RESEARCH REPORT

The Surface Paleoindian Record of Northern Warner Valley, Oregon, and Its Bearing on the Temporal and Cultural Separation of Clovis and Western Stemmed Points in the Northern Great Basin

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The chronological and technological relationships between Clovis and Western Stemmed Tradition (WST) projectile points in the Great Basin are unclear. There are no dated and stratified sites containing both point types. We present data from Oregon's Warner Valley, where a rich Paleoindian surface record associated with dated landforms and differences in raw materials represented within each technology allow us to evaluate current hypotheses regarding Clovis and WST points. Our results provide little support for the hypothesis that Clovis and WST points were initially components of the same lithic toolkit in the northern Great Basin. Instead, we suggest that the technologies were separated by a narrow period of time or that two cultural traditions existed during the terminal Pleistocene in the northern Great Basin.

Keywords Great Basin archaeology, Clovis and Western Stemmed projectiles, Paleoindians

1. Introduction

The relationship between Clovis and Western Stemmed Tradition (WST (Bryan 1980)) projectile points remains poorly understood in the Great Basin. Some researchers (e.g., Jennings 1986; Willig 1988) argue that WST points developed from Clovis points – a regional manifestation of the "Clovis first" model. Others (e.g., Bryan 1980; Fagan 1988) argue that WST points represent a second terminal Pleistocene cultural tradition. This possibility has seen renewed interest among researchers (e.g., Beck and Jones 2010, 2012a, 2012b, 2013; Davis et al. 2012; Jenkins et al. 2012), who have presented supporting chronological, technological, and source provenance data (but see Fiedel and Morrow 2012; Goebel and Keene 2014). Finally, a few researchers (e.g., Tuohy 1974) suggest that Clovis and WST points were components of the same toolkit.

Ideally, this debate could be resolved with radiocarbon dates associated with WST and Clovis points or their respective stratigraphic positions at sites. Unfortunately, neither source of information is available. In lieu of such data, researchers have contributed to the Clovis–WST debate using surface assemblages; for example, using obsidian hydration to establish their relative ages (e.g., Beck and Jones 2012a, 2013; O'Grady et al. 2012) or the spatial distributions of points relative to dated landforms to argue for sequential occupations of locations (e.g., Warren 2000; Willig 1988). We present results from Oregon's Warner Valley, where rich terminal Pleistocene/early Holocene (TP/EH) environmental and cultural records have been found. We compare the vertical (i.e., elevation) distribution of Clovis and WST points relative to a dated relict pluvial lakeshore, the spatial association between the point types, and the raw material types represented among Clovis and WST points. We acknowledge shortcomings in our dataset but find no evidence that both point types were components of the same Paleoindian toolkit.

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2. The Clovis–WST debate in the Desert West

Grayson (2011) outlines possible relationships between Clovis and WST points: (1) Clovis points predate WST points and mark the region's earliest occupations; (2) WST points briefly overlapped with Clovis points and reflect a second TP/EH cultural tradition; and (3) Clovis and WST points were different tools (e.g., projectiles and knives) in the Paleoindian lithic toolkit. His overview summarizes current views on the topic and provides a framework within which to test hypotheses. We expand upon it here and use it later to evaluate data from Warner Valley.

Clovis was long thought to represent the basal cultural stratum in the Great Basin (Jennings 1986; Willig 1988), although this possibility has not been established as fact because reliable Clovis radiocarbon dates are few (see Beck and Jones 2010, table 6). Furthermore, because those dates are younger than Clovis points elsewhere in North America (either ~13,400–12,900 (Taylor et al. 1996) or ~13,125–12,925 cal yr BP (Waters and Stafford 2007)),[1] many researchers consider them inaccurate. The few dated Clovis points and their apparent late ages notwithstanding, the Great Basin version of the Clovis first model holds that the region was colonized by Clovis groups, who focused on wetlands and bypassed higher-elevation zones, whereas later WST groups expanded into uplands as productivity increased (Grayson 2011). Support for this model includes the facts that: (1) most early dates associated with WST points postdate the Clovis era, however it is defined (Goebel and Keene 2014); (2) most Clovis points occur in valley bottoms whereas WST points occur in various settings (Taylor 2002); and (3) at least two "pure" Clovis assemblages (i.e., those lacking WST points or possessing spatially discrete concentrations of Clovis points) are known (e.g., Oregon's Dietz and Sage Hen Gap sites).

Not everyone accepts the Clovis first model. Building on arguments made by Bryan (1980, 1988), Beck and Jones (2010, 2013; also see Davis et al. 2012; Jenkins et al. 2012) argue that WST and Clovis points were employed coevally during the TP. Beck and Jones (2010, 2012a, 38) suggest WST points mark the initial arrival to the region from the Pacific Coast while Clovis points arrived later from the North American interior. Davis et al. (2012) share a similar view but instead of arguing for an arrival of Clovis-point *users*, they suggest Clovis-point *technology* diffused westward. In support of their argument, Beck and Jones (2010) note that: (1) WST points occur in Clovis-age deposits at the Paisley Caves, Oregon (Jenkins et al. 2012, 2013); (2) radiocarbon dates associated with Clovis points in the Great Basin postdate the Clovis era; (3) many Great Basin fluted points are morphologically distinct from Clovis points found on the southern Plains used to first define the type, as might be expected if they were derived from an earlier Clovis form; and (4) prismatic blades and cores – hallmarks of Clovis technology elsewhere (Collins 1999) – are rare in the Great Basin. Alternatively, Tuohy (1974, 101) argued that Clovis and WST points were components of the same toolkit, suggesting "the reason why Western Clovis points are found cheek by jowl with stone tool kits of Lake Mohave persuasion is because *they belong there* [emphasis in original], just as surely as if one were to open a modern tool box and find a variety of small hand tools in the same container." This possibility could explain why Clovis and WST points often co-occur.

Evaluating these possibilities has been hindered by a lack of dated Clovis points and stratified sites containing Clovis and WST points. Researchers have instead relied on less precise methods of establishing the ages of and relationship between Clovis and WST points. Work at Oregon's Dietz site, where both Clovis and WST points were found (Fagan 1988; O'Grady et al. 2012; Pinson 2008, 2011; Willig 1988), exemplifies such approaches. Beck and Jones (2013) compared hydration-rim depths of the Clovis and WST points and argued that because WST rim readings are contained within the Clovis rim reading range – and in most cases occur at the older end of the range – they were contemporary.[2] They suggest those results indicate that "the two forms could be components of the same lithic industry" or that "two different cultural traditions associated with different populations" visited the site during the same general period but not concomitantly (Beck and Jones 2012a, 36). Due to raw material differences between the Clovis and WST samples, they favor the latter possibility (Beck and Jones 2013).

