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Recovering Lost Information From Avocational Projectile Point Collections

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RECOVERING LOST INFORMATION FROM AVOCATIONAL PROJECTILE POINT COLLECTIONS

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by

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ABSTRACT

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Human prehistory in North America has sparked the interest of private citizens for decades, sometimes leading to an accumulation of avocational artifact collections that lack site-level provenience. The Wild/Clymer artifacts (n = 1,371) are one such collection where precise site provenience was lost. The analysis aims to recover regional provenience by using morphology, raw material sourcing, and typology to create a data set. The avocational collection data set was analyzed by comparing it to the professionally recorded archaeological data sets from within 100 miles of Frenchglen, Oregon. A paradigmatic classification approach identified 606 typeable points in the avocational collection, in addition to other morphological traits. Systematic typological schemes used throughout the Great Basin identified 15 different projectile point types, with the densest concentration consisting of Elko Eared (20%) projectile points. The results of portable X-ray fluorescence (pXRF) analysis identified 62 obsidian sources from the northwest Great Basin, although it was dominated by Beatys Butte obsidian.

Many morphological, typological, and sourcing characteristics of the Wild/Clymer Collection sample are consistent with professionally analyzed archaeological records within the northern Great Basin. We conclude that lost information can be recovered and used to evaluate scientific information potential, which facilitates the identification of affiliated Tribes for collaboration in the continued care and management of the collection.

ACKNOWLEDGEMENTS

First and foremost, this project would not have been possible without the dedication and tireless efforts of Dennis Wilson. Mr. Wilson spearheaded the retrieval of the Wild/Clymer Collection and contributed countless hours to rehousing, inventorying, labeling, and analyzing the artifacts that enabled that propagation of this project. The magnitude of appreciation and gratitude I have for Mr. Wilson's contributions are difficult to put into words, but I owe the success of this project to him. My thesis committee also deserves my utmost gratitude for the countless hours spent helping develop, craft, and polish this thesis over the last two years. I offer my appreciation for the individual expertise of each committee member that uniquely added to the success of this research. Dr. McCutcheon, thank you for pushing me to think outside the box and face an archaeological problem that many others might shy away from. Thank you for your continued dedication to this project and for lending your expertise to refine, not only this project, but my skills as an archaeologist. Dr. Hackenberger, thank you for continuing to encourage me to pursue all my research interests and for your tireless enthusiasm about this project and archaeology in general. Craig Skinner, it is safe to say that your research paved the way for this research to take place. Your contributions to raw material sourcing in archaeological contexts have shaped the methods, approaches, and results critical for provenance studies in general, and more specifically for this research.

I owe additional gratitude to those whose unwavering assistance made the completion of this project possible. Alex Nyers, the results and interpretation of this research would not have been possible without your assistance with the sourcing and calibration of our pXRF results, and help assuring the results were reproducible and well-reported. Mallory Triplett and Nikolai Simurdak, thank you for spending hours in the lab watching me draw non-sense on the whiteboard and helping to develop the classification that started it all. Mars Galloway, thank you for taking time from your own research to make maps that demonstrate critical information within this thesis. Angela Neller (Wanapum Heritage Center), thank you for helping to determine the best practice for rehousing, cataloging, and storing the Wild/Clymer Collection. Thank you to all entities who provided funding for this project: Dennis and Nancy Archaeological Scholarship, Hultquist Distinguished Service Award, the CWU Graduate Student Research Grant, and the Roy F. Jones Memorial Scholarship.

To the people behind the scenes that kept me smiling, pressing forward, and well-fed over the last two years, I owe you my most sincere thank you. So, here is to you Mom, Dad, Abby, Ella, Juan, CERMA, Cristina, Ana, Nikki, Nick, Natalie, Dillon, Mikaela, Charles Shaw, Interlibrary Loan and Caffeine, *cheers*.

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CHAPTER I

INTRODUCTION

Artifact collecting has a convoluted and contentious history amongst museums, archaeologists, and private citizens (Fowler and Malinky 2006). The legality of this historical practice has been questioned since 1906 with the introduction of the Antiquities Act and avocational artifact collecting has resulted in an accumulation of lithic artifact collections that often lack provenience information (Boulanger and Graves 2017). While the density of surface archaeological sites in western North America hold a remarkable potential for archaeological research (Jones and Beck 1999), the preservation of surface sites in place has been a continuous obstacle for cultural resource managers. Primary depositional context is critical for answering research questions regarding past human behavior and land use, creating a unique challenge in understanding where the artifacts lacking provenience fit into archaeological research and the archaeological record (Canaday 2003, 2016). This unusual difficulty often leaves avocational artifact collections unstudied, with archaeologists and resource managers unsure how to approach their continued care and management. Museums and universities are often the recipients of amateur collections (Boulanger and Graves 2017). Amid a "collections crisis," addressing the problem of accumulating collections in repositories is a critical problem facing archaeologists, resource managers, and museum curators (Marquardt et al. 1982:410).

Problem

The limited provenience information often associated with avocational collections can diminish the scientific value of the artifacts, leaving extensive stone tool collections under-studied and susceptible to resale (Boulanger and Graves 2017). However, it is possible to apply stone tool analysis methods and techniques to artifacts despite lost site and artifact provenience information (Davis et al. 2012; Davis et al. 2014; Goebel 2007; O'Connell 1967; Oetting 2004; Skinner et al. 2004). When collecting morphological, provenance, and typological data for a site's artifacts (Bettinger et al. 1991; Clewlow 1967; Flenniken and Wilke 1989; Heizer and Hester 1978; Smith et al. 2013; Tadlock 1966; Thomas 1981), researchers identify characteristics specific to that site, sometimes called a "fingerprint" (Fulton et al. 1999:4). If the same data are collected for artifacts in an avocational collection and characteristics are identified as consistent with those identified at sites from a specific region (Canaday 2003), it may be possible to recover some level of regional provenience. Previous analyses have sought to identify provenience of avocational artifact collections using these variables (Amick 2004; Boulanger and Graves 2017); however, these studies did not investigate the relationship between data generated from the avocational collection and the data published from a specific archaeological region.

Purpose

The purpose of this research is to collect morphological, typological, and raw material source (i.e., provenance) data from an avocational lithic artifact collection and determine if those characteristics are consistent with lithic artifact assemblages from a specific archaeological region. To accomplish this, a multidimensional model identifies and defines data fields for systematic comparison to local/regional professional archaeological stone tool research. This model will permit an assessment of how consistent or comparable avocational collection data set is to professional data sets. For these purposes, consistency is defined as similar characteristics or fingerprints indicating that two samples are derived from the same population. This model considers what morphological characteristics are present in the collection, identifies biases inherent to the collection methods, and focuses on projectile point types in the collection that are represented in published data. The determination of variables and objectives in this model seek to answer the primary research question: can morphological, typological, and raw material provenance analysis be used to assign regional provenience to an avocational artifact collection by identifying characteristics in those collections that are consistent with professionally generated assemblages of known provenience? Regional provenience is defined as a geographically larger scale of location from which the artifacts were collected, whereas provenience is the *in situ* location where an artifact was deposited. Utilizing the following objectives will achieve the purpose of this research and provide an answer to the research question.

Objective One

I reviewed previous approaches to identifying provenience of avocational lithic artifact collections necessary to identify variables that proved useful in previous provenience identification research (Amick 2004; Boulanger and Graves 2017). A comprehensive review of methods used in previous avocational collections analyses is necessary to identify data fields that recover the largest breadth of lost information from the avocational collection.

Objective Two

Using the variables identified in objective one, I developed and applied a morphological classification scheme that identifies technological and stylistic variation in artifacts in an avocational projectile point collection. Patterns of lithic technological variability may be unique to a region based on the availability of raw material and the degree of sedentism for the groups utilizing the technology (Andrefsky et al. 1994). These patterns will be evident through an analysis of morphological characteristics and I will compare them to identified characteristics for site assemblages with known provenience.

Objective Three

I applied artifacts determined to be stylistically typeable by the paradigmatic classification to a systematic classificatory scheme used widely in published projectile point analyses. These schemes provide archaeologists a mechanism for identifying variability and trends in lithic industries through time that can be used as indicators of chronology (Clewlow 1967; Heizer and Hester 1978; Layton 1970; Thomas 1981). This process provides an opportunity to make systematic comparisons between avocational projectile point collections and professional assemblages to determine if the unprovenienced artifacts are consistent with artifact data from assemblages with known provenience.

Objective Four

Utilize portable X-ray fluorescence (pXRF) methods to identify the raw material source, or provenance, for each artifact in the avocational artifact collection. The trace element characterization of western North America obsidian sources has been investigated by archaeologists since the 1980's (Hughes 1986, 1993; Oetting 2004; Skinner 1983; Skinner et al. 2004). Archaeologists utilize raw material sourcing to investigate raw material acquisition and movement across the landscape (Fulton et al. 1999). Therefore, the provenance data from an avocational artifact collection indicates the regional provenience of the collection.

Objective Five

Compare the morphological, typological, and raw material source data from the avocational collection to similar data reported for assemblages with known provenience. Analyzing the relationship between these three different data points acts to strengthen conclusions of regional provenience by limiting bias inherent to drawing conclusions from a single analyzed variable. The null hypothesis (H_O) is that a consistent relationship between the artifact morphology, style, raw material provenance of an avocational artifact collection and published archaeological data cannot be identified. The alternative hypothesis (H_A) is that a consistent relationship between the artifact morphology, style, raw material provenance of an avocational artifact collection and published archaeological data can be identified. The Methods chapter will cover the model developed to accomplish these objectives and test the null hypothesis.

Objective Six

Disseminate the results of this study within a peer-reviewed context. The commonality of avocational lithic artifact collections makes the objective of determining consistencies in an avocational collection and the archaeological record for a specific region a goal of many archaeologists and museum curators. Publishing the results of this research in a peer-reviewed journal provides a fundamental review of the methods and results, in addition to sharing the methods with researchers in similar situations.

Significance

This research is significant because it could recover lost information for artifacts removed from a specific archaeological region or sub-region (Boulanger and Graves 2017). With the pronounced "collections crisis" amidst the archaeological community (Marquardt et al. 1982:410), it is critical to develop a model that addresses the multi-dimensional information lost through the avocational collection practice and recovers some lost information (e.g. morphological, stylistic, and raw material source) that leads to a narrowed interpretation of artifact provenience. Developing a replicable method for analyzing collections using current approaches to typology and provenance studies allows archaeologists to act as stewards to collections that previously lacked research potential. In addition, it also provides an evidence-based model for identifying regional provenience of avocational collections. Stone tools can tell us about cultural traits like trade, adaptation, and mobility (Andrefsky 2005) and archaeologists can identify a vast amount of information when using methods that yield replicable and comparative results. The aim of the research reported here is to develop methods to recover information otherwise lost from the practice for avocational artifact collecting and create an inventory of previously uncatalogued and unstudied artifacts (Boulanger and Graves 2017).

When the provenience of an artifact collection is unknown, the affiliated Native group(s) are also unknown, which makes determining methods for proper care and management difficult, if not impossible (Neller 2004). After identifying the location of origin for a collection, it is then possible to undergo collaboration and consultation with descendent communities of that area regarding the collection. Neller (2004) expresses the view that each Native American community takes different approaches to artifact management, therefore identifying affected groups, pursuing consultation to build a working relationship is critical for proper stewardship (Society for American Archaeology 1996). Emerson and Hoffman (2019) also emphasize the importance of maintaining the connection with archaeological collections and their provenience and collection method data for continued consultation with Native American tribes from the region, information that is unknown for most avocational collections. This analysis may effectively identify the affiliated group and allow for a collaborative method of curation and care.

Chapter II details the history and contents of the Wild/Clymer Collection, the avocational artifact collection utilized to address the research question and tests the hypothesis and objectives for this analysis. Chapter III: Study Area outlines the pertinent background information on the environmental and archaeological history of the northern Great Basin to provide context for the research and data presented throughout this thesis. The extensive archaeological research undertaken throughout the northern Great Basin that pertains to the development and implementation of each objective is summarized in Chapter IV: Literature Review. Data available across this region allow for comparison to the data collected from the Wild/Clymer Collection. The procedures used to identify consistencies between the archaeological record and the Wild/Clymer Collection are presented in Chapter V: Methods and Techniques. Chapter VI: Recovering Lost Information from Avocational Projectile Point Collections is a journal manuscript, which includes a modified and summarized version of the first five chapters, the results of this research, and a discussion of conclusions and recommendations for future avocational collections analyses.

CHAPTER II

THE WILD/CLYMER COLLECTION

In 1991, Katherine Wild and her late husband Arnold Wild donated an avocational artifact collection to the John Ford Clymer Museum (Clymer Museum) in Ellensburg, Washington. The collection consisted of 4,461 lithic artifacts in 52 artistically arranged display cases (Figure 1) and nine unlabeled bags. In 2017, Dennis Wilson, a member of the Clymer Museum, was informed of and shown a large collection of Native American stone tools in the museum's attic that were part of the donated Wild collection. Intrigued by the large size of the collection and its potential to serve a scientific and educational purpose, he began discussions with museum staff and director about the possibility of having the museum loan the collection to Dr. Patrick McCutcheon at Central Washington University (CWU). Later that year the university received the collection on loan (Appendix A). The loan agreement stipulated the completion of an analysis of the collection's potential to serve a scientific purpose after rehousing the collection to proper curation standards (Knoll and Huckell 2019).


Figure 1: Original Wild/Clymer Collection display cases.

The Wild/Clymer Collection, when loaned to CWU, was housed in display cases, each of which had a place name scribed on the back of the case. Eighteen display cases were labeled with Frenchglen, Oregon and the other 34 cases were labeled with one or more of the following place names (alphabetical order by state): California (Cedarville, Warner Valley), Nevada (Dixie Valley, Duck Flat, Fallon, Hawthorn, Massacre Lake), Oregon (Hart Mt.), Utah (Escalante, Kanab), and Wyoming (Flaming Gorge). The cases labeled as Frenchglen, Oregon consisted of primarily obsidian artifacts, whereas other cases were dominated by artifacts made of crypto-crystalline silica (CCS) or Fine Grained Volcanic (FGV) materials. The Clymer Museum did not provide any additional information with the collection, so it was determined by Dennis Wilson, the CWU anthropology staff, and the curator of the Wanapum Heritage Center (see acknowledgements), determined that an inventory and catalog system was necessary to inventory and manage the collection.

Boulanger and Graves (2017) concluded that locating original records from the collector would provide the most utility for determining the collection's provenience. To investigate whether Katherine and Arnold Wild had recorded notes on the provenience of the Wild/Clymer Collection artifacts, a thorough review of the history of the collection was undertaken. This process was also employed to ensure that artifact provenience for the Wild/Clymer Collection was, in fact, unknown. Dennis Wilson spearheaded a preliminary review of the Wild/Clymer Collection's history before this research began (see acknowledgements). Mr. Wilson started by requesting to view any documents that the Clymer Museum had associated with the collection. An article in the Daily Record describes the donation of the collection to the Clymer Museum and explains that Mr. Wild had "arranged, categorized, and framed" the artifacts he had "spent a lifetime collecting" (Daily Record 1991). This information supported the primary hypothesis that the place name labels on each case do not provide reliable provenience information for the artifacts within each case. Additional efforts to contact family members, newspaper writers, and museum employees who may have information about records associated with the collection did not provide any information about the collection's history. All avenues for recovering notes from the collector were exhausted with no additional information received about the collection's provenience.

I chose the artifacts from cases marked with Frenchglen, Oregon (n = 1,371) (Figure 2) as the Wild/Clymer Collection sample because of the large number of obsidian artifacts for raw material sourcing analysis. Frenchglen is located in southeast Oregon, within the northern Great Basin geographic and archaeological region. Frenchglen, Oregon, is used as the center point for this investigation's study area because of the case label. The stylistic arrangement of artifacts in the display cases and the lack of collection notes necessitated the application of this analysis to support this regional provenience designation and collect information lost from the avocational collection method.

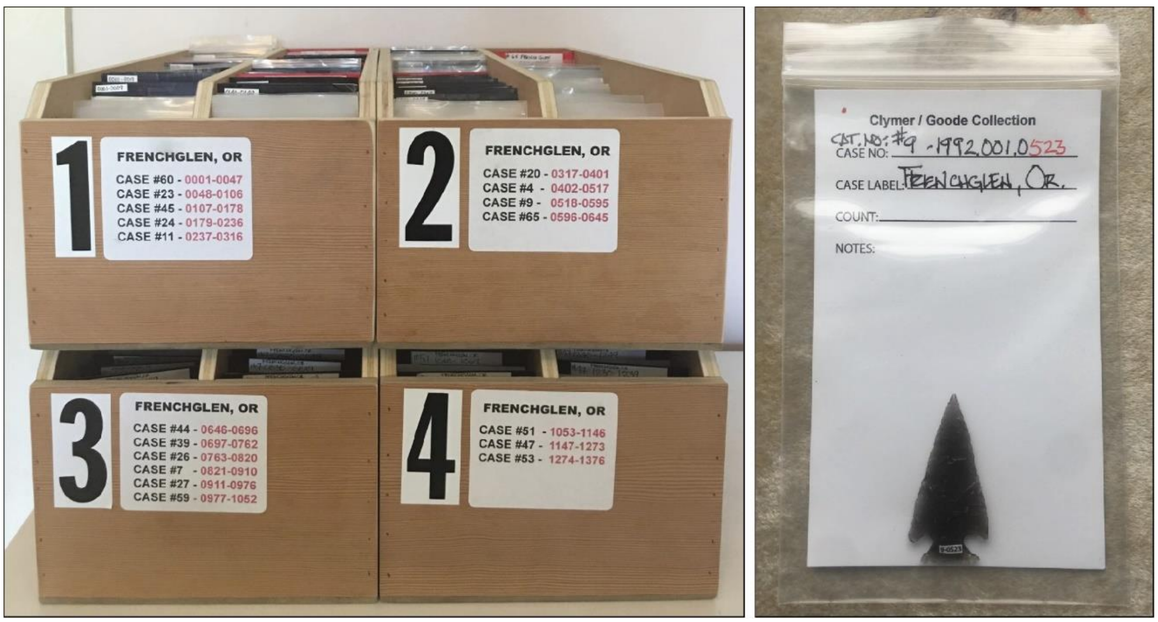

Figure 2: Current state of Wild/Clymer Collection following rehousing.

CHAPTER III

STUDY AREA

To identify consistencies between the Wild/Clymer Collection sample and the reported archaeological record of a specific region, the study area and literature review include the area within a 100-mile radius surrounding Frenchglen, Oregon, hereforward referred to as the study area. The focal point of the study area, Frenchglen, Oregon, is located within the northern Great Basin region, providing unique and abundant resources since the arrival of humans to the region as early as 13,000 years ago (Aikens et al. 2011; Jenkins et al. 2012; Brown et al. 2019) (Figure 3). This section introduces important background information for this analysis, including pertinent environmental, geologic, and cultural context for the northern Great Basin, supporting the interpretation of lithic characteristics present in assemblages recovered from the northern Great Basin area.

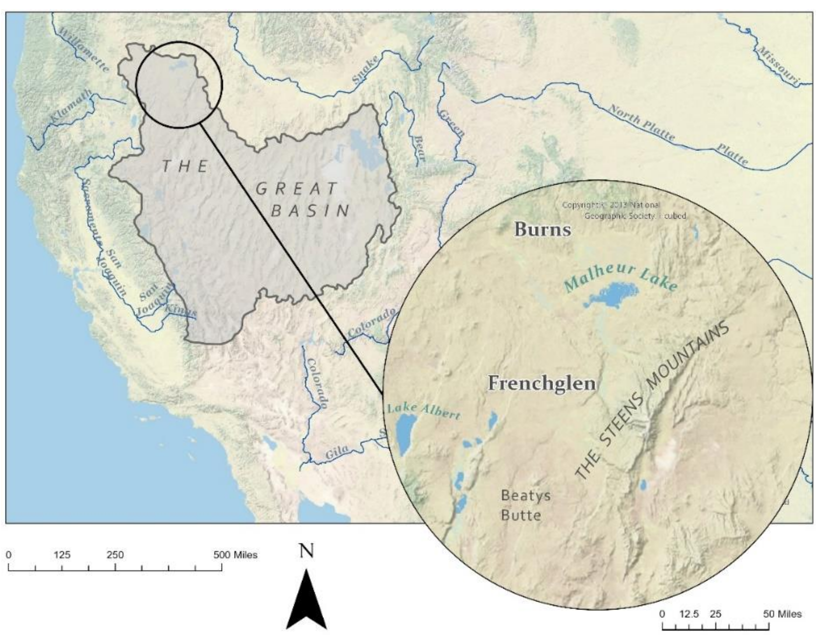

Figure 3: Great Basin overview with highlight on the study area (created by Mars Galloway from as ESRI base map, see acknowledgements).

Great Basin Environment

The Great Basin is an approximately 200,000 square mile region of the western North America, identified by its flora, fauna, hydrologic system, climate, and geology (Grayson 1993). This unique area has been the home to many cultural groups since as early as 13,500 cal BP. (Jenkins et al. 2012; Brown et al. 2019). The difference in elevation between the valley floors and the mountain peaks of the Great Basin can be upwards of 5,000 feet, making this region topographically challenging and rich in biodiversity for the earliest hunter gatherers to the Numic speakers (Northern Paiute, Shoshone, Ute, Mono, and Southern Paiute) who first encountered Europeans during their arrival (Aikens et al. 1982; Aikens et al. 2011; Grayson 1993; Toepel et al. 1980).

The Great Basin has experienced three major climatic periods since the late Pleistocene-Holocene transition (Antevs 1948; 1955). The earliest (9,000-7,000 years BP) was warmer and drier than the modern environment and is designated as the Anathermal. The following period (7,000-4,500 years BP) decreased in temperature and increased in moisture and is designated as the Altithermal. The most recent period (4,500-present) is represented by current temperatures and is designated as the Medithermal (Antevs 1948; Antevs 1955).

The Basin and Range topography of the landscape caused significant climate variability between areas that are otherwise in close proximity (Aikens 1993; Toepel et al. 1980). The Steens Mountain area lies between Harney County and Malheur County in the northernmost corner of the Great Basin and includes three major vegetation zones, including ponderosa pine, western sagebrush, and big sagebrush (Toepel et al. 1980).

This intricate landscape supports nearly 100 mammal, 230 bird, and 600 vertebrate species (Grayson 1993). The density of federally managed land in the northern Great Basin, which requires thorough cultural resource review under the National Historic Preservation Act (NHPA) Section 106 prior to any projects, is advantageous for the continued identification and management of archaeological sites in the northern Great Basin (Figure 4).

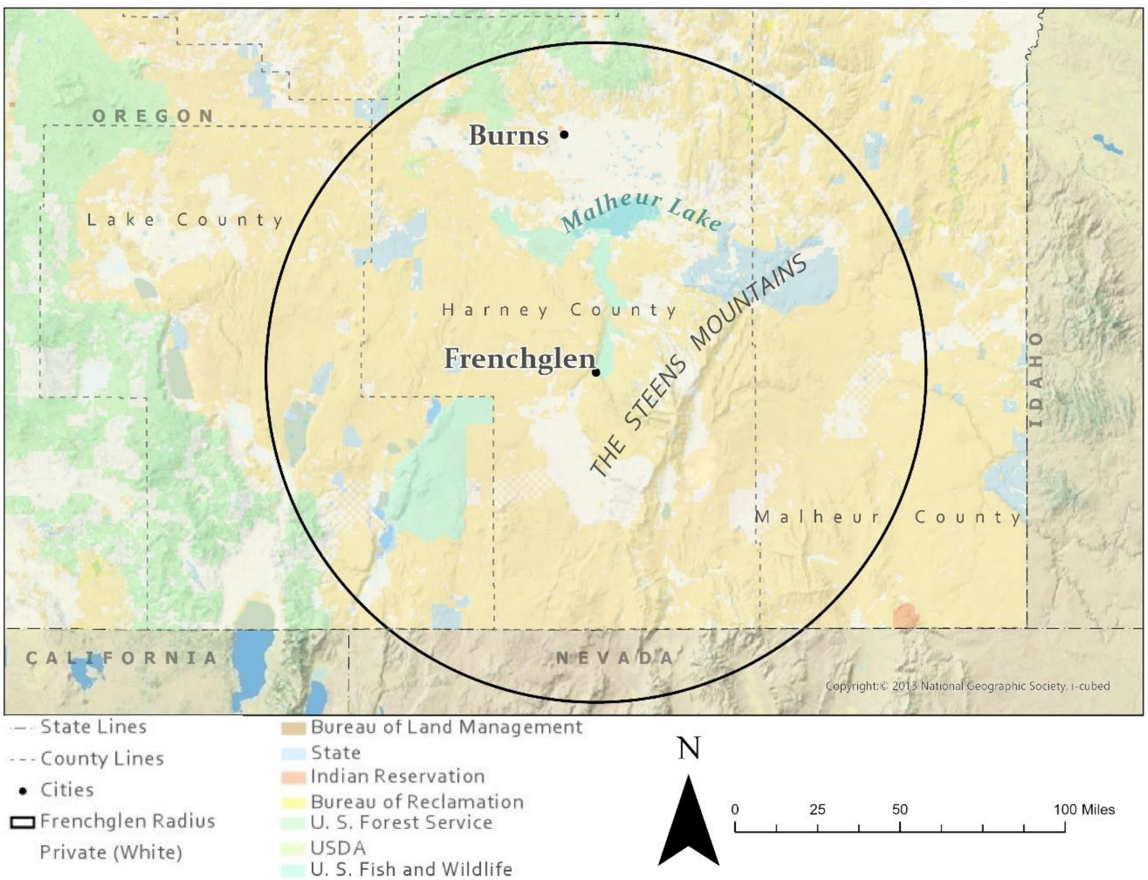

Figure 4: Map and legend depicting distribution of federally managed lands in the northern Great Basin with the study area (Map created by Mars Galloway from USGS base map, see acknowledgements).

