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ARTICLE

Spirit Cave Resilience: How Do We Explain a 10,000-Year Continuity?

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Abstract
Paleoindians buried Spirit Cave Man in a Nevada cave, and archaeologists excavated these remains in 1940. Radiocarbon testing in 1996 dated the burial and associated grave goods as older than 10,700 years. Living just 10 miles from Spirit Cave, the Fallon Paiute-Shoshone Tribe filed a NAGPRA claim in 1997 requesting the repatriation of the Spirit Cave ancestor they call "The Storyteller." This claim ignited a 20-year legal dispute that led the Fallon Paiute-Shoshone Tribe to make the gut-wrenching decision to permit DNA testing. This article documents a 10,000-year genetic continuity firmly linking Paleoindians at Spirit Cave to the Lovelock culture and that strongly suggests continuities to modern Paiutes living there today with no population replacement. We explore the associated radiocarbon record of these dynamics to understand the syncopated population movements that responded to shifting resource distributions. Resilience theory provides an operational way to understand this extraordinary continuity through key concepts, including tipping points, early warning signals, sunk-cost effects, and loss-of-resilience hypotheses. The Spirit Cave case also underscores the moribund concepts and assumptions underlying a century of Great Basin anthropological study that misread this long-term episode of Indigenous resilience and survivance.

Resumen
El individuo conocido como el "Spirit Cave Man" fue enterrado por los Paleoindios en la Cueva del Espíritu, situada en la Cuenca Lahontan, Nevada, Estados Unidos. Arqueólogos excavaron restos humanos en el año 1940 y pruebas de radiocarbono 14 fueron realizadas en el 1996, Los resultados de las pruebas de radiocarbono 14, confirmaron la edad del entierro y objetos funerarios, aproximadamente entre los años 8760 al 8630 aC. En 1997, viviendo a solo 10 millas de la Cueva del Espíritu, la tribu Fallon Paiute-Shoshone presentó a NAGPRA una reclamación, solicitando la repatriación de los restos al que llaman "The Storyteller" o "Spirit Cave Man". Esta nueva información fue el cataclismo para una disputa legal de dos décadas, la cual llevó a la tribu Fallon a tomar la difícil decisión de someter a los restos humanos a las pruebas de ADN. Los resultados de las pruebas de ADN, establecen una relación genética de 11.000 años, la que une a los Paleoindios, la cultura Lovelock, y por último, a los Paiute modernos, que hoy residen cerca de la Cueva del Espíritu en Nevada, EEUU. La teoría de la resiliencia, proporciona un medio operativo para comprender esta extraordinaria continuidad a través del concepto clave de *Archaic Past*, que incluyen puntos de inflexión, señales de alerta temprana, efectos de costos de hundimiento e hipótesis de pérdida de resiliencia. El caso de la Cueva del Espíritu también subraya los conceptos y suposiciones moribundas que fomentaron un siglo de estudio antropológico de la Gran Cuenca para malinterpretar por completo este episodio a largo plazo de resiliencia y supervivencia indígena.

Keywords: Great Basin; Spirit Cave; Paleoindian; Lovelock culture; Northern Paiute; oral history; DNA; tipping points; sunk-cost effects; loss of resilience; survivance

Palabras clave: Gran Cuenca; Cueva del Espíritu; Paleoindio; cultura Lovelock; Paiute del Norte; historia oral; ADN; puntos de inflexión; efectos del costo hundido; pérdida de resiliencia; supervivencia

> One might think it's terrible that scientists are always discovering new ways that they're wrong. But that's really where scientists' superpowers come from.
>
> —Nobel Prize-winner Saul Perlmutter (*Issues in Science and Technology* 40[4]:30–33, 2024).

The Fallon Paiute-Shoshone Tribe (FPST) knows their ancestors have lived in the Lahontan Basin since the beginning of time. Oral history and spirituality define this ancestral homeland as a sacred place still requiring protection. More than 10,000 years ago, this was home to a man buried in Spirit Cave who Paiute descendants call "The Storyteller."

Archaeologists excavated The Storyteller eight decades ago, and in 1997, Paiute-Shoshone leaders asked that his remains be returned home. The Bureau of Land Management (BLM) declined to do so because, like most archaeologists of the day, its staff interpreted the deep history of the Lahontan Basin as a sequence of independent sequential cultures lacking cultural and genetic continuity. Thus, they considered the Paiute people to be recent arrivals within the last several centuries.

During the ensuing two-decades-long legal struggle, the tribe spent considerable money and eventually made the difficult decision to permit DNA testing of the Spirit Cave remains. The genetic results upheld what the tribe already knew from their oral history: there was long-term continuity from the Paleoindian Storyteller through the Lovelock culture communities that likely extended to the Paiute-Shoshone people who live there today.

A curious incongruity resulted. Western science frequently urges Indigenous people to cooperate with genetic testing, but the unexpected continuities that are increasingly emerging from such DNA studies often conflict with standard-issue twentieth-century anthropological thinking. Although The Storyteller was returned and reburied, the Fallon Tribe is concerned that the deeper significance of the genetic results has been ignored and left unexplained. Science, it would seem, has a responsibility to explore the deeper significance of the Spirit Cave results with Indigenous and global communities at large. How did a century of Great Basin anthropological investigation misread this episode of Indigenous resilience and survivance spanning more than 10,000 years?

The Spirit Cave Dispute

In 1940, S. M. and Georgia Wheeler from the Nevada State Parks Commission excavated a small overhang called Spirit Cave (Figure 1), uncovering ancestral remains of two people (one mummified) wrapped in tule matting and two later cremations (Wheeler and Wheeler 1969). Later that summer, the Wheelers displayed the Spirit Cave burials at the Nevada State Fair (Hockett and Palus 2018:1), after which the remains were curated at the Nevada State Museum in Carson City.

The Wheelers (1969:74) estimated the Spirit Cave mummy to be probably 1,500–2,000 years old, but when Ervin Taylor of the University of California, Riverside, radiocarbon dated the Spirit Cave burials, the stunning results indicated a date of 10,700 years ago (Tuohy and Dansie 1997:Table 1).[1] The popular press has since trumpeted the news that Nevada's Spirit Cave mummy is the oldest in the world—three times more ancient than Egypt's famed King Tut (e.g., Begley and Murr 1999; Keenan 2021).

Paiute Perspectives on The Storyteller

According to Len George, chairman of the Fallon Paiute-Shoshone Tribe, "Thousands of years ago, the remains of several people were buried in their final resting place within Spirit Cave, Nevada. Spirit Cave is located on the aboriginal lands of the Fallon Paiute-Shoshone Tribe, and the Tribe's oral histories and spiritual beliefs provide that Spirit Cave is a sacred place containing the remains of the Tribe's ancient ancestors" (Len George, personal communication 2014).

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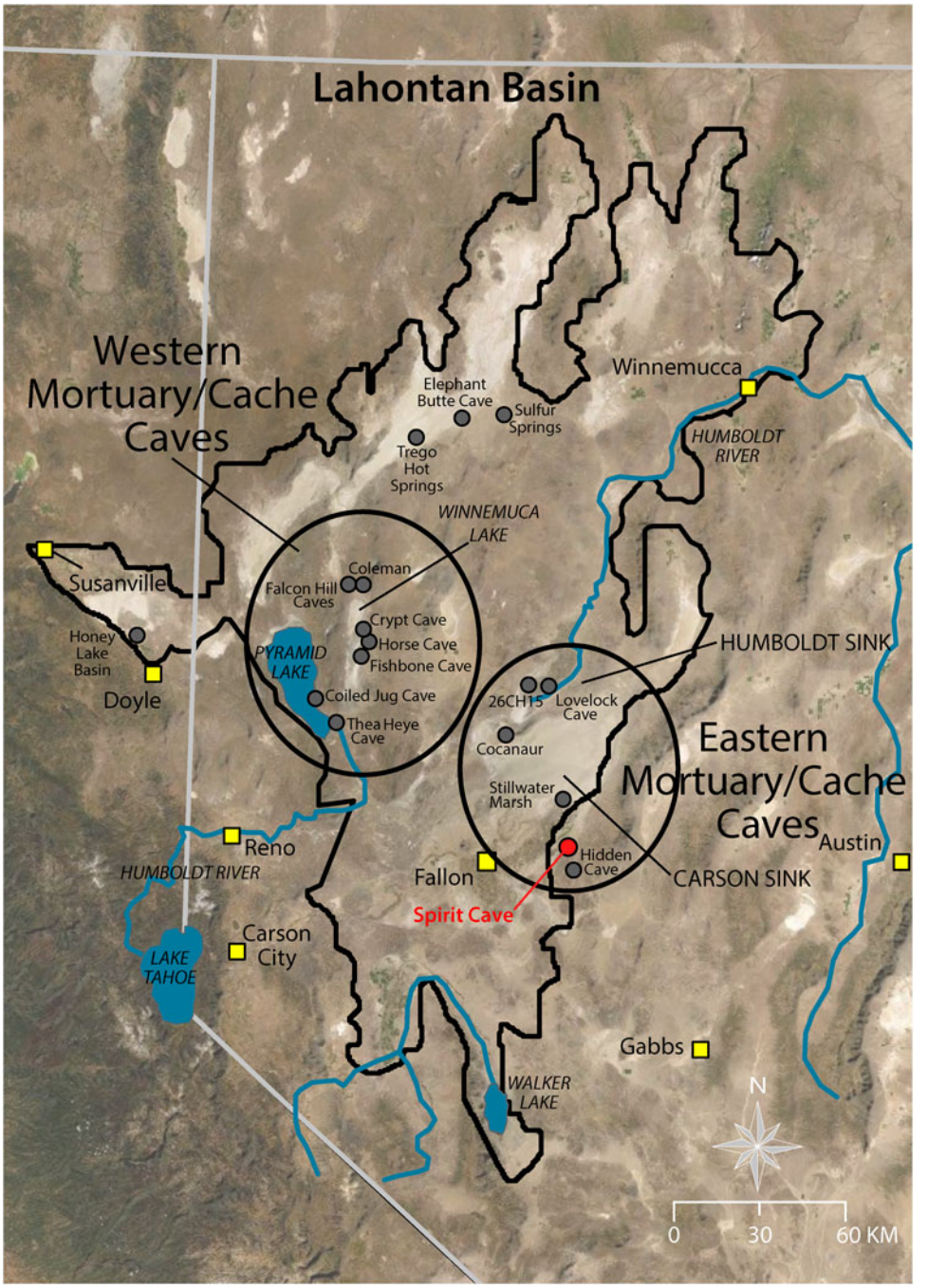

Figure 1. Key localities in the Lahontan Basin (Nevada).

Paiute people know that they have lived in their Lahontan Basin homeland since time immemorial. Their rich oral history documents a time when the pluvial lakes were full and ice sometimes blocked passage into the mountains.