Willig (1988) compared the spatial distribution of Dietz Clovis and WST points across the site to establish their relative ages. Upon noting that Clovis points clustered on the basin floor whereas WST points clustered along its margin, she argued that Clovis points were deposited during a dry period and WST points deposited during a wet phase corresponding with the Younger Dryas (~12,900–11,600 cal yr BP), the implication being that WST points postdated Clovis points. Pinson's (2008, 2011) geoarchaeological interpretations question Willig's (1988) environmental reconstruction but not the fact that the two point types were spatially segregated, suggesting they were either deposited sequentially (*sensu* Willig 1988) or by different groups who visited the basin around the same time but used different parts of it (*sensu* Beck and Jones 2012a).

Although poor substitutes for stratified sites containing both Clovis and WST points, work at the Dietz site demonstrates that surface assemblages can contribute to the Clovis–WST debate. Here, we present data from surface Paleoindian sites in Oregon's Warner Valley and compare the vertical distribution of Clovis and WST points relative to a dated fossil lakeshore, evaluate the horizontal distribution of the point types to determine to what degree they are spatially associated, and compare the toolstone types represented among Clovis and WST points. Our results do not support the hypothesis that Clovis and WST points were components of the same toolkit. Instead, the two technologies were either separated by a brief interval or, more likely, reflect two TP cultural traditions in the northern Great Basin.

3. The Northern Warner Valley Study Area

Warner Valley is located in the northern Great Basin (Figure 1) and contained pluvial Lake Warner during the TP. In 2011, we initiated a multi-year research program there, delineating a ~54,600-acre (22,096-hectare) area called the Northern Warner Valley Study Area (NWVSA). Below, we describe the hydrographic and archaeological records of the NWVSA and how we used them to evaluate

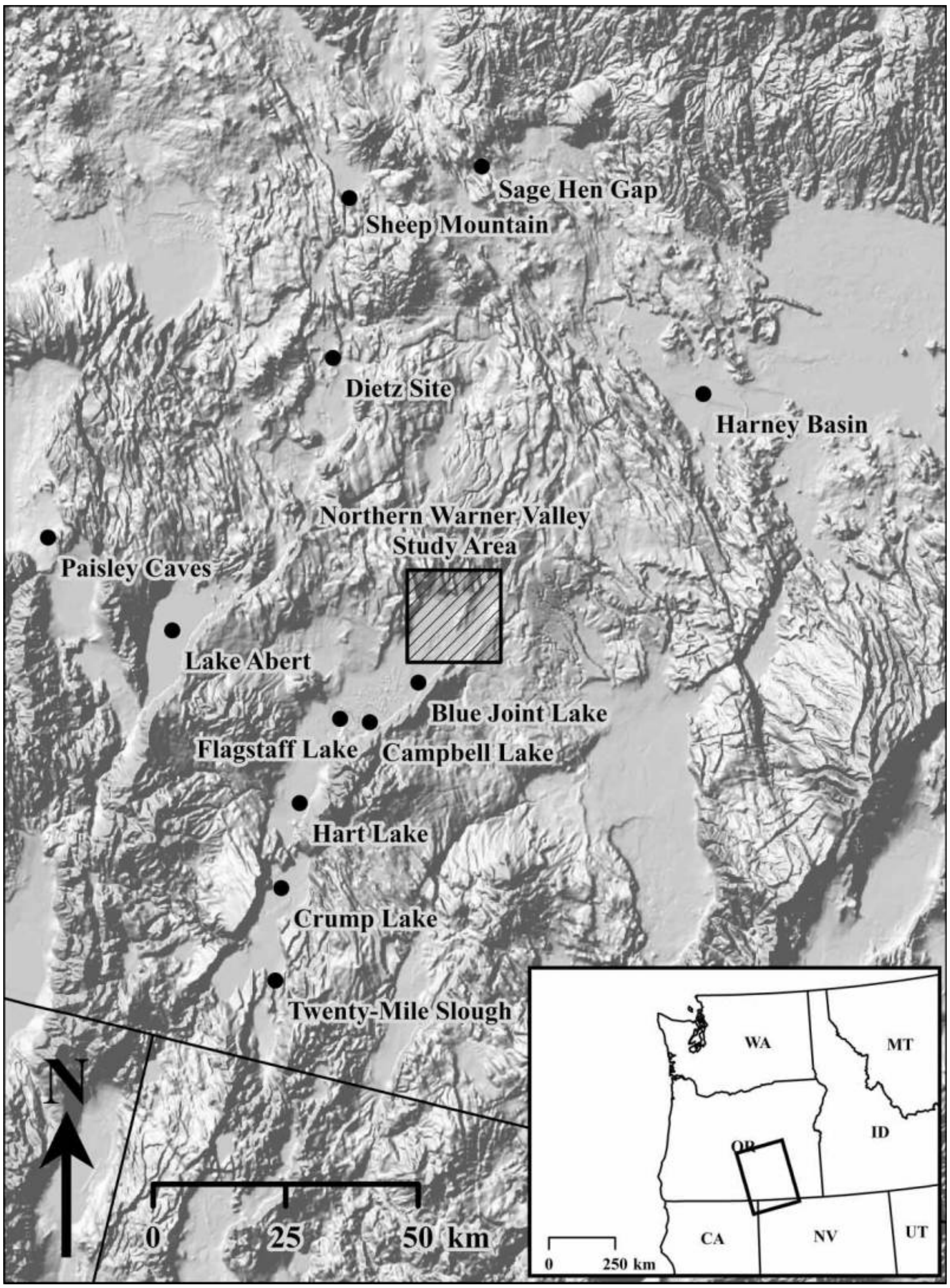

Figure 1 The northern Great Basin showing the NWVSA and other locations discussed in the text.

hypotheses about Clovis and WST points in the northern Great Basin.

3.1 The hydrographic history of the NWVSA

Lake Warner reached a maximum elevation of ~4760 ft (1451 m) above mean sea level (AMSL) during the Last Glacial Maximum before receding (Weide 1975). Recurring still-stands or stalls in its regression are marked by shoreline features ringing the valley. On the valley's gradual northern slope where the NWVSA is situated, features include parallel gravel-and-sand beach ridges separated by intervening troughs. Such ridges form by overwash deposits in the wave swash zone during high-energy storm surges (Komar 1998) or over long periods of shoreline stability. Troughs between ridges served as water catchments for back bar ponds and marshes as the lake receded and groundwater levels remained high. Temporary lake transgressions occasionally remolded the beach ridges, damming local drainages, and creating short-term marshes in troughs upstream until the drainage systems broke through the ridges and again debouched into the lake or valley floor below. Ridges-and-troughs in the NWVSA are notable because Paleoindians discarded Clovis and WST points there. Given the difficulty of dating surface Paleoindian occupations, these sites made understanding the valley's hydrographic history critical to understanding its cultural history.