The following study area summary includes a geologic history of the area in order to demonstrate the complexity of features in the landscape and how the volcanic activity provided prehistoric groups the raw material necessary to manufacture the stone tools found here. Included is a cultural history to better illustrate the stone tool variability encountered in the archaeological record. The discussion of variability that exists amongst stone tools in the Great Basin throughout time occurs in order to determine characteristics that require further investigation.

Obsidian Sources

The northern Great Basin is considered to be one of the most obsidian rich areas in the world (Skinner 1983), providing many sources of obsidian toolstone advantageous for toolmakers in the region. Field and geochemical research have identified over 100 chemically-unique obsidian sources across Oregon (Skinner 1983; Stueber and Skinner 2015) (Figure 5), nearly 60 unique sources of obsidian across Nevada (Figure 6), and 52 identified sources in California, with 24 in northeast California alone (Figure 7) (Northwest Research Obsidian Studies Laboratory 2012). Continued research on the homogeneity of obsidian individual flows has identified multiple unique trace element fingerprints within some larger flows, for example, nine unique trace element signatures at the Glass Buttes source (Stueber and Skinner 2015). With approximately 100 geochemically-unique sources of obsidian in Oregon, the chemical characterization of volcanic glass can provide an important tool for understanding the prehistoric use of the resource (Skinner 1983).

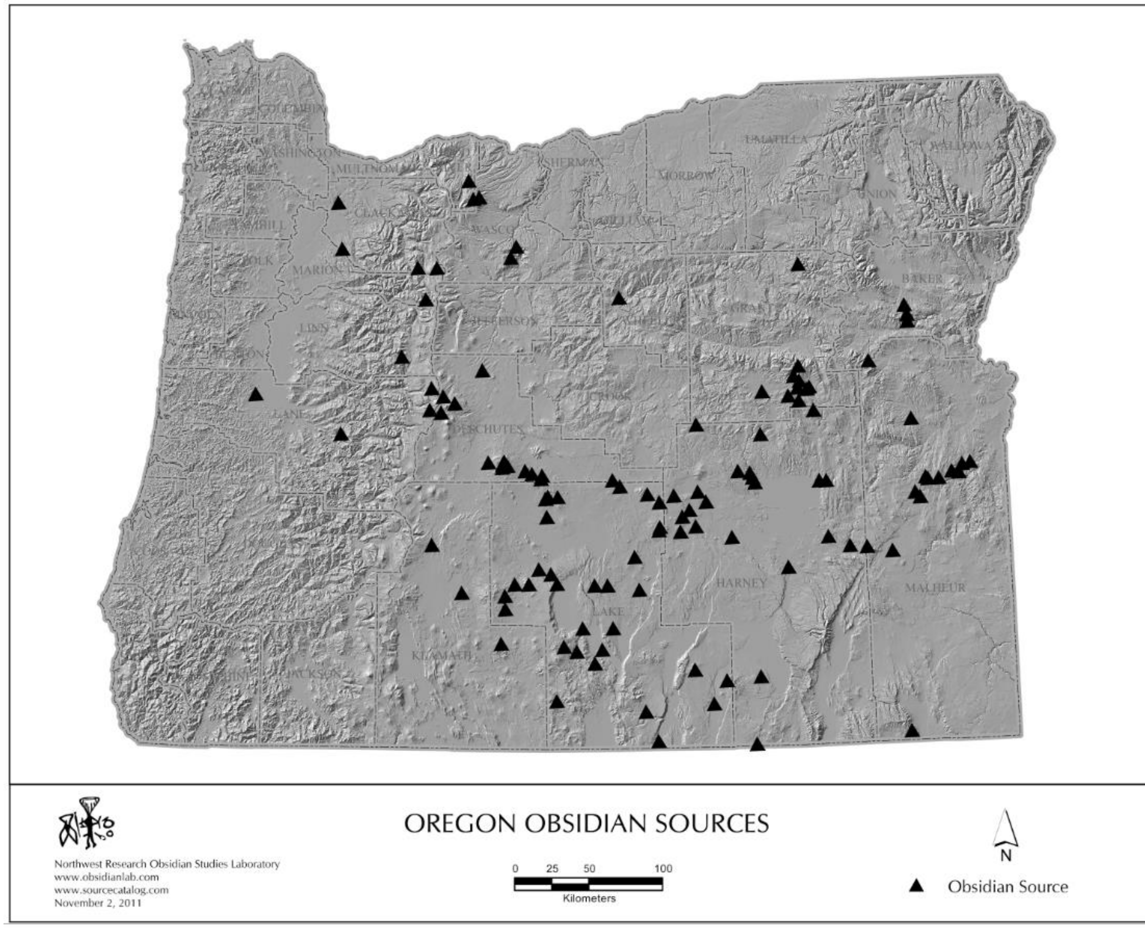

Figure 5: Obsidian sources in Oregon (Northwest Research Obsidian Studies Laboratory 2009)

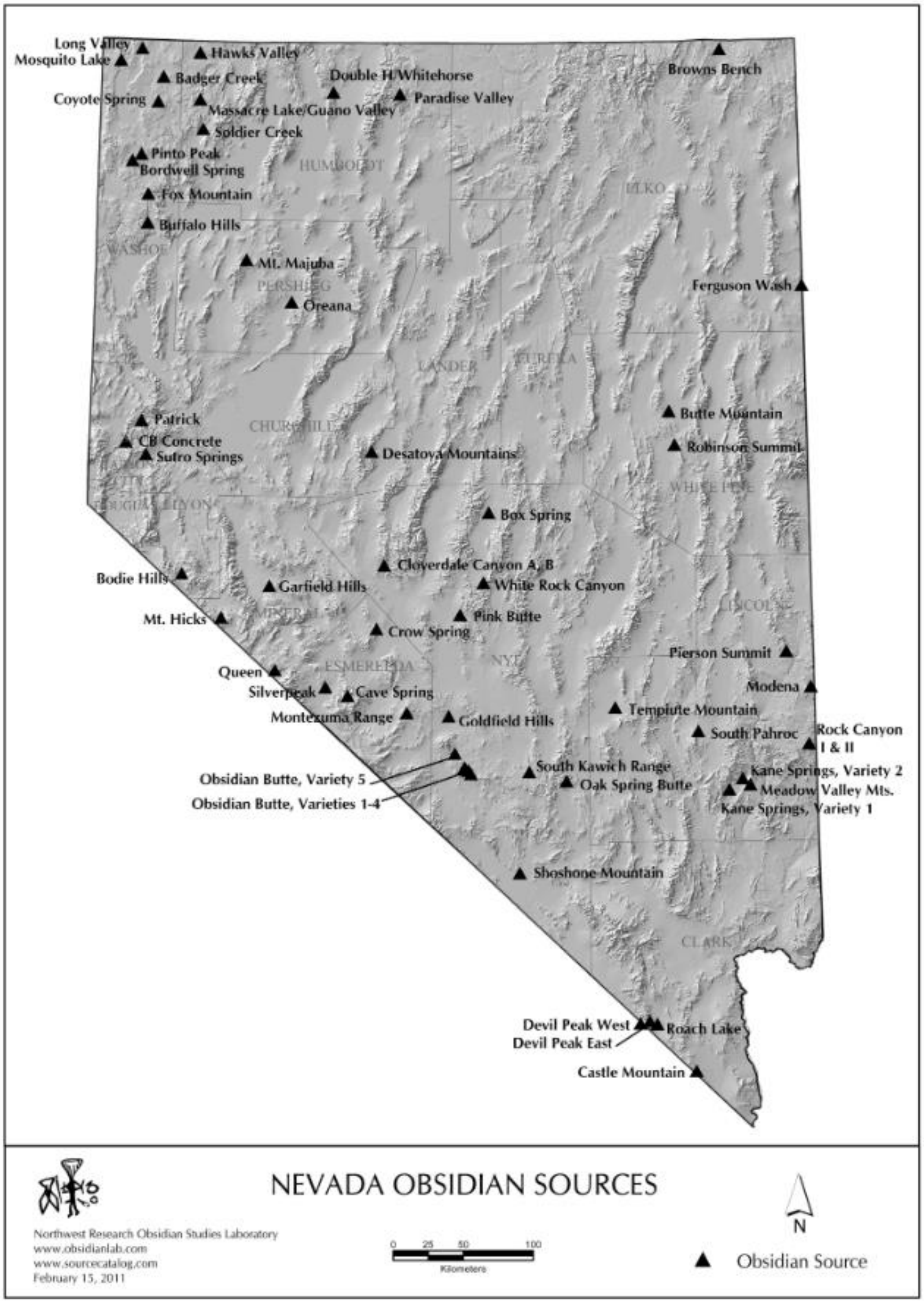

Figure 6: Obsidian sources in Nevada (Northwest Research Obsidian Studies Laboratory 2011).

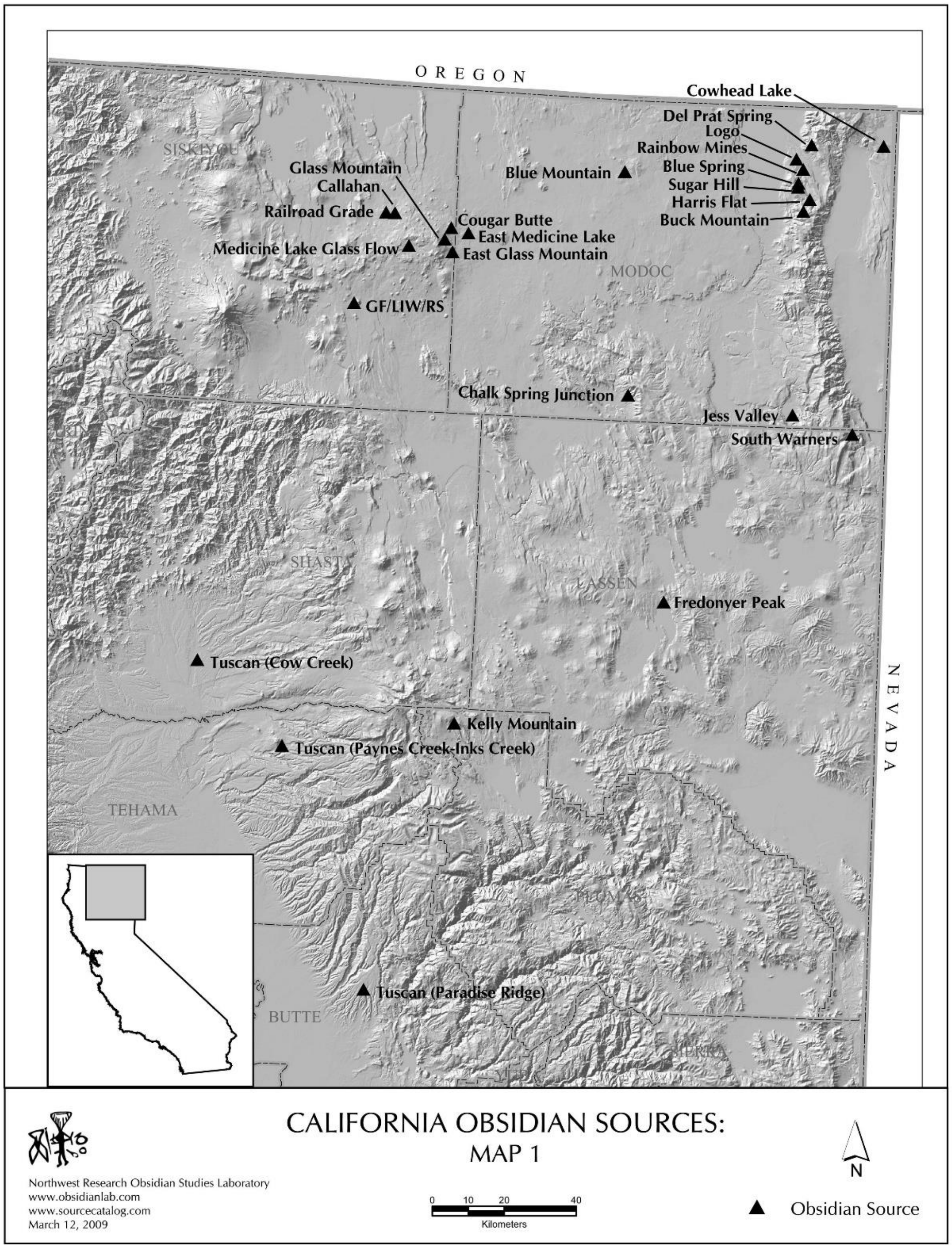

Figure 7: Obsidian sources in northeast California (Northwest Research Obsidian Studies Laboratory 2009).

Lithic Industries

Variability of stone tools within an archaeological assemblage can indicate changes in environment, resource availability and use, and technology (Wilde 1985). Alternatively, consistency of tools within an assemblage can indicate highly mobile groups and homogeneous geomorphology of the landscape (Beck 1984). Because projectile points tend to be the most chronologically diagnostic artifacts within an assemblage, archaeologists have worked extensively to develop methods for understanding trait variability through time (Beck 1994; Carr 1994; Largaespada 2006; Thomas 1981). Seriation dating has also allowed researchers to infer a chronological order that is used often to identify similarities and differences across a region (Figure 8 and 9) (Largaespada 2006; Thomas 1981). This often includes the interpretation, or interjection, of different cultural phases, for example, the Paleo-Indian Stage (Jenkins and Connolly 1990), the Western Pluvial Lakes Tradition (Bedwell 1973), the Paisley Period, the Fort Rock Period (Jenkins et al. 2004), and the Surprise Sequence (Hildebrandt et al. 2002; O'Connell 1975; O'Connell and Inoway 1994). Each of these stages, traditions, periods, and sequences are assigned based on the presence of stemmed points, stemmed points recovered near a Pleistocene lake, a combination of dart and arrow points, or predominantly arrow points.

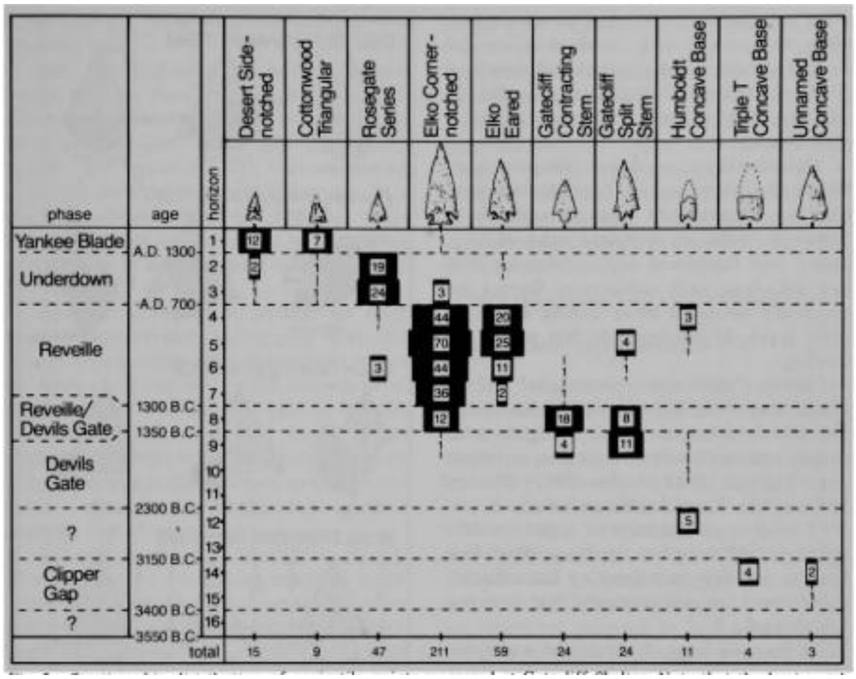

Figure 8: Projectile point types and their associated temporal phase from the Gatecliff Shelter (Monitor Valley, NV) (Thomas 1981: Figure 2).

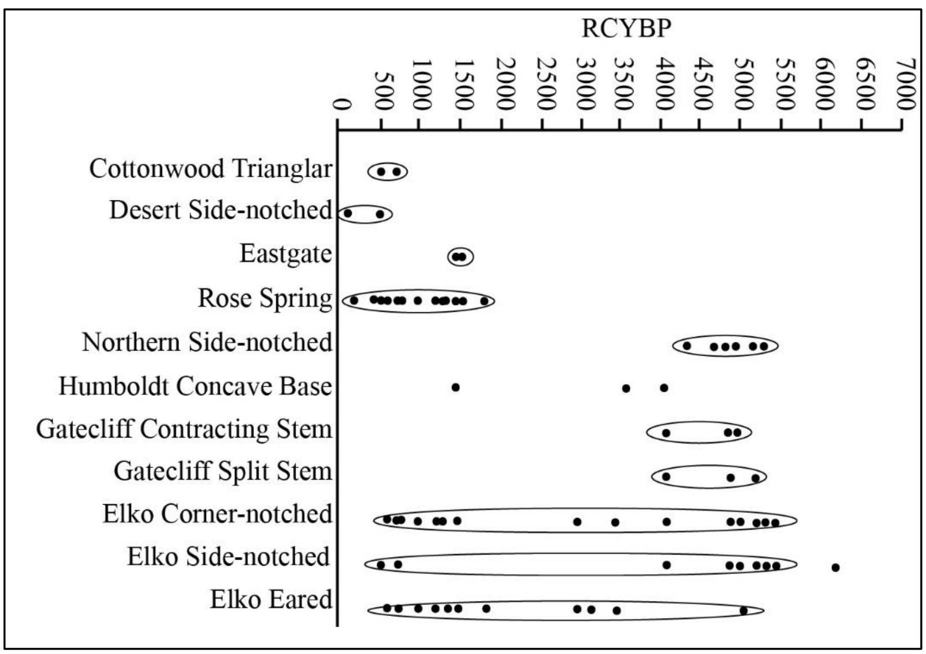

Figure 9: Radiocarbon dates (n = 37) from charcoal and marine shell directly stratigraphically associated, by feature, with typeable projectile points from archaeological sites in Fort Rock, Oregon (adapted from Largaespada 2006: Figure 4).

Understanding the developmental context for lithic industries and cultural heritage of the Great Basin is critical for interpreting traits present in assemblages from the archaeological region. The extensive stone tool analyses that has occurred across the Great Basin since the 1940's (Cressman et al. 1942), partnered with the understanding of extensive obsidian source distribution across the area, is advantageous for determining if the Wild/Clymer Collection sample is consistent with professional lithic assemblage analyses.

CHAPTER IV

LITERATURE REVIEW

Early research in the Great Basin evoked a wide array of research questions about adaptive change (Jones and Beck 1999), mobility (Smith and Harvey 2018), and technology (Hockett 1995; Flenniken and Wilke 1989; O'Connell and Inoway 1994; Thomas 1981). The extensive body of research and data that has accumulated from these pursuits has continued to contribute to the emergence of new, unexplored research questions. For example, the development and exploration of lithic conveyance zones offers an example of research questions that have developed following advanced research techniques and an increase in available site data across a vast region (Fowler 2014; Jones et al. 2003; Smith 2015; Smith and Harvey 2018).

In the following section, the above references and others are used to introduce literature surrounding each of the objectives identified in the previous chapter. Research surrounding morphological classification, typology and obsidian sourcing is abundant, providing critical information for building an analytical model for comparing the Wild/Clymer sample to data from the literature. The literature review sections below are organized by the objective's outlined in Chapter I.

Objective 1: Previous Models Used to Identify Provenience of Avocational Collections

Previous research has explored three lines of inquiry to investigate the provenience that might be gleaned from undocumented collections. Those lines of evidence are the utility of morphological trait characteristics, typology, and obsidian sourcing analysis to identify the provenience of avocational lithic artifact collections (Amick 2004; Boulanger and Graves 2017).

Amick (2004) conducted the analysis of provenience on the McNine Collection, an avocational collection of 19 large bifacial tools. The researcher identified one projectile point type, Parman (n = 6), and a variety of morphological traits in the collection, including late stage, stemmed preforms (n = 4), early stage preforms (n = 5), ovoid biface blanks (n = 2), a small triangular preform (n = 1), and a heavy scraper (n = 1) (Amick 2004:122-123). The researcher hypothesized that collection's provenience was northwest Nevada based on field notes left by the collector. Typological analysis using Justice (2002) identified point types consistent with the Western Stemmed Tradition. Additionally, the raw material source of each artifact was determined using XRF analysis methods, identifying sources from northwestern Nevada. The series of analyses applied to the McNine Collection, in addition to influence from the collector's notes, identified the regional provenience of the collection to northwestern Nevada.

In a more recent study, Boulanger and Graves (2017) sought to determine the provenience of the James M. Collins Collection, an avocational lithic collection donated to Simon Fraser University. Their research model utilized raw material sourcing, previously documented information from the collectors, and visually matched morphological characteristics to determine projectile point types using Justice (2002). The initial objective of the analysis was to rehouse the collection to curation standards, document the contents of the collection, and confirm the validity of documents associated with the collection. The results of the typological analysis identified provenience in southeastern Oregon and the raw material sourcing results identified provenience from southwestern Idaho. The researchers hypothesized that the artifacts may have been recovered from near the Oregon-Idaho border to account for the two different provenience designations. However, it would be interesting to compare these two designations to the archaeological record from both regions as additional support to their conclusion. Though each study outlined similar research objectives, neither used all three lines of inquiry simultaneously nor did they refer to the archaeological record of the identified region to support their hypotheses, leading to inconclusive results.

It is evident from these previous studies that combining morphological, typological, and provenance analysis can identify projectile point characteristics present in an avocational collection and recover information lost due to the avocational collection method. Based on these studies, the identification of morphological characteristics present in a collection may help to further narrow the geographic range where similar morphological characteristics appear in the archaeological record.

Objective 2: Morphological Classification

To analyze a large lithic artifact collection, the construction of a classification scheme with mutually exclusive and exhaustive dimensions structured to match the research question is necessary to ensure replicable analysis (Andrefsky 2005; Dunnell 1978). The use of similar classification schemes by archaeologists have proven useful in the identification of differences in morphology present in an assemblage (Beck 1984; Campbell 1981; Dunnell 1978; Kassa and McCutcheon 2016). Morphological analysis of lithic artifacts looks at variations in form (Gall and Hamilton 2013) and technological modification (Beck 1984). Research suggests that identifying morphological traits using mutually exclusive and exhaustive artifact groups assists with typological designations that use quantitative methods for replicable type determinations for individual time periods (Keene 2018; Thomas 1981). Dunnell (1978) emphasized the importance of recognizing that each research question and parameter that lacks clear definitions becomes ambiguous and can result in morphological attributes being arbitrarily selected for, against or neutral to selection.

Researchers have identified the necessity to include well-defined classification parameters in lithic analysis since as early as 1893 (Holmes 1893). Early studies understood that stone tool manufacture includes a variety of stages important for interpreting site function and that effectively communicating these stages requires exhaustive classification parameters (Jeffries 1982; Raab et al. 1979). Campbell (1981) established a well-defined paradigmatic classification scheme to answer questions about artifact assemblage characteristics and the model has since been adapted to answer new research questions (Beck 1984; Kassa and McCutcheon 2016; McCutcheon 1997; Parfitt and McCutcheon 2017). Explicitly defined dimensions and modes have been used to identify many different characteristics present in an assemblage, including bifacial reduction (Andrefsky 2005; Hildebrandt et al. 2016; Kelly 2001; O'Grady 2006), edge wear (Beck 1984; Jenkins and Connolly 1990), retouch (Campbell 1981; Crabtree 1972; Partfitt and McCutcheon 2017), corner-notched bases (Beck 1984), stemmed bases (Beck 1984), flake tools (Andrefsky 2005; Jenkins and Connolly 1990), and collateral flaking (Andrefsky 2005; Crabtree 1972). Morphological classification used descriptive groups of attributes to determine the degree of variability within an archaeological assemblage (Thomas 1989).

Beck (1984) emphasizes the utility of designing a paradigmatic classification scheme with exhaustive dimensions and modes to avoid inadvertently combining different style types and provide specific units for analyzing the assemblage. Creating and utilizing exhaustive classification dimensions allows researchers complete inter- and intra- collection comparisons between characteristics to separate the assemblage into groups that more explicitly help to answer research questions. Andrefsky (2005:76) and Andrefsky et al. (1994) provide a generalized morphological classification scheme that helps filter assemblages to better understand the diversity of artifact attributes within the collection. Identifying morphological traits present in the collection provides a means to identify which artifacts (e.g., projectile points) in the collection may be considered chronologically diagnostic for further typological analysis.

Objective 3: Great Basin Typologies

Interdisciplinary research by Luther Cressman (1942) and others (Cressman et al. 1940) mark the beginning of archaeological research and projectile point typology in the Great Basin (Aikens et al. 2011; D'Azevedo 1986). Early researchers in this coined "Explanatory Period" (Thomas 1981:8) focused on locating and recovering unique artifacts. Continued recovery of chronologically diagnostic artifacts in the Great Basin shifted interest towards the identification of different point types and the creation of chronologies based on their duration of use (Aikens 1978; Aikens et al. 1982; Amsden 1935; Bedwell 1973; Butler 1970; Clewlow 1967; Clewlow 1968; Cressman et al. 1942;

Daugherty 1962; Heizer and Hester 1978; Heizer and Baumhoff 1961; Hester 1973; Hocket 1995; Jenkins and Connolly 1990; Justice 2000; Lanning 1963; Layton 1970; Musil et al. 2002; Oetting 1994; Ozbun et al. 1996; Pettigrew 1979) (Figure 10). Many of these early chronologies are based on rockshelter sites, where deep stratification of occupations reveals the arrangement of artifacts through time (Jones and Beck 1999). Researchers during this period of "Americanist Archaeology" treated chronologies as the most important objective, where cultural periods only became legitimate when corroborated by absolute chronology (Lyman and O'Brien 2001:310). These projectile point types were determined intuitively based on reoccurring point characteristics in the archaeological record then assigned a certain time period (e.g., Heizer and Baumhoff 1961). The presence of diagnostic projectile points, interpreted to be associated with certain time periods, have proven useful for dating surface and subsurface occupations in the absence of or in collaboration with other absolute dating methods (Pettigrew 1979). Although the typologies established during this time continue to be used today, as the practice continued, regional variability and inconsistencies in the typologies have been identified and addressed by numerous researchers (Beck 1984; Beck and Jones 1989; Keene 2018; Jones and Beck 1999; Smith et al. 2013; Solimano et al. 2019).