Living fewer than 10 miles (16 km) from Spirit Cave, the Fallon Paiute-Shoshone Tribe also knows that archaeological excavations disturbed this ancestor's spiritual journey. Chairman Len George spoke for generations of his tribe in urging that the Spirit Cave ancestors be brought home under the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA).

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Paiute people have long maintained tribal, communal, and familial perspectives on the deceased and the afterlife. Ancient ancestors sometimes buried their deceased inside the wave-cut caves that ring their Lahontan homeland. Modern Paiutes avoid these nearby caves out of respect, knowing that an ancestor was likely buried inside. Only those with a higher purpose, such as a healer gifted with special medicine or a spiritual adviser, feel they can enter those places.

Paiutes also avoid the caves out of fear. If they enter—even just out of curiosity—they risk disturbing the deceased and conjuring the spirits back. This could accidentally trigger a ghost sickness that begins after a loved one passes, typically bringing lethargy and nightmares, sometimes with feelings of dread, impending doom, and suicidal thoughts (Putsch 1988).

Ghost sickness remains a reality of Paiute life; some say it is the second or third most common cause of illness among the Paiute today (Varner 2010:14). When medicine men and women were buried, their powers were buried with them. Those passing into the next life must answer to these ancestors, some of whom were good people, but others could inflict ghost sickness. If those ancestors take you away, there is no coming back. Dug up and curated at the Nevada State Museum, the man from Spirit Cave could no longer continue his journey. He and others may someday ask why they were not good enough to come home.

Paiutes prefer not to speak of the deceased at all—even within their own family— fearing that the spirits might hear them and come back. Not knowing the name of the man buried almost 11,000 years ago in Spirit Cave, the Paiute generally use the generic term "Spirit Cave remains," and some call him "The Storyteller."

The FPST leadership knew their request to repatriate The Storyteller would cost them dearly and potentially become controversial within the tribe. Many tribal members see NAGPRA itself as an "unhealthy" process because speaking of the dead or handling repatriated remains carries great personal risk. Bringing ancestors home is delicate and dangerous because nobody knows what kind of people they were in life. Over a decade, FPST spent more than $300,000 on this single repatriation, and some in this small tribe thought perhaps this money should have been used instead to improve tribal healthcare and education. Yet, responsibilities to ancestors and the fear of ghost sickness underscored the urgency of returning The Storyteller home.

Repatriating the Spirit Cave Remains

In March 1997, the FPST, representing all Northern Paiute tribal governments, formally asserted a NAGPRA claim of cultural affiliation with the Spirit Cave remains and associated artifacts (Edgar et al. 2007). The BLM responded a year later, concluding that, although the Spirit Cave remains are unquestionably Native American, they could not be culturally affiliated with any living individual or contemporary human group (Barker et al. 2000). The following year, FPST tribal attorneys sent a memorandum to BLM detailing the legal and substantive arguments supporting their affiliation to their Spirit Cave ancestor.

The BLM responded by reviewing all available evidence relevant to the Spirit Cave remains: geographical, kinship, biological, archaeological, anthropological, linguistic, folklore, oral tradition, historical, and opinion. NAGPRA regulations require that an earlier human group be defined for Native American skeletal remains, followed by an unbroken continuity from that ancient human group to a modern individual or tribe. Reflecting archaeological perspectives of the time, the BLM saw nothing in the evidence defining an unbroken continuity and once again concluded that the Spirit Cave remains could not be culturally affiliated with any living individual or contemporary human group.

FPST then submitted the Spirit Cave dispute to the NAGPRA Review Committee in 2001. By a 6–1 vote, the committee determined the BLM "had failed to fairly and objectively consider all the available and relevant information" and concluded that the Spirit Cave remains should be affiliated with the Northern Paiute (National Park Service 2001). The tribe then requested that BLM Nevada consider the Review Committee's findings, but the agency did not change its decision. FPST then asked the secretary of the interior and the BLM director in Washington, DC, to reverse this decision, but they did not (Hockett and Palus 2018).

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The tribe sued the BLM in 2004, and two years later, the court found the BLM had been "arbitrary and capricious" in not considering the NAGPRA Review Committee's recommendation. While not reversing BLM's initial determination, the court ordered the BLM to adequately weigh all available evidence and justify why one theory or set of evidence should be chosen over another. The BLM did this over the next eight years, contracting and evaluating fresh reviews from several scientists.

Spirit Cave DNA

The Spirit Cave standoff shifted in 2014 when the BLM explored the possibility of DNA analysis. Independently, geneticist Eske Willerslev of the University of Copenhagen had requested permission from the BLM for DNA analysis of the Spirit Cave remains. When referred to the FPST, the tribe initially refused to grant Willerslev permission, prompting him to visit Fallon three times to confer (Figure 2).[2] He explained that his previous involvement in DNA research with the Confederated Tribes of the Colville Reservation in Washington State had facilitated the repatriation and reburial of Kennewick Man/The Ancient One (Rasmussen et al. 2015). Offering to work with the Fallon Paiute in the same way, Willerslev suggested that respectful and limited DNA analysis could resolve the Spirit Cave controversy as well.

Donna Cossette (former tribal chair) and Yvonne Mori (vice chair of the Tribal Council) visited Willerslev's DNA facilities in Copenhagen.[3] These consultations convinced FPST to permit destructive DNA analysis on The Storyteller—an especially gut-wrenching decision because the Paiute believe that bodies must be intact to move to the other side. The Lovelock Paiute tribe also permitted genetic study of five interments from Lovelock Cave that both tribes believe house ancestors.

Science published the DNA results (with chairman Len George as a coauthor). Generating multiple Spirit Cave and Lovelock Cave genomes, Moreno-Mayar and colleagues (2018) established a genetic continuity connecting The Storyteller to Lovelock descendants living 9,000 years later—a startling result given previous interpretations of Great Basin abandonments because of extreme climate change.

Using as a proxy the Mixe, a Mesoamerican population of Uto-Aztecan speakers related to a separate Numic language (Campbell 1997), Moreno-Mayar and colleagues (2018) identified a genetic

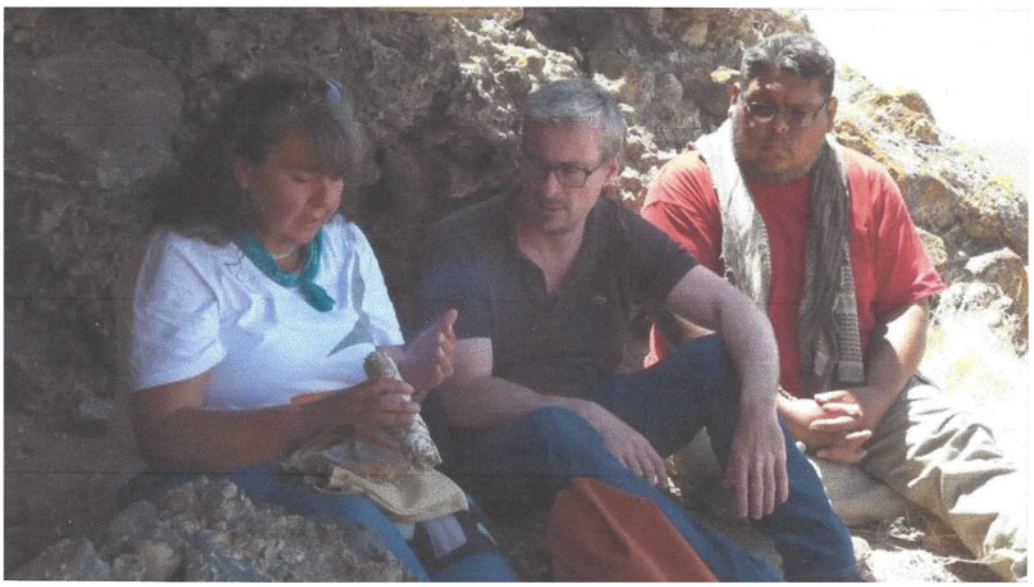

Figure 2. Donna Cossette, Eske Willerslev, and Joey Allen conferring about The Storyteller in the entrance to Spirit Cave (screenshot from Mørk 2023).

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admixture absent in all earlier Lovelock Cave burials but present in Lovelock3 (AD 1289). They believe this reflects a Mesoamerican-related population(s) that expanded north and south, "possibly marking the movement of relatively small groups that did not necessarily swamp local populations genetically or culturally" (Moreno-Mayar et al. 2018). DNA evidence cannot, of course, determine the language involved, but most archaeologists agree it was likely Numic.

Some tribes still view DNA analysis as a scientific tool of colonialism imposed and enforced by the dominant non-Indigenous population. In the case of Spirit Cave, tribally sanctioned genetic research broke through the legal impasse, and The Storyteller was repatriated to FPST for respectful reburial within 31 days (Hockett and Palus 2018). But some Fallon tribal members feel that the deeper significance of Spirit Cave and Lovelock Cave genetics is still largely ignored and unexplained.

Resilience and The Storyteller

Two of us (Robinson and Thomas 2024) have hypothesized that foragers typically retain a long-term resilience often found lacking in agricultural-based economies (see also Byrd et al. 2022). We further suggested that abrupt climatic change tends to create more significant impacts to farming populations, with hunter-gatherers being more vulnerable to "gradual" climate events. We believe the deep history of the Lahontan Basin reflects such processes, and we suggest resilience theory as an operational way to understand the unexpected 10,000-year legacy linking The Storyteller to the Lovelock culture and likely his modern Paiute descendants.

Redman (2005) introduced resilience theory to archaeology as a conceptual framework for exploring long-term continuities and change within socioecological domains (Fitzhugh et al. 2019; Thomas 2024:Chapters 14 and 15). Developed within ecological systems theory, overarching resilience perspectives are remarkably straightforward (Van Meerbeek et al. 2021): resilience tends to decline as a system matures, effectively creating "an accident waiting to happen" (Holling 1986). Should this system eventually collapse, it creates "a window of opportunity" for transformation (Davoudi 2012:302). Resilience theory shifts the way some scientists view the world: rather than assuming an orderly, mechanical universe, resilience perspectives emphasize an inherently changing, chaotic, complex, uncertain, and unpredictable world.

Resilience theory also offers a toolbox of key concepts—including tipping points, early warning signals, sunk-cost effects, and loss-of-resilience hypotheses—that we find helpful in approaching the remarkable continuities now evident in the Lahontan Basin. Applying resilience perspectives to the Spirit Cave also helps identify some moribund concepts and assumptions that effectively blinded Great Basin archaeology to this notable record of continuity.

Historicizing the Phase Concept

Twentieth-century chronologies in the Great Basin were grounded in projectile-point, ceramic, and textile sequences, beginning and ending with clean breaks that defined horizons typologically with the layer cake of time; Meltzer (2024:281) suggests that marble cakes might be a more appropriate analogy. These coarse-grained chronologies flattened out spatiotemporal variability into phase-level chunks that unintentionally overemphasized within-phase stasis, punctuated by sequential population replacements.