An extensive backhoe-trenching effort identified two assayable strata associated with ridges-and-troughs: (1) shell lenses deposited by the lake; and (2) soils created in troughs. Lenses of freshwater clam shell were preserved among gravel strata near the apex of one of the beach ridges ~4563 ft (1391 m) AMSL, exposed by Backhoe Trench 2 (BT2). Up to 2 ft (60 cm) of gravel and sand lenses accumulated as the lake remained at this level long enough for these deposits to accrue, which could have been within one storm, a single season, or over several years. This shell returned an AMS date (AA-95087) of 12,355 ± 63 ^{14}C yr BP (midpoint = 14,486 cal yr BP; 2σ range = 14,962–14,009 cal yr BP);[3] however, because freshwater shells often produce older dates due to older carbon uptake (Goodfriend and Hood 1983), this date may be too old. However, similar dates were reported for highstands of pluvial Lake Chewaucan by Licciardi (2001), who obtained multiple dates on gastropods in shoreline terraces 39–89 ft (12–27 m) above nearby remnant Lake Abert between 11,560 ± 120 ^{14}C yr BP (midpoint = 13,368 cal yr BP; 2σ range = 13,610–13,126 cal yr BP) and 12,030 ± 90 ^{14}C yr BP (midpoint = 13,919 cal yr BP; 2σ range = 14,132–13,706 cal yr BP).

A paludal paleosol was discovered in Backhoe Trench 1 (BT1), placed in a trough at ~4565 ft (1392 m) AMSL and upslope of shell-bearing BT2. We obtained an AMS date (AA-95109) of 10,469 ± 67 ^{14}C yr BP (midpoint = 12,401 cal yr BP; 2σ range = 12,627–12,174 cal yr BP) on the soil's bulk carbon and an accompanying AMS date (AA-95109-H) of 10,297 ± 55 ^{14}C yr BP (midpoint = 12,222 cal yr BP; 2σ range = 12,440–12,004 cal yr BP) on its humate fraction. Because soil typically produces younger dates due to continued carbon accrual until the soil is buried and becomes a closed system (Scharpenseel and Becker-Heidmann 1992), the bulk date may be too young although agreement between the humate and bulk carbon fraction ages suggests minimal contamination by younger carbon and bolsters the credibility of the date. The paleosol likely formed when the lake was above ~4560-ft (1390-m) AMSL given that the beach ridge would have been cut through by a drainage known as Clovis Creek relatively soon after lake recession. This paludal paleosol, which is 3 ft (95 cm) below surface, is topped by a more weathered subaerial paleosol and bioturbated aeolian sand (Figure 2). Relatively mesic, albeit fluctuating, regional conditions are supported by comparison to the nearby Harney Basin where Wriston (2003) reported a 9860 ± 80 ^{14}C yr BP (midpoint = 11,251 cal yr BP; 2σ range = 11,361–11,141 cal yr BP) assay for a highstand of pluvial Lake Malheur.

By obtaining a shell date from BT2 (downslope) and paleosol date from BT1 (upslope), we know that between ~14,500 and ~12,400 cal yr BP, Lake Warner's level was ~4560 ft (1390 m) AMSL. Based on the distribution of Clovis and WST points relative to the dated lake level (see below), people likely mapped onto near-shore resources during the latter part of that interval. As such, the NWVSA offers some temporal constraint for Paleoindian sites: (1) sites below the dated shoreline must postdate Lake Warner's 4560-ft (1390-m) AMSL stand; and (2) sites associated with that elevation may roughly date to when the lake was at ~4560 ft (1390 m) AMSL, although they could be younger.

More work is needed to understand Lake Warner's recession after ~12,400 cal yr BP. We know that when Mazama tephra fell ~7700 cal yr BP, 3 ft (95 cm) of marsh peats had accumulated in Crump Lake (~4418 ft (1347 m) AMSL) ~50 km south of and ~60 ft (18 m) lower than the NWVSA (Hansen 1947; Weide 1975). This suggests that near modern paludal conditions were reached before ~7700 cal yr BP at Crump Lake and nearby Hart Lake and Twenty-mile Slough. Another 11 ft (3.4 m) of peat then accumulated atop the tephra, which indicates stable marsh conditions within this portion of the basin during the middle Holocene. Based on these

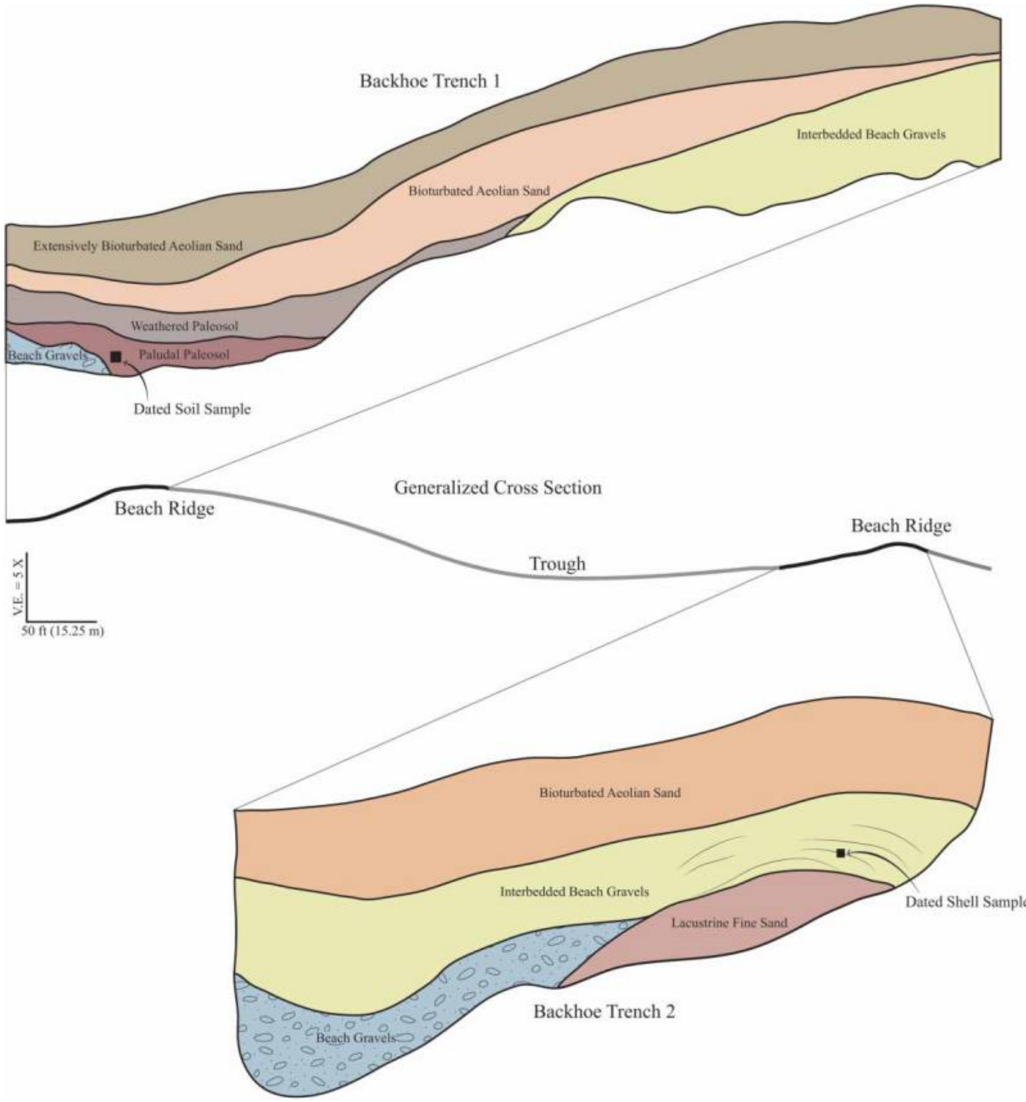

Figure 2 **Generalized stratigraphic profile showing the relationship between backhoe trenches and dated samples.**

