LATE HOLOCENE TOOLSTONE USE AND GROUP MOBILITY AT THE CONNLEY CAVES, OREGON

by

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This research investigates patterns of hunter-gatherer mobility based on the identification and analysis of late Holocene arrow points from the Connley Caves archaeological site in central Oregon. Looting and expedient excavation in the 1960s left the late Holocene upper deposits of the Connley Caves that contained arrow points highly disturbed. Because projectile points are time diagnostic, this research thus addresses the gap in knowledge concerning site use during the last 2000 years. To investigate these patterns, I identified each arrow point from the Connley Caves using the Monitor Valley Key, and sourced the obsidian from which they are composed using an X-ray fluorescence spectrometer. Previous research in the region suggests that following the introduction of the bow and arrow (~2000 years ago), people increased the frequency and distance of their movement to procure stone tool raw materials. If this is true in the Fort Rock Basin, I hypothesize that late Holocene arrow points from the Connley Caves should exhibit a higher average transport distance and a greater diversity of sources than dart points that preceded bow and arrow technology. Findings suggest that late Holocene inhabitants of the Connley Caves procured toolstone from primarily local sources (< 20 km), likely due to the high concentration of obsidian flows within the local radius. This marks the Connley Caves as a potential outlier in the region, and greatly advances our understanding of lifeways at the site and of mobility and toolstone use in central Oregon during the last two millennia.

Acknowledgements

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1. Introduction and Background

1.1 Introduction

Archaeologists are often interested in patterns of mobility when investigating hunter-gatherer lifeways, as mobility can provide valuable insights into aspects of life in the past such as subsistence patterns and trade. One way that archaeologists assess mobility is through the geochemical sourcing of stone tools, which can provide insights into the movements people made in procuring, using, and ultimately discarding lithic materials. Stone tool sourcing is an especially prevalent method used to investigate mobility in the Great Basin region of North America due to the diverse range of chemically distinct obsidian flows there (e.g. Smith and Harvey 2018). Archaeologists in the Great Basin have identified a number of diachronic trends across time through the sourcing of obsidian and have proposed varying degrees of mobility and territorial ranges through different periods in the past (Smith 2010). For example, X-ray fluorescence (XRF) data indicates that during the terminal Pleistocene/early Holocene (>8,200 calendar years before present [cal BP]), populations in the Northern Great Basin (NGB) generally carried toolstone further than populations in more recent times. This long-distance transport also coincides with a greater diversity of sources present during this period (Smith 2010). Moving into the middle Holocene (8,200 to 4,200 cal BP), there was a notable decrease in procurement and transport distances as well as source diversity (Smith 2010). There was then a rebounding shift in the late Holocene (< 4,200 cal BP) towards increasing material transport distances and source diversity, especially in the last 2,000 years ago, roughly coinciding with the emergence of bow and arrow technology (Bettinger 2015; Blitz 1988).

A robust diachronic stone tool sample is crucial to test these patterns. Because data are greatly affected by equifinality in which tools can be transported to a site in multiple different ways, sourcing studies of this nature are best conducted with larger sample sizes. Many sites in the Great Basin are surface palimpsests with materials from a range of periods mixed together due to prevalent deflation in the region, making these sites difficult to rely on as indicators of major pattern shifts across time. It is best then to turn to deeply stratified sites in the region that provide reliable chronological control.

The Connley Caves archaeological site, located in the NGB, provides an ideal setting to conduct research of this nature. The site consists of a series of rockshelters with ~4 m of stratified deposits, containing one of the most continuous archaeological records in the region (McDonough et al. 2022). The stone tool assemblage from the site includes projectile point technologies reflecting occupations before, during, and after the transition from atlatl and dart to bow and arrow technology. Yet, excavated arrow points lack extensive analysis due to their position in the upper deposits of the site that have been preferentially affected by vandalism (Rosencrance et al. 2022). This thesis identifies the arrow point types and toolstone sources at the Connley Caves, and tests proposed models of mobility patterns in the NGB. As past research shows, there was a period of mobility expansion following the introduction of the bow and arrow (Smith 2010); investigating this understudied period at the Connley Caves will allow for a diachronic analysis of these trends because the site contains materials from before and during the late Holocene.

1.2 Background

1.2.1 Obsidian Sourcing

My research focuses on obsidian sourcing, which is a common and widely applied method for investigating toolstone use and mobility in places with volcanic toolstone availability. XRF analysis determines the specific geochemical composition of toolstone and matches it to the signature of a particular geologic obsidian flow. The returned sourcing data then allows archaeologists to determine the distance an item was carried from the site of procurement, acting as a proxy for the distance a group or individual traveled or traded.

There are, however, caveats in conducting sourcing studies. An important concept to consider when interpreting sourcing results is equifinality, or the reaching of a similar effect or result by many potential means (Smith and Harvey 2018). In other words, sourcing data can show the locations and theorized zones through which materials moved, but this may have occurred through several different means, including direct procurement, trade, or for different reasons. For example, an individual may have inhabited a site for an extended period of time, crafted projectile points from local toolstone and discarded unused or inadequate points. Points or lithic materials may have also been traded between groups or individuals and brought from long distances to a particular site. This displays how archaeologists cannot truly know which of these scenarios represents how a point was found at any given site, and why equifinality is crucial to consider in the interpretation of sourcing data. Thus, it is critical to not assert particular behaviors as the driving factor behind the data, but rather to present it at face value representing directionality while also acknowledging the various scenarios that produced the archaeological record. When large sample sizes are present, particularly at buried sites, it is possible to favor one scenario over another depending on the data.

Behavior, though, may be assessed by incorporating different tool types. Projectile points are time diagnostic (certain forms are restricted to periods of time) and act as excellent proxies for particular periods, but they can lack in behavioral associations if sourced alone. By incorporating other tool/artifact types such as bifaces, debitage, or edge-modified flakes (EMFs), it is possible to then shift results from not only mobility but to forms of behavior that may be associated with raw material availability, tool use, and discard (Smith and Harvey 2018). It is also important to note that multiple studies show projectile points were generally carried further than other tools, which can impact the results of a study like this which only incorporates projectile point data (Smith 2011). Unfortunately, my study is limited to projectile points because of disturbances that exist in many late Holocene deposits at the Connley Caves due to illegal artifact collecting and antiquated excavation methods in the 1960s. Because of this, few deposits at the site from this period contain non-time diagnostic tools in primary context, so I must rely upon time-diagnostic projectile points to obtain secure sourcing data.

Sourcing data is visually and conceptually represented with lithic conveyance zones (LCZs), which detail the regional movement of toolstone, and by extension groups of people, by considering the distances and directions of original toolstone sources away from any given site or group of sites. Therefore, arrow point XRF data from the Connley Caves will contribute to the future refinement of LCZs in the northern Great Basin. These trends are determined by the amount of local and non-local sources represented in the data, and in the context of this project local obsidian sources have been defined as those occurring within a 20 km radius of the site, with all others considered to be non-local (see below). Foraging behavior and mobility assuredly vary amongst groups and individuals across space and time, and LCZs cannot tell us over how much time they formed and by what behaviors (Smith and Harvey 2018).