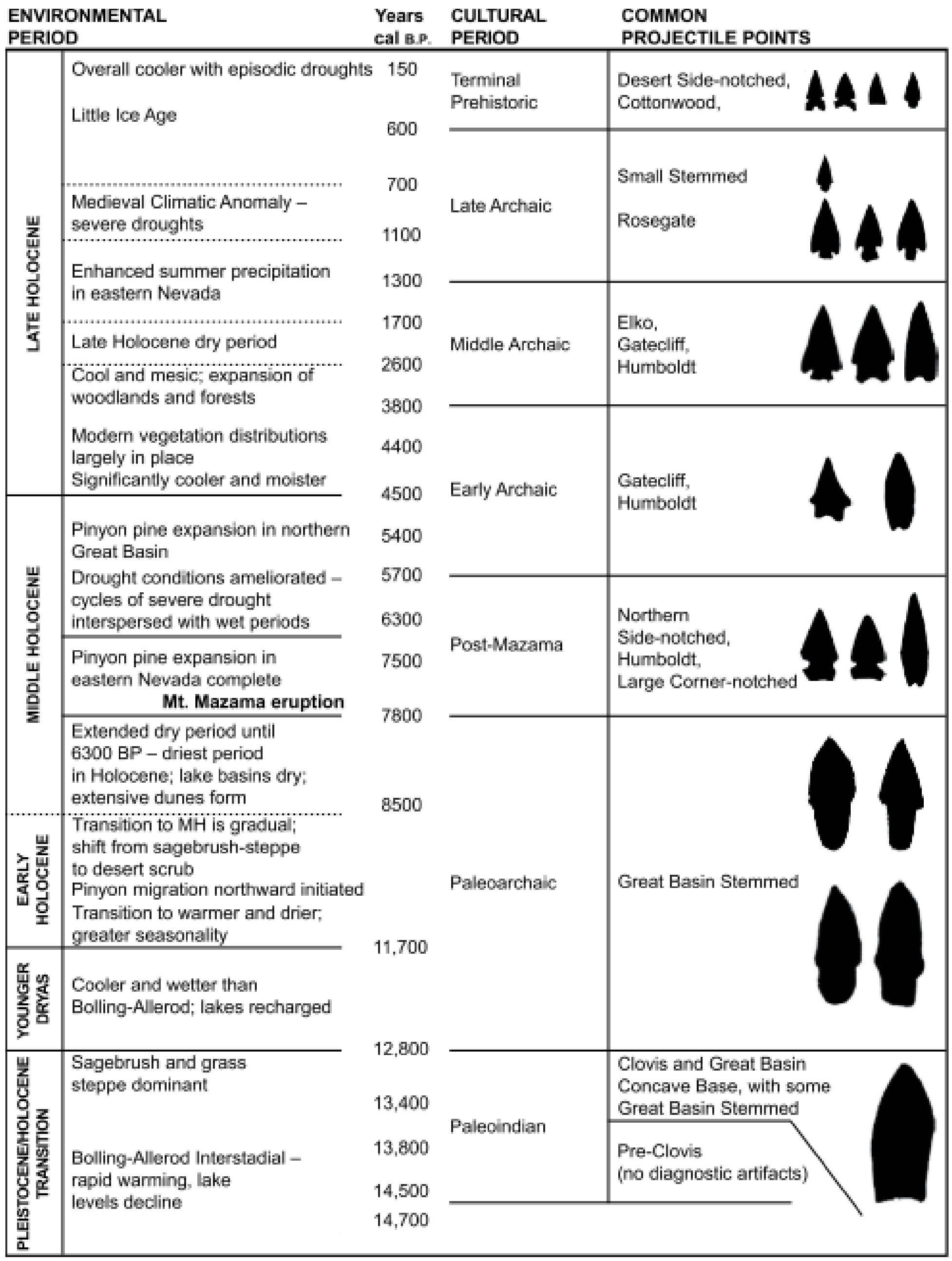

Figure 10: Chronological relationships between projectile point types and environmental change in the Great Basin (Hildebrandt et al. 2016: Table 7).

Thomas (1970, 1979, 1981) sought to mitigate inconsistent type determinations by developing a method to systematically assign point types using a mutually exclusive and exhaustive key (Figure 11). The Monitor Valley Key includes point types which occur in the archaeological record after the Mount Mazama eruption approximately 7,000 years BP (Aikens et al. 1982, Toepel et al. 1980). Establishing this key, Thomas (1981) emphasized that regional variability of point types is a limitation of using such a rigid key and the distance from Monitor Valley should be taken into consideration when utilizing the scheme. Researchers continue to use the Monitor Valley key across the Great Basin (Hester 1973; Jenkins and Connolly 1990; Musil et al. 1990; O'Grady 2006; Raven and Elston 1992; Wriston 2003) including areas extending to northern California (Koerper et al. 1996), southern California (Jenkins 1987) and south-central Nevada (Kelly 2001). Within the study area, the Monitor Valley Key (Thomas 1981) is still used in archaeological investigations (Table 1).

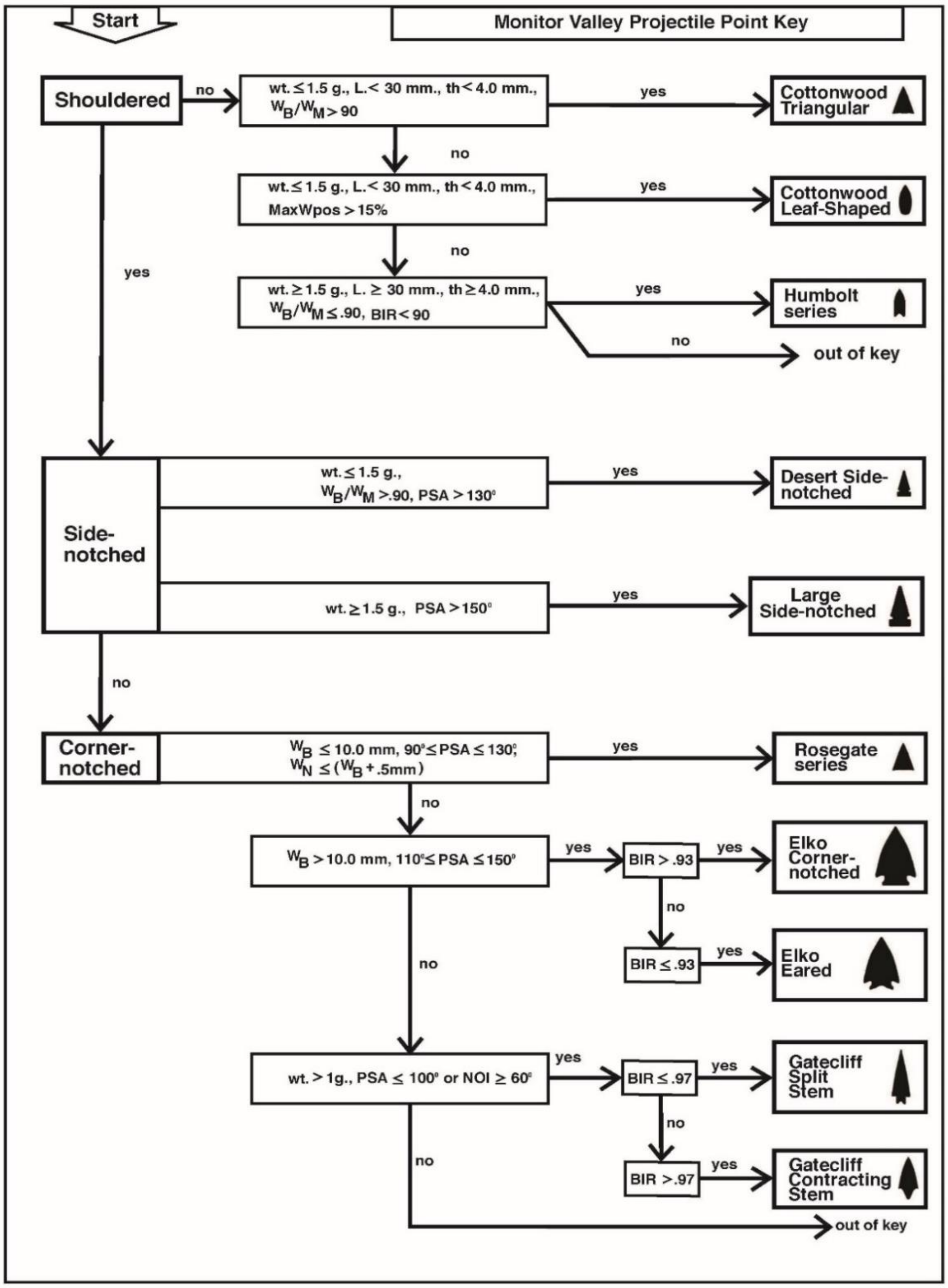

Figure 11: Monitor Valley typological key (Thomas 1981:25) (adapted by Dennis Wilson, see acknowledgements).

Table 1: Projectile Point Analyses Using the Monitor Valley Key (Thomas 1981)

Citation	**Site**	**# of Points**	**Types Present**
Jenkins and Connolly 1990	35HA1421	19	Rosegate, Elko Eared, Gatecliff Split Stem (GSS), Humboldt
Musil et al. 1990	35HA1261	16	Rosegate, Elko Eared, Northern Side Notched (NSN), Stemmed, Humboldt
Musil et al. 1991	35HA1263	120	Desert Side Notched (DSN), Small Stemmed, Elko Eared, Elko Eared
O'Grady 2006	35HA2423	15	Cottonwood Tri, Eastgate, Elko Eared, Elko Corner Notched (Elko CN)
O'Grady 2006	35HA2422	22	Eastgate, Elko CN, Humboldt, Small SN
O'Grady 2006	35HA2692	23	Eastgate, Rose Spring, Small Stemmed, NSN
Raven and Elston 1992	35HA1028	22	DSN, Great Basin Stemmed, Humboldt
Solimano et al. 2019	35HA4897	9	Elko series, Humboldt, GSS
Solimano et al. 2019	35HA4844	3	Northern SN, Cottonwood Triangular
Solimano et al. 2019	35HA4845	1	Eastgate
Solimano et al. 2019	35HA4847	11	Eastgate, Elko series, Rose Spring

Following the continued use of the typological key introduced by Thomas (1981), researchers have adapted the key to different regions of the Great Basin (Hildebrandt et al. 2016; Keene 2018; Largaespada 2006). Largaespada (2006) tested the utility of the Monitor Valley Key on assemblages from the northern Great Basin, adapting the key to account for identified variability in side-notched points (Figure 12). The analysis of eight sites by O'Grady (2006) supported the utility in adapting the Monitor Valley Key to account for variability of side-notched points in the northern Great Basin. Hildebrandt et al. (2016) adapted the Monitor Valley Key to account for variability in the size of dart and arrow points not captured by the original typology. Keene (2018) added to the key to include types occurring prior to the Mazama eruption, including Western Stemmed, Birch Creek, Salmon River, Pinto and Avonlea points.

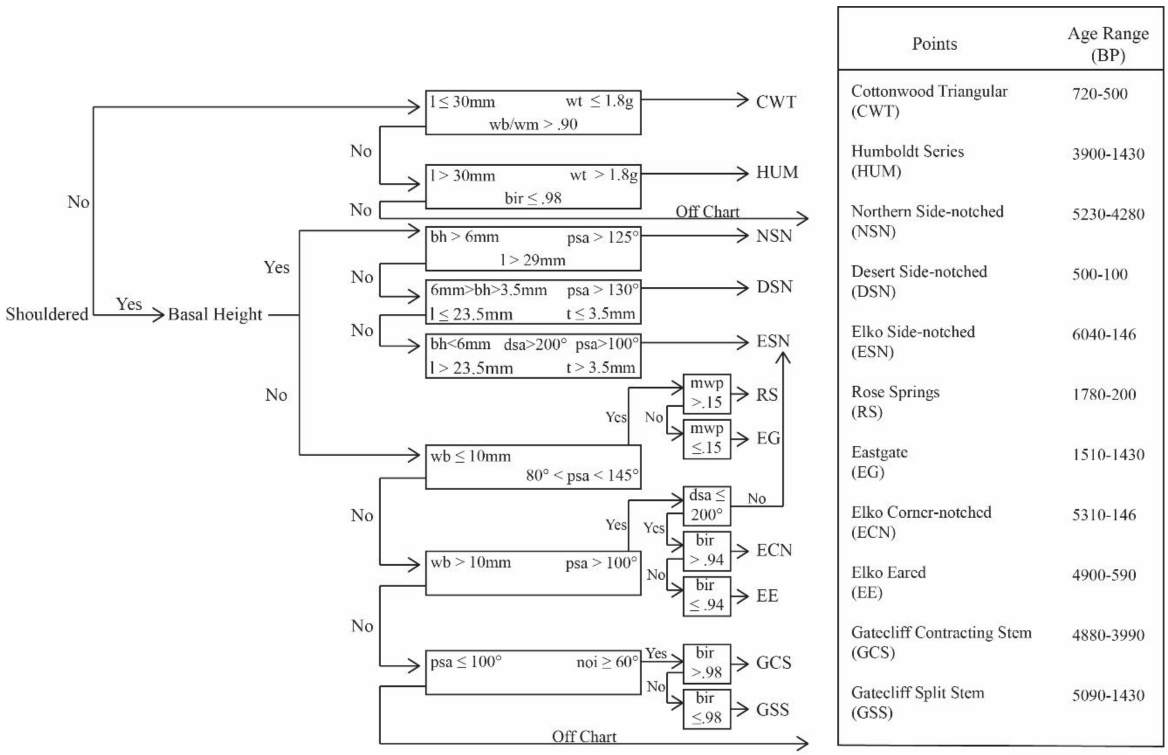

Figure 12: Typological key for determining projectile point types within the northern Great Basin and associated chronology (adapted from Largaespada 2006: Figure 10 and Table 1).

Today, the most common use for typologies and time-sensitive point types is in cultural resource management. When resource managers are working under the National Historic Preservation Act (NHPA Section 106), chronologically diagnostic point types present at an archaeological site help to identify site age, a useful tool in ascertaining site significance. Since the introduction of NHPA, compliance in this region has identified a vast number of surface and subsurface sites that have undergone archaeological investigation, including the use of typologies to evaluate site significance (Fulton et al. 1999; Gall and Hamilton 2013; Gilmour et al. 2016; Hildebrandt et al. 2016; Jenkins and Connolly 1990; Musil 2004; Musil et al. 1990; Musil et al. 2002; Ozbun et al. 1996; Sappington 1980; Solimano et al. 2019; Wriston 2003). After determining the variability of projectile point types present in the collection, some researchers continued the analysis to include provenance studies to answer additional research questions (Gilmour et al. 2016; Jenkins and Connolly 1990; Solimano et al. 2019).

Objective 4: Provenance Studies

Hughes (1986) and Skinner (1983) were two of the first researchers to systematically record the geochemical variability of obsidian tool stone raw material from archaeological contexts in western North America, establishing the utility of obsidian sourcing studies (Skinner and Thatcher 2003). X-Ray fluorescence (XRF) methods measure the trace element concentrations unique to specific sources of obsidian (Fulton et al. 1999). XRF analysis has been used in archaeological investigations to answer diverse range of research questions (Beck and Jones 2010; Newlander 2012; Jones et al. 2003; Shackley 2018).

Large-scale excavations, data recovery projects, and NHPA Section 106 compliance have made significant contributions to the understanding of source use in Great Basin. XRF methods have been employed to understand and infer source procurement ranges, (Gilmour et al. 2016; Jenkins and Connolly 1990; Ozbun et al. 1996; Shackley 1998, 2002), source use through time (Solimano et al. 2019), and to support obsidian hydration analyses (Fulton et al. 1999). Cultural resource management reports from archaeological projects within the study area are extensive, providing a robust body of information that can be used to identify archaeological characteristics of the region (Table 2). For instance, the PGT-PG&E Pipeline Expansion project was a large contributor of provenance information at 22 prehistoric sites stretching across Idaho, Washington, Oregon, and California (Schalk et al. 1995). The FTV Western Fiber Build Project (Fulton et al. 1999; Skinner and Thatcher 2003) (Figure 13), the Tuscarora-Alturas Project (Hildebrandt and King 2002), and the Ruby Pipeline Project (Hildebrandt et al. 2016) were all large-scale compliance projects that utilized XRF methods to identify raw material sources for thousands of artifacts recovered from sites across the Great Basin.

Table 2: Obsidian Sourcing Analyses

Citation	Site	# of Specimens	Sources Present
Gilmour et al. 2016	35HA3293	22	Burns, Rimrock Springs
Jenkins and Connolly 1990	35HA1421	19	Beatys Butte, Chickohominy, Venator, Whitewater Spring, Horseshoe Bar
Lyons et al. 2001	35HA792	32	Massacre Lake/Guano Valley, Tule Spring, Beatys Butte
Lyons et al. 2001	35HA1263	10	Venator, Beatys Butte, Indian Creek Buttes, Wolf Creek, Burns
Musil et al. 2002	35HA403	48	Burns, Dog Hill, Glass Buttes, Tule Spring, Venator, Whitewater Ridge
Ozbun et al. 1996	35HA2555	30	Burns, Wolf Creek, Riley
O'Grady 2006	35HA2423	11	Burns, Dog Hill, Venator, Double O, Wolf Creek
O'Grady 2006	35HA2422	15	Whitewater Ridge, Burns, Dog Hill, Beatys Butte
O'Grady 2006	35HA2692	46	Burns, Chickahominy, Riley, Rimrock Springs, Double O
Skinner and Thatcher 2003	35LK2544	40	Glass Buttes 1, 3, 4, 5, 6 and 7
Skinner and Thatcher 2003	35LK3171	20	Big Stick, Riley, Glass Buttes 3, 4, 5, and 7
Skinner and Thatcher 2003	35HA80	20	Glass Buttes 3, 4, 5, 6 and 7
Skinner and Thatcher 2003	35HA2875	16	Quartz Mountain, Glass Buttes 3, 4, and 9
Skinner and Thatcher 2003	35HA2876	20	Glass Buttes 1 and 4
Skinner and Thatcher 2003	35HA2877	20	Glass Buttes 3, 4, and 9
Skinner and Thatcher 2003	35HA2878	20	China Lake, Glass Buttes 4
Skinner and Thatcher 2003	35HA2879	20	Glass Buttes 3, 4, 5, and 7, Tank Creek

Table 2. (continued)

Skinner and Thatcher 2003	35HA2880	20	Beatys Butte, Big Stick, Buck Spring, Chickahominy, Glass Buttes 1, 3 and 4, Palamino Buttes A, Rimrock Spring, Squaw Mountain, Tank Creek, Upper Lake Gap
Skinner and Thatcher 2003	35HA2885	20	Chickahominy, Double O
Skinner and Thatcher 2003	35HA2893	20	Buck Spring, Burns, Double O, Riley
Skinner and Thatcher 2003	35HA2895	20	Beatys Butte, Big Stick, Buck Spring, Burns, Dog Hill, Riley, Venator, Whitewater Ridge
Skinner and Thatcher 2003	35HA2899	20	Buck Spring, Burns, Mud Ridge, Rimrock Spring
Skinner and Thatcher 2003	35HA2901	20	Burns, Dog Hill, Squaw Mountain
Skinner and Thatcher 2003	35HA2904	20	Buck Spring, Burns, Chickohominy, Dog Hill, Rimrock Spring, Whitewater Ridge
Skinner and Thatcher 2003	35HA2905	20	Burns, Dog Hill, Mud Ridge, Whitewater Ridge
Skinner and Thatcher 2003	35HA2906	20	Burns, Dog Hill, Gregory Creek, Tule Spring, Whitewater Ridge
Skinner and Thatcher 2003	35HA70	20	Curtis Creek, Gregory Creek, Tank Creek, Tule Spring, Van Gulch, Wolf Creek
Skinner and Thatcher 2003	35HA2913	10	Gregory Creek, Van Gulch, Wolf Creek, Unknown
Solimano et al. 2019	35HA4899	4	Burns
Solimano et al. 2019	35HA4897	15	Burns, Dog Hill, Burnt Mountain, Riley
Solimano et al. 2019	35HA4844	7	Burns, Whitewater Ridge, Mud Ridge, Coyote Wells, Dog Hill
Solimano et al. 2019	35HA4845	6	Burns, Rimrock Spring
Solimano et al. 2019	35HA4846	27	Burns, Glass Buttes, Dog Hill, Tule Spring, Venator
Solimano et al. 2019	35HA4847	8	Burns, Tule Spring, Rimrock Spring, Indian Creek Buttes

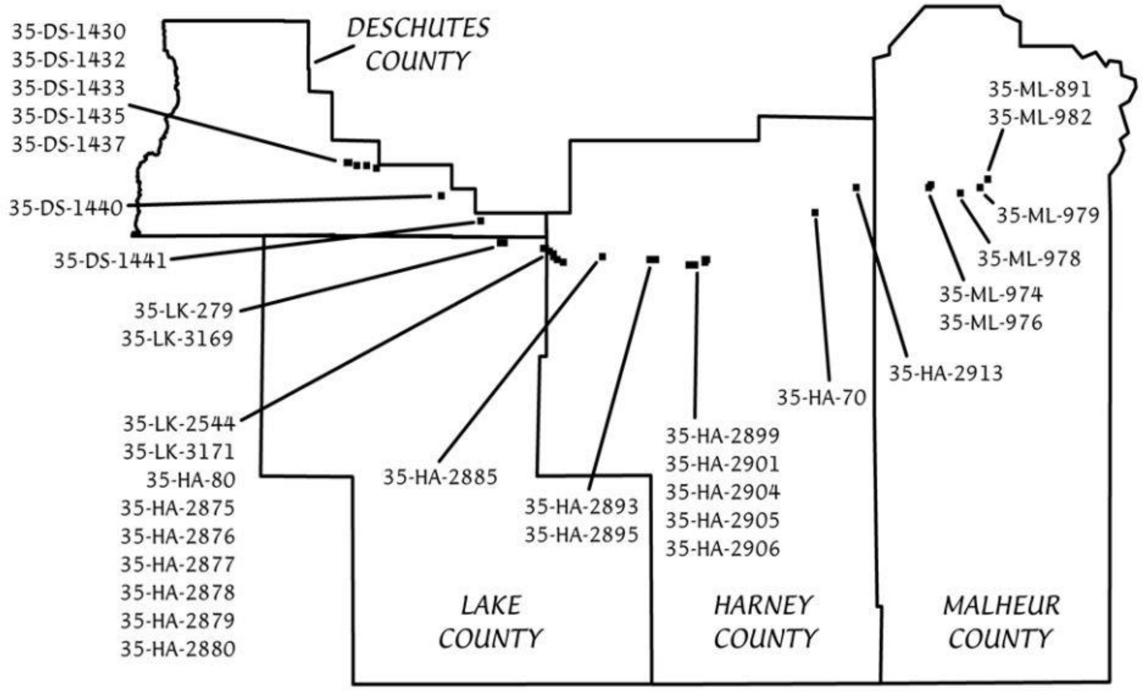

Figure 13: Distribution of sites identified during the FTV Western Fiber Build Project (Skinner and Thatcher 2003: Figure 1).

Following the recovery of many artifacts at a site, it is often necessary to sub-sample the assemblage when approaching provenance studies to ensure information gleaned from the chosen artifacts will address specific research questions within budgetary constraints (Pettigrew 1979). Researchers apply XRF methods to a sub-sample of chronologically diagnostic artifacts when their research question involves interpretation specific to those artifacts (O'Grady 2006; Solimano et al. 2019). When an analysis investigates differential source use between diagnostic points and debitage, researchers chose a random sample of both artifact types for XRF analysis (Hildebrandt et al. 2016). To describe the entire population of obsidian sources across a project area, researchers chose a random sample from each excavation unit in order to identify raw material source (Gilmour et al. 2016; Fulton et al. 1999). Researchers may also apply trace element analyses to specific artifacts identified as useful for answering research questions about site use and function (Ozbun et al. 1996).

Objective 5: Comparison and Interpretation

By partnering typological and provenance analysis of lithic artifacts (O'Grady 2006; Solimano et al. 2019; Jenkins and Connolly 1990; Ozbun et al. 1996; Musil et al. 2002; Fulton et al. 1999; Sappington 1980; Lyons et al. 2001), archaeologists have hypothesized a relationship between raw material source use and projectile point types present throughout the northern Great Basin. Depending on the research questions, the researcher's goal for including typological analysis and raw material sourcing can change. Investigators seeking to identify patterns in source use during different occupations at the site would benefit from including both typological analysis and raw material sourcing useful in the analysis (Lyons et al. 2001; O'Grady 2006; Solimano et al. 2019). Gathering both typological and raw material source data at a site assists researcher's interpretation of preferential use of certain obsidian sources for different projectile point types (Fulton et al. 1999). Researchers seeking to compare the use of local and distant obsidian sources through time may identify both raw material source use and projectile points at the site (Lyons et al. 2001). Typological analysis and raw material sourcing prove useful for researchers in interpreting the movement of material and groups across the landscape (Jenkins and Connolly 1990; Jones et al. 2003).