marsh sedimentation and peat accumulation rates, Weide (1975) suggested that such conditions developed as early as ~9650 cal yr BP, which would have left the NWVSA dry. Weide's (1975) interpretation is supported by additional evidence: (1) extant dune-and-slough topography, created when low groundwater makes lakebed sediment available for wind transport, was established on the northern margins of south-central Warner Valley's better watered lakes (e.g., Campbell, Flagstaff, Bluejoint, and Crump) during the EH (Young 2000); and (2) we discovered WST sites as low as 4470–4480 ft (1362–1366 m) AMSL (the southernmost and lowest part of the NWVSA), meaning that lake levels fell below that point before ~8300 cal yr BP (the terminal age of WST points (Beck and Jones 1997)). The lack of water-worn artifacts and presence of small retouch flakes at those lower-elevation WST sites, coupled with Crump Lake's marsh deposits, indicate that Lake Warner never again rose to that level following the EH.

3.2 The Paleoindian record of the NWVSA

In 2011, we employed a stratified random sampling survey strategy dividing the NWVSA into four landforms: (1) uplands (tablelands surrounding Warner Valley); (2) canyons (drainages cut into tablelands); (3) beach ridges (areas dominated by fossil lakeshore features); and (4) valley bottoms (areas that were underwater during high lake-level periods) (Figure 3). We randomly selected and surveyed 500×500-m parcels and recorded all archaeological sites and isolated artifacts. In 2012–2013, we employed a non-random survey strategy targeting high potential beach-ridge and valley-bottom parcels. In total, we surveyed ~5400 acres (2185 hectares) (~10 per cent of the NWVSA). Diagnostic Paleoindian artifacts recovered include 123 WST points, 11 fluted points, 11 crescents, and two unfluted concave base points (Figure 4). Most points are made on obsidian (dominant) or fine-grained volcanic (FGV) toolstone (rare). Although fragmentary and incapable of providing much metric data,

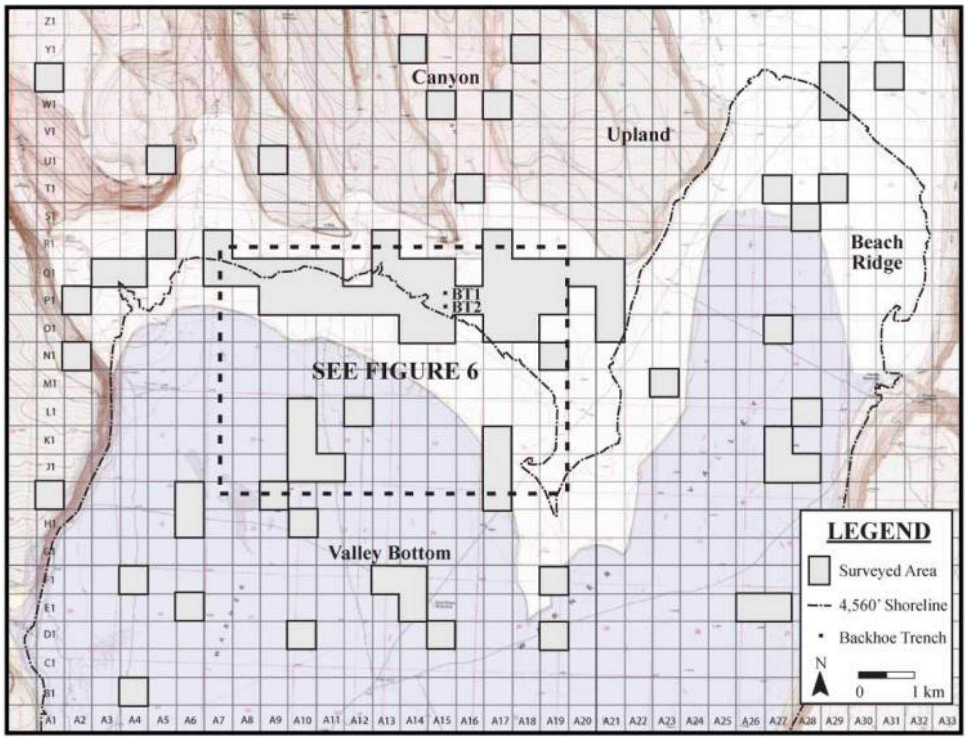

Figure 3 The NWVSA showing stratified sampling strategy, locations of survey parcels, backhoe trenches, and hypothesized 4560-ft (1390-m) AMSL Lake Warner shoreline.

fluted points generally conform to Howard's (1990) morphological criteria for Clovis points, suggesting they are not post-Clovis variants.

Clovis and WST points provide the materials for our study. We used them to evaluate the hypothesized relationships outlined above in three ways. First, we compared the vertical distribution of the point types relative to the dated Lake Warner shoreline by assigning each artifact to a 10-ft (3-m) elevation interval using a digital elevation model superimposed on the NWVSA. Second, we compared the horizontal (i.e., X-Y coordinate) distribution of Clovis and WST points to evaluate the degree to which they are associated by calculating the average distance the two point types are found from one another. Finally, we compared source provenance data for 11 Clovis and 55 WST points and calculated average transport distances and richness for the two samples.[4] Because WST points persisted longer than Clovis points, we only included WST points at least minimally spatially associated with Clovis points, assuming that they are also somewhat temporally associated. We compared transport distances and richness using three samples of geochemically characterized artifacts: (1) Clovis points and WST points found ≤ 100 m from Clovis points ($n = 3$); (2) Clovis points and WST points found ≤ 200 m from Clovis points ($n = 8$); and (3) Clovis points and all sourced WST points located above the dated 4560-ft (1390-m) AMSL shoreline ($n = 55$). We excluded WST points found below 4560 ft (1390 m) AMSL because that area was underwater until after ~12,400 cal yr BP; as such, artifacts there necessarily postdate the Clovis era.