1.2.2 Site Setting

The Connley Caves are situated in the Fort Rock Basin of the NGB, overlooking Paulina Marsh in central Oregon (Figure 1). The site contains eight rockshelters, formed by wave action as a result of the late Pleistocene pluvial Fort Rock Lake. Several major obsidian sources fall within the 20 km range for being considered local to the caves, including the Cougar Mountain and Silver Lake/Sycan Marsh obsidian flows (Thatcher 2000). There are also abundant obsidian sources considered non-local, with over 55 distinct obsidian flows within a 100 km radius of the Connley Caves.

During the late Holocene occupation, Paulina Marsh would have been a rich source of subsistence for those residing there (McDonough et al. 2024). The marsh was the only source of perennial water in the basin and acted as an important aquatic and terrestrial resource for plants, animals, and people alike in the past and present. The site's position above the marsh also likely provided an ideal view of the valley below, allowing for the tracking of game from a distance and the coordination of hunting efforts.

Figure 1. Map displaying the location of the Connley Caves, Oregon. The bold outline displays the boundaries of the NGB in Oregon, California, and Nevada.

1.2.3 Connley Caves Background

The Connley Caves contain a rich history of human occupation spanning from the terminal Pleistocene (ca. 12,600 years ago) to the 19th Century, including late Holocene arrow points (McDonough et al. 2022). First excavated in the 1960s by Stephen Bedwell (Bedwell 1970, 1973), the site is currently being reinvestigated by the University of Oregon (UO) Museum of Natural and Cultural History (MNCH) Archaeology Field School. Looting and expedient excavation in the 1960s left the upper deposits of the site that contained arrow points highly disturbed (Jenkins et al. 2017; Rosencrance et al. 2022). This is the key reason why the late Holocene is understudied at the site, and how this research will thus address the gap in knowledge concerning site use during the last 2000 years.

1.2.4 Cultural Groups

The Connley Caves are situated within the traditional homelands of the Northern Paiute, Klamath, and Modoc peoples, whose descendants today are members of the Klamath Tribes, Burns Paiute Tribe, Confederated Tribes of Warm Springs, the Fort Bidwell Indian Community, and other communities. These groups have similar traditional foodways, but their distinct subsistence patterns and lifeways highlight cultural differences.

The Northern Paiute occupied the most extensive and dry area of the region and speak a Numic language, whose linguistic relatives range from Mexico to southern Idaho and Wyoming. Individual bands within the group occupied distinct home ranges (*tibiwa)* that overlapped and were fairly fluid, making band composition quite fluid itself (Aikens et al. 2011). As characterized by anthropologists, the Northern Paiute were highly mobile people who lived off of hunting, gathering, and fishing; they followed an intricate annual subsistence round which greatly influenced when and where they moved. At different times of the year, new resources would become available as others faded. This promoted seasonal movement to camps where they could hunt, gather, or fish for newly abundant resources. For the Harney Valley Paiutes in particular, late April to early May brought about the first major annual round event of the year as they moved in large numbers and from great distances to their spring root camp. Here, “bitterroot [*Lewisia*], biscuitroot [*Lomatium*], yampa [*Perideridia*], wild onion [*Allium*] and other species—grew in inexhaustible quantity,” for people to collect (Aikens et al. 2011: 34-35). Annual rounds like this are not unique to the Northern Paiute and were quite common amongst Native inhabitants of the NGB and beyond. The contemporary Burns Paiute Tribe is composed of many descendants of the Wadatika sub-group of the Northern Paiute. This group was forcibly relocated from their land on the Malheur Reservation following the Bannock War, being moved to Fort Simcoe and Fort Vancouver in Washington State. Over time some individuals escaped the forts and were able to return to their homeland in the Harney Valley, only to unfortunately find that their land had been returned to public domain. However, the tribe fought hard to buy back land and were ultimately successful, currently residing on a reservation outside of Burns, Oregon, which was converted to federal trust status (Burns Paiute Tribe 2024).

The Klamath people are centered on the western edge of the NGB in one of the richest environments of the region. Unlike the Northern Paiute, they speak a dialect of the Penutian language, which exists in the Columbia Plateau and Pacific-bordering regions from Alaska to California (Aikens et al. 2011). Due to their positionality near a multitude of lakes, rivers, and marshes at the base of the eastern Cascades, they lived in much more sedentary groups than the Northern Paiute (Aikens et al. 2011). Because of this, they were also more socially stratified and structured with more traditional villages. The Klamath developed a two-village system for subsistence in the winter and spring/summer. Spring/summer settlements were temporary and were positioned near the best fishing and wocas locations. Winter settlements were more permanent and were positioned on the edges of lakes and marshes where they could be sheltered and subsist off of fishing and foraging (Aikens et al. 2011). In the 1950s, the Klamath tribes took economic advantage of their resources and became one of the wealthiest self-sufficient tribes in the United States. Then, in 1954, Congress terminated the tribe from federal recognition, which was accompanied by a loss of their land and human services. The Klamath and Bureau of Indian Affairs opposed the termination, but Congress still went forward with the Klamath Termination Act. Following this, the tribe regained their Treaty Rights to hunt, fish, and gather in 1974 after a federal court ruling. Then, in 1986, they regained Restoration of Federal Recognition. While this did not return their ancestral land, it did support them in becoming economically self-sufficient once again, and the Klamath Economic Self-sufficiency Plan continues to be crucial in their local economy (The Klamath Tribes 2024).

The Modoc people share a very similar Penutian language with the Klamath, and while considering themselves distinct still had extensive interactions with networks of trade, festivities, and marriage between them (Aikens et al. 2011). The Modoc occupied the southeastern region of the NGB near the now Oregon-California border, and their territory was more reliably watered than the Northern Paiute, but less so than the Klamath. Three main bands are recognized amongst the Modoc, all of which were fluid with individuals moving between bands often (Ray 1963: 201–211). Similar to the Klamath, the Modoc also followed a two-village system. They had permanent winter villages of three to seven lodges, leaving during the spring months to follow annual rounds (Aikens et al. 2011). At all times of the year, settlements were generally near important hunting, fishing, and root collection grounds, becoming less sedentary during the spring/summer months (Aikens et al. 2011). In 1872-1873, the Modoc wars saw Indigenous Modocs fighting off the U.S. Army from the taking of their land. While they were able to successfully hold the army off for a long period, Modoc chief Kintpuash was eventually captured in 1873 and was sentenced to death along with other Modoc leaders. His people were then forcibly removed from their land, with many being moved to Oklahoma where many of their descendants still reside today (Oregon History Project 2024). Other Modocs remain in central Oregon and continue living in their ancestral homelands.

