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Bridging the Gap: Using Significance Modeling to Identify Data Gaps in Lithic Sites Within the Tualatin River Basin

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by

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Abstract

Archaeologists commonly evaluate National Register of Historic Places (NRHP) eligibility for precontact sites in Cultural Resource Management archaeology under Criterion D. This focus on Criterion D can create the false paradigm that precontact sites are only significant by virtue of their information potential. This paper explores precontact sites in the Tualatin River Basin in northwestern Oregon and identifies some key deficiencies in the ways those sites are recorded and documented by archaeologists. This paper then discusses the development of a geodatabase of site attributes and a significance model with contributions and feedback from relevant parties and Tribal representatives.

The geodatabase includes precontact lithic sites in the Tualatin River Basin that were available on the Oregon State Historic Preservation Office (SHPO) online database at the time of this research. To those sites, I catalogued 27 attributes from the site record forms when the information was available. The resulting geodatabase can display the spatial distribution of any of those attributes across the region. It also serves to identify potential gaps in data where attributes were not recorded or available for sites.

The significance model focused on categorizing potential NRHP and tribal significance. I developed a list of significance attributes based on nearby NRHP eligible sites as well as on relevant parties and Tribal representative feedback. I then assigned significance score values to each of the sites using two different metrics: 1) documented presence of each significance attribute and 2) assumed presence of each significance

attribute unless otherwise documented. By comparing these scoring metrics, broad gaps in data of recorded site attributes in the region are obvious.

Identifying and addressing regional-scale gaps in data are necessary before archaeologists can make accurate and complete eligibility evaluations of cultural resources. My research results show that there are many instances of missing site attributes in the Tualatin River Basin that inhibit the ability to accurately evaluate or assess NRHP or Tribal significance on both site and regional scales. The data gap modeling I developed focuses primarily on information-potential data due to the nature of the extant information in site record forms. The reliance on data-focused and incomplete archaeological documentation creates a recursive effect in which sites are only valued for information potential. Oral histories and the archaeological record could be integrated in the same way as historic documentation already are, resulting in both information sets being more complete. The data gap modeling presented here could be used to identify missing data in multiple types of information sets and identify areas where data from one information set may fill a gap, reinforce, or contradict the data in other information sets.

Dedication

To Lyra and Jamie for helping me remember what truly matters and supporting me in this endeavor. You always believed I could do this even when I did not. And to our second child, you aren't born yet, but hearing your heartbeat is a reminder that even when things are difficult, the future also holds so much joy and happiness.

Acknowledgements

First, I would like to thank my advisor Dr. Douglas Wilson for all his patience, advice, support, and so, so many edits. Without his help and encouragement, completing this would not have been possible. I am grateful that you pushed me to take the second level GIS course that I absolutely did not want to take. Without that course, I would not have the skills I needed to complete this project. And a big thank you for getting me an internship with the NPS so I could afford to focus on my thesis and not worry about fieldwork. I also want to thank the chair of my committee Dr. Shelby Anderson for helping me start my graduate journey and guiding me through the beginnings of multiple thesis ideas. Her classes helped me grow as a student and pushed me to do my best. I also want to thank my final committee member Bradley Bowden, without whom I would not be doing this project in the first place. Brad brought the idea of focusing on the Tualatin River Basin to me and for that I am grateful.

I want to express a huge thank you to Briece Edwards and Michael Lewis at the Confederated Tribes of the Grand Ronde Community of Oregon. Their willingness to make time to meet with me and discuss this project forever changed its trajectory for the better. Their comments and feedback helped me recognize where my results deviated from my intensions. Finally, without their 2023 SAA poster, I would not have thought to test assumed significance and look at data gaps.

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Thank you to all of my fellow archaeologists in the Portland area with whom I discussed this project endlessly. A special thank you to Thomas Brown for always being ready with materials to read and no-nonsense advice. Thank you to Tom Connolly for responding to my emails and graciously providing the village map he was working on. A big thank you to Dave Ellis, who was willing to share his vast knowledge of Tualatin River Basin archaeology with me. I also want to thank Virginia Butler; you have been an inspiration to me since the first undergraduate course I took from you, and I wouldn't be the archaeologist I am today if not for you.

Thank you to my fellow Portland State University Anthropology graduate students for being in this with me, especially my friends Dianna Wilson and Nathan Jereb. It was always encouraging to reach out and hear that you were also about to tear your hair out. Being in graduate school mid and post COVID was hard, but it always made it feel a little more normal when we saw each other.

Finally, and most of all, thank you to my wife Lyra and my son Jamie. You put up with so many days and nights of me staring at books and my computer. You picked me up when it all seemed too hard to do and gave me a reason to keep going. Thank you.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Archaeological investigations are inherently probabilistic and incomplete in the information they provide about past human activities and lifeways (Sundstrom 1993). Most archaeological investigations in the United States are done under the umbrella of Cultural Resource Management (CRM) tied to Section 106 compliance. The resulting data are often incomplete due to restrictions such as arbitrary project boundaries, tight deadlines, and budget constraints which lead to site evaluations and mitigation efforts being on the scale of individual sites, or even portions of sites, which fall within the project (McManamon et al. 2016). The incomplete nature of many evaluations along with destruction and alteration of the existing archaeological record due to development means that sites previously evaluated as unimportant may now hold a higher level of significance that goes unrecognized (Minor 1994). A landscape-scale synthesis and analysis of regional data can support archaeologists in making more informed evaluations of sites by providing the necessary archaeological, historic, cultural, geographic, and ecological context of identified cultural resources (Hardesty and Little 2009). This type of synthesis can also help identify areas of deficiency in documentation practices.

Significance modeling is an approach that draws on the tools of land-use modeling and predictive modeling to utilize available archaeological data to aid archaeologists and land managers in comparing the relative values and research themes of cultural resources within a region or landscape system. Archaeologists can then make management recommendations based on direct impacts to specific sites while considering the cumulative impacts to cultural resources in the region (Heilen et al. 2018;

McManamon et al. 2016). The models can, and should, be updated and sites reevaluated to reflect changes in the archaeological record, new methodologies, and changes in research and cultural priorities. Significance modeling is not a replacement of National Register of Historic Places (NRHP) eligibility evaluations, it is a method of predicting and understanding the potential significance of sites that have not yet had formal evaluations completed.

Research Overview

My thesis project consists of three main stages: (1) Synthesize the current archaeological record data of precontact lithic sites in the Tualatin River Basin into an ArcGIS Pro geodatabase, (2) Develop a sample significance model based on recorded site attributes and relevant parties input, (3) Apply the model to sites and test it for completeness and accuracy by analyzing gaps in the sample attributes used to create the model.

For my research area, I selected the traditional homelands of the Tualatin Kalapuyan people. The area broadly encompasses the Tualatin River watershed and the northern portion of the Greater Yamhill watershed (Figure 1). Because most of the research area lies within the Tualatin River Basin, I will refer to this project area as the Tualatin River Basin throughout this paper. I chose this region because lands within the Tualatin River Basin are largely privately owned (Figure 2) and there are no state-level or local processes or ordinances that require archaeological survey or testing. Archaeological investigations in the region are primarily done under Section 106 compliance for federally funded or permitted projects, which results in sites being recorded and evaluated within arbitrary project boundaries and not fully delineated. Furthermore, no research has yet synthesized or analyzed the known precontact archaeological data of the region, which makes it more difficult to accurately define the regional context of individual sites to make accurate NRHP eligibility recommendations. Based on my own analysis of the currently documented sites of the 203 resources in the Tualatin River Basin, 2 are listed as eligible, 49 are listed as not eligible, and 152 are listed as Unevaluated/Important for NRHP eligibility. That means nearly 75 percent of identified precontact archaeological resources in the region have not been formally evaluated for listing on the NRHP and less than one percent are listed or eligible.

My research helps to fill this data deficiency by synthesizing and standardizing the recorded archaeological information for the Tualatin River Basin into an ArcGIS Pro geodatabase which I then used to develop a sample significance model for the region and assess documentation deficiencies in the sample attributes used to create the model. The model and data gap analysis can be used to aid archaeologists and land managers in identifying the types of information important in evaluating precontact sites in the region for NRHP eligibility and provide a local and understandable toolkit for making land management decisions as they relate to cultural resources. This allows archaeologists, land managers, and relevant parties to understand the contextual significance contributions of cultural resources even if they do not currently meet NRHP eligibility criteria or have not yet been formally evaluated for NRHP significance.

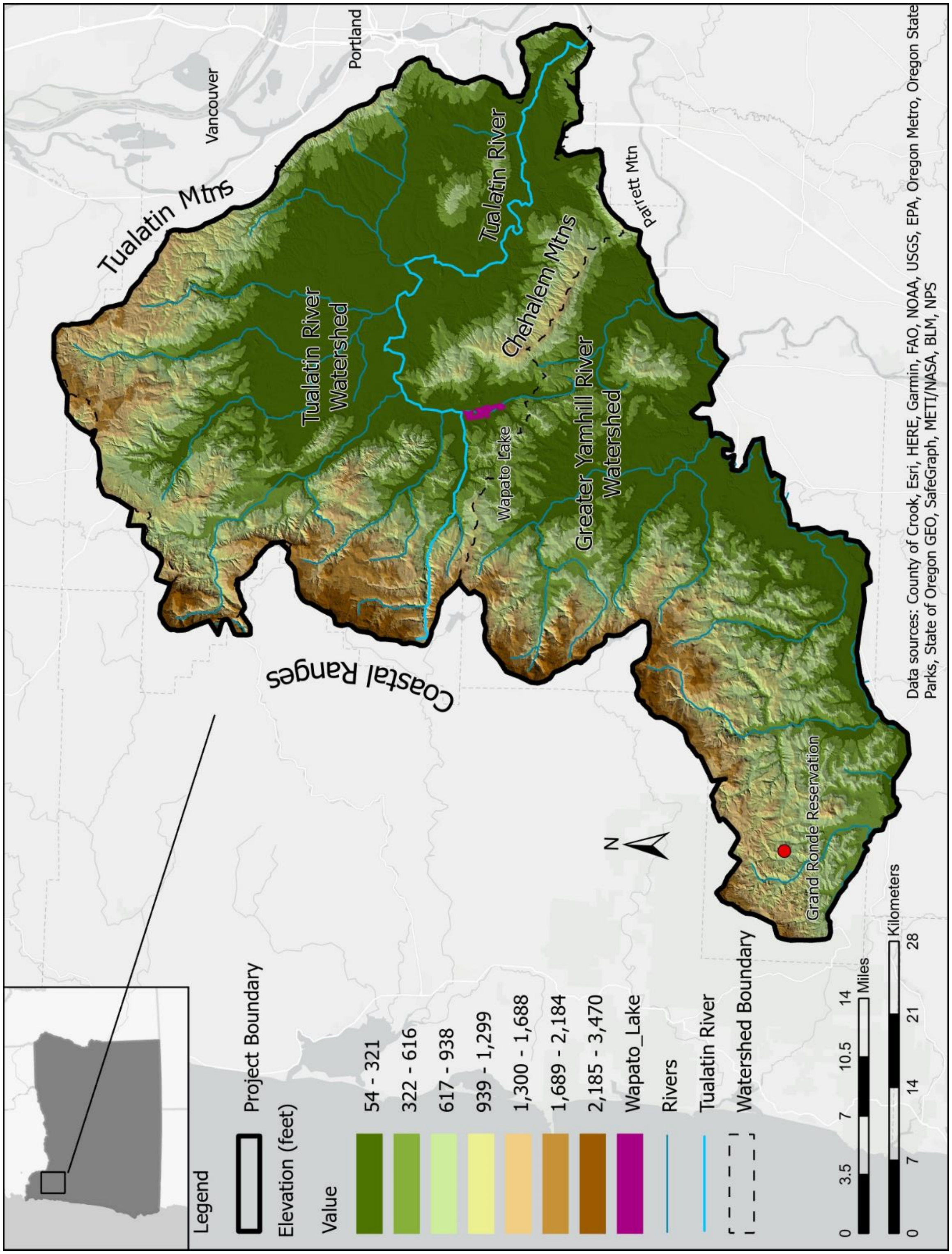


Figure 1: Elevation hill shade (in feet) of research area with geographic landmarks.

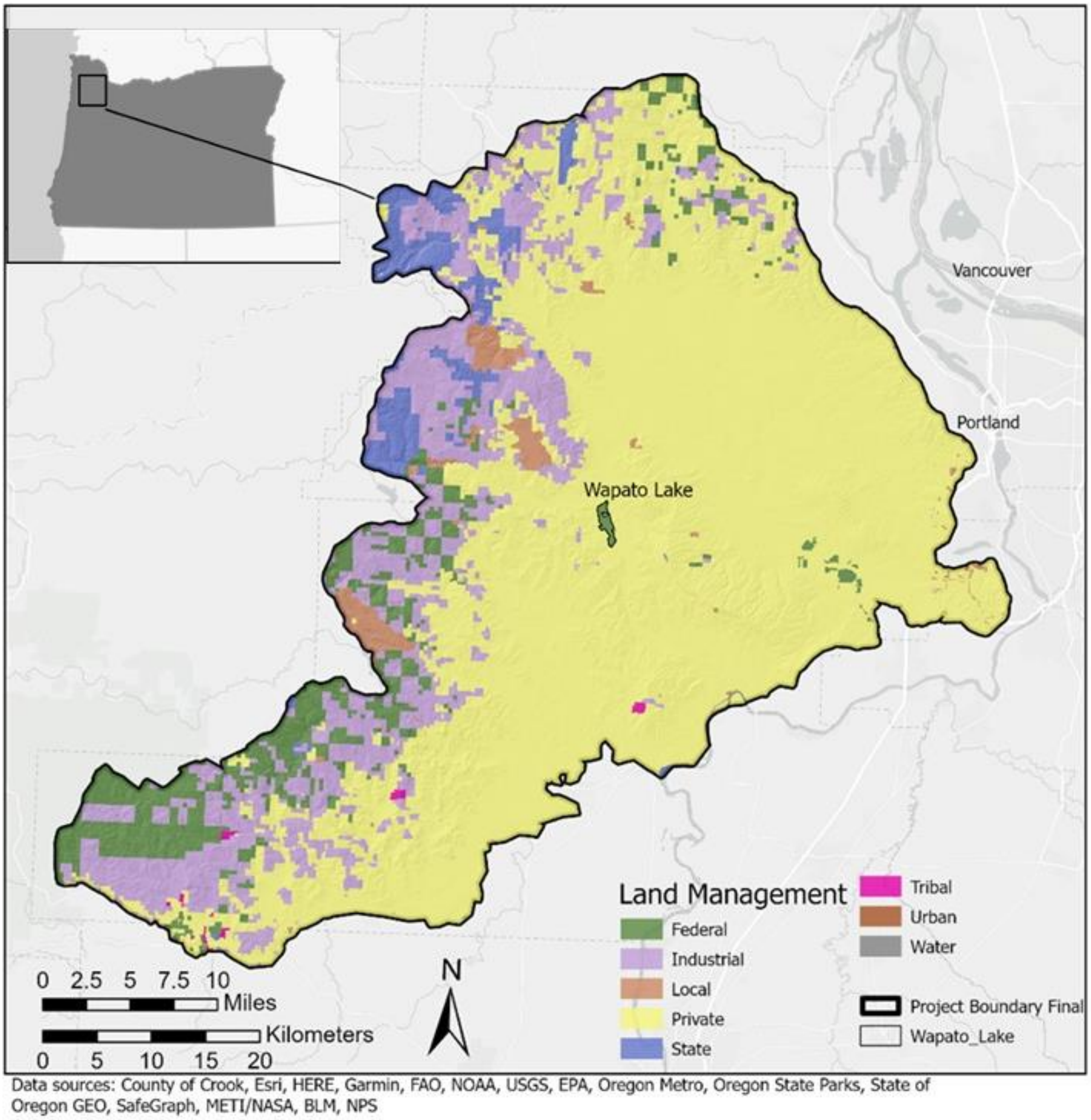


Figure 2: Land management map of the study area with Wapato Lake labeled.

Conceptual Frameworks

In this section I define and discuss a few key concepts of significance modeling and this research. Some terms used in significance modeling and in this research may differ from the way they are commonly used in archaeological discussions. To ensure clarity of the concepts discussed here, and in acknowledgement that the terms and words we use to describe cultural resources matter, this section defines the terms "significance," "precontact," and "relevant parties."

Significance

A key aspect of significance modeling is recognizing the distinction between significance and National Register of Historic Places (NRHP) eligibility. Conversationally in archaeology, the term significance is often used interchangeably with NRHP eligibility. In significance modeling and this research, the term significance is used not only in relation to NRHP eligibility, but also to cultural and regional significance qualities that may not easily fit the NRHP criteria (Cushman and Sebastian 2016). Further, it should be recognized that significance is not an inherent attribute of archaeological sites but an ascribed trait that is culturally defined and may change over time and vary between groups and individuals.

Precontact

Throughout this research, I use the term "precontact" to refer to archaeological sites made up of predominantly lithic materials. However, I want to acknowledge that the division of precontact (or prehistoric) and post contact (or historic) archaeology is a manufactured distinction which has been critiqued within the archaeological community for decades (Lightfoot 1995; Silliman 2005). Use of lithic reduction technologies did not stop when Europeans invaded and made contact with Indigenous communities (Silliman 2003), and it is probable that some sites that have been labeled as precontact based on presence of lithic technology date to a time period after European contact and may or may not be associated with Indigenous peoples. Assimilation of culture also results in sites with Colonially introduced materials could be Indigenous sites. Despite these issues, the division of precontact and post contact sites persists within archaeology, and sites are divided as such in archaeological site record forms. Here, I use the term precontact to indicate sites of predominantly lithic cultural materials with the recognition that the term broadly generalizes the types of material evidence left behind by Indigenous people in the past.

Relevant Parties

Significance modeling research uses the term “stakeholder” to refer to people and organizations with interest and association to the archaeological sites within the research area. These interests may be cultural, academic, scientific, geographical, regulatory, economic, personal, or a combination of these or other interests and associations not listed here. However, it was brought to my attention after completing this research that the term stakeholder is offensive to some due to the colonial and oppressive roots of the term (Reed 2022, 2023). In recognition of that, I have removed that term from my own research and replaced it with the term “relevant parties” as suggested in Reed (2022). Examples of relevant parties in this project are: Indigenous communities (Confederated Tribes of Grand Ronde), Federal land managing agencies (United States Fish and Wildlife Service), State regulatory agencies (Oregon State Historic Preservation Officer), educational institutions (Portland State University) and CRM professionals and companies. It is important to note that the terms stakeholder and its replacement ”relevant parties” do not accurately reflect the privileges, roles, and ties that Tribes and Indigenous communities and governments hold under laws such as Section 106. In this research, I had ongoing conversations with the representatives from the Confederated Tribes of Grand Ronde and invited them to review in-progress results during the research process and provide additional feedback.

Thesis Structure

This thesis is organized into five chapters. Chapter 1 introduces the area of study and frameworks for this research. In Chapter 2, I discuss the geological and environmental background of the Tualatin River Basin, followed by a summary of previous archaeological research in the region. I then discuss the ethnographic context for the region and cultural background of the Tualatin Kalapuyan peoples. I then introduce the theoretical and legal frameworks on which my thesis is based including Indigenous archaeology, values-based archaeology, land-use and predictive modeling, and significance modeling. Lastly, I give a brief overview of the lithic analysis techniques I used as part of this research. In Chapter 3, I discuss my research design and methods in detail. I discuss my methods in: 1) data preparation and data synthesis; 2) univariate and multivariate environmental analysis; 3) setting up a relevant parties input meeting; 4) development, application, and testing of the significance model; 5) lithic analysis methods; and 5) function of the Willamette Water Supply sites in this research. In Chapter 4, I present the results of: 1) my data synthesis and geodatabase; 2) univariate and multivariate environmental analysis; 3) the relevant parties input meeting; 4) the significance model and data gaps; and 5) the lithic analysis and additional site data application. Finally in Chapter 5, I discuss the successes and failures of this project and consider the implications of my work for future studies on site significance evaluations and identification of missing site data. I conclude by discussing potential future research directions and recommendations on how the results of this work could be used.

Chapter 2: Background

In this chapter I introduce the environmental background of the project area followed by a discussion of prior archaeological research. I then discuss the available ethnographic information on the Tualatin Kalapuyan people. Following that, I provide a brief overview of the theoretical and legal frameworks in which my project is set before discussing the emerging practice of significance modeling.

Thorough and diverse background research is necessary for interpretation and significance assessments of archaeological sites. Context of archaeological sites can be divided into four types of data: 1) Ecological, 2) Cultural, 3) Historical, and 4) Archaeological (Pouley et al 2023). Knowledge of environment and ecology inform on understanding of past resources, climates, and landscapes that can help address environment-related significance. Cultural and heritage knowledge helps to inform on chronology and cultural traditions that may be evidenced in the archaeological record and includes place-based knowledge and cultural understandings of living descendant communities. Historical knowledge can help identify significant events, people, and places through written records, oral histories, and traditional stories. Regional archaeological knowledge is needed to compare the relative attributes of sites to each other and across a region and provides broader understanding of the interrelationship of sites and how past people lived on the landscape.

Location and Environmental Background

The Tualatin River basin is located in northwestern Oregon west of the Willamette River, encompassing most of Washington County and includes small sections of

Clackamas, Multnomah, Tillamook, and Yamhill counties (TRWC 2022). The watershed is bounded to the north and east by the Tualatin mountains, to the south by the Chehalem and Parrett mountains, and to the west by the Coast Range (Figure 1) (Cope 2012). The historic boundaries of the Tualatin Kalapuyan territory largely align with the watershed description but extend notably further south and southwest to the South Yamhill River based on the Dayton Treaty of 1855 (Figure 3). An 1877 ethnographic interview conducted by A.S. Gatschet, the hunting limits of the Tualatin Kalapuyan people were described as up to “half the mountains” separating from Tillamook country, south to the Yamhill River, and north up to the Clatskanie tribe. Henry Zenk (1994) described the Tualatin Kalapuyans as occupying the Tualatin River drainage and Chehalem Creek as well as possibly the North Yamhill drainage. For the purposes of this study, I will use the boundaries defined by the Dayton Treaty of 1855 as the traditional territory of the Tualatin Kalapuyans (Figure 3). While there is some uncertainty as to whether the traditional lands extend south and west into the Greater Yamhill Basin, I chose this boundary because it is the largest area recorded as associated with the Tualatin Kalapuyans. I manually transcribed the boundaries defined in the Dayton Treaty into ArcGIS Pro to create the boundary for my research project area (Figure 1 and Figure 3).

