level (MSL) to mountain ridges of 507.5 meters above MSL (National Oceanic and Atmospheric Administration 2010). Maps derived from the DEM include slope, elevation, and aspect in different interval values in order to explore the level of detail that would best represent the topographic variety. Spatial Analyst curvature tools were used to initially identify moderate convex and concave raster cell clusters. This aided in determining initial valley like depressions, ridges, and transitional landforms such as descending ridge noses. Curvature was then scaled with a 5% interval slope, and a 50m interval elevation contour layer to identify broader low slope areas, flat ridge tops, terraces, benches, and moderate to steep hill slopes. The topographic layer was later intersected with the hydrologic layer to derive the extent of freshwater and estuary floodplains.

In reviewing National Oceanic and Atmospheric Administration information for tidal datums and historic water levels, a measurement 1.5 meters above high mean high water (HMHW) level was used to derive the maximum extent of the tidally influenced floodplains around the bay and at the mouths of rivers. High elevation freshwater creek floodplains were represented by the scoured extent of historic channels (Belcher 1921; Laird 2007). Table 1 lists the mutually exclusive and distinct topographic criteria illustrated in Figure 6.

Table 1. Topographic classes used in this model and the criteria by which they were defined.

TOPOGRAPHIC CLASS	CRITERIA
Freshwater Terrace or Floodplain	Historic extent of scoured channels and beds
Tidal Floodplain or Estuary	From bay water edge to 1.5 meters above MHW
Flat	Less than 15% slope
Hillslope	15%-45% slope
Steep Slope	Greater than 45% slope
Flat Ridgetop	Less than 15% slope on a ridgeline

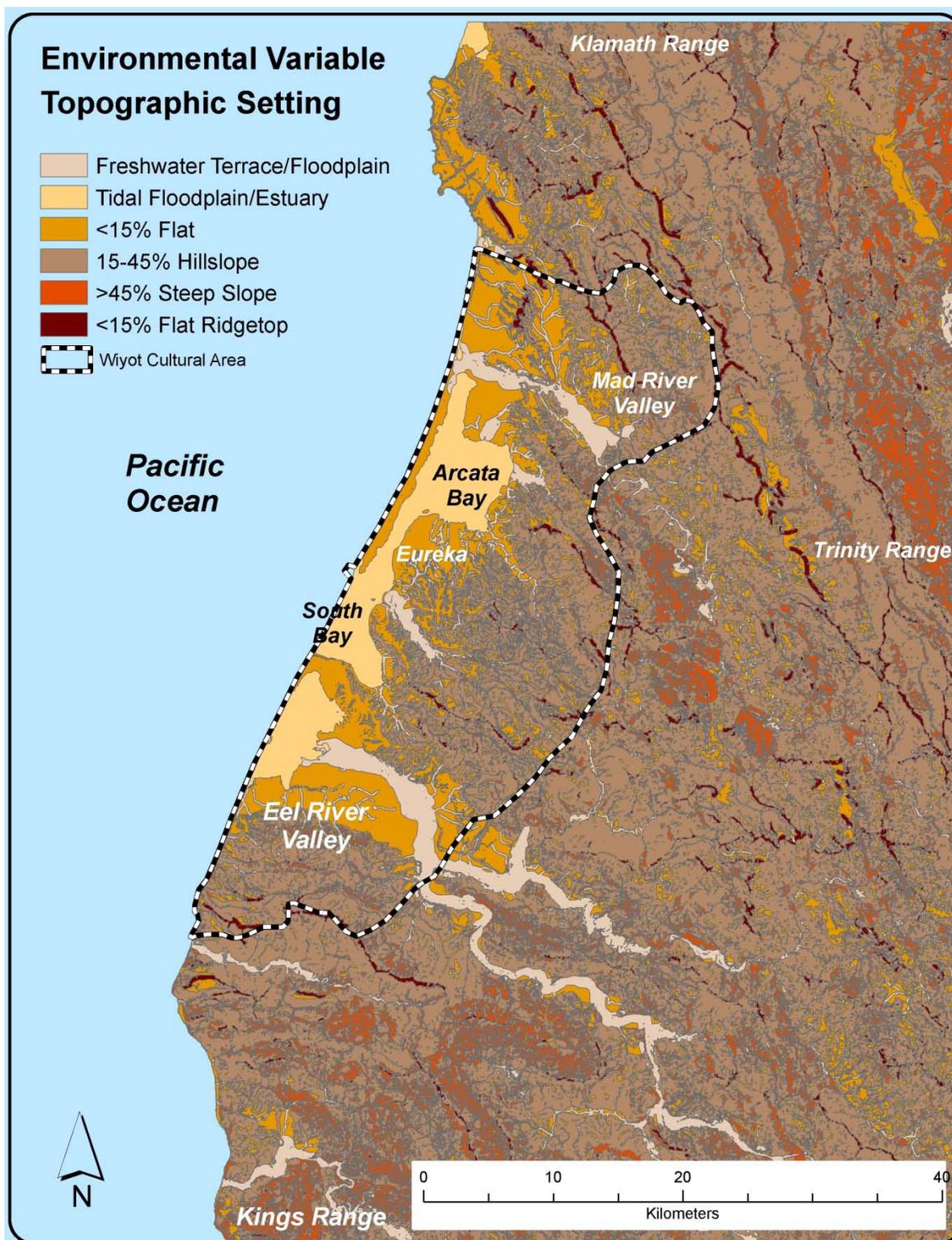


Figure 6. Geographic distribution of topographic classes across the study area.

Vegetation

The vegetation layer (Figure 7) proved to be the most difficult of the environmental layers to construct. Because the study area was so heavily impacted by the logging and ranching industries, accurate representation further than 70 years into the past was subjective. Shapefiles and geo-rectified maps were obtained from the U.S. Forest Service Region 5 GIS clearinghouse and CALATLAS. These layers depicted current and historic forest range including extent and type of vegetation. The goal was to recreate the vegetal extent in 1850, but verifiable vegetation maps only went back to 1934. Still they were very useful in re-coding urbanized or developed areas and in extending the range and type of historic forests.

The initial vegetation data included areas coded as barren, rocky outcrop, and urban. Barren and rocky areas were used to inform the water and topography layers while the urban areas needed re-coding. Barren areas were combined with the freshwater river layer to determine the extent of river scouring activity. Defining seasonally scoured areas aided in determining the active flood-plain of freshwater channels based on the inability of woody, permanent plant life to be sustained within those boundaries. Areas coded as urban use were re-coded to the correct historic vegetation cover through the use of transparent overlays of historic maps of previous forest cover in their place. Lastly, historic maps showing wetland extents, Loud's ethnography, and a few particularly well researched historical reports on Humboldt Bay (Laird 2007; Eidsness 1993) were scanned for verbal descriptors and delineations of vegetation extent and type.



Figure 7. Vegetation layer derived from digital coverages and historic maps of forest extents.

Diversity of terrain and moderate climate create many small ecotones, transitional zones between two dominant plant communities, containing the characteristic species of each. Therefore it was necessary to generalize vegetation types that at times encompass similar or the same plant species. Five classes were derived to designate vegetation covers. These were barren ground (sand, gravel, and rocky outcrops); herbaceous areas, including prairies and sand stabilizing grasses and mats; wetlands, both salt and freshwater; coniferous forests, primarily coastal and redwood belts; and hardwood woodlands, located primarily inland or on fringe/margins of conifer forests where there is enough sunlight to sustain these varieties.

Lastly, additional research publications on local history were consulted for specific environmental descriptions of particular geographic areas that informed both the water and vegetation layers. These were particularly useful in re-coding developed urban areas around the bay and included excerpts from the Suzie Baker Fountain Papers (1967), Bennion and Rohde (2003), and Coonan (1959).

Cultural Data for analysis

The primary sources for the cultural data layers were L.L. Loud's 1918 map of village locations, Nomland and Kroeber's (1935) map of Wiyot village locations, and a sampling of archaeological site records from the study area that spanned 1913 to 2004. The information within these records had not been digitized and each kind of data extraction and interpretation presented its own set of challenges.

Archeology Sites

To include the choice of archaeological site placement in the model, site locations had to be mapped within the digital environment. As previously stated, the breadth and depth of site documentation varied and a hierarchical rule for site placement was established based on the kind of information presented with the site record or ethnographic material. Ideally, a complete professional level record would include several cross references for locational data including a defined area on a USGS topographic map, Universal Transverse Mercator (UTM) or latitude and longitude coordinates, a site map drawn to scale, and a site datum within the site map. The site record could include anyone or all of these elements.

For point representation the first preference for plotting was the archaeology site datum represented in a scaled site map. Lacking a site datum, the site boundaries depicted in the scaled site map were drawn as a polygon and the point placed centrally. My third choice in point representation was the site placement on a USGS topographic map. This map placement out-ranked the use of UTM and latitude/longitude coordinates because the coordinates listed were often one hundred meters or more away from one or more cross referenced locations within the record. This is likely due to human error in calculating the lat/longs and/or a differentiation in the map projection used when collecting the UTM data which differed from the projection being used within my GIS model.

For polygon representation, my first preference was the boundary represented on a scaled site map as it often depicted detailed nuances of the landscape such as springs,

gullies, and roads and gave a definitive site boundary. My second preference was the extent of the site boundaries listed on the USGS topographic map *in conjunction with* the site measurements listed in the record delineating the North-South and East/West extents of the site. My third choice was site measurements placed within the nearest quarter-quarter map section listed in the record. Lastly, if only a dot on the USGS map depicted the placement and extent of the site, an arbitrary polygon measuring 60m x 60m was placed in the location with a coinciding central point. The first extraction was to map all village sites listed on Loud's map. Loud had several methods of cross-referencing site locations, uses, and place names. Although the map was hand-drawn, it referenced major geographic features including river bends and sloughs, buttes, major prairies, and was labeled with modern topographic map sections. The map quarter sections enabled the village locations to be placed at least within the correct quarter-quarter section of a USGS topographic map. The second information extraction was garnered from archaeological site records. Occasionally site records would inform of other elements, such as on-site springs, that were not listed on larger regional maps. This additional environmental information was incorporated into the appropriate environmental layer when I encountered it.

Working from Loud's site-type/use notes and the archaeological site records, several classifications emerged. They were first coded as being within or outside of Wiyot territory and secondarily classified as a lithic, village, or resource procurement site based on the site components. The type and number of sites identified in the data set as a whole are in Table 2 and Table 3.

Table 2. Site types and components used in the building of this model.

Site Type or Components	Units in training set	Units in test set	Total units
Lithic	44	47	93
Dense/Extensive Lithic Scatter	2	3	5
Lithic Generalized - no quantity noted	15	13	28
Lithic Moderate	4	4	8
Lithic Sparse/Light	19	23	42
Lithic Isolated Projectile	4	5	10
Inland Resource Procurement (IRP)	23	21	44
Lithics and Groundstone	19	15	35
Lithics and Midden	3	4	7
Lithics, Groundstone, and Midden	1	2	3
Other	6	4	10
Other – Petroglyph	0	2	2
Other – Trail	1	1	2
Other - Burial or Cemetery	2	0	2
Other - Dentalium Deposit	1	0	1
Other - Boundary Cairn/Tree	2	0	2
Other - Religious or Spiritual	0	1	2
Aquatic Resource Procurement (ARP)	14	9	23
Shell ARP, Fire Affected Rock	2	3	5
Shell ARP, Fire Affected Rock, Lithics	6	3	10
Shell ARP and Lithics	1	2	3
Shell ARP, Bone, Fire Affected Rock, Lithic	5	1	8
Total Sites for Table 2a.			170

Table 3. Site types and components used in the building of this model (continued).

Site Type or Components	Units in training set	Units in test set	Total units
Shell Habitations	34	38	72
Shell, Midden	1	3	5
Shell, Midden, ARP, Fire Affected Rock	1	1	3
Shell, Midden, Fire Affected Rock, Lithics	3	1	4
Shell, Midden, Sea Mammal Bone, ARP, FAR	1	0	1
Shell, Midden, Village, House Pits	7	9	16
Shell, Midden, and Village	15	14	29
Shell and Village	5	8	13
Shell, Village, and House Pits	1	2	3
General Habitations	70	84	154
Village, House Pit, Midden (Non Wiyot)	3	4	9
Village, House Pit (Non Wiyot)	2	0	2
Village, House Pit (Wiyot)	10	9	19
Village, Midden (Non Wiyot)	4	4	8
Village, Midden (Wiyot)	2	0	2
Village (Non Wiyot)	14	15	29
Village (Wiyot)	35	52	87
Native Sites - Unknown Use	3	4	7
Quarry	3	2	5
Total Sites for Table 3.			170
Total Sites for Table 2.			238
Total Sites			408

To be methodologically consistent, categorical inclusion had to be based solely on the description exhibited in the written records. For example, although it is highly likely that all Wiyot villages situated on the bay contained shell deposits, they could not be included as a shell village unless it was explicitly stated that shell was observed at that location.

Sampling Method

A total of 408 sites were entered into the GIS. Approximately half (n=197, or 48%) were randomly selected as a training set to be used in construction of the model. The remainder (n=210, or 52%) were reserved to be used as a test set later in the analysis. This is known as split sampling (Connolly and Lake 2006) and is useful when the time or means does not allow for field investigation. Ebert (2000) claims the problem with this method is that it only proves homogeneity within your data set. This statement can be countered by meeting the statistical requirements of having a large sample set with a random selection of site types. A sample of computer generated random location points (n=197) was also selected from the study area. It is *assumed* in this model that the random points are not archaeological locations. The distribution of all three data sets is found in Figure 8.