1.2.5 Significance of This Work

Materials excavated from disturbed contexts can often not be taken at face value; however, time-diagnostic items such as projectile points can still be used to assess broad-scale trends at a site. The upper deposit disturbances at the Connley Caves have subsequently led to a significant gap in knowledge concerning the late Holocene, and thus the time-diagnostic nature allows for analysis of these points. Projectile point technology, unlike other objects such as faunal remains, ecofacts, charcoal, or botanicals, may then act as a pivotal means of understanding life for those who occupied the caves in the late Holocene based on their diagnostic temporal associations. Even when lacking context, late Holocene arrow points can provide valuable insights into life at the site during this time, primarily concerning mobility throughout the region. Through the sourcing of obsidian and determination of where exactly the geologic materials for the arrow points were procured, light can be shed on the movement patterns of those who occupied the caves.

There are four main research questions guiding this research. First, (1) what arrow point types are present at the Connley Caves and how many have been excavated from the site; (2) what are the toolstone sources the arrow points in the dataset are made from; (3) how does the toolstone profile of the arrow points compare to that of dart points from earlier periods at the Connley Caves; and (4) do late Holocene toolstone conveyance trends at the Connley Caves align with broader trends across the Great Basin during this period. To answer these questions, I identified the typology of all arrow points and added them to a complete catalog of projectile points from recent excavations at the Connley Caves (2014-2023). I then sent unsourced points for XRF analysis, and compared the Connley Caves results to broader lithic conveyance trends in the NGB.

2. Materials and Methods

This study focuses on all arrow points excavated from the Connley Caves. It particularly focuses on 18 previously unclassified arrow points that had yet to undergo XRF analysis, as well as 13 earlier dart points that were analyzed in an effort to determine any diachronic trends in the region. Combined with past projectile point data from the site, I use 59 Elko series and 29 Rosegate series projectile points in analysis. All projectile points sourced from the Connley Caves are from recent UO field school excavations at caves 4, 5, and 6.

The first step in this research was to make a typological assessment of projectile points to determine if they were dart or arrow points using the Monitor Valley Key (MVK). This key was developed by Thomas (1981) as a way to objectively identify dart and arrow points from the Great Basin, and is still widely used today in archaeological management and research in the region. It uses measurements displayed in Figure 2, including whether the point is shouldered or non-shouldered, the distal shoulder angle (DSA), the proximal shoulder angle (PSA), the basal indentation ratio (BIR), the length-width ratio (L/W), the maximum width position (MaxWpos), and basal width-maximum width (BW/MW). Through these measurements, Thomas (1981) developed a flow chart (Figure 3) as a guide to assign a type to a point, thus providing an objective and replicable typological system. Once I determined the types of previously unanalyzed arrow points, I added them to a collection of previously typed (with the MVK) Elko series projectile points (dart points that precede arrow points) to allow as diachronic comparisons.

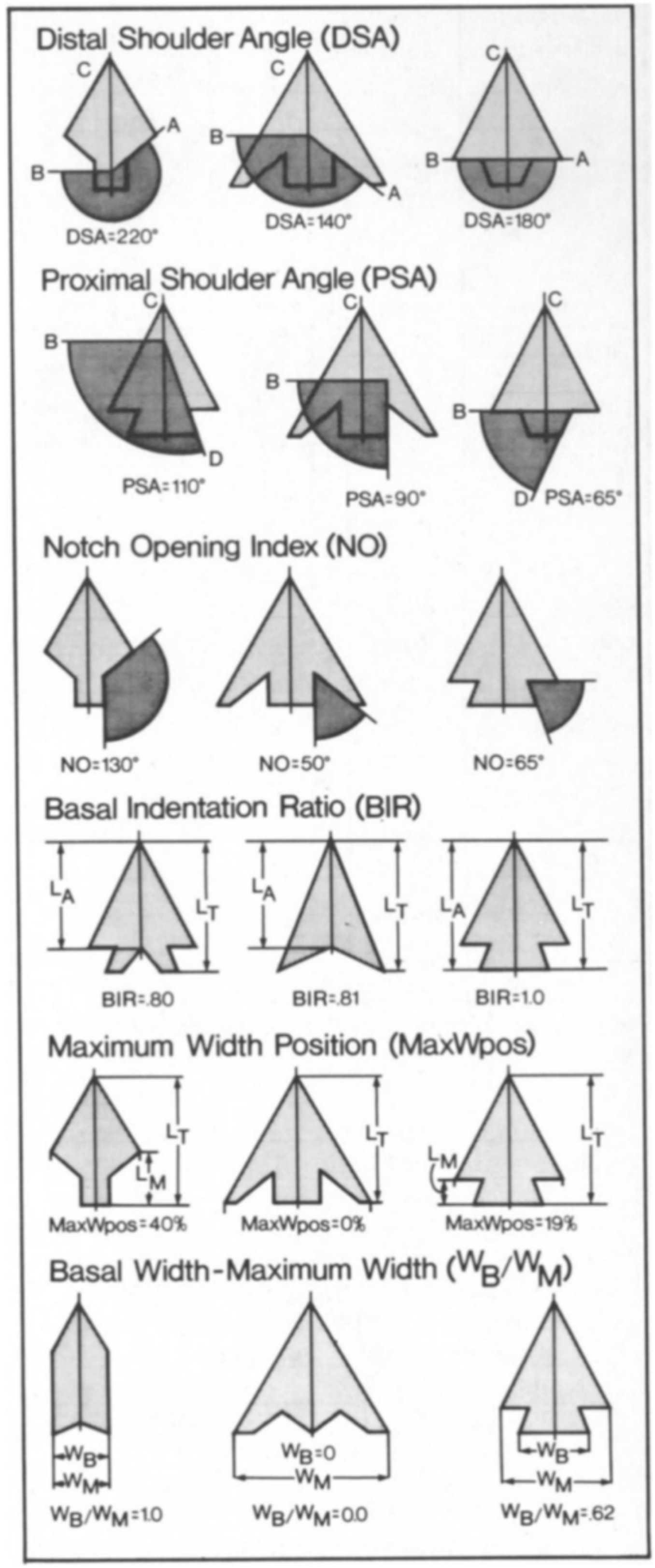

Figure 2. Schematic showing the different measurements recorded in the MVK. Image modified from Thomas (1981).