Research undertaken at the Headquarters Site (35HA403) since the 1980's offers insight on relationships identified using typology and raw material sourcing. The

Headquarters Site lies within the Malheur National Wildlife Refuge and represents one of many large federal undertakings requiring cultural resource management on the refuge. Investigations at the Headquarters Site have provided a vast body of information on projectile point types recovered throughout Harney County, Oregon, in addition to more recent raw material sourcing data (Musil et al. 2002). The researchers interpret that the provenance results to demonstrate localized obsidian use, including obsidian from Burns Butte, Dog Hill, Glass Buttes 3 and 6, Indian Creek Buttes A, Tule Spring, Venator, and Whitewater Ridge (Musil et al. 2002:2). Investigations at the McCoy Creek site (35HA1263) and the Lost Dune site (45HA792) in southeast Oregon provide an example for how the relationship between typology and raw material source use can change over time (Lyons et al. 2001).

Typological and sourcing data from an assemblage is used to demonstrate the frequency that specific obsidian sources are used to manufacture specific projectile points. Researchers can apply frequency data for each source across a landscape to identify where occupants of specific sites extracted their raw material (Lyons et al. 2001) (Figure 14). When comparing the results of an archaeological analysis with sites in the area, morphological and typological analysis can identify traits that are consistent with others in the region (Canaday 2003). This method has proved useful in Archaeological Resource Protection Act (ARPA) compliance investigations in Death Valley National Park (Canaday 2003) and in the Malheur National Wildlife Refuge (Canaday 2016) to determine if disturbed artifacts are consistent with the archaeological record in a specific area.

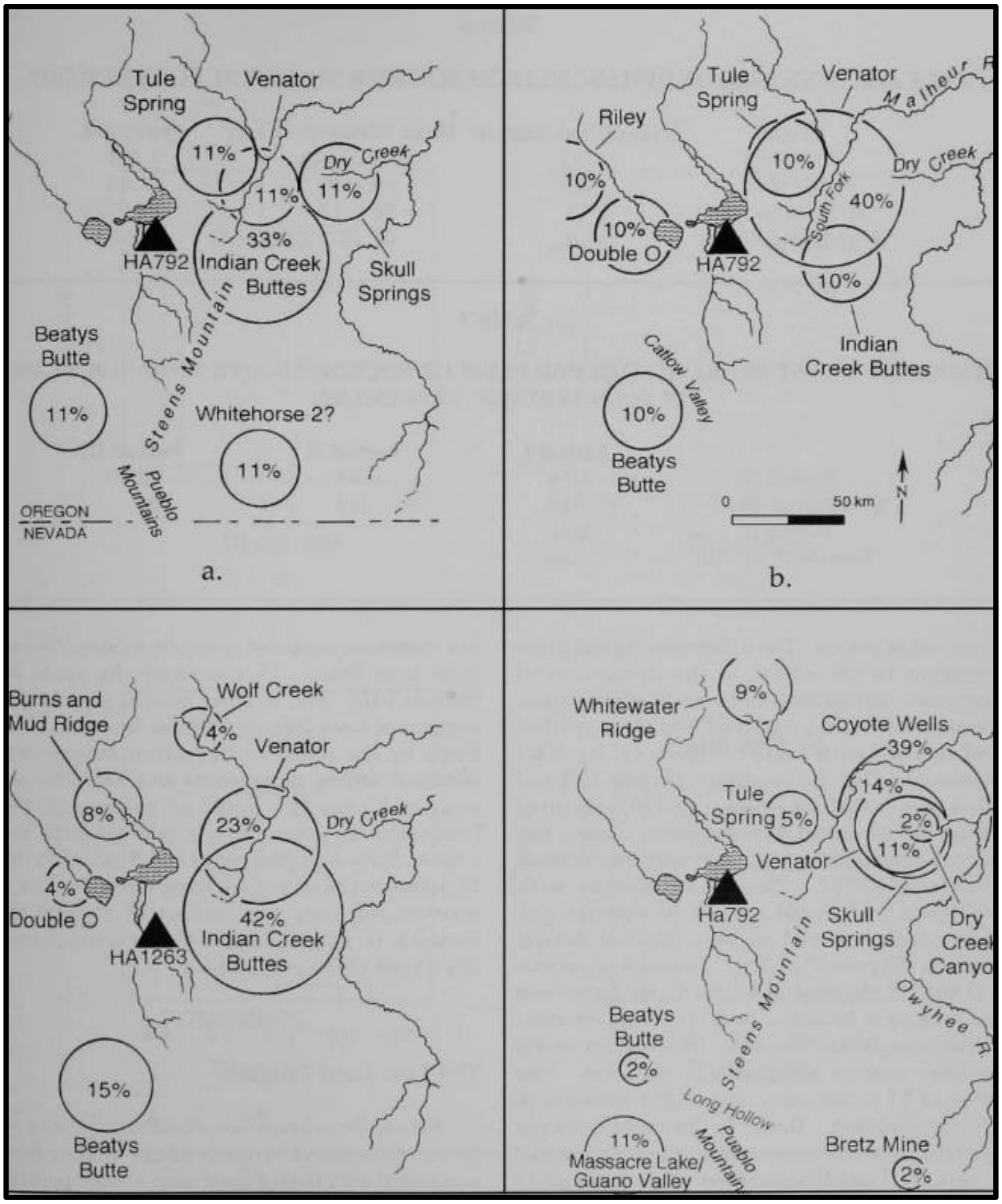

Figure 14: Changing obsidian source procurement distributions at the Lost Dune site (35HA792) and the McCoy Creek site (35HA1263) across four time periods (a. 3,500-2,000 B.P., b. 2,000-500 B.P., c. cal. A.D. 1,400's, and d. cal. A.D. 1,500's) (Lyons et al. 2001:Figure 3).

Antiquity in the northern Great Basin has been of interest to archaeologists for decades (Cressman et al. 1942) and of interest to private citizens for centuries (Fowler and Malinky 2006). This culmination of research and exploration has left a vast body of information pertaining to lithic characteristics and frequencies unique to this area. The diverse archaeological record in the northern Great Basin is attributed to the concentration of raw material sources and variability of cultural and technological traditions in the area for thousands of years. The following chapter presents established methods and techniques used to analyze projectile points from known archaeological sites and outlines their application to an avocational lithic artifact collection.

CHAPTER V

METHODS AND TECHNIQUES

This section introduces the framework used to analyze each variable used to determine if the Wild/Clymer Collection sample is consistent with the regional archaeological record within the study area (Figure 15). The analysis will include methods and techniques used by previous researchers. Many of them are modified to adapt to the morphological, typological, and raw material provenance characteristics present in the Wild/Clymer Collection sample. The following analysis uses three lines of evidence to investigate the primary research question for this analysis: can morphological, typological, and raw material provenance analyses be used to assign regional provenience to the Wild/Clymer Collection sample by identifying characteristics in the collection that are consistent with professionally generated assemblages with known provenience?

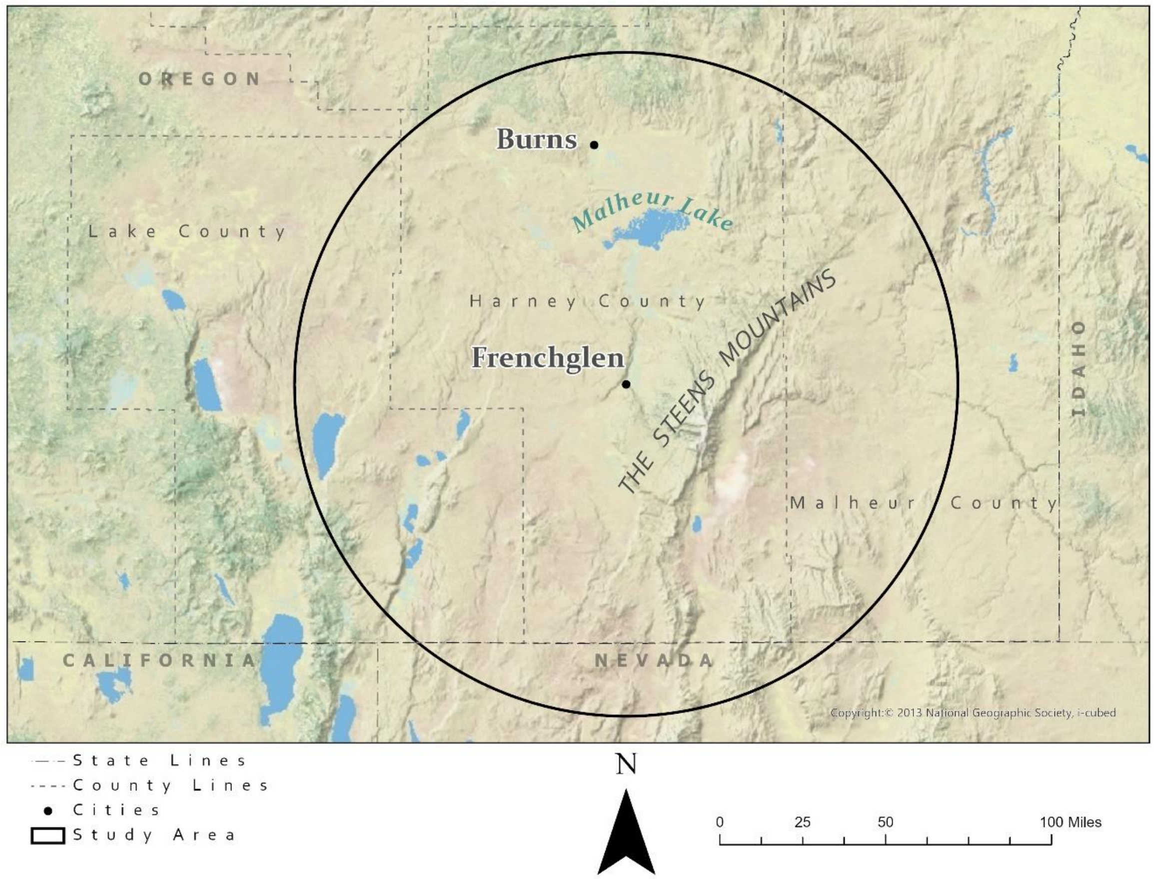

Figure 15: Map depicting the study area (created by Mars Galloway from an ESRI base map, see acknowledgements).

An analytical model was created that articulates and addresses the intervariable relationships between morphology, typological, and provenance. These relationships can be explored by rephrasing them as hypothetical statements (i.e. hypotheses) of relatedness. For instance, the more similarities in stylistic characteristics of the Wild/Clymer Collection sample when compared to the professionally recorded archaeological records, the more likely they were drawn from the same population of stone tool makers and users. The reason for this is explained in the first section of this chapter, Objective 1: Model Development. The following sections outline the methods and techniques involved in collecting morphology and style, projectile point type, and raw material provenance data from the Wild/Clymer Collection. The process of describing, comparing and contrasting, and then interpreting the data collected from the Wild/Clymer Collection sample and assemblages with known provenience from within the study area is discussed in the last section.

Objective 1: Model Development

A model for analysis was constructed to illustrate the relationship of each variable (e.g. morphology, type/style, and raw material provenance) to the research question (Figure 16). The goal of this approach is to use analytical schemes that interpret tool making behaviors from the northern Great Basin to provide the greatest degree of comparability to analyzed assemblages with known provenience from within the study area. This expands on previous studies of avocational collections that used similar variables (Amick 2004; Boulanger and Graves 2017) but did not compare those characteristics to the robust archaeological literature containing comparable artifact assemblage descriptions. Identifying the impact of intervariable relationships on the presence of characteristics in the Wild/Clymer Collection sample is critical for interpreting the presence or absence of certain traits and how they may be disproportionally represented compared to professionally analyzed site assemblages.

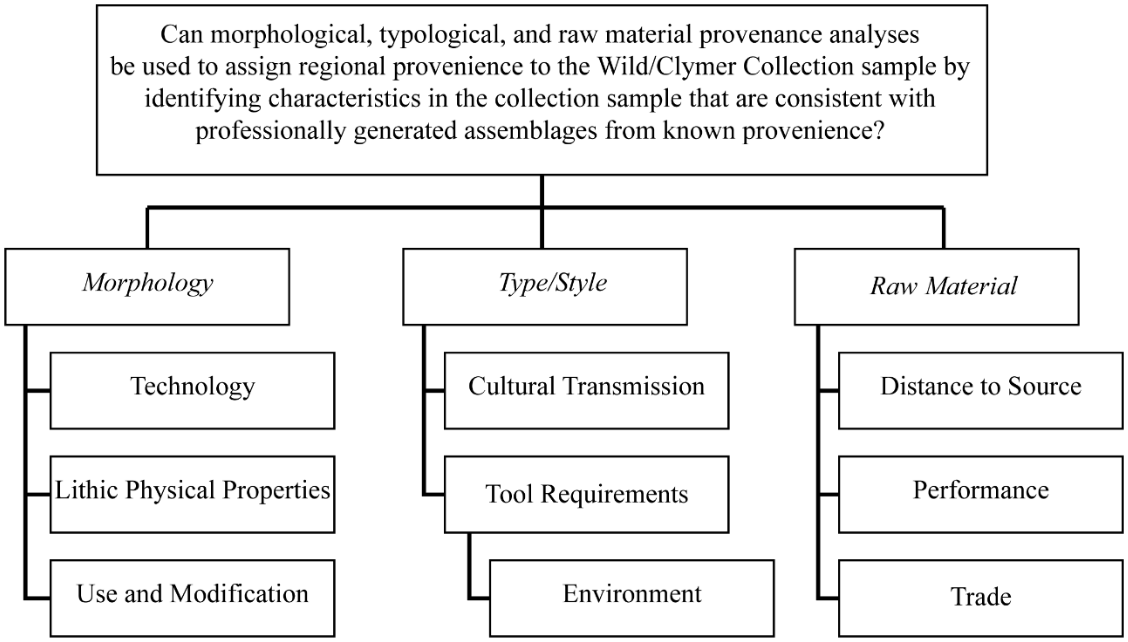

Figure 16: Model of research question.

The morphology of stone tools is dependent on three sub-variables: technology, lithic physical properties, and use and modification. The steps of manufacture used to produce different objective pieces is dependent on the raw material morphology, the size of the raw material used, the reduction trajectory, and the abundance of raw material (McCutcheon 1997). A manufacturing site located near a poor raw material source likely possesses more expedient morphological traits, whereas a site near a high-quality raw material source likely possesses more formalized or curated tools (Andrefsky et al. 1994; Smith 2015). The distance to raw material source also impacts the quantity of waste products produced resulting in additional impacts to use life and modifications prior to discard. Identifying use and remodification of projectile points evident through morphology can be attributed to different styles and their intended function (Andrefsky 2005). The amount of use and retouch found on projectile points from sites within obsidian-scarce versus obsidian-dense areas is found to be statistically different between the two regions (Smith 2015).

While technology, lithic physical properties, and use and modification affects the morphological characteristics present in a projectile point assemblage, each is also impacted by the raw material used and the intended style. The availability of raw material resources intertwines with the ability for flintknappers to produce different morphological and stylistic projectile point characteristics. More specifically, abundance, size, and quality of local raw material affects the lithic technology present at an archaeological site (Andrefsky et al. 1994). Different available material types influence the variability of projectile point types and their persistence in the archaeological record in certain areas (Thomas 2013). The regional distribution of raw material sources, whether highly localized or widely distributed, represented in an avocational projectile point collection will also have an impact on the presence of formal stylistic traits (Andrefsky et al. 1994; Binford 1977; Kelly 2001), degree of retouch and reuse (Smith 2015), and the utility of projectile point typological schemes from areas other than the original provenience of the collection's artifacts (Thomas 2013).

While it is beyond the scope of this analysis to interpret the function of each projectile point, the presence of remodification (e.g. asymmetrical and different flaking pattern on blade and haft) (Kelly 2001; Smith 2015; Smith et al. 2013) and retouch (Wriston 2003) describes the durability of both projectile point style and raw material. The location where projectile points are being manufactured in the landscape determines the distance to and effort necessary to extract raw material and is necessary to consider when interpreting style and artifact type. This relationship is hypothesized by some to be a function of rejuvenation rather than the transmission of new stylistic techniques to a new area (Flenniken and Wilke 1989). However, others infer that the continuity of traits is a product of cultural transmission passed directly through generations of tool makers (Lyman and O'Brien 2001).

Understanding how morphology, type/style, and raw material source influence each other contributes to the understanding of the consistencies between the results from an avocational artifact collection and from analyses of professional assemblages with known provenience. This process recovers information beyond each individual variable and recovers information otherwise lost from the avocational collection strategy, helping to infer a regional provenience designation. The execution of analyzing these three variables in the Wild/Clymer Collection sample and their relationship to the archaeological record for a specific region is presented as a flow chart (Figure 17). A critical feature of this analytical approach is the comparison between collection characteristics and the characteristics of professional assemblages from a specific archaeological region. This step allows for the information recovered, through analyzing the three variables and their inter- and intra-correlation, interpreted as originating from a specific region with consistent correlations occurring in site data with known provenience.

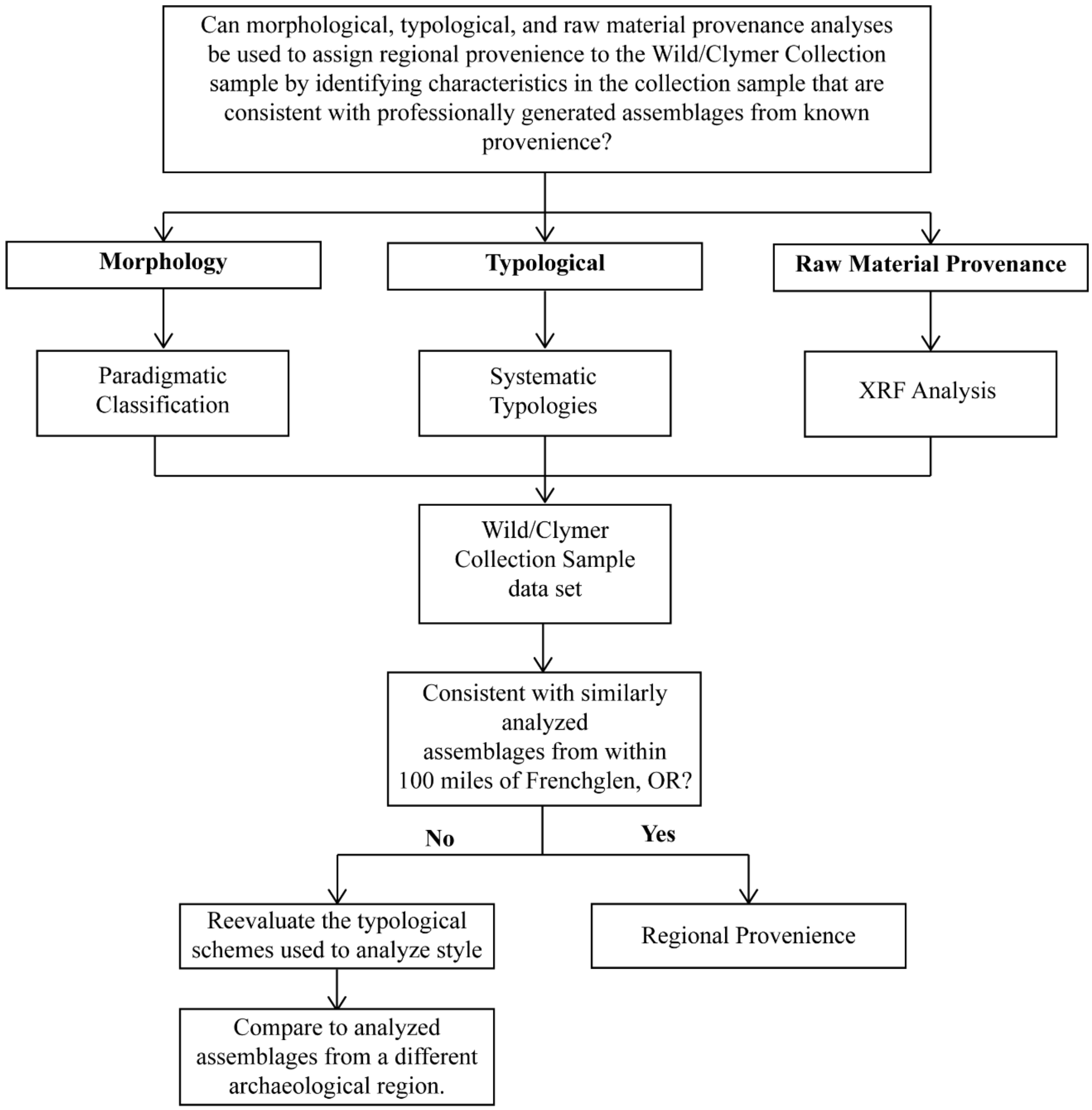

Figure 17: Flow chart used to determine reginal provenience of an avocational artifact collection.

Objective 2: Classification

In order to gather information on the variability of morphological and stylistic characteristics present in the Wild/Clymer Collection sample (n = 1,376), the utility of a general morphological scheme by Andrefsky (2005) and Andrefsky et al. (1994) was tested. The "nominal variable flow chart" (Andrefsky 2005:76) was used to identify general morphological characteristics in the collection; however, the parameters of the scheme were not found to be inclusive to attributes identified in the collection and the definitions used in the key were not mutually exclusive. Neither of these characteristics were supposed to be part of the key as its intent was only a basic sorting tool.

Hughes et al. (2019) created a classification scheme, modified from several sources (Andrefsky 2005; Andrefsky et al. 1994; Campbell 1981; McCutcheon 1997). This classification scheme seeks to isolate projectile point characteristics that indicate raw material availability (Smith 2015), intended function (Andrefsky et al. 1994), reuse (Andrefsky 2005), transportation damage (Amick 2004), and haft characteristics (Largaespada 2006; Thomas 1981). The goal of this scheme was to use mutually exclusive and exhaustive dimensions and modes to determine classes of technological and stylistic attributes present in the collection sample. To support replicability, the parameters for each dimension and mode was explicitly defined (Table 3) using several sources (Andrefsky 2005; Beck 1984; Campbell 1981; Crabtree 1972; Dunnell 1978; Hildebrandt et al. 2016; Jenkins and Connolly 1990; Parfitt and McCutcheon 2017; Pettigrew 1979).

Table 3. Paradigmatic Classification Scheme

I. **Modification Type:** the most rudimentary means of classification determined based on the overall characteristics of the piece.

1. **Biface**: a shaped lithic artifact with only negative flake scars which meet at the edge where to two, modified faces meet and circumscribe the entire perimeter of the objective piece.
2. **Nonbiface**: a lithic artifact with multiple platforms and percussion flake scars occurring across the artifact that do not occur from one consistent area, where the objective pieces were the intended tools and there are no recognizable ventral and dorsal surfaces.
3. **Flake**: a piece detached from an objective piece during percussion, with striking platform, bulb of percussion, and ventral surface present.
4. **Nonflake**: a piece detached from an objective piece with no recognizable dorsal or ventral surfaces, no negative flake scars, and no striking platform or bulb of percussion present.

II. **Wear:** chipping, abrasion, crushing, grinding and/or polishing that occur on the rock following artificial motion.

1. **Absent:** no wear visible on any surface of rock
2. **Present**: wear visible on a minimum of one location on the rock

II. **Edge Wear:** damage from artificial wear is concentrated on the edge, or abrupt intersection between two surfaces that meet abruptly at an angle.

1. **Absent**: no evidence of wear present on any edge of the object.
2. **Basal Edge Wear**: edge wear occurs only on the basal (hafting) element.
3. **Blade Edge Wear**: edge wear occurs only on the blade element.
4. **Full Circumference Wear**: edge wear occurs homogenously on all edges circumnavigating the object.
5. **Other Wear**: edge wear occurring in an isolated location on the artifact edge, despite lack of distinct basal (hafting) element or blade.

IV. **Surface Wear:** damage from artificial wear occurs on the surface of the object, most visible on arises.

1. **Absent**: no evidence of wear present on any surface of the object.
2. **Unifacial Wear**: surface wear occurs only on one surface of the object
3. **Bifacial Wear**: surface wear occurs on both surfaces of the object

V. **Retouch/Other Modification:** the removal of microflakes, commonly by pressure flaking, on the edge of object that create a steep, sharper edge angle due to conchoidal fracture.

1. **Absent:** no visible retouch (small flakes) on any of the object’s edges.
2. **Present:** retouch (microflakes) are visible in one or more locations on the object’s edge.

Table 3. (continued)

VI. **Body Orientation:** the degree of a complete (not broken) biface's symmetry.

1. **Symmetrical**: when the biface is mirrored at the axial length (see Appendix B), the two sides are symmetrical.
2. **Asymmetrical**: when the biface is mirrored at the axial length, the two sides are asymmetrical.
3. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
4. **N/A**: the object is not a biface.

VII. **Base Shape (Biface):** the direction of curvature, or lack of curvature, present on the basal element of a biface.

1. **Convex**: the basal element extends outwards, away from the proximal end of the biface.
2. **Concave**: the basal element curves inwards, towards the proximal end of the biface.
3. **Straight**: the basal element of the biface is straight (horizontal) with no curve.
4. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
5. **N/A**: the object is not a biface.

VIII. **Base Type (Biface):** the stylistic/technological characteristics of the basal element of a biface.

1. **Leaf/Lanceolate**: bilaterally symmetrical, lozenge shaped biface with convex to straight sides and the widest point not at the base.
2. **Corner Notched**: on either side of the biface base, a notch is absent from the corner (for a haft).
3. **Side Notched**: on either side of the biface base, a notch is absent from the side of the blade, where the biface's vertical axis is perpendicular to the notch.
4. **Basal Notched**: a notch occurs on either side of the vertical access of the biface, that occurs on the basal element.
5. **Bifurcate**: the basal element is split, with deep concavity and base and high shoulders.
6. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
7. **Other**: the biface has a diagnostic base type that does not fit into the above base type's (e.g. stemmed, triangular).
8. **N/A**: the object is not a biface.

Table 3. (continued)

IX. **Lithic Morphological Characteristics**: the object form and degree of technological modification (Beck 1984; Gall and Hamilton 2013).