We developed expectations regarding the proposed relationships between Clovis and WST points (Table 1). If the technologies were used sequentially, then WST and Clovis points should be distributed at different elevations, assuming that as Lake Warner regressed southward, people moved downslope with it. Additionally, Clovis and WST points should not be associated in their horizontal distributions (i.e., clustered together). Finally, different toolstone types may be represented in the two point samples, as reflected by both transport distance and richness. Alternatively, if Clovis and WST points were components of the same toolkit, then they should be closely associated along both the vertical and horizontal dimensions, and similar toolstone sources should be represented among both point types. Finally, if Clovis and WST points reflect distinct but coeval cultural traditions, then they should occur at roughly the same elevations, indicating contemporary use of Lake Warner's near-shore resources. Clovis and WST points should also cluster separately along the horizontal dimension. Lastly, the point types may exhibit different source profiles, depending on if their users' land-use strategies differed.

4. Results

4.1 *The vertical distribution of Clovis and WST points*

WST points occur in most 10-ft (3-m) elevation intervals, with concentrations occurring at 4480–4490 ft

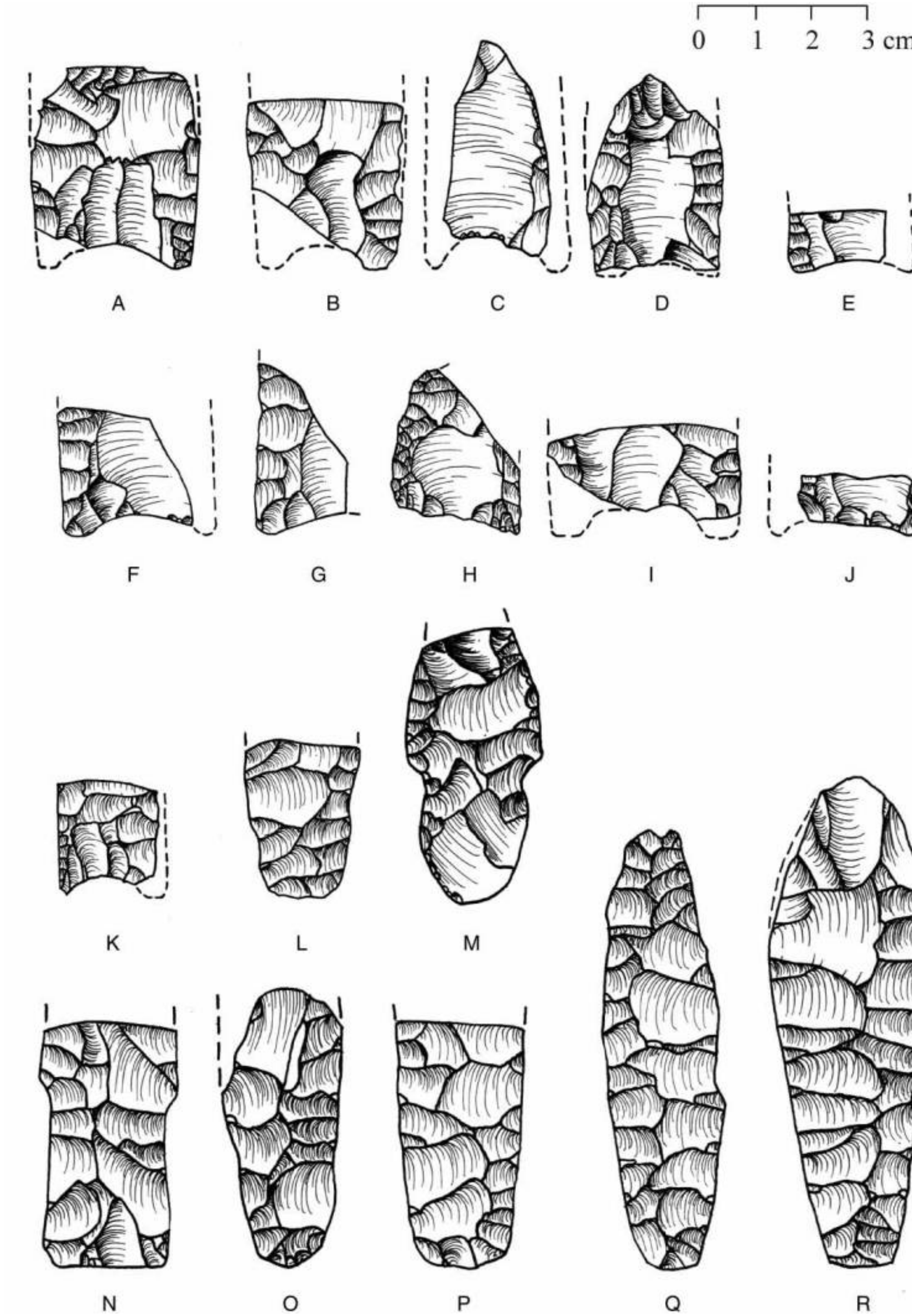

Figure 4 Clovis (A–K) and select WST points (L–R) recovered from the NWVSA.

Table 1
Expectations for the proposed relationships between Clovis and WST points

	Hypothesized relationships between Clovis and WST Points		
Measure	**Sequential traditions**	**Same toolkit**	**Coeval traditions**
Point elevation	Different	Same	Same
Point clustering	Different	Same	Different
Transport distance	Different	Same	Different
Toolstone diversity	Different	Same	Different

(1366–1369 m) ($n = 16$), 4570–4580 ft (1393–1396 m) ($n = 23$), and 4590–4600 ft (1399–1402 m) AMSL ($n = 23$) (Figure 5). This broad vertical distribution is due in part because WST point technology was used for ~4000 years encompassing Lake Warner's southward regression through the NWVSA. The fact that WST points are common in the southern (i.e., lowest elevation) NWVSA indicates that the valley floor was dry while WST technology was still used; again, this may have occurred by ~9650 cal yr BP (Weide 1975). The high number of WST points at 4570–4580 ft (1393–1396 m) AMSL may reflect

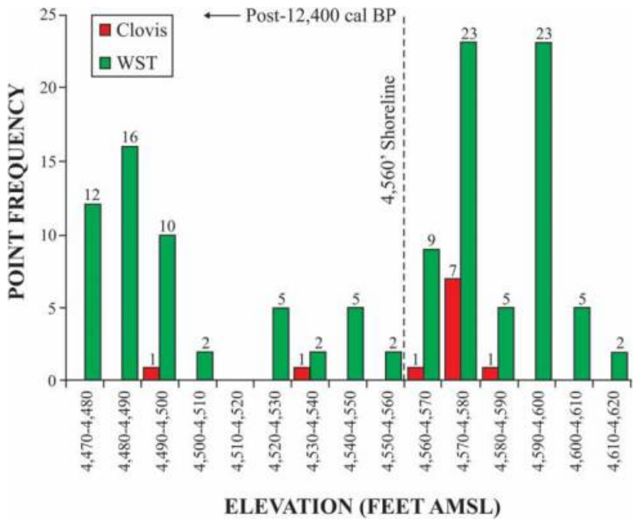

Figure 5 The vertical distribution of Clovis and WST points by 10-ft (3-m) interval in relation to the 4560-ft (1390-m) AMSL Lake Warner shoreline.

marshside occupations prior to ~12,400 cal yr BP – a possibility we consider below.