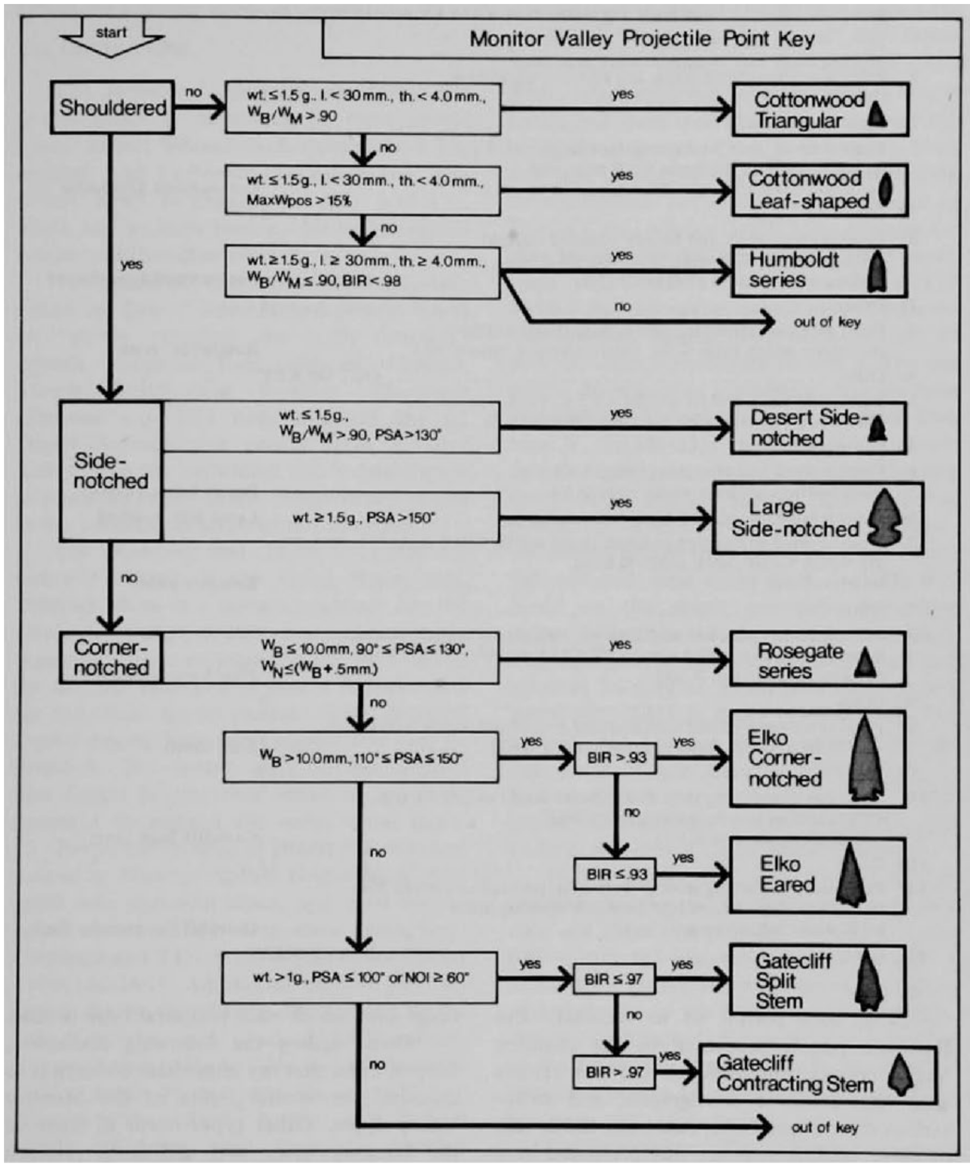

Figure 3. Flow Chart showing how measurements determine point typology in the MVK. Image Modified from Thomas (1981).

Following typological identification, I submitted all unsourced points to the Northwest Research Obsidian Studies Laboratory (NWROSL) in Corvallis, Oregon for XRF analysis. The NWROSL lab used a Thermo Scientific ARL Quant'X energy dispersive X-ray fluorescence (EDXRF) spectrometer, which provides analysis of the elemental composition of points ranging from sodium to uranium using an X-ray tube excitation source and a solid-state detector (Nyers 2024). The trace element values yielded from analysis were then compared to known values of obsidian and fine-grain volcanic (FGV) sources from published and unpublished literature. These values were determined by analyzing geologic source samples (Nyers 2024). I added the results to a sourcing catalog with previously obtained data on dart points from the Connley Caves.

I used the sourcing results to measure the distances to each source from the Connley Caves. Once straight-line distances were determined, I calculated the average distance to source for my samples of arrow points (Rosegate and Desert Side-notched) and dart points (Elko series). In the context of this project, I define local sources sources as those occurring within a 20 km radius of the site. This distance is based on the ethnographic record, representing a proposed trip during which individuals travel 5 km/hr for 8 hr/day (Kelly 2011; Surovell 2009). Under this assumption, an individual would at the most be able to walk 40 km in a single day, making a round trip of 20 km to a location and back. If the majority of sourced points are shown to be procured from local geologic sources, there is potential for the skewing of transport distance results exhibiting a non-normal distribution. In this case, I used bootstrapping to compare transport distances through a resampling approach. This method draws a predetermined number of random samples from a dataset and calculates the probability that differences between them are significant in place of a standard statistical test (Smith 2010). This allows for the comparison of two datasets with different sample sizes. For this study, I pulled 1,000 random samples of 29 points from the larger 59-point sample of Elko points to directly compare the transport distances of the samples.

I also utilized bootstrapping in my analysis to determine source diversity between samples. Because sample sizes varied between Elko and Rosegate points, the larger Elko sample was bootstrapped to directly compare source diversity between samples. This was again done using 1,000 iterations of random sampling. A p-value representing significance as well as a value representing the average sample size adjusted diversity was yielded. For both transport distance and source diversity, a p-value < 0.05 indicated significance.

I then synthesized the arrow and dart data to consider directionality of toolstone movement centered on the Connley Caves. Mapping the represented sources provides a visual and conceptual portrayal of the distances and directions that toolstone was conveyed across the landscape to the site, detailing the possible routes that people took to procure and trade lithic raw materials. The boundaries of this conveyance area are determined by the geologic sources where raw materials of the dataset are represented, with an ellipsoid being created to delineate regions of toolstone conveyance (Smith and Harvey, 2018).

3. Results

Results of Monitor Valley Key analysis of 32 untyped and/or unsourced projectile points yielded 27 Rosegate series arrow points, two Desert Side-notched (DSN) arrow points, two Elko series dart points, and one Gatecliff Contracting Stem dart point. Geochemical sourcing of 31 unsourced points identified nine sources (Table 1). The majority of points are made from local sources (n = 27; 87.1%) and include Cougar Mountain (n = 11; 35.5%), Silver Lake/Sycan Marsh (n = 11; 35.5%), Quartz Mountain (n =4; 12.9%), and Variety 5 (n = 1; 3.2%). Figure 4 is a map displaying the obsidian sources represented in Rosegate and Elko samples.