1. **Hafted Biface**: an objective piece with biface characteristics and the presence of a haft element (notching, stem, or wear on the basal element).
2. **Unhafted Biface**: an objective piece with biface characteristics and no presence of a haft element.
3. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
4. **Unimarginal Flake Tool**: a piece with flake characteristics (striking platform, bulb of percussion, and ventral surface present) and presence of systematic wear along one edge or surface.
5. **Bimarginal Flake Tool**: a piece with flake characteristics (striking platform, bulb of percussion, and ventral surface present) and presence of systematic wear along one or more edges and/or surfaces.
6. **Unidirectional Core Tool**: an objective piece with positive and negative flakes removed from a singular direction, with evidence of wear on the edge and/or surface.
7. **Multidirectional Core Tool**: an objective piece with positive and negative flakes removed from one or more direction, with evidence of wear on the edge and/or surface.
8. **Proximal Flake**: a debitage piece with identifiable flake characteristics (striking platform, bulb of percussion, and ventral surface).
9. **Flake Shatter**: a fragmentary debitage piece with no identifiable striking platform, but identifiable ventral/dorsal surfaces.
10. **Angular Shatter**: a fragmentary debitage piece with no identifiable striking platform or ventral/dorsal surfaces.

X. **Flaking Pattern (Biface):** the pattern in flaking direction, or lack of homogenous direction, as a result of shaping the bifacial piece via percussion flaking.

1. **Random**: flaking pattern is multi-directional, with no consistent or homogenous flaking direction.
2. **Double Diagonal**: flaking alternates from both edges and terminates near the medial line, angled towards the base of the object (e.g. herringbone pattern).
3. **Horizontal Transverse**: flaking originates from one edge and extends horizontally across the object surface.
4. **Oblique Transverse**: flaking originates from one edge and extends diagonally across the object surface.
5. **Collateral (Medial Ridge)**: flaking originates from both edges of the object at right angles before terminating along the center line, forming a medial ridge.
6. **N/A**: the object does not have morphological characteristics necessary for the distinction.

Each artifact was assigned a mode for each dimension of the paradigmatic classification scheme based on visual characteristics of morphology and style. A Ken-A-Vision compound microscope at 20X magnification was used to identify wear and retouch present or absent on each artifact. Initially, the paradigm was tested by four researchers (see acknowledgements) using 30 artifacts (cat #60.1992.001.0001-60.1992.001.0030) to determine if any of the dimensions/modes needed modification and to assure the definitions were clear enough to gather similar results amongst different analysts. The paradigmatic classification scheme was applied to all 1,376 artifacts in the Wild/Clymer Collection and identified five objects that were not artifacts, reducing the sample size to 1,371. The initial classification process served to determine which of the 1,371 artifacts were typeable based on the basal elements and completeness.

Objective 3: Typology

In order to retrieve the most comparable and replicable type designations, the typological scheme proposed by Thomas (1981) for the area surrounding Monitor Valley, Nevada (see Figure 3) and the Largaespada (2006) adaptation for the northern Great Basin region (see Figure 4) were applied to the typeable projectile points in the Wild/Clymer Collection sample. Utilizing these two typological schemes created the greatest opportunity to compare the results to investigations of projectile points in assemblages from within the study area.

The paradigmatic classification scheme served to isolate typeable projectile points prior to application of the two typological schemes. Based on the attribute metrics required to apply the typological schemes (Largaespada 2006; Thomas 1981) to projectile points in the Wild/Clymer Collection sample, the following metrics were collected (Figure 18): Maximum Length (LM), Axial Length (LA), Maximum Width (WM), Base Width (WB), Neck Width (WN), Distal Shoulder Angle (DSA), Proximal Shoulder Angle (PSA), Weight (W), Thickness (TH), Basal Height (BH), and Length to Maximum Width (LMW) (Definitions for each measurement included in Appendix B).

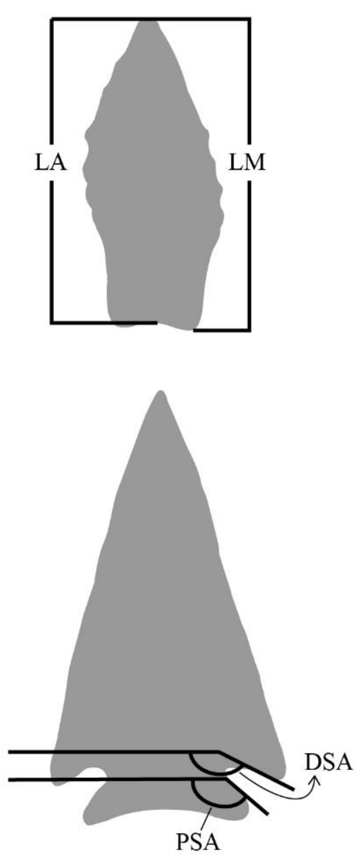

Figure 18: Standardized measurements applied to artifact silhouettes from the Wild/Clymer Collection sample adapted from Keene (2018: Figure 2), Largaespada (2006: Figure 2), and Thomas (1981: Figure 3).

The measurements collected for this analysis were used in a number of ratios utilized by both typologies including: WB/WM, LM/WM, DSA-PSA (called the Notch Opening Index (NOI) by Thomas and Bettinger (1976)), LA/LM (called the Basal Indentation Ratio (BIR) by Thomas (1981), and LMW/LT (called the Maximum Width Position (MaxWPos) by Thomas (1981) (Appendix B) (Figure 19). These ratios facilitate the measurements to provide additional information about the style and shape of the projectile points. The above ratios were calculated using Microsoft Office Excel, 2016. Each typeable artifact was applied to the two typological keys, one focusing on variability in the central Great Basin (Thomas 1981) and one adapted for northern Great Basin (Largaespada 2006), using the collected measurements. Identifying variability in projectile point types present in the Wild/Clymer Collection sample provides an extensive body of knowledge that is comparable to assemblages from the study area and is often analyzed in association with raw material provenance studies.

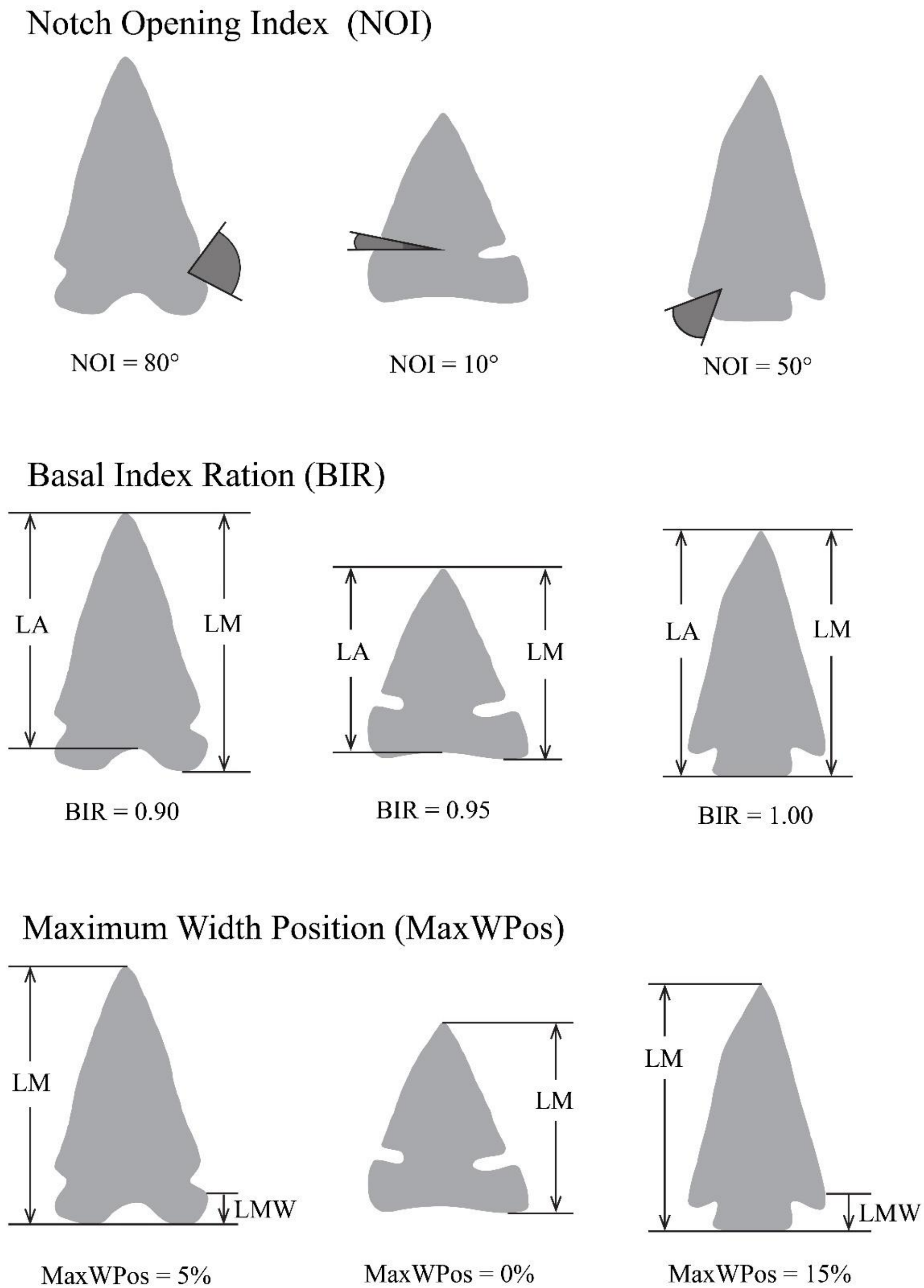

Figure 19: Standardized measurement ratios applied to artifact silhouettes from the Wild/Clymer Collection sample adapted from Thomas (1981: Figure 3) and Keene (2018: Figure 2).

Objective 4: Raw Material Sourcing

In order to determine the raw material sources, present in the Wild/Clymer Collection sample, an analysis of the trace element signatures of the obsidian was carried out. Using a portable X-ray fluorescence instrument (pXRF), the Bruker Tracer 5i, the chemical composition of the raw material was determined for each artifact in the Wild/Clymer Collection sample (n = 1,371). The pXRF instrument is owned by the Murdock Research Laboratory at Central Washington University and is operated under the Department of Geological Sciences. The training required to operate the pXRF was completed on April 5, 2019. Operation of the instrument followed the Bruker Tracer 5i XRF Standard Operating Procedure. Each pXRF session began with a preliminary scan of an obsidian standard, this is a piece of obsidian with known trace element concentrations, to ensure that the instrument was operating properly. Each artifact was then subject to a major and trace element scan. The suite of elements identified by this process included potassium (K), calcium (Ca), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), tin (Sn), barium (Ba), and thorium (Th). Based on the requirements for proper operation of the instrument and the primary interest in obsidian raw material, a number of problematic artifacts were eliminated from the analysis after their initial analysis. Artifacts were eliminated due too small size, presence of cortex, or if their chemical composition indicated that they were not obsidian.

While the trace element concentrations were identified using the pXRF instrument, the Murdock Laboratory did not possess the obsidian source trace element comparative information for characterizing the obsidian sources present in the Wild/Clymer Collection sample. Therefore, it was necessary to submit a random sub-sample of artifacts to the Northwest Research Obsidian Studies Laboratory (NWROSL) for further trace element characterization analysis. To maximize the utility of this process, groups were created of artifacts with similar trace element concentrations. Initially, Zr counts were isolated and processed using Artax software to identify artifacts with similar quantities. Six groups were identified using Zr and the consistent concentrations were confirmed using the remaining suite of elements. The final grouping process confirmed the six unique groups with similar trace element signatures, with some remaining artifacts that did not fit into any of the six groups. A 15% random sub-sample from each group, including 15% from the artifacts that were not assigned to one of the six groups, were submitted for source characterization to the NWROSL (n = 200).

Alex Nyers, the owner and principal researcher at the NWROSL, ran all 200 artifacts using the laboratory's Thermo Electron QuanX EC energy-dispersive XRF (EDXRF) spectrometer. The readings from 50% of those artifacts (n = 100) were entered into a pre-configured Microsoft Excel database that created a linear calibration curve for each trace element between the EDXRF and the pXRF readings. The other 50% of the samples were used to test the calibration curve. Each pXRF readings was entered into the database, applying the calibration curve. This process allowed for source characterization using the results of the pXRF, despite different instruments and different operating conditions. Identifying the raw material provenance for the Wild/Clymer Collection sample is instrumental for comparing provenance data with other sites within the study area.

Objective 5: Interpretation

The morphology, type and style, and provenance information from the Wild/Clymer Collection sample was compared to the body of knowledge on archaeological assemblages in the northern Great Basin which have regional association and chronological significance, summarized in Chapter 2, to identify commonalities (Figure 20). The published projectile point type and raw material source data from each site was extracted and correlation was extrapolated using correspondence analysis when applicable. The relative quantities of each variable were graphed and analyzed in comparison with the Wild/Clymer Collection sample data. A comparison of the morphological, style, typological, and raw material provenance data for the Wild/Clymer Collection to sites analyzed using similar methods from within the study area was critical for determine consistencies between the two bodies of knowledge.

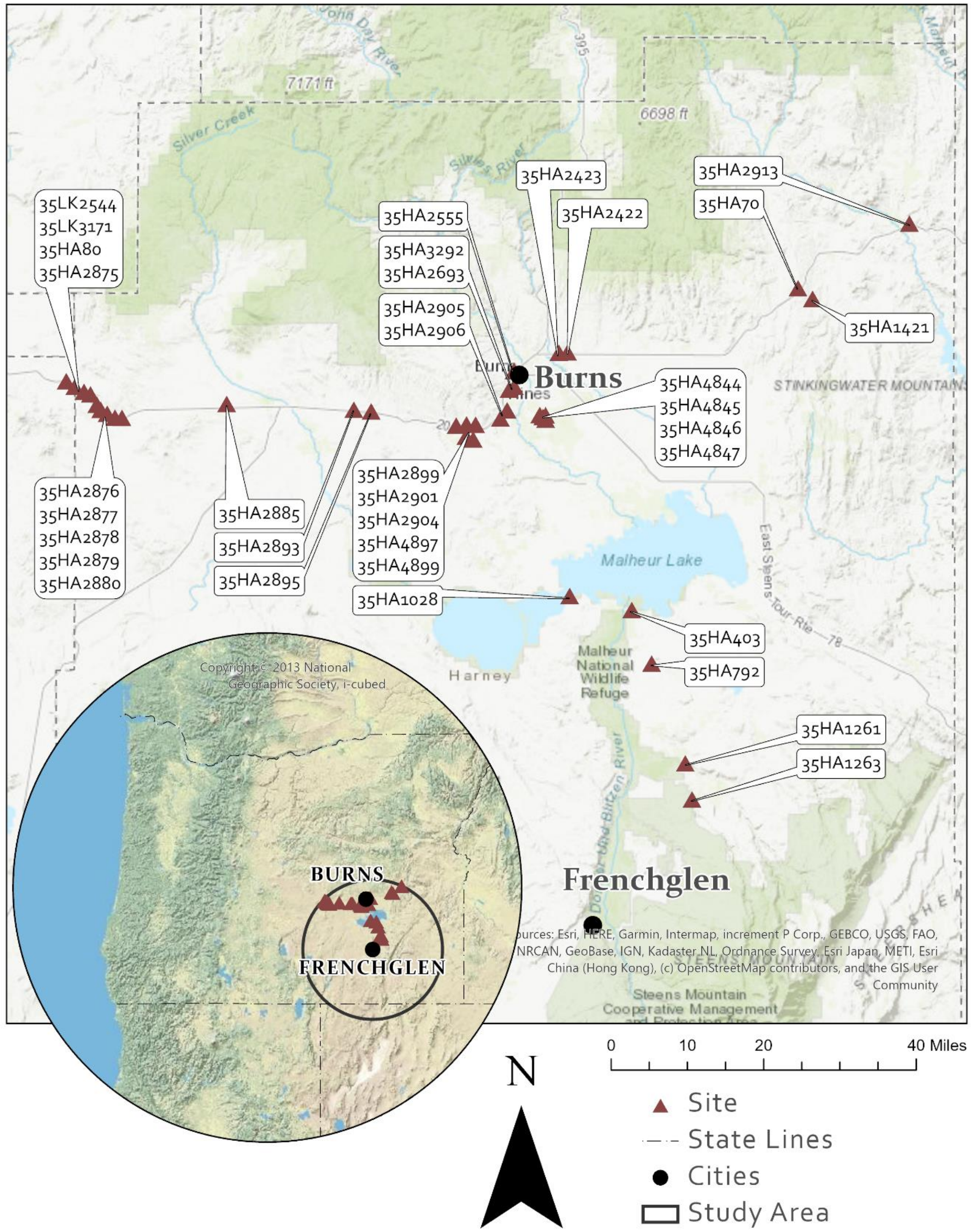

Figure 20: Map of sites from within the study area (in development by Mars Galloway).

Objective 6: Dissemination

The final results of this investigation will be presented at the Great Basin Anthropological Conference 2020, the Northwest Anthropological Conference 2021, and the Annual Meeting of the Society for American Archaeology 2021. Additionally, the results of this research will be published in a peer-reviewed journal, such as *Advances in Archaeological Practice.* By publishing the results of this investigation, archaeologists will have the opportunity to utilize the methods, share input on beneficial modifications, and introduce new research questions. A report of findings will be distributed to Tribes in the identified region(s). Consultation and involvement of Native tribes will determine the desired approach to care and management of the collection in the future (Neller 2004).

CHAPTER VI

ARTICLE

RECOVERING LOST INFORMATION FROM AVOCATIONAL PROJECTILE POINT COLLECTIONS

The following manuscript includes the results of this analysis and may be subject to changes following acceptance of this thesis by the Central Washington University School of Graduate Studies and the journal peer-review process. The manuscript will be submitted to the *Advances in Archaeological Practice* journal. This manuscript was written by Mackenzie Hughes and thesis committee chair Dr. Patrick McCutcheon. The article manuscript begins on the following page.

RECOVERING LOST INFORMATION FROM AVOCATIONAL PROJECTILE POINT COLLECTIONS

Mackenzie Hughes and Patrick T. McCutcheon

ABSTRACT

Human prehistory in North America has sparked the interest of private citizens for decades, sometimes leading to an accumulation of avocational artifact collections that lack site-level provenience. The Wild/Clymer artifacts (n = 1,371) are one such collection where precise site provenience was lost. The analysis aims to recover regional provenience by using raw material sourcing, morphology, and typology to create a data set. The avocational collection data set was analyzed by comparing it to the professionally recorded archaeological data sets from within 100 miles of Frenchglen, Oregon. The results of portable X-ray fluorescence (pXRF) analysis identified 62 obsidian sources from the northwest Great Basin, although it was dominated by Beatys Butte obsidian. A paradigmatic classification approach identified 606 typeable points in the avocational collection, in addition to other morphological traits. Systematic typological schemes used throughout the Great Basin identified 15 different projectile point types, with the densest concentration consisting of Elko Eared (20%) projectile points. Many sourcing, morphology, and typological characteristics of the Wild/Clymer Collection sample are consistent with professionally analyzed archaeological records within the northern Great Basin. We conclude that lost information can be recovered and used to evaluate scientific information potential, which facilitates the identification of affiliated Tribes for collaboration in the continued care and management of the collection.

INTRODUCTION

While projectile point analysis has continued at the forefront of archaeological investigations in the Great Basin (Brown et al. 2019; Davis et al. 2017; Davis et al. 2015; Keene 2018; Scott 2016; Skinner 2018; Smith 2015), few have explored the utility of these methods for studying avocational projectile point collections (Boulanger and Graves 2017). The volume of avocational artifact collections held by museums and private citizens (Fowler and Malinky 2006) alone make this line of inquiry worth pursuing. Amidst a collection crisis (Marquardt et al. 1982:410), it has become increasingly important to address avocational archaeological collections and their potential to serve a scientific purpose (Boulanger and Graves 2017), despite lost primary depositional context (Canaday 2003, 2016).

Previous analyses of avocational collections used morphological and raw material provenance analyses. These researchers (Amick 2004; Boulanger and Graves 2017) aimed to recover information lost by the avocational collection process (i.e., the collection of lithic artifacts without recording precise provenience information) by using lithic analyses. Both studies used X-ray fluorescence (XRF) to identify tool stone raw material sources locations, referenced Justice (2002) in their comparison of stone tool morphology, and identified similar types/traditions. Amick's (2004) study lacked any collector information and Boulanger and Graves (2017) information was of limited use. Both of these studies made state-level regional provenience determinations, Nevada and southern Idaho respectively. Neither of these studies used sub-regional archaeological records (e.g., articles or grey literature) with which to compare their collections.

We further explore the utility of these methods and expand on them by considering the role of the professional archaeological record as a comparative tool. Our goal of this research is to create a complete model that permits not only an assessment of the potential to determine regional provenience, but also to determine whether avocational collections lend themselves to scientific research. Following the stepped model, our goal is to first determine if the collection can be assigned regional provenience. Following a comparison between the avocational collection sample and the professionally analyzed archaeological record, our objective is then to determine whether the avocational collection is a biased sample. The intention of the data table frequencies is to determine what can be learned from the avocational collection's characteristics about obsidian use in the identified region.

Recovering the regional provenience of an avocational artifact collection can and may identify the Native group(s) associated with that identified region. This information promotes and facilitates a collaborative approach towards continued curation and care of the collection (Neller 2004). The development of a replicable method for analyzing raw material sources (Hughes 1986; Skinner 1983), morphological (Andrefsky 2005; Andrefsky et al. 1994; Beck 1984; Campbell 1981), and typological (Largaespada 2006; Thomas 1981) characteristics will demonstrate that avocational collections lend themselves to scientific exploration and should not be disregarded when considering new research questions and endeavors.

METHODS AND TECHNIQUES

The model for this research was designed to capture a data set for the Wild/Clymer collection to identify data consistency a set of data from a sample of professionally recorded sites. The research question is: can using professional data collection protocols create a set of data from an avocational collection that can be compared to a set of professionally recorded data so that a determination of consistency can be made? Here we use data consistency as a means to determine whether two independent samples, one avocational and one professional, were drawn from the same population of artifacts from a specific archaeological region.

Our model is constructed using three variables: raw material source or provenance, stone tool morphology, and projectile point type or style. Previous research investigated the intervariable relationship between each variable and how performance and availability of obsidian impacts the acquisition of raw material depending on the source proximity (Andrefsky et al. 1994; Smith 2015; Thomas 2013). The regional distribution of raw material sources, for example, not only impacts the raw material sources present in an assemblage, but also impacts the expediency of stylistic traits (Andrefsky et al. 1994; Binford 1977; Kelly 2001), the degree of retouch and reuse (Smith 2015), and the utility of projectile point typological schemes from areas other than the original provenience of the collection's artifacts (Thomas 2013). Interpreting the relationship between each variable and how they relate to the archaeological record provides information to infer regional provenience of the collection.

For the purposes of this research, provenience is defined as the *in situ* location where an artifact was deposited, and provenance is defined as the source location of the raw material (Price and Burton 2011). While recovery of precise and accurate provenience for avocational collections is likely unobtainable without detailed notes from avocational collectors (Boulanger and Graves 2017), some lost information may be recoverable by determining the degree of consistency (provenance, morphology, style) between an avocational data set and those of professionally analyzed archaeological records. We define regional provenience as a geographically larger scale of location from which the artifacts were collected. Clearly, to achieve maximum comparability, both collections need to be analyzed with similar protocols. It is our hope that by describing and interpreting the lithic characteristics of an avocational collection using the model described below we will recover lost information, while simultaneously collecting data that can determine the source region of the artifacts. Once regional provenience is recovered, how representative an avocational collection is to the professionally generated archaeological record can be assessed and the information potential of said collection is determined. A flow chart demonstrates the model originating from the primary research question specific for analyzing the Wild/Clymer Collection sample, though the model can be adapted for analyzing other avocational collections of stone tools or other general artifact categories (e.g., ceramics) (Figure 1).

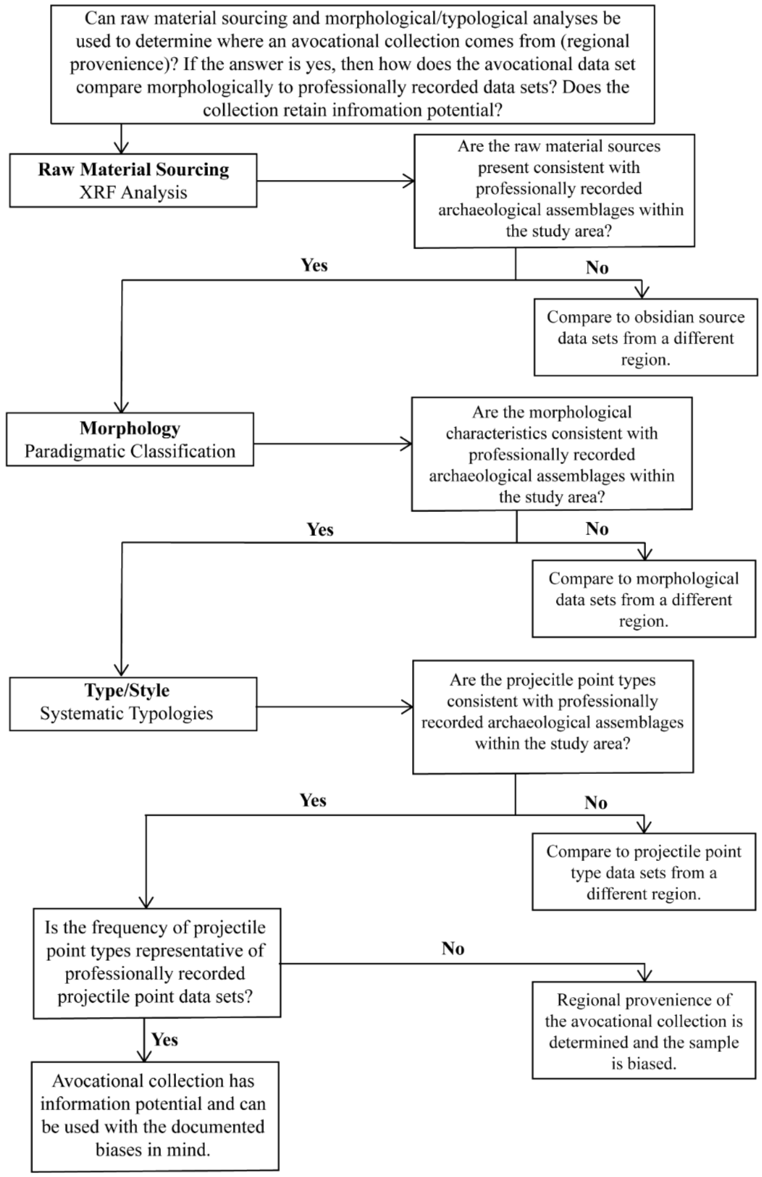

Figure 1: A flow chart of the stepped model for this analysis.