Ethnographically Informed Layers

As previously discussed prairies and canoes were integral to Wiyot life. From the geographic data, Euclidian distance functions were used to measure supposed

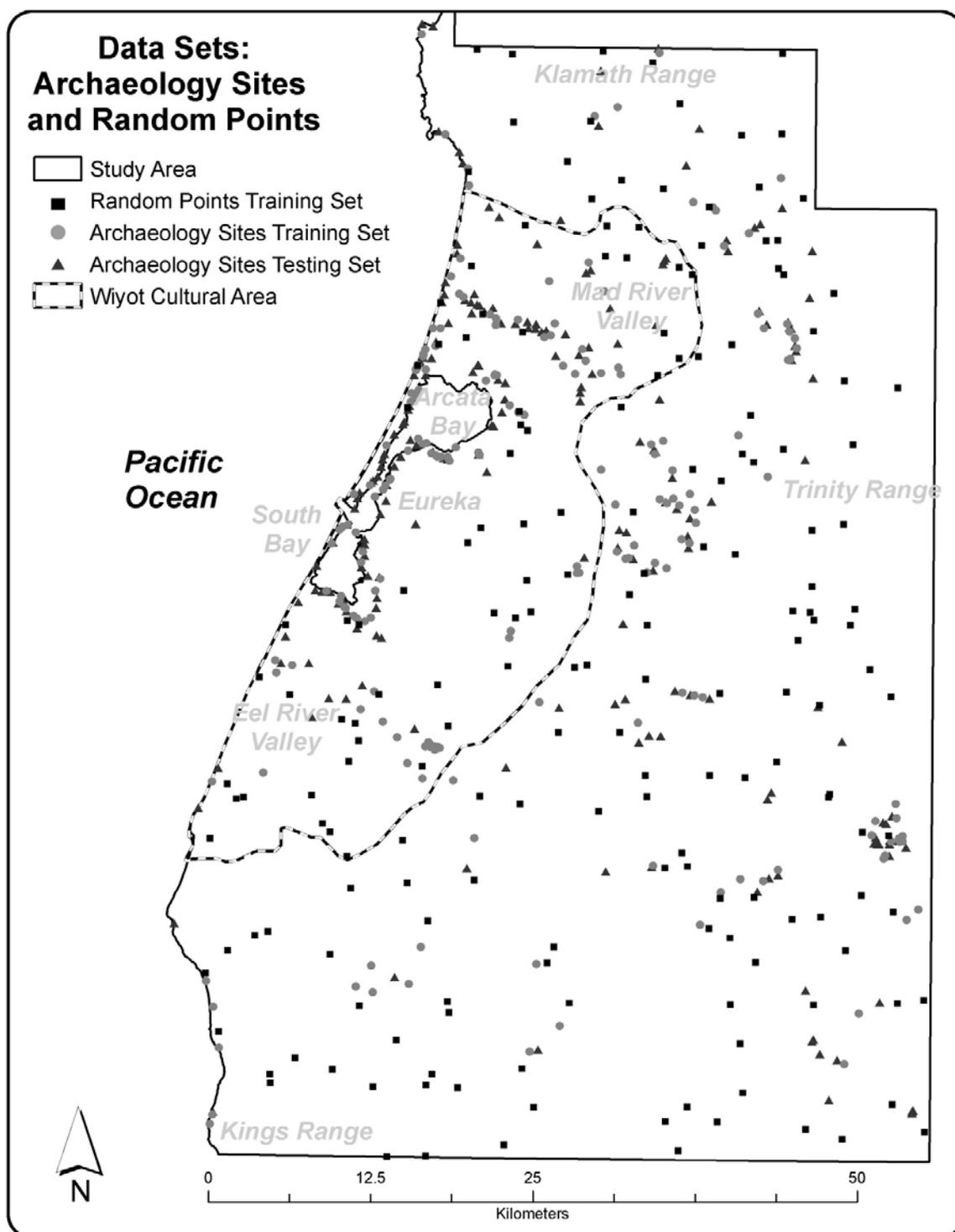


Figure 8. Split sampling method applied to the study area included training and testing sets of archaeology sites, and a random point data set for comparison.

culturally important distances including freshwater, navigable waterways, and prairies. Prairies were classified as an herbaceous area of 10 acres or larger. The value or distance for each variable at each archaeological site was extracted from the GIS data and exported to SPSS for statistical analysis. Loud's monograph and the additional archaeological records covered many more culturally specific aspects of Wiyot life including kinds of marine species identified in middens, kinds of lithic materials, resources available at certain locations, place names, and familial access to specific resource areas and locations. However the number of records containing these particular kinds of data were not numerous enough to validate their use as cultural variables while retaining the statistical strength of a large sample size.

The goal of my predictive model was to establish clear patterns of environmental or cultural characteristics related to archaeology site selection that differentiate themselves from the general space of the study area. This is an inductive model that uses specific information to come to generalized conclusions and is appropriate for the hunter-gatherer tradition found in this region (Maschner 1992). The process began with an exploration of the potential variables, statistically selecting for strongest variables through logistic regression, applying accompanying map algebra to obtain the probabilistic model, and finally internal and statistical testing of the model.

Initial investigation of the variables included an exploration of the data set with regard to site type, cultural affiliation, and environmental settings. Dual-sided histograms compare the environmental signature of the random data set to the signature produced by the training set of archaeology sites. This was followed by exploration of frequencies

differentiating the Wiyot preferences from those of the neighboring cultural groups. Site type and cultural affiliation were also examined in relationship to each variable and cultural group.

Logistic Regression Analysis

SPSS software was employed to statistically assess the strength of each variable and determine its inclusion in the model. The dependant variable data set (archaeology sites) was coded as 1, while the dummy variable (random point) was coded as 0. As nominal variables, topography and vegetation were treated as categorical co-variates while distance to fresh water, distance to navigable water, elevation, and distance to prairies were regular covariates. Significance was set to the 0.05 level for entry into the model with removal occurring at 0.1.

Based on the review of the environmental and ethnographic data, a forward conditional logistic regression model was employed using the categorical variables of topography (X_1) and dominant vegetation (X_2), and the ordinal variables of distance to freshwater (X_3), distance to navigable water (X_4), distance to open prairie (X_5), and elevation (X_6). The logistic regression calculated covariate values (b_j) and a constant value of a in order to calculate a value of V (Equation 1).

Equation 1. Step one: calculate "V" score using a constant (a) in conjunction with variables (x) and their covariates (b).

$$V = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \dots$$

The value of V was then used to determine an estimate of probability (P) over the entire study area. By this method each raster cell in the study area is given a P value by using the following formula where the value of P_i on a scale of 0.0 to 1, is the relative probability of a site at that raster cell location (Equation 2).

Equation 2. Step two: calculate relative probability (P) for each cell in the study area.

$$P_i = \frac{V_i}{1 + \exp(V_i)}$$

All variables were entered into a forward conditional regression. The regression process gave significance values for all variables. Variables were retained for the final formulation only if they met a significance level of 0.05, of which there were three.

Because the navigable water variable was a cultural variable specific to the Wiyot, it was not appropriate to apply this variable to the neighboring cultural areas that did not utilize watercraft in the same way as the Wiyot. Following a similar example by Wescott and Kuiper where shell and non-shell sites were being modeled, I decided to run two iterations over the area. The first would include the two variables that were significant to the entire study area which were topography (X_1) and distance to open prairie (X_5). A separate iteration would be run which would include the third variable of distance to navigable water (X_4) over the Wiyot cultural area only. This would result in two probability maps which would then be combined for a final map

Two methods were used to evaluate model performance. First, the independent test set of archaeological sites tested against the map in order to ascertain what

percentage was correctly predicted. Second Kvamme's Gain Statistic was employed as a measure of the utility of the model over random guessing. Cumulative percent prediction curves, or S curve, for both sites and non-sites were also examined.

RESULTS

Training Set Exploration

Cultural affiliation was determined using maps by Loud (1918), and Kroeber and Nomland (1936) which defined the extent of Wiyot language and territory. Although randomly selected from the entire data set by the statistical software, the Wiyot sites numbered 21 more than the non-Wiyot sites, producing a ratio of 1.25 Wiyot sites per each non-Wiyot in the training set. Table 4 shows the composition of the training set in relationship to site type and cultural affiliation.

Table 4. Cultural affiliation and site types within the study area.

Site Type	Cultural Area		Total
	Non-Wiyot	Wiyot	
Lithic	30	14	44
Lithic and Inland Resource	20	3	23
Marine Resource	6	13	19
Non-Wiyot Village	26	3	29
Other	6	6	12
Wiyot Village	0	70	70
Total Count	88	109	197
Total Percent	44.7%	55.3%	100.0%

Topography

The topography histogram (Figure 9) reflects the major land forms of the study areas and signatures created by the random data and the archeological training set. The majority of the study area is steep with 15-45% slopes covering 66% of the study area. In contrast, most of the archaeology sites (n=140) are occurring in locations that fall in areas of less than 15% slope, only 29% of the study area.

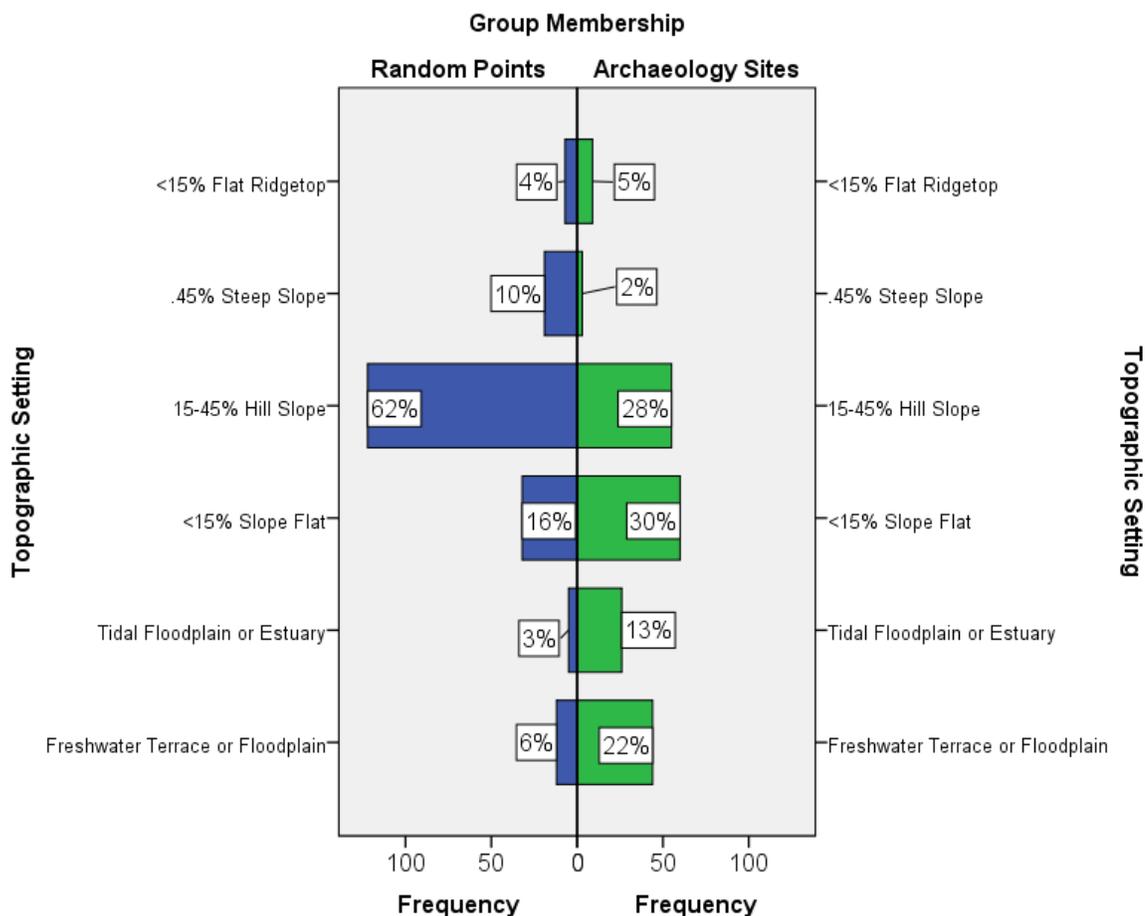


Figure 9. Distribution of archaeology sites and random data points across topographic settings.

When examined by cultural group two trends were observed (Figure 10). First, Wiyot sites occurred in floodplains (42%) and gentle slopes (47%) but also exhibited placement in the uplands (5%). Second, non-Wiyot areas showed a high occurrence of sites in steep terrain (52%), freshwater floodplains, and gentle slopes (21%). When examined by site type, a majority of the sites in the 15-45 % hill-slope category in non-Wiyot areas were lithic sites, which can occur on any terrain. Second a majority of sites in freshwater and tidal floodplains categories were villages with a few lithic sites interspersed.