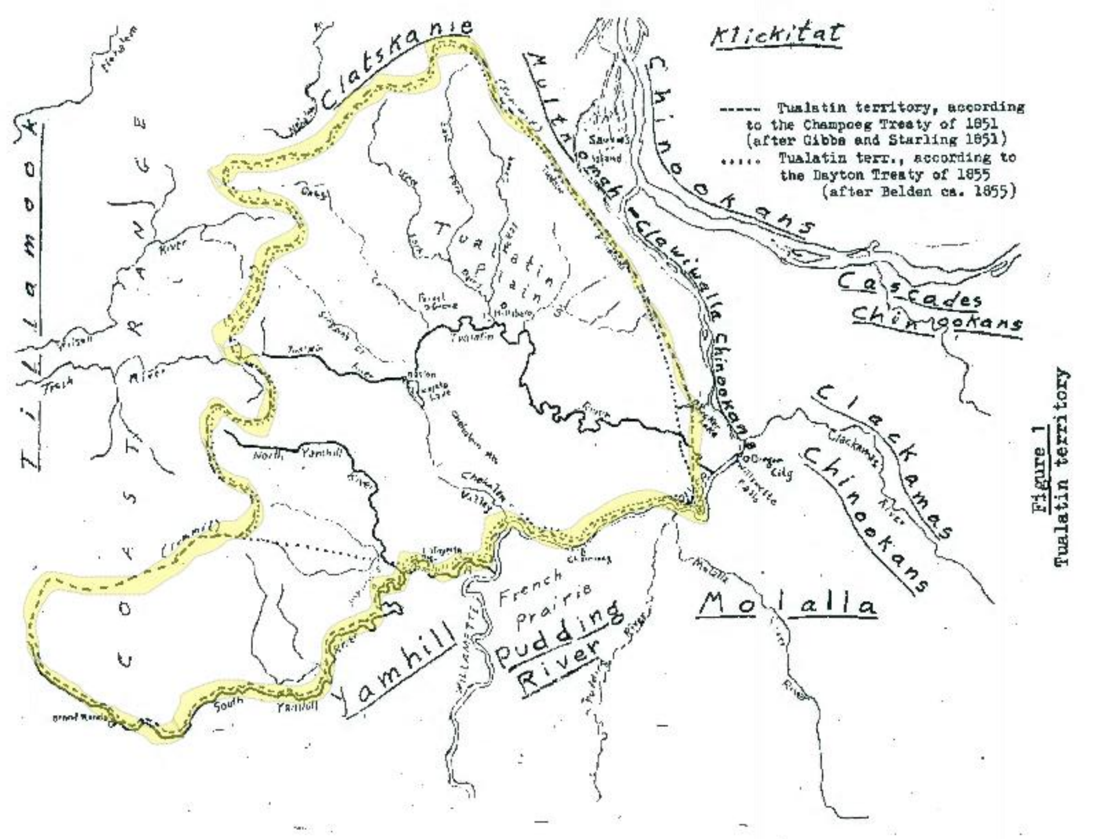


Figure 3: Map of Tualatin Territory with Dayton Treaty boundary highlighted. Adapted from Zenk (1976) "Contributions to Tualatin Ethnography: Subsistence and Ethnobiology."

During the early Holocene, the Willamette Valley, including the Tualatin River basin, experienced a warm and dry period, termed the hypsithermal or Holocene Climatic Optimum (HCO), from 8,000 to 4,000 BPE (Bell 1981, Cope 2012). During this period, the upland areas of valleys were characterized by oak savannah, which thrived in the warm and dry climate. After 4,000 BPE, the climate became wetter and cooler, but the oak savannah vegetation zones remained. This was largely due to Indigenous land management practices such as intentional burning (Cope 2012). The Tualatin valley floor was prone to flooding due to the slow-moving Tualatin River, which created marshy wetland areas suitable for edible vegetation of great importance to Indigenous people including wild onion, wapato, and camas (Aikens et al. 2011: 286-289; Zenk 1994). The edible tuber of *Sagittaria latifolia*, wapato was productive enough and predictable enough to be intensively exploited as a staple food source (Darby 1996). Wapato and camas are known to have been of major importance in Tualatin subsistence (Zenk 1976). Wapato Lake, located near what is now the town of Gaston (Figure 1), was the primary location for harvesting wapato and was an important cultural gathering spot in autumn for the annual wapato harvest (Cope 2012; Zenk 1976, 1994). Following White settlement, many of these important plant resources were drastically reduced due to agricultural practices and livestock like hogs being set loose to feed on the camas and wapato, forcing the surviving Kalapuyans to be reliant on the colonial economic system (Zenk 1976). In the mid-1930's, the lake was drained and filled by a local coalition of farmers referred to as the Wapato Improvement District to create more agricultural fields for domesticated onions. Today the now-dry former lake is managed by U.S. Fish and Wildlife as part of the Tualatin River National Wildlife Refuge Complex (Cope 2012; USFWS 2023).

While once the valley floor was dominated by seasonal wetlands, today the valley is dominated by agricultural fields and developed lands. As the Portland metro population has increased, development has intensified and pushed further into the Tualatin River Basin (Cope 2012). Recently, ecological groups have recognized the importance of wetland habitats, advocating for restoration of the environmentally and culturally important ecosystems (Cope 2012).

Prior Archaeological Research

In this section I summarize current archaeological research on precontact sites in the Tualatin River Basin. The primary source of archaeological data in the Tualatin River basin are cultural resources compliance reports that document a total of 203 precontact archaeological resources in the Oregon SHPO database, 92 of which are designated as archaeological sites with Smithsonian trinomials with the remainder composed of isolated finds and reported but unsubstantiated sites. Approximately 10% of the Tualatin River Basin has been surveyed by archaeologists for cultural resources compliance projects (Figure 4). An area of approximately six miles square in the center of Figure 4 represents a surveyed area with no references or documentation and appears to be a database error, and I excluded that polygon in the surveyed area calculations. This makes analysis of spatial distribution of sites across the landscape difficult as the low survey density and clustering of surveys in the valley floor makes the site data susceptible to spatial autocorrelation and may not be reflective of land use practices across the region (Banning 2020).

Chronology and Dating

A 1993 master's thesis by Linda Lani Freidenburg compared projectile points collected from two sites on farms within the Tualatin Valley with established point typologies for the Portland Basin by Richard Pettigrew and Kathryn Toepel (Freidenburg 1993). Based on established radiocarbon date ranges for the comparison typologies, Freidenburg concluded that the two Tualatin Valley sites had evidence of occupation at least 6,000 years ago, possibly earlier (Freidenburg 1993). Only one radiocarbon date has been established for the Tualatin River Basin region since Freidenburg's work. The only absolute dating results in the region are from a burned earth feature in site 35YA23 with a date of 3270 Years Before Present (YBP) (Walker 2011) and obsidian hydration analysis on site 35WN93 with multiple results ranging from 490 and 3240 years before present (Gerrish 2016).

NRHP Eligible or Listed Sites

There are two precontact sites eligible for listing on the NRHP in the Tualatin River Basin: sites 35YA23 and 35WN114. Examining the records of these two sites can help indicate what attributes of sites may contribute to significance in this region.

Site 35YA23 consists of a pit feature identified in 2009 during heavy machinery excavation monitoring. The pit feature was identified approximately one meter below the sod layer and is U-shaped containing charcoal, fire-modified rock (FMR), one lithic flake, and burned sediments. The site consists of the pit feature, several middle to late Archaic period projectile points, lithic formed tools, lithic cores, and three pieces of copper including a copper arm band. As previously mentioned, a sample from the feature was submitted for radiometric dating and returned a result of 3270 years BP, which is currently the only radiometric date in the region. The site contains obsidian flakes, one of which was submitted for XRF analysis and determined to be sourced from Obsidian Cliffs in the Cascade Range (Walker 2011). The NRHP nomination form for site 35YA23 noted the chronologically diagnostic artifacts, datable features, diverse tool assemblage, possible status and trade items, and intact stratigraphy as attributes contributing to the significance of the site.

Site 35WN114, identified in 2019, consists of an FMR scatter and lithic assemblage including eight projectile points in a two-acre area. The highest density of artifacts lies within a 925 square meter locus within the site. The site consists of approximately 75 pieces of FMR (50 of which are within the locus), 3 to 4 lithic flakes, 1 ground stone mano fragment, 1 pebble hammerstone, and 8 projectile points of various styles and sizes (Valentine 2019a). In addition to material objects, this site was recommended as eligible for the NRHP due to being located between Chicken Creek wetland and an open prairie near the Tualatin River, making it an ideal location for camas and tarweed harvesting. This context was used to interpret the FMR as potential evidence of rock ovens used to roast camas and of cultural burning for harvesting of tarweed (Valentine 2019b). The attribute of a site being located at the interface between different physical environmental settings, specifically wetlands and prairies, could be a significance indicator when cooking or processing features have also been observed. This site evaluation serves as an example of how to integrate geomorphic and environmental attributes into eligibility recommendations.

Willamette Water Supply System

The Willamette Water Supply System is a water pipeline project that runs approximately north-south/southeast from Highway 26 in Hillsboro near Rock Creek Powerline Park to the Willamette River near where it crosses to the west side of Interstate 5. The United States Army Corps of Engineers issued federal permits for the project, which triggered Section 106 compliance, resulting in systematic survey of the entire pipeline corridor and testing of archaeological deposits. This linear project provides recent survey and testing data that spans almost the entire north-south aspect of the project area. I took part in many of the surveys and excavations on this project, and I am familiar with the field and recording methods. I used the data from the WWSS project as examples to assist in analyzing and standardizing the legacy data in the OARRA database. I also reserved data from three WWSSP sites described below during development of the model to use as tests.

Recently Tested Sites

There are four sites in the region that have undergone recent phase II archaeological testing excavations, the data from which was not included in the development of the significance model but was used to test the application and flexibility of the model. Three of the sites are tied to the Willamette Water Supply System Pipeline project and one tied to a graduate student thesis at Portland State University. The four sites are 35WN130, 35WN133, 35WN134, and 35PO95. I took part in phase II testing excavations at sites 35WN133 and 35WN134 as an archaeological field technician in 2020.

35WN130

Site 35WN130 was first identified in 2016 during phase I survey of the WWSSP by Historical Research Associates (HRA). The initial survey involved pedestrian survey and a total of seven shovel probes which identified five pieces of cryptocrystalline silica (CCS) debitage, one piece of course grained volcanic (CGV) debitage, and one possible FMR. The site is located on a plowed and disturbed terrace approximately 260 meters north of the nearest water source, Butternut Creek (Dinwiddie 2019).

The site was revisited in 2019 for boundary delineation and testing. The primary research questions of the site testing were what was the: 1) Extent of deposits; 2) Age of occupation and chronology; 3) Site function; 4) Past environment(s); 5) Tool stone sources; and 6) Settlement and subsistence strategy (Dinwiddie et al 2020). During this site visit, HRA excavated 16 additional shovel probes and two 50cm by 50cm Quarter Test Units (QTUs). The northern, eastern, and southern boundaries were delineated with multiple negative shovel probes, but the western boundary was not fully delineated due to project area limitations. Overall, 16 pieces of debitage and one projectile point were recovered from the site during excavations. HRA was not able to delineate the boundary of or test the entire site due to boundary limitations of the project. HRA did recommend that the portion of the site within the project boundary did not contribute to the larger resource's eligibility, but portions of the site outside the project area remain uninvestigated and unevaluated (Dinwiddie et al 2020).

35WN133

Site 35WN133 was first identified in 2017 during phase I survey of the WWSSP by HRA. The initial survey involved pedestrian survey and excavation of 17 shovel probes which identified 12 pieces of debitage, one biface fragment, and one FMR. The boundaries of the site were delineated within the project area, but the western, eastern, and southern boundaries were undetermined due to project limitations. The site is located in a plowed and disturbed gently sloping terrace located 280 meters from the nearest water source, the Tualatin River (Bialas 2017a).

The site was revisited in 2020 for boundary delineation and testing. The primary research questions of the site testing were the same as site 35WN130 above. During this site visit, HRA excavated 21 QTUs. Overall, 66 pieces of debitage and four formed artifacts (two bifaces, one end scraper, and one core) were recovered from the site. HRA was not able to make an eligibility recommendation of the full site due to delineation being limited. HRA did recommend that the portion of the site within the APE did not contribute to the larger resource's eligibility (Dinwiddie et al 2021).

35WN134

Site 35WN134 was first identified in 2017 during phase I survey of the WWSSP by HRA. The initial survey involved pedestrian survey and excavation of eight shovel probes which identified one piece of debitage and 10 FMR. The boundaries of the site were delineated within the project area, but the western and southern boundaries were left undetermined due to project limitations. The site is located in a plowed and disturbed gently sloping terrace located 260 meters from the nearest water source: the Tualatin River (Bialas 2017b). The original site form also notes that site 35WN134 is separated by a distance of 20 meters and an ephemeral drainage from site 35WN133 and that they may represent parts of a larger use of the landscape. Also noted on the site form is the concentration of 10 FMR that could be associated with cooking and resource processing (Bialas 2017b).

The site was revisited in 2020 for boundary delineation and testing. The primary research questions of the site testing were the same as site 35WN130 and 35WN133 above. During this site visit, HRA excavated eight QTUs recovering 12 pieces of debitage and two formed artifacts, both gravers. HRA was not able to make an eligibility recommendation of the full site due to delineation being limited. HRA did recommend that the portion of the site within the APE did not contribute to the larger resource's eligibility (Dinwiddie et al 2021).

35PO95

Site 35PO95 is a multicomponent site that was first identified in 2008 during phase I survey by Willamette Cultural Resources Associates (WCRA). While the historic component is substantial for this site, my research is focused on the lithic component. The initial survey involved pedestrian survey and a total of 27 shovel probes which identified 22 pieces of debitage, 5 FMR, 1 faunal remain, and 2 CCS bifaces in addition to 7 ceramics, 34 glass shards, 8 metal tools, and 8 other metal items. The site is located on the southern edge of a heavily plowed agricultural field on a terrace on the northern portion of the South Yamhill River flood plain (Ogle 2008).

The site was revisited in 2009 with an additional six shovel probes and three 1x1-meter test units excavated. During these excavations an additional 61 pieces of lithic debitage, three knapped stone tools, and 11 faunal remains were recovered plus an additional 70 historic artifacts. The site as a whole remained unevaluated after these excavations, but WCRA recommended the portion tested as not containing significant archaeological deposits due to sediment disturbance and lack of integrity (Solimano 2009).

Site 35PO95 was revisited in 2023 by Portland State University graduate student Nathan Jereb in conjunction with the Confederated Tribes of Grand Ronde during which an additional four 1x1-meter test units were excavated. One of the primary research questions of that investigation was to assess the extent of damage and movement caused by agricultural plowing to artifacts. Because no cataloging or lithic analysis had yet been done on the lithic materials from the most recent test units, I coordinated with Jereb to visit the lithics lab in Grand Ronde to do my own independent lithic analysis. Jereb later completed his own analysis of the materials, but it was not completed in time to include in this research.

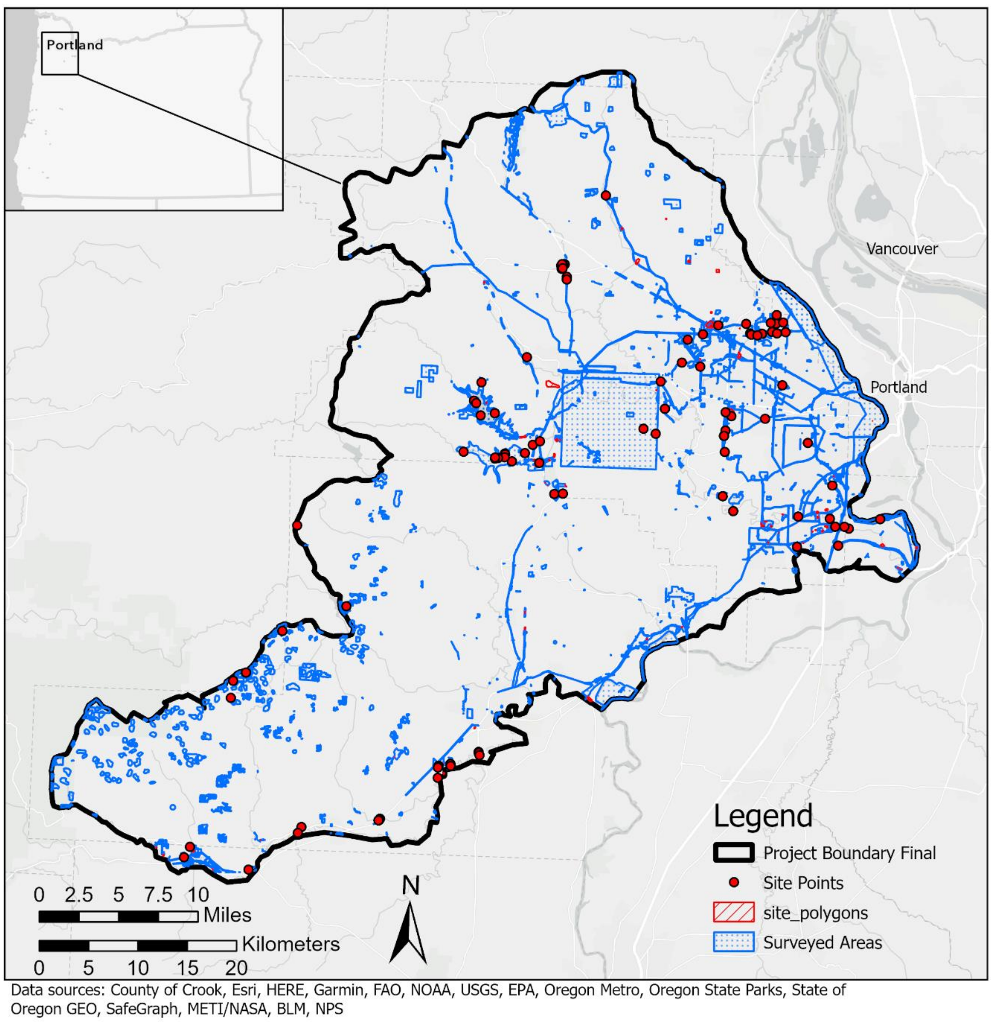


Figure 4: Site locations and archaeologically surveyed areas within the research boundary. Note the large square near the center that appears to be a database error.

Ethnographic Research

The Tualatin Kalapuya, also known as the Atfalati, Twalaty, or Faladin, have inhabited the Tualatin River Basin since long before European contact (Zenk 1994). The Tualatin Kalapuya are one of approximately 13 tribes that speak Kalapuyan languages and whose traditional territories consist of the Willamette Valley and part of the Umpqua River drainage (Zenk 1990). The Tualatin Kalapuya population is estimated to have been between 1,000 and 2,000 people organized into 15-20 winter village groups. By the time of the Champoeg treaty of 1851, the Tualatin population had been severely reduced by the smallpox epidemic of 1782 and the "fever and ague" (malaria) outbreak of the 1830's with a remaining population of only around 60 people (Zenk 1976, 1994). The Champoeg treaty negotiated in 1851 designated a reservation that included the culturally important Wapato Lake, but this treaty was never ratified by the U.S. Senate. The Dayton Treaty of 1855 was signed and ratified to establish the Grand Ronde reservation, and in 1866, the remaining Tualatin Kalapuyans were forcibly removed to that reservation, which encompassed an area of about 42 km^2 in the far southwest portion of their homelands (Figure 1 Figure 3) (Zenk 1976).

Ethnographic information on the Tualatin Kalapuyans is almost entirely derived from the interviews of linguist A.S. Gatschet in 1877 who worked with two Tualatin men, k'ínai (also known as Peter Kenoyer) and yécgawa (Dave Yatchkawa). Both men had experienced Tualatin life in pre-reservation times, but Gatschet's training was as a linguist, so his interviews are primarily focused on recording the Tualatin Kalapuyan language (Zenk 1994). While both k'ínai and yécgawa had firsthand experience of pre-reservation Tualatin life, their accounts are from after the time when diseases had ravaged the community, and each had only partial and secondhand information about life before the population decline. Henry Zenk (1976; 1990; 1994) used Gatschet's field notes along with the works of Leo Frachtenberg and Melville Jacobs to derive a cultural ethnography of the Tualatin Kalapuyans, which I summarize in the following sections.

Political and Social Life

The basic political and social units in Tualatin society were autonomous winter village groups which consisted of one or more patrilocal extended families co-residing during the winter months. Each winter village group had a chief who was distinguished by wealth. Village groups without a chief were described as having a leader who reported to the chief of a neighboring village. From spring to fall, the Tualatins lived in transitory camps and then reoccupied winter houses around November (Zenk 1990).

Kalapuyan social organization was less stratified and differentiated than the neighboring Chinookan system. There were three general classes of social rank known in Kalapuyan society: 1) Chiefs and their families; 2) The general population of Kalapuyans; and 3) Slaves, who were most often captives or their descendants. The Tualatins and other northern Kalapuyans were more active in slave trade than other Kalapuyans, including sending slave raids out to central and southern Kalapuyans (Zenk 1990). Trade items include food and prestige items such as camas, animal furs, dentalium shells, bone and shell beads, jewelry, feathers, and slaves. Later trade goods included European-introduced items such as trade beads, blankets, guns and gunpowder, and horses (Zenk 1976).

The Tualatin Kalapuya were culturally closely related to the Yamhill Kalapuya to the south and were known to cross territory lines. However, the case was not true of the Clatskanie Tribe to the north unless a Tualatin was invited (Zenk 1976). There is not a clear description in Gatschet's notes of the relationships with the Tillamook Tribe to the west, the Chinook tribe to the north, or the Molalla tribe to the east.

Religious Beliefs and Ceremonies

Tualatin and other Kalapuyan religious ceremonialism were based around guardian-spirit powers. These powers could be associated with animals, supernatural beings, natural phenomena, or inanimate objects (Zenk 1994). Socially significant achievements were considered to be tied to possession of guardian spirit powers and all individuals regardless of gender or social class, including slaves, could gain such powers. (Zenk 1976, 1990). Powers could be sought through quests at power places and strengthened or intensified, especially by shamans, through the singing of power songs during winter dances (Zenk 1994).

Subsistence and Food Resources

Resources for the Tualatin were temporally and spatially limited. The seasonal cycle of subsistence involved harvesting camas (noted as the single most important subsistence resource for the Tualatin) beginning early spring through fall, harvesting berries and hazelnuts in the hills in midsummer, berries and large game in the mountains in late summer, tarweed and other seeds in the prairies in late summer and early fall, and a large gathering to harvest wapato from Wapato Lake in October. This cycle is supplemented year-round by hunted and trapped game animals. Around half of the year was spent in substantial houses at the winter-village sites (Figure 5) relying on stored provisions for sustenance as well as hunted and trapped game animals. The annual wapato harvest was held around October each year, during which the whole tribe would gather around Wapato Lake (Zenk 1976, 1994). Tarweed prairies were not shared between winter village groups and often had individual ownership (Zenk 1994).

Winter Village Locations

Henry Zenk identified sixteen village locations from Gatschet's notes after identifying and removing duplicate entries and incorrectly identified locations. Zenk refers to these as "conjectured" village locations, but in this research, I will refer to them as ethnographically recorded village locations. In 2023, Tom Connolly re-digitized the village locations onto a more detailed background map using computer drawing software, which I then geolocated using ArcGIS Pro (Figure 5). Using ArcGIS Pro, I determined that of the 16 village sites, 6 are located immediately around Wapato Lake and an additional 2 are within 4 miles of the lake, further indicating the importance of Wapato Lake as a cultural hub. This is consistent with Zenk's findings in which he noted that villages 7, 8, 9, 10, 11, 12, and possibly 13 and 14 may have been a single village complex instead of distinct villages (Zenk 1990: 155).