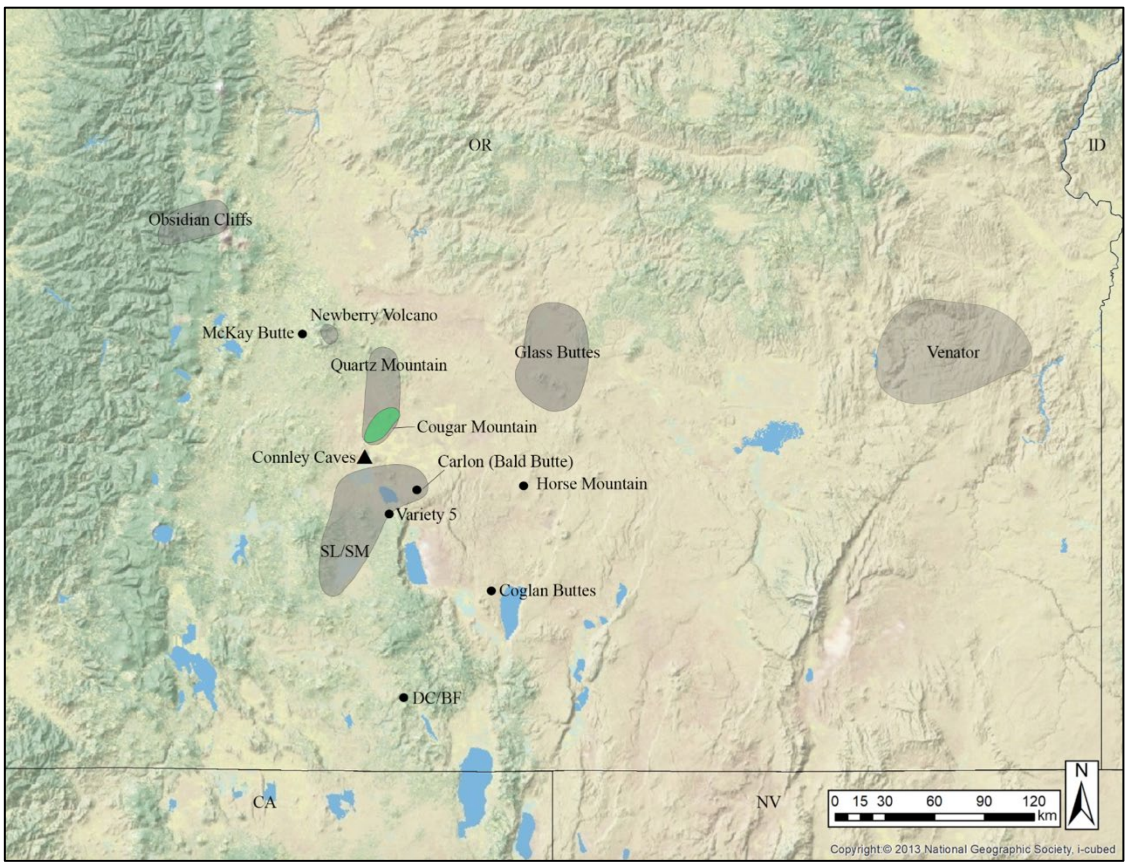

Figure 4. Map displaying the location of key geochemical obsidian sources present in the dataset. SL/SM stands for Silver Lake/Sycan Marsh and DC/BF stand for Drews Creek/Butcher Flat. The Cougar Mountain source is displayed in light green, as its distribution overlaps with Quartz Mountain.

Of the Elko series points, 76% (n = 45) of the toolstone was procured locally, with 51% (n = 30) coming from Cougar Mountain and 22% (n = 13) from SL/SM. For Rosegate series points, 76% (n = 22) of toolstone was from local sources, with 31% (n = 9) coming from Cougar Mountain and 31% (n = 9) from SL/SM. The average transport distance was 21.66 km for Elko series points and 34.91 km for Rosegate series points. The furthest Rosegate point came from the Obsidian Cliffs source, 123 km away, while the furthest DSN point came from the Venator source 260 km away. The furthest Elko point came from the Buck Mountain source 170 km away. Representative samples of newly sourced Elko and Rosegate points can be seen in Figures 5 and 6.

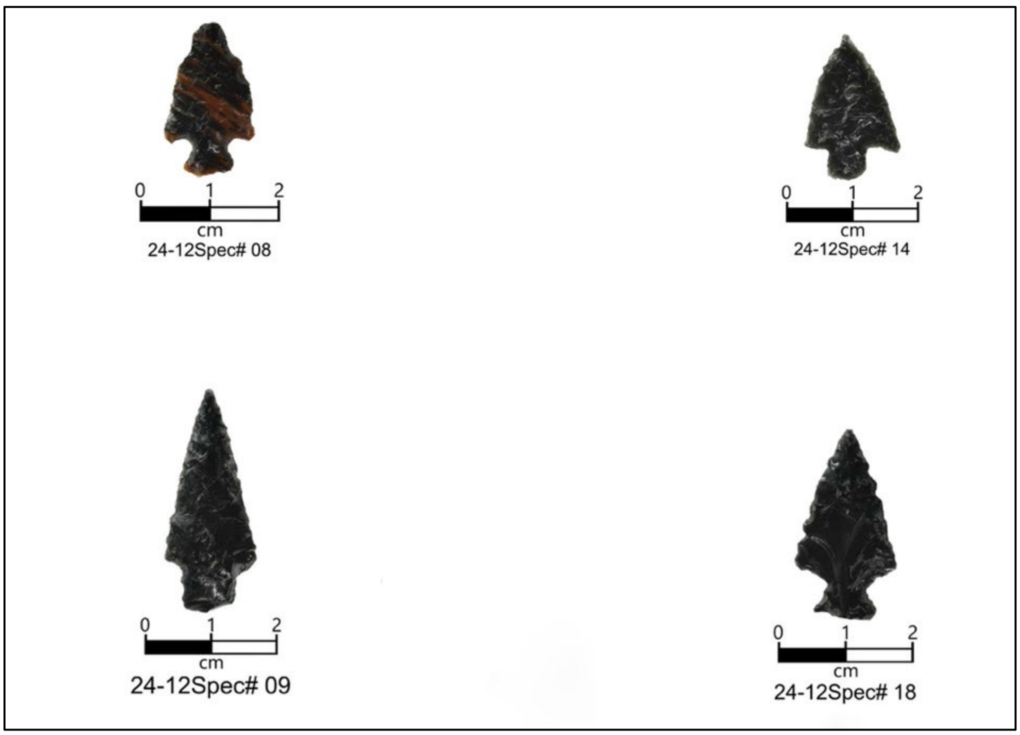

Figure 5. A representative sample of newly sourced Rosegate series arrow points. Photos adapted from Nyers (2024).

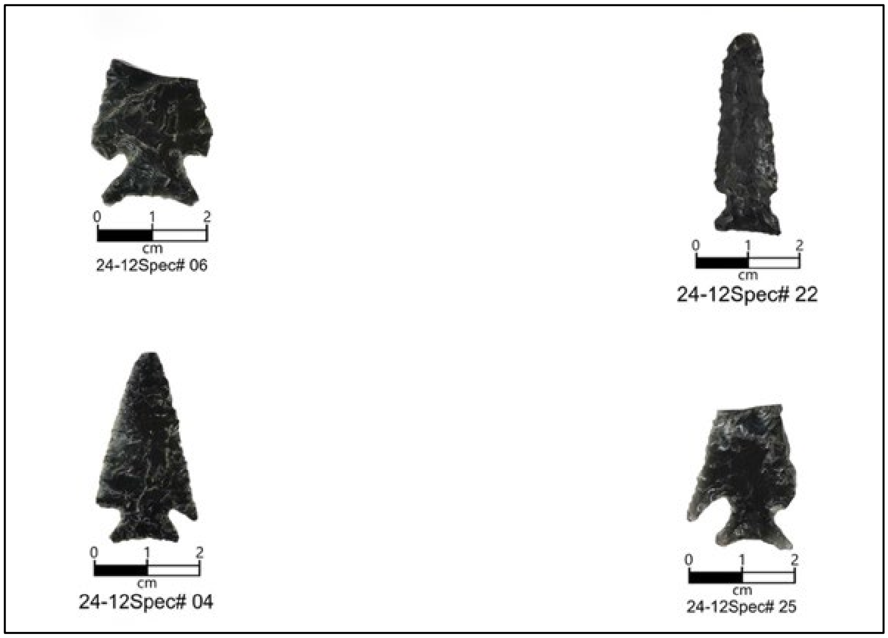

Figure 6. A representative sample of newly sourced Elko series dart points. Photos adapted from Nyers (2024).