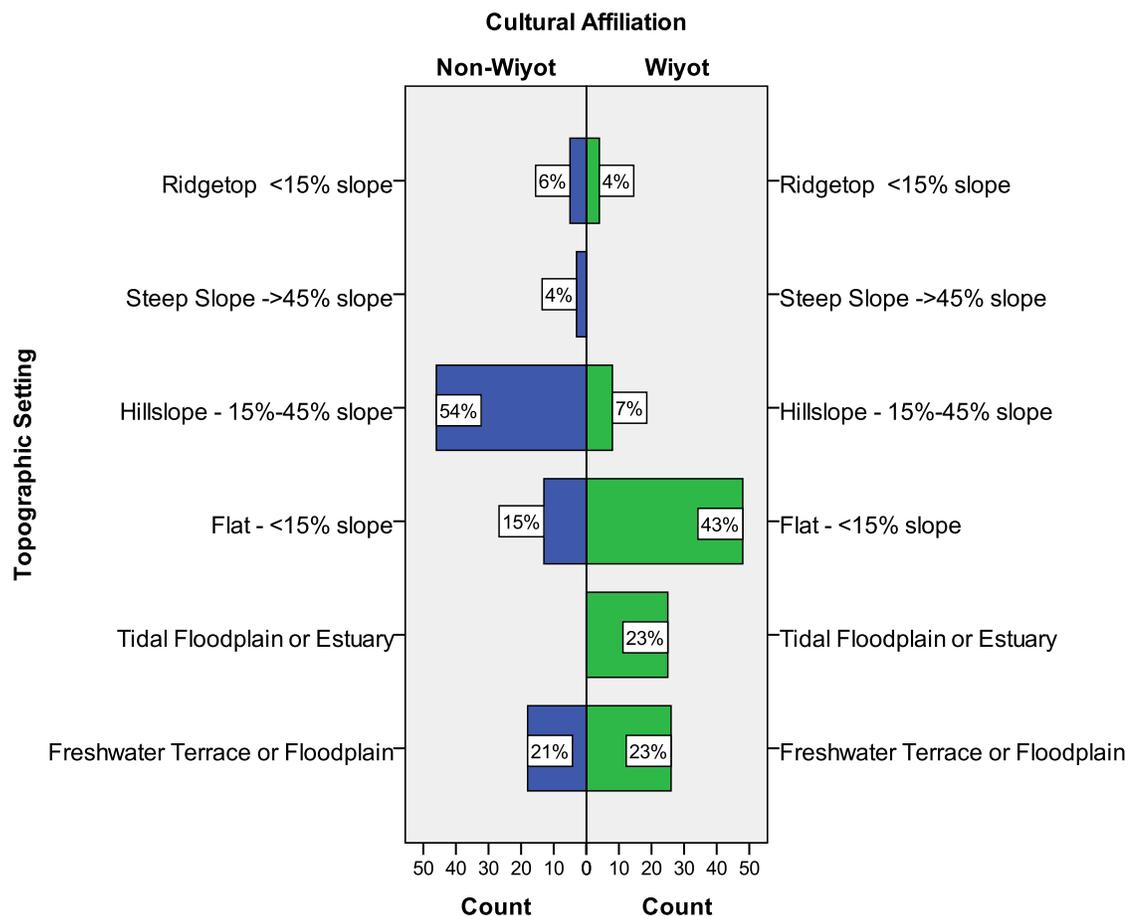


Figure 10. Distribution of archaeology sites by cultural affiliation and topographic setting. Additionally, Table 5 illustrates which kind of project prompted these sites to be recorded. Fifty-one lithic sites were recorded in response to timber or development operations compared to only three from academic sources. In contrast, seventy-nine village sites were recorded during ethnographic research efforts as opposed to ten from timber and development operations. It was evident that the reason a site was recorded influenced the proportional representation of sites across the landscape, forcing a closer look at type and topography by category. Lithic sites occurred in a greater variety of

topographic environments, predominantly on the steeper upland slopes of the interior region. Villages were dominant in the lower river canyons.

Table 5. Training set of archaeology sites in relationship to why a record was created.

Reason Data was Recorded		Site Type						Total
		Lithic	Lithic and Inland Resource	Marine Resource	Non-Wiyot Village	Other	Wiyot Village	
Academic	Count	3	0	6	14	1	65	89
	% of Total	1.50%	0%	3.00%	7.10%	0.50%	33.00%	45.20%
Other	Count	0	0	1	0	1	0	2
	% of Total	0%	0%	0.50%	0%	0.50%	0%	1.00%
State Lands Maintenance	Count	0	0	2	4	0	0	6
	% of Total	0%	0%	1.00%	2.00%	0%	0%	3.00%
Timber and Development	Count	31	20	8	6	8	4	77
	% of Total	15.70%	10.20%	4.10%	3.00%	4.10%	2.00%	39.10%
Unknown	Count	10	3	2	5	2	1	23
	% of Total	5.10%	1.50%	1.00%	2.50%	1.00%	0.50%	11.70%
TOTAL	Count	44	23	19	29	12	70	197
	% of Total	22.30%	11.70%	9.60%	14.70%	6.10%	35.50%	100.00%

Distance to Freshwater

Distance to freshwater did not reveal any major difference between the archaeological sites and randomly generated points (Figure 11). Distance to freshwater compared between cultural groups (Figure 12) indicated that the Wiyot were more likely

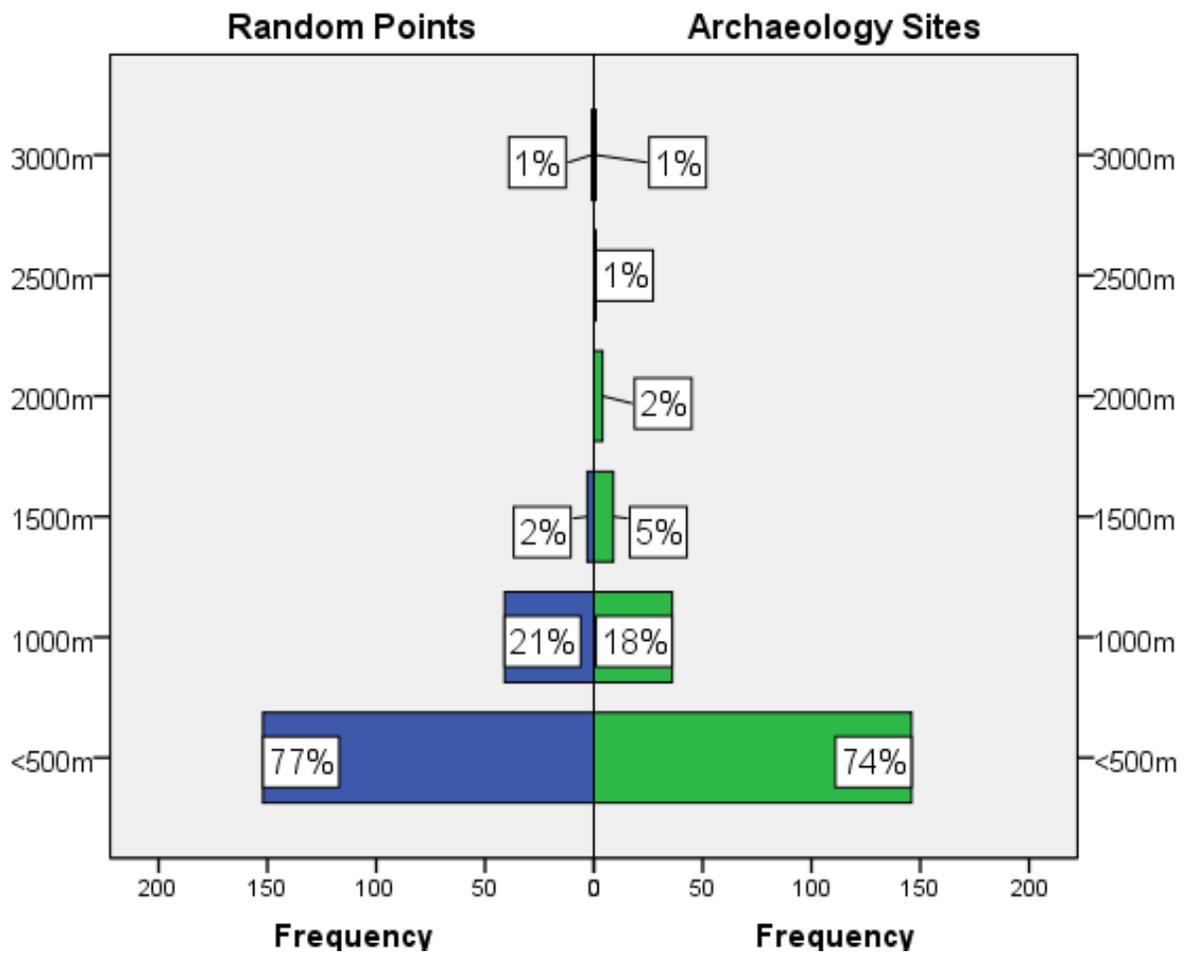


Figure 11. Distance of random points and archeological sites to freshwater sources.

to have activity areas farther from freshwater than non-Wiyot groups. The Wiyot sites that were greater than 1,000m from a noted freshwater source were characterized as permanent settlements (n=9) and marine resource procurement areas (n=5) and were located on the peninsulas (n=11), islands (n=2), and a bayside sand spit (n=1).

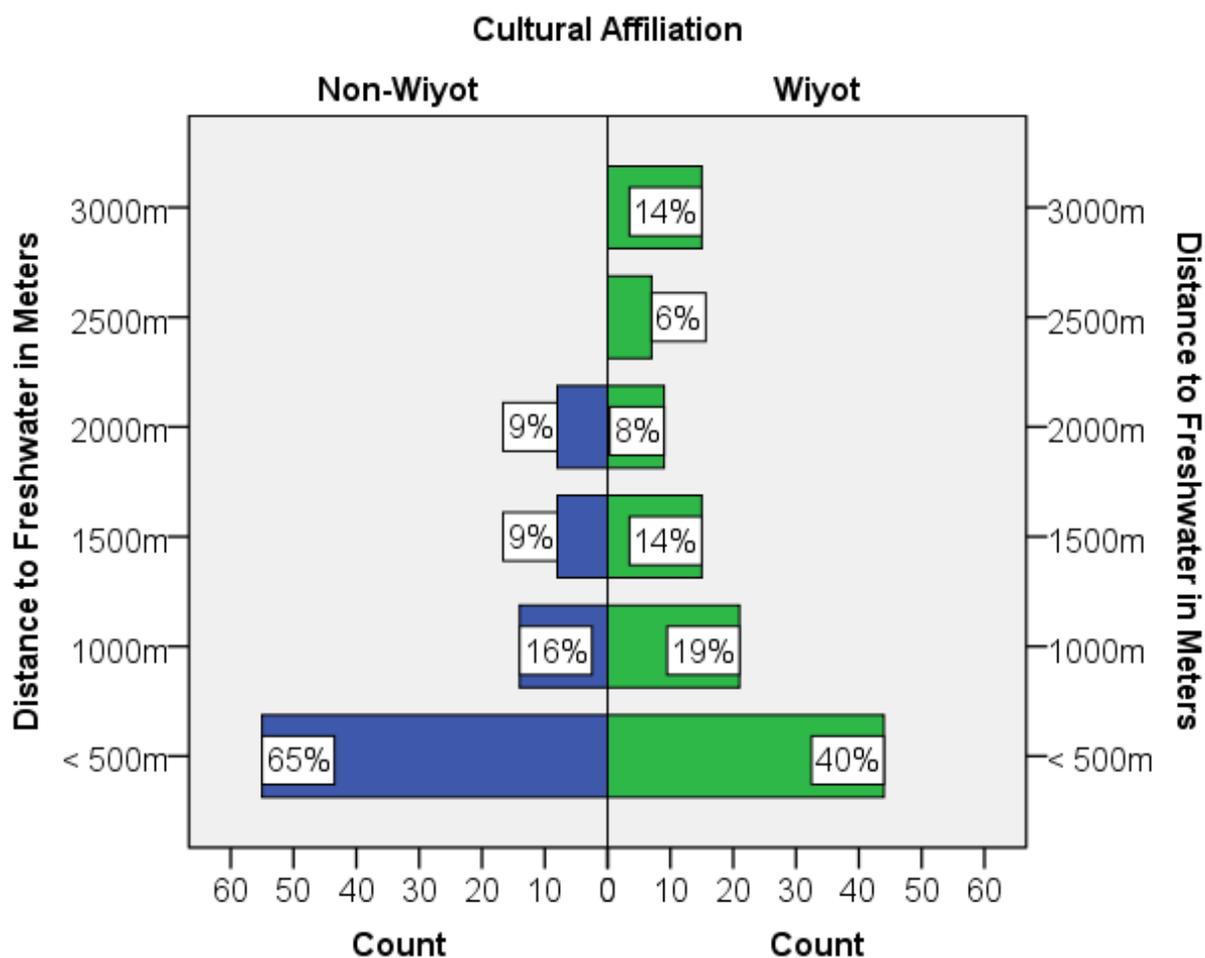


Figure 12. Distance of archeological sites to freshwater sources by cultural affiliation.

Distance to Navigable Water

Distance to navigable waterways was examined as a culturally influenced variable and was highly correlated with archaeological sites as seen in Figure 13. Comparing cultural groups and navigable water (Figure 14), 86% of sites identified as Wiyot settlements were within 500m (n=83) or 1000m (n=12) of navigable waters. Of the remaining sites (n=15) only two were village sites which fell 1012m and 1047m from a navigable waterway. The remaining Wiyot sites (n=13) were characterized as lithic,

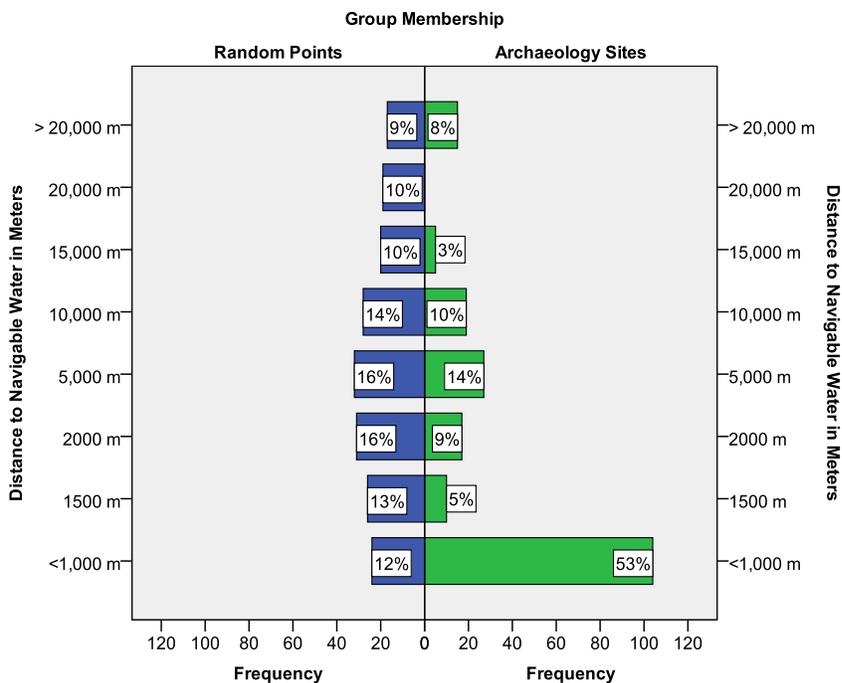


Figure 13. Proximity of random points and archaeology sites to navigable waterways.