While WST points occur at various elevations both above and below the dated shoreline, the Clovis points' distribution is more restricted. Nine of 11 fluted specimens (~82 per cent) occur within a 30-ft (9-m) range immediately above the dated shoreline, which we also interpret as evidence of marshside occupations when the lake paused during its retreat – a period that encompasses both the Clovis era and early Younger Dryas. Two additional fluted points were found below the shoreline at 4530–4540 ft (1381–1384 m) and 4490–4500 ft (1369–1372 m) AMSL, respectively. Those locations, which are exceptions to the fluted-point pattern, are 20 and 60 ft (6 and 18 m) below the dated shoreline; therefore, they necessarily postdate ~12,400 cal yr BP. Neither point is water worn as might be expected if they were redeposited by natural processes during the lake's recession. We do not know if they represent post-Clovis fluted points deposited as groups followed the lakeshore south or Clovis points collected from above the dated shoreline and redeposited by later groups. One of them (Figure 4K) may be a post-Clovis variant due to its smaller size, although it is heavily reworked. The other (Figure 4A) possesses morphological and metric attributes within the range of Clovis points from outside of the Great Basin. The fact that most Clovis points occur within the same elevation intervals as numerous WST points, coupled with the fact that those elevation intervals occur just above the dated lakeshore, suggests both point types were used when groups camped adjacent to Lake Warner prior to ~12,400 cal yr BP.

We recognize that the Lake Warner shoreline only provides a limiting absolute age: we can only say for certain that artifacts found below it postdate ~12,400 cal yr BP because prior to then the valley floor was underwater. We cannot know how old sites found above it are based on their location alone – they could either predate or postdate the lakeshore. Furthermore, we do not currently fully understand the degree to which the landscape has been modified since artifacts were deposited (e.g., how much sites have deflated). We do know that backhoe trenching near WST and Clovis point concentrations failed to locate Mazama tephra, indicating that some middle Holocene sediment is locally absent. Similarly, Trego Hot Springs tephra ejected ~28,000 cal yr BP was found just beneath the current ground surface in a third backhoe trench (BT18) ~2.5 km southwest of and 71 ft (21.6 m) below the dated Lake Warner shoreline, indicating that some TP- and all Holocene-aged sediment is missing there.

4.2 The horizontal distribution of Clovis and WST points

While we continue to assess the degree to which the NWVSA landscape was modified during the Holocene, we currently interpret the co-occurrence of Clovis and WST points along the Lake Warner shoreline as evidence they were used during the same general period. The horizontal distribution of Clovis and WST points relative to the shoreline, which is arguably less susceptible to post-depositional reconfiguration due to topographic constriction by beach berms, provides stronger evidence regarding their relationship (Figure 6). Clovis points occur 54–264 m from the nearest WST point, and the two point types occur an average of ~117 m apart. Furthermore, most Clovis points were found in a 225 × 175-m area that may represent a single occupation. Within that concentration, only two WST points were found. Thus, while the vertical distributions of the two

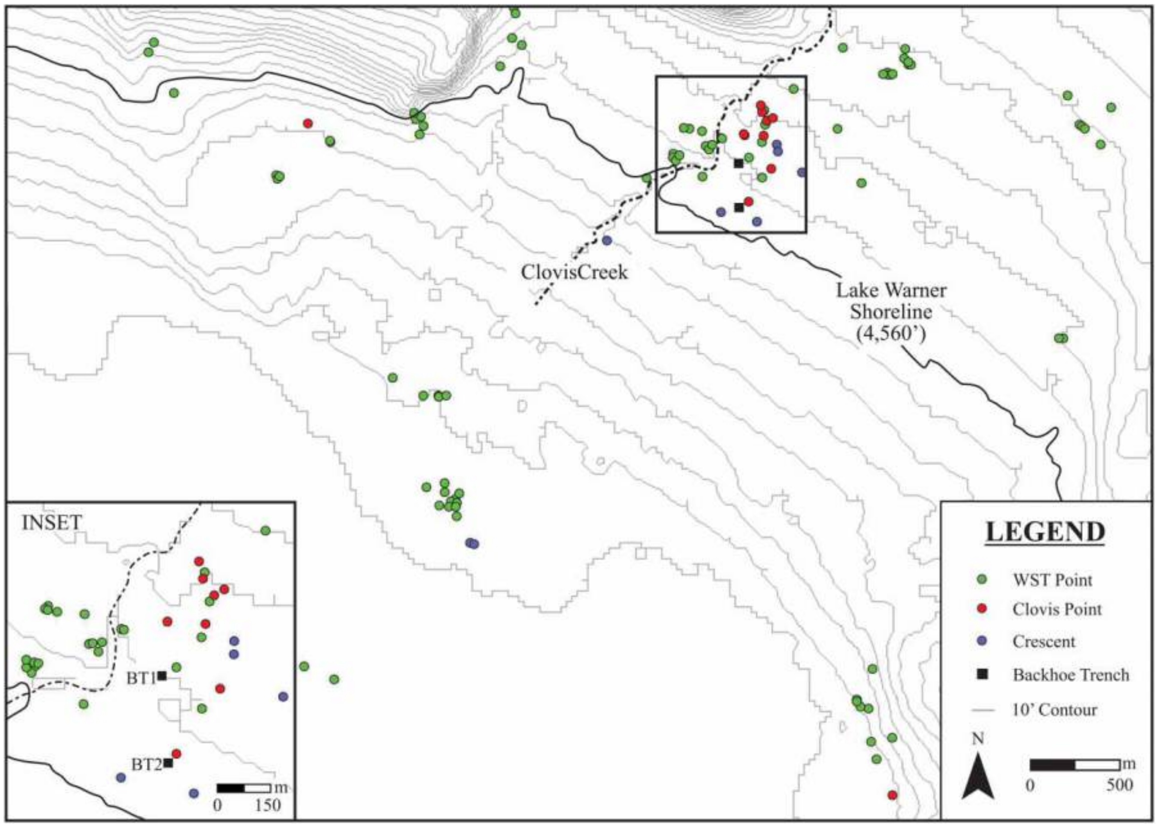

Figure 6 The horizontal distribution of Clovis and WST points in the NWVSA.

point types suggest they may be somewhat *temporally* associated, their horizontal distributions suggest they are not closely *spatially* associated. Instead, they may mark separate but roughly contemporary or sequential visits by Clovis- and WST-point users to the NWVSA, where the confluence of Clovis Creek and Lake Warner offered lacustrine and marsh resources.

4.3 Raw material representation in Clovis and WST points

Table 2 presents X-ray fluorescence (XRF) data for Clovis and WST points from the NWVSA. Thirty-one obsidian and FGV types found 9–745 km from the NWVSA are represented. Unsurprisingly, the closest obsidian sources – Beatys Butte (37 km) and Horse Mountain/Horse Mountain B (57 km) – are well-represented (18.2 and 19.7 per cent of the sample, respectively). Numerous other northern Great Basin obsidians are also represented.