The recent historical turn in American archaeology questions the time-honored phase concept (Ethridge and Bowne 2020). Index-fossil chronologies fare poorly compared to finer-grained cultural and paleoenvironmental proxies that granularize the past with precision at times approaching the human lifespan. It has become increasingly clear that some of the most significant cultural and climatic shifts took place *within*—rather than *between*—typological phases (Thomas 2013:145). New proxies allow archaeologists to better appreciate records of change and stasis by seeking out multiple meanings of "abandonment" and "continuity."

Testing the Radiocarbon Record

We previously compared two time-sensitive proxies of temporal change in the Great Basin, assembling 5,000 cultural radiocarbon ages and more than 47,000 time-sensitive projectile-point frequencies

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(Robinson and Thomas 2024; Thomas 2024). The highly statistically significant correlation between these independent indices ($r = 0.988$, $p < 0.001$) reinforces their overall value as proxies for monitoring past demographic change in the Intermountain West when measured at vastly different scales.

We concentrate here on a subsample of radiocarbon ages ($n = 482$) from well-known archaeological sites in the Lahontan Basin, including Lovelock Cave, Hidden Cave, the Falcon Hill Caves, Pyramid Lake, Stillwater Marsh, Elephant Butte Cave, and Spirit Cave (detailed in Supplemental Table 1; Figure 1). After applying appropriate chronological hygiene (discussed in Robinson and Thomas 2024), we developed summed probability distributions (SPDs) of these aggregated radiocarbon data. Two hypothesis-testing approaches addressed potential biases in SPDs caused by the nonlinearity of the radiocarbon calibration curve, as well as variability in radiocarbon sample preservation (taphonomic bias) and availability due to specific research histories of different times and places (collection biases). These approaches use Monte Carlo simulations to evaluate the statistical significance of an empirical radiocarbon SPD projected against theoretical or permuted models. We conducted these tests of the Lahontan Basin dataset using the "rcarbon" package (Crema and Bevan 2021) in RStudio (R Core Team 2024).[3]

Following Shennan and colleagues (2013) and Timpson and colleagues (2014), we aggregated and calibrated our sample of Lahontan Basin dates using the IntCal20 curve (Reimer et al. 2020). This produced an SPD that can be compared to an exponential null model using a Monte Carlo simulation to generate confidence intervals using a 100-year running mean. Applying the exponential null model against the Lahontan-wide SPD generated by 1,000 simulations, Z-score transformations of the simulated and empirical SPDs removed any underlying biases caused by fluctuations in the calibration curve. Figure 3 details statistically significant peaks (pink) and troughs (blue) in the empirical Lahontan-wide SPD in which Z-scores exceeded the 95% confidence interval.

Figure 3 also reconstructs and compares radiocarbon-defined profiles at the millennial- to subcentennial-scale. Judging strictly from this empirical distribution, one might conclude that Indigenous Lahontan Basin populations experienced exponential population growth with multiple

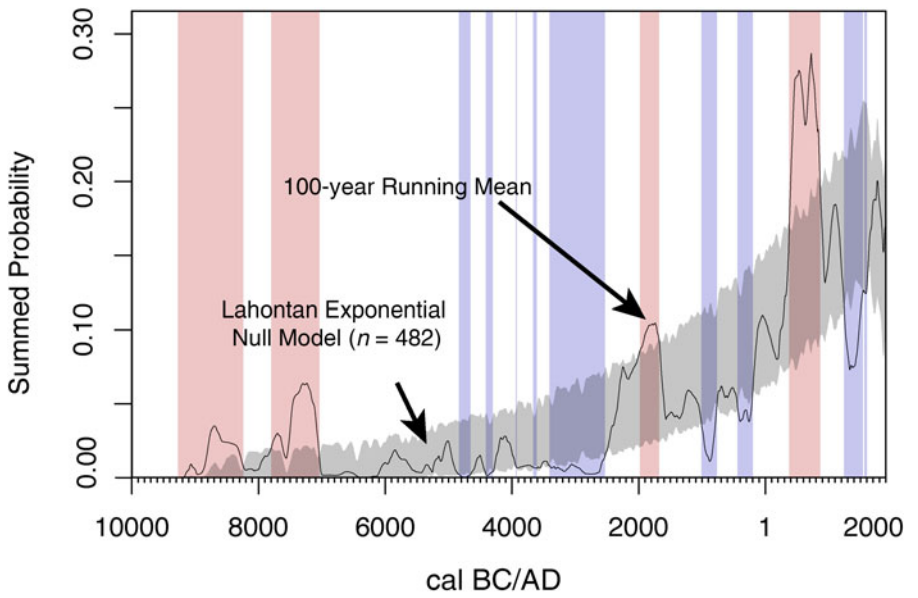

Figure 3. Distribution of 482 cultural ^{14}C dates (Supplemental Table 1) from the Lahontan Basin. The 100-year running mean (black line) is projected against the Lahontan Basin-wide null model (gray band). The statistically significant negative deviations from the null model are highlighted in blue, and the statistically significant positive deviations are indicated in pink (exact crossing points provided in Supplemental Table 2).

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dramatic demographic peaks and troughs over the past 12,000 years. Figure 3 documents positive local deviations at 9277–8239 BC, 7794–7042 BC, 3434–2535 BC, 1985–1683 BC, and AD 374–868, often separated by lengthy statistically significant negative deviations (especially during the Late Holocene).

Minding the Time Traps

But what do these peaks and valleys mean? Do these Holocene peaks actually reflect changing human demography in the Lahontan Basin?

When interpreting such long-term radiocarbon proxies, archaeologists can ill afford to ignore potential distortions in SPDs caused by biases affecting sample collection, preservation, taphonomy, and calibration (Rick 1987; Williams 2012). Evaluating the large-scale ^{14}C probability distributions shown in Figure 3 requires archaeologists to be wary of the significant time traps that lurk within.

We address these potential time traps through a second hypothesis-testing approach. Crema and colleagues (2016) developed permutation testing by building on the null hypothesis modeling of Shennan and coworkers (2013) and Timpson and coauthors (2014). This strategy compares radiocarbon datasets by taking their respective sampling histories into account. Rather than comparing an empirical SPD to a theoretically derived null model to define statistically significant peaks and troughs, permutation testing determines statistical significance by comparing a specific empirical SPD to the 95% confidence interval of a null model produced by permuting all the empirical SPDs being considered (Crema et al. 2016). In this way, permutation testing seeks out the time traps involved in aggregated SPDs by comparing different types of radiocarbon samples, archaeological sites, or regions. As with the exponential null hypothesis comparison of the full Lahontan Basin dataset described earlier, we produced these permutation models with the rcarbon package (Crema and Bevan 2021) by calibrating ages with the IntCal20 calibration curve (Reimer et al. 2020), using a running mean of 100 years with 1,000 Monte Carlo simulations.

We specifically addressed sample collection bias—an acute problem within the Lahontan Basin ^{14}C dataset—by partitioning the pooled radiocarbon profile into three (mutually exclusive) subsets reflecting geographic/hydrological divisions and site functions: (1) western mortuary/cache caves (the Pyramid-Winnemucca Lake drainages), (2) eastern mortuary/cache caves (the Carson and Humboldt Sinks), and (3) residential sites from throughout the Lahontan Basin (Figure 1). Figure 4 compares the temporal distribution of ^{14}C evidence within each context-specific subdivision against the Lahontan Basin-wide null model (detailed in Figure 3), also generating statistically significant peaks (pink) and troughs (blue).

By separating mortuary from residential contexts, Figure 4 provides a far richer understanding of human demographic change within the Lahontan Basin over the last 12,000 years. Had we relied solely on the pooled SPD profile of these same dates (Figure 3), we would have arrived at a highly distorted and misleading picture of exponential population growth.

Syncopated First Americans

The Storyteller and his Paleoindian colleagues were among the earliest colonists of North America. Spirit Cave DNA is closely linked genetically to the Anzick child (around 10,900 BC; Montana), with both diverging from a common ancestor that moved south about 14,000 years ago (Moreno-Mayar et al. 2018). These linkages suggest a rapid early peopling of the Americas, with distance and geographic barriers leading to cultural drift and regional adaptations (Willerslev and Meltzer 2021). The findings underscore the too-often ignored point that language, material culture, and genetics need not be congruent or causally linked (Beck and Jones 2024; Johannsen et al. 2017; Meltzer 2024).

Paleoindian Mortuary Patterns

Paleoindians began burying their deceased inside Lahontan Basin caves at least 11,000 years ago.[4] This long-term trend is unique within the Intermountain West: Indigenous communities living elsewhere almost never buried ancestors in caves or rockshelters (Figure 1).[5] These distinctive Paleoindian mortuary practices defined the Lahontan Basin as a uniquely spiritual space, rather than just some place to live.[6]

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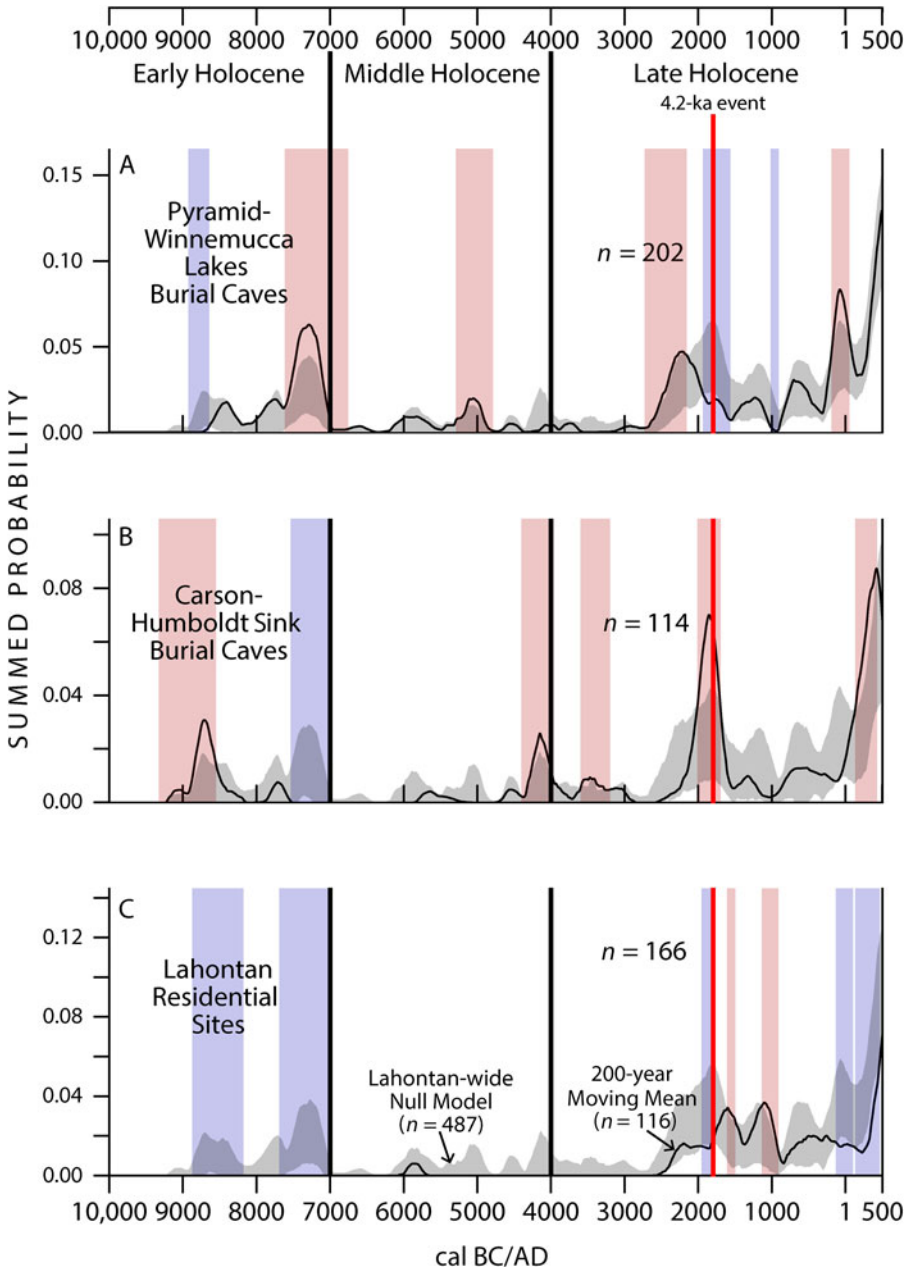