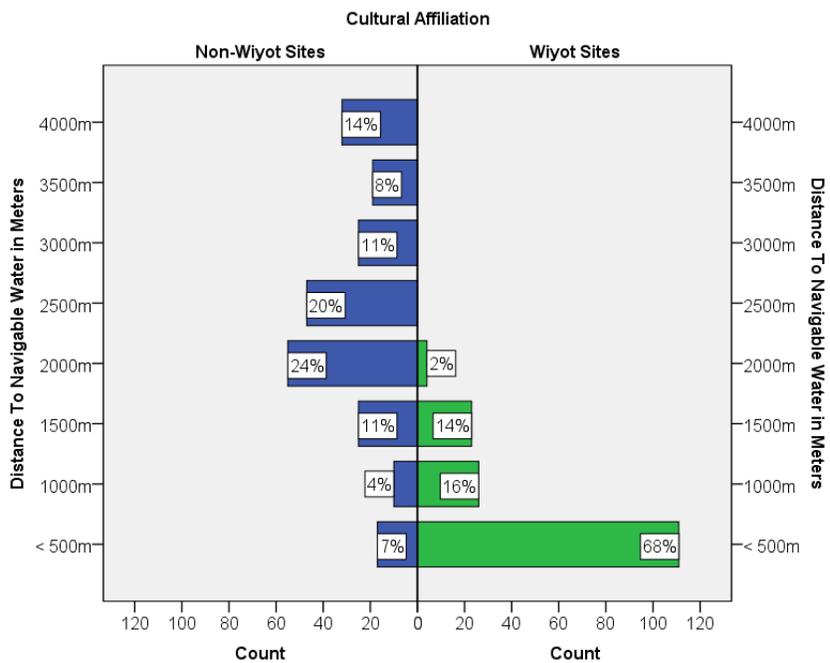


Figure 14. Proximity of archaeology sites to navigable waterways by cultural affiliation

inland resource procurement areas, and quarries.

Elevation

Comparisons of elevation between the random points and the archeology data set (Figure 15) indicated a spike in low elevation sites with graduated distribution as elevation increased. When examined by cultural groups, the divergence was reflective of overall topography in relationship to cultural area (Figure 16). When examined by site type, there were no occurrences of Wiyot villages over 61 meters. The predominance of lithic sites in the non-Wiyot area at high elevation was again noted (Figure 17).

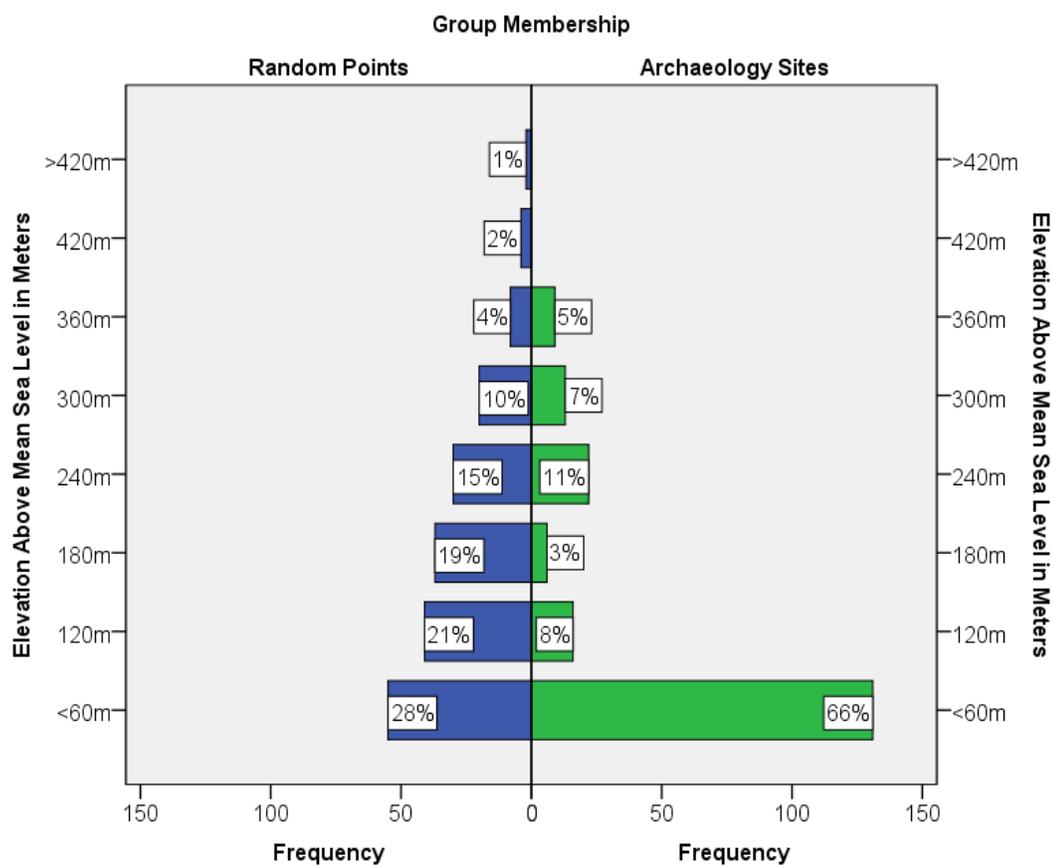


Figure 15. Distribution of random points and archaeology sites by elevation.

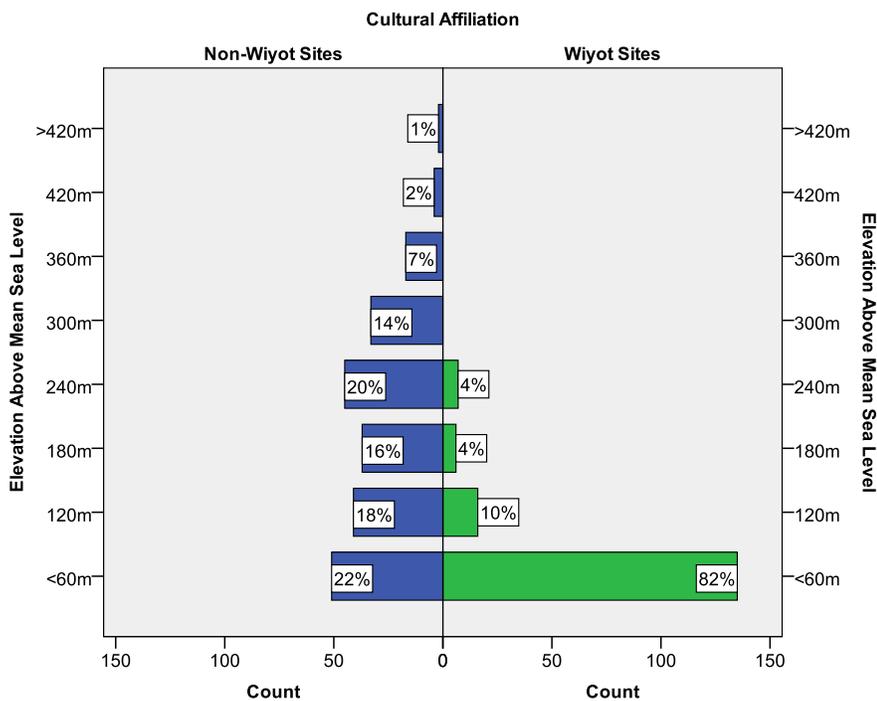


Figure 16. Distribution of archaeology sites by elevation and cultural affiliation.

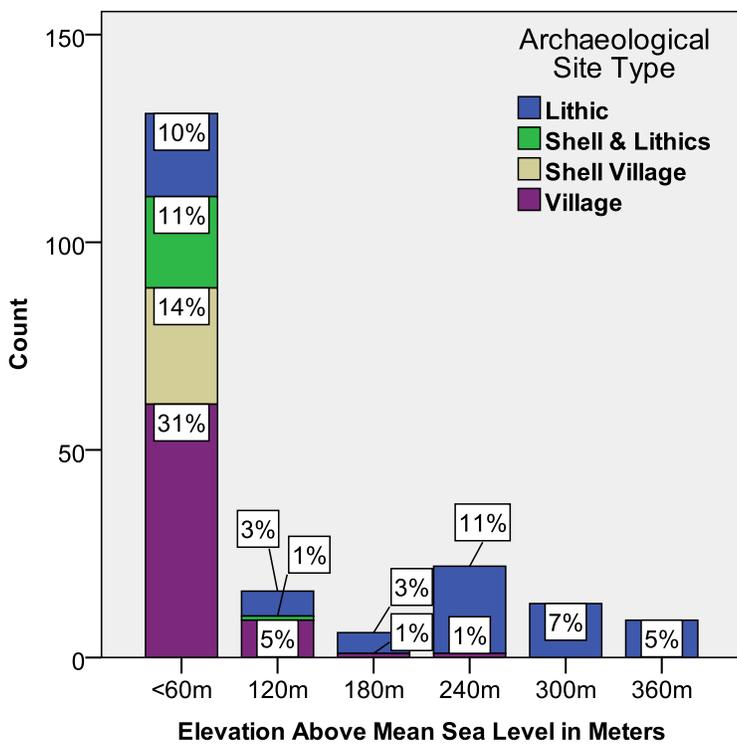


Figure 17. Distribution of archaeology site types by elevation.

Dominant Vegetation Community

The archaeology site locations reflected two opposing trends within the vegetation community (Figure 18). There was an almost equal site preference for either open spaces of wetlands and herbaceous prairies (n=97), or for the covered forested areas (n=100) within the training set. Comparison by cultural area showed that Wiyot sites were more likely than their neighbors to occur an open, non-canopy environment (63%) over their neighbors (32%). Site type in relationship to vegetation indicated that permanent settlements were equally likely to occur in open (n=37) and canopied areas (n=35) as indicated in Figure 16.

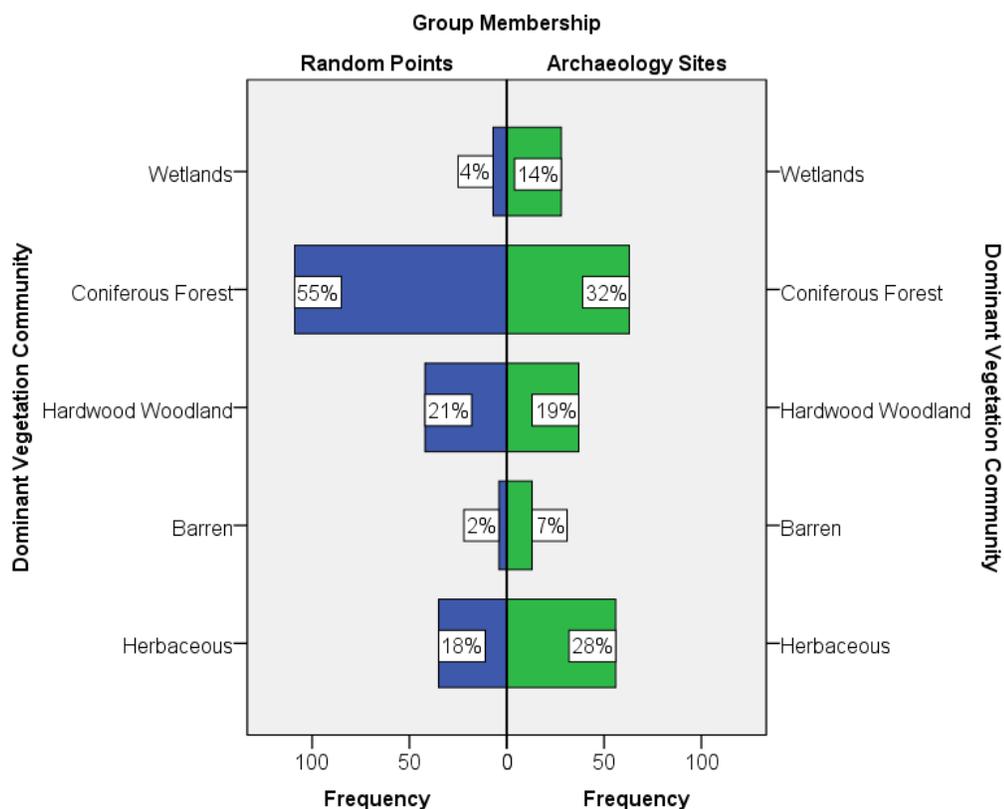


Figure 18. Distribution of archaeology sites and random data points by vegetation community.