Table 3 summarizes the results of comparisons of artifact transport distance and richness for Clovis and WST points found ≤ 100 and ≤ 200 m from Clovis points as well as Clovis points and all sourced WST points found above the dated shoreline. They indicate that Clovis and WST points exhibit different source profiles. In each comparison of transport distance, WST points were transported farther (117.0, 85.6, and 70.6 km) than Clovis points (45.8 km). WST points are generally made on more diverse raw materials than Clovis points, although only significantly so when Clovis points are compared to all WST points found above the dated shoreline. Despite the lack of statistical significance in richness for Clovis and WST points found ≤ 100 and ≤ 200 m apart, a comparison of raw materials in both samples suggests differential toolstone selection. Clovis and WST points ≤ 100 m apart share only one raw material source (Horse Mountain/Horse Mountain B obsidian). Similarly, when Clovis and WST points ≤ 200 m apart are compared, only one additional source – Beatys Butte (the closest major obsidian source to the NWVSA) – occurs in both samples. Only when Clovis points and all WST points found above the dated shoreline are compared do the same toolstone types appear in both samples. In those cases, the raw material sources are those found closest to the NWVSA. In sum, the geochemical profiles of Clovis and WST points differ substantially. WST points are made on a wider range of raw materials, most of which are found further away than those used to make Clovis points.

5. Discussion

During the TP, a gradual slope combined with freshwater input from Clovis Creek (which provided nutrients and seasonal water flow) and protected back-beach environments fostered marshlands in northern Warner Valley. Groups using Clovis and

Table 2
Source provenance data for NWVSA Paleoindian projectile points

Geochemical type	Distance to source (km)*	Comparisons of Clovis and WST points					
		≤ 100 m		≤ 200 m		All WST above shoreline	
		Clovis	WST	Clovis	WST	Clovis	WST
Badger Creek, NV	119	–	–	–	–	–	1 (1.8%)
Bald Butte, OR	50	–	–	–	–	–	1 (1.8%)
Beatys Butte, OR	37	3 (27.2%)	–	3 (27.2%)	3 (37.5%)	3 (27.2%)	9 (16.4%)
Big Stick, OR	48	–	–	–	–	–	3 (5.5%)
Blue Spring, CA	126	–	–	–	–	–	1 (1.8%)
Buck Mountain, CA	129	–	–	–	1 (12.5%)	–	-
Buck Spring, OR	9	2 (18.2%)	–	2 (18.2%)	–	2 (18.2%)	1 (1.8%)
Camp Creek FGV, OR	110	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	–
Double O, OR	54	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	1 (1.8%)
Double O FGV, OR	54	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	–
Glass Buttes 3, OR	76	–	–	–	–	–	1 (1.8%)
Glass Buttes 4, OR	76	–	–	–	–	–	2 (3.6%)
Gregory Creek, OR	177	–	1 (33.3)	–	1 (12.5%)	–	2 (3.6%)
Horse Mountain, OR	57	–	1 (33.3)	–	1 (12.5%)	–	11 (20%)
Horse Mountain B, OR	57	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	1 (1.8%)
Indian Creek Buttes, OR	121	–	–	–	1 (12.5%)	–	1 (1.8%)
Long Valley, NV	104	–	–	–	–	–	1 (1.8%)
ML/GV, OR/NV**	64	–	–	–	–	–	5 (9.1%)
McComb Butte, OR	55	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	–
Mosquito Lake, NV	110	–	–	–	–	–	1 (1.8%)
Mud Ridge, OR	99	–	–	–	–	–	1 (1.8%)
Silver Lake/Sycan Marsh, OR	98	–	–	–	–	–	1 (1.8%)
Sugar Hill, CA	128	–	–	–	–	–	1 (1.8%)
Tank Creek, OR	50	–	–	–	–	–	2 (3.6%)
Tucker Hill, OR	115	–	–	–	–	–	2 (3.6%)
Wagontire, OR	58	–	–	–	–	–	2 (3.6%)
Wildhorse Canyon, UT	745	–	1 (33.3)	–	1 (12.5%)	–	1 (1.8%)
Yreka Buttes, OR	106	–	–	–	–	–	2 (3.6%)
Unknown 1	?	–	–	–	–	–	1 (1.8%)
Unknown FGV 1	?	1 (9.1%)	–	1 (9.1%)	–	1 (9.1%)	–
Total	–	11 (100%)	3 (100%)	11 (100%)	8 (100%)	11 (100%)	55 (100%)

Note: All geochemical types are obsidian unless otherwise indicated as FGV.
*Distance to source reflects the shortest distances between known sources of the various geochemical types and artifacts made on those raw material types.
**ML/GV = Massacre Lake/Guano Valley.

WST points visited the area, and based on point distributions relative to the dated 4560-ft (1390-m) AMSL shoreline they likely first arrived during or slightly prior to the early Younger Dryas. The fact that both point types cluster along the lakeshore suggests these visits occurred around the same time. WST points below the shoreline indicate they continued to be used during the EH while the general lack of Clovis points there suggests they fell out of use before the end of the Pleistocene. Differences in the horizontal distribution and source profiles of Clovis and WST points suggest they were not components of the same toolkit and either mark roughly contemporary or sequential visits to the NWVSA – local reflections of either the Clovis first or Paleoindian co-tradition hypotheses. Unfortunately, the coarse-grained nature of current chronological data prevents us from further resolving this debate using the NWVSA record alone, although the discovery of Clovis-aged WST points at the nearby Paisley Caves (Jenkins et al. 2012, 2013) indicates the two technologies were contemporaneous for at least a short time.

Our results from Warner Valley reflect an emerging pattern in the northern Great Basin. As previously noted, Clovis and WST points are spatially segregated at the nearby Dietz site. O'Grady et al.'s (2012) recharacterization of obsidian types used there produced results that mirror ours: Clovis and WST points are made on different raw materials, and Clovis points reflect a smaller geographic area than WST points. O'Grady et al. (2012) also report XRF data for Clovis points from two other northern Great Basin sites – Sheep Mountain and Sage Hen Gap – which also reflect small geographic areas. Conversely, WST points from Sheep Mountain reflect a larger area – the same trend represented in the Dietz and NWVSA WST samples. We suggest these data are evidence that Clovis and WST points were initially not part of the same toolkit and instead reflect different land-use strategies employed by different groups during early Great Basin colonization. If the northern Great Basin was where descendants of two New World migrations – one via the Pacific Coast and one via an Ice-Free Corridor – first shared the landscape (*sensu*

Table 3
Comparison of toolstone transport distance and richness for Clovis and WST points

Projectile point comparisons	Transport distance (km)	*P*	Adjusted richness*	*P*
WST points ≤ 100 m of Clovis points				
Clovis (*n* = 11)	45.8	0.041	1.9	0.970
WST (*n* = 2)	117.0		3.0	
WST points ≤ 200 m of Clovis points				
Clovis (*n* = 11)	45.8	0.060	5.8	0.714
WST (*n* = 8)	85.6		6.0	
All sourced WST points above dated shoreline				
Clovis (*n* = 11)	45.8	0.027	7.0	<0.001
WST (*n* = 55)	70.6		7.9	

Note: The WST point made on Wildhorse Canyon obsidian, which is an obvious outlier that would skew distance results, is not included in transport-distance calculations. Similarly, specimens made on geochemically distinct but geographically unknown toolstone types are not included in transport-distance averages; however, both specimens made on both Wildhorse Canyon and geographically unknown toolstone types are included in adjusted richness calculations.
*Although geochemically distinct, the Horse Mountain/Horse Mountain B, Glass Buttes 3/4, and Double O obsidian/Double O FGV sources are each located in virtually the same geographic locations. As such, each pair of geochemical types was considered a single type in richness calculations.