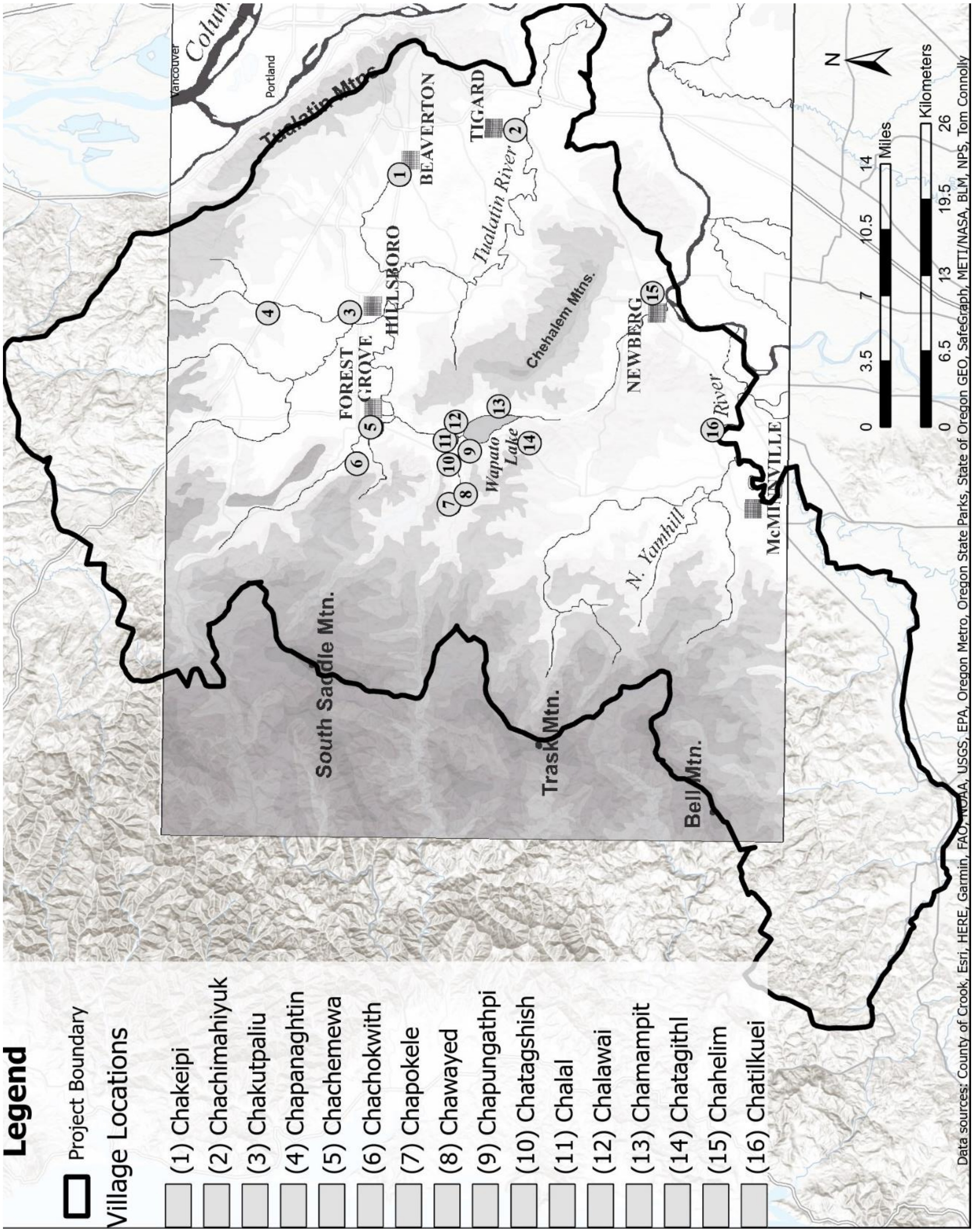


Figure 5: Map of Tualatin village locations georeferenced onto project boundary. Village location map by Tom Connolly (personal communication 2023).

Theoretical and Legal Framework

Section 106 of the National Historic Preservation Act (NHPA) requires that federal agencies consider how their undertakings (a project, activity, or program at least partially funded by, permitted by, or under the jurisdiction of a federal agency) affect historic properties, including archaeological sites, that are listed on or eligible for listing on the NRHP (King 2008, McManamon 2018). The NHPA defines historic properties as "any prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on, the National Register, including artifacts, records, and material remains relating to the district, site, building, structure, or object" (NHPA 1966). To evaluate whether a site is eligible to be listed on the NRHP, archaeologists often test the site using subsurface techniques such as shovel probing or test unit excavations. Archaeological permitting on non-federal land is handled at the state level by the State Historic Preservation Officer (SHPO), who is responsible for administering the State's historic preservation program (NPS 2023). In Oregon, a permit is required by the SHPO for excavating or collecting from an archaeological site on non-federal public or on private lands or to probe for an archaeological site on non-federal public lands (OPRD 2023). Within Oregon, State law OAR 736 states that part of the requirements for an archaeological permit is defining the "universe of study," including "pertinent information about the area's history" (Oregon SHPO 2020). The Oregon SHPO further requests archaeologists to perform "inter- and intra-site comparisons, relating to regional contexts and patterns, placing a site within a culture history/chronology" (Oregon SHPO 2016). Despite these requirements, site evaluations and subsequent mitigation efforts in

CRM are often on the scale of individual sites, or portions of sites, which fall within the area of potential effects (APE) for a given project (McManamon et al. 2016). To improve archaeological and heritage standards, the 2020-2025 Oregon Heritage Plan has four goals: 1) Include more voices; 2) increase access to heritage; 3) promote the value of heritage; and 4) pursue best practices (Oregon State Parks 2020). Significance modeling and regional-scale synthesis are two ways to help meet those heritage goals and satisfy the regulatory requirement of regional context by including Indigenous voices, identifying regional contexts, and making significance evaluations a more transparent and equitable process.

Historic properties (including archaeological sites) are evaluated for eligibility at the national level and within the State of Oregon using the four NRHP criteria outlined in 36CFR60 (Table 1), but archaeological sites are typically found eligible under only Criterion D. Sites must also retain integrity as defined by the seven aspects of integrity: 1) location; 2) design; 3) setting; 4) materials; 5) workmanship; 6) feeling; and 7) association (National Register of Historic Places 2024). Critiques of NRHP criteria and significance assessments within the archaeological community have been discussed and published for decades (Clark 2022; Cushman and Sebastian 2008; King 1985; Mason 2004; Morgan 2022; Raab and Klinger 1977). One of the critiques is that evaluations based on information potential as the primary criterion are made based on our current understanding of the site and current archaeological methods, tools, and technologies and do not consider potential changes in those understandings, methods, tools, and technologies. This means it is possible that sites currently seen as unimportant may yield important information in the future as these aspects of data collection change and improve (Cushman and Sebastian 2008). Another critique of eligibility under only Criterion D is that information potential significance can often be fully mitigated through excavation and data recovery, leading to the loss of any unrecognized value the site may have held that could have been illuminated through Tribal collaboration (Mason 2004). Focusing on only the information potential of precontact sites makes it more difficult to integrate traditional cultural values into discussions of significance and frames archaeological sites as resources that can be documented and then destroyed.

Table 1: NRHP Criteria and definitions in 36CFR60.

Criterion	**Definition**
A	Associated with events that have made a significant contribution to the broad patterns of our history
B	Associated with the lives of persons significant in our past
C	Embody the distinctive characteristics of a type, period, or method of construction that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction
D	Have yielded, or may be likely to yield, information important in prehistory or history

Indigenous Archaeology

One method of creating more ethical and equitable archaeological practice is to increase the level of collaboration with Indigenous communities beyond the consultation requirements of Section 106. True collaboration and partnership can lead to a greater depth of understanding of archaeological sites by expanding background information sources and the types of data we collect resulting in new research topics and more complete interpretations of sites (Clark 2022; Ferguson 2009; Nicholas et al. 2011; Silliman 2008). Indigenous archaeology and Community Based Participatory Research are two related ways of addressing the colonial roots of archaeology by striving to make archaeological research include and benefit Indigenous communities (Atalay 2006; Gonzales and Edwards 2020; Lightfoot 2008). Close collaboration with Tribes can help archaeologists expand their ideas of what components and attributes of sites should be considered eligible and gather the necessary information to make successful recommendations under multiple NRHP criteria (Clark 2022). Significance modeling presents an opportunity to take a landscape-scale approach and consider not only the information potential of archaeological sites, but also their cultural and ecological context in discussing what makes a site significant. When done properly, this can result in a regional list of the potential significance contributions of each site as well as associated research goals and priorities crafted not only by archaeologists, but also by Indigenous communities and Tribal representatives.

Indigenous Archaeology and Site Significance

Significance from an Indigenous perspective can take a multitude of forms. In this research, I rely on two main works to inform on Indigenous significance which I will briefly describe. The first work by Sutton et al. (2013) discusses an overview of Indigenous perspectives on significance in the Hunter Valley, New South Wales, Australia. The second work is by Solimano et al (2019) that discusses the Burns Paiute Tribe's definitions of significance as they relate to NRHP criteria in a CRM report of a solar testing project near Burns, Oregon.

All Our Sites Are Significant

Sutton et al (2013) discuss the Environmental impact Assessment and Aboriginal Cultural Heritage Assessment processes and the Aboriginal consultation requirements as applied in the Hunter Valley of New South Wales, Australia. The concepts described below, while set in the heritage management framework of Australia, are also relevant to archaeological and heritage management in the CRM setting in the United States.

A key concept is the author's definitions of "value" and "significance". These two interrelated concepts are often treated as intrinsic to, and embodied within, a place and that they can be documented and quantified by archaeologists. However, the authors pose that significance is not an intrinsic trait of a place and that the values that make a place significant are made and held by people and are inherently social in nature. The authors further define values as being able to change over time and influenced by social, cultural, religious, and environmental factors. They go on to say that significance can only be determined by first defining whose values are used in determining significance.

The second key concept in Sutton et al. (2013) is that by consistently elevating scientific values as the primary driver of significance assessments, there is a focus on material remains, like stone artifacts, which does not account for or include intangible heritage. Intangible heritage includes not only places historically important in Indigenous histories, but importantly the relationships between contemporary Indigenous people and the environment.

The final key concept is that the official statements made by Aboriginal groups are that all of their sites are of high significance to them. This often manifested in refusal to participate in the cultural heritage process. The authors explain that refusal as being due to the process being perceived as unjust or compromised. A specific issue the authors raise is that the cumulative impact of developments on cultural heritage resources over time is not typically addressed in these processes. This can lead to sites considered to be common becoming scarce over time due to continued development-related destruction.

Redefining "Significant Events" and "Persons"

Solimano et al. (2019) reports on Section 106 archaeological testing of seven precontact sites near Burns, Oregon. The Burns Paiute Tribal perspective on significance is embodied within their definitions of the NRHP criteria as described in Solimano et al. (2019), summarized in Table 2 below.

One of the primary differences between the Burns Paiute application of NRHP criteria (Table 2) and traditional applications (Table 1) is the expansion of what constitutes a significant event and significant persons. In traditional NRHP evaluations, significance under Criterion A must be tied to specific events and Criterion B must be tied to specific persons. In these adapted definitions, the Burns Paiute challenge that by stating patterns of activity through history each constitute an important event and that all ancestors are significant persons.

Table 2: Burns Paiute Tribe NRHP significance definitions.

NRHP Criteria	**Tribal Definition**	**Explanation**
A	Associated with events that made a significant contribution to broad patterns of tribal history	Examples: early allotments used by tribal members; important gathering sites for culturally important plants; location of burials of ancestors of Tribal members; sites with proximity to a named place; central locations of important traditional stories.

B	Associated with the lives of persons significant in tribal history	Can be applied to named individuals in Tribal history, but also tribal members in general. To the Burns Paiute, all ancestors of Tribal members are significant persons. "Persons" also includes characters in traditional stories. Transmission of Tribal knowledge through generations, all significant persons, is of importance in maintaining Tribal identity.
C	Embodies distinctive characteristics of type, period, or method of construction; or representative of significant and distinguishable entity whose components may lack individual distinction	One of the least used criteria. Can include distinct and unique geographic features or highly visible landmarks, especially those with place names. Places created and identified in traditional stories.
D	History of yielding, or potential to yield, information important in prehistory or history	Applied by Tribal members in accessing, understanding, and preserving their culture.

Values-based Approach to Archaeological Resources

Values are not intrinsic to archaeological sites; they are ascribed attributes. The values-based approach to discussing archaeological resources used in my research is based on a 2009 publication by William D. Lipe. In that publication, Lipe describes six kinds of archaeological value: 1) Preservation; 2) Research; 3) Cultural Heritage; 4) Aesthetic; 5) Educational; and 6) Economic. Lipe describes an idealized archaeological resource management program as having six steps: 1) identify sites; 2) assess sites considering their intrinsic characteristics and resource values; 3) respond to potential destruction with proactive planning; 4) actively promote preservation of archaeological resources; 5) properly curate records and collections; and 6) provide direct or indirect access to the resources to the public. Significance modeling and my research falls primarily in the second step of this process.

Lipe's (2009) definition of "value" as it pertains to archaeological resources is focused on the idea that because values are ascribed to resources, they are dependent on context and may change not only over time, but also be different between different groups of people. Lipe goes on to discuss how value and integrity of sites are related. He states that determinations of integrity are relative to the type of value(s) ascribed to the site.

I used the values described in Lipe (2009) as a framework for the relevant parties input meeting I held as part of developing the significance model for the Tualatin River Basin. Understanding the different types of values sites may have and understanding that those values may differ between different relevant parties is key in determining significance categories and attributes for sorting sites.

Land-use Modeling and Predictive Modeling

In this section, I give a brief overview of land-use and predictive modeling in archaeology. Significance modeling uses a similar toolset to predictive models, and it is necessary to understand the differences and similarity in application between the two.

Early settlement-pattern analysis, focused on prehistoric human-environment interactions and how environmental factors such as climate, geomorphology, and resources influenced settlement locations (Ebert and Kohler 1988). In the Willamette Valley, John White (1975) identified four types of Kalapuyan habitation sites in his settlement pattern analysis: 1) Valley edge sites (spring/summer); 2) Narrow valley plain sites (spring/summer); 3) Primary flood plain sites (year-round); and 4) Riparian sites (year-round). The settlement pattern analysis work by John White, Lewis Binford, and others focused on observed correlations between site locations and environmental variables (Ebert and Kohler 1988; O'Rourke 2005). Modeling settlement patterns, later referred to as land-use or locational modeling, are based on three main theoretical frameworks: 1) cultural ecology; 2) site catchment analysis; and 3) optimal-foraging theory (Doelle et al 2016). Cultural ecology seeks to identify and recognize the ways in which changes in culture are the result of adaptations to the environment (Steward 1972). In this research I use some of the framework of cultural ecology in my environmental variable analysis of site locations. Site catchment analysis is the analysis of archaeological sites and their relationship with environmental surroundings. A basic site catchment maximum daily radius is defined as 10 kilometers for hunting and gathering sites (Bailey 2013). In this research I use site catchment analysis to propose an area of daily resource exploitation activities using the 16 ethnographically recorded village sites as centers. The basis of optimal foraging theory is that if one type of resource gathering (e.g. fishing) has a higher return rate than another (e.g. gathering berries) then foragers would forgo gathering berries in favor of fishing. Based in part on the extremely limited archaeological data for the region, I do not use optimal foraging theory in this research. There is not currently enough information on subsistence practices to support the inclusion of optimal foraging theory. The function of modeling is to develop and test expectations for different land use strategies and use those results to organize sites into defined categories (Solimano et al. 2019).

Predictive models function to test different hypotheses of what attributes or variables observed at site locations can act as predictors of likely site locations. This is accomplished by comparing the values of the variables in site locations to those in non-site (background environmental) locations (Doelle et al 2016). In the development of predictive models, archaeologists often use logistic regression or multivariate statistics to determine which variables are potential indicators of site presence (Doelle et al 2016; O'Rourke 2005). One major criticism of predictive models raised by Ebert (2000) is that predictive models connect archaeological materials and presently observed conditions, but do not inherently link those materials to the past. Ebert (2000) and Dunnell (1992) have additionally critiqued the concept of sites as a unit of human activity and proposes that a landscape-level assessment that includes the spaces between sites as a spectrum of human activity may be more accurate. Additionally, as demonstrated in the environmental variable modeling in this research, predictive models are useful for identifying more common sites, but can miss potentially important and unique sites in the outlier data.

Significance Modeling

In this section, I first define the concept of significance modeling, an examination of a case study in significance modeling by Cushman and Sebastian (2008) and conclude with how significance modeling is applied in this research. Significance modeling is a suite of techniques used to predict the information potential and cultural sensitivity of sites using the attributes commonly recorded during archaeological survey and testing. It focuses on landscape-scale assessments of site characteristics to assign values and categorize the sites. It uses a series of logical if/then statements to leverage the available archaeological data to provide a replicable, proactive, and transparent approach to NRHP eligibility evaluations and provide a broad understanding of the distribution of cultural resources and their relative values prior to conducting site excavations and other land management activities (Doelle et al. 2016; Heilen et al. 2018). Significance models help archaeologists in evaluating the research, heritage, and cultural importance of archaeological sites and make informed eligibility recommendations in compliance with CFR 800 and the section 106 process of the NHPA to address the broader issues of the "loss or destruction of significant scientific, cultural, or historic resources" per the NEPA (Cushman and Sebastian 2008). The classifications created by the significance model are designed to change over time as the available information and regional needs change, and the models are designed so that archaeologists can easily re-run them to include new data, sites, and revised categories or sorting rules as needed. Due to the flexibility in the approach and locally derived categories for significance thresholds, significance models can be designed to incorporate traditional cultural values by collaborating with local Indigenous communities and Tribal representatives, making it easier to include those values into land management decisions.

The core concept of significance modeling is that the nature of the type of information (not the information itself) that could be gained through excavation and data recovery of a site can be predicted using specific physical and culturally defined characteristics of the site. These can include morphological characteristics such as the types, quantity, density, and distribution of artifacts; the size of the site; presence of temporal diagnostics; signs of structures or features; ash or charcoal; or other evidence of buried cultural materials. Other characteristics that could be relevant include geomorphic age of the site surface, the depositional setting, and post-depositional processes (Cushman and Sebastian 2008). The specific characteristics used to develop a significance model change from region to region based on the local archaeology, ethnohistory, cultural resources and land management needs, and the needs and values of Indigenous communities and representatives as well as local relevant parties. These characteristics and criteria can also change over time as new information is added to the archaeological record or as local needs and values change.

Origins of Significance Modeling: Cushman and Sebastian 2008

Cushman and Sebastian (2008) developed the concept of significance modeling, laying the framework for what significance models are and how to develop them. In 2004 David Cushman and Lynne Sebastian, working for Statistical Research Institute (SRI), were contracted by the Department of Defense to evaluate the present use of archaeological predictive models on US military installations. The two military installations selected for the pilot program of their research were Eglin Air Force Base in Florida and U.S. Army Fort Drum in New York. The results of the authors' analysis were that the installations were underutilizing their current predictive models and that the models would have additional benefit if they were able to also predict the potential significance of archaeological sites. The authors describe military installations as a good fit for this type of modeling due to the single land-managing agency with large tracts of land with many identified sites.

The main problem the authors identify is the issue of unevaluated archaeological sites. Unevaluated sites are assumed eligible for the NRHP and therefore present obstacles in developments on the military installations unless they are evaluated and found not eligible. They proposed significance modeling as a rule-based approach to predicting significance potential for large quantities of sites. The significance models would take into account not only the information potential of sites, but also traditional cultural values of local Tribes. While their discussion focuses on information potential, they note that significance models could include methods of assessing additional values such as types of sites or features or physiographic settings. The results of significance modeling could then be used by the installations to select areas most likely to contain sites that are of lower significance as potential locations for future developments.

After developing the concept, Lynne Sebastian created a conceptual significance model using site, survey, and geoarchaeological information for the Utah Test and Training Range (UTTR). The authors note that the model is a conceptual example only and that to create a working significance model would require consultation with UTTR cultural resource staff, the SHPO, culturally affiliated Tribes, and regional professional archaeologists. The authors describe UTTR as having ideal physical characteristics for a significance model: 1) good surface visibility; 2) widely distributed archaeological survey coverage; and 3) substantial numbers (n=455) of recorded archaeological sites. Additionally, the UTTR participates in the Intermountain Antiquities Computer System (IMACS) which catalogues dozens of site variables in a database, ensuring parity in data among the sites.

As part of the conceptual significance model, Sebastian outlined the steps of creating the model along with example site attributes for the UTTR. Sites were organized into five categories which primarily focused on data potential. The five categories were: Category 1) sites with potential to yield information for current research questions; Category 2) sites with limited data potential; Category 3) sites whose data potential was exhausted through survey recordation; Category 4) sites which may have substantial data potential in the future; and Category 5) sites with high traditional cultural values. Sebastian then created three sorting modules to sort sites using regional attributes into the five categories. Sebastian stresses that the purpose of significance modeling is not to create permanent classifications for sites and that the models should be routinely updated and re-evaluated to be used in land management decisions.

Significance Modeling as Applied in this Research

Significance modeling shows high potential in sorting and mapping relative significance of large quantities of sites on military installations in the United States (Cushman and Sebastian 2008; Doelle et al 2016). These studies assigned the information potential of sites on a scale from low to high based on specific characteristics for each region (Doelle et al 2016). In these prior applications, there is a single land managing agency: the US military branch that manages the property. One of the primary differences in my research is that I applied significance modeling in a region with multiple types of landowners and predominantly privately owned land (Figure 2). Furthermore, while publications on significance modeling often discuss the problems with Criterion D assessments, they also focus heavily on categorizing the information potential of sites.

For my research and application of significance modeling, I chose to broaden the category assignments to better reflect the potential of all four NRHP criteria.

Lithic Analysis

As stated in the introductory chapter, my thesis research is limited to precontact sites in the Tualatin River Basin. Most of the sites in this study consist of almost exclusively lithic reduction materials. Lithics are often analyzed using a variety of characteristics: raw material type; reduction method; tool form and typology; size and amount of cortex of debitage. An analysis of lithic materials can shed light on potential significance attributes such as time depth, intra and inter-regional trade, site function, economies, and regional subsistence activities (Andrefsky 2005; Odell 2004; Shott 1994).

Chapter 3: Research Design and Methods

The primary question driving my research is "how do individual archaeological sites within the Tualatin River Basin relate to the broader archaeological and cultural heritage of that region and what values or characteristics are essential for a site to meaningfully contribute to that heritage?" To answer this research question, I chose to employ the significance modeling toolset. By using significance modeling to answer this question in the Tualatin River Basin region, it will serve as an example of how it could be used by CRM archaeologists in other regions and cultural contexts. My research project consists of three stages: 1) data synthesis; 2) development of the model; and 3) application of the model.

Preparing the Data

The first step of synthesizing the available archaeological data was to prepare the data so it could be analyzed and compared in ArcGIS Pro and Microsoft Excel. First, I set up a geodatabase in ArcGIS Pro and created a polygon layer to represent the boundary of my research area. To do this, I downloaded the Tualatin watershed boundary from the Oregon Spatial Data Library and then extended that polygon to the south and southwest along the South Yamhill River, matching the boundary shown in the Dayton Treaty (Figure 1 andFigure 3) and the written descriptions of Tualatin Kalapuyan territory (Zenk 1994). As I added layers to the ArcGIS Pro project, I clipped the extent of all layers to only display data that lies within the project boundary polygon.

I connected to the Oregon Archaeological Records Remote Access (OARRA) ArcGIS Server and imported the site point, site polygon, and survey polygon datasets into

ArcGIS Pro. I then selected only precontact and multicomponent sites (leaving purely historic sites not selected) for both site point and site polygon layers and created two new layers: Site Points and Site Polygons using the "Make Layer From Selected Features" tool in ArcGIS Pro. The resulting layers are one layer of 107 precontact site polygons within the project boundary and one layer of 96 precontact site points within the project boundary. I then used the "Create Random Points" tool in ArcGIS Pro to create a feature layer containing 219 randomly dispersed points throughout my project area. I chose to use 219 random points to ensure there were at least as many random points as site points (O'Rourke 2005). I used these randomly generated points to represent the background environmental values of the project area.

I used ArcGIS Pro to import, manipulate, and add elevation, slope, distance to water, and historic vegetation data (Figure 7-10) to the archaeological site locations and randomly generated point locations (Table 3). The elevation, slope, and distance to water attributes are based on current geomorphological data (Table 4). The Historic vegetation is sourced from GLO survey data between 1851 and 1910. The vegetation classifications present in this research area are: (1) Woodland, (2) Upland Forest, (3) Prairie, (4) Riparian & Wetland, (5) Savanna, (6) Emergent Wetland, (7) Shrubland, and (8) Water. These data are the closest approximation of pre-European American contact vegetation that is available for this region (Table 4). The dataset covers a majority of my research area but has gaps along the southwest edge of the boundary as visible in Figure 10. The area not covered by these data includes 6 archaeological site points and 7 randomly generated points. Because the total number of points affected is relatively low and approximately equal between site points and random points, I do not believe the overall integrity of the historic vegetation analysis was affected by this deficiency.

Table 3: Summary of ArcGIS dataset manipulations.