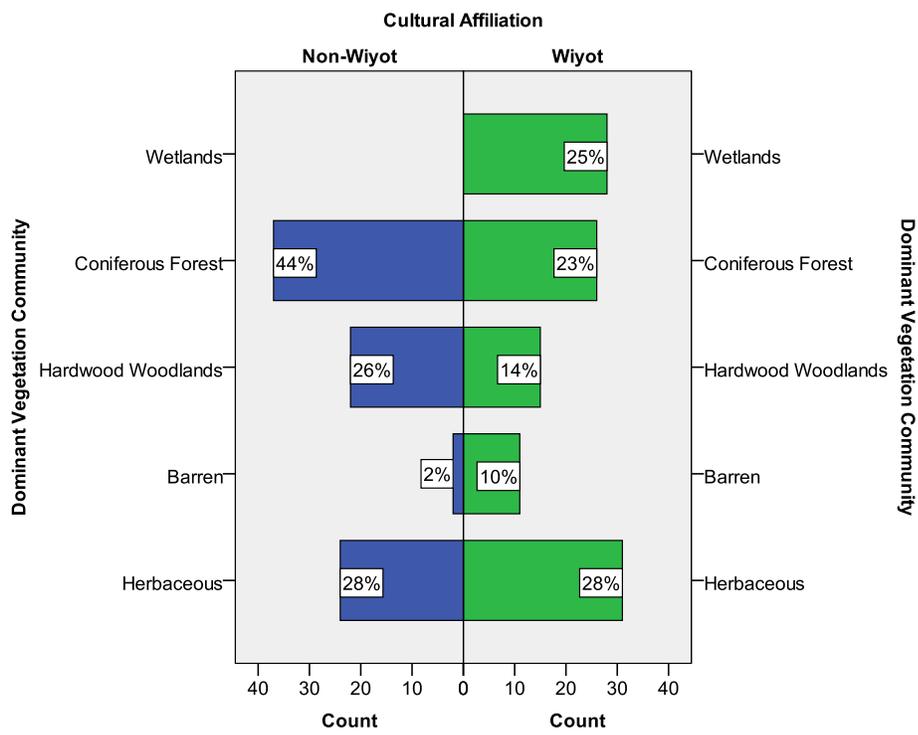


Figure 19. Distribution of archaeology sites by cultural affiliation and vegetation community.

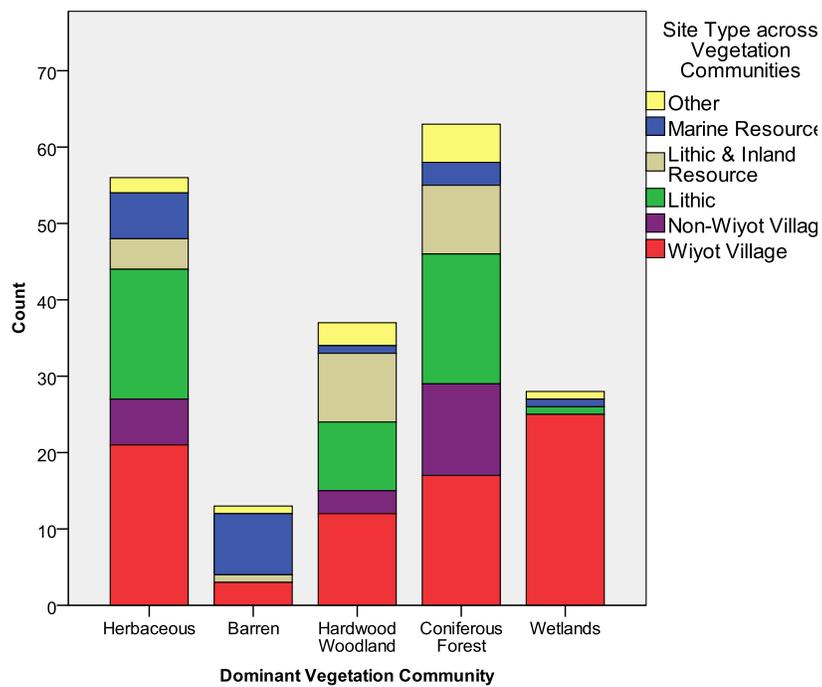


Figure 20. Distribution of site types by vegetation community

Distance to Prairies

The ethnographic literature prompted a look into the relationship between sites and prairies. Prairies were defined as herbaceous areas of open grasses of 10 acres or larger. Initially it was observed that 72% of sites are within 1000m of a prairie compared with 56% of the random point data set (Figure 21). Differences between cultural groups indicated that both groups had similar preference for being nearer to open prairies with the distribution curve being similar for both groups (Figure 22).

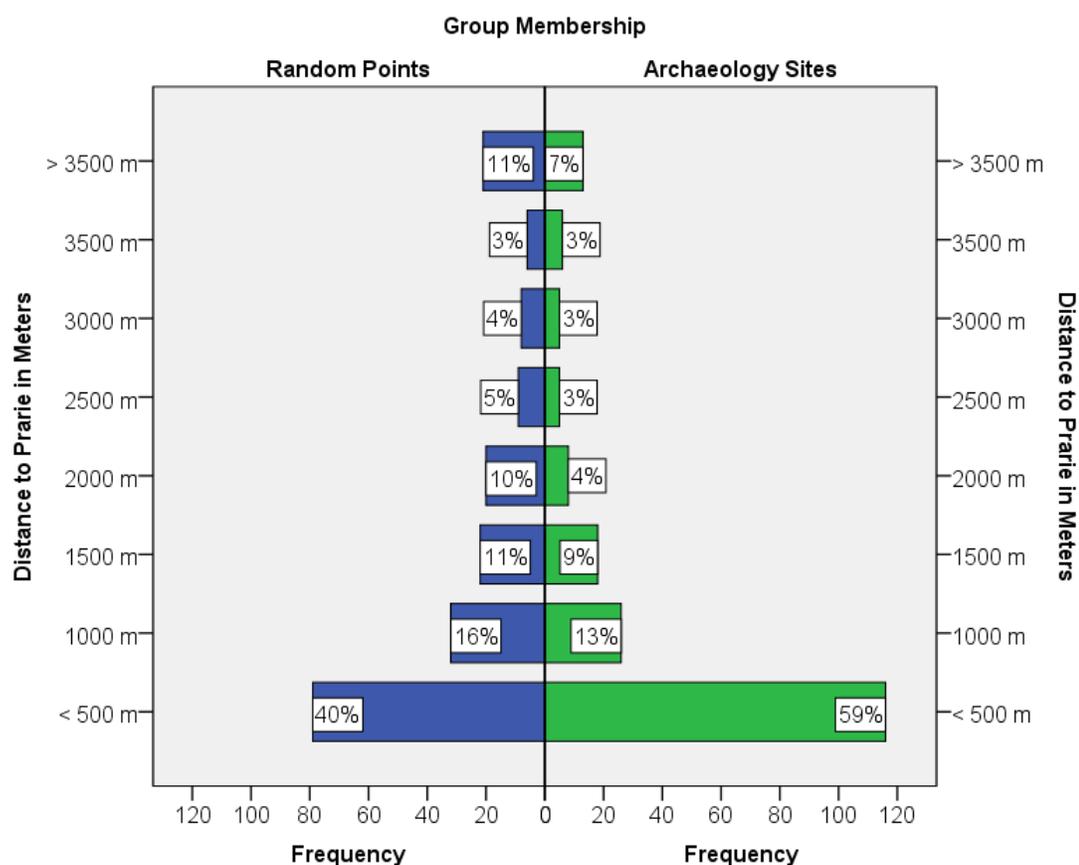


Figure 21. Distance to prairies from random points and archaeology sites

A cross tabulation of all types of archaeology sites and their distance to prairies reveals that 59% (n=116) are within 500m of an open prairie and 13% (n=26) are within 1000m of a prairie (Table 6). Of these two classes, 74 are confirmed village sites or 38% of the data set. Figure 23 illustrates the raster layer used to process these distances.

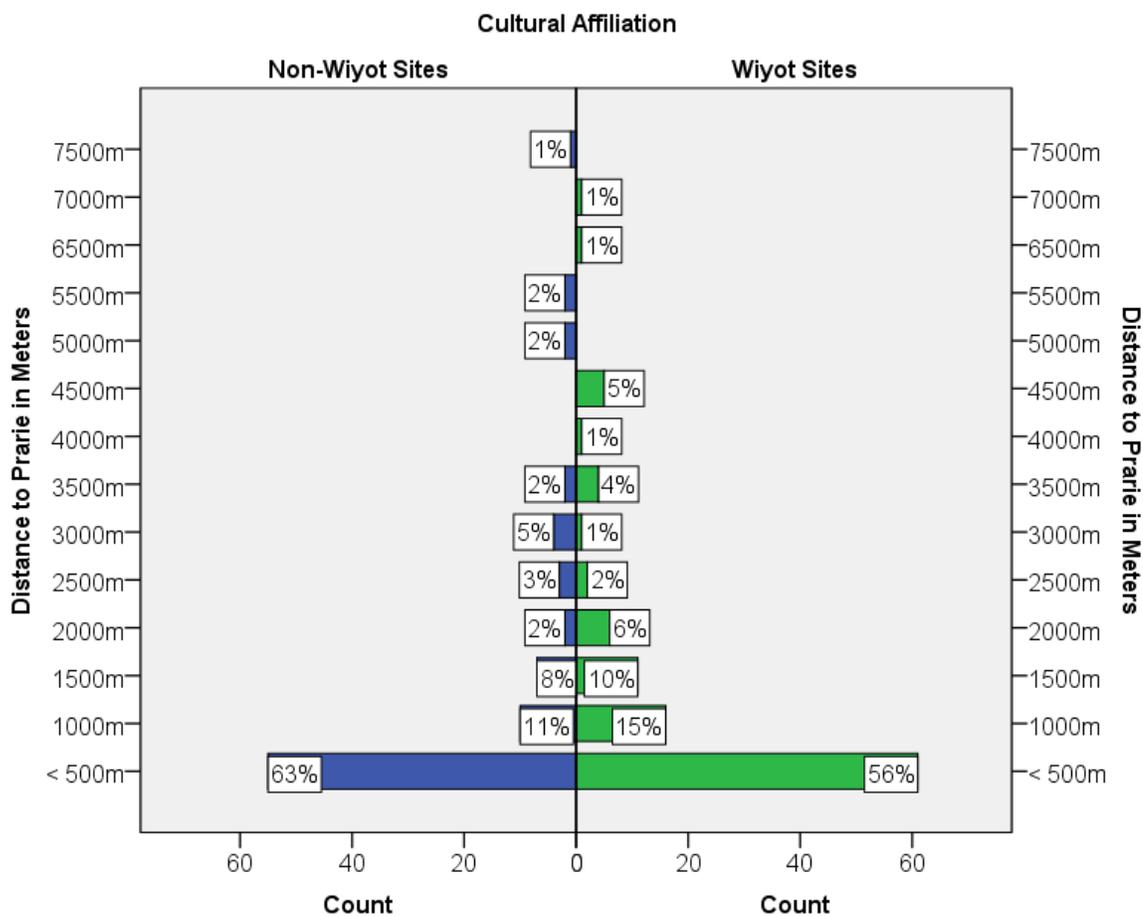


Figure 22. Distance to prairies from archaeology sites by cultural affiliation.

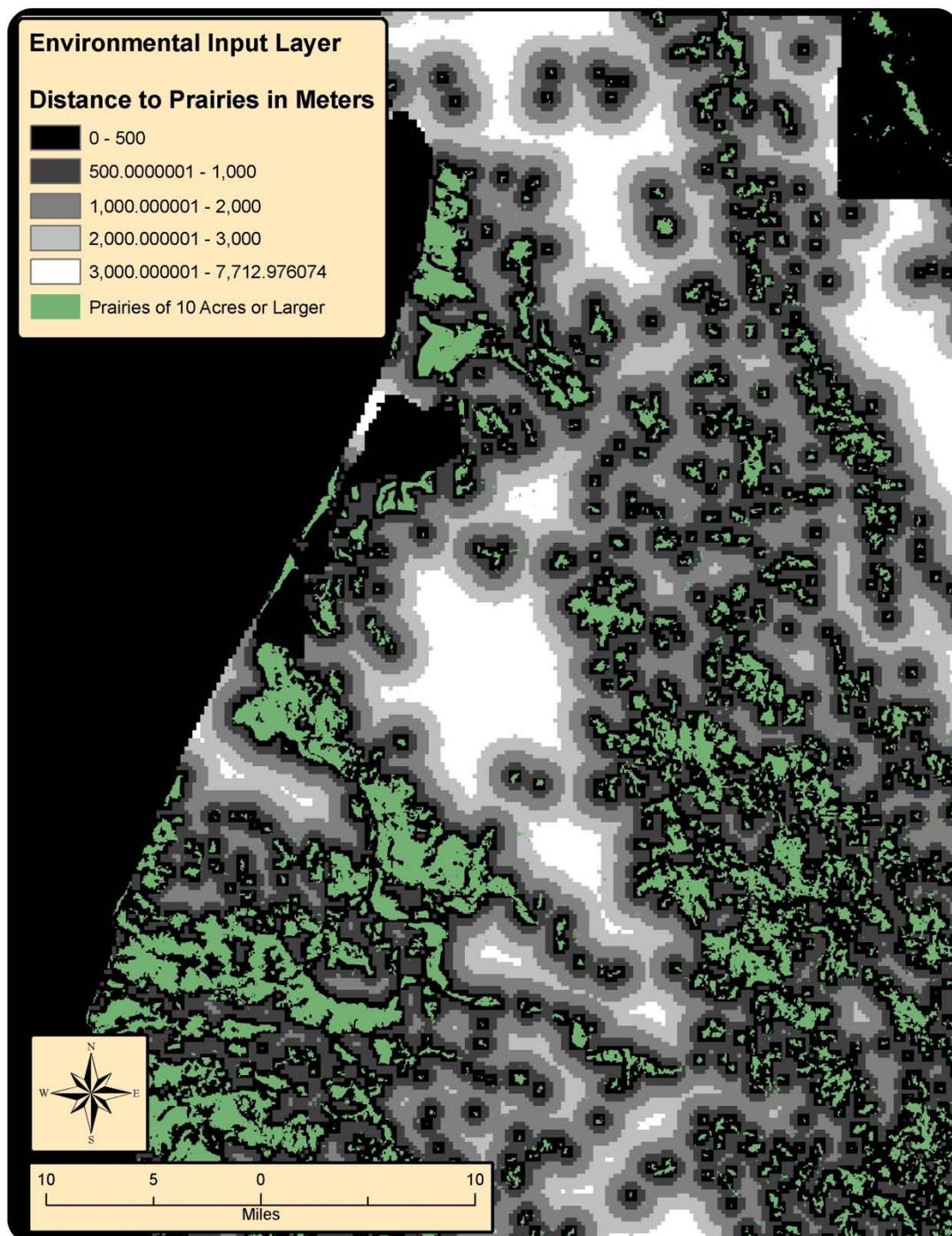


Figure 23. Distance from sites to prairies was one of the final cultural variables which was derived from ethnographic literature.