Figure 4. Long-term distribution of cultural ^{14}C dates, comparing mortuary/cache caves of (A) the Pyramid-Winnemucca Lakes and (B) the Carson and Humboldt Sinks with residential sites throughout (C) the Lahontan Basin. The 200-year moving mean (black line) for each subset is projected against the Lahontan Basin-wide null model (gray band, as defined by the 482 radiocarbon dates in Supplemental Table 1). The statistically significant negative deviations from the null model are highlighted in blue, and the statistically significant positive deviations are indicated in pink.

Archaeologists have long recorded extensive clusters of Paleoindian artifacts along the pluvial lake margins, and as elsewhere in the Great Basin, few such surface assemblages suggest long-term residential occupations (Smith and Barker 2017; Smith et al. 2020). Adams and colleagues (2008:608) characterized the surface Paleoindian record of the Lahontan Basin as "isolated occurrences of humans in an otherwise empty landscape."[7] This is why the Early Holocene ^{14}C record of the Lahontan Basin derives almost exclusively from mortuary/cache contexts.

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East–West Syncopation

For seven millennia, Indigenous communities in the Lahontan Basin syncopated between the western mortuary/cache caves of the Pyramid-Winnemucca Lake drainages and similar caves in the Carson and Humboldt Sinks to the east.[8] Figure 4 documents at least five such east–west shifts during the Early and Middle Holocene.

The earliest burials (interred at Spirit Cave and a dozen other mortuary/cache caves of Carson and Humboldt Sinks) define statistically significant peaks at 9096–8997 and 8863–8556 BC (Supplemental Tables 1 and 2). The contemporary Pyramid-Winnemucca Lake mortuary/cache complex to the west shows a corresponding gap at 8780–8608 BC.

After an almost 1,500-year radiocarbon hiatus, Paleoindians shifted burial practices westward, with twin positive pulses at 6066–5960 and 5247–4760 BC (and a corresponding gap to the east). Mortuary patterns reversed again when Carson and Humboldt Sinks reached a significant peak at 4366–4022 BC. A millennium later, the Lahontan Basin syncopated once again westward, with peaks at 2851–2769 BC, 2714–2278 BC, and 2228–2158 BC. Two centuries later, ritualized landscapes shifted back to the Carson-Humboldt mortuary/cache complex at 1984–1705 BC, with Pyramid-Winnemucca Lake dropping into troughs at 1925–1711 and 1633–1521 BC.

Such repeated east–west syncopation by groups sharing the same baseline material culture reflects a deliberate resilience strategy of Paleoindian and post-Paleoindian communities to even out the distinctively variable local hydrology. This is because the Pyramid and Winnemucca sub-basins get most of their water from the Lake Tahoe drainage via the Truckee River (Figure 1). But the Carson and Humboldt Sinks to the east are fed primarily by the Carson River and the vast Humboldt River drainage (Adams and Rhodes 2019). Although the Pyramid-Winnemucca sub-basin and the Carson and Humboldt Sinks reflected the same overarching paleoclimatology, localized variability meant that sometimes the sub-basin was much better watered than the sinks to the east, and at other times, the reverse was true.

Such resilience perspectives emphasize an adaptive diversity driven by individual decision-making, small camp-group mobility, demographic fluidity, and the within-community "plasticity" of "residential cycling" (Upham 1984). By highlighting regional syncopation, temporary site abandonments can be viewed as strategic behavioral practices that helped sustain regional occupational continuity (Nelson and Hegmon 2001). The finer-grained proxies and the tools of resilience theory also enable archaeologists to look "beyond the metaphors of ethnic groups acting in lockstep, with whole villages or entire 'peoples' packing up on moving day and going somewhere" (Simms 1999:39). Phase-level archaeological chronologies have long obscured these short-term abandonments and reuse.

Building on the centennial-scale radiocarbon indices developed here, resilience theory suggests that decadal or even annual adjustments took place as well. These were evident among ethnohistoric Great Basin populations whose foraging itineraries were "usually the same each year [but] not always fixed. Seasonal variation in rainfall and consequently in crop growth frequently required that they alter their routine" (Steward 1938:232). Rather than maintain a single, invariant settlement structure, Lahontan Basin communities existed in "several sets of roles and groups which appear and disappear according to the tasks at hand" (Gearing 1958:1149).

Transcending models grounded in strictly environmental change, economic crisis, or both, the concepts of resilience and syncopation reflect Indigenous responses to their changing world. Because such abrupt environmental shifts varied locally, the distinctive east–west syncopation now recognized in the Lahontan Basin was directly related to localized hydrological shifts that helped ensure regional community and sustainability without requiring internal structural changes (Scheffer et al. 2021:5).

Lovelock Culture Genesis

The 4.2 ka event (2200–1980 BC)—one of the most pronounced climatic intervals of the Holocene—shows up in paleoclimatic proxies across seven continents. Although sometimes billed as a "global mega-drought" (Railsback et al. 2018:87), Great Basin impacts were exactly the opposite, with three centuries of cooler, wetter weather triggering repeated flooding at higher elevations, tree lines moving downslope, springs rebounding, lakes refilling, rivers shifting course, and marshlands expanding.

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The Lovelock culture emerged during this transformation, shifting the Lahontan Basin from a sparsely occupied sacred space into a homeland of nearly sedentary settlements, such as Stillwater Marsh and 26CH15. This lacustrine culture relied on marshland resources that required considerable time to collect and process, with these costs offset by their abundance, reliability, and close spacing (Madsen and Rhode 1994:394; Simms 2008:32–35). According to Raven (1993:8), "The sheer richness, diversity, and predictability of marshside productivity invited virtually continuous exploitation."

Three dozen radiocarbon dates from several early Lovelock villages define peaks at 1598–1467 and 1118–913 BC. Still using their ancestral burial places in the nearby caves of the Carson and Humboldt Sinks, Lovelock communities augmented long-standing mortuary practices by burying the deceased near their marshland villages. They stayed away from the Pyramid-Winnemucca mortuary/cache caves (with gaps at 1925–1716, 1633–1511, and 1049–896 BC).

This newly historicized archaeological record allows us to explore how resilient Lovelock communities addressed the next four episodes of dramatic and abrupt climatic change: the Late Holocene Dry Period (1150 BC–AD 150) followed by droughts terminating at AD 750, AD 1150, and around AD 1350 (Mensing et al. 2008).

Late Holocene Dry Period (1150 BC–AD 150)

Indigenous communities across the Great Basin were challenged by the megadrought of the Late Holocene Dry Period (LHDP) that lasted longer than a millennium (Mensing et al. 2023; Thomas et al. 2023). New fine-grained proxies demonstrate that the LHDP was the driest Great Basin climate of the last six millennia and was more extreme than the better-known Medieval Climatic Anomaly (MCA; around AD 1000–1450; Stine 1994).

The Tipping Point

In the parlance of resilience theory, the LHDP was a "tipping point"—a threshold with one or more perturbations capable of triggering large, abrupt, and sometimes irreversible transitions (Scheffer et al. 2021). When approaching such catastrophic thresholds in ecosystems and climate, societies sometimes experienced increasingly slow recoveries from even small perturbations (Dakos et al. 2019:14308). Longer-term internal developments also caused some societies to lose resilience through time, effectively "setting them up for collapse" (Scheffer et al. 2021:1), recalling Holling's (1986) phrase, an "accident waiting to happen."

The LHDP perturbation spanned 1,300 years and played out in three distinct intervals (Mensing et al. 2023): an initial 900-year dry period (1150–2250 BC), followed by two centuries of wetter climate (250–50 BC), and terminating in two centuries of extreme drought (50 BC–AD 150). Indigenous Great Basin communities addressed the LHDP tipping point in multiple ways (Thomas et al. 2023). Detailed site-by-site occupational histories and pooled radiocarbon trajectories in Figures 3–6 illustrate the complex patterning of LHDP abandonments and reoccupations within the Lahontan Basin.

Sunk Costs

The Storyteller was born into an embellished landscape where boulders could speak. More than 10,500 years ago, Paleoindians of the Winnemucca Lake sub-basin carved deep grooves and multiple cupules on a prominent tufa mound. Located within 50 miles (80 km) of Spirit Cave, these are the oldest petroglyphs known in North America (Benson et al. 2013). The storied rocks of the Lahontan Basin held power (*puha*) before the birth of The Storyteller, and they remain sacred to the Pyramid Lake Paiute Tribe to this day. It is no small wonder that Lovelock communities could not simply walk away from the power places within their homeland.

Although consensus is sometimes heralded as a goal among small-scale societies, that is hardly what emerged during the LHDP tipping point. Most Great Basin localities south of 40° N latitude were abandoned during the initial dry phase; some were briefly reoccupied during the short mesic interval and abandoned again during the most extreme drought (50 BC–AD 150; Figure 5).