Dataset	ArcGIS Pro tools used	Manipulations done
National Hydrology Database: Flowline	1. Clip 2. Select 3. Make Layer From Selected Features	1. Clipped features with 1,000-meter buffer outside project area 2. Selected "StreamRiver" features 3. Created layer containing only Stream and River classes
National Hydrology Database: Waterbody	1. Clip	1. Clipped features with 1,000-meter buffer outside project area
Digital Elevation Model	1. Extract by Mask 2. Extract Values to Points 3. Sample 4. Slope	1. Clipped DEM to Project Boundary 2. Added elevation data to attribute tables of Site Points and Random Points 3. Sampled elevation raster within each polygon of Site Polygons layer using bilinear resampling (Figure 6) and added results to the attribute table. 4. Created Slope layer and repeated steps 1-4 above to add Slope data to Site Polygons, Site Points, and Random Points.
Site Polygons **Site Points** **Random Points**	1. Feature to Point 2. Merge	1. Used on Site Polygons only to create point feature class from centroids of each polygon resulting in Site Polygons Point layer 2. Added attribute column titled SiteValue and assigned points from Site Polygon Points and Site Points a value of 1 and Random Points a value of 0

		3. Merged Site Polygon Points, Site Points, and Random Points into new All Points layer.
GLO Historic Vegetation	1. Clip 2. Spatial Join	1. Clipped layer to Project Boundary 2. Added vegetation class information to All Points Layer

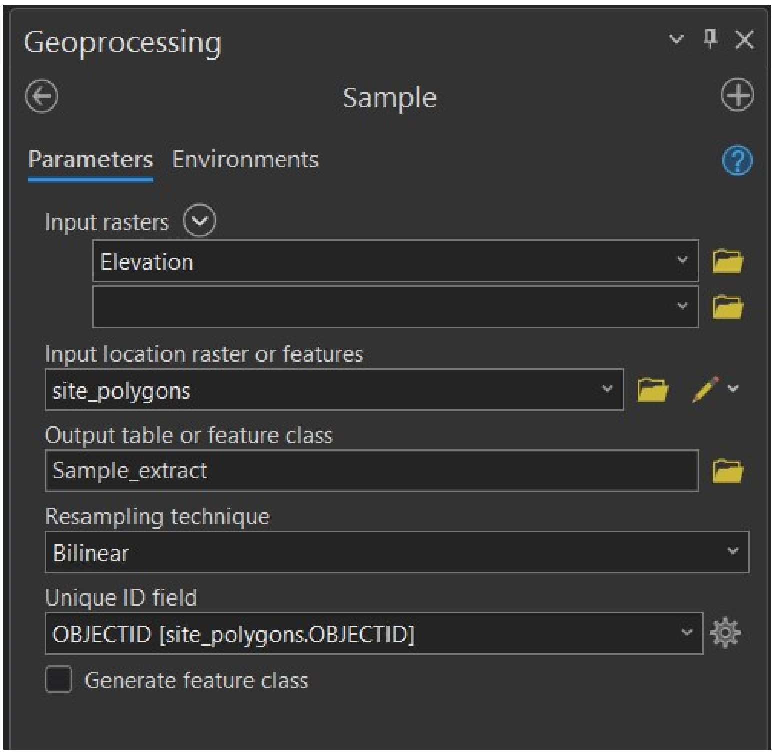


Figure 6: Sample tool parameters for elevation.

Finally, I georeferenced a currently unpublished map created by Tom Connolly in 2023 in which he re-digitized the ethnographically recorded Tualatin village site locations (Figure 5). I georeferenced the map using 4 distinct river intersections as control points in ArcGIS Pro. I then created a polygon layer consisting of 16 circle polygons matching the village locations on the original map. I made the circle polygons 2 km in diameter to match the size of the village location circles in the georeferenced map. I cross-referenced this polygon layer to Henry Zenk's 1994 Tualatin Kalapuyan village list to add village names (Figure 5). Lastly, I used the Spatial Join tool to calculate the distance from each recorded site point to the nearest village location and appended the name to the site data.

Seven sites were noted as Village site types in the Oregon SHPO database with two additional sites being noted as potentially associated with a village in the site record form. Of those nine sites, six are greater than two km away from the nearest ethnographically recorded village site based on the georeferenced village locations map (Figure 5). This brings into question how village sites are being assessed as such and what type(s) of data are being used in making the designation. I identified an additional 11 sites that fall within one of the ethnographically recorded village locations that are not categorized as the Village site type and do not have an indication in the site record forms that they are potentially village-associated sites. Because these 11 sites fall on the locations of ethnographically recorded villages, I flagged them as potential village sites for significance model categorizations. The result of the data preparation is a single feature layer containing 203 site points representing all recorded precontact archaeological sites within the project area, a second feature layer of the 219 randomly generated points representing the background environmental data, and a third feature layer containing both sets of points. All of these points have elevation, slope, and distance to water environmental data, and all but the 13 points noted above have historic vegetation data. All the site points also have distance to and name of the nearest ethnographically recorded village location. These data were now prepped for running spatial analytics in ArcGIS Pro as well as exporting the attribute table to Excel to add additional site data from archaeological site record forms.

Table 4: Datasets used in environmental modeling.

Dataset Type	Dataset Description	Source
Hydrography	Oregon Hydrography (National Hydrography Dataset) - 2020	US Geological Survey (USGS). Downloaded from: Oregon GeoHub https://geohub.oregon.gov
Elevation	10m resolution Digital Elevation Model	Oregon Department of Forestry. Downloaded from: https://www.oregon.gov/dogami/lidar/
Historic Vegetation	GLO historical vegetation of the Willamette Valley, Oregon, 1851-1910	Oregon Biodiversity Information Center (ORBIC), Portland State University. Downloaded from: Oregon Geohub https://geohub.oregon.gov
Archaeological	Survey and Recorded Sites	Oregon Archaeological Records Remote Access (OARRA)

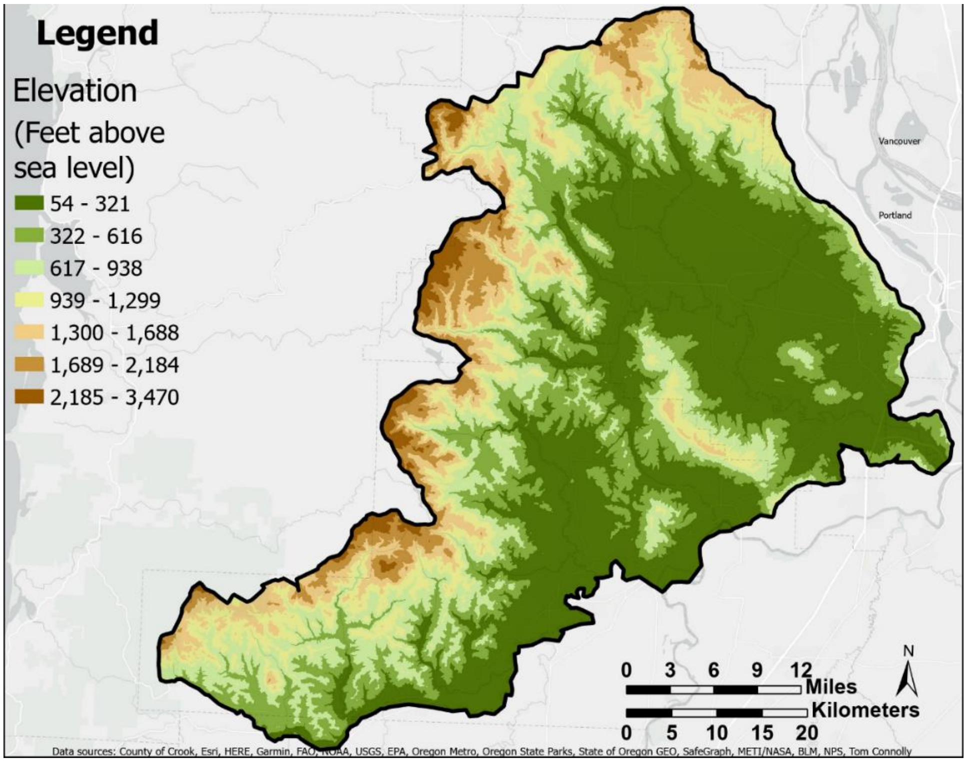


Figure 7: Elevation data clipped to project area.

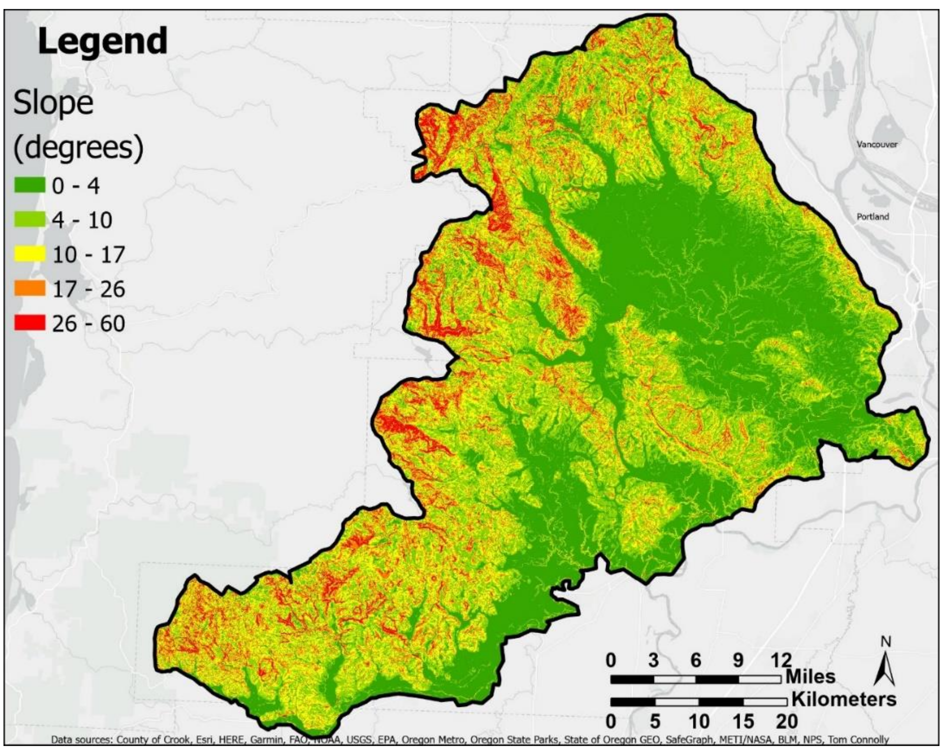


Figure 8: Slope data clipped to project area.

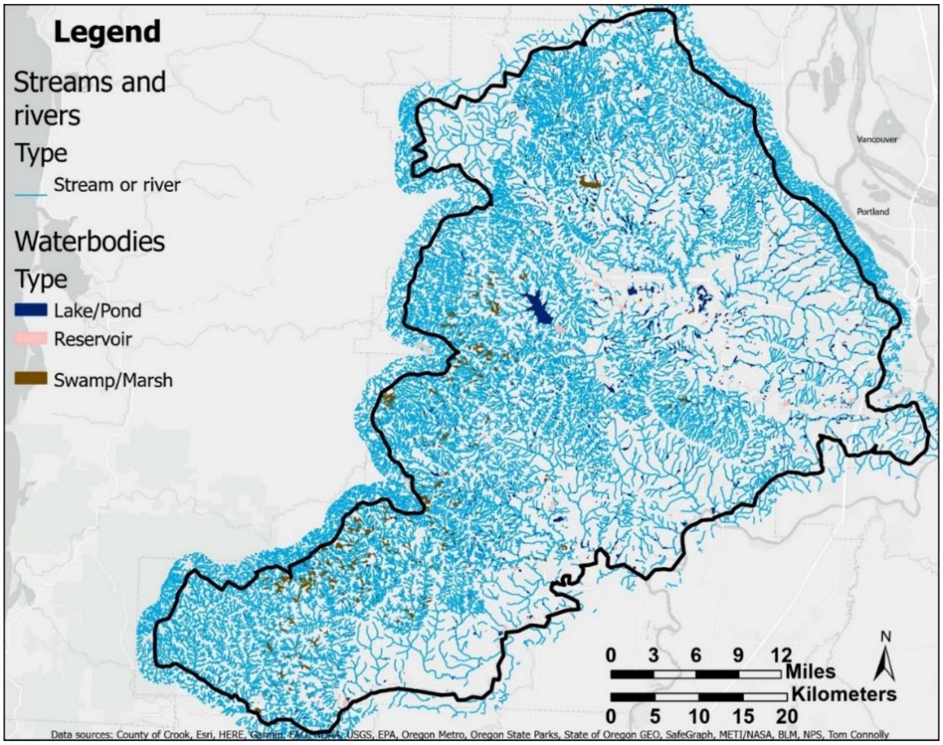


Figure 9: Stream, river, and waterbody data clipped to project area.

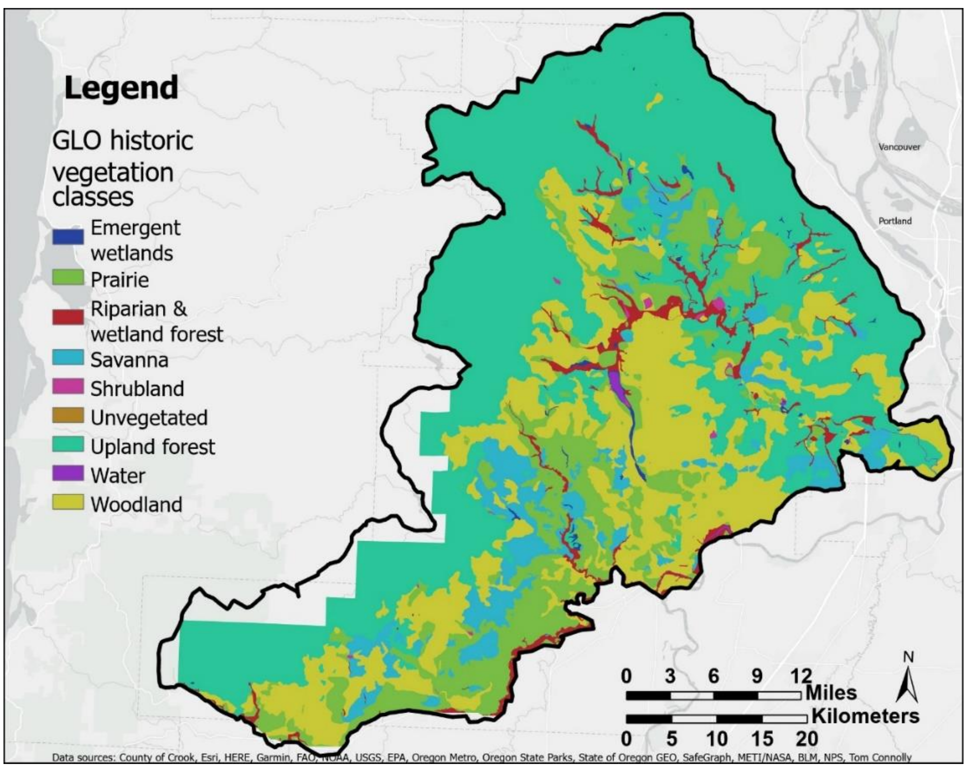


Figure 10: GLO 1850 historic vegetation classes clipped to project area.

Data Synthesis

The next step of my research project was to synthesize the currently available archaeological data for the Tualatin River Basin region. For this step, I exported the attribute table from the All Site Points ArcGIS feature layer into an Excel spreadsheet. The important attributes I imported to the spreadsheet from ArcGIS Pro were: Trinomials, NRHP Eligibility, Biblio_Title, Comments, Site Type, Historic Vegetation Class, Distance to Water, Slope, and Elevation. I also retained all original attributes from the SHPO database, but they were not used in, or useful to, this study. To that data I added information that I gathered from archaeological site record forms and site reports on file with the Oregon SHPO (Table 5).

Data Consistency

One of the most important attributes data must have to be properly synthesized is consistency. If information is recorded in different formats and different levels of detail, it is much more difficult to synthesize into a single database. To synthesize the data, I first had to identify inconsistencies and attempt to standardize the data.

Archaeological isolates do not have trinomial designations and do not have site forms on file in the OARRA database. Due to the practicality of accessing the (often limited) information about these isolates, I only pulled information for the 92 sites that have trinomials and site forms of the 203 total resources in the project area. The remaining 111 resources only have the attributes filled in that were exported from the ArcGIS Pro attribute table and any information present in the OARRA database Comments line.

Archaeological site record forms within the project area range in recording date from 1977-2023. Due to the broad timeframe, the type, detail, and quality of information recorded about sites varies dramatically. Some of the earlier recorded sites in the region (e.g. 35WN 00012) have as little description as, “few flakes, one artifact” (Turner 1980). The result of these data inconsistencies is a bias towards more recently recorded sites having a greater detail of description and increased conformity of information available. When information was unavailable in a site record form, those fields were left blank or labeled Unknown. This step resulted in an Excel spreadsheet file with a line for each recorded site in the region that includes the data pulled from OARRA, environmental variables appended in ArcGIS Pro, and additional data from site forms where available. This step also identified some of the gaps and inconsistencies in reporting that make it more difficult to develop regional context.

Table 5: Attributes added to site data spreadsheet and geodatabase.

Attribute Name	**Description**	**Data type**
Form_dist_wat	Distance to nearest water source in meters as listed on site form	Integer
form_wat_source	Name or type of nearest water source as listed on site form	Descriptive
Form_soils	Soil description from site form	Descriptive
Landform	Landform of site location as listed on site form	Descriptive/Categorical
Subsurface	Was excavation or subsurface testing done?	Yes/No/Unknown
Subsurface Depth	Depth of cultural deposits in centimeters as listed on site form.	Integer range

Excavation	Type and quantity of excavation, if any, listed on site form (e.g. shovel probes n=3)	Categorical/numerical
Site_length	Length of one side of site in meters as listed on site form	Integer
Site_width	Length of one side of site in meters as listed on site form	Integer
Site_area	Area of site in meters as listed on site form	Integer
Lithic_deb	Number of lithic debitage recorded as listed on site form	Integer
Lithic_deb_material	Material types of lithic debitage present as listed on site form.	Categorical
Flaked_Tools	Count of flaked tools as listed on site form	Integer
Lithic_tool_mat	Material types of flaked lithic tools present as listed on site form	Categorical
Lithic_tool_type	Type and quantity of flaked lithic tools present as listed on site form	Categorical/Integer
Obsidian	Presence of obsidian indicated on site form	Yes/No/Unknown
Groundstone	Type and quantity of groundstone artifacts present on site form	Categorical/Integer
FMR	Quantity of FMR indicated on site form	Integer
Faunal	Quantity of faunal remains indicated on site form	Integer
Other_artifacts	Type and number of artifacts not counted in previous categories.	Categorical/integer
Feature_count	Quantity of features indicated on site form	Integer

Feature_type	Type(s) of feature(s) indicated on site form	categorical
Burial	Presence of burials or human remains recorded on site form	Yes/No/Unknown
Village_associated	Association with village site indicated on site form	Yes/No/Unknown
Village_dist_m	Distance to closest ethnographically recorded village site in meters	Integer
Village_nam	Name of closest village site	Descriptive
Name_translation	Translation of village name, if given, by Zenk (1994)	Descriptive
Site_Date	Date range for site and method of dating (e.g. 3270 YBP: radiometric dating)	Descriptive
Other_info	Other information from site form	Descriptive
Collected	Were artifacts collected according to site form	Yes/No/Unknown
Last Site Update	Date of last site update	Date (DD/MM/YYYY)
Site_condition	Site condition of last visit as indicated on site form	Categorical

Univariate and Multivariate Analysis of Environmental Factors

The first step I took in analyzing the known archaeological sites was to perform univariate and multivariate analysis of environmental factors comparing known site locations to randomly generated points that represent the background environmental data. I then used ArcGIS Pro to perform a generalized logistic regression analysis to see if there were environmental factors that occur more commonly in site locations and could act as indicators of site presence. Doing this analysis also provided the opportunity to look at sites located in outlier data of environmental variables to identify potentially significant sites that may be missed by traditional predictive model techniques.

The environmental variables I analyzed were slope, elevation, distance to water, and historic vegetation. For slope, elevation, and distance to water I first did a visual univariate analysis, followed by an analysis of the minimum, maximum, median, and outlier values comparing the site points and random points. For historic vegetation, I did a visual analysis followed by an analysis of counts of vegetation classes present comparing site points and random points. Due to the vegetation data being categorical in nature, assessing minimum, maximum, median, and outlier values was not an appropriate analysis method.

After completing the univariate analysis for each of the environmental factors, I used the Generalized Linear Regression (GLR) tool in ArcGIS Pro to test multiple combinations of variables in their ability to distinguish archaeological site locations from background environmental data. The input feature for the tool was the All Points feature layer and the Dependent Variable was SiteValue which indicates site presence with a 1 and random points with a 0. Because the dependent variable is binary and indicates presence/absence, I ran the GLR as a Binary (Logistic) model type with four different permutations of explanatory variables (Table 6). This methodology allowed me to identify which variables contributed most to the success of the model and which variables had minimal impact on the model's success.

Because the historic vegetation data are categorical in nature, it is not usable in the Generalized Linear Regression tool without first "dummy coding" the vegetation classes into a series of separate binary variables. The results of the univariate analysis on the historic vegetation data (Figure 11) did not show a strong correlation between most of the vegetation classes and site presence except for the Riparian & Wetland Forest class. Riparian & Wetland Forests had more than five times higher representation in recorded site locations than in random points. With those results, I chose to use distance to Riparian & Wetland Forest as an Explanatory Distance Feature in my GLR analysis. The Explanatory Distance Feature in ArcGIS Pro calculates the distance to the nearest feature class chosen and uses that data as part of the GLR analysis.

Table 6: Generalized Linear Regression variable combinations. “X” represents variable used; “O” represents variable not used.

Test Number	Slope	Elevation	Distance to Water	Distance to Riparian & Wetland
1	X	X	X	X
2	X	X	X	O
3	X	X	O	X
4	X	X	O	O

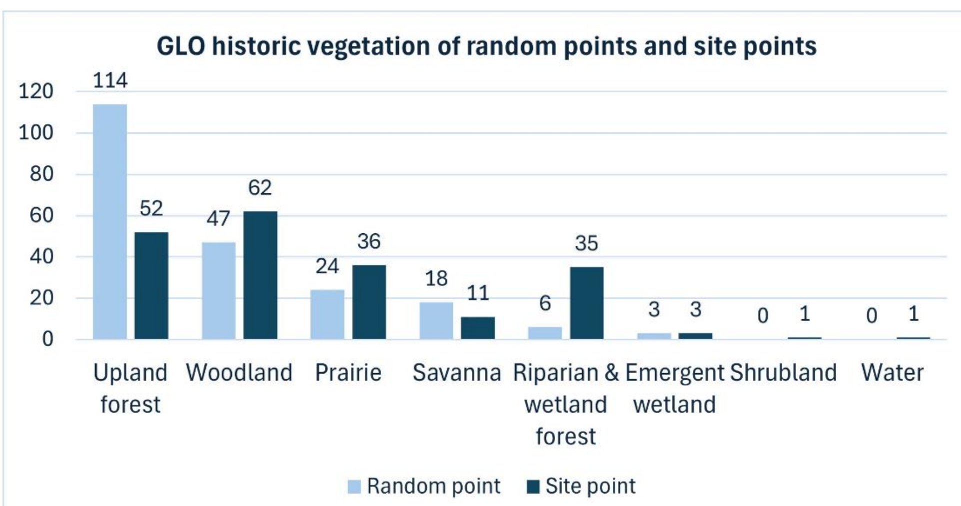


Figure 11: Comparison of distribution of GLO historic vegetation classes of random points and site points.