Logistic Regression Analysis

Significant environmental variables included topography (X_1) and the ethnographic variables of distance to navigable water (X_4) and distance to open prairie (X_5) (Figure 23). The nominal variable of topographic setting reached significance as a whole, but some categories were more significant than others within that variable (Table 7).

Table 6. Statistical significance values (Sig.¹), constant value (²) and Beta values (β^3) of final variables used in Equation 1 for this model.

Variable Class	B^3	S.E.	Wald	df	Sig. ¹	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
TOPOSET			39.967	5	0.00			
TOPOSET(1)	0.127	0.601	0.044	1	0.833	1.135	0.349	3.688
TOPOSET(2)	-0.509	0.405	1.576	1	0.209	0.601	0.272	1.33
TOPOSET(3)	-1.722	0.38	20.561	1	0.00	0.179	0.085	0.376
TOPOSET(4)	-2.657	0.717	13.73	1	0.00	0.07	0.017	0.286
TOPOSET(5)	-0.678	0.616	1.211	1	0.271	0.508	0.152	1.698
Nav2	-0.178	0.056	10.022	1	0.002	0.837	0.75	0.934
Prarie2	-0.094	0.041	5.376	1	0.02	0.91	0.841	0.986
Constant	1.949 ²	0.381	26.172	1	0.00	7.022		

Probability Model and Evaluation

Relative probability was calculated for each cell over the entire study area. Two variables (X_1 and X_5) were applied to the entire study area while the third variable (navigable water, X_4) was applied only to the Wiyot cultural area. Figure 24 represents the combined product of both iterations into one map. Site likelihood calculation ranges from 0 to 1. For instance, a cell with a value of 0.2 indicates no site presence or a very low likelihood while a cell with a value of 0.9 indicates a high likelihood of site presence. More variation was observed in the Wiyot cultural area than in the neighboring areas. There are also large sections of forest that show no site likelihood. It is important to keep in mind that this map represents primarily settlement and lithic sites and does not consider other site types that were not used in developing this map.

Split Sample Testing

The testing sample of sites reserved from the original data set was imported into the GIS set and projected onto the probability map with favorable results (Table 8).

Table 7. Distribution of archaeology test set as distributed across probability classes.

Sensitivity	Probable Site Cells				Probable Non-Site Cells				
	High	Medium-High	Medium	Low	Very Low				
Probability Class	0.9	0.8	0.7	0.6	0.5	0.4	0.3	2	0.1
Number of Sites Within Each Class	67	60	9	5	2	46	0	3	18
Percent of Test Set	32%	29%	4%	2%	1%	22%	0%	1%	9%

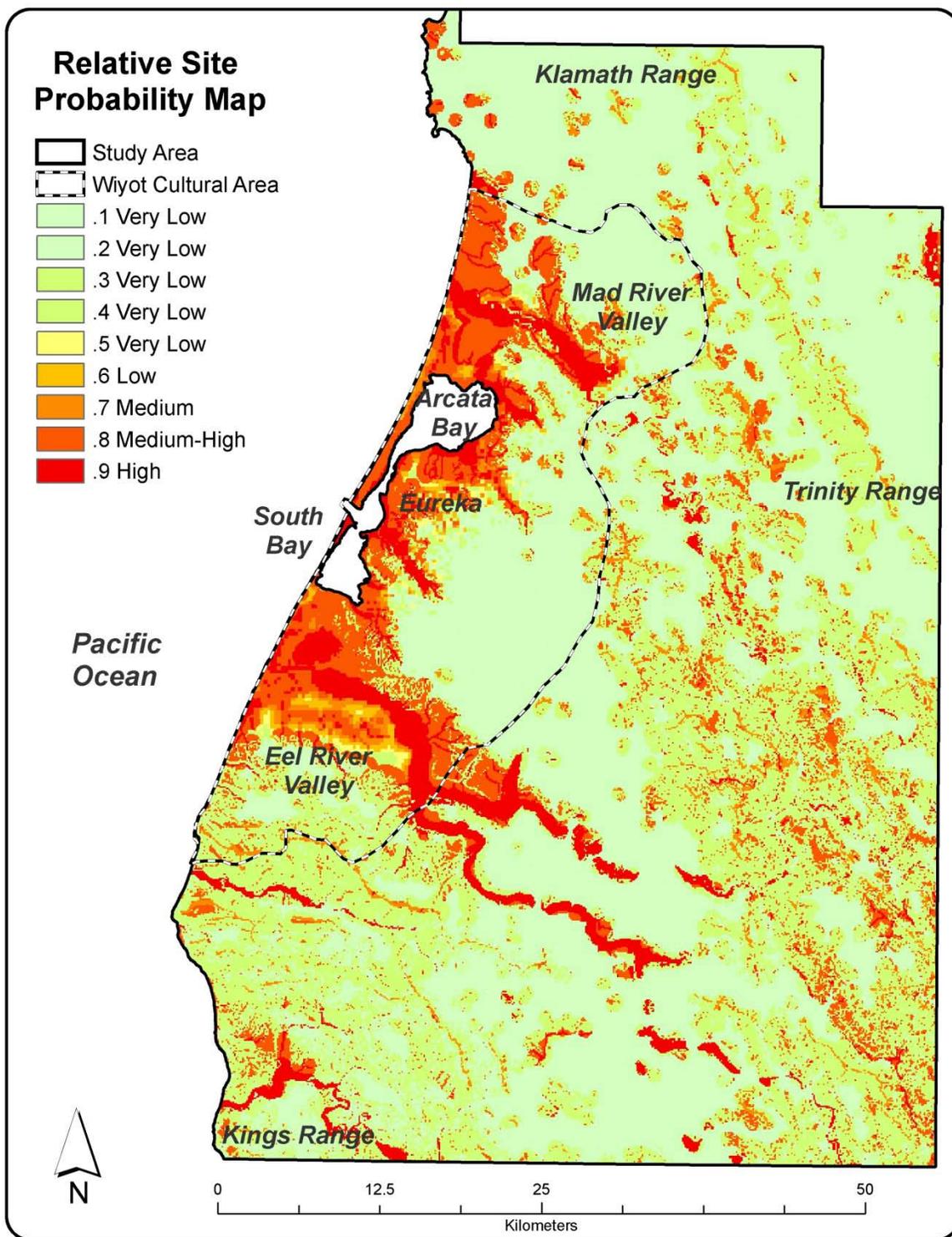


Figure 24. The final product for this model was a relative probability map of the study area.

Cumulative Percentage Curves

Next, the cumulative percents for both site and non-site prediction were observed (Figure 25). The frequency distributions for sites and non-sites are significantly different. This is a positive relationship which reflects the trend of non-sites to occupy areas with criteria that are significantly different than those preferred for activity sites. The exception was the 0.4 category. When these frequencies are plotted on a graph, they are called cumulative percentage curves. Figure 26 illustrates the combined cumulative percentages curves for this study. Together they aid in assessing the predictive power of this model for sites and non-sites over the entire study area.

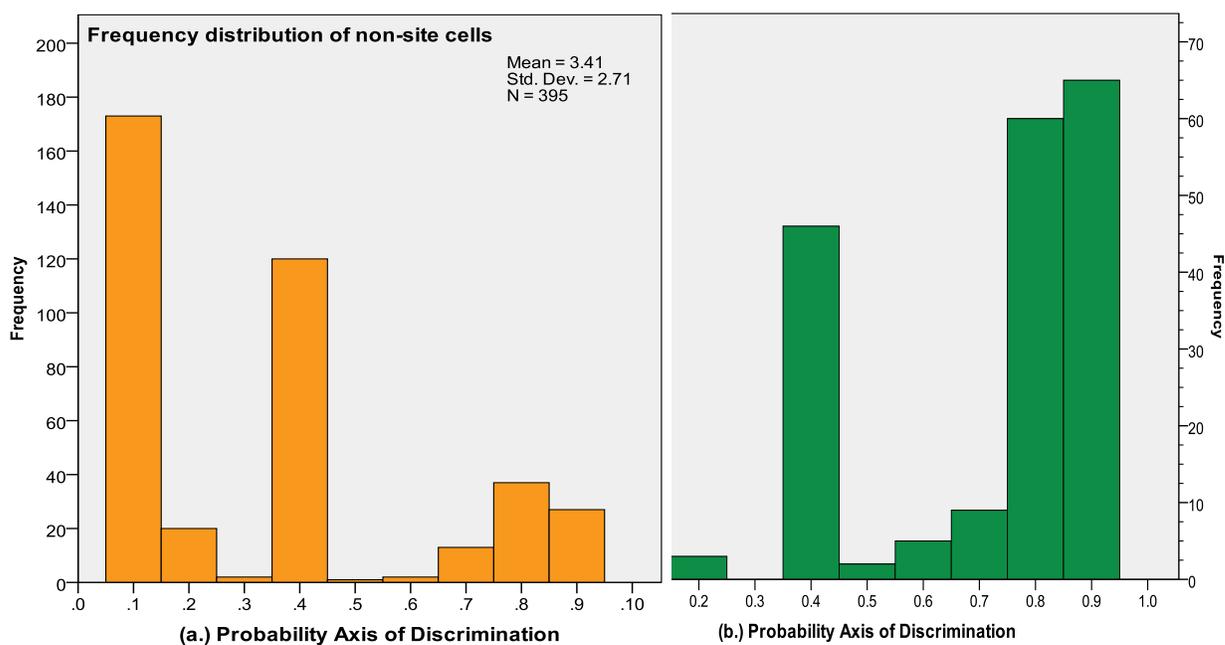


Figure 25. Frequency distributions of (a) non-site cells and (b) site cells along the axis of discrimination for the Humboldt area predictive model

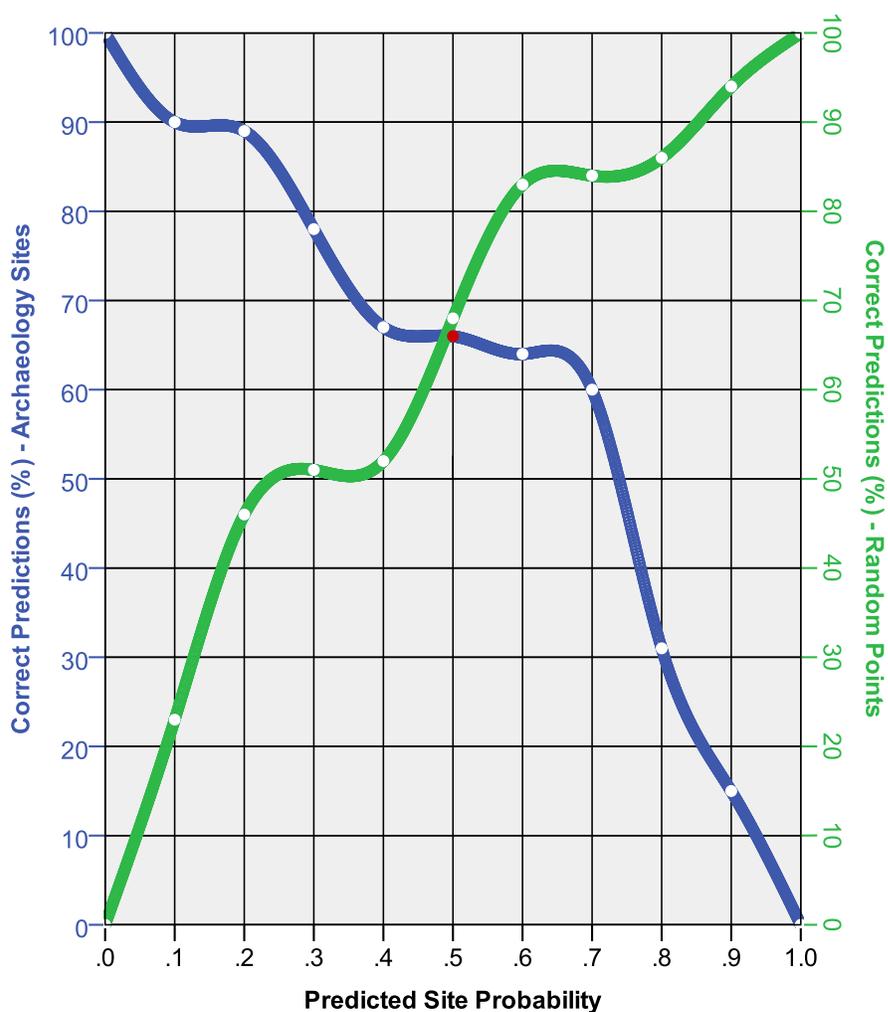


Figure 26. Distribution S-curve for this model showing cumulative percent predictions for sites and non-sites for all probabilities of occurrence. Where the cumulative curves intersect represents the point where the model correctly predicts the same number sites as non-sites.