In the face of such massive and widespread aridity, sunk-cost investments must have encouraged some to stick with the status quo, even when the need for change was evident to others (Janssen

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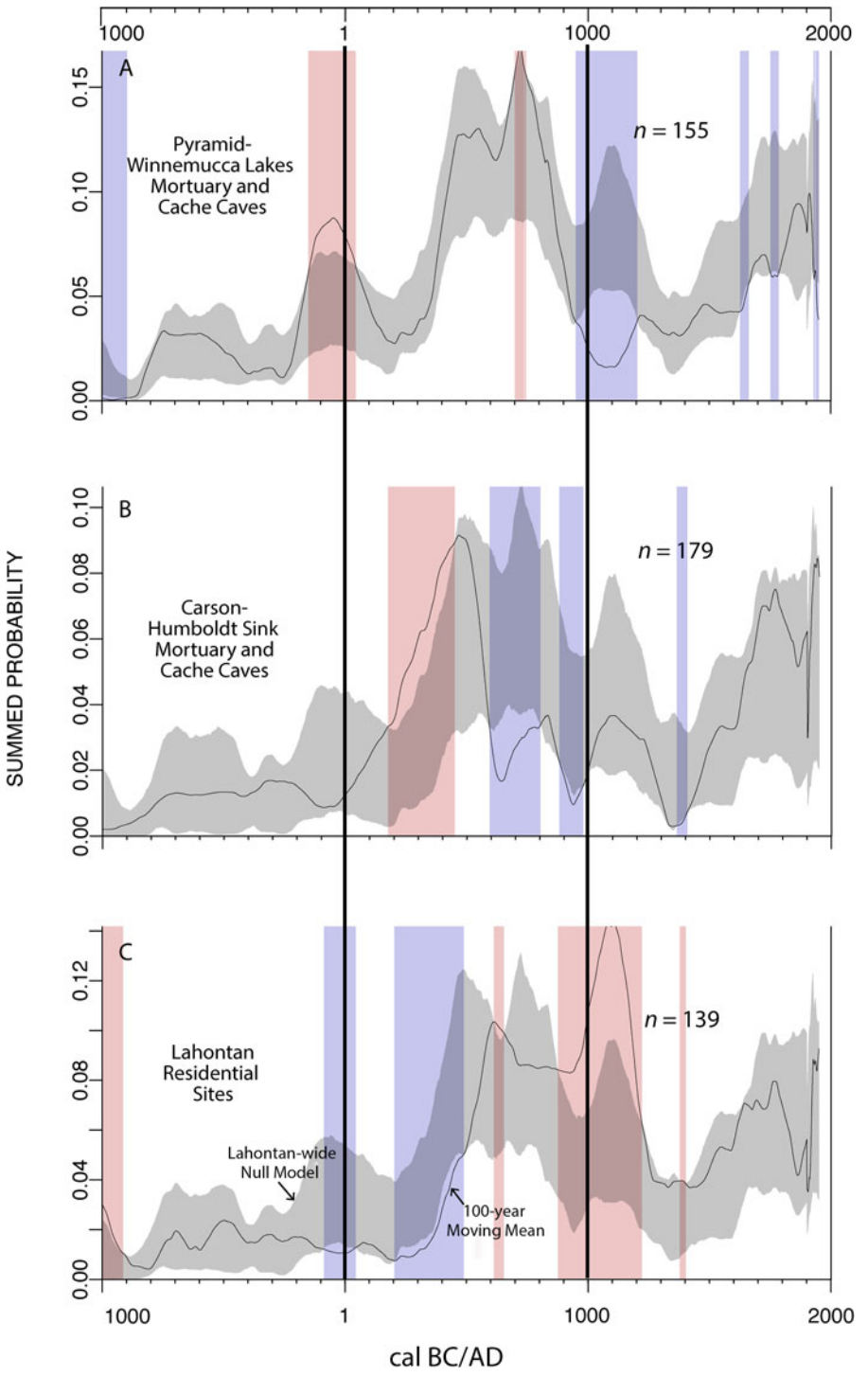

Figure 5. Long-term distribution of cultural ^{14}C dates over the last 3,000 years (following the protocols in Figure 3).

et al. 2003). Sunk costs heavily conditioned the nature of LHDP abandonments in the high mountains of the central Great Basin (Thomas et al. 2023:411). The same was true of their Lovelock neighbors, rooted in the sacred marshland landscapes dating to their Paleoindian ancestors.

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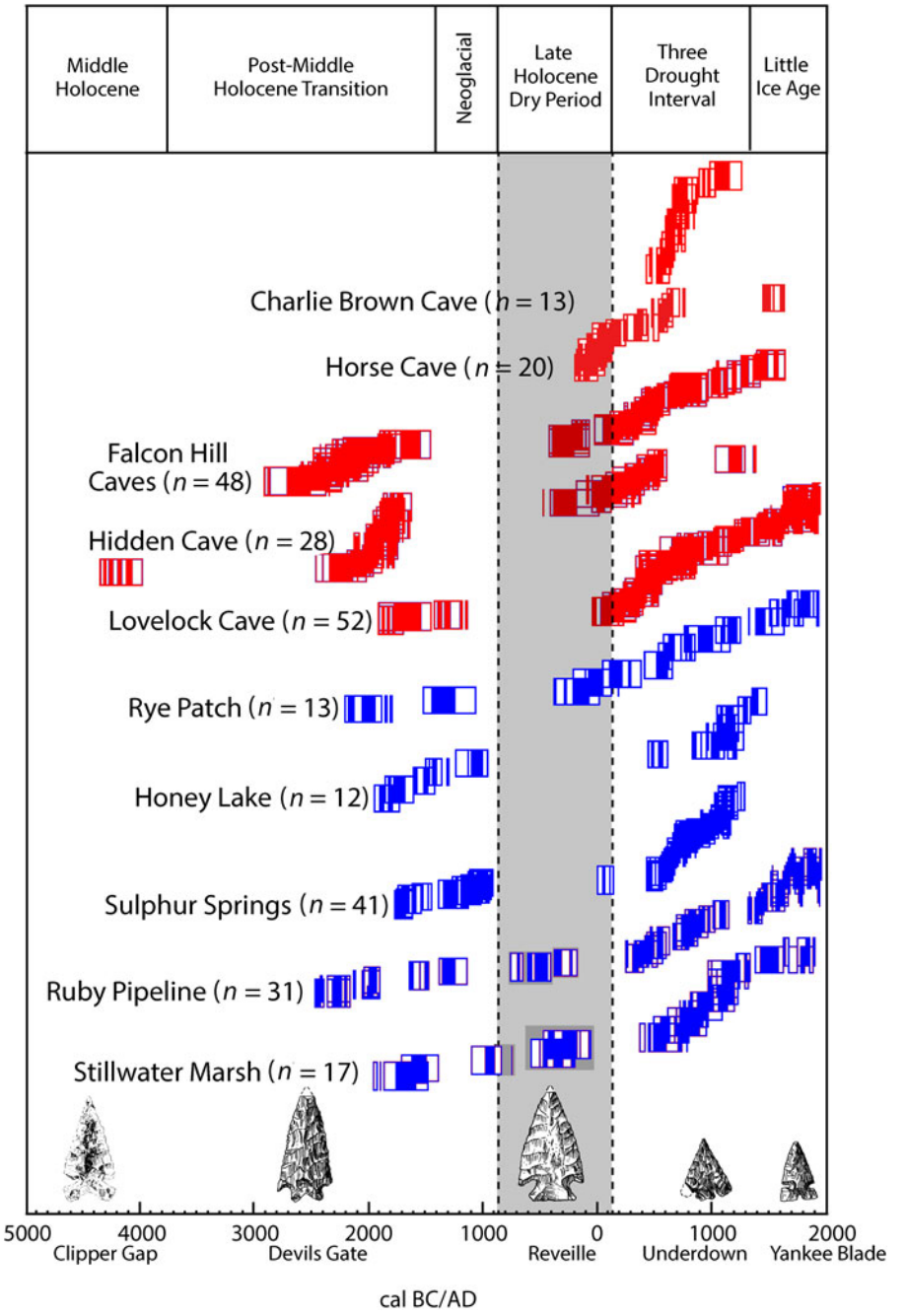

Figure 6. Distribution of site-specific radiocarbon dates from the Lahontan Basin, with time-diagnostic projectile points illustrated along the baseline. The dates in blue come from residential sites; those from mortuary/cache caves are shown in red.

Leaving the Lahontan Homeland

The LHDP began in the Lahontan Basin with a radiocarbon peak in the eastern mortuary complex spanning 1118–913 BC (Figure 5), with the western mortuary/cache caves experiencing a concurrent trough (1049–896 BC). Lovelock villages in the Black Rock Desert were then abandoned between 850 BC and AD 450 when the LHDP archaeological record "essentially goes dark" (McGuire et al. 2018:51, 197).

Where did they go?

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The Lahontan Basin straddles an ENSO 42°–40° N dipole, remaining relatively stable through time, with southern lowlands drying out while the northwestern reaches stayed relatively mesic (Mensing et al. 2023). Resilient Lovelock communities deliberately crossed this dipole, seeking to mitigate the persistent aridity desiccating their Lahontan Basin homeland by moving to upland refugia in the adjacent Sierran front. Figure 6 charts specific site histories for several Lovelock communities that temporarily left their marshland settlements during the height of the LHDP.

Despite the shift in settlement pattern, Lovelock foragers maintained long-distance ties to the virtually deserted Pyramid-Winnemucca Lake basin and Carson-Humboldt Sinks by burying ancestors and sometimes caching out-of-season belongings in the caves of their homeland. Genomics establishes an unmistakable continuity from Spirit Cave that continued through the LHDP and carried through at least AD 1347 (the Lovelock5 burial).[9]

Coming Back Home

The Lahontan Basin experienced radiocarbon troughs during the LHDP at 86 BC–AD 43 and AD 203 (Figure 5), after which Lovelock communities left their highland refugia and came back home during the drought terminating at AD 750 (reflected in the positive ^{14}C peak at AD 617–653). Returning to the Black Rock Desert, Sulphur Springs, Pyramid Lake, Humboldt Sink, and Stillwater Marsh, some Lovelock communities refurbished the same villages their ancestors had deserted a millennium earlier.

Despite the hiatus, the diehard Lovelock culture retained the same baseline material culture. Hunters still fashioned Elko spear points, and Lovelock weavers still crafted Catlow Twine textiles, adding the distinctive Lovelock Wickerware baskets to their repertoire (Camp 2017; Connolly et al. 1998). Although they continued burying their deceased in the mortuary/cache caves of the Carson and Humboldt Sinks (with a positive peak at AD 175–499), Lovelock communities also interred many of their dead in villages at Stillwater Marsh (AD 100–750). Western Pyramid-Winnemucca mortuary/cache caves reflect similar continuities, with peaks at AD 699–738 and AD 740–746.