Obsidian Sourcing

Identifying where an avocational collection is from is critical for choosing the appropriate morphological and typological schemes. As the Wild/Clymer collection is dominated by obsidian, we used an obsidian sourcing approach to recover lost regional provenience. Since the initial utility of obsidian sourcing was demonstrated by Hughes

(1986) and Skinner (1983), XRF analysis has been employed to understand source procurement ranges (Gilmour et al. 2016; Jenkins and Connolly 1990; Ozbun et al. 1996; Shackley 1998, 2002), source use through time (Solimano et al. 2019), and to support obsidian hydration analyses (Fulton et al. 1999). Raw material sources represented at an archaeological site are often local to the site area (Fulton et al. 1999; Renfrew 1977).

The trace element concentrations of different obsidian artifacts and sources is identified using XRF techniques (Gilmour et al. 2016; Jenkins and Connolly 1990; Lyons et al. 2001; Musil et al. 2002; Ozbun et al. 1996; O'Grady 2006; Skinner and Thatcher 2003; Solimano et al. 2019). Analyzing an avocational collection using XRF permits using the body of obsidian source information available in the comparative source collection of the analyzing laboratory (NWROSL 2020). After sources present in the avocational collection are identified, this regional provenience information will be used to determine appropriate morphological information and typological scheme for comparisons.

Morphology

Approaching the replicable analysis of a large lithic collection required the construction of a classification scheme with mutually exclusive and exhaustive dimensions. Creating replicable dimensions and modes provides data that can be compared to the published data sets within the study area (Andrefsky 2005; Andrefsky et al. 1994; Beck 1984; Campbell 1981; McCutcheon 1997). Research suggests that identifying morphological traits using mutually exclusive and exhaustive artifact class definitions assists with typological designations that use quantitative methods for replicable type determinations for individual time periods (Keene 2018; Thomas 1981). Dunnell (1978) emphasized the importance of mitigating ambiguous research questions and classification parameters that lacks clear definitions and that by avoiding such ambiguous exhaustive classification dimensions facilitate research comparisons between artifact assemblage characteristics even when slightly different classifications are used among researchers.

For instance, Hughes et al. (2019) created a paradigmatic classification scheme, modified from several sources (Andrefsky 2005; Andrefsky et al. 1994; Beck 1984; Campbell 1981; McCutcheon 1997). The goal of this scheme was to use mutually exclusive and exhaustive dimensions and modes to determine classes of technological, functional, and stylistic attributes present in the collection sample. This classification scheme sought to isolate projectile point characteristics that indicate raw material availability (Smith 2015), intended function (Andrefsky et al. 1994), reuse (Andrefsky 2005), transportation damage (Amick 2004), and haft characteristics (Largaespada 2006; Thomas 1981). To support replicability, the parameters for each dimension and mode was explicitly defined (Table 1) using the following sources: Andrefsky 2005, Beck 1984, Campbell 1981, Crabtree 1972, Dunnell 1978, Gall and Hamilton 2013, Hildebrandt et al. 2016, Jenkins and Connolly 1990, Parfitt and McCutcheon 2017, and Pettigrew 1979. One of the outcomes of the classification process is to identify which artifacts are stylistically typeable based on a combination of attributes, including a complete Base Shape (Dimension VII) and a lack of Indistinguishable/Broken attributes (Dimensions VI-IX).

Table 1. Paradigmatic Classification Dimensions and Attributes

I. **Modification Type:** the preliminary means of classification determined based on the overall characteristics of the piece.

1. **Biface**: a shaped lithic artifact possessing only negative flake scars initiated from the edge, which circumnavigates the entire perimeter of the objective piece.
2. **Nonbiface**: a lithic artifact with multiple negative flake scars (e.g. core) and percussion flake scars occurring across the artifact that do not occur from one consistent area, where the objective pieces were the intended tools and there are no recognizable ventral and dorsal surfaces.
3. **Flake**: a piece detached from an objective piece using percussion, with striking platform, bulb of percussion, and ventral surface present.
4. **Nonflake**: a piece detached from an objective piece with no recognizable dorsal or ventral surfaces, no negative flake scars, and no striking platform or bulb of percussion present.

II. **Wear:** chipping, abrasion, crushing, grinding and/or polishing that occur on the rock following artificial motion.

1. **Absent:** no wear visible on any surface of rock
2. **Present**: wear visible on a minimum of one location on the rock

II. **Edge Wear:** damage from artificial wear is concentrated on the edge, or abrupt intersection between two surfaces that meet abruptly at an angle.

1. **Absent**: no evidence of wear present on any edge of the object.
2. **Basal Edge Wear**: edge wear occurs only on the basal (hafting) element.
3. **Blade Edge Wear**: edge wear occurs only on the blade element.
4. **Full Circumference Wear**: edge wear occurs homogenously on all edges circumnavigating the object.
5. **Other Wear**: edge wear occurring in an isolated location on the artifact edge, despite lack of distinct basal (hafting) element or blade.

IV. **Surface Wear:** damage from artificial wear occurs on the surface of the object, most visible on arises.

1. **Absent**: no evidence of wear present on any surface of the object.
2. **Unifacial Wear**: surface wear occurs only on one surface of the object
3. **Multifacial Wear**: surface wear occurs on both surfaces of the object

V. **Retouch/Other Modification:** the removal of microflakes, commonly by pressure flaking, on the edge of object that create a steep, sharp edge angle.

1. **Absent:** no visible retouch (small flakes) on any of the object’s edges.
2. **Present:** retouch (microflakes) are visible in one or more locations on the object’s edge.

Table 1. (continued)

VI. **Body Orientation:** the degree of a complete (not broken) biface's symmetry.

1. **Symmetrical**: when the biface is mirrored at the axial length (see Appendix B), the two sides are symmetrical.
2. **Asymmetrical**: when the biface is mirrored at the axial length, the two sides are asymmetrical.
3. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
4. **N/A**: the object is not a biface.

VII. **Base Shape:** the direction of curvature, or lack of curvature, present on the basal element of a biface.

1. **Convex**: the basal element extends outwards, away from the proximal end of the biface.
2. **Concave**: the basal element curves inwards, towards the proximal end of the biface.
3. **Straight**: the basal element of the biface is straight (horizontal) with no curve.
4. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
5. **N/A**: the object is not a biface.

VIII. **Base Type:** the stylistic/technological characteristics of the basal element of a biface.

1. **Leaf/Lanceolate**: bilaterally symmetrical, lozenge shaped biface with convex to straight sides and the widest point not at the base.
2. **Corner Notched**: on either side of the biface base, a notch is absent from the corner (for a haft).
3. **Side Notched**: on either side of the biface base, a notch is absent from the side of the blade, where the biface's vertical axis is perpendicular to the notch.
4. **Basal Notched**: a notch occurs on either side of the vertical access of the biface, that occurs on the basal element.
5. **Bifurcate**: the basal element is split, with deep concavity and base and high shoulders.
6. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
7. **Other**: the biface has a diagnostic base type that does not fit into the above base types (e.g. stemmed, triangular).
8. **N/A**: the object is not a biface.

Table 1. (continued)

IX. **Lithic Morphological Characteristics**: the object form and degree of technological modification

1. **Hafted Biface**: an objective piece with biface characteristics and the presence of a haft element (e.g. haft element identified by notching, stem, or presence of wear on the basal element).
2. **Unhafted Biface**: an objective piece with biface characteristics and no presence of a haft element.
3. **Indistinguishable/Broken**: artifact is fragmentary and/or does not possess the morphological characteristics necessary for this distinction.
4. **Unimarginal Flake Tool**: a piece with flake characteristics (striking platform, bulb of percussion, and ventral surface present) and presence of systematic wear along one edge or surface.
5. **Bimarginal Flake Tool**: a piece with flake characteristics (striking platform, bulb of percussion, and ventral surface present) and presence of systematic wear along one or more edges and/or surfaces.
6. **Unidirectional Core Tool**: an objective piece with positive and negative flakes removed from a singular direction, with evidence of wear on the edge and/or surface.
7. **Multidirectional Core Tool**: an objective piece with positive and negative flakes removed from one or more direction, with evidence of wear on the edge and/or surface.
8. **Proximal Flake**: a debitage piece with identifiable flake characteristics (striking platform, bulb of percussion, and ventral surface).
9. **Flake Shatter**: a fragmentary debitage piece with no identifiable striking platform, but identifiable ventral/dorsal surfaces.
10. **Angular Shatter**: a fragmentary debitage piece with no identifiable striking platform or ventral/dorsal surfaces.

X. **Flaking Pattern:** the pattern in flaking direction, or lack of homogenous direction, as a result of shaping the piece via percussion flaking.

1. **Random**: flaking pattern is multi-directional, with no consistent or homogenous flaking direction.
2. **Double Diagonal**: flaking alternates from both edges and terminates near the medial line, angled towards the base of the object (e.g. herringbone pattern).
3. **Horizontal Transverse**: flaking originates from one edge and extends horizontally across the object surface.
4. **Oblique Transverse**: flaking originates from one edge and extends diagonally across the object surface.
5. **Collateral (Medial Ridge)**: flaking originates from both edges of the object at right angles before terminating along the center line, forming a medial ridge.
6. **N/A**: the object does not have morphological characteristics necessary for the distinction.

Typology

Typologies used in archaeological research permit the identification and description of historical types (Dunnell 1978). Dunnell (1978) discusses the relatedness of historical types that are a result of cultural transmission, which provides a mechanism that sorts qualitative, quantitative, morphological, formal, and neutral traits across space and time (Darvill 2002). The systematic typological scheme applied to the avocational collection's typeable artifacts is determined based on the results of the raw material provenance analysis. Using the most commonly applied scheme (e.g., Thomas 1981) in the archaeological region is advantageous for determining consistencies between the avocational collection and a specific professionally recorded archaeological record. A systematic typological scheme is advantageous because it creates replicability and provides a comparable data set between avocational collection and professionally generated artifact analyses.

By combining typological and provenance analysis of lithic artifacts (O'Grady 2006; Solimano et al. 2019; Jenkins and Connolly 1990; Ozbun et al. 1996; Musil et al. 2002; Fulton et al. 1999; Sappington 1980; Lyons et al. 2001), archaeologists have hypothesized a relationship between raw material source use and projectile point types present throughout the northern Great Basin. Typological and raw material source data permit the analysis of their interrelatedness. The movement of different raw materials across the landscape and the cultural transmission of projectile points styles are related to material acquisition and the cost associated with traveling to further material sources in order to create specific projectile point types more effectively (Beck et al. 2002; Smith 2015).

By having comparable data sets from the avocational collection and the professionally recorded archaeological investigations, a determination of the collector biases and information potential is possible. This assumes that we know the biases of the professionally generated archaeological record and that comparable data sets are possible. If patterns between the avocational collection and the professional record do not emerge, it can be inferred that the avocational collection sample is biased to the collector's preferences, and without knowing those, limits the informational potential of such collections.

CASE STUDY

In 1991, Katherine Wild and her late husband Arnold Wild donated an avocational artifact collection to the John Ford Clymer Museum (Clymer Museum) in Ellensburg, Washington. In 2017, Dr. Patrick McCutcheon (Department of Anthropology and Museum Studies, Central Washington University [CWU]) received the collection on loan from the Clymer Museum for a period of three years. The loan agreement stipulated that CWU would rehouse the collection to proper curation standards (Knoll and Huckell 2019) and that it would serve a scientific and educational purpose. The collection consisted of 51 aesthetically arranged display cases and 9 unlabeled artifact bags. On many of the case backs there was a single geographic label ranging from Frenchglen, OR to Cedarville, CA. Cases in the Wild/Clymer Collection labeled with Frenchglen, Oregon, serve as the sample for this analysis, consisting of n = 1,371 primarily obsidian artifacts.

As the case labels were the only information received with the collection sample, an arbitrary sphere of 100 miles with Frenchglen, Oregon, at the center serves as the study area. Frenchglen is located within the northern Great Basin archaeological region. The Great Basin is considered to be one of the most obsidian-rich areas in the world (Skinner 1983), with over 100 unique obsidian sources across Oregon alone (Northwest Research Obsidian Studies Laboratory 2012). The dense archaeological record throughout the Great Basin region and its associated site analyses (Jenkins and Connolly 1990; Lyons et al. 2001; Musil et al. 1990; Musil et al. 1991; Musil et al. 2002; Ozbun et al. 1996; O’Grady 2006; Raven and Elston 1992; Skinner and Thatcher 2003; Solimano et al. 2019) provide critical information for the comparison of those traits analyzed in avocational projectile point collections. Sites within the study area where obsidian sourcing, morphological, and/or typological data was professionally reported were compared to the Wild/Clymer Collection sample (Figure 2).

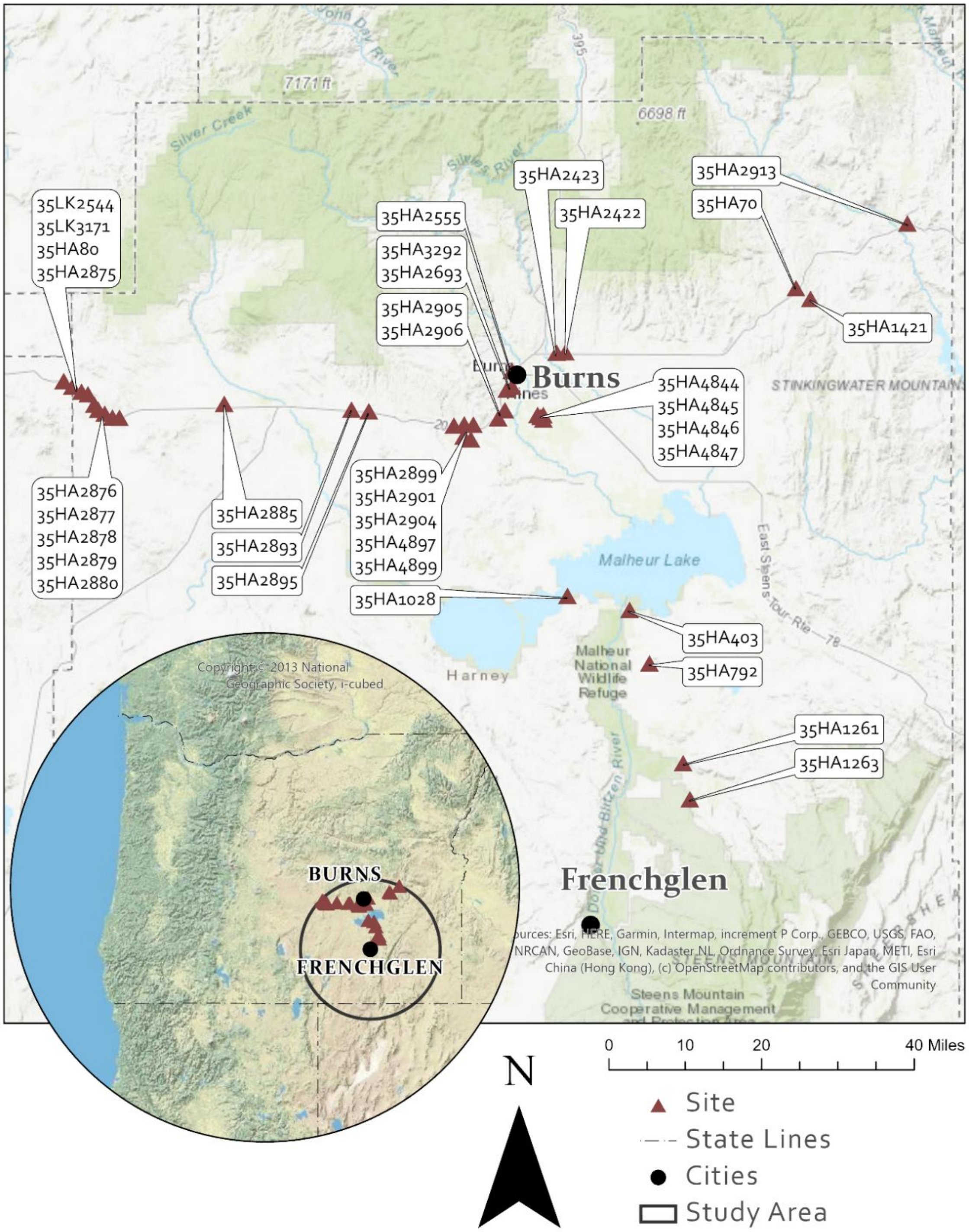

Figure 2: Map of the study area with sites that involved professional assemblage analyses (Jenkins and Connolly 1990; Lyons et al. 2001; Musil et al. 1990; Musil et al. 1991; Musil et al. 2002; Ozbun et al. 1996; O'Grady 2006; Raven and Elston 1992; Skinner and Thatcher 2003; Solimano et al. 2019) that can be compared to the Wild/Clymer Collection sample characteristics (map created by Mars Galloway).

Obsidian Sourcing

The obsidian trace element signatures present in the Wild/Clymer Collection were identified using a Bruker Trace 5i portable X-ray fluorescence (pXRF) instrument in Central Washington University's Murdock Research Laboratory. The suite of elements identified using the pXRF mirrored those used by the Northwest Obsidian Research Studies Laboratory (NWROSL) (Nyers 2020).

While the trace element spectra were identified using the pXRF instrument, the Murdock Laboratory did not possess quantitative parts per million trace element information for characterizing the obsidian sources. To identify source types, we contracted with the NWROSL to analyze a stratified random sub-sample for source characterization. NWROSL used a QuanX EC energy-dispersive XRF (EDXRF) spectrometer to determine the parts per million trace element concentration in the sub-sample of artifacts (n = 200). The pXRF and EDXRF readings from a random 50% of the sub-sample were entered into a pre-configured Excel datasheet to find a linear calibration curve for each of the trace elements. The calibration curves were tested using the other 50% of the sample and successfully created a calibration curve for each trace element. This process allowed the NWROSL source catalog to be applied to the results of the pXRF instrument, despite being analyzed with different instruments and with different operating conditions.

Morphology

Initially, the paradigmatic classification was used by four researchers using 30 artifacts (cat #60.1992.001.0001-cat#60.1992.001.0030) to determine if significant inter-analyst variability existed despite the explicit definitions. In testing the utility of the paradigmatic classification scheme, inter-analyst variability correlated with level of experience. The use of multiple analysts was abandoned so that consistency in classification could be assured. The junior author checked a sample of assignments made by the senior author to check for errors. The classification process determined which of the 1,371 artifacts were typeable (temporally diagnostic).

Typology

In order to retrieve the most comparable and replicable type designations, the typological scheme proposed by Thomas (1981: Figure 2) and more recent adaptation by Largaespada (2006: Figure 10) for the northern Great Basin region were applied to the typeable projectile points in the Wild/Clymer Collection sample. Professionally published projectile point analyses from site assemblages within the study area utilize both the Monitor Valley Key and the northern Great Basin adaptation. The utilization of both keys created the greatest opportunity to compare the Wild/Clymer Collection sample data to published analyses of projectile point assemblages within the study area. Additionally, the adaptation to the Monitor Valley Key accounts for projectile point type variability specific to the northern Great Basin region, which allowed for a comparison of which regional adaptation was more consistent with the Wild/Clymer Collection sample characteristics. Based on the attribute metrics required, the following metrics were collected (Figure 3): Maximum Length (LM), Axial Length (LA), Maximum Width (WM), Base Width (WB), Neck Width (WN), Distal Shoulder Angle (DSA), Proximal

Shoulder Angle (PSA), Weight (W), Thickness (TH), Basal Height (BH), and Length to Maximum Width (LMW) (Keene 2018; Largaespada 2006; Thomas 1981).

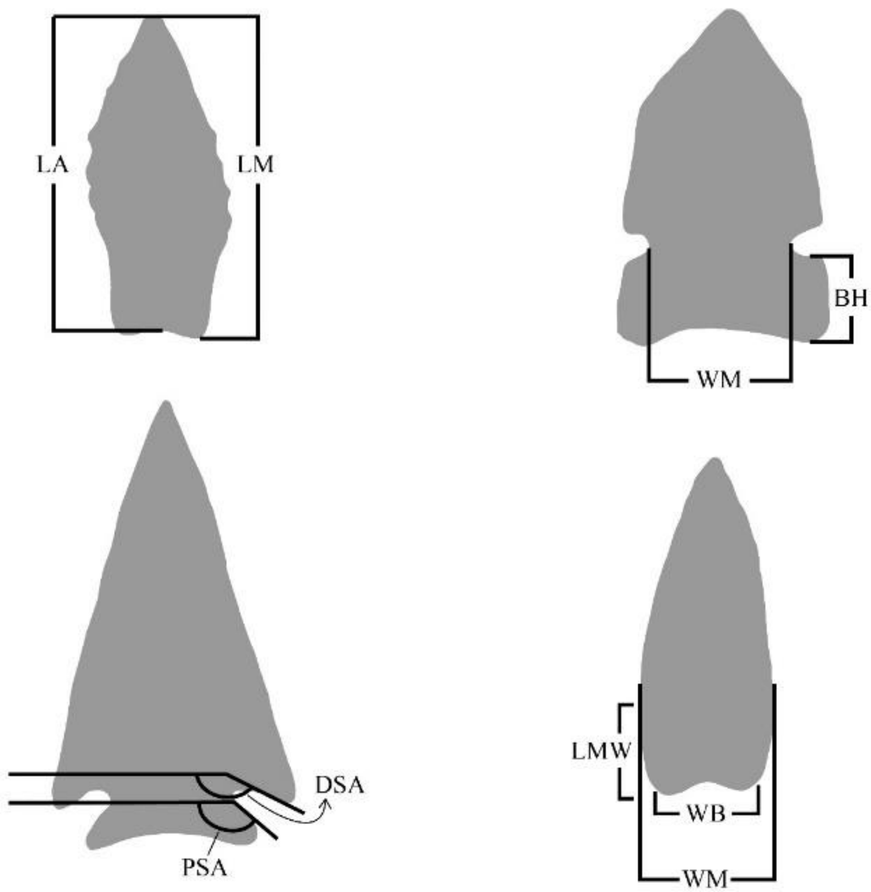

Figure 3: Standardized measurements applied to the Wild/Clymer Collection sample.

The measurements collected for this analysis were used in a number of ratios utilized by both typologies including: WB/WM, LM/WM, DSA-PSA (called the Notch Opening Index (NOI) by Thomas (1981)), LA/LM, and LMW/LT (called the Maximum Width Position (MaxWPos) by Thomas (1981)) that provide additional information about the style and shape of the projectile points. Analyzing the typological and raw material source characteristics in the Wild/Clymer Collection sample should reflect those characteristics of a sample of the professionally analyzed assemblages within a certain region.

RESULTS

Wild/Clymer Collection Sample Obsidian Sourcing

The Wild/Clymer Collection sample included 1,345 artifacts suitable for raw material sourcing (Nyers 2020) (Table 2). Obsidian from the Beatys Butte source makes up the largest number of artifacts in the collection sample (57.2%). Few other sources make up large percentages of the collection's raw material, for example the next highest two are Massacre Lake/Guano Valley (10.9%) and Bordwell Springs/Pinto Peak/Fox Mountain (3.8%) obsidians. All other obsidian sources represented in the collection (n = 59) occur in less than 2.5% of the collection sample. The Burns and Glass Buttes obsidian sources, which occur widely in the archaeological record across the study area, are present in the Wild/Clymer Collection sample, though in small quantities.

Table 2. Obsidian Sources in the Wild/Clymer Collection sample

Geochemical Source	Collection sample N =	Collection sample %	Geochemical Source	Collection sample N =	Collection sample %
Alturas FGV	1	0.07	Indian Creek Buttes B	9	0.67
Badger Creek	9	0.67	Long Valley	1	0.07
Beatys Butte	769	57.22	Malheur Gap	2	0.15
Beatys Butte B	6	0.45	Massacre Lake/Guano Valley	147	10.94
Big Stick	1	0.07	McComb Butte	4	0.30
Black Bull Spring (FGV)	1	0.07	Mosquito Lake	3	0.22
BS/PP/FM*	51	3.79	Mt. Hicks	2	0.15
Buck Mountain	31	2.31	Mt. Majuba	1	0.07
Buck Spring	10	0.74	Obsidian Cliffs	6	0.45
Buffalo Hills	4	0.30	Paradise Valley	2	0.15
Burns	13	0.97	Parsnip Creek	1	0.07
Camp Creek	2	0.15	Quartz Mountain	1	0.07
Chickahominy	1	0.07	Rainbow Mines	5	0.37
Coglan Buttes	1	0.07	Riley	4	0.30
Cougar Mountain	1	0.07	Rimrock Spring	5	0.37
Cowhead Lake	7	0.52	Silver Lake/Sycan Marsh	1	0.07
Coyote Spring	4	0.30	Skull Springs	2	0.15
Coyote Spring FGV	1	0.07	Sourdough Mountain	2	0.15
Craine Creek	3	0.22	South Warners	14	1.04
Del Prat Spring	2	0.15	Sugar Hill	4	0.30
Dog Hill	1	0.07	Surveyor Spring	11	0.82
Double H/Whitehorse	30	2.23	Tank Creek	2	0.15
Double O	12	0.89	Tucker Hill	6	0.45
Double O FGV	1	0.07	Tule Spring	6	0.45
Drews Creek/Butcher Flat	20	1.49	Unknown Obsidian	23	1.71
East Medicine Lake	2	0.15	Unknown Obsidian 1	8	0.60
GF/LIW/RS**	1	0.07	Unknown Obsidian 5	1	0.07
Glass Buttes 1	1	0.07	Venator	31	2.31
Hawks Valley	13	0.97	Whitehorse 2	14	1.04
Horse Mountain	5	0.37	Whitewater Ridge	2	0.15
Indian Creek Buttes	20	1.49	Wolf Creek	1	0.07

*Bordwell Spring/Pinto Peak/Fox Mountain
**Grasshopper Flat/Lost Iron Well/Red Switchback

Obsidian sources represented in the Wild/Clymer Collection sample are located within the northern Great Basin (Figure 4). The Beatys Butte obsidian source is located south of Frenchglen, Oregon, while other obsidian sources represented in the collection sample occur outside of the study area (e.g. the Wolf Creek source occurs approximately 120 miles to the north and the Buffalo Hills source is found approximately 190 miles to the south). The Massacre Lake/Guano Valley source occurs over a wide geographic area between 80-130 miles south of Frenchglen, Oregon.