According to Kvamme (1988), the point where the cumulative curves intersect reflects the optimal utility level for the model. It represents the point where the model correctly predicts the same number of sites and non-sites. Along the percentage gradient, as site probability increases, the number of actual sites predicted decreases (blue). Conversely as the probability of non-site predictions decrease, the accuracy increases

(green). For this model, the optimal performance level is approximately 66%. A performance level of 66% is good for a model based on available data. A higher percentage does not necessarily mean a better model because a model that predicts a small number of locations correctly is more useful than a model that predicts a large number of site locations inaccurately (Connolly and Lake 2006).

Kvamme's Gain Statistic

Lastly, the strength of the model was also measured using Kvamme's Gain Statistic (G) which measures the models utility in comparison to random guessing (Equation 3).

Equation 3. Kvamme's Predictive Gain formula (Kvamme 1988)

$$G = 1 \left[\frac{\text{Percent of total area where sites are predicted}}{\text{Percent of observed sites within the area they are predicted}} \right]$$

The G, or resulting gain, can range from 1 (no predictive utility) to -1 (the model predicts the reverse of what it is supposed to) (Connolly and Lake 2006; 185). When Kvamme's gain statistic was calculated, the result was 0.71 which showed that this model was a 71% improvement over random guessing in the areas rated with a 0.6 probability or higher.

Wiyot Site distribution and Use

There was varied representation of artifact assemblage within the study area including sites with house pits, sparse to extensive lithic scatters, milling items, fire cracked rock, hearths, middens, and avian, sea mammal, and terrestrial animal bones. Condensed and classed by general site type, trends were observed specifically for the Wiyot area regarding settlements and activity areas.

Humboldt Bay Focus – Central Wiyot Area

Wiyot settlement preference was bay-shore or slough-side and included both brackish and freshwater systems with some, but not complete, tree cover. North peninsula settlements were situated only on the protected east side of the peninsula in deep dunes sheltered from immediate ocean winds. Sites on the exposed western sides of the peninsulas were characterized only by lithic debitage, shell debris, sea mammal bone, and fire affected rock, alluding to resource procurement activities or temporary camping. The extensive slough system allowed for additional settlement in the sheltered small valleys east of the bay. Additionally a few large sloughs penetrated the backside of Eureka proper in pre-historic and historic times.

Southbay followed a similar patterning to Northbay with the addition of a number of sites high up on the bluffs. Most sites in the Southbay were characterized as permanent settlements, with a few lithic scatters and one inland resource procurement area characterized by lithics and groundstone. Though somewhat elevated, the sloping,

crenulated face of Table Bluff may have provided enough shelter from immediate ocean winds while still giving excellent access to marine resources.

Mad River Focus – North Wiyot Area

The oceanside bluff and prairies north of the bay run to the northern edge of Wiyot territory and exhibit only a few known settlements. However, the records state the assemblages are large and extensive. The lower Mad River drainage settlements are within or just outside the floodplains of the river. All main stem sites are characterized as permanent settlements. Several sites in nearby tributary watersheds are characterized by lithic scatters or milling assemblages, alluding to inland resource procurement for plant based foods. These appear to be located in both low and high elevations of inland areas. One quarry was also located in this lower region.

Eel River Focus – Southern Wiyot Area

The Eel River valley was a dynamic environment, as evidenced by the broad and braided extent of the historic river bed. Similar to the peninsulas to the north, sites located on the open beach were characterized by assemblages representing marine resource procurement, but not permanent habitation. Fewer settlements were present in comparison to the Mad River area, which is notably smaller in geographic size. Similar to the Mad River and McKinleyville interface to the north, most settlement sites are identified just out of the floodplains and on the high bluffs.

Site Distribution and Use in Neighboring Cultural Groups

Site clusters and distribution were examined for the neighboring Chiluala, Whilkut, and Nongatl, Sinkyone, and Mattole cultural groups. Ethnographically identified villages and middens were located primarily along the bottom of steep river canyons on river terraces and floodplains. There were occasional lithic sites that occurred riverside, but they were the minority site type in this context. Conversely, multiple lithic and groundstone sites were clustered along the uplands and were particularly correlated with open ridgetop prairies.

Moving south-east into the lower reaches of the Nongatl area, the terrain changes as do the use signatures. The terrain opens up in comparison to the steep, narrow canyons to the north and the landscape is characterized by gentler hills with extensive tracts of open prairies and oak woodlands. Sites were observed in both strings along rivers and centralized around ridge-top prairies, exhibiting all site use types in close proximity. Generally, the ratio was one midden or village site observed for every two sites that exhibited only lithic or ground-stone signatures. The exception was a location that contained a quarry on a large ridgetop prairie which resulted in a concentrated complex of nineteen lithic sites, three large middens with hearths, and one village with housepits.

In comparison to the other cultural areas, Mattole and Sinkyone cultural sites were sparse. All but two (n=21) sites in these areas are represented by inland or marine resource procurement assemblages. The two habitation sites reside on creekside terraces with the lithic sites predominantly on ridgetops. However, the sample size is simply too small to imply a consistent patterning within this model.

DISCUSSION

The model I developed is primarily descriptive, but provides an initial assessment of the prehistoric landscape and establishes a strong point of engagement for patterning and systems analysis in the Wiyot cultural area. Internal and statistical test results indicated that this model has a sound foundation which may assist in determining site likelihood in certain geographic areas. This model attempted to be a blend of both inductive and deductive methods by employing environmental variables and attempting to derive culturally relevant variables from ethnographic literature. It was anticipated that these parameters would reflect both cognitive choices and economic use within the landscape. Several conclusions can be drawn regarding the variables used in this model, the distribution of site types within Wiyot and neighboring cultural groups, and contributions by the ethnographic literature that may inform a network use model of the study area.

Testing

Statistical methods aided in identifying pertinent variables and verifying model results. Internal testing of this model indicated a positive result when the split-sample testing method was applied to the predictive map. Maschner (1990) criticizes this method of testing, indicating that it only points to homogeneity in the data. I contend a large sample size, an equal number of sites and non-sites in the regression analysis, and

engaging cluster pattern analysis were successful mitigations of this criticism, as suggested by Gillling and Wheatley (2002) and Kvamme (1988).

Kvamme's Gain statistic (Connolly and Lake 2006) indicates that this model is heading in the right direction, but should be regarded as a theoretical measure where utility is concerned. This model has a stronger likelihood of predictive power within the Wiyot territory than the neighboring cultural areas. I believe this is consistent with model bias towards Wiyot sites, as evidenced by the 1.25 ratio of Wiyot sites to non-Wiyot sites in the training set. It is likely the use of three variables within Wiyot cultural area enabled a more discriminating map to be produced. This indicates the models accuracy can be improved through the addition of more inland sites especially in the eastern and southern regions of the study area. My recommendation for the use of this model is conservative in that I would only consider utilizing the top twenty percent of predictions, for both sites and non-sites, in a planning capacity.

Technical considerations were scrutinized in regard to the overall model. One particular observation of note was spatial relationship of sites from the testing set that fell in a low predictive cell, but very near a high predictive cell. There were a high number sites that fell into the 0.4 probability range (n=46). Figure 27 shows the relationship of incorrectly classed sites and their distance to High or Medium-High cells, many of which came very close to falling in the desired category but were just outside the boundary.

Thirty-three sites were one (120 meters) or two (240 meters) cells away from being correctly classed. This demonstrates that edge effects within a GIS environment affect the final analysis of the data and should be addressed when assessing model

performance (Connolly and Lake 2006; Wheatley and Gillings 2000; Steinberg and Steinberg 2006).

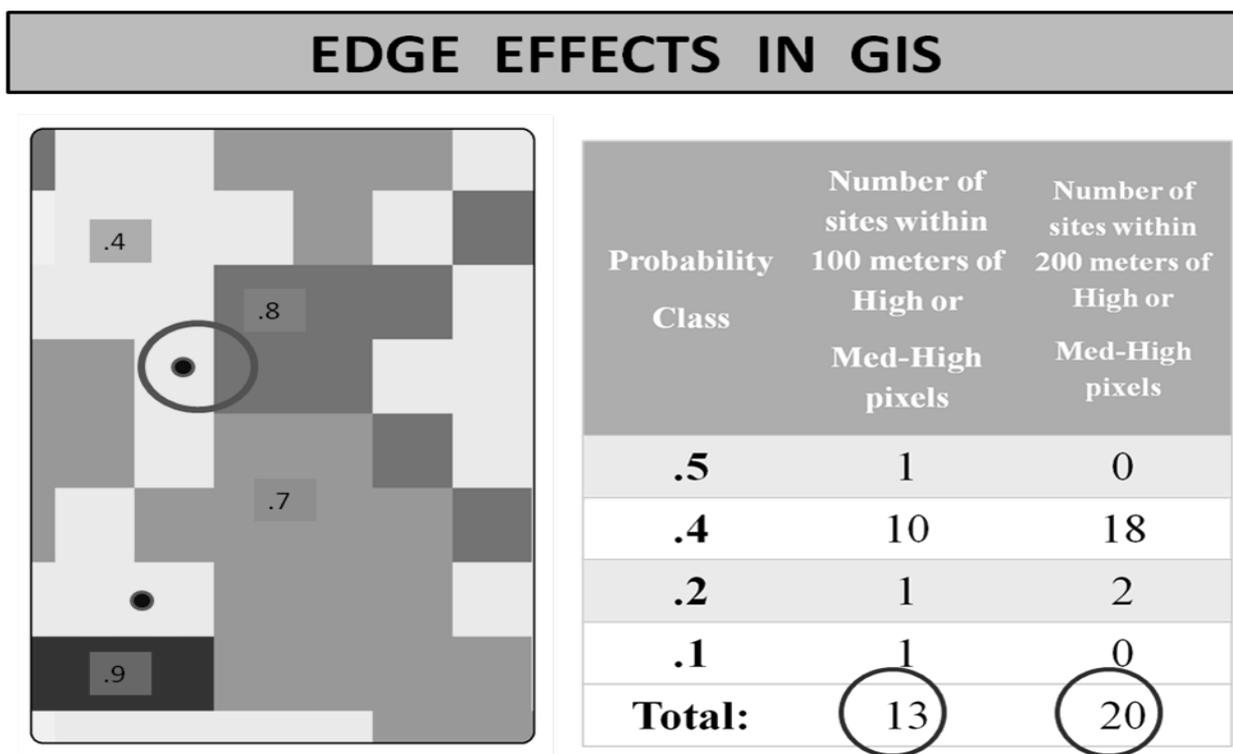


Figure 27. Edge effects should be examined to locate archaeology sites (black dots) that fall close, but still outside of, high probability cells (.7, .8, .9).

Allen (1990) suggests cell size be consistent with the smallest unit being examined. Given the range of recordation quality in denoting site size, an educated but subjective decision was made regarding cell size within the model. The final cell size for the model was 120 meters by 120 meters. This size was manipulated in an attempt to test if the scale of the cell had affected the outcome. When cell size was doubled to 240 meters squared per cell, the result was a decrease by 1 in the correctly classed sites. A

second iteration in which the pixel size was tripled to 360 meters squared per cell also showed a decrease in accuracy by 11 incorrectly mis-classed sites. This indicates that increasing cell size may decrease accuracy, inferring that decreasing cell size may increase model accuracy.

This model demonstrates that a few important variables can produce a model with some degree of utility, yet it also points to the need to add other discriminating variables to further refine differentiation in each cell. Freshwater access did not play a major role in this model as there are approximately 2,727 miles of perennial creeks, streams, and rivers within the study area providing this essential resource (Zalarvis-Chase 2010). The great distance between some Wiyot settlements and freshwater sources could indicate one of several things; that the Wiyot had the ability to carry and store enough water for these locations; or that the water data is not adequate to reflect a source; or that the ability to travel by boat enabled activity in these areas without concern to a permanent water source.

Vegetation was an integral part of this model. Generalized classes of vegetation were useful, but need refinement to gain statistical significance. Ethnographic support for the importance of prairies is evident in this model which demonstrates a good correlation between site placement and prairie or herbaceous settings. Given the culture of wild land fire suppression and the prohibition of the traditional cultural use of fire to maintain prairies over the last century (Kliejunas 2005), it is possible that the village locations that are in full forest cover reflect the encroachment of the forest that has occurred into areas previously maintained as margin lands by cultural fire. I would argue that site locations

of permanent or seasonal settlements were formerly situated at the margin-lands, in mixed ecotones where open and forested areas meet. As the correlation between the two was initially tenuous, logistic regression aided in determining a pattern of significance.

The logistic regression process implies that elevation was not statistically significant within the model, but it appears there may be a relationship between elevation and site types that differs between cultural groups.

Other Variable Considerations

Although there was a great range of information in the records used to compile the training set, the various levels of recordation eliminated the potential for this study to examine temporality, soils, and site size in relationship to use patterns. Maschner (1995) demonstrates the correlation of beach gravel sizes and mooring areas for canoes in relationship to settlements in the Pacific North-west. Given this precedence, it would be desirable to include a soils layer in relationship to Wiyot site placement.

A temporal component would likely be a great improvement to the model, enabling an investigation into patterns of use through time. Temporality coupled with a soils layer may point to environmental process that have interrupted or influenced cultural deposition or erosion processes, which in turn affects the interpretation of the spatial distribution of site types (Ebert *et al.* 1996). Carbon dating of shell-mound strata would also lend information regarding seasonal occupation and age of use at mound sites (Sanger 1996).