Buildup to the Drought Terminating in AD 1150

The drought terminating in AD 1150 was accompanied by the anomalously warm temperatures of the MCA (Mensing et al. 2023). The drought-reduced inflow from the Carson, Truckee, and Humboldt Rivers, and the Lahontan Basin wetlands shrank. The water level in Pyramid Lake dropped, and the Carson-Humboldt Sinks likely dried up completely. Wetland plants shifted from lacustrine lowlands to stream floodplains, fisheries collapsed, and drinking water was hard to come by. Although some turned to freshwater springs, those springs in the Carson and Humboldt Sinks flowed relatively high above the basin floor and likely ceased flowing in the autumn months.

Despite these climatic impacts, the Late Lovelock continuity persisted with a positive demographic peak at AD 876–1221. These villages correlated with a Carson Sink high stand (AD 1040–1290) that was likely augmented by an "unearned" inflow from the Walker River through a paleochannel and perhaps input from the Humboldt River (Adams and Rhodes 2019:Table 3, Figure 5, 165).

The Thirteenth-Century "Collapse"

After the moist pluvial (AD 1100 and AD 1200) that separated the two centennial-scale droughts of the MCA (Hatchett et al. 2015), the late thirteenth century signaled the so-called collapse of the Lovelock culture.

Benson and colleagues (2007:348) summarized conventional interpretations: the twin droughts of AD 1150 and the late thirteenth century "acted as a slow-motion, one-two punch with the first blow putting the [Lovelock] cultures on their knees and the second blow ending the fight." According to this phase-level thinking, when the distinctive Lovelock Wickerware was no longer manufactured, the trait-list-defined Lovelock culture "collapsed" around AD 1250.

As during the LHDP, Lovelock communities still shared vested interests in the sacred marshland landscapes of their ancestors. Sunk costs must still have made it painful to walk away, but this time, most did just that. Watching their homeland turn unfriendly, many must have felt that their sunk-cost investments failed to compensate for a status quo that just was not working anymore.

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So why did resilient Lovelock communities survive the Late Holocene Dry Period—the second-worst megadrought of the Holocene—yet "collapse" during the less severe Medieval Climatic Anomaly? Could the Lovelock communities have persisted once again by temporarily retreating into more mesic highland refugia until the droughts went away?

Loss-of-Resilience Hypothesis

Hypotheses connecting social "collapses" to abrupt climate change have long suffered from broadly dated paleoclimatic proxies with uncertain societal effects; such disconnects make it difficult to establish robust and nuanced causal interpretations linking human societies to their environments. Although climate extremes are often implicated in large-scale cultural transformations of ancient societies, rarely is climate the sole cause (Kintigh and Ingram 2018).

It seems possible that post-LHDP exponential growth had packed the peripheries around the Lahontan Basin, discouraging further (even temporary) relocations (Thomas and Millar 2024:92–94; Thomas et al. 2023). But there is another possibility.

The loss-of-resilience hypothesis (Scheffer et al. 2021) holds that repeated and dramatic transformations were sometimes preceded by critical intervals of slowing down and fragility. That is, as societies became increasingly vulnerable through time, even relatively small perturbations could trigger large-scale transformations, including a radical rejection of the status quo and a search for alternative pathways.

Such loss-of-resilience processes may have come into play with the Lovelock culture. During the post-LHDP boom and bust/mesic-xeric cycling, the Lahontan Basin was buffered by hydrological windfalls bringing to the Carson Sink waters from the Sierra Nevada range that had previously been destined for Walker Lake. Could such "unearned water" have triggered subtle losses of resilience that fostered discontent with increasing social and economic inequalities, crowded conditions caused by renewed exponential growth, and possible escalating violence?

Perhaps later Lovelock communities behaved like their ancestors by resorting to temporary syncopated shifts to accommodate decadal-scale swings in temperature and hydrology. But when those swings metamorphosed into centennial-scale envelopes of variability, the less resilient Lovelock culture ran into trouble.

Those Who Stayed

The Numic Spread hypothesis holds that Late Lovelock survivors moved en masse westward over the Sierra Nevada, becoming ancestral to ethnohistoric Penutian-speaking groups (such as the Maidu, Klamath, and Modoc) and highlighting the Great Basin origins of these now-Plateau communities. Simultaneously, Numic-speaking Monache populations from the south arrived in the depopulated Lahontan Basin to become the Paviotso (Northern Paiute)—all within the past seven centuries or so. Considerable linguistic and archaeological evidence supports this hypothesis, with complete population replacement universally assumed (Bettinger and Baumhoff 1982; Camp 2017; Hattori 1982; Lamb 1958:99).

Spirit Cave and Lovelock Cave genomes reflect a degree of continuity at odds or even contradictory to the Numic Spread hypothesis (Rhode and Madsen 1994; Thomas 2019). Despite a "collapsing" Lovelock culture that largely depopulated the Lahontan Basin, genetic evidence suggests that some resilient Indigenous people decided to stick it out and stay behind. Lovelock ancestors buried toward the end of the LHDP (AD 12–212) show strong ties to the Spirit Cave ancestors that continued through Lovelock5 (AD 1347). But Lovelock3 (AD 1289) belongs to the B2a1 haplogroup that reflects Mesoamerican genetic ties that were absent earlier. Although DNA does not specifically identify the arriving group, it is highly likely that Numic speakers are responsible.

Long-Term Paiute Resilience and Survivance

That Lovelock5 lacks Mesoamerican ties and is three generations later than Lovelock3—a statistically significant difference—seriously brings into question the long-standing assumption of a complete Numic population replacement. Despite the Lovelock culture "collapse," tribally supported DNA

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research suggests that Numic speakers mixed in with Lovelock survivors, consistent with the Indigenous oral history of a startling survivance spanning at least 10,000 years (and likely longer).

Rather than a total Numic replacement, Northern Paiute oral history embodies a long-dismissed (yet more plausible) scenario. Sarah Winnemucca (who lived around 1844 to 1891) related a tale told by her grandmother about the aftermath of defeating the infamous red-haired giants at Lovelock Cave. Although they were "barbarians" and "people-eaters," the Paiutes sometimes took "these people into their own families" (Hopkins 1883:73–75).

These findings are consistent with Freeman and colleagues' (2024) claim that many such "population collapses" (with their dramatic recessions in carrying capacity) have antecedents dating back decades or centuries, perhaps even reflecting transformations of human infrastructure systems across millennia. This is precisely what the fine-grained behavioral and paleoenvironmental chronologies from the Lahontan Basin show, underscoring the survivance of communities coping with both gradual and abrupt climate change since the Late Pleistocene. Through shifting land-use strategies that changed through time, resilient Indigenous populations chose when to stay, when to go, and when to return (if ever).

Moving On

American archaeology largely turned a cold shoulder toward Indigenous perspectives during the twentieth century: it is hardly coincidental that, although the Colville and Fallon Paiute-Shoshone tribes agreed to accept destructive DNA analysis, both opted for a Danish scientist to do the research (see also Willerslev and Meltzer 2021:362–363). Despite considerable resistance from nearby tribes, the Colville Confederated tribes (Washington) elected to volunteer the DNA samples that would ultimately link them to Kennewick Man / The Ancient One: "Because of the way science has treated our people in the past, it was a tough decision to actually submit," said James Boyd, board chairman of the Colville tribes. "We're happy for the outcome . . . but we knew what the outcome would be" (Rosenbaum 2015). The Fallon tribe felt similarly, stressing that they did not mistrust science—it was American scientists they did not trust.

Peter Whiteley (2002:405) sensed "something of a thaw" emerging in the early twenty-first century between estranged American archaeology and Indigenous communities. The agonizing—and successful—Colville and Paiute collaborations have helped pave the way for similar alliances. Several California tribes, including the Chumash, actively participated in DNA studies to establish genomic continuities for at least 8,000 years (Byrd et al. 2022; Nakatsuka et al. 2023; Severson et al. 2022), genetic continuity has been established between Picuris Pueblo and ancient individuals from Ancestral Puebloan sites (Pinotti et al. 2025), and DNA analysis recently upheld the persistence of Blackfoot peoples since glacial times (First Rider et al. 2024).[10] Archaeological–Indigenous collaborations increasingly reinforce and amplify tribal objectives in the establishment of long-term genetic continuities—validating tribal oral history, furthering repatriation efforts, and underwriting legal claims for treaty rights—all while ensuring that Indigenous communities retain control of their genetic data.

The practice here is not to replace Western knowledge with Indigenous knowledge or even necessarily to meld the two but rather "to weave, braid, or bind them together so that both can be understood and appreciated" (Antoine et al. 2018). In so doing, archaeologists need to remember that, as potential partners in consuming archaeological information, many Indigenous people still resent the degree to which their history has been defined by non-Natives (Zimmerman and Conkey 2024). Archaeological terms such as "collapse" and "abandon" retain negative connotations for many Indigenous people (Colwell-Chanthaphonh and Ferguson 2006). Despite their negative connotations, we use these terms here to emphasize the evolving linkages between established Western science and the Indigenous perspectives. This reflects the trend in recent DNA research that tends to shift the focus from abandonment/collapse to persistence (Laluk and Aguilar 2023).

We argue that resilience theory holds great promise for exploring the archaeological implications of demographic diversity and its social consequences (Hegmon et al. 2016; Leslie and McCabe 2013; Nelson et al. 2011). Perspectives from resilience theory—specifically, tipping points, early warning signals, sunk-cost effects, and loss-of-resilience hypotheses—provide tools to help archaeologists unravel

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the processes that drove long-term Indigenous resilience and survival. That much is evident from The Storyteller across the past 10,000 years.

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Supplemental Material. For supplemental material accompanying this article, visit https://doi.org/10.1017/aaq.2024.85.
Supplemental Table 1. Radiocarbon Dates.
Supplemental Table 2. Permutation Testing Results.
Supplemental Text 1. Great Basin Mortuary Caves outside the Lahontan Basin.

Notes

1. The seven dates from the Spirit Cave mummy, when calibrated by the IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (Reimer et al. 2020), have a median age of 8998 BC.
2. These conversations can be viewed in *Uncovering the Truth about the Origins of America's Indigenous People | Witness Documentary* (Mørk 2023).
3. All radiocarbon dates are calibrated, so the prefix "cal" has been eliminated throughout.
4. Specific mortuary/cache caves in the Lahontan Basin are listed in Supplemental Table 1.
5. The rare exceptions to this patterning within the Intermountain West are detailed in Supplemental Text 1.
6. Only a handful of the caves and rockshelters of the Lahontan Basin show even sparse habitation.
7. This may be overstated (Geoffrey Smith, personal communication 2023). More recent research shows a few exceptions from elsewhere—including Sunshine Wells, the Old River Basin, Hawksy Walksy Valley, and Parman Lake—that do indeed document much longer-term residential patterns.
8. Syncopation is defined as "a temporary displacement of the regular metrical accent in music caused typically by stressing the weak beat; a syncopated rhythm, passage, or dance step" (Merriam-Webster 2025). This term has been used archaeologically to emphasize variability around a central theme (e.g., Thomas 2020:894–896, fn. 3).
9. Radiocarbon results reported in Moreno-Mayar and colleagues (2018) have been recalibrated using the IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (Reimer et al. 2020).
10. Although relevant genetic data are lacking, it is likely that multiple tribes across the American West are likewise descended from The Storyteller. Washoe tribal oral history and archaeological evidence, for instance, link the modern Washoe to the Martis complex (D'Azevedo 1986:466; Elston 1986) that dates to at least 6,000 to 7,000 years ago (Hockett and Spidell 2022).