Relevant Parties Input Meeting

Development of a significance model requires discussions with relevant parties (Cushman and Sebastian 2008). To gather input and hold discussions, I organized a relevant parties input meeting on November 3rd, 2023. The meeting was scheduled remotely via Zoom to ensure as many relevant parties as possible could attend. I invited representatives from Indigenous descendent communities, Oregon SHPO, Land-management agencies, regional professionals, and educational institutions. Table 7 lists the agencies and groups, their representatives, and whether they attended the meeting or not. I used the steps outlined in *Appendix D: Conceptual Significance Model for Utah Test and Training Range* by Cushman and Sebastian (2008) along with other published works on significance modeling (Doelle et al. 2016; McManamon et al. 2016) as references for how to develop a significance model. As discussed in a previous chapter, I used the six types of value of archaeological sites as defined by Lipe (2009) as a framework for discussions of the value of archaeological resources in the relevant parties input meeting.

Table 7: Relevant parties input meeting attendees.

Agency or group	**Relevant Party Association**	**Representative(s)**	**Confirmed**	**Attended**
Confederated Tribes of Grand Ronde (CTGR)	Indigenous community; land-managing agency; regional professionals	Michael Lewis Briece Edwards	Yes No	Yes No
Oregon State Historic Preservation Office (SHPO)	Oregon SHPO	John Pouley	Yes	No

United States Fish & Wildlife (USFWS)	Land-managing agency; regional professionals	Viriginia Parks Patrick Rennaker	Yes Yes	Yes Yes
Historical Research Associates	Regional professionals	Bradley Bowden	Yes	Yes
Willamette Cultural Resources Associates	Regional professionals	David Ellis	Yes	Yes
Portland State University	Educational institution	Douglas Wilson Shelby Anderson	Yes No	Yes No

The purpose of the relevant parties input meeting was to develop a draft list of the component parts of a significance model for the research area. The component parts discussed in the meeting were: (1) Research and Heritage Themes/Questions, (2) Site Types and Variables, (3) Significance Categories, and (4) Modules. Research and Heritage Themes/Questions are broad questions and themes relevant to archaeology in the region; Site Types and Variables refer to defining categories in which to organize sites as well as development of characteristics, or variables, of sites that may contribute to significance; Significance Categories are a short list of broad categories that indicate the contribution to significance of a given site; and Modules are the rules for sorting sites into the significance categories. At the request of representatives of the CTGR, and as Tribal information is sensitive, the CTGR and I scheduled a private meeting to discuss appropriate ways to incorporate views and information from CTGR into the final model.

Model Development

To begin developing the model, I reviewed the results of the relevant parties input meeting and private CTGR meeting and compared the research and heritage themes, site types and variables, and significance categories we developed with the results of my archaeological data synthesis. I also referenced the draft significance model by Cushman and Sebastian (2008) and literature on incorporating Indigenous views into significance evaluations (Sutton et al 2013). I then developed a list of research and heritage themes, site types and variables, and significance categories and used those to create a draft model. To develop the significance categories, I used a modified approach to that of Cushman and Sebastian (2008). In that literature, the authors used categories that primarily relate to the information potential of sites, correlating to application of NRHP Criterion D. Because one of the goals of my research is to broaden archaeological site significance assessments of precontact sites beyond Criterion D, I chose to create modified categories based on the application of NRHP Criteria A through C used by the Burns Paiute Tribe (Solimano et al 2019). The resulting draft significance categories are described in Table 10. I developed a set of two modules (Figure 12 andFigure 13) describing how to sort sites into these significance categories. The categories for sorting sites are non-exclusive; each site may be sorted into one or more categories. These categories represent the potential types of significance each site may have based on current information about the site and its location. This modified approach sacrifices the value-based resolution and sliding scale of information potential that traditional applications of significance modeling have (Cushman and Sebastian 2008; Heilen et al

2018) for a more coarse-grained assessment that evaluates sites under all four NRHP criteria as well as Tribal significance.

To return a level of value-based resolution to the model, I chose to use a sample of 12 attributes to sort sites into the model and assign two different scores for comparison purposes. The first scoring method assumes each site begins at a score of zero and adds one point for each attribute documented in a site record form, ethnographic research, or environmental attributes identified in ArcGIS Pro based on site location. This scoring method represents the typical way sites are evaluated for NRHP eligibility; by observing what was documented as being present in the site, or portion of the site within the APE of a given project and using that documented presence to evaluate the site. The second scoring method begins with the assumption that all sites could contain presence of each attribute and begins with a score of 12. A point is then deducted if there was documentation of a good faith effort to identify each attribute but the attribute was not found at the site. This scoring method represents an alternative approach to significance evaluations in which sites are assumed significant until a good faith effort to document significance contexts of the site has been completed (Pouley et al. 2023).

The 12 sample attributes I selected are based on results of the relevant parties input meeting and Tribal consultation meeting, an analysis I completed of 16 sites within the region or neighboring regions that are eligible, listed, or assumed eligible for the NRHP (Table 8), and my own synthesis and analysis of data from the region. The 12 attributes are explained in Table 9. It is important to note that these are only a sample of potential attributes that could be used to assess significance and that they are mostly data-driven examples correlating to Criterion D of the NRHP. This is because the attributes were sourced from existing nomination forms, all of which were nominated under Criterion D. Different sets and amounts of attributes could be used to evaluate specific types of significance or to evaluate significance at a higher resolution.

Table 8: Sample of sites listed on or eligible for the NRHP within the Tualatin River Basin and nearby regions.

Site	**NRHP nomination reasons**	**Nomination Criteria**
35MA293	Intact deposits High artifact density (1,000-3,000/m^{3}) Hearth/fire feature Presence of obsidian Large artifact type diversity	D
35CL262	High artifact density (>1,000/m^{3}) Depositional integrity Large artifact type diversity Chronologically sensitive tool types Features	D
35CL274	High artifact density (>1,000/m^{3}) At interface of different physical settings	D
35CL75	Intact cultural deposits High artifact density (>1,000/m^{3}) Likely that site extends beyond APE	D
35CL164	Intact cultural deposits High artifact density (>1,000/m^{3})	D
35MU234	Lithic tools associated with plant processing, indicating potential features Site location largely undisturbed	D
35CL293	High artifact density (1,000-3,000/m^{3}) Intact buried deposit Located at interface of different physical settings	D
35CL224	High artifact density (>1,000/m^{3}) Intact buried deposit	D

35CL261	Discrete and intact cultural deposit sediments High artifact density (>10,000/$m^{3)}$	D
35CL165	Intact sediments up to 1 meter below surface High artifact density (1,000-9,000/$m^{3)}$ 2 distinct precontact occupation components	D
35YA23	Chronologically diagnostic artifacts Datable features Large tool diversity Possible status/trade items Intact stratigraphy	D
35LIN554	Intact sediments below plow zone Possible feature (burned lens) below plow zone Raw materials indicate possible trade	D
35CL376	Evidence of multiple occupations Provides information on inter-site relations Obsidian sources indicate trad or travel	D
35WN93* *Site further tested after recommendation and changed to "not eligible" due to low number of artifacts and disturbed sediments	High quantity of obsidian artifacts Indication of manufacture/maintenance of bifaces Potential trade center between Obsidian Cliffs and groups to the north and west	D
35WN43* **35WN44*** *Both sites assumed eligible by USFWS for management purposes	FMR and bisque features Location at interface of wetland and prairie indicates possible food processing sites	A, D

Table 9: 12 sample site significance attributes used in the model development and application.

Attribute	Source	Explanation
associated with events in Tribal histories	relevant parties input meeting	Correlates with Category a in Table 2.

associated with specific Tribal persons in the past	relevant parties input meeting	Correlates with Category b in Table 2.
"high" artifact density	NRHP site analysis	Defined as ≥ 1,000 artifacts per cubic meter.
located at or near the interface of physical environmental settings and contains FMR concentrations, cooking features, or food processing features	NRHP site analysis	Defined for this region as the interface off prairie and wetland ecozones that may indicate tarweed, camas, or wapato cultivation, harvesting, or processing.
has intact sediment deposits with cultural materials	NRHP site analysis	Site has stratigraphic integrity and layers with cultural deposits appear undisturbed by post-depositional processes.
the site, or type of site, is unique for the region	NRHP site analysis	The type of site or recognized attributes of the site are described as or otherwise known to be singularly unique or exceedingly rare for the region.
has a large diversity of tool types	NRHP site analysis	"Large" here defined as ≥ four tool types. This metric is based on my data synthesis and analysis which identified 76% of sites have less than four tool types.
contains chronologically sensitive artifact types	NRHP site analysis	Site contains tools or other artifacts with typologies that have a known chronological data range
contains features	Regional synthesis/analysis	Site contains features of any kind. This metric is based on my data synthesis and analysis which identified that less than 10 percent of sites have features present.
has obsidian present	Regional synthesis/analysis	Attribute selected to represent potentially sourceable and dateable material types.
Potential for multiple occupations	NRHP site analysis	Site potentially occupied successively over time based on descriptions in site record forms

is Tribally significant or assumed Tribally significant	Tribal consultation meeting	Based on discussions with CTGR representatives, all sites are considered Tribally significant.

The draft model was then sent to the attendees of the relevant parties input meeting for review and comments before finalizing the model. I also held a final review meeting with the CTGR to ensure that the model appropriately and accurately incorporated Tribal opinions, views, and priorities. The final step of developing the model was to review the final round of comments and adjust the model as necessary. I then used the model to sort sites into significance categories, assigned the two scores to each site, and assessed data gaps and model performance.

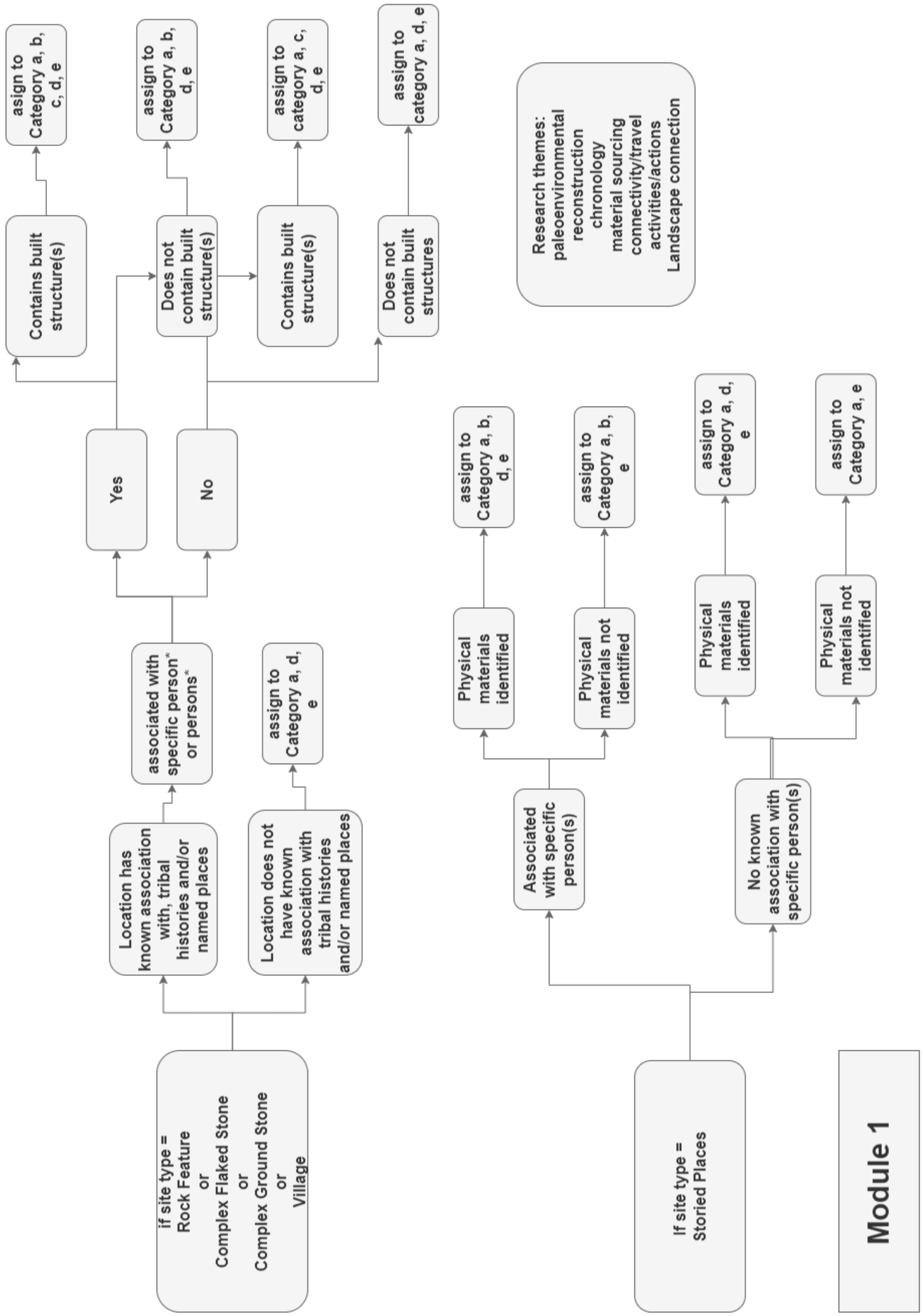


Figure 12: Draft of Module 1.

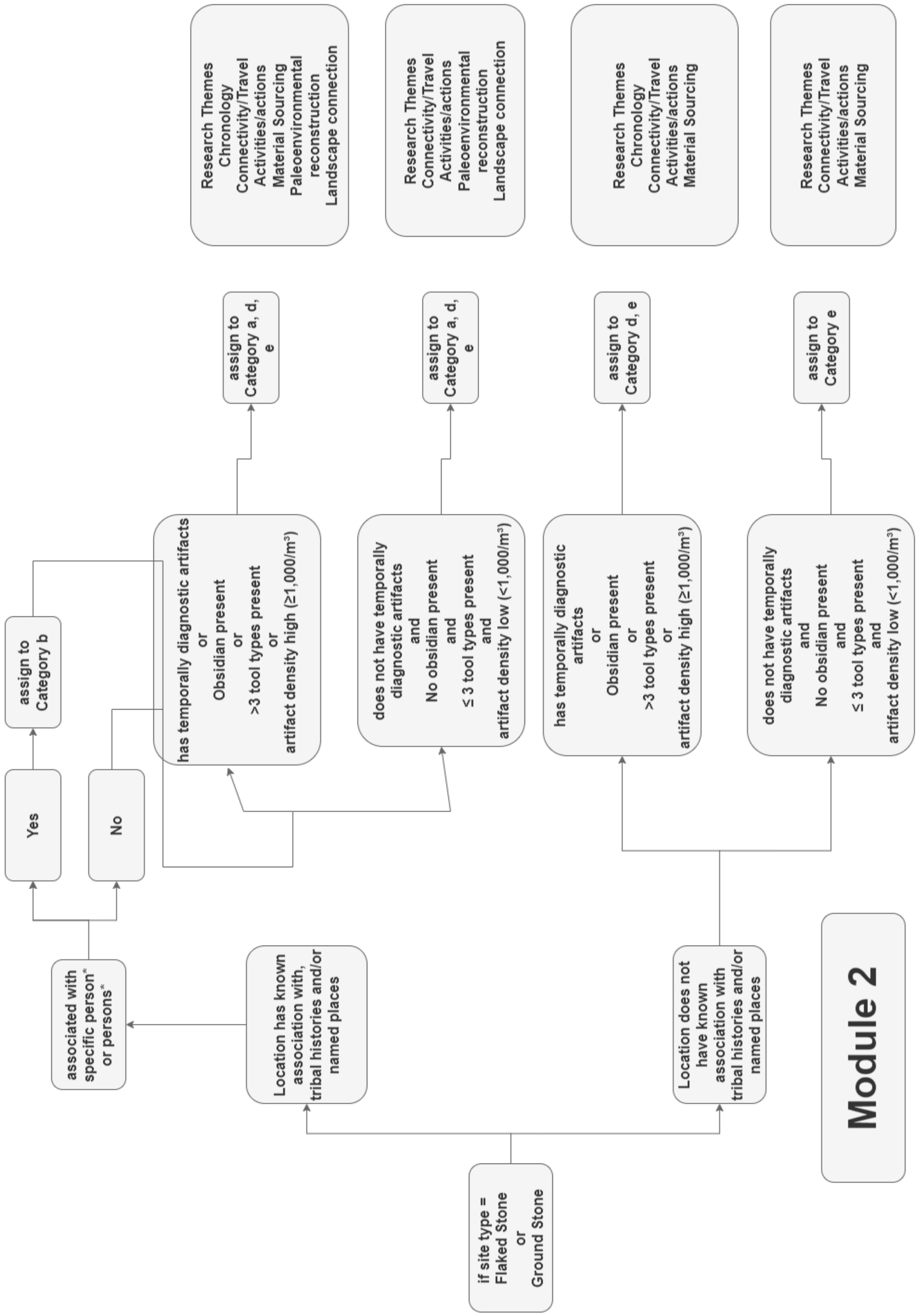


Figure 13: Draft of Module 2.

Application of the Model

After completing the final model, the next step I took was to apply the model to the archaeological sites in the database I compiled. This was done in two stages: Stage 1 was to apply the model to the list of recorded sites used in model development; Stage 2 was to run a test of the model by applying it to recently recorded or updated sites whose data were not included in the initial development of the model. These sites consist of three sites tested during the Willamette Water Supply System Project and one site with new information from recent testing by Portland State University graduate student Nathan Jereb in conjunction with the Confederated Tribes of Grand Ronde.

To apply the model, I first added a new column to the Excel spreadsheet containing all the archaeological sites in my dataset. I labeled this new column "Significance Category." The possible values for the column are alphabetical characters from a to f (Table 10). The categories I developed were based on contributions from the relevant parties input meeting, literature on significance modeling (Cushman and Sebastian 2008; McManamon et al 2016), and literature on Tribal definitions of significance (Solimano et al 2019; Sutton et al 2013). Each site may be assigned to one or more categories based on the individual site attributes. To sort sites into significance categories, I manually inspected the site attributes spreadsheet and assigned categories based on the module rules. Due to the inconsistency of the recorded archaeological data, many sites have unknown or null values for one or more variables used to assess significance categorization. For this reason, the significance category applications should be interpreted as the minimum of categories that a site is likely to apply to based on currently available information. As new information is added or sites are revisited, the categorizations can, and should, be reevaluated.

Table 10: Significance categories and descriptions.

Category	**Description**	**Examples (non-exhaustive list)**
a	Is or may be associated with significant events in broad patterns of history	Social and cultural gathering sites, resource gathering and harvesting places, named places
b	Is or may be associated with significant persons in the past	Association with ancestors and/or ancestral knowledge, or to persons and/or beings from stories and mythos
c	Does or may embody distinctive characteristics of a type, period, or method	Distinct geographic features and visible landmarks, places created and identified (named) in traditional stories.
d	Yields or may yield important information about the past	Data-driven important information or culturally important information
e	Does or may hold high traditional cultural value or significance to descendant communities.	Cultural landscapes, meeting places, named places. Places with identification of Tribal presence on the landscape.
f	Sites currently without enough information to fit into categories a-e	Uninvestigated sites, sites previously excavated/looted or otherwise destroyed

Testing Model Application and Flexibility

To test the validity of the assumptions and underlying data on which the model is based, I tested for gaps in data. To do this, I used the two-score method described in the model development subsection above and further detailed here. I first added the number of significance attributes with documented presence at each site, starting with a score of zero. This resulted in a 'traditional' significance score of documented presence of significance attributes. Because I used a sample of 12 attributes in development of the model, the possible scores range from zero: no sample attributes documented, to 12: all

12 sample attributes documented. I then calculated a second score for each site based on assumed presence of the 12 significance attributes with each site starting with a score of 12. 1 point was deducted if a good faith effort was made to document an investigation into a significance attribute but it was not found to be present. If a site was noted as extending outside the APE or had no subsurface testing without documentation of shallow sediments, the site was given a score of 12 to reflect the unknown extent and contents of the site.

To analyze the broad-scale gaps in data, I subtracted the first score from the second, resulting in a score ranging from zero to 12 documenting the number of unknown attributes for each site. These scores provided indicators as to whether sites are being classified based on complete documentation or on absence of evidence. The closer to '0' the scores are, the more complete the underlying site documentation data are that I used to sort sites into the significance model. The closer to 12 the scores are, the less complete the underlying site documentation is. The expected results are that if the model is reliable the scores will be low overall and if the model is unreliable the scores will be high overall. High amounts of missing attributes affect the reliability of the model and must be addressed in order to trust the results of the significance model.

To test the application of my model, I withheld data from three sites recently tested as part of the Willamette Water Supply System Pipeline (WWSSP). The information from these sites was then used to test how newly added site data would be categorized by the model and to compare the model significance categorizations with the recommendations made in the site record. I also used the data from these sites as a sample to compare the number of missing sample attributes in recently documented sites to the average number of missing sample attributes across the region. These sites provide a better state of archaeological documentation in the present and may be more representative of the types of documentation oversights that still need to be addressed. To test the flexibility of the model, I included existing data from site 35PO95 in model development, but withheld information from a recent site update. I then added the update into the completed model to see if the significance categorizations were changed by the update.

Lithic Analysis Methods

The data added to site 35PO95 from recent excavations consisted of additional lithic debitage and a single lithic tool. Because one of the primary research questions in the recent excavations was to assess the degree and depth of disturbance by agricultural equipment, I used a lithic analysis method that focused on identifying the degree of completeness of lithic debitage as recommended by a CTGR archaeologist. The method I used was Andrefsky's adapted version of Sullivan and Rozen's 1985 Free Standing Typology system (Sullivan and Rosen 1985; Andrefsky 2005). I used this method because the lithics were primarily debitage and it could provide information to indicate whether flakes within the plow zone were subject to more breakage than those below the plow zone. Additionally, Sulivan and Rosen's Free Standing Typology was one of several lithic analysis methods used by HRA on the three WWSSP sites (Dinwiddie et al 2020). In addition to the Sullivan and Rozen classification system, I documented material type, depth, presence/absence of cortex, number, and size of flakes. For size, I used a 3-

category size range: Small <1cm, Medium ≥1cm<3cm, Large ≥3cm measured using a concentric-ring template that was consistent with methods used by HRA on the three WWSSP sites that were also withheld from the model during development (Dinwiddie et al 2020). I then added the new lithic data for site 35PO95 to the site attribute spreadsheet and reassessed the site with the model to see if the significance categories were changed by the new data.

Willamette Water Supply System Sites

I reserved the data from the three WWSSP sites described in Chapter 2 during development of the model. This provided additional data to feed into the model to test application of the model to sites not used in its development. Because I took part in excavations of two of the three WWSSP sites, I am familiar with the excavation and documentation methods used. The techniques used to analyze the lithic debitage by HRA are similar to the techniques I used in my analysis of debitage from 35PO95, which ensures that the new data going into the model is of comparable quality and level of detail. The application of these three sites into the model and missing sample attribute analysis of these sites serve to test the completeness of newly recorded archaeological data and identify potential areas in which increased documentation is needed. These data also serve to test how the model accepts new information.