I used a Microsoft Excel macro program to perform a bootstrapping statistical procedure to account for the disparity in sample size between Elko series and Rosegate series points while testing for significant differences in source diversity and toolstone transport distance. Results found no significant difference in diversity ($p = 0.946$) or transport distance ($p = 0.154$) between the two samples. The adjusted diversity for the larger dataset is 8.52.

Because the Cougar Mountain source dominates both samples, and is a nearby, large, and high-quality local source, I hypothesized that this source could be skewing the results. As such I removed Cougar Mountain examples from each dart and arrow point sample and performed the bootstrapping analysis again on the data to determine the impact that this major local source had on the results of the study. This analysis displayed similar results, with no significant difference in source diversity ($p = 0.987$) or transport distance ($p = 0.437$). The new adjusted diversity resulted in a value of 8.96. Average toolstone transport distances were also calculated with the absence of Cougar Mountain samples, resulting in an average distance of 34.24 km for Elko series points and 45.30 km for Rosegate series points. Thus, the original analyses do not appear to be skewed by the prevalence of an abundant, high-quality, local source.

Table 1. Table of points included in results. Catalog number, point type, geochemical source, distance to source, and direction to source are indicated for each.

Catalog Number	Point Type	Geochemical Source	Distance to Source (km)	Direction to Source
2823-CC-6/20-1-6	Elko Series	Buck Mountain	170	SE
1195-CC-4-D-22-1	Elko Series	Coglan Buttes	74	SE
1195-CC-6-B-10-1	Elko Series	Coglan Buttes	74	SE
2823-CC-6/4A-26-6	Elko Series	Coglan Buttes	74	SE
2823-CC-6/4A-26-6	Elko Series	Coglan Buttes	74	SE
3021-CC-6/B-1-4	Elko Series	Coglan Buttes	74	SE
2823-CC-6/4A-34-3	Elko Series	Connley Hills FGV	1	Site
1195-CC-1-C-8-1	Elko Series	Cougar Mountain	9.5	N
1265-CC-10-B-9-1	Elko Series	Cougar Mountain	9.5	N
1195-CC-1-A-19-1	Elko Series	Cougar Mountain	9.5	N
1195-CC-6-B-8-2	Elko Series	Cougar Mountain	9.5	N
1195-CC-6-D-11-1	Elko Series	Cougar Mountain	9.5	N
1195-CC-7-B-15-1	Elko Series	Cougar Mountain	9.5	N
1265-CC-6-A-20-1	Elko Series	Cougar Mountain	9.5	N
2556-CC-2/7-13-2	Elko Series	Cougar Mountain	9.5	N
2556-CC-2/8-5-1	Elko Series	Cougar Mountain	9.5	N
2380-CC-4/9-13-1	Elko Series	Cougar Mountain	9.5	N
2380-CC-4/2c-7-2	Elko Series	Cougar Mountain	9.5	N
2202-CC-4/8-6-23	Elko Series	Cougar Mountain	9.5	N
2380-CC-4/1B-8-2	Elko Series	Cougar Mountain	9.5	N
1195-CC-4-C-16-1	Elko Series	Cougar Mountain	9.5	N
1195-CC-6-A-14-3	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/9-20-4	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/14-21-6	Elko Series	Cougar Mountain	9.5	N
3021-CC-6/15-31-5	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/16-23-2	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/16-25-8	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/17-19-5	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/18-8-10	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/18-12-2	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/18-15-2	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/25-7-18	Elko Series	Cougar Mountain	9.5	N
2823-CC-6/4C-44-6	Elko Series	Cougar Mountain	9.5	N
2823-CC-6/4C-44-6	Elko Series	Cougar Mountain	9.5	N
3021-CC-6/B-4-21	Elko Series	Cougar Mountain	9.5	N
2202-CC-4/3-31-1651	Elko Series	Cougar Mountain	9.5	N
2928-CC-6/13-15-33	Elko Series	Cougar Mountain	9.5	N
2556-CC-5/30-2-1	Elko Series	Duncan Creek	19	S
1195-CC-7-14-1	Elko Series	Glass Buttes	77	NE
1195-CC-6-C-14-1	Elko Series	Glass Buttes	77	NE

1195-CC-6-C-2-1	Elko Series	Hagar Mtn	8	S
2380-CC-5/21-11-1	Elko Series	McKay Butte	64	N
2823-CC-6/9-13-15	Elko Series	SL/SM	5	SE
1195-CC-2-A-23-2	Elko Series	SL/SM	5	SE
1195-CC-5-B-19-1	Elko Series	SL/SM	5	SE
1195-CC-6-A-14-1	Elko Series	SL/SM	5	SE
1195-CC-6-B-17-1	Elko Series	SL/SM	5	SE
1195-CC-4-D-25-1	Elko Series	SL/SM	5	SE
1265-CC-6-D-WC-4	Elko Series	SL/SM	5	SE
2823-CC-6/9-5-5	Elko Series	SL/SM	5	SE
2928-CC-6/9-22-11	Elko Series	SL/SM	5	SE
2928-CC-6/9-24-1	Elko Series	SL/SM	5	SE
2928-CC-6/16-24-4	Elko Series	SL/SM	5	SE
2928-CC-6/25-5-2	Elko Series	SL/SM	5	SE
2928-CC-6/25-14-1	Elko Series	SL/SM	5	SE
1195-CC-4-D-18-1	Elko Series	Spodue Mtn	24	S
2928-CC-6/18-8-2	Elko Series	Spodue Mtn	24	S
1195-CC-6-A-16-1	Elko Series	Variety 5	26	SE
2823-CC-6/12-11-25	Elko Series	Yreka Butte	68	NE
1265-CC-7-B-22-1	Rosegate Series	Carlon (Bald Butte)	22	SE
1195-CC-4-D-22-1	Rosegate Series	Coglan Buttes	74	SE
2823-CC-6/5A-26-38	Rosegate Series	Cougar Mountain	9.5	N
3021-CC-6/9-26-9	Rosegate Series	Cougar Mountain	9.5	N
2928-CC-6/25-8-14	Rosegate Series	Cougar Mountain	9.5	N
2823-CC-6/5A-30-16	Rosegate Series	Cougar Mountain	9.5	N
3021-CC-6/B-2-1	Rosegate Series	Cougar Mountain	9.5	N
2380-CC-4/52-4-2	Rosegate Series	Cougar Mountain	9.5	N
2202-CC-3-backfill-1470	Rosegate Series	Cougar Mountain	9.5	N
1195-CC-2-A-4-1	Rosegate Series	Cougar Mountain	9.5	N
1195-CC-1-A-1-1	Rosegate Series	Cougar Mountain	9.5	N
1195-CC-3-C-9-1	Rosegate Series	Drews Creek/Butcher Flat	113	SE
1195-CC-4-B-20-1	Rosegate Series	Glass Buttes	77	NE
2663-CC-5/0-1-9	Rosegate Series	Glass Buttes	77	NE
2380-CC-4/52-4-1	Rosegate Series	Horse Mountain	66	NE
1195-CC-3-A-7-1	Rosegate Series	McKay Butte	64	N
2823-CC-6/13-1-12	Rosegate Series	Obsidian Cliffs	123	NW
2928-CC-6/11-14-11	Rosegate Series	Quartz Mountain	18	N
2928-CC-6/9-18-6	Rosegate Series	SL/SM	5	SE
2923-CC-6/10-13-1	Rosegate Series	SL/SM	5	SE
1265-CC-13-B-5-1	Rosegate Series	SL/SM	5	SE
1195-CC-7-17-1	Rosegate Series	SL/SM	5	SE
2928-CC-6/15-10-1	Rosegate Series	SL/SM	5	SE
2380-CC-4/52-4-3	Rosegate Series	SL/SM	5	SE
1195-CC-T-6-1	Rosegate Series	SL/SM	5	SE
2928-CC-6/15-9-2	Rosegate Series	SL/SM	5	SE
1195-CC-2-A-23-1	Rosegate Series	SL/SM	5	SE
2823-CC-6/17-6-2	Rosegate Series	Variety 5	26	SE
2663-CC-8/0-1-10	Rosegate Series	Newberry Volcano	56	N
1195-CC-5-D-11-1	Desert-Side Notched	Venator	260	NE
1195-CC-5-C-15-1	Desert-Side Notched	Quartz Mountain	18	N