Wiyot Site Use and Structure

Humboldt Bay Focus – Central Wiyot Area

The model indicates a high level of probable site locations around the entire bayside and throughout the slough and freshwater tributaries networks. The dominant probability classes are 0.09, 0.08, and 0.07 around the perimeter of the water networks, but drops rapidly as one moves outward from waterways or eastward into higher elevations. The site pattern suggest some limited-activity areas such as discreet marine resource procurements sites situated near open ocean and bay-sides which were likely not suitable for year round habitation. However, evidence of the processing of resources from these marginal areas occurs in settlement sites as well. Overall, Wiyot habitation and resource procurement activities occur in close proximity to each other and in similar contexts. This differs from the pattern observed in some of the neighboring cultural areas.

Mad River Focus – North Wiyot Area

The large ocean side prairies of McKinleyville and the lower reaches of the Mad River drainage constitute the northern reaches of Wiyot territory. The model indicates that these mixed open lands with some tree cover and close proximity to the ocean and rivers have a high probability of containing more settlement locations as well as marine or riverine resource procurement sites. The dominant probability classes are 0.09, 0.08, and 0.04. Seasonal river levels and course changes of the Mad River would have reinforced a mixed mosaic of vegetation creating margin-lands with both cover and open

space. The prairies coupled with native fire practices may have reinforced a similar mixed mosaic. At the time of Loud's documentation, the mouth of the Mad River was said to have several settlements. Although this contradicts the settlement patterning on the peninsulas adjacent to this area, the model indicates there was once a significant intact dune environment to appeal to Wiyot inhabitants.

Eel River Focus – Southern Wiyot Area

The model indicates that homogeneity of the valley environs and the extensive river network give a large portion of the valley a high probability for settlement choice. The dominant probability classes are 0.09, 0.08, and 0.04. Significantly fewer settlements are noted here compared with the Mad River area, which is notably smaller in geographic size. However, historic levels of salmon on the Eel River (McEvoy 1986) would have supported many more settlements than were currently identified in the Eel River delta.

The powerful river, combined with agriculture and development of the valley floor, has likely obliterated surface remnants of many permanent settlements in the Eel River valley. Winter water levels rise rapidly causing extensive flooding, deposition, and erosion. Development has severed the intertidal slough system and radically changed the course of the river since Loud's time and several of Loud's sites have never been successfully relocated. Depressions in the landscape are all that remain to allude to the extinct slough networks which indicate where settlements may have occurred.

However, on a large open bluff above the river, occupied by the town of Rohnerville, there are numerous sites characterized only as lithic scatters and midden

with groundstone. I contend that these sites, which are very much clustered, may actually represent a large settlement in which the housepit features were not identified because of agricultural practices and rapid development.

Lastly, the model indicates that tributary and ridge areas immediately adjacent to the main river stems are of a medium probability as well. A minor but consistently higher probability pattern occurs far from the main water stems. These discreet areas of higher probability are characterized by one or two habitations surrounded by a small number of sites with resource procurement signatures of lithic debitage or groundstone. The peripheries of these clusters exhibit very low probabilities. This pattern was noted along a route from the east side of Dows Prairie through Fieldbrook to the Mad River, on the North Fork of Mad River, and at the western edge of Kneeland Prairie. This pattern is also observed on the South Fork of Elk River, but it occurs in a very low probability area of 0.01 that is quite large and of dense forest. This indicates two things. First there is a need for further discriminate variables to identify cultural or environmental factors. Second, there is a need to include site types that may not leave much trace but can be ethnographically important and correlated to particular environs such as full forest cover (Lookabill 1998).

Site Distribution and Use in Neighboring Cultural Groups

This model indicates high sensitivity in the river canyons and ridgetops of the surrounding cultural groups. The dominant probability classes are 0.09, 0.08, and 0.04. Ethnographically identified villages and middens were correlated with river terraces and

floodplains while clusters of lithic and groundstone sites were correlated with open ridgetop prairies. Contrary to the Wiyot pattern, sites in the Chilula (north-east), Whilkut (east), and Nongatl (south-east) exhibited site use and type clusters in discreet environments. Hilldebrandt (2007) names these tribes as part of the California Culture Area and states a pattern of seasonality that emphasized summer in the highlands, making use of vegetation resources, and winters in the riverine environs where anadromous fish would be the resource focus. His statements are supported by this model and are congruent with the site patterning and geographic sensitivity found in this model.

Moving to the south-east extent in Nongatl territory, no opposing or discreet use patterns were occurred. Instead site clusters were observed both in strings along rivers and centralized around ridge-top prairies, exhibiting all site use types and assemblages in close proximity. Generally, the ratio was one midden or village site observed for every two sites that exhibited only lithic or ground-stone signatures. The exception was a location that contained a quarry on a large ridgetop prairie which resulted in a concentrated complex of nineteen lithic sites, three large middens with hearths, and one village with housepits. This pattern concurs with Baumhoffs (1958) discussion of subsistence patterns among the Athabascan speaking groups of south-eastern Humboldt County. The clustering of settlement sites does not necessary fit the family-level band as described by Nomland (1935) and seems more associated with the extended family or triblet organization proposed by Kroeber (1932).

In comparison to the other cultural areas, sites were sparse and dispersed with regard to the Mattole and Sinkyone cultural areas to the south and south-east,

respectively. Additional sites would be required to make any informative statements regarding this area in relationship to this model.

Ethnographic Contributions to Modeling and Interpretation

This model supports the successful use of ethnographic literature in the modeling process similar to uses by Sanger (1996), Allen (1990), Lookabill (19918), Newell and Constandse-Westermann (1996) and Binford (1980). The literature, coupled with the site distribution analysis, evokes questions regarding subsistence and social organization. Informed by the ethnography, I view the archaeology sites as routes and nodes within a social and subsistence network, attempting to move outside the environmental-correlative predictive model heavily criticize by Ebert (2000). I propose that the natural geography of the ridge line may have functioned as a discreet physical signal between cultural groups, and that the Wiyot sites reflect a highly mobile subsistence network influenced by social bonds and reflective of behavior that exceeds basic economic necessity.

The ethnographic literature certainly informed the model parameters but indicates the presence of a travel and procurement network that extends beyond the water-focused Wiyot territory, the boundary of which is dubious in itself. An examination of the prairie locations shows that there is an abundance of grasslands in the Mad River and Eel River Valleys, and a reasonable number of herbaceous areas surrounding Humboldt Bay easily accessible from most sites on foot. Additionally, there are two quarries in low-lying areas. Loud indicated that major trails that terminate at high inland prairies all had trailheads that began from the terminal ends of the navigable water systems including

Mad River, Jacoby Creek, Eureka Slough, and Elk River. Rapid travel to the trailheads would have been facilitated by canoe. Returning from these uplands, canoes would have also played a role in the redistribution of raw materials from the high prairies. Therefore, accessing these distant resources clearly points to either a cognitive choice of preference for resource quality or quantity, or the scarcity of needed or specific resources closer to permanent habitation areas.

The location of cultural boundaries as noted by Loud (1918) and Kroeber (1919) initiates a conversation on visual signaling of cultural boundaries and use of the uplands. Baumhoff (1958) discusses boundary preferences of regional ethnographers Merriam and Kroeber, stating how Merriam's research, mapped by his daughter Mrs. M. Talbot, favored streams and drainages. In contrast, Baumhoff (1958) contends Kroeber had a preference for ridgelines. In contrast, Loud (1918) states his territorial boundary actually delineates the limits of the Wiyot language but does not imply anything further about the limits of resource boundaries or the strict observance of territorial relationships. The language premise can be supported by noting that the Wiyot share an Algonquin language family affinity only with the Yurok to the north (Kroeber 1919; Golla 2007; Goddard 1975). Kroeber (1919) claims there was intermarriage among these neighboring tribes, but also hostilities, particularly between the Chilula and the Wiyot. Although located 6km past the prairie ridge, one site in Chilula territory is noted in the record as being a boundary cairn, presumably between cultural groups.

In a practical sense, the ridgeline is a dominant feature on the landscape and may have been used as a signaling feature between territories of the water-based Wiyot and

their inland neighbors. It is possible the highly visible ridge prairies may have been a zone of contact and mutual resource zone available to either party. The view from a majority of the Wiyot bay and riverside sites encompasses the visual edge of the Wiyot territorial boundary, which are defined by a series of transverse ridge fingers that presume to separate the Wiyot from their neighboring territories. These ridges harbor a number of large prairies at or near the ridgeline. Therefore, crossing these prairies places one in a neighboring cultural territory. Strawberry prairie borders Yurok territory; Elk, Longs, Lost, and Bald prairies cross over into Chilula lands; Boynton, Diamond, Kneeland, and Lawrence Prairies border Whilkut lands; Myriaks and Goose Lake prairies border Nongatl lands; crossing Eagle Prairie places one in Sinkyone lands; and finally the vast prairies along Bear River Ridge form the boundary between the Mattole and the Wiyot.

Kneeland Prairie in particular is very large, is visible from a large portion of the Wiyot bay area, and exhibits a dense cluster of sites including five lithic sites, two quarries, and several house pits. It is located at the intersection of Loud's proposed Wiyot, Nongatl, and Whilkut territories. The need for raw lithic material of good quality is surely incentive to travel to this distant upland. Kneeland prairie can be accessed by walking two of the trails that Loud mapped from Eureka (Freshwater) Slough and Elk River, and is also accessible by following the ridge lines that ascend from Jacoby Creek in the Northbay and Salmon Creek in the Southbay making it accessible to every major settlement cluster in Wiyot territory. Although there is insufficient evidence to firmly state boundary signaling or a mutual resource area, the point warrants future thought.

The site type and distribution network exhibited in Wiyot territory points to subsistence strategies that cross classification lines, meaning they cannot be discreetly classified as exclusively as foragers or as hunter-gathers in the classic sense. According to Binford's (1980) discussion on characteristics of each group, the Wiyot sites exhibit the pattern of off-site processing (marine resources) and specialized work parties of foragers which takes the consumer to the distant source, as in upland resource procurement or quarry site. Seasonal movement of the Wiyot area favors Binford's hunter-gatherer definition, in that they have specialized resource parties that cache seasonal goods at permanent bases (Hildebrandt 2007) because of yearly interruptions in the supply of a particular resource (Binford 1980). This strategy, and hunter-gatherer classification, is also in line with Binford (1980) and Murdock (1967) statements regarding subsistence and sedentism in correlation with seasonal climate changes.

However, Loud's documentation of social structure further obfuscates a strict use and classification pattern. Loud (1918) indicates permanent but multi-local family habitations were the norm and that access to some seasonal resource patches were governed by familial association. The use of the canoe as a mobile strategy would also allow for the re-distribution of resources, with one's family group as priority, in a way incomparable to terrestrial means. In studying the familial habitation association and resource use patterns stated by two of Loud's informants, I compared the informant's home range with catchment areas around Humboldt Bay. I found that familial access created a home range for both informants that by far exceeded the range necessary to encompass the minimum spectrum of common subsistence resources used in the Wiyot

cultural area (Zalarvis-Chase 2008). This indicates a strong familial influence on mobility and subsistence patterns which could help ameliorate resource shortages within a family group due to occasional resource stress (Allen 1990; Keeter 2009).

This kind of social information can be simultaneously informative and frustrating. It cannot be applied to the entire study area because it maps out the pattern for only two family groups, but it can prevent drawing overall conclusions that disregard the influence of cultural organization (Keeter 1990) in subsistence and settlement patterning. As this kind of information cannot be recovered by traditional research means at an archeology site, it reaffirms the specific insights ethnographic information can lend in a modeling environment and contributes to understanding the use of space by ethnically different groups (Sanger 1996).

Implementation and Use

This predictive model for the Humboldt region shows promise for use on several levels of engagement. A visualization of the study area, manifested as the probability map, was achieved and has been implemented for use as a management tool by the Wiyot tribe at Table Bluff. Therefore, the purpose of partnering with the Wiyot tribe to provide a useful tool for rapid communication and heritage resource management was achieved. This model encountered a number of limitations, but should still be of interest to planners and developers keeping in mind that the results are *relative* probabilities, not actualities. External testing to validate and refine the model could be in future studies.

This model may be helpful in aiding cultural studies and management outside of development goals. Additional layers of concern, such as plant and food resource gathering areas, could eventually be used for cultural education within a tribal environment while simultaneously adding culturally based variables to strengthen the overall archaeological model.

CONCLUSION

Although challenging to create, probability models are a popular tool employed by archaeologists to aid in cultural resource management, research, and project planning. The ideal model will employ both environmental and culturally derived variables in order to reflect social perceptions, cognitive choices, and economic uses of a culturally influenced landscape. Statistical methods aid in identifying pertinent variables and the testing of results, while the GIS environment grants the capabilities to integrate and analyze large amounts of spatial, cultural, and environmental data.

The predictive model for the Humboldt area is a strong representation of the characteristics of prehistoric settlement patterning in the Wiyot Traditional Cultural Area with regard to permanent settlements and resource procurement areas, particularly at the time of contact with Europeans. The model could be improved with a better understanding of neighboring cultural groups but the greatest improvement to the model would be the addition of temporality to the site locations in order to look at patterns of use through time. Modeling of the social networks in relationship to site networks poses a challenge for future thought.

Overall project planning, compliance, and preservation efforts are enhanced through efficient data sharing among stakeholders in a GIS environment. For immediate use, this model will assist in determining high probability areas in the preliminary stages of project planning. This benefits local entities and planners who come from out of the

area and are in need of a rapid orientation to the environmental characteristics and site cluster patterns found in this region.

The appropriate circulation of such information brings many voices together to preserve a collective heritage in a rapidly developing world. It is through collaborative efforts of these multiple voices and data sources that creative solutions may be achieved which allow for communal growth while honoring the contemporary and past community identities within our region. I hope always to encourage communities to view heritage preservation as a collective responsibility to each other, and to future generations, regardless of individual origins.

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