Chapter 4: Results

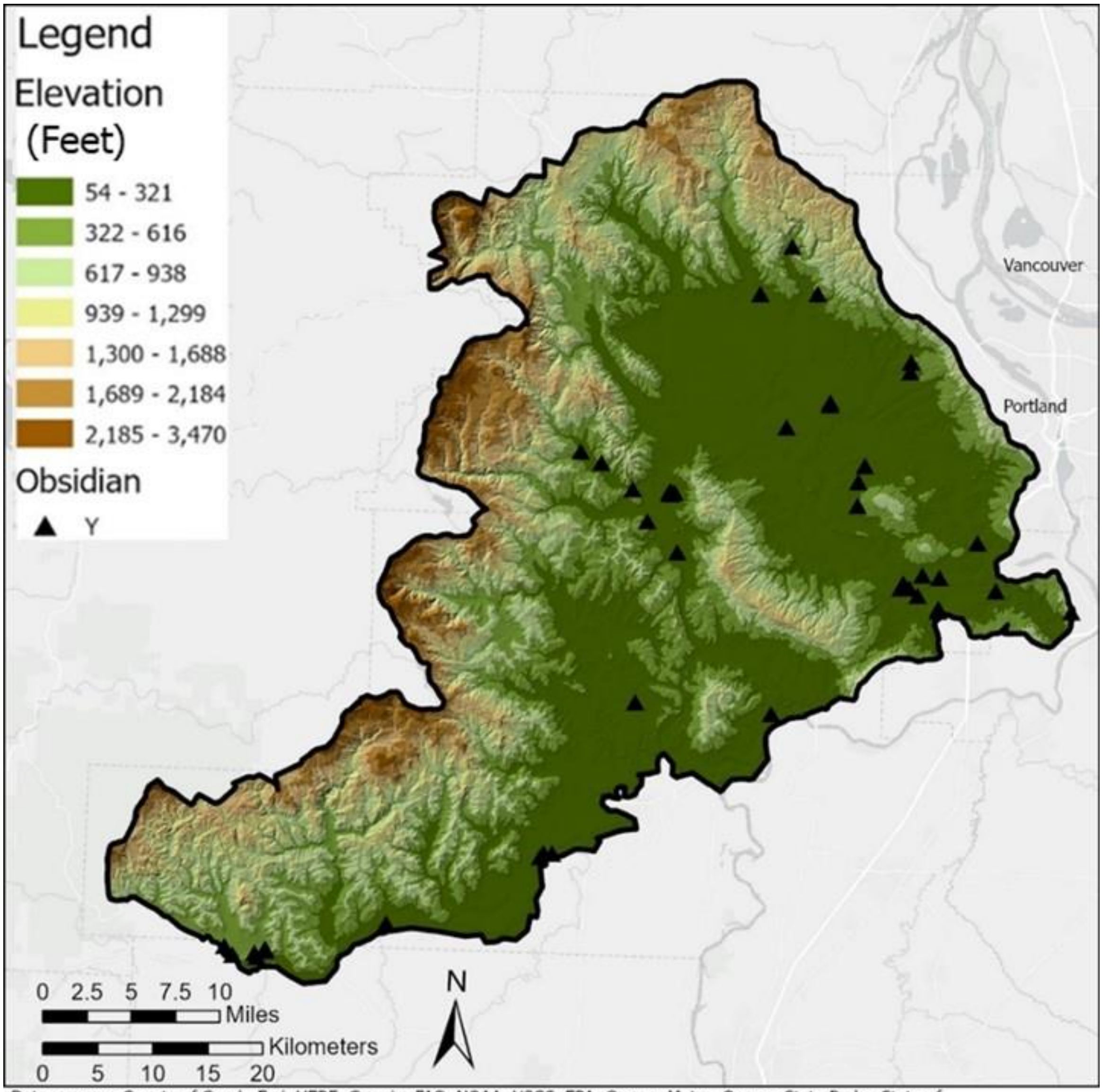
In this chapter, I discuss the results of each component of this project: 1) Data synthesis and creation of a geodatabase; 2) environmental variables analysis results; 3) relevant parties input meeting results; and 4) significance model results including an analysis of data gaps.

Data Synthesis and Geodatabase Results

The result of my synthesis of archaeological data for the region is the creation of a geodatabase that links the attributes in Table 5 to site locations. To do that, I catalogued 27 attributes pulled from SHPO site records for the 203 sites and isolates into an Excel spreadsheet. Where no data were available for a given attribute, that attribute was left blank. I imported the Excel spreadsheet into ArcGIS Pro and joined it to the site location data resulting in a geodatabase containing the 203 resource locations with the attributes as described in Table 5. The ArcGIS Pro geodatabase can be used to easily visualize spatial distribution across the Tualatin River basin of any of the site attributes I added. Figure 14 below is an example of how the geodatabase can be used to show spatial distribution of specific attributes, in this case only sites with presence of obsidian are shown on the map. A visual analysis of Figure 14 shows similar overall site distribution to that shown in Figure 4 with clustering around Wapato Lake and clusters of sites in the eastern part of the region. This indicates that based on current data there does not appear to be a difference in spatial distribution of sites with obsidian compared to the overall site distribution. However, it is important to note that any spatial correlations or clustering may be due to the low percentage and unequal distribution of surveyed area (Figure 4).

Figure 15 displays only lithic sites that have been dated through typology, obsidian hydration, or radiometric dating. There are only 12 lithic sites in the region with date ranges in the site record forms and no sites around Wapato Lake have been dated. Further, there is only a single site with an absolute date. The lack of relative or chronometric dating of sites is a major roadblock in establishing a chronology for the region.

As stated above and shown in Figure 14 andFigure 15, the ArcGIS Pro geodatabase I created from synthesizing data of lithic sites can be used to visually display and compare any of the attributes recorded. This is useful in understanding spatial distribution as well as in identifying potential gaps in attribute documentation.



Data sources: County of Crook, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, Oregon Metro, Oregon State Parks, State of Oregon GEO, SafeGraph, METI/NASA, BLM, NPS, Tom Connolly

Figure 14: Distribution of sites with documented presence of obsidian shown over elevation hillshade map.

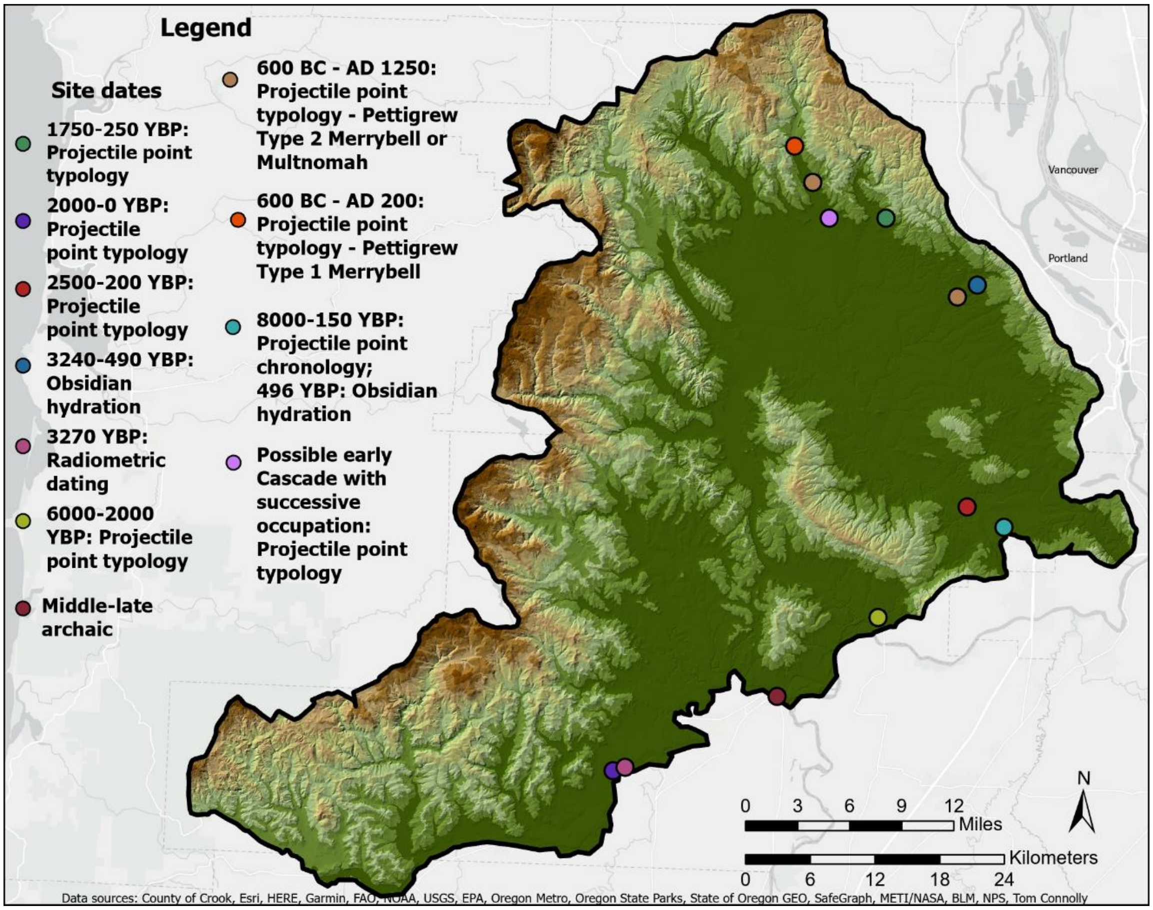


Figure 15: Spatial distribution of dated lithic sites with method of dating shown over elevation hillshade.

The most common site types recorded on the archaeological site record forms were Isolate and Lithic Scatter (Figure 16). Isolates are often assumed unimportant due to the low quantities of artifacts found (defined as less than ten). In this region, 42 of the 49 'not eligible' resources are isolates. The perceived lack of importance in isolated finds can lead to archaeological resources not being properly assessed and important information and context potentially missed (Morton 2015). These and other "small sites" can contain valuable and significant information, especially when looked at on a regional scale (Glassow 1985). Similarly, lithic scatters as a site type are often not fully investigated and are discounted as unimportant because of the perceived ubiquity of such sites (Cain 2015; Glassow 1985). Neither of these two site types describe the function or cultural context of the archaeological materials and both serve as convenient lump categories for sites with perceived lack of importance. When small or common site types are not adequately documented and investigated, it can have a negative impact on the overall quality and consistency of the data used to establish regional context.

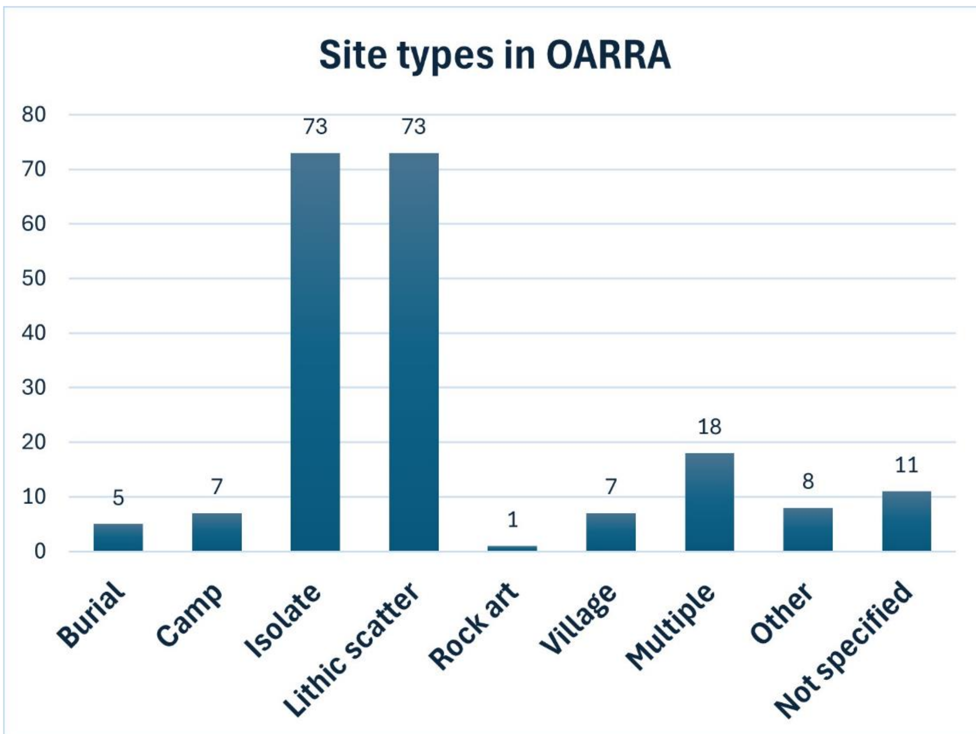


Figure 16: Site types as listed in SHPO OARRA database.

Univariate Environmental Analysis Results

Univariate analysis of environmental variables against site location showed mixed results. Of the 3 variables analyzed (Slope, Distance to Water, and Elevation), slope and elevation had the most promising results (Figure 17). I evaluated the univariate analysis results by comparing the mean and median values for each variable in recorded site locations with the randomly generated points. All three variables had lower median values and greater clustering around the median value in site locations compared to random point locations. Sites tended to be on less sloped areas (median value of 2 degrees), be at lower elevations (median value of 187.87 feet above sea level), and slightly closer to water (median value of 57.81 meters to water). However as noted previously when discussing spatial distribution, these apparent trends in site location may be skewed by the lack of comprehensive survey coverage. As stated in Chapter 2, only 10% of the total project area has been surveyed, and most of the larger surveyed areas are at lower elevations in or near developed areas on the valley floor (Figure 4). Additional survey coverage across the project area could help verify or refute these apparent trends in the data.

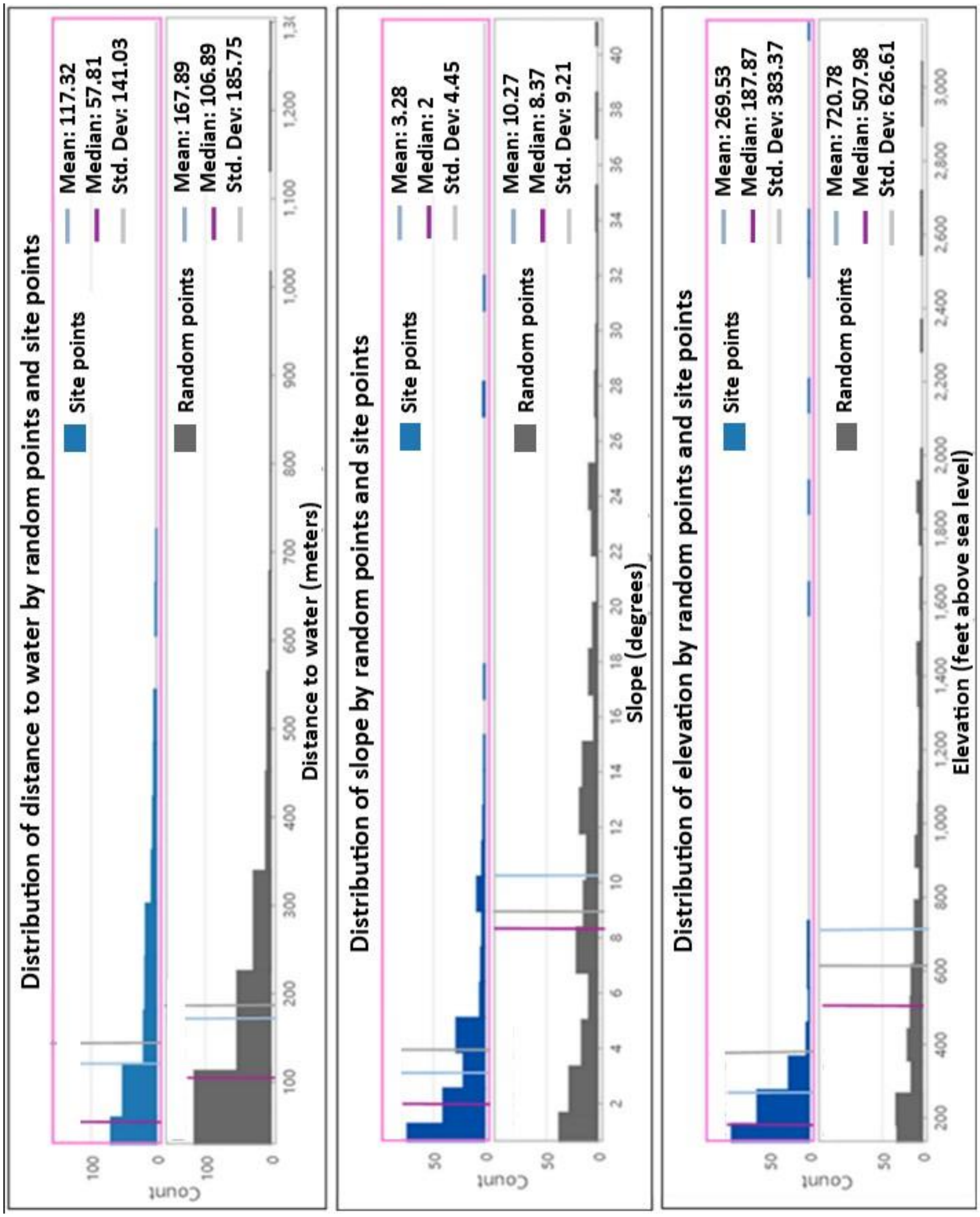


Figure 17: Comparison of distribution of distance to water, slope, and elevation variables of site points and random points.

Multivariate Environmental Analysis Results

For the multivariate environmental analysis, I used ArcGIS Pro to do a Generalized Linear Regression (GLR) using distance to water, elevation, and slope as variables. I used GLR results to identify commonly occurring environmental variables of sites, which this model has succeeded in doing given the currently available information. The results of this model should not, however, be used as a means of predicting site locations as it demonstrably misidentified two unique sites with uncommon environmental attributes that are clearly significant. The GLR results show promise in identifying the most common environmental factors tied to site location, but due to the poor survey coverage a greater range of data on site locations is needed to create a working predictive model.

This resulted in correctly identifying 83% of the recorded site locations (Figure 18). Based on the distribution of explanatory variables (Figure 19), elevation and slope contributed much more than distance to water in the success rate of the GLR model, which makes them greater indicators of site location.

My GLR analysis resulted in the misidentification of two unique sites in the outlier data for elevation and slope. Site 35YA06 is the highest elevation site at 3,226 ft. This site is a prayer seat consisting of stacked rocks located on Trask Mt and is the only prayer seat site recorded in the region. Site 35WN05 is the steepest slope site at 29 degrees aspect. This site is a petroglyph located within the range of two ethnographically recorded villages: Chawayed and Chapokele. Both sites are unique in composition and location and were not correctly identified as sites by the GLR model as they were in outlier data for the two highest contributing explanatory variables. These results point out a flaw in using GLR for predictive modeling in that analyzing site locations using the most commonly occurring environmental factors is only useful in identifying sites in typical locations while missing sites in outlier locations. These results also indicate that known site locations found in outlier environmental zones have potential to be unique and significant sites in part because they are outside the typical site locations.

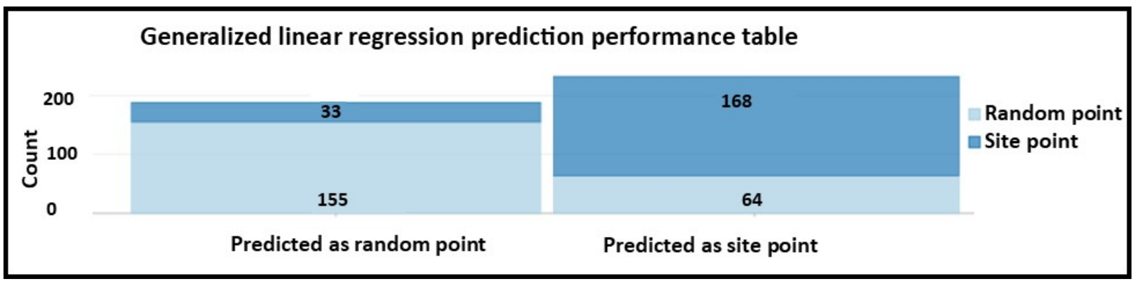


Figure 18: Generalized linear regression results using distance to water, elevation, and slope variables.

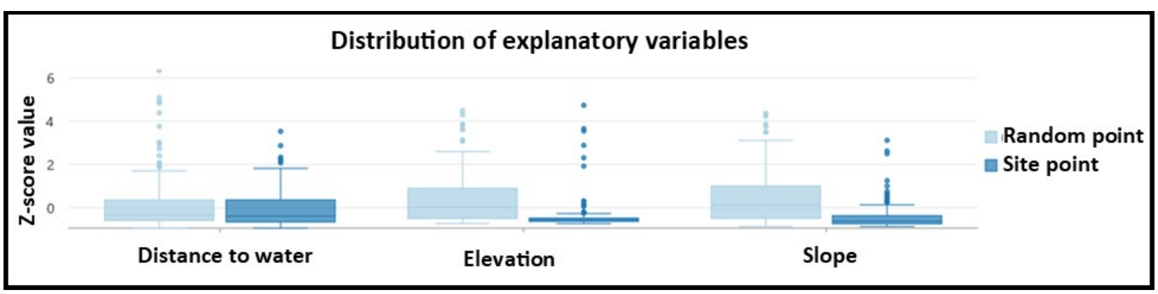


Figure 19: Generalized linear regression distribution of explanatory variables results.

Relevant Parties Input *Meeting Results*

The relevant parties input meeting resulted in a preliminary list of research themes, site types, and site variables developed by the participants in the meeting. I then compared these preliminary lists to existing significance models (Cushman and Sebastian

2008) and to my data synthesis results and initial predictive modelling to develop the final lists.

The research themes identified for this region are: (1) paleoenvironmental reconstruction. (2) chronology, (3) connectivity, trade, and travel, (4) activities and actions of the past, (5) material sourcing, and (6) landscape connections (Table 11). However, comments from the CTGR representatives pointed out that these research themes remain rooted in a data-centric archaeological approach. These research themes are useful as a representation of the type of research themes typically included in archaeological reports and site investigations but should not be considered an exhaustive list of themes for the region.

Table 11: Six research themes of Tualatin River Basin.

Research Theme	Explanation	Site Attributes
Paleoenvironmental Reconstruction	Sites that may contain evidence of past environmental conditions	Hearth features, buried surfaces, botanical remains, places described in oral histories
Chronology	Sites that may contain evidence of temporal association (relative or absolute)	Known point typologies, hearth features, in-situ charcoal, obsidian artifacts, places described in oral histories
Connectivity, trade, and travel	Sites that inform on aspects of trade and travel routes	Evidence of non-local materials or techniques, sites connected through geography or oral histories
Activities and actions of the past	Sites that inform on past human activities on the landscape	Lithic debitage, tools, hearth and cooking features, ethnobotanical remains, evidence of humans interacting with the landscape.

Material Sourcing	Sites that inform on local and extra-local sources of raw lithic materials	Obsidian artifacts, quarry sites, material sources described in oral histories
Landscape connection	Sites that inform on human-environment and human-landscape relationships	Landscape features in or near sites, sites with outlier elevation and/or slope values, places described in oral histories

The eight site types developed after the relevant parties input meeting are shown in Table 12. Site types 1 through 4 were taken from Cushman and Sebastian's draft significance model explanation (2008). Cushman and Sebastian used the terms "Simple Flaked Stone Assemblage" and "Simple Ground Stone Assemblage" which I have modified to "Flaked Stone" and "Ground Stone" to avoid using the potentially evaluative word "simple" in the site type designation. Types 5 through 9 were developed from the results of the relevant parties input meeting, discussion with CTGR archaeologists, and my own data synthesis results. No sites were sorted into the site type Storied Places. This is a currently unused placeholder site type for places identified by CTGR Tribal representatives. Eighteen sites had no information available and were designated as Unknown site type and excluded from sorting into significance categories.

Seven sites were categorized under the Other category. This label was only used when the sites could not be placed into one of the more descriptive categories. SHPO comments that describe these seven sites are in Table 13 below. Two of the sites were reassigned from Lithic Scatter to Other due to there being no description of the site contents; two sites were reclassified from Isolate to Other; and three sites were originally designated as Other and retained that label.

Table 12: Precontact site types of Tualatin River Basin.

Site Type	Explanation	Number of sites
(1) Flaked Stone	Site contains flaked stone debitage and tools only, no features	*n*=120
(2) Ground Stone	Site contains at least one ground stone artifact, may also contain flaked stone. No features.	*n*=13
(3) Complex Flaked Stone	Site contains flaked stone with processing, cooking, habitation, or storage features.	*n*=7
(4) Complex Ground Stone	Site contains flaked and ground stone with processing, cooking, habitation, or storage features.	*n*=2
(5) Rock Features	Site contains non-habitation rock features such as petroglyphs, stacked rocks, or prayer seats	*n*=5
(6) Village or Village Associated	Sites associated with villages through oral histories, stories, or digitized ethnographically recorded locations of village sites.	*n*=23
(7) Storied Places	Places associated with oral histories, stories, or mythos. May or may not contain extant or tangible materials.	*n*=unknown
(8) Burials	Locations or reported locations of human burials.	*n*=7
(9) Other	Sites that do not fit in the above categories.	*n*=7

Table 13: ”Other” site type descriptions.