4. Discussion

The results of this study show that people used Rosegate and Desert Side-notched arrow points during their visits to the Connley Caves, and that those later groups did not transport toolstone significantly further or from a more diverse range of sources than earlier groups who left dart points. These results do not support the hypothesis that people using arrow points transported toolstone farther, as observed elsewhere in the NGB at sites such as the Parman Localities (Smith 2010), Last Supper Cave (Smith 2010), and several sites in the Fort Rock Basin (Skinner et al. 2004). This analysis was conducted without the inclusion of debitage or other tools unearthed during excavation at the Connley Caves; because of this, we are limited in the knowledge we can learn from the results of this study. For example, while results of sourcing can determine general trends of toolstone transport and mobility of groups, we cannot discern how or why said toolstone was deposited at the Connley Caves. I present several potential explanations for the observed patterns of transport distance and source diversity, but further analysis of more diverse artifact types like debitage, EMFs, scrapers, etc. will be required to test those ideas.

4.1 Monitor Valley Key Analysis

The results of Monitor Valley Key analysis of untyped projectile points provided numerous new insights into the number and type of projectile points from the Connley Caves. I expected to identify both Rosegate and Elko points as a part of my research due to the high frequency of those styles in the area, but the two DSN points were unexpected as these points are relatively rare in the NGB compared to other parts of the Great Basin. Of particular interest, toolstone for one DSN point was procured from the Venator source in eastern Oregon, found over 260 km away, the furthest of any point in the samples.

The number of arrow relative to dart points identified at the Connley Caves is generally lower than other sites in the region (Skinner et al. 2004; Smith 2010). This presents several possibilities; the first, and potentially most impactful factor may be extensive looting of the site prior to excavation. In this case, there is collection bias that exists in my interpretation of the present dataset. This potential collection bias may impact interpretation of the number of inhabitants at the site at any given time, the frequency of site use during a given period, and more. To assess the prevalence of looting and the impact that it had on the assemblage of the site, it could be useful to assess the amount of debitage present relative to the number of projectile points recovered. In the case of looting, individuals are likely to take full or partial projectile points rather than the debitage left behind from their creation or re-sharpening. Therefore, by assessing the amount of debitage relative to the amount created during projectile point creation and resharpening, a range of points expected to be found could be determined and compared to the actual number found. In the case of the Connley Caves where looting is documented, I hypothesize that there would be an underrepresentation of projectile points in relation to the number of debitage flakes in the collection.

Alternatively, the dominance of local sources coupled with a relatively low number of arrow points compared to dart points could indicate that the Connley Caves were used as some form of seasonal hunting or collecting camp. It is also possible that non-locally sourced points were brought to the caves and discarded for toolstone from the higher quality local obsidian from the Cougar Mountain or SL/SM sources, occurring in seasonal or annual rounds. To test this hypothesis, use-wear and resharpening analysis of non-local points could provide insights into the use of these points while at the caves. Also, the inclusion of ethnographic, botanical, and faunal data from the late Holocene components at the Connley Caves may allow for interpretations about the season and durations of site use.

4.2 Projectile Point Sources

The majority of toolstone represented in this study came from local geochemical sources for both Elko (76%) and Rosegate (76%) projectile points; this, coupled with the lack of significant difference between samples in transport distance and source diversity, leads me to reject the hypothesis that later groups traveled further and to more diverse sources for toolstone. I expected to find some local source in both datasets simply due to the abundance of local sources, but the high percentage of local toolstone in the late Holocene was unexpected given the observed trends in the region. Of the arrow and dart points, the furthest toolstone source was an Elko point, not a Rosegate point. These results act as a clear indication that while occupying the Connley Caves, individuals preferentially selected local toolstone over non-local, whatever the reason may be. Seeing as more than 75% of toolstone for both samples came from local sources, a very apparent trend already emerges prior to statistical analysis in that local toolstone was the raw lithic materials of choice for thousands of years at the site.

Use of local, high quality toolstone is an expected trend. In the event that high-quality local materials are available in abundance, as they are the Connley Caves, people are expected to use them first as it is the optimal situation (Andrefsky 1994). What is especially interesting at the Connley Caves is that projectile point toolstone in particular is dominated by local sources. This implies that people were not arriving at the site from far distances and discarding non-local toolstone to be replaced with Cougar Mountain or other local sources; instead, people likely arrived from nearby already carrying local toolstone, then going out and making new points with local toolstone (e.g., Cougar Mountain) and discarding them upon their return to the site. The directionality of present toolstone sources in the dataset (Table 1) allows for elaboration of this idea. Under the notion that people arrived at the Connley Caves and likely began crafting projectile points from Cougar Mountain toolstone, the direction of other sources from the sites allows for interpretation of where people may have been arriving from. Cougar Mountain is the only source from the north of the site with extensive representation in the dataset. Aside from this, the majority of points (41%) came from sources to the south or southeast of the site. This leads me to believe that the majority of site inhabitants likely traveled to the site from the south/southeast, potentially bringing local toolstone with them, such as Silver Lake/Sycan Marsh, and using Cougar Mountain obsidian to make new projectile points.