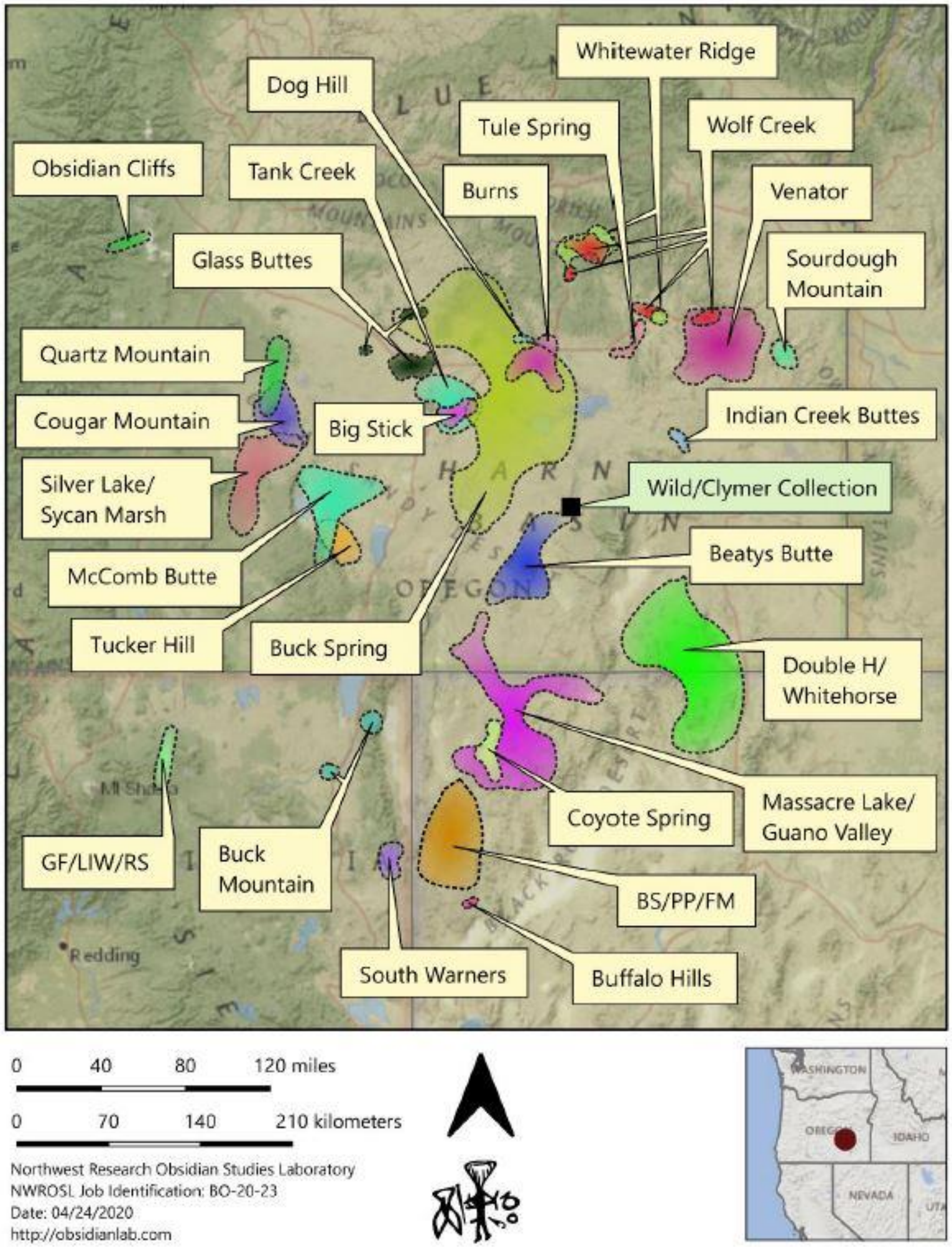

Figure 4: Locations of a selection of major sources that occur within the Wild/Clymer Collection sample, with the collection sample located at Frenchglen, Oregon, for demonstration purposes (Nyers 2020).

Professionally Recorded Archaeological Obsidian Sourcing

The archaeological record within the study area includes a variety of obsidian sources, though Burns obsidian is the most common across the study area as most sites are close to that source. Of the professionally analyzed sites within the study area that utilized raw material sourcing analysis (n = 34), 16 of which were from the FTV Western Fiber Build Project (Skinner and Thatcher 2003). Artifacts made from Burns obsidian occur at 20 sites (59%). Site assemblages that occur in the northeast of the study area (35HA80, 35HA2875, 35HA2876, 35HA2877, 35HA2878, 35HA2879, 35LK3171, and 35LK2879) include primarily sources that are in the same area like Glass Buttes obsidian varieties. Chickahominy, Dog Hill, and Riley obsidian sources occur often, in small quantities at sites across the whole study area. Beatys Butte obsidian occurs in six of the site assemblages (18%) and represents between 5-16% of the raw material sources identified.

All obsidian sources represented at sites within the study area are located between 5-20 km (3-12 miles) of the site, except for 35HA2880. This site, located in the northeast of the study area, includes 12 different obsidian sources among 20 artifacts. The furthest of which is located 90 km (56 miles) to the southwest (Beatys Butte) and represented 5% of the sample (n = 1). All other obsidian sources in the assemblage sample are located within 20 km of the site. Overall, the proximity of obsidian sources to the site location is consistent with research that suggests, when available, local raw material sources are prioritized (Fulton et al. 1999; Skinner and Thatcher 2003).

Wild/Clymer Collection Sample Morphology

The morphological characteristics present in the Wild/Clymer Collection sample are highly variable, although some trends do appear (Table 3). Of the paradigmatic classification scheme's 2.304 million possible class definitions, the Wild/Clymer Collection sample filled 781 classes (0.03%). To test the utility of the paradigmatic classification, we will parse out the dimensions and explore the relationship between Body Orientation (Dimension VI) and Base Type (Dimension VIII), both of which apply to the bifaces that make up 93% of the collection sample (n = 1,283). Only 275 artifacts (20%) were identified as symmetrical, while 474 artifacts (35%) were asymmetrical, 543 artifacts (40%) were Indistinguishable/Broken, and 78 (5%) artifacts did not apply to this dimension (N/A). The most common base type among the symmetrical artifacts is leaf/lanceolate projectile points (n = 108, 39%), followed by corner-notched points which represent 20% of the symmetrical artifacts (n = 55). In contrast, corner-notched points make up the most common base type (n = 356, 26%) in the Wild/Clymer Collection sample and leaf/lanceolate were the second most common (n = 287, 21%). These differences could be attributed to how susceptible corner-notched points are to breakage, whereas leaf/lanceolate points are less susceptible.

Table 3. Morphological Characteristics of the Wild/Clymer Collection Sample

Dimension		Mode	Wild/Clymer Collection	
			Count	%
I.	Modification Type	Biface	1283	93%
		Nonbiface	3	0.5%
		Flake	82	6%
		Nonflake	3	0.5%
II.	Wear	Absent	256	19%
		Present	1115	81%
III.	Edge Wear	Absent	295	22%
		Basal Edge Wear	52	4%
		Blade Edge Wear	497	36%
		Full Circumference Wear	512	37%
		Other Wear*	15	1%
IV.	Surface Wear	Absent	815	59%
		Unifacial Wear	64	5%
		Bifacial Wear	492	36%
V.	Retouch/Other Modification	Absent	885	65%
		Present	486	35%
VI.	Body Orientation	Symmetrical	275	20%
		Asymmetrical	474	35%
		Indistinguishable/Broken	544	40%
		N/A	78	5%
VII.	Base Shape (Biface)	Convex	208	15%
		Concave	564	41%
		Straight	207	15%
		Indistinguishable/Broken	273	20%
		N/A	119	9%
VIII.	Base Type (Biface)	Leaf/Lanceolate	288	21%
		Corner Notched	357	26%
		Side Notched	171	12%
		Basal Notched	29	2%
		Bifurcate	115	9%
		Indistinguishable/Broken	169	12%
		Other**	148	11%
		N/A	94	7%

Table 3. (continued)

IX.	Lithic Characteristics	Hafted Biface	1089	79%
		Unhafted Biface	130	9%
		Indistinguishable/Broken	77	6%
		Unimarginal Flake Tool	8	0.7%
		Bimarginal Flake Tool	58	4%
		Unidirectional Core Tool	1	0.1%
		Multidirectional Core Tool	1	0.1%
		Proximal Flake	3	0.5%
		Flake Shatter	4	0.6%
		Angular Shatter	0	0%
X.	Flaking Pattern (Biface)	Random	1035	75%
		Double Diagonal	92	7%
		Horizonal Transverse	9	1%
		Oblique Transverse	49	4%
		Collateral (Medial Ridge)	159	11%
		N/A	27	2%

Additional observations can be made regarding trends in the other dimensions. Two of the most occupied classes vary only by the base shape and base type (e.g. 16 artifacts have a concave base shape and corner-notched base type and 17 artifacts have indistinguishable/broken base shape and indistinguishable/broken base type). Seventeen artifacts occupy the third most populous class, differing by the absence of wear and presence of a concave, corner-notched basal element. Between one and 10 artifacts (an average of 4) occupy the other 778 classes. Presence of wear (81%) and retouch (65%) were the most common characteristics throughout the Wild/Clymer Collection sample. Of the artifacts classified as bifaces, the most common characteristics were concave base shape (41%), corner-notched base type (26%), and random flaking pattern (79%).

While artifacts other than bifaces were the least common among the Wild/Clymer Collection sample (7%), the most common characteristic among all artifacts was the presence of wear (81%). Of the 1,115 artifacts with detectable wear, 1,060 had edge wear (95%) and 553 had surface wear (49%). Wear that circumnavigated the entire perimeter edge of the artifact was the most common edge wear location (37%), while bifacial wear was the most common among artifacts with detectable surface wear (36%). Hafted bifaces represent 79% of the lithic characteristics (Dimension IX) identified by the paradigmatic classification, followed by unhafted bifaces (9%). Application of the paradigmatic classification scheme to the Wild/Clymer Collection sample determined that 606 out of 1,371 artifacts analyzed (44%) had temporally diagnostic characteristics.

Professionally Recorded Archaeological Morphology

Not much can be learned from the morphological comparison as most of the literature did not report formal morphological analysis with well-defined parameters, with the expectation of 35HA3293 (Gilmour et al. 2016). Researchers recovered nine flaked stone tools during the investigation. Of the four flake tools recovered, all four had use wear present (100%), and two also had retouch present (50%). The five additional tools were classified as bifaces and did not have any use wear present (100%). Debitage accounted for the majority of lithic artifacts recovered from the site (n = 2,459). Early-stage core percussion flakes, late-stage core percussion flakes, bipolar flakes, undetermined percussion flakes, and undetermined flakes were the technological categories used to classify the debitage (Gilmour et al. 2016:53). The fracture type also divided the debitage classes including core percussion (8.4%), biface percussion (37.3%), pressure flaking (53.2%), diagnostic debitage (36.7%), and non-diagnostic debitage (63.3%).

Wild/Clymer Collection Sample Typology

The typological key adapted from the Monitor Valley Key for use in the northern Great Basin (Largaespada 2006) assigned a projectile point type to the greatest number of points within the Wild/Clymer Collection sample (n = 469, 77%). However, the Monitor Valley Key (Thomas 1981) assigned a type to only 65% of the typeable points (n = 394). Modifications to the Monitor Valley Key that proved to account for variability in style present in the Wild/Clymer Collection sample include the introduction of basal height as a determinative characteristic for notched points, the separation of Rosegate into Rose Spring and Eastgate, the addition of Elko Side-notched points, and other changes to the measurement parameters (Largaespada 2006). Elko Eared (n = 93), Elko Corner-notched (n = 84), and Rose Spring (n = 69) points occur the most often in the Wild/Clymer Collection sample using the Northern Great Basin key. Elko Corner-notched (n = 78), Gatecliff Split Stem (n = 74), and Elko Eared (n = 70) occur the most often according to the Monitor Valley Key (Figure 5).

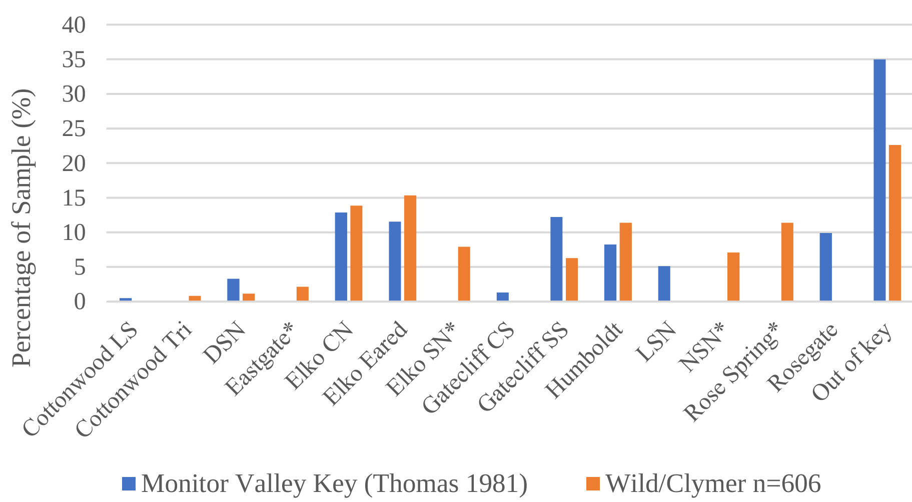

Figure 5: Distribution of projectile point types in the Wild/Clymer Collection sample using two typological keys.

Professionally Recorded Archaeological Typology

Sites professionally analyzed within the study area utilize both the Monitor Valley key (Thomas 1981) and key adapted for the northern Great Basin (Largaespada 2006) to systematically determine projectile points present in a site assemblage. Elko Eared points occur at the highest frequency at sites within the study area, accounting for an average of 20% of the artifacts at each site. Rosegate points (Thomas 1981) are the second most common, accounting for an average of 17% of the artifacts at each site. Other points with dense representation in the assemblage data are Rose Spring points (13%) (Largaespada 2006) and Elko Corner-notched points (8%). Of the types that occur most often at each site, Elko Eared points are present at the greatest number of sites (n = 9), while Rosegate and Rose Spring points only occur at four sites. Though Northern Side-notched (8%) and Elko Corner-notched (6%) points do not occur in the highest densities at each site, both types are present in 50% of the sites within the study area. The sample size at each site is small (average n = 23), increasing the utility of comparing percentages of points per assemblage (Figure 6). The Wild/Clymer Collection sample is listed at the top, representing the focal point of the study area, and the sites are listed by increasing distance from the focal point. Another comparison is made between the Wild/Clymer Collection sample and the combined densities of projectile points from all sites within the study area sample (Figure 7). This demonstrates that, while the projectile points from both samples is consistent based on presence/absence, the frequencies are inconsistent. Based on the model, this signifies that the Frenchglen assemblage is biased towards the preferences of the collector, rather than being a representative sample from the northern Great Basin archaeological region.

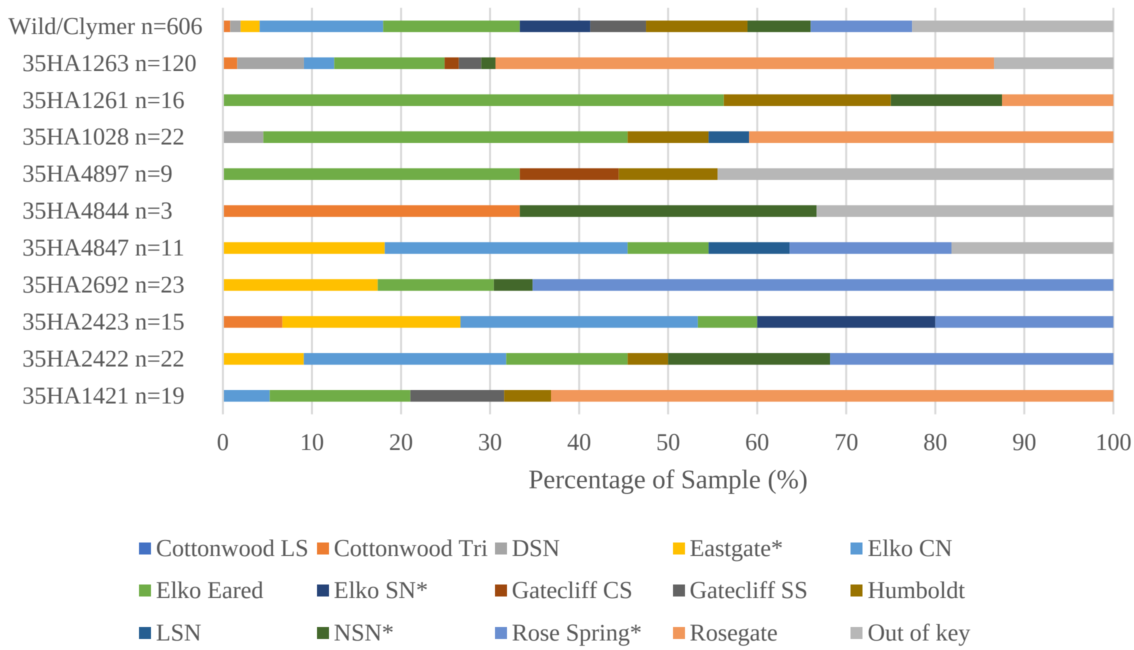

Figure 6: Distribution of projectile point types at a sample of professionally analyzed site assemblages from sites within the study area (Jenkins and Connolly 1990; Musil et al. 1990; Musil et al. 1991; O'Grady 2006; Raven and Elston 1992; Solimano et al. 2019). [*Projectile point types listed with a (*) are from an adaptation of the Thomas (1981) key (Largaespada 2006).]

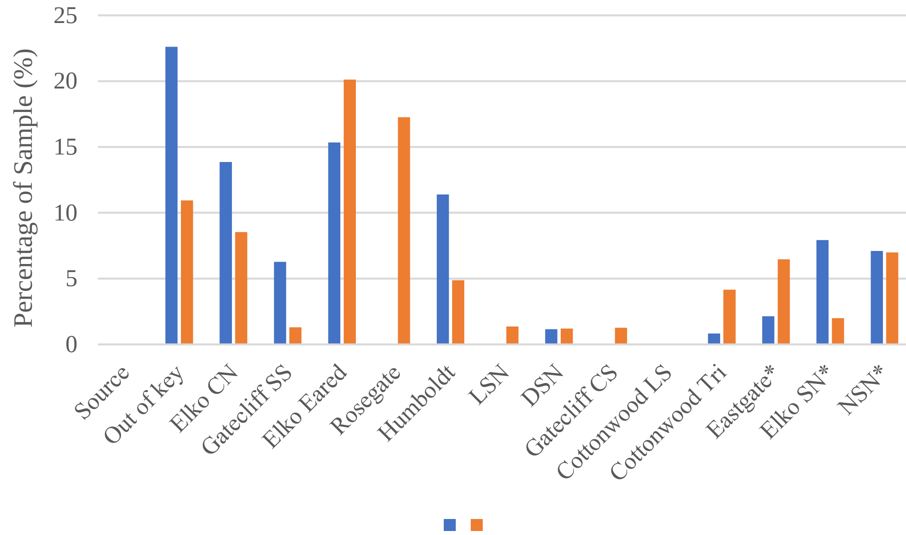

Figure 7: Comparison of projectile points present in the Wild/Clymer Collection sample and the combined distribution of projectile points present within the professionally analyzed archaeological sites.

Results of the raw material source, morphological, and typological analyses created the Wild/Clymer Collection sample data set, which includes information useful to compare to assemblage data within the study area. Identifying consistencies between the Wild/Clymer Collection sample and the sample of site assemblage data within the study area determined the likelihood that the two samples are from the sample population. As shown in the previous avocational collection studies (Amick 2004; Boulanger and Graves 2017), creating the Wild/Clymer Collection data set recovers information lost through the avocational collection process. This recovered information alone helps to infer the archaeological region where the artifacts in the collection sample were originally collected from, but a comparison to the archaeological record strengthens the conclusions that artifacts in the Wild/Clymer Collection sample were selected from the population of artifacts within the study area.

INTERPRETATION: MAKING AN ARGUMENT FOR CONSISTENCY

Differences in sample size between professionally analyzed sites and the Wild/Clymer Collection create notable difficulty in comparing the statistical similarities between the two samples. Also, the variety of strategies used to create each sample (e.g. avocational collection, random sampling, prioritizing analysis of projectile points) does not meet the assumption for statistical comparison between the two samples. Assessing the presence and absence of traits among the two samples permits inference of a consistent relationship. While the Wild/Clymer Collection sample shared similar typological and raw material source characteristics with sites across the study area, it appears that sites closer to Frenchglen, Oregon yielded the more consistent relationships.

Raw Material Sourcing

The Wild/Clymer Collection sample includes obsidian from 62 unique obsidian sources. The collection sample includes 25 obsidian sources that have representation in site assemblages within the study area (40%). Sites across the study area include obsidian from 42 unique sources, 22 of which have representation in the Wild/Clymer Collection sample (50%). Both the Wild/Clymer Collection sample and site assemblages within the study area included unknown obsidian sources, which this argument for consistency excludes. The sites within the study area that include the most representative distribution of obsidian sources compared to the Wild/Clymer Collection sample are 35HA792, 35HA1263, 35HA1421, 35HA2880, 35HA2895, and 35HA2422. The six most consistent site assemblages based on raw material sourcing all include obsidian from the Beatys Butte source.

The closest site (35HA1263) is located just 15 miles to the north-northeast of Frenchglen, Oregon, while the two furthest sites are located 65 miles to the northwest (35HA2880) and 65 miles to the north-northeast (35HA1421). Of the 28 sites that did not have any artifacts made from Beatys Butte obsidian, only three sites (35HA80, 35HA2877, and 35HA2878) did not have any artifacts made from obsidian sources included in the Wild/Clymer Collection sample. These three sites only represent 8% of the sites within the study area used in this analysis and are all located between 70-75 miles to the northwest of Frenchglen, Oregon. At 10 sites of the 25 remaining sites, 100% of the obsidian sources represented are also represented in the Wild/Clymer Collection sample, despite a lack of artifacts from the Beatys Butte source. At the remaining 15 sites, between 16% - 80% of the obsidian sources are also represented in the Wild/Clymer Collection sample.

At the sites located north of Frenchglen, Oregon, closest to the Burns obsidian source, the Burns source accounts for an average of 50% of the raw material within the site assemblage. The sites with the highest density of Burns obsidian are located within 10 miles (16 km) of the obsidian source. Fulton et al. (1999), following raw material sourcing at sites extending across southern Oregon from Deschutes county to Malheur county, concluded that all raw material sources identified at the site occurred locally. This observation supports the conclusion that the presence of Beatys Butte obsidian in the Wild/Clymer Collection sample (57.22%) is consistent with a population of artifacts within 10-15 km of the Beatys Butte obsidian source. The Beatys Butte obsidian source is the closest source to Frenchglen, Oregon.

Morphology

The minimal quantity of morphological data reported for archaeological sites within the study area is a function of each study's goals and research questions (Dunnell 1978). The goal of this investigation is to gather the greatest amount of information about the Wild/Clymer Collection sample and compare it to available data within the study area. This research objective does not align with the objective of other studies, most prominently the goals of compliance archaeology.

Despite the small sample size at 35HA3293, the morphological characteristics offer information comparable to the data in the Wild/Clymer Collection sample data set. The presence of use wear on 100% of the flake tool artifacts (n = 4) and on 0% of the bifacial preforms (n = 5) is not consistent with the morphological data in the Wild/Clymer Collection sample. However, the lack of temporally diagnostic projectile points at 35HA3293 (n = 0) is not consistent with the composition of the Wild/Clymer Collection sample, which includes 44% (n = 606) temporally diagnostic projectile points.

The use wear reported at 35HA3293 occurs in localized areas of the flake tools, whereas the 37% (n = 512) of the artifacts in the Wild/Clymer Collection sample has use wear occurring on the entire edge circumference of the artifact. According to Amick (2004), this wear pattern is not functional use, and instead is created by post-depositional transport of the artifacts by the avocational collector. The researcher (Amick 2004) identified similar wear on the artifacts within the avocational collection analyzed in that study and did not represent tool use behavior. However, the density of artifacts in the collection sample with surface wear consistent with surface archaeological sites provides evidence for regional provenience within the northern Great Basin environments and support that the artifacts were collected from surface archaeological sites (Beck 1984; Clewlow 1968; Reaux et al. 2018).