SHPO Site Type	Reassigned Site Type	SHPO Comments
OTHER	Other	Reported Indian Battlefield site circa 1850-60s
OTHER	Other	Blazed oak tree
OTHER	Other	Location of Fuller Mound by Doris (Fuller) Lien who grew up on property
LITHIC SCATTER	Other	CHACHIP, Horse Oak Site; the temporary number on the original SHPO map no longer applies

LITHIC SCATTER	Other	Site reported 1984 correspondence file: now gone, later investigated and found no surface evidence SHPO report 17599
ISOLATE	Other	FMR fragment
ISOLATE	Other	FMR/Cobble/insulator/milk glass

After sending the draft model to the attendees of the relevant parties input meeting, only the CTGR representative and one other attendee responded with comments and feedback. The feedback identified that the model and model components expand somewhat on but are still rooted in an "archaeo-centric" methodology and framework. Further identified is the need for greater use of oral histories and ethnographic histories in a way that works in tandem with, rather than as an addendum to, the archaeological data and context. The CTGR feedback identified the assumed significance score and data gap analysis results as the most interesting and useful parts of the model.

Based on the results of the significance model below and the feedback received on the draft model, I chose not to revise the model and instead discuss the results of the model in the context of the feedback received.

Significance Model

The results of the significance model were underwhelming. The model proved an easy method to quickly assign potential significance categories (Figure 20), but the accuracy of those assignments was hindered by the limitations of the source data and the assumptions on which the model is based. As visible in Figure 20 below, over half of the sites were classified into only categories d or e, indicating data potential and Tribal significance. The model assigned 23 sites the potential for category a in addition to d and e indicating potential to link those sites to events in Tribal history. While a greater inclusion of category a is a step in the right direction, the model results still have a strong bias toward data potential of sites.

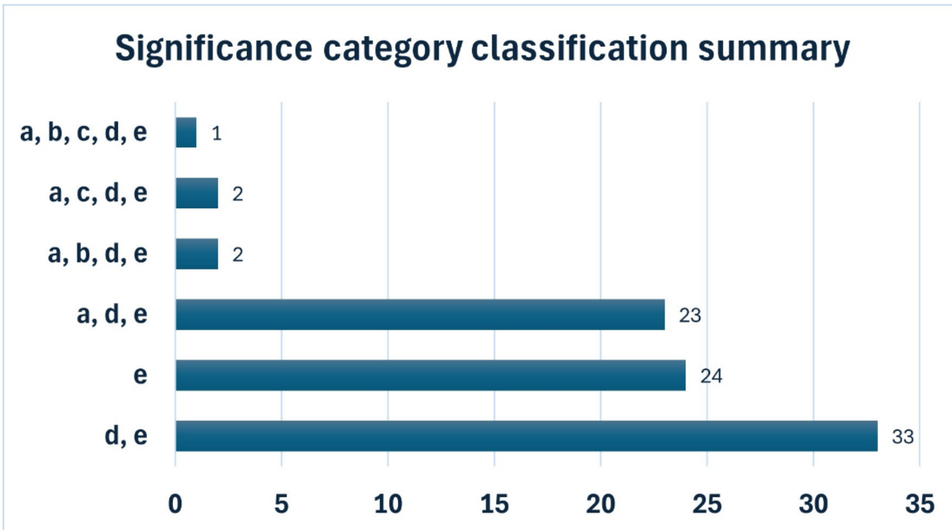


Figure 20: Significance model final category classification counts.

The first scoring method, representative of a standard documented presence approach, resulted in scores ranging from 1 to 7 out of 12. As visible in Figure 21 below, most of the sites in the region scored between one and three attributes present with an average score of 2.5. This result could indicate one of two things: 1) most sites in the region do not have more than three of the 12 sample attributes present; or 2) most of the sites in the region do not have adequate documentation of the sample attributes.

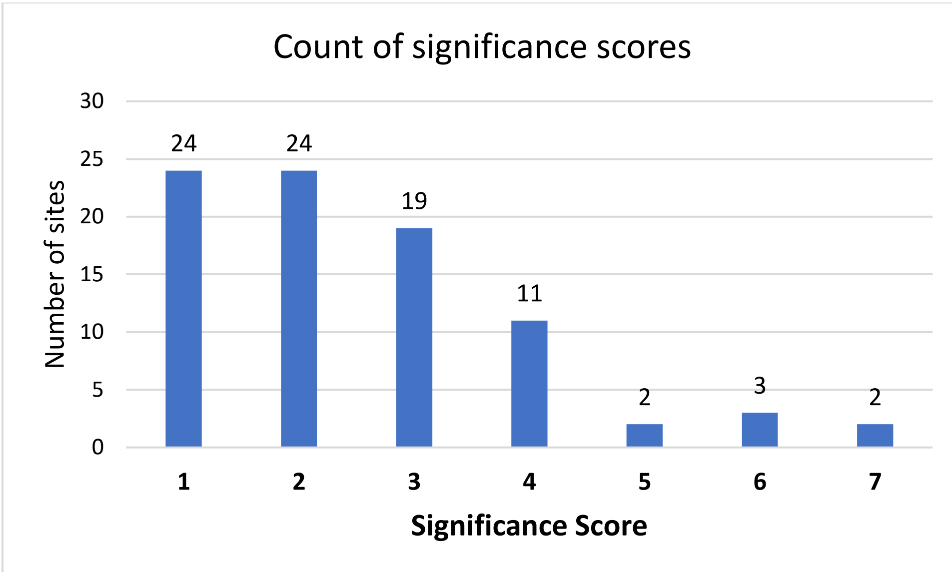


Figure 21: Results of standard significance scoring.

The second scoring method, which assumes presence of significance attributes, resulted in scores ranging from 4 to 12 out of 12. As visible in Figure 22 below, most of the sites in the region scored 12 out of 12 using the assumed scoring method with an average score of 9.6. Like the first scoring method, this result could indicate one of two things: 1) most sites in the region have all 12 sample attributes present; or 2) most of the sites in the region do not have adequate documentation of the sample attributes. Of note and as described in the methodology for the assumed score is that if a site boundary was not fully delineated or the site was not subsurface sampled, it was assigned a score of 12 to represent those unknowns.

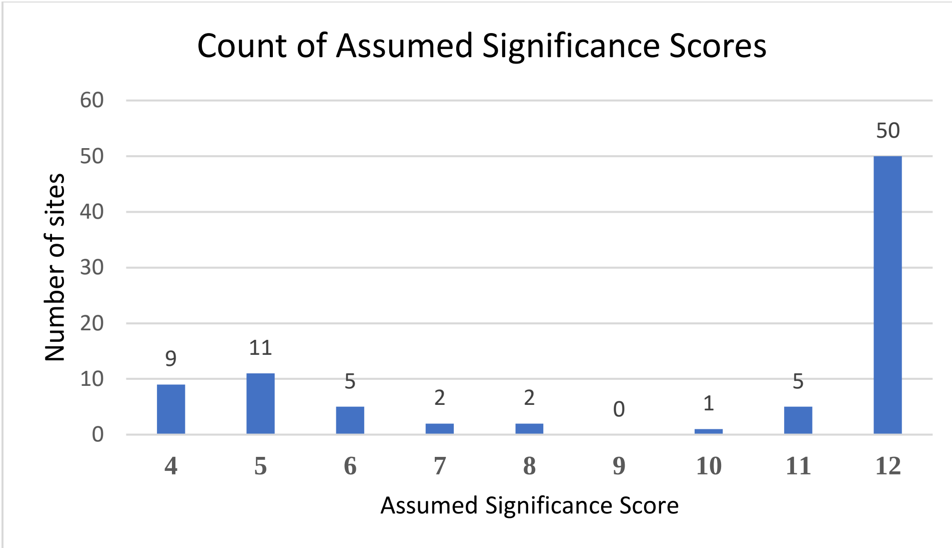


Figure 22: Results of assumed significance scoring.

The results of the two scoring methods are incongruous. These results indicate that rather than the scores reliably indicating the number of sample attributes present, they instead are indicators of a lack of documentation of the sample attributes.

Data Gaps

As discussed in the methods chapter, I identified gaps in data by subtracting the first significance score from the second significance score for each site. This resulted in a "data gap" score for each site indicating how many of the 12 sample attributes were not documented in the site record form or identifiable in the ethnographic record or environmental data used in building the model. The possible ranges for the score are 0 to 11. Because every site was assigned at least one point for being Tribally significant, no sites had all 12 attributes missing. As visible in Figure 23 below, gaps in data range from 1 to 11 and over half of the sites have gaps that are greater than 7. The large quantity of sites with a score of 3 represent sites that had documentation of subsurface testing and good documentation of quantitative data in the site record forms. These gap results indicate that the underlying data on which the model is based are incomplete for the twelve sample attributes used in this test. With over half of the sites having a data gap greater than seven, the significance categorizations made by the model should be considered unreliable until the data gaps are investigated.

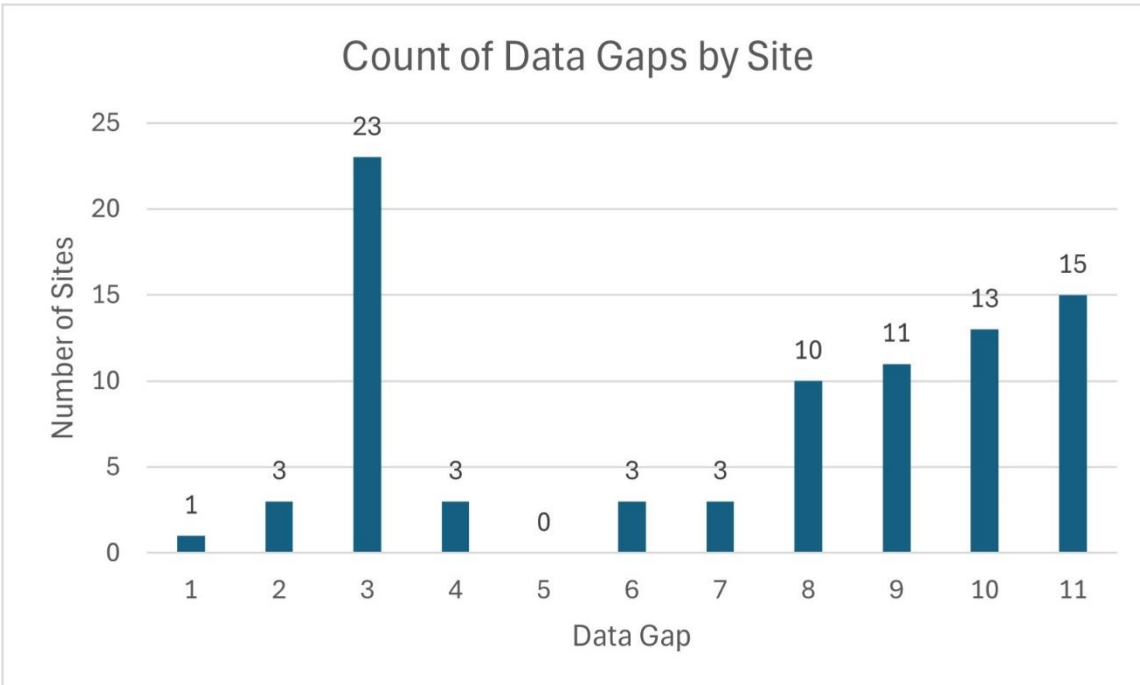


Figure 23: Counts of data gaps by site.

Another method of assessing gaps in the data is to look at key attributes appended to the data in creation of the geodatabase. Figure 24 below shows the number of sites with missing data in 15 different site attributes included in the geodatabase and used in development and application of the model. Site date has by far the highest frequency of missing data, followed by tool diversity, lithic tool material, lithic debitage material, presence of groundstone artifacts, and presence of obsidian. The results of this analysis indicate that even though chronology of sites is a fundamental research question, it is also the most under-documented attribute. Furthermore, nearly a quarter of the sites lack documentation of basic observation attributes like debitage and tool material types and tool diversity metrics.

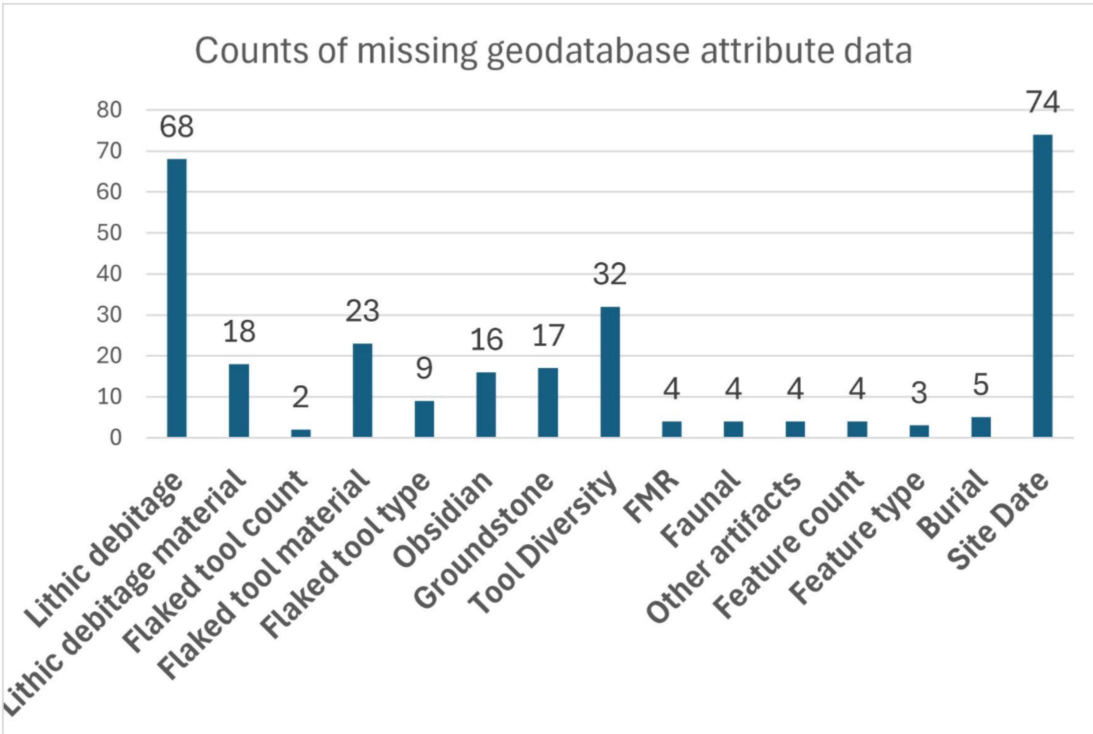


Figure 24: Counts of missing geodatabase attribute data pulled from site forms of 90 precontact lithic sites.

Lithic Analysis Results and Additional Site Data

I analyzed lithic artifacts recently excavated from site 35PO95 and then added the information into the database to see if the significance categorizations of the site were changed by the new information. The lithic data I recorded are reproduced in Appendix A. I also added information from 3 sites tested during the WWSSP project that were withheld from the initial model development to test how the model adapts to new site information being added.

Recent excavations at site 35PO95 yielded 61 pieces of lithic debitage, 1 tool, and 4 fire modified rocks, increasing the debitage count by over 60% (Table 14). The new assemblage is predominantly made of mudstone (Figure 25) and are flake fragments (Figure 26) between 1 cm and 3 cm long (Figure 27). The tool found during recent excavations is a modified flake tool made of CCS (Figure 28) and appears to be a unifacial modified flake tool. In addition to the artifact assemblage, recent excavations identified cultural materials to a depth of 100 cm below surface. This increases the depth of cultural materials for the site from the previous depth of 75 cm below surface.

Table 14: Previous data and recent updates to site 35PO95.

Site Update	Debitage Count	Predominant Deb Material	Tool Count	Tool Material	FMR
2009	94	CCS	6	CCS	5
2023	61	Mudstone	1	Mudstone	4
Total	155	CCS, Mudstone	7	CCS, Mudstone	9

The recently excavated materials are consistent with those identified during previous excavations of 35PO95. The lack of cortex on all but a single piece of debitage indicates primarily mid to late-stage lithic reduction (Andrefsky 2005). The number of fragmented flakes (Figure 26) made determination of flake type and lithic reduction method difficult. Most of the flakes appeared to be bipolar or bending flakes, indicating core or biface reduction and bipolar reduction techniques (Andrefsky 2005). Previous excavations identified the presence of core reduction, biface reduction, and pressure flaking reduction techniques with primary, secondary, and tertiary reduction stages present (Solimano and Ellis 2009).

The previous interpretation of lithics at the site was that lithics represent a diffuse boundary, tool richness is low, and the analysis of flake debris indicates a wider range of tasks (Solimano and Ellis 2009). The results of my analysis of recently excavated materials and documentation on previous excavations are that the Solimano and Ellis (2009) interpretation of lithics at site 35PO95 remains true. While the new assemblage increased the total lithic debitage counts and added one tool to site 35PO95, none of the new materials contradict that interpretation. The significance categorizations made by the model were also not changed by these additions (Table 15). Site 35PO95 has two missing sample attributes with a standard significance score of 2 and an assumed significance score of 4. While the categorizations made by the model are considered unreliable due to gaps in the data, site 35PO95 is an example of a site with most of the sample attributes documented sufficiently.

Table 15: Significance categorization comparison for site 35PO95.

Significance Category	**Before Update**	**After Update**
a	No	No
b	No	No
c	No	No
d	Yes	Yes
e	Yes	Yes

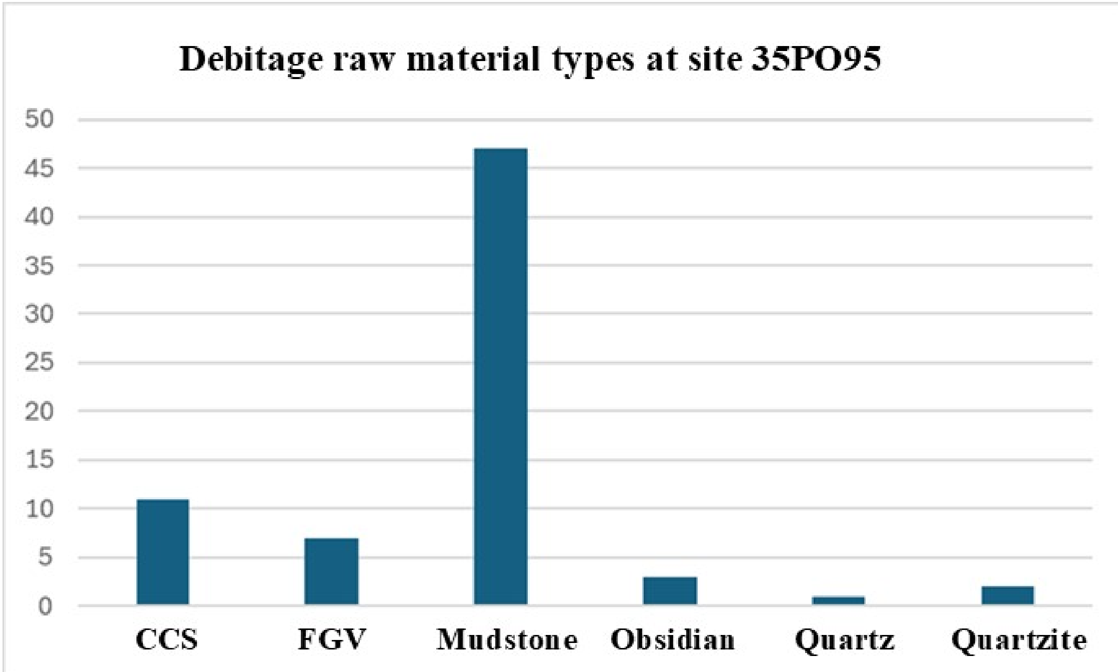


Figure 25: Debitage raw materials of artifacts collected from site 35PO95 during most recent excavations.

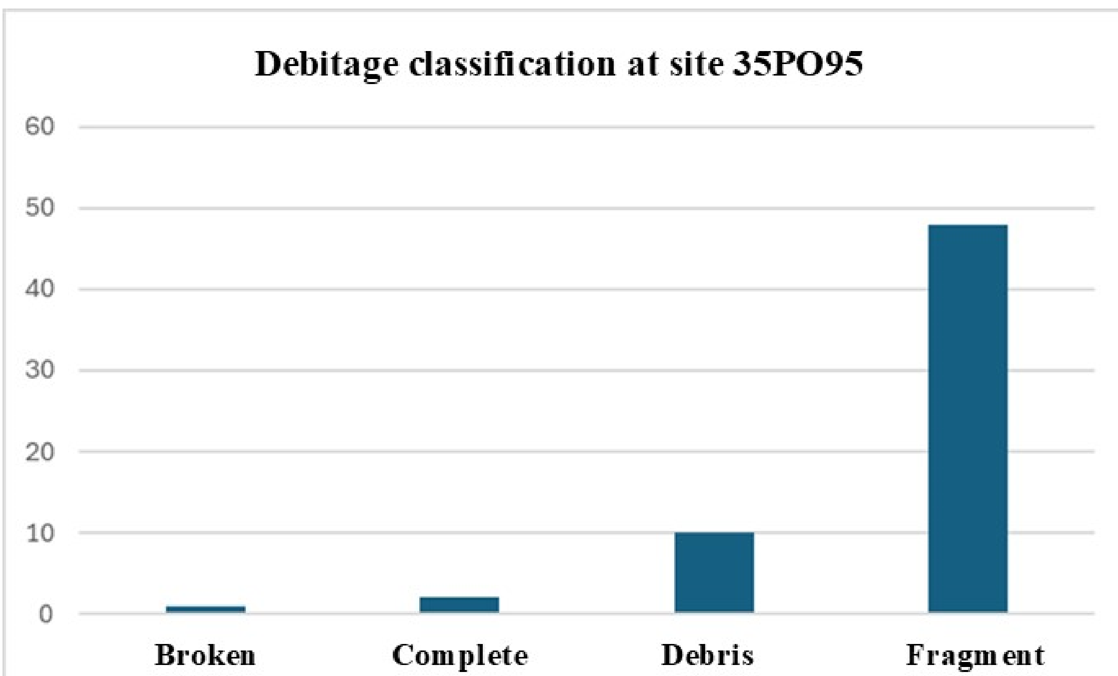


Figure 26: Debitage classification of artifacts collected from site 35PO95 during most recent excavations.

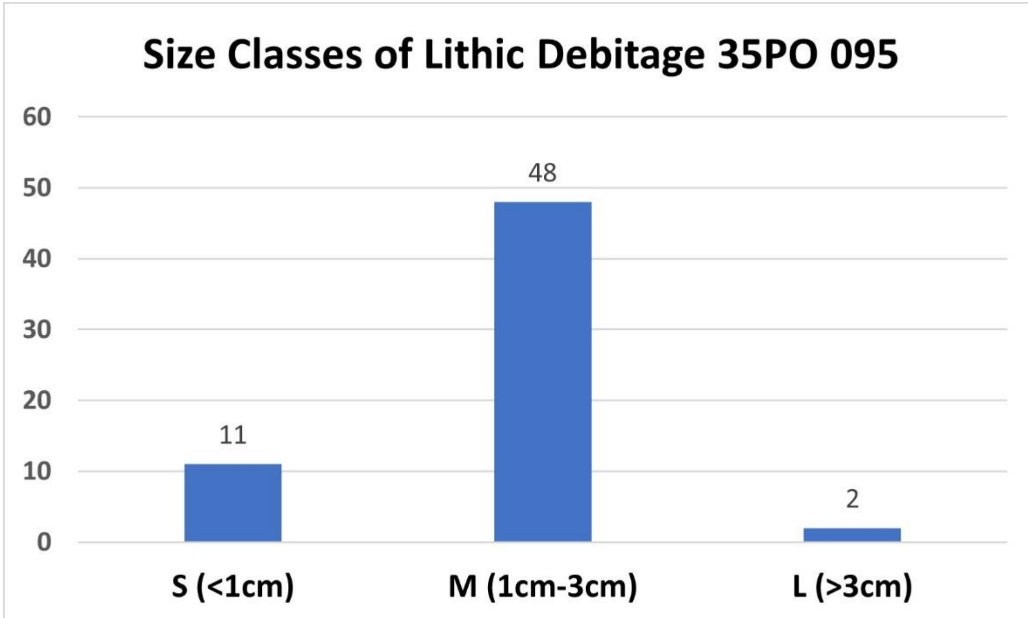


Figure 27: Size classes of lithic debitage collected from site 35PO95 during most recent excavations.