References Cited

Adams, Kenneth D., Ted Goebel, Kelly Graf, Geoffrey M. Smith, Anna J. Camp, Richard W. Briggs, and David Rhode. 2008. Late Pleistocene and Early Holocene Lake-Level Fluctuations in the Lahontan Basin, Nevada: Implications for the Distribution of Archaeological Sites. *Geoarchaeology* 23(5):608–643.

Adams, Kenneth D., and Edward J. Rhodes. 2019. Late Holocene Paleohydrology of Walker Lake and the Carson Sink in the Western Great Basin, Nevada, USA. *Quaternary Research* 92(1):165–182.

Antoine, Asma-na-hi, Rachel Mason, Roberta Mason, Sophia Palahicky, and Carmen Rodriguez de France. 2018. *Pulling Together: A Guide for Curriculum Developers*. BCcampus, Victoria, British Columbia.

Barker, Pat, Cynthia Ellis, and Stephanie Damadio. 2000. *Determination of Cultural Affiliation of Ancient Human Remains from Spirit Cave, Nevada*. Report on file, Bureau of Land Management, Reno, Nevada.

Beck, Charlotte, and George T. Jones. 2024. Cultural Transmissions and the Interaction of Cultural Traditions in the Far West. In *Current Perspectives on Stemmed and Fluted Technologies in the American Far West*, edited by Katelyn N. McDonough, Richard L. Rosencrance, and Jordan E. Pratt, pp. 240–261. University of Utah Press, Salt Lake City.

Begley, Sharon, and Andrew Murr. 1999. The First Americans—New Digs and Old Bones Reveal an Ancient Land That Was a Mosaic of Peoples—including Asians and Europeans: Now a Debate Rages: Who Got Here First? *Newsweek* 133(17):50–57.

Benson, Larry V., Michael S. Berry, Edward A. Jolie, Jerry D. Spangler, David W. Stahle, and Eugene M. Hattori. 2007. Possible Impacts of Early-11th-, Middle-12th-, and Late-13th-Century Droughts on Western Native Americans and the Mississippian Cahokians. *Quaternary Science Reviews* 26(3–4):336–350.

Benson, Larry V., Eugene M. Hattori, John Southon, and Ben Aleck. 2013. Dating North America's Oldest Petroglyphs, Winnemucca Lake Subbasin, Nevada. *Journal of Archaeological Science* 40(12):4466–4476.

Bettinger, Robert L., and Martin A. Baumhoff. 1982. The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47(3):485–503.

Byrd, Brian F., Monica V. Arellano, Lauren Engbring, Alan Leventhal and Michael Darcangelo. 2022. Community-Based Archaeology at *Síi Túupentak* in the San Francisco Bay Area: Integrated Perspectives on Collaborative Research at a Major Protohistoric Native American Settlement. *Journal of California and Great Basin Anthropology* 42(2):135–158.

Camp, Anna J. 2017. Catlow Twine Basketry through Time and Space: Exploring Shifting Cultural Boundaries through Prehistoric and Ethnographic Basketry Technology in the Northwestern Great Basin. PhD dissertation, Department of Anthropology, University of Nevada, Reno.

Campbell, Lyle 1997. *American Indian Languages: The Historical Linguistics of Native America*. Oxford University Press, New York.

Colwell-Chanthaphonh, Chip, and T. J. Ferguson. 2006. Rethinking Abandonment in Archaeological Contexts. *SAA Archaeological Record* 6(1):37–41.

Connolly, Thomas J., Catherine S. Fowler, and William J. Cannon. 1998. Radiocarbon Evidence Relating to Northern Great Basin Basketry Chronology. *Journal of California and Great Basin Anthropology* 20(1):88–100.

Crema, Enrico R., and Andrew Bevan. 2021. Inference from Large Sets of Radiocarbon Dates: Software and Methods. *Radiocarbon* 63(1):23–39.

Crema, Enrico R., Junko Habu, Kenichi Kobayashi, and Marco Madella. 2016. Summed Probability Distribution of ^{14}C Dates Suggests Regional Divergences in the Population Dynamics of the Jomon Period in Eastern Japan. *PLoS ONE* 11(4):e0154809.

Dakos, Vasilis, Blake Matthews, Andrew P. Hendry, Jonathan Levine, Nicolas Loeuille, Jon Norberg, Patrik Nosil, Marten Scheffer, and Luc De Meester. 2019. Ecosystem Tipping Points in an Evolving World. *Nature Ecology and Evolution* 3(3):355–362.

Davoudi, Simin. 2012. Resilience: A Bridging Concept or a Dead End? *Planning Theory and Practice* 13(2):299–307.

D'Azevedo, Warren L. 1986. Washoe. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 466–498. Handbook of North American Indians Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington, DC.

Edgar, Heather J. H., Edward A. Jolie, Joseph F. Powell, and Joe E. Watkins. 2007. Contextual Issues in Paleoindian Repatriation: Spirit Cave Man as a Case Study. *Journal of Social Archaeology* 7(1):101–122

Elston, Robert G. 1986. Prehistory of the Western Area. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 135–148. Handbook of North American Indians Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington, DC.

Ethridge, Robbie, and Eric E. Bowne (editors). 2020. *The Historical Turn in Southeastern Archaeology*. University Press of Florida, Gainesville.

First Rider, Dorothy, Annabel Crop Eared Wolf, John Murray, Alida de Flamingh, Andre Luiz Campelo Dos Santos, François Lanoë, Maria N. Zedeño, Michael DeGiorgio, John Lindo, and Ripan S. Malhi 2024. Genomic Analyses Correspond with Deep Persistence of Peoples of the Blackfoot Confederacy from Glacial Times. *Science Advances* 10(14):eadl6595.

Fitzhugh, Ben, Virginia L. Butler, Kristine M. Bovy, and Michael A. Etnier. 2019. Human Ecodynamics: A Perspective for the Study of Long-Term Change in Socioecological Systems. *Journal of Archaeological Science: Reports* 23:1077–1094.

Freeman, Jacob, Erick Robinson, Darcy Bird, Robert J. Hard, Raymond P. Mauldin, and John M. Anderies. 2024. The Long-Term Expansion and Recession of Human Populations. *PNAS* 121(12):e2312207121.

Gearing, Fred. 1958. The Structural Poses of 18th Century Cherokee Villages. *American Anthropologist* 60(6):1148–1157.

Hatchett, Benjamin J., Douglas P. Boyle, Aaron E. Putnam, and Scott D. Bassett. 2015. Placing the 2012–2015 California-Nevada Drought into a Paleoclimatic Context: Insights from Walker Lake, California-Nevada, USA. *Geophysical Research Letters* 42(20):8632–8640.

Hattori, Eugene M. 1982. *The Archaeology of Falcon Hill, Winnemucca Lake, Washoe County, Nevada*. Anthropological Papers No. 18. Nevada State Museum, Carson City.

Hegmon, Michelle, Jacob Freeman, Keith W. Kintigh, Margaret C. Nelson, Sarah Oas, Matthew A. Peeples, and Andrea Torvinen. 2016. Marking and Making Differences: Representational Diversity in the U.S. Southwest. *American Antiquity* 81(2):253–272.

Hockett, Bryan, and Emily Palus. 2018. A Brief History and Perspective on Spirit Cave, Nevada. *PaleoAmerica* 4(1):1–7.

Hockett, Bryan, and Jason Spidell. 2022. *Early and Middle Archaic Projectile Point Typology and Chronology across the Great Basin*. Contribution to the Study of Cultural Resources Technical Report No. 19. 19:1–123. Nevada Bureau of Land Management, Reno.

Holling, Crawford Stanley. 1986. The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change. In *Sustainable Development of the Biosphere*, edited by William C. Clark and Robert E. Munn, pp. 292–320. Cambridge University Press, Cambridge.

Hopkins, Sarah Winnemucca. 1883. *Life among the Piutes: Their Wrongs and Claims*. G. P. Putnam's Sons, New York.

Janssen, Marco A., Timothy A. Kohler, and Marten Scheffer. 2003. Sunk-Cost Effects and Vulnerability to Collapse in Ancient Societies. *Current Anthropology* 44(5):722–728.

Johannsen, Niels N., Greger Larson, David J. Meltzer, and Marc Vander Linden. 2017. A Composite Window into Human History. *Science* 356(6343):1118–1120.

Keenan, Sheila. 2021. *What Is the Story of the Mummy?* Penguin Workshop, New York.

Kintigh, Keith W., and Scott E. Ingram. 2018. Was the Drought Really Responsible? Assessing Statistical Relationships between Climate Extremes and Cultural Transitions. *Journal of Archaeological Science* 89:25–31.

https://doi.org/10.1017/aaq.2024.85 Published online by Cambridge University Press

Laluk, Nicholas C., and Joseph Aguilar. 2023. Archaeological Tropes That Perpetuate Colonialism. *SAPIENS*, September 6. https://www.sapiens.org/archaeology/indigenous-people-archaeology/, accessed October 28, 2024.

Lamb, Sydney M. 1958. Linguistic Prehistory of the Great Basin. *International Journal of American Linguistics* 24(2):95–100.

Leslie, Paul, and J. Terrence McCabe. 2013. Response Diversity and Resilience in Social-Ecological Systems. *Current Anthropology* 54(2):114–143.

Madsen, David B., and David Rhode (editors). 1994. *Across the West: Human Population Movements and the Expansion of the Numa*. University of Utah Press, Salt Lake City.

McGuire, Kelly R., William R. Hildebrandt, D. Craig Young, Kaely Colligan, and Laura Harold. 2018. *At the Vanishing Point: Environment and Prehistoric Land Use in the Black Rock Desert*. Anthropological Papers No. 103. American Museum of Natural History, New York.

Meltzer, David J. 2024. Across the Continental Divide. In *Current Perspectives on Stemmed and Fluted Technologies in the American Far West*, edited by Katelyn N. McDonough, Richard L. Rosencrance, and Jordan E. Pratt, pp. 277–298. University of Utah Press, Salt Lake City.

Mensing, Scott A., Jeremy Smith, Kelly Burkle Norman, and Marie Allan. 2008. Extended Drought in the Great Basin of Western North America in the Last Two Millennia Reconstructed from Pollen Records. *Quaternary International* 188(1):79–89.