This paradigmatic classification scheme provided a systematic and consistent method for analyzing the morphology of the Wild/Clymer Collection sample. For analyzing avocational collections, the paradigmatic classification scheme provides a mechanism to determine the variability of traits and determines the utility of introducing typological and raw material sourcing analyses to recover additional lost information. The quantity of complete, temporally diagnostic points (44%) and obsidian artifacts (99%) in the Wild Clymer Collection sample provided preliminary information for the application of type/style and raw material sourcing analysis.

Typology

Comparing the projectile points present in the Wild/Clymer Collection sample and the archaeological record within the study area supports the conclusion that the sample was collected from the archaeological record of the northern Great Basin. The sites most consistent with the typological characteristics of the Wild/Clymer Collection sample are 35HA1261 and 35HA1421. Both site assemblages include Elko Eared, Rosegate (Thomas 1981), and Humboldt projectile points and lack smaller, arrow-sized points like Cottonwood Triangular and Northern Side-notched points. Of these two sites, 35HA1261 is located closest to Frenchglen, Oregon, only 30 miles to the northeast. A neighboring site, 35HA1263, possesses similar characteristics as the Wild/Clymer Collection sample, though differing in the presence of Northern Side-notched points in the site assemblage. Overall, eight of the 11 sites within the study area that utilized the systematic typological keys include distributions of projectile point types similar to the Wild/Clymer Collection sample. The sites closest to Frenchglen included the characteristics most consistent with the Wild/Clymer Collection sample.

The northern Great Basin key adaptation was able to capture the greatest amount of projectile point variability. This conclusion provides additional support that the Wild/Clymer Collection sample was removed from the archaeological record in the northern Great Basin. Differentiating between Rose Spring (n = 69) and Eastgate (n = 13) increased the number of projectile points assigned to those types, whereas the Monitor Valley Key's grouping of the two types into Rosegate (n = 60) did not classify as many points. However, the ability of the Monitor Valley Key to identify only 65% of the projectile point types is not disadvantageous for this conclusion. Though Thomas (1981) emphasizes that the key is most effective near Monitor Valley, its use in projectile point analyses across the Great Basin, at a minimum, supports that the Wild/Clymer Collection sample was removed from the archaeological within the wider Great Basin region.

CONCLUSIONS AND RECOMMENDATIONS

The Wild/Clymer Collection sample shared characteristics consistent with those within the study area, particularly typological and raw material source characteristics. The three variables included in the flow chart for this analysis recovered a diverse, replicable, and comparable data set for the Wild/Clymer Collection sample that permitted a determination of consistency between the collection sample characteristics and those characteristics of sites within the study area. Some variability identified between the two samples was expected due to the bias inherent to avocational projectile point collecting and research objectives defined narrowly in the professionally recovered data sets. The adaptations to previous avocational collection analyses (Amick 2004; Boulanger and Graves 2017) successfully determined from which population the Wild/Clymer Collection sample was removed from. The results of this analysis demonstrate the ability to recover lost information from avocational artifact collections.

As archaeologists, museum curators, and tribes continue to come into possession of avocational collections, the methods introduced and tested in this investigation offer a valid and replicable approach to recovering lost information. Like the conclusion of Boulanger and Graves (2017), recovering provenience information from the original collector may be the only mechanism for identifying precise provenience information (i.e., site locations). As these documents do not often exist, analyzing the raw material source, morphological, and typological characteristics of the collections provides a viable mechanism for recovering some provenience information for artifacts within the collection. The Frenchglen, OR label scribed on the Wild/Clymer Collection sample artifact cases provided a focus for the analysis that proved advantageous for choosing which typological schemes to apply. If these methods were applied to an avocational collection that lacked any location information to serve as the focal point of the study area, the morphological classification scheme would provide coarse grained information about the collection that could be used to choose a typological scheme to apply. The model for this analysis, as demonstrated in the flow chart (see Figure 3), accommodates this process that may be necessary for applying these methods to other avocational collections.

The results of this analysis provide information on the regional provenience of the Wild/Clymer Collection sample. This offers the opportunity to share the information with tribes from the identified region and to engage in consultation to determine the best approach for continued care and management of the collection. Without recovering the information lost through the avocational collection method, identifying the associated tribe to consult with about the collection would be more difficult. As researchers continue to engage in archaeological research across the West, the body of information available to compare to data collected via this method increases, only amplifying the precision of these methods.

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Appendix A

LOAN AGREEMENT

This loan agreement in entered into this__21___day of_FEB____,20_18,
By and between Central Washington University, hereinafter deemed the recipient, and the Party loaning the property:

Lender's Name:
Institution: John Ford Clymer Myseum
Address: 416 N.Pearl St.
City: Ellensburg
County: Kittitas
State: Washington
Phone: 509.962.6416
E-mail: director@clymermuseum.org

Hereinafter deemed the lender. The lender and recipient shall be individually referred as a "party" and collectively as "parties."

PURPOSE OF LOAN: To provide Central Washington University's Department of Anthropology and Museum Studies the opportunity for students to clean, study and catalog the Darwin Goodey Stone Tool Collection.

DESCRIPTION OF LOAN: The loan of the Stone Tool Collection is to be of an agreed upon duration of_three_years. At the conclusion of the loan period Central Washington University will return the collection to the Clymer Museum in a condition that is in accordance with established museum archiving practices. The items will be cleaned, numbered, cataloged and undergo scientific examination to determine the nature of the materials and their culture history type, if possible. Each item will be returned in a separate plastic bag with tag and an electronic catalog will be provided.

The parties agree:

1. Term of Loan: The loan of property shall be for__three__years from the date of this agreement, unless terminated by the recipient at an earlier date. Notice of an earlier termination will be communicated in writing by the recipient to the lender.
2. Termination: Recipient may terminate the Loan agreement, with or without cause, by providing notice of termination to the lender, its successors or assigns, in accordance with the notice provision in this agreement. In case such notice is returned to the recipient as undeliverable, the recipient shall be authorized to make appropriate disposition of said property in any manner the recipient may deem proper no sooner than ninety (90) days after such notice is returned to the recipient.
3. Notice to Lender: Notices to the lender required under this loan agreement shall be communicated by United States certified mail and addressed and delivered to the address last communicated to the recipient by the lender.

LOAN AGREEMENT

4. Recipient's Standard of Care: The recipient shall be responsible only for the exercise or ordinary care in the protection and preservation of the above-described property when that property is in the possession and control of the recipient.
5. Loan agreement Not Binding on Agent of Recipient: This loan shall not be binding upon any individual agent of the recipient.

IN WITNESS WHEREOF, the parties hereto have set their hands this 21st day Of Feb. 2018.

CONDITIONS OF LOAN

1. Central Washington University will give borrowed objects the same care it does comparable property of its own.
2. Damage to borrowed objects, whether in transit or while in the University's possession regardless of responsibility, will be reported immediately to the lender.
3. No alteration, restoration or repair will be undertaken without authorization from the lender.
4. Unless otherwise noted in writing, the borrowed objects may be photographed or reproduced by the University for educational, catalog, and publicity purposes subject to copyright restrictions.
5. Unless the University is notified in writing, it will release borrowed objects only to the lender. In case of change of legal ownership, including dissolution of the lending establishment, the new owner is required to establish his legal right by proof of satisfactory to the University and to indicate its intention as to continuance of the loan.
6. The costs and arrangements for receiving and returning borrowed objects will be agreed upon by the lender and the University at the time the loan is negotiated.
7. The University will provide "All Risk" insurance coverage for objects which have been brought into the Museum at its request unless the lender expressly elects to maintain his or her own insurance coverage. Insurance in such cases will be effected at the lender's value (which must reflect fair market value) as stated on the face of the agreement, and such insurance will cover only those risks against which the University insures its own property under such policy, subject to the following standard exclusions: wear and tear, gradual deterioration; repairing, restoration or retouching process. The lender agrees that in the event of loss or damage, recovery, if any, shall be limited to such amount as may be paid by the insurer, hereby releasing Central Washington University, its boards, officers, agents, and employees from liability for any and all claims arising out of such loss or damage.
8. In case of long-term loans, it is the responsibility of the lender to notify Central Washington University of current insurance valuations.
9. If the lender elects to maintain his or her own insurance, then prior delivery or shipping Central Washington University must be supplied with a Certificate of Insurance and naming the Museum as an additional insured or waiving rights of

LOAN AGREEMENT

subrogation. Failure of the lender to provide the agreed upon insurance constitutes release of Central Washington University from any liability for damaged to or loss of the property placed on the loan.

The conditions of loan listed (pages 2 & 3) are agreed to and understood by the lender named above

Signature of Lender: James B. Tepper

Title/Position Pres. of Clymer BOD **Date** 2-21-18

INSURANCE (See #7, page 2 and circle appropriate condition below

Carried by Central Washington University

Carrier by Lender JBT **Insurance Waived**

This loan is accepted for Central Washington University by an authorized official or representative

Signature of authorized official: ____________

Title/Position DEAN, COTS **Date** 1/29/18

DB 1/24/18

LOAN RETURN

Return of Loaned Artifacts is hereby Acknowledged:

Lender's Signature: ____________

Title/Position ____________ **Date** ____________

CWU Official's Signature: ____________

Title/Position ____________ **Date** ____________

Appendix B

Maximum Length (LM) – the total length of the projectile point. This measurement was collected using digital calipers to the nearest millimeter (mm). For fragmentary points, the LM was collected and associated notes were recorded about the breakage (Amick 2004).

Axial Length (LA) – the total length from the center axis of the projectile point. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the LA was collected and associated notes were recorded about the breakage (Amick 2004).

Maximum Width (WM) – the maximum width at the widest portion of the projectile point. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the WM was collected, and associated notes were recorded about the breakage (Amick 2004).

Base Width (WB) – the width at the basal element of the projectile point. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the WB was collected and associated notes were recorded about the breakage (Amick 2004).

Neck Width (WN) – for notched points, the width between the deepest portion of the notch of either side of the projectile point. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the WN was collected and associated notes were recorded about the breakage (Amick 2004).

Distal Shoulder Angle (DSA) – for notched and stemmed points, the angle for the distal (top of the notch) angle of the projectile point. This measurement was collected using the Adobe Illustrator angle measuring tool (Keene 2018). For points with asymmetrical notches, the notch with the smallest DSA was recorded (Thomas 1981). Angle measurements were recorded to the nearest 5° (Thomas 1981).

Proximal Shoulder Angle (PSA) – for notched and stemmed points, the angle for the proximal (bottom of the notch) angle of the projectile point. This measurement was collected using the Adobe Illustrator angle measuring tool (Keene 2018). For points with asymmetrical notches, the notch with the smallest PSA was recorded (Thomas 1981). Angle measurements were recorded to the nearest 5° (Thomas 1981).

Weight (W) – this is the total weight of the projectile point (grams). This measurement was recorded using an Ohaus digital scale and recorded to the nearest 100^{th} of a gram.

Thickness (T) – the maximum width of the projectile point. Thickness is recorded perpendicular to the width measurement. This measurement was collected using digital calipers to the nearest mm.

Basal Height (BH) – for side notched points, the distance from the more inferior part of the base to the bottom (proximal edge) of the notch. This measurement is a critical addition to the Largaespada (2006) typological key for identifying variability in side-notched points identified in the northern Great Basin. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the LM was collected and associated notes were recorded about the breakage (Amick 2004).

Length to Maximum Width (LMW) – the distance from the most inferior part of the base to the location of the maximum width. This measurement was collected using digital calipers to the nearest mm. For fragmentary points, the LMW was collected and associated notes were recorded about the breakage (Amick 2004).

Base Width/Maximum Width (WB/WM) – the ratio between the basal width and the maximum width of the project point. The two width measurements were collected using digital calipers to the nearest mm and divided using a cell formula.

Maximum Length/Maximum Width (LM/WM) – the ratio between the maximum length measurement and the perpedicular maximum width measurement. Both measurements were collected using digital calipers to the nearest mm and divided using a cell formula. This ratio is between 0 to 0.90 (Thomas 1981).

Notch Opening Index (NOI) – the difference between the DSA and the PSA (Thomas and Bettinger 1976). This measurement indicates the angle of the notch opening and was not recorded for unshouldered points. The NOI was collected by subtracting PSA from the DSA using a cell formula.

Basal Indentation Ratio (BIR) – the ratio between the LM and the LA. This ratio identifies the depth of the basal concavity relative to the LM of the projectile point. For straight and convex based projectile points, this ratio is 1.0. The BIR was collected by dividing the LM measurement by the LA measurement using a cell formula.

Maximum Width Position (MaxWPos) – the ratio between the LMW and the LM. This ratio identifies the position of the maximum width relative to the LM. The MaxWPos was collected by dividing LMW measurement by the LM measurement using a cell formula.

Appendix C

X-Ray Fluorescence Analysis of Obsidian Artifacts from the Wild/Clymer Collection, Harney County, Oregon

Alex J. Nyers
Northwest Research Obsidian Studies Laboratory

Two hundred artifacts from the Wild/Clymer Collection, Harney County, Oregon, were submitted for energy dispersive X-ray fluorescence trace element provenance analysis. The samples were prepared and analyzed at the Northwest Research Obsidian Studies Laboratory (NWROSL) under the accession number 2020-23. Additionally, photon count results from 1,145 artifacts analyzed using Central Washington University's Bruker Tracer 5i pXRF device were calibrated to the NWROSL QuanX-EC spectrometer and compared to the NWROSL source database.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the samples was completed using a Thermo NORAN QuanX-EC energy dispersive X-ray fluorescence (EDXRF) spectrometer. The analyzer uses an X-ray tube excitation source and a solid-state detector to provide spectroscopic analysis of elements ranging from sodium to uranium (atomic numbers 11 to 92) and in concentrations ranging from a few parts per million to 100 percent. The system is equipped with a Peltier-cooled Si(Li) detector and an air-cooled X-ray tube with a rhodium target and a 76 micron Be window. The tube is driven by a 50 kV 2mA high voltage power supply, providing a voltage range of 4 to 50 kV. During operation, the tube current is automatically adjusted to an optimal 50% dead time, a variable that is significantly influenced by the varying physical sizes of the different analyzed samples. Small specimens are mounted in 32 mm-diameter sample cups with mylar windows on a 20-position sample tray while larger samples are fastened directly to the surface of the tray.

For the elements that are reported in Table A-1, we analyzed the collection with a 3.5 mm as well as an 8.8 mm beam collimator installed with tube voltage and count times adjusted for optimum results. Instrument control and data analysis are performed using WinTrace software (version 7) running under the Windows 7 operating system.

The diagnostic trace element values used to characterize the samples are compared directly to those for known obsidian and fine-grained volcanic (FGV) sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2020a). Artifacts are correlated to a parent obsidian, FGV, or basalt source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Data were provided from the Bruker Tracer 5i in the form of photon counts. These data were calibrated to concentration data by building linear calibration curves using one hundred randomly sampled submitted artifacts and then tested using the second hundred submitted artifacts. For additional details on the configuration of the pXRF device please refer to the Central Washington University Department of Geology.

Results of Analysis

X-Ray Fluorescence Analysis. The 200 obsidian artifacts analyzed by NWROSL were correlated with thirty-two known obsidian sources. Including the additional 1,145 artifacts analyzed via pXRF, 61 established obsidian and FGV sources were identified. Thirty artifacts could not be correlated with any established geologic source of obsidian in the NWROSL database, however nine of these artifacts correlate with previously analyzed archaeological artifacts found in Lake County, Oregon. The locations of the site and the identified sources are shown in Figure 1 and Figure 2. Analytical results are presented in Table A-1 in the Appendix and are summarized in Table 1 and Figure 3. Calibration curves for the Bruker Tracer 5i pXRF are included with the final report as Microsoft Excel files. Analyzed obsidian artifacts are shown in Figure F-1 in the Appendix.

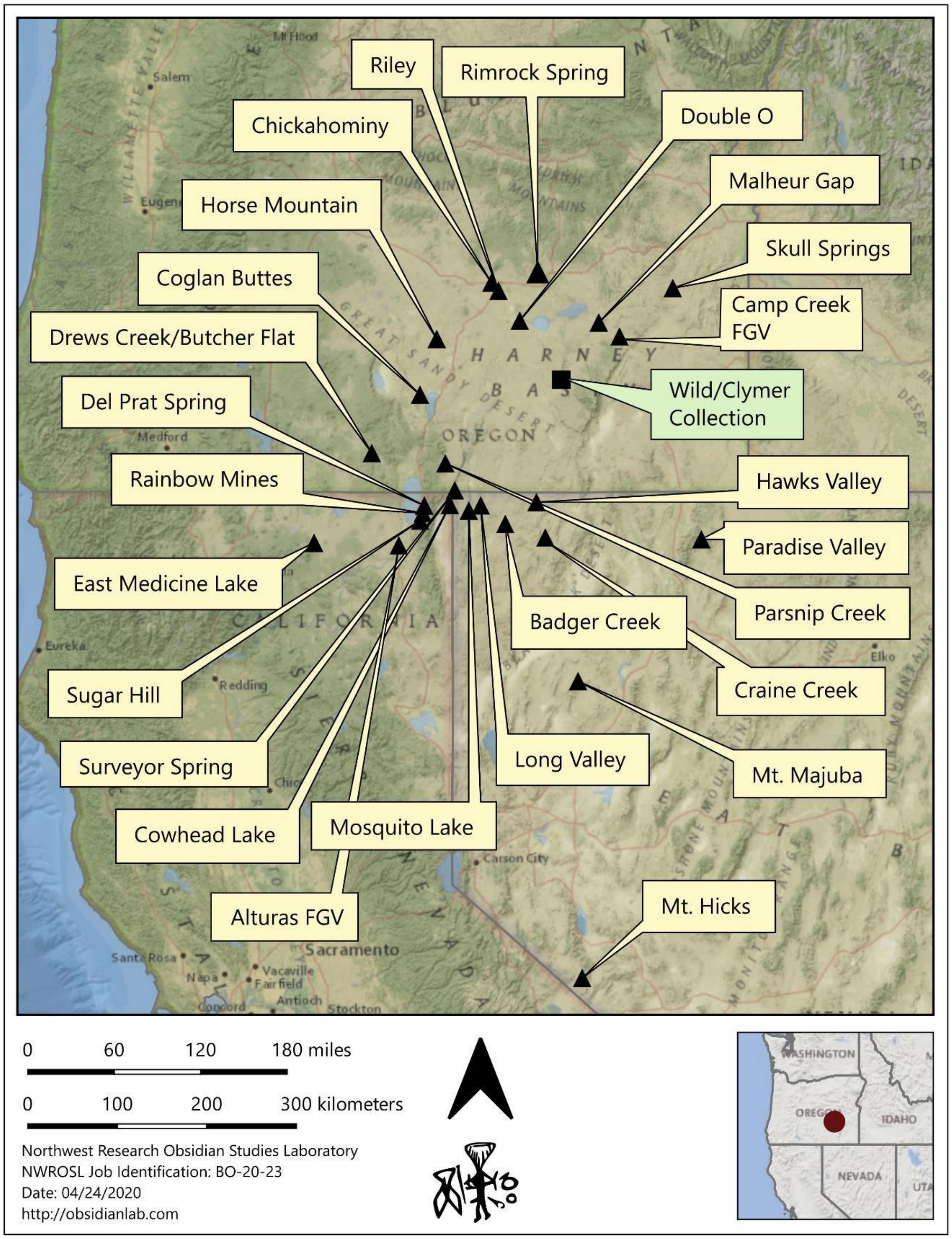

Figure 1 - Locations of the project collection area and sources of the analyzed obsidian and FGV artifacts. Geologic obsidian sources shown in this figure are expressed in discrete geographic locations. NOTE: Some sources are not shown on this map due to limited area, please see http://obsidianlab.com or http://sourcecatalog.com for source coordinates.

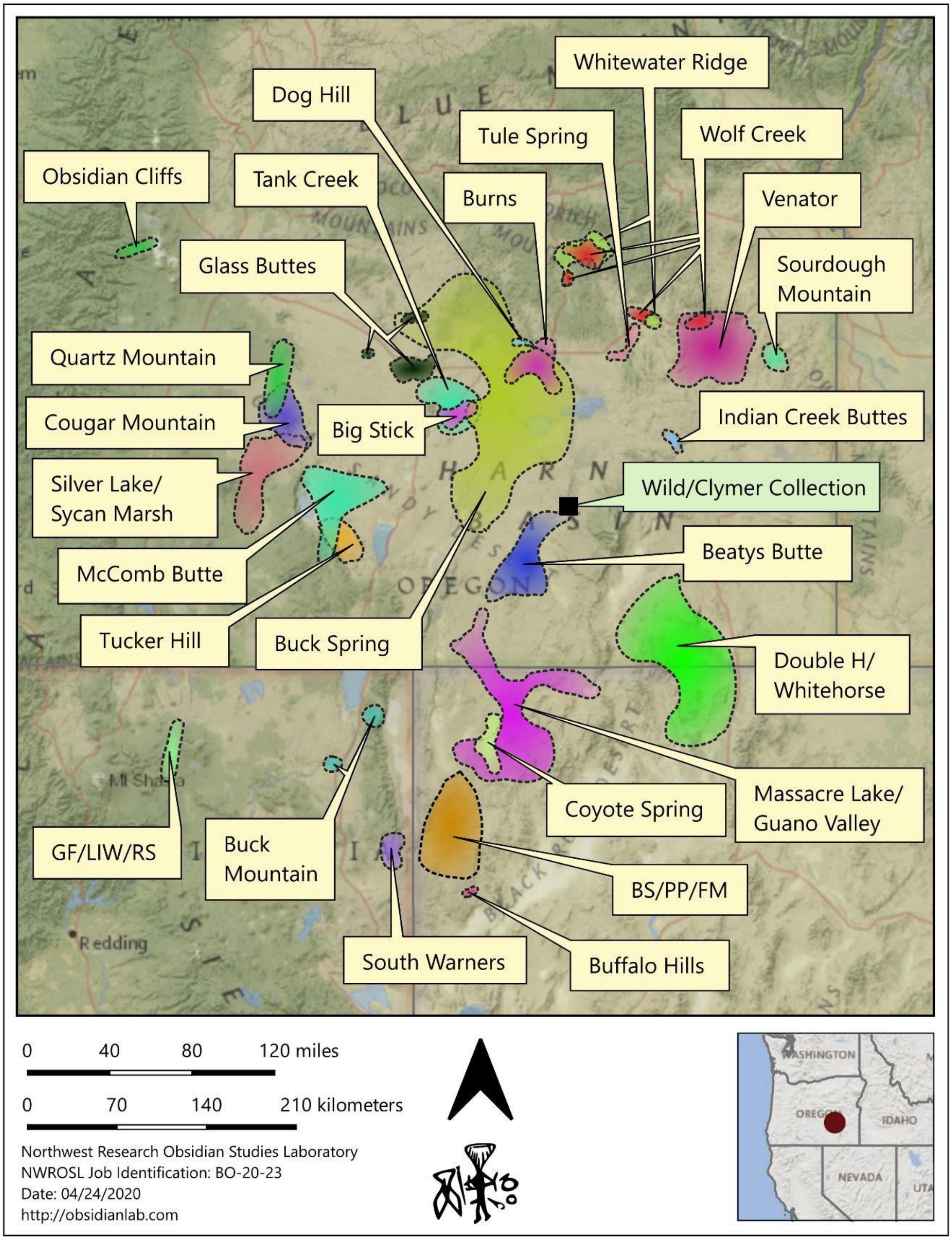

Figure 2 - Locations of the project site and sources of the analyzed obsidian artifacts. Geologic obsidian sources shown in this figure are expressed across a wide geographic area.

Table 1 - Summary of results of trace element analysis of the project specimens.

GEOCHEMICAL SOURCE	N =	PERCENTAGE
Alturas FGV	1	0.07
Badger Creek	9	0.67
Beatys Butte	769	57.22
Beatys Butte B	6	0.45
Big Stick	1	0.07
Black Bull Spring (FGV)	1	0.07
BS/PP/FM	51	3.79
Buck Mountain	31	2.31
Buck Spring	10	0.74
Buffalo Hills	4	0.30
Burns	13	0.97
Camp Creek	2	0.15
Chickahominy	1	0.07
Coglan Buttes	1	0.07
Cougar Mountain	1	0.07
Cowhead Lake	7	0.52
Coyote Spring	4	0.30
Coyote Spring FGV	1	0.07
Craine Creek	3	0.22
Del Prat Spring	2	0.15
Dog Hill	1	0.07
Double H/Whitehorse	30	2.23
Double O	12	0.89
Double O FGV	1	0.07
Drews Creek/Butcher Flat	20	1.49
East Medicine Lake	2	0.15
GF/LIW/RS	1	0.07
Glass Buttes 1	1	0.07
Hawks Valley	13	0.97
Horse Mountain	5	0.37
Indian Creek Buttes	20	1.49

Indian Creek Buttes B	9	0.67
Long Valley	1	0.07
Malheur Gap	2	0.15
Massacre Lake/Guano Valley	147	10.94
McComb Butte	4	0.30
Mosquito Lake	3	0.22
Mt. Hicks	2	0.15
Mt. Majuba	1	0.07
Obsidian Cliffs	6	0.45
Paradise Valley	2	0.15
Parsnip Creek	1	0.07
Quartz Mountain	1	0.07
Rainbow Mines	5	0.37
Riley	4	0.30
Rimrock Spring	5	0.37
Silver Lake/Sycan Marsh	1	0.07
Skull Springs	2	0.15
Sourdough Mountain	2	0.15
South Warners	14	1.04
Sugar Hill	4	0.30
Surveyor Spring	11	0.82
Tank Creek	2	0.15
Tucker Hill	6	0.45
Tule Spring	6	0.45
Unknown Obsidian	23	1.71
Unknown Obsidian 1	8	0.60
Unknown Obsidian 5	1	0.07
Venator	31	2.31
Whitehorse 2	14	1.04
Whitewater Ridge	2	0.15
Wolf Creek	1	0.07
TOTAL	**1345**	**100**