One of the more intriguing discoveries in the dataset was the DSN point with toolstone from the Venator source found about 240 km to the east. This discovery is of particular interest not only because this is the most distant source from the Connley Caves in the dataset, but also because it may represent a pattern of peoples coming into Oregon from the Snake River Plain in Idaho within the last 500 years. In particular, a shift in obsidian sources used in central and eastern Oregon just prior to European impacts in North America provides insights into these patterns. Lyons et al. (2001) investigated a shift from toolstone use in the Malheur/Catlow region (eastern Oregon) over an extensive 1,500-year period before identifying a major shift to the east with sources such as Venator and others in Idaho in the last 400 years. McDonough and Rosencrance (2019) similarly report a DSN point from eastern Oregon made on Bear Gulch obsidian in eastern Idaho more than 400 km away. A similar, but reciprocal pattern has also been observed from western Wyoming, southwestern Montana, and eastern Idaho, with toolstone from sites dating directly prior to European arrival containing obsidian from over 300 km away in

Oregon (Scheiber and Finley 2011). The Venator sourced DSN point from the Connley Caves discovered as a part of this study continues to support this trend.

4.3 Late Holocene Trends

Arguably, the most intriguing result of this study is the fact that no significant difference was found between Rosegate and Elko series points in toolstone transport distance or source diversity. Research across the region has shown a general trend of increased transport distance and source diversity moving into the late Holocene (Scheiber and Finley 2011; Skinner et al. 2004; Smith 2010). The most relevant explanation for this likely comes from the high number of local obsidian sources at the Connley Caves, and the high quality of toolstone yielded from these sources. Five local sources were included in the sample set analyzed in this research, with the majority of toolstone from both periods coming from the Cougar Mountain and SL/SM sources. It may then be inferred that toolstone from these sources was preferentially selected over others due to both its close proximity as well as its high quality.

For this reason, I reran the diversity and transport distance analyses with the most prevalent local source, Cougar Mountain, omitted. While it was expected that this would have a significant impact on the data and display the originally hypothesized difference in Rosegate and Elko points, this was not the case. The sustained lack of significant difference with the exclusion of Cougar Mountain samples supports the fact that toolstone was preferentially selected from local sources. Between periods of Elko and Rosegate use, Cougar Mountain persisted as an important toolstone source for inhabitants of the Connley Caves. This result shows that the Connley Caves may be an outlier in the region. There are likely various explanations for this such as the close proximity of the Cougar Mountain source to the site would allow for minimal expenditure of energy or time to obtain toolstone. Even with the emergence of more robust trade networks and increased group mobility moving into the late Holocene, it would appear that Cougar Mountain obsidian may have been selected over other non-local sources due to its high quality in the knapping of stone tools. Therefore, while other sites display patterns of further toolstone transport and greater source diversity in the late Holocene, this culmination of factors at the Connley Caves allows for a non-significant change in toolstone transport and diversity across major temporal periods.

4.4 Future Research

4.4.1 Incorporation of Diverse Lithic Artifacts

There are a number of potential avenues to further investigate patterns of projectile point typology, toolstone transport, source diversity, and site use at the Connley Caves. The most effective way to learn more about site use and lifeways in the late Holocene would be to incorporate all recovered lithic materials into the analysis. By doing so, our knowledge would no longer be limited to where projectile point toolstone came from and the diversity of these sources. Instead, we could potentially understand how and why these tools were deposited at the Connley Caves, as well as the behaviors of individuals associated with said tools. While I did posit a number of ideas related to this, including how or why these trends may be apparent, the inclusion of a more diverse dataset of lithic artifacts would allow for the future testing of those hypotheses.

4.4.2 Incorporation of Botanical and Ethnographic Evidence

Incorporating botanical and ethnographic data could also help test when and for how long individuals may have visited the site at any given time. While there may be potential evidence for the introduction of non-local toolstone that was then replaced by local sources, sole examination of projectile points does not afford knowledge of how long this may have taken place. For example, the presence of a single species of flora that is known to be seasonal may indicate that occupations likely lasted for that single season or less, while the inclusion of multiple seasonal plants in a hearth feature may indicate a more extended occupation of the site. Those data could then be coupled with the ethnographic record of Indigenous communities who have ancestral ties to the land and carry deep oral traditions of ancestral hunting or harvesting sites, sites of extended occupation, and more. With this information, a more complete picture may be painted of the individuals who occupied the Connley Caves, why they visited the site, and for how long.

4.4.3 Experimental Studies

Another way to assess current gaps in knowledge at the site is through the implementation of experimental studies. In particular, experimental flint knapping studies can potentially provide a plethora of knowledge as to why certain toolstone was selected over others, the effects of looting at the site, and more. For example, one key idea posits that the high quantity of local toolstone across long periods of time at the Connley Caves may be due to its high quality. To test this, one could use local Cougar Mountain obsidian to knap Elko and Rosegate points, comparing it to toolstone from non-local sources such as Glass Buttes or Obsidian Cliffs. In doing so, toolstone from each source could be assessed based on a number of criteria such as durability, ease of percussion, accuracy of flaking, time taken to knap, etc., to determine if local toolstone is truly higher quality than that of some non-local sources.

In a similar fashion, looting may be assessed by knapping Elko and Rosegate points, as well as other tools present at the site, to determine a minimum number of individual (MNI) projectile points that would be present based on the average debitage created. If looting were present to a degree more extensive than previously believed, it would be expected that the MNI based on debitage would greatly outnumber the true quantity of points present at the site, and vice versa. In the case that looting was deemed to be a major factor in our collection biases, studies related to sourcing, point typology, tool use, and more at the site may need to be reassessed, and all future studies would have to keep this in mind when studying the disturbed late Holocene deposits.

5. Conclusion

Through this research I was able to answer four main questions. First, (1) what projectile arrow point types are present at the Connley Caves and how many have been excavated from the site; (2) what toolstone sources are the arrow points in the dataset are made from; (3) do late Holocene toolstone trends at the Connley Caves align with broader trends across the Great Basin during the late Holocene; and (4) how does the toolstone profile of the arrow points compare to earlier periods at the Connley Caves. I hypothesized that diachronic trends in toolstone transport and source diversity would be present between Elko and Rosegate points that were compared, as is the case across much of the NGB, but no significant difference was yielded. Therefore, the Connley Caves is a potential outlier in the region due to its low transport distance and source diversity in late Holocene arrow points relative to other sites in the region.

It appears that inhabitants of the Connley Caves overwhelmingly preferred local toolstone over non-local through major temporal periods, specifically the Cougar Mountain and SL/SM sources. I posit that this may be a result of both the close proximately of these sources, as well as the high quality toolstone that comes from them. The high prevalence of local sources may also represent a pattern of groups or individuals traveling to the site with local toolstone, remaining at the site for at least multiple days, procuring new local toolstone and crafting new points, and discarding it at the Connley Caves before leaving. This may then indicate that the caves were used as a short-term hunting or gathering camp.

The results of the study display that researchers should be cautious to group all individuals of a given time period and region into existing trends. Instead, we must assess each site or assemblage on its own terms. It is clear that late Holocene inhabitants of the Connley Caves displayed different trends of toolstone procurance than those who occupied many other sites in the NGB. The results of this research, while not supporting the main hypothesis, greatly advance our understanding of lifeways at the Connley Caves and of mobility and diachronic toolstone use in central Oregon over thousands of years.

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