Mensing, Scott, Wei Wang, David Rhode, Douglas J. Kennett, Adam Csank, David Hurst Thomas, Cedar Briem, et al. 2023. Temporal and Geographic Extent of the Late Holocene Dry Period in the Central Great Basin, USA. *Quaternary Science Reviews* 300:107900.

Merriam-Webster. 2025. "Syncopation". *Merriam-Webster's Collegiate Dictionary*. https://unabridged.merriam-webster.com/collegiate/syncopation, accessed January 16, 2025.

Moreno-Mayar, J. Víctor, Lasse Vinner, Peter de Barros Damgaard, Constanza De La Fuente, Jeffrey Chan, Jeffrey P. Spence, Morten E. Allentoft, et al. 2018. Early Human Dispersals within the Americas. *Science* 362(6419):eaav2621.

Mørk, Linus (director). 2023. *Remains*. Magus Film, Beat Film. https://youtu.be/tt7PxrrYCmI?si=pvWKOrFRDUVmfo9U, accessed January 16, 2025.

Nakatsuka, Nathan, Brian Holguin, Jakob Sedig, Paul E. Langenwalter, John Carpenter, Brendan J. Culleton, Cristina García-Moreno, et al. 2023. Genetic Continuity and Change among the Indigenous Peoples of California. *Nature* 624(7990):122–129.

National Park Service. 2001. Minutes: Native American Graves Protection and Repatriation Review Committee, Twenty-Second Meeting November 17, 18, and 19, 2001. Harvard Law School, Cambridge, Massachusetts.

Nelson, Margaret C., and Michelle Hegmon. 2001. Abandonment Is Not as It Seems: An Approach to the Relationship between Site and Regional Abandonment. *American Antiquity* 66(2):213–235.

Nelson, Margaret C., Michelle Hegmon, Stephanie R. Kulow, Matthew A. Peeples, Keith W. Kintigh, and Ann P. Kinzig. 2011. Resisting Diversity: A Long-Term Archaeological Study. *Ecology and Society* 16(1): 25.

Pinotti, Thomaz, Michael A. Adler, Richard Mermejo, Julie BitzThoren, Hugh McColl, Gabriele Scorrano, Motahare Feizabadi, et al. 2025. Continuity and DNA at Picuris Pueblo. *Nature*, in press.

Putsch, Robert W. 1988. Ghost Illness: A Cross-Cultural Experience with the Expression of a Non-Western Tradition in Clinical Practice. *American Indian and Alaska Native Mental Health Research* 2(2):6–26.

R Core Team. 2024. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/, accessed January 16, 2025.

Railsback, L. Bruce, Fuyuan Liang, George A. Brook, Ny Riavo G. Voarintsoa, Hillary R. Sletten, Eugene Marais, Ben Hardt, Hai Cheng, and R. Lawrence Edwards. 2018. The Timing, Two-Pulsed Nature, and Variable Climatic Expression of the 4.2 ka Event: A Review and New High-Resolution Stalagmite Data from Namibia. *Quaternary Science Reviews* 186:78–90.

Rasmussen, Morten, Martin Sikora, Anders Albrechtsen, Thorfinn Sand Korneliussen, J. Víctor Moreno-Mayar, G. David Poznik, Christoph P. E. Zollikofer, et al. 2015. The Ancestry and Affiliations of Kennewick Man. *Nature* 523(7561):455–458.

Raven, Christopher 1993. Prehistoric Wetland Adaptations in the Great Basin and the Special Case of Malheur Lake. In *Land and Life at Malheur Lake: Preliminary Geomorphological and Archaeological Investigations*, edited by Christopher Raven and Robert G. Elston, pp. 5–12. US Department of the Interior, Fish and Wildlife Service, Portland, Oregon.

Redman, Charles L. 2005. Resilience Theory in Archaeology. *American Anthropologist* 107(1):70–77.

Reimer, Paula J., William E. N. Austin, Edouard Bard, Alex Bayliss, Paul G. Blackwell, Christopher Bronk Ramsey, Martin Butzin, et al. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon* 62(4): 725–757.

Rhode, David, and David B. Madsen. 1994. Where Are We? In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by David B. Madsen and David Rhode, pp. 213–222. University of Utah Press, Salt Lake City.

Rick, John W. 1987. Dates as Data: An Examination of the Peruvian Preceramic Radiocarbon Record. *American Antiquity* 52(1): 55–73.

Robinson, Erick J., and David Hurst Thomas. 2024. Intermountain Demography. In *Defining the Central Mountains Archaic: Great Basin Natural and Cultural Biographies: The Archaeology of Monitor Valley, Contribution 5,* Anthropological Papers No. 106, by David Hurst Thomas, pp. 770–790. American Museum of Natural History, New York.

Rosenbaum, Cary. 2015. Colville Tribal DNA Bridges Native American Connection with Kennewick Man. *Tribal Tribune*, June 18 (updated June 25). https://www.tribaltribune.com/news/article_851e2d0a-160a-11e5-be1f-bbd70c445943.html, accessed January 22, 2025.

https://doi.org/10.1017/aaq.2024.85 Published online by Cambridge University Press

Scheffer, Marten, Ingrid van de Leemput, Els Weinans, and Johan Bollen. 2021. The Rise and Fall of Rationality in Language. *PNAS* 118(51):e2107848118.

Severson, Alissa L., Brian F. Byrd, Elizabeth K. Mallott, Amanda C. Owings, Michael DeGiorgio, Alida de Flamingh, Charlene Nijmeh, et al. 2022. Ancient and Modern Genomics of the Ohlone Indigenous Population of California. *PNAS* 119(13): e2111533119.

Shennan, Stephen, Sean S. Downey, Adrian Timpson, Kevan Edinborough, Sue Colledge, Tim Kerig, Katie Manning, and Mark G. Thomas. 2013. Regional Population Collapse Followed Initial Agriculture Booms in Mid-Holocene Europe. *Nature Communications* 4:2486. https://doi.org/10.1038/ncomms3486.

Simms, Steven R. 1999. Chasing the Will-o'-the-Wisp of Social Order. In *Models for the Millennium: Great Basin Anthropology Today*, edited by Charlotte Beck, pp. 105–110. University of Utah Press, Salt Lake City.

Simms, Steven R. 2008. *Ancient Peoples of the Great Basin and Colorado Plateau*. Left Coast Press, Walnut Creek, California.

Smith, Geoffrey M., and Pat Barker. 2017. The Terminal Pleistocene/Early Holocene Record in the Northwestern Great Basin: What We Know, What We Don't Know, and How We May Be Wrong. *PaleoAmerica* 3(1):13–47.

Smith, Geoffrey M., Daron Duke, Dennis L. Jenkins, Ted Goebel, Loren G. Davis, Patrick O'Grady, Dan Stueber, Jordan E. Pratt, and Heather L. Smith. 2020. The Western Stemmed Tradition: Problems and Prospects in Paleoindian Archaeology in the Intermountain West. *PaleoAmerica* 6(1):23–42.

Steward, Julian H. 1938. *Basin-Plateau Aboriginal Sociopolitical Groups*. Smithsonian Institution Bureau of American Ethnology Bulletin 120. US Government Printing Office, Washington, DC.

Stine, Scott. 1994. Extreme and Persistent Drought in California and Patagonia during Medieval Time. *Nature* 369(6481): 546–549.

Thomas, David Hurst. 2013. Great Basin Projectile Point Typology: Still Relevant? *Journal of California and Great Basin Anthropology* 33(2):133–152.

Thomas, David Hurst. 2019. A Shoshonean Prayerstone Hypothesis: Ritual Cartographies of Great Basin Incised Stones. *American Antiquity* 84(1):1–25.

Thomas, David Hurst. 2020. *Alpine Archaeology of Alta Toquima and the Mt. Jefferson Tablelands (Nevada): The Archaeology of Monitor Valley, Contribution 4*. Anthropological Papers No. 104. American Museum of Natural History, New York.

Thomas, David Hurst. 2024. *Defining the Central Mountains Archaic: Great Basin Natural and Cultural Biographies: The Archaeology of Monitor Valley, Contribution 5*. Anthropological Papers No. 106. American Museum of Natural History, New York.

Thomas, David Hurst, and Constance I. Millar. 2024. Pinyon Pine and People Progressing Simultaneously across the Great Basin: Coincidence? Causality? *Journal of California and Great Basin Anthropology* 44(1):73–109.

Thomas, David Hurst, David Rhode, Constance I. Millar, Douglas J. Kennett, Thomas K. Harper, and Scott Mensing. 2023. Great Basin Survivance (USA): Challenges and Windfalls of the Neoglaciation/Late Holocene Dry Period (3100–1800 cal BP). *American Antiquity* 88(3):402–418.

Timpson, Adrian, Sue Colledge, Enrico Crema, Kevan Edinborough, Tim Kerig, Katie Manning, Mark G. Thomas, and Stephen Shennan. 2014. Reconstructing Regional Population Fluctuations in the European Neolithic Using Radiocarbon Dates: A New Case-Study Using an Improved Method. *Journal of Archaeological Science* 52:549–557.

Tuohy, Donald R., and Amy Dansie. 1997. New Information Regarding Early Holocene Manifestations in the Western Great Basin. *Nevada Historical Society Quarterly* 40(1):24–53.

Upham, Steadman. 1984. Adaptive Diversity and Southwestern Abandonment. *Journal of Anthropological Research* 40(2):235–256.

Van Meerbeek, Koenraad, Tommaso Jucker, and Jens-Christian Svenning. 2021. Unifying the Concepts of Stability and Resilience in Ecology. *Journal of Ecology* 109(9):3114–3132.

Varner, Gary R. 2010. *Ghosts, Spirits & the Afterlife in Native American Folklore and Religion*. Lulu Press, Raleigh, North Carolina.

Wheeler, S. M., and Georgia N. Wheeler. 1969. Cave Burials Near Fallon, Churchill County, Nevada. In *Miscellaneous Papers on Nevada Archaeology, 1–8,* Anthropological Papers No. 14, edited by Doris L. Rendall and Donald R. Tuohy, pp. 70–78. Nevada State Museum, Carson City.

Whiteley, Peter M. 2002. Archaeology and Oral Tradition: The Scientific Importance of Dialogue. *American Antiquity* 67(3): 405–415.

Willerslev, Eske, and David J. Meltzer. 2021. Peopling of the Americas as Inferred from Ancient Genomics. *Nature* 594(7863): 356–364.

Williams, Alan N. 2012. The Use of Summed Radiocarbon Probability Distributions in Archaeology: A Review of Methods. *Journal of Archaeological Science* 39(3):578–589.

Zimmerman, Larry J., and Margaret Conkey. 2024. Different Understandings? The Colonialist Implications of Basic North American Archaeological terminology. *SAA Archaeological Record* 24(1):18–23.

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