Beck and Jones 2013), then the greatest differences in spatial segregation, raw material representation, and land-use patterns between Clovis and WST points should occur there.[5] Results from the NWVSA, Dietz, Sheep Mountain, and Sage Hen Gap sites suggest this was the case.

Because both Clovis and WST points are associated with relict TP/EH wetlands, both populations likely focused on such locations, which likely served as central places (Duke and Young 2007; Elston and Zeanah 2002; Madsen 2007). Lithic conveyance zones (*sensu* Jones et al. 2003) reconstructed using source provenance data for Clovis and WST points suggest that while users of both technologies utilized wetlands, how they moved between such locations differed. Data for WST points found near Clovis points (e.g., at NWVSA, Dietz, and Sheep Mountain sites), presumably those marking roughly contemporary occupations, suggest long-distance moves through large territories or even extensive trade networks; in either case, a different kind of system. Initially, WST groups may have moved unencumbered by other in situ populations. Such movements, which may have included both high residential and logistical mobility, could produce the substantial transport distances exhibited by early WST point assemblages in the region.

Conversely, Clovis point data suggest shorter residential moves or logistical forays; in both cases, an emphasis on local land-use. The fact that many Clovis points in the northern Great Basin were made, transported, and discarded within restricted geographic territories is at odds with models portraying Clovis point users as a mobile, colonizing population, and based on the early WST point dates from the Paisley Caves (Jenkins et al. 2012, 2013), they probably were not. However, if Clovis foragers' early forays into the northern Great Basin occurred while WST point-user populations were low, then perhaps they employed a "leap-frogging" strategy (Anthony 1990) in which groups moved into unoccupied productive areas and used them intensively. The archaeological manifestation of such behavior should be "islands of settlement in desirable or attractive locations, separated by significant expanses of unsettled, less desirable territory" (Anthony 1990, 903). This prediction corresponds with the Clovis pattern in the northern Great Basin: concentrations of points made, used, and discarded locally in a few places overlain by a veneer of isolated specimens marking movements between locations. Pinson (2011) posits a similar scenario where Clovis groups arrived to a northern Great Basin sparsely populated by WST groups. The restricted geographic ranges suggested by Clovis source profiles may reflect an "estate-settler" strategy where Clovis groups operated "within and on the edge of already colonized lands" (Pinson 2011, 308).

If Clovis point users employed a leap-frogging or estate-settler strategy within a northern Great Basin landscape initially populated by WST point users, then we must develop models capable of addressing Fiedel and Morrow's (2012, 379) recent question: "if Clovis and Western Stemmed represent contemporaneous populations of differing ancestry […] how could they have partitioned the same habitat during several centuries of intimate coexistence?" In the NWVSA and elsewhere, Clovis and WST points occur on the same landforms, often close together, suggesting those places were visited by users of both technologies during the same intervals. If the two technologies represent two ethnolinguistic populations, then they likely did not operate in isolation from each other.

6. Conclusions

The relationship between Clovis and WST technology remains an enduring question in Great Basin archaeology that has broader significance to debates about New World colonization. Researchers have proposed three hypotheses: (1) Clovis points predate WST points; (2) WST points signal a second TP cultural tradition; and (3) Clovis and WST points were components of a single toolkit. Results from Warner Valley indicate that although the point types are found in the same general area and were probably discarded around the same time (prior to or during the early Younger Dryas), they are not spatially associated. Furthermore, Clovis and WST points are made on different raw materials, suggesting: (1) they were not components of the same toolkit; and (2) their users employed different land-use strategies. Similar trends in Clovis and WST point samples from other northern Great Basin sites suggest it is in that region that the best evidence for two TP traditions in the Intermountain West is found.

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Notes

1 Taylor et al. (1996) do not present calibrated ages for their radiocarbon dates so we used calibrated dates presented in Beck and Jones' (2010) Table 1. Acknowledging shortcomings in current calibration curves, Waters and Stafford (2007) present multiple possible calendar age ranges for Clovis: (1) using INTCAL04, they suggest a maximum range of 13,250–12,800 cal yr BP and a minimum range of 13,125–12,925 cal yr BP; and (2) using Fairbanks et al.'s (2005) approach, they suggest a maximum range of 13,110–12,660 cal yr BP and a minimum range of 12,920–12,760 cal yr BP. Because Waters and Stafford (2007, 1124) believe that 13,125–12,925 cal yr BP "probably represents the true age of Clovis," we reference that range. See Haynes et al. (2007) for a critique of Waters and Stafford's (2007) study.

2 Beck and Jones' (2012a) comparisons of obsidian-hydration rim and raw-material differences between Clovis and WST points are based on source data compiled in 2002 and results originally presented by Fagan (1996). The geochemical types represented in the Dietz assemblage have recently been revised by O'Grady et al. (2012). As such, those comparisons should not be relied upon too heavily until the new sourcing data are published.

3 We used Stuiver et al.'s (2013) Calib 6.0 program for all radiocarbon date calibrations.

4 Students' *t*-tests are often used to determine if two samples are significantly different; however, because the distribution of artifact-transport distances are generally skewed toward local sources, they are often not normally distributed. As such, artifact-transport distances often violate one of the assumptions of *t*-tests. We instead bootstrapped the means by pooling all the values for both point types, drawing samples of sizes $n1$ and $n2$, and comparing the difference between the new means. The two-tailed probability is calculated as the relative frequency of bootstrapped mean absolute differences greater than the absolute observed difference. Based on our experiences, the P values obtained using *t*-tests and bootstrapping are generally similar. Because traditional measures of richness may be influenced by sample size (Grayson 1984; Kintigh 1984), following Eerkens et al. (2007), we calculated it using a bootstrapping routine. We bootstrapped larger samples (using 1000 iterations) so that we could directly compare richness between point types. For example, to compare the 11 Clovis points to the 55 WST points, we drew 1000 samples of 11 points each (with replacement) from the WST point sample and averaged the number of geochemical types represented in each sample.

5 To Charlotte Beck, we owe the idea that the greatest spatial and raw-material selection differences between Clovis and WST assemblages should occur in the northern Great Basin if that is where users of both technologies initially encountered one another, who suggested it during a casual conversation and encouraged us to explore it in this paper.

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