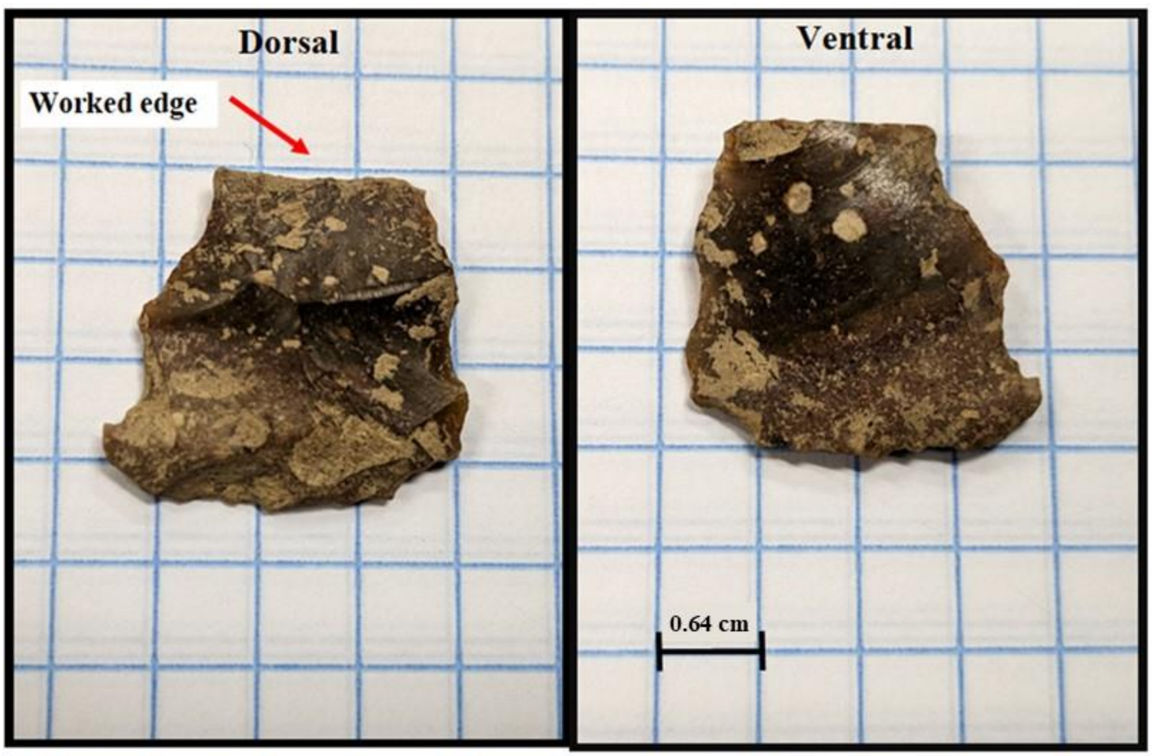


Figure 28: Flake tool recently added to 35PO95.

Willamette Water Supply System Pipeline Sites

I reserved data from three sites associated with the WWSSP project (35WN130, 35WN133, and 35WN134) while creating the model. I then used these sites to test how the model adapts to sites being added, comparing the significance categorizations to the NRHP recommendations made in the site reports, and assessing whether recently excavated sites are being documented more fully than the average for the region.

Table 16 below shows the results of significance categorizations, significance scoring, assumed significance scoring, and data gaps for the three WWSSP sites. The site data were easy to add to the model and did not require any reworking of the model to accept the new data. Of note is that all three sites extended outside the project area and were not fully delineated. Using the scoring methodology established in Chapter 3, all three sites were given an assumed score of 12. All three WWSSP sites have more missing attributes than the regional average of seven (Table 16). However, if the sites are scored based on the portion of the site tested and not given an assumed score of 12 because the site boundaries were not fully delineated, each site would have only two missing attributes. The limitations of arbitrary project boundaries on evaluation and interpretation of archaeological sites are made clear in these results.

These results highlight the tension in CRM archaeology between the duty to document and evaluate sites with the constraints of arbitrary project boundaries. This is also reflected in the NRHP eligibility recommendations made by HRA for sites 35WN133 and 35WN134. Both sites are Unevaluated/Important, but the portion of the site tested by HRA was recommended as non-contributing. While 35WN130 was noted as not being fully delineated due to project boundary constraints, the site as a whole was recommended not eligible for the NRHP. This piecemeal approach, common in CRM, of evaluating portions of sites or entire sites based on the portion tested without knowing what lies beyond the project boundary risks destruction of potentially significant sites one project at a time.

Table 16: Model results for 35WN130, 35WN133, and 35WN134.

Site	**Significance Categorization**	**Significance Score**	**Assumed Significance Score**	**Data Gap**
35WN130	d, e	2	12	10
35WN133	d, e	3	12	9
35WN134	e	1	12	11

Chapter 5: Discussion and Conclusion

In this chapter I discuss the research project as a whole and touch on some of the broader implications of this work followed by suggestions for future research.

An Interpretation of Archaeological Resources of the Tualatin River Basin

As stated in Chapter 3, the question driving my research was, "how do individual archaeological sites within the Tualatin River Basin relate to the broader archaeological and cultural heritage of the region and what are the values or characteristics that are essential for a site to meaningfully contribute to that heritage?" Due to the unreliable results of the significance model, that question cannot be fully answered here. It can, however, be answered in part through my work in synthesizing the available information and identification of areas of documentation deficiencies.

A majority of recorded precontact archaeological sites in the Tualatin River Basin are located around Wapato Lake or along the Tualatin River. This is consistent with the ethnographic record and ethnographically recorded village site locations. However, an important note in discussing site locations is that only approximately 10% of the region has been surveyed by archaeologists (Figure 4), and most of those surveys are in lowland areas where modern developments have occurred. The lack of survey coverage is perhaps the most damaging component in attempting to create a regional synthesis of archaeological data and has the potential to negatively affect attempts at interpretating the spatial distribution of sites (Banning 2020).

I have identified some evidence that nearly the entire region could be considered within the land-use areas of at least one of the 16 ethnographically recorded village sites.

Based on the 1970 site catchment analysis work of Claudio Vita-Finzi and Eric Higgs (Bailey 2013), the maximum daily radius for hunting and gathering outside of sites can be approximated at 10 km. I created a basic site catchment analysis map in ArcGIS Pro with 10 km buffers around each of the 16 ethnographically recorded village sites. This analysis uses a linear 10 km buffer that does not take topographic elements into account. Figure 29 below shows the basic site catchment analysis results, with almost the entire region being within the daily radius of at least one village site. These should be viewed as preliminary results that indicate additional research into site catchment may prove useful in establishing a regional context.

The Tualatin have some of the most detailed ethnographic data of any early-contact period Kalapuyan Tribe (Zenk 1994). Despite this, the archaeological record is incomplete, characterized by missing data, especially in establishing chronology of sites. The ethnographic record describes village locations, but no archaeological evidence of houses or other structures has been found in the Tualatin River Basin. One way to help fill in some of the missing information is to establish a dialogue between the archaeological record and the ethnographic record and oral histories similar to the relationship already common between the archaeological record and historic sources (Galloway 2009). Due to forced removal and cultural genocide of Native peoples, oral histories are often fragmented. The archaeological record has the potential to provide information to help augment oral histories, while oral histories have the same potential to address informational deficiencies in the archaeological record. These conversations between archaeology and oral histories will not always be complementary and at times may contradict one another. However, in contradictions there is potential to investigate the reasons for that contradiction with the result being a more complete understanding of the past than if it assumed that one record must be correct and the other false (Beck and Somerville 2005).

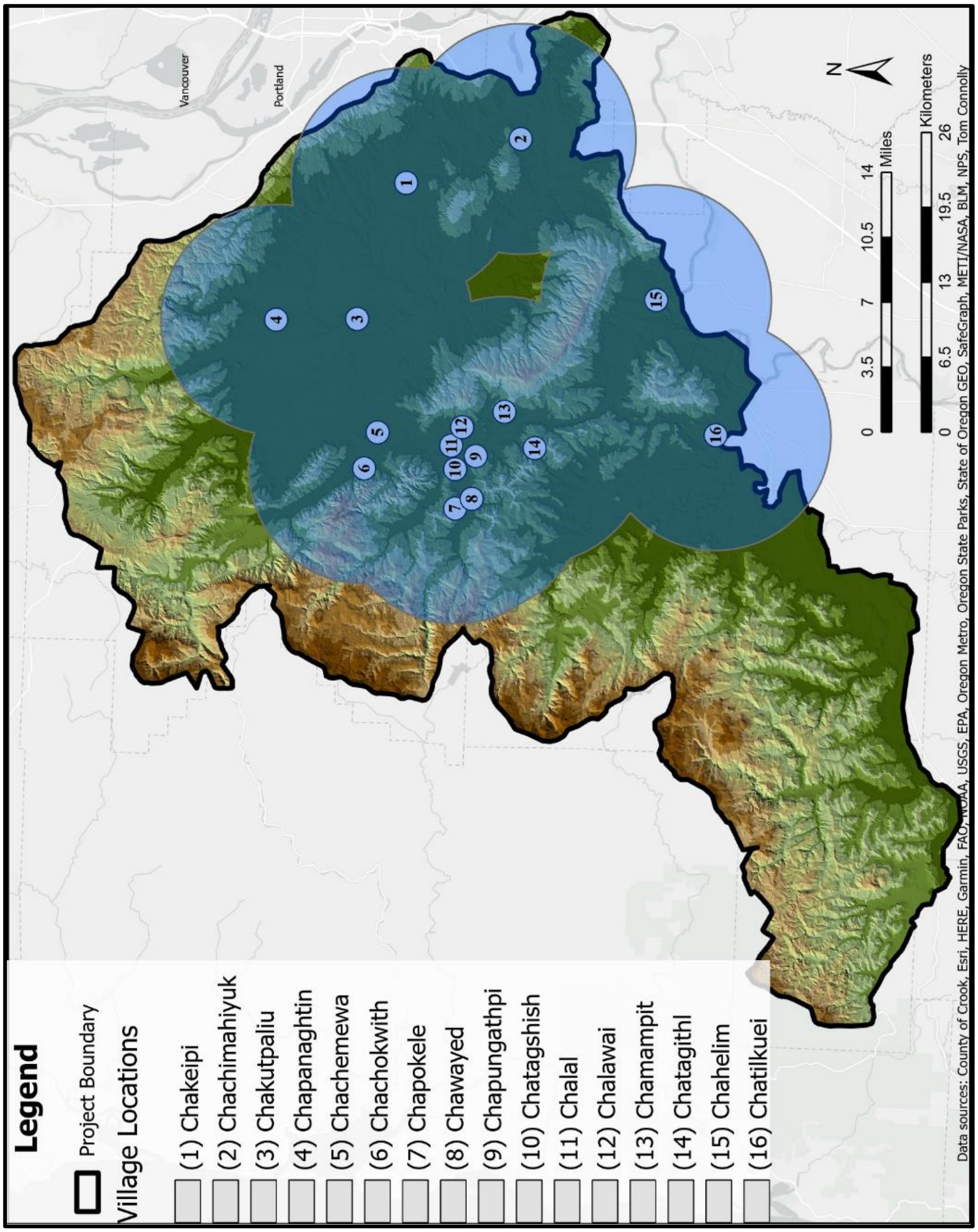


Figure 29: 10 km site catchment buffer around village sites.

Can significance modeling be successfully implemented using CRM-driven data?

A key question in this research was whether significance modeling can be successful using CRM-driven data. My results indicate that the data available in a CRM driven setting is currently too fragmented and inconsistent to be used in significance modeling. Additionally, the conceptual frameworks of both CRM and significance modeling are highly data-driven and incompatible with integration of Tribal views beyond noting sites or attributes as “Tribally significant.”

Significance models rely on a central database that houses a multitude of attributes for every site within the assessment area (Cushman and Sebastian 2008). While I was able to create a database for the Tualatin River Basin, many of the attributes needed to make even data-driven assessments of sites were not available resulting in gaps in the data.

Integrating, Not Using, Tribal Knowledge

One of the key comments I received from the Confederated Tribes of Grand Ronde on the results of this project was that while it took steps forward in integrating Tribal views in some ways, I still framed the project in a data-centric and archaeo-centric lens. Ultimately my research did not integrate Tribal knowledge, like oral histories with the archaeological record, it used oral histories to inform the archaeological model. Recognizing and addressing this distinction is important in creating an Indigenous-focused archaeological practice. The relationship between archaeology and oral histories must be a conversation, acknowledging where they agree, diverge, or contradict with one another (Beck 2005). A similar relationship already exists between material archaeology and historical texts and accounts (Galloway 2009).

Archaeological research should be purpose-built to have a beneficial impact on the often-marginalized groups to whom the resulting knowledge is important. This can only be accomplished through revising the research process in a way that provides more voice, power, and context to those groups of people (Reed 2023). Archaeological knowledge should be viewed as part of a larger knowledge ecosystem and put into conversation with, but not held above, Tribal cultural context, historical context, and ecological context (Beck 2005; Reed 2023).

Modeling Significance or Modeling Data Gaps

As stated above, there are many inconsistencies and gaps in site record forms that limit the development of a significance model from a CRM driven dataset. Instead, the tools of significance modeling can be used as they have in this research to identify deficiencies in archaeological data and to suggest ways to better integrate ethnographic, ethnohistoric, and oral history data. Beyond quantifying the missing attributes of a sample attribute set for each site, I have shown that these tools could be used to identify specific types of missing data (Figure 24).

Modeling data gaps and understanding what information we do not have for sites can help archaeologists make more informed evaluations by understanding what we do and do not know about the regional context. This can then be put into conversation with oral histories to identify areas of overlap and divergence.

Future Work

As stated above, the categorizations made by the significance model developed during this research are unreliable due to data and documentation deficiencies and a framework that is not Indigenous-centered. One method of resolving some of the data gaps in future iterations would be to consult with Indigenous people, including the CTGR, to better integrate the archaeological record and the oral history record to resolve the gaps in each. Minimally, the available ethnographic and ethnohistoric data could be better defined spatially and put into conversation with Tribal oral history. Once sufficient progress in resolving deficiencies in data and documentation has been made, the idea of a significance model could be revisited cautiously. The significance of sites is socially constructed, multivocal, complex, and impermanent (Sutton 2013). Creating a working significance model for a cultural region would require not only filling data gaps, but extensive consultation and Tribal involvement to avoid favoring quantitative data and Criterion D as a reflection of the archaeological records used to develop the model.

The geodatabase I created is one example of how to create a standardized database in which sites can be sorted, compared, and spatially visualized. This type of database is useful not only for significance modeling; it is useful in establishing regional context, understanding spatial distribution of site attributes, understanding where data are missing, and has potential to integrate information from oral and ethnographic histories. For the geodatabase to be useful, future work would need to start with establishing a central hub on which the geodatabase for this and other regions could be hosted and accessed by archaeologists and Tribal representatives. The integration of oral and ethnographic histories, when appropriate, would be highly beneficial to the completeness of the geodatabase and could identify areas where those histories and the archaeological record complement and contradict each other.

Identification of missing data is a critical step in assessing whether a good faith NRHP recommendation can be made. The model I made identified gaps in data based on 12 sample attributes. These attributes can and should be expanded on, altered, and replaced over time. As recommended by the CTGR representative, a different set of attributes could be designed in a way that shows the gaps in Tribal cultural context and compares them to the gaps in archaeological data. That comparison could potentially provide an argument for spending increased resources on evaluating sites under NRHP criteria beyond data potential.

Conclusions and Recommendations

This research has three main contributions to archaeology of the region: 1) a geodatabase with 32 attributes added to each site location; 2) a draft significance model for the Tualatin River Basin; and 3) a method of identifying gaps in data on a site and regional level.

The results show how a regional synthesis can be used to give greater context and understanding to individual sites. By understanding a uniform set of site attributes and environmental variables for every site in a region, we can make more relevant evaluations of potential site significance as they relate to regional context. Further, having the synthesis connected to a geodatabase allows for spatial visualization of individual attributes or groupings of attributes. However, the development of regional context is hindered by lack of consistent data and a focus on the archaeological, historic, and environmental contexts of sites. To fully understand precontact sites, the Tribal cultural context and Tribal knowledge must also be integrated into the methodology from the beginning of site recording all the way up to NRHP eligibility recommendations.

Some of the gaps in data identified by this research can be addressed through a revision of standardized state site forms to include additional fields. I strongly recommend that the following attributes be documented with initial site recording: 1) Distance and relationship to known village locations; 2) Type(s) and number of units excavated and delineation status of site.

Recording the distance and relationship to the nearest village locations will help prompt an investigation into regional context and may bolster site interpretations. Village locations should include not only those that have been verified with archaeological investigations but also ethnographically recorded village locations. This field could be a simple drop-down menu with distance ranges, a second drop-down menu with village names, and a text box to describe the geographic, environmental, and Tribal relationships the site has with the village.

While types and number of units excavated are often included in the site narrative or maps, the data is inconsistently formatted and missing from some site forms. Including a field for the type(s) of excavations performed and number of units excavated would make that data more apparent. This would allow archaeologists to more easily understand the level to which sites have been investigated. Further, including information on the extent of delineation of the site would allow archaeologists to easily understand how project limitations may have affected site interpretations and eligibility recommendations. This field could be simplified into four check boxes to indicate if the north, south, east, and west boundaries of the site have been delineated using subsurface techniques.

These additions would be relatively simple to implement and would improve the ability to discuss regional context of sites. Additional changes that would take some planning to implement but would further improve site documentation are 1) Have a database of site attributes hosted by the Oregon SHPO in spreadsheet and geodatabase formats. This would require an extensive overhaul of the way archaeological data is hosted for remote access and require continual updates to ensure accurate data. However, the benefits of a system like this would be similar to the results of the geodatabase I created and would allow for a deeper understanding of what we know and where there are gaps in data. 2) In addition to standard site forms, have region-specific documentation requirements based on Tribal input and input from other relevant parties. This would require extensive consultation meetings and discussions with multiple Tribes and relevant parties. However, the results would be a step toward archaeological documentation that matches the needs and interests of the communities to whom the sites are important and provide tangible benefits to those communities.

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Appendix A

Lithic Data from Site 35PO95

Bag#	Level	Quad	Depth (cm)	Material	Cortex	Size (s<1cm, m1cm-3cm, L>=3cm)	complete, broken, fragment	FMR
TU1								
01_36	11	sw	50-55	mudstone	N	m	broken	
01_28	7		30-35	ccs	n	m	complete	
01_28	7		30-35	CCS	n	m	fragment	
01_35	11	SE	50-55	mudstone	n	m	fragment	
01_35	11	SE	50-55	mudstone	n	m	fragment	
01_40	12	ne	55-60	mudstone	n	m	fragment	
01_40	12	ne	55-60	mudstone	n	m	fragment	
01_58	20	SE	95-100	mudstone	n	m	fragment	
01_25	6	SE	25-30	mudstone	n	m	debris	
01_25	6	SE	25-30	mudstone	y	m	fragment	
01_14	3	ne	10-15	mudstone	n	s	fragment	
01_14	3	ne	10-15	mudstone	n	m	fragment	
01_14	3	ne	10-15	mudstone	n	m	fragment	
01_56	20	sw	95-100	ccs	n	s	fragment	
01_54	17	SE	80-85	CCS	N	s	fragment	
01_55	18	SE	85-90	CCS	N	m	fragment	
01_53	16	SW	75-80	mudstone	n	m	fragment	
01_53	16	SW	75-80	mudstone	n	m	fragment	
01_49	16	SE	75-80	mudstone	n	m	fragment	
01_42	12	SW	55-60	mudstone	n	s	fragment	
01_42	12	SW	55-60	mudstone	n	s	fragment	
01_46	16	NW	75-80	mudstone	n	m	fragment	
01_44	15	SW	70-75	mudstone	n	m	fragment	
01_43	13	NW	60-65	mudstone	n	m	fragment	
01_57	20	nw	95-100	mudstone	n	m	fragment	
01_57	20	nw	95-100	mudstone	n	m	fragment	
01_59	21	sw	100-105	quartz	n	m	fragment	
01_12	2	sw	5-10	fgv	n	m	debris	

01_12	2	sw	5-10	mudstone	n	m	fragment	
01_12	2	sw	5-10	fgv	n	m	fragment	
01_12	2	sw	5-10	mudstone	n	m	debris	fmr=1
01_11	2	se	5-10	mudstone	n	m	fragment	FMR=1
01_11	2	se	5-10	mudstone	n	s	debris	
01_11	2	se	5-10	mudstone	n	m	fragment	
01_11	2	se	5-10	fgv	n	m	fragment	
01_11	2	se	5-10	fgv	n	m	fragment	
01_11	2	se	5-10	fgv	n	m	fragment	
01_02	1	ne	0-5	quartzite	n	s	debris	
01_02	1	ne	0-5	ccs	n	m	debris	
01_02	1	ne	0-5	fgv	n	m	fragment	
01_26	7	ne	30-35	mudstone	n	m	debris	
01_26	7	ne	30-35	obsidian	n	s	fragment	
01_51	16	SW	75-80	obsidian	n	m	fragment	
01_01	1	nw	0-5	mudstone	n	s	fragment	
01_01	1	nw	0-5	mudstone	n	m	fragment	
01_01	1	nw	0-5	fgv	n	m	fragment	
01_24	6	nw	25-30	mudstone	n	m	fragment	
01_24	6	nw	25-30	mudstone	n	l	fragment	
01_30	8	SE	35-40	CCS	n	m	Unifacial flake tool	
TU2								
02_22	5	nw	20-25	mudstone	n	s	debris	
02_08	2	ne	5-10	ccs	n	m	fragment	
02_09	2	se	5-10	ccs	n	m	fragment	
02_38	10	nw	45-50	mudstone	n	m	fragment	
02_38	10	nw	45-50	ccs	n	m	fragment	
02_42	2	nw	5-10	mudstone	n	m	fragment	
02_42	2	nw	5-10	mudstone	n	m	fragment	
02_45	17	sw	80-85	mudstone	n	m	fragment	
02_46	2	ne	5-10	quartzite	n	m	debris	
TU-3								
03_12	4a	nw	17-20	mudstone	n	m	fragment	
03_13	12	sw	55-60	ccs	n	l	complete	
03_09	4	ne	15-20	obsidian	n	s	fragment	FMR=2
TU4								
04_19	4	se	15-20	ccs	n	m	debris	

Appendix B

Supplemental File Information

The following supplemental files accompany this thesis.

Tualatin River Basin Lithic Site Data Spreadsheet

This file is an Excel spreadsheet consisting of rows for each site used in this research and columns with the archaeological site attributes I added from site forms and environmental datasets. The attributes transferred from the SHPO OARRA database and location information have been redacted from this version of the spreadsheet. A full version, along with the geodatabase, is held by the Portland State University Anthropology Department.

File type: .xlsx

File name: TRB_site_attributes.xlsx

File size: 74 KB

Required software: Microsoft Excel