Supplementary Materials for

**Investigating (a)symmetry in a small mammal’s response to warming and cooling events across western North America over the late Quaternary**

Meghan A. Balk\*, Julio L. Betancourt, and Felisa A. Smith

**This file includes:**

Tables S1–4

**Table S1.** Results for temperature anomaly (relative to 1,000-yr mean) and shifts in 100-yr bins compared to the estimated temperatures during midden formation over the last 25,000 yr using a Kolmogorov-Smirnov (KS Test) and un-paired Wilcoxon Signed-Rank tests. Shifts are calculated in three ways: (Shift1) the difference between the latest recorded temperature and the earliest recorded temperature in each 100-yr bin; (Shift2) the maximum difference for all possible temperatures, regardless of chronology, for each 100-yr bin; (Shift3) maximum from the first differences of the temperatures in each 100-yr bin. Of note, interpretation of results does not differ based on method of calculating shifts.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Anomaly | Shift1 | Shift2 | Shift3 |
| Locality | Window (ka) | N | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| All | 25–0 | 163 | >0.01 | >0.01 | 0.39 | 0.84 | 0.48 | 0.96 | 0.03 | 0.92 |
|  | 5–0 | 104 | 0.80 | 0.37 | 0.96 | 0.68 | 0.94 | 0.78 | 0.74 | 0.63 |
|  | 6–1 | 80 | 0.63 | 0.36 | 0.77 | 0.60 | 0.83 | 0.75 | 0.79 | 0.45 |
|  | 7–2 | 52 | 1.00 | 0.99 | 0.20 | 0.07 | 0.20 | 0.07 | 0.08 | 0.04 |
|  | 8–3 | 34 | 0.95 | 0.43 | 0.04 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
|  | 9–4 | 16 | 0.28 | 0.08 | 0.20 | 0.07 | 0.13 | 0.07 | 0.26 | 0.13 |
|  | 10–5 | 14 | 0.98 | 0.92 | 0.82 | 0.55 | 0.90 | 0.64 | 0.86 | 0.60 |
|  | 11–6 | 11 | 0.88 | 0.53 | 1.00 | 0.76 | 0.99 | 0.70 | 0.68 | 0.72 |
|  | 12–7 | 17 | 0.31 | 0.37 | 0.84 | 0.79 | 0.97 | 0.84 | 1.00 | 0.94 |
|  | 13–8 | 19 | 0.97 | 0.88 | 0.95 | 0.90 | 0.91 | 0.96 | 0.95 | 1.00 |
|  | 14–9 | 21 | 1.00 | 0.79 | 1.00 | 0.83 | 1.00 | 0.78 | 1.00 | 0.76 |
|  | 15–10 | 17 | 0.96 | 0.60 | 0.99 | 0.86 | 0.99 | 0.82 | 0.99 | 0.81 |
|  | 16–11 | 16 | 0.99 | 0.79 | 0.95 | 0.81 | 0.99 | 0.83 | 1.00 | 0.97 |
|  |  |  | **Anomaly** | **Shift1** | **Shift2** | **Shift3** |
| Locality | Window (ka) | N | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
|  | 17–12 | 12 | 0.79 | 0.97 | 0.94 | 0.91 | 0.92 | 0.88 | 0.95 | 0.75 |
|  | 18–13 | 12 | 0.55 | 0.80 | 0.65 | 0.66 | 0.85 | 0.76 | 0.80 | 0.55 |
|  | 19–14 | 13 | 0.47 | 0.53 | 0.98 | 0.98 | 0.98 | 1.00 | 0.99 | 0.92 |
|  | 20–15 | 16 | 0.17 | 0.45 | 0.94 | 0.78 | 0.96 | 0.93 | 0.95 | 0.81 |
|  | 21–16 | 15 | 0.08 | 0.16 | 0.48 | 0.36 | 0.52 | 0.42 | 0.44 | 0.31 |
|  | 22–17 | 16 | 0.66 | 0.60 | 0.64 | 0.36 | 0.69 | 0.43 | 0.66 | 0.34 |
|  | 23–18 | 16 | 0.69 | 0.66 | 0.76 | 0.37 | 0.76 | 0.37 | 0.68 | 0.38 |
|  | 24–19 | 15 | 0.71 | 0.35 | 0.52 | 0.34 | 0.52 | 0.34 | 0.36 | 0.36 |
|  | 25–20 | 12 | 0.21 | 0.10 | 0.72 | 0.62 | 0.72 | 0.62 | 0.76 | 0.81 |
| Northern | 25–0 | 22 | 0.00 | 0.00 | 0.32 | 0.66 | 0.23 | 0.79 | 0.11 | 0.90 |
|  | 5–0 | 20 | 0.33 | 0.13 | 0.99 | 0.95 | 0.75 | 0.88 | 0.77 | 0.93 |
|  | 6–1 | 14 | 0.71 | 0.49 | 0.88 | 0.90 | 0.91 | 0.87 | 0.97 | 0.88 |
|  | 7–2 | 7 | 0.53 | 0.28 | 0.84 | 0.56 | 0.94 | 0.64 | 0.81 | 0.36 |
|  | 8–3 | 5 | 0.16 | 0.20 | 0.46 | 0.33 | 0.47 | 0.43 | 0.53 | 0.20 |
|  | 9–4 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 10–5 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 11–6 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 12–7 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 13–8 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 14–9 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 15–10 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 16–11 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 17–12 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 18–13 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  |  |  | **Anomaly** | **Shift1** | **Shift2** | **Shift3** |
| Locality | Window (ka) | N | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
|  | 19–14 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 20–15 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 21–16 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 22–17 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 23–18 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 24–19 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 25–20 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Middle | 25–0 | 23 | 0.00 | 0.00 | 0.94 | 0.59 | 0.68 | 0.73 | 0.39 | 0.86 |
|  | 5–0 | 16 | 0.89 | 0.90 | 0.41 | 0.22 | 0.09 | 0.16 | 0.32 | 0.53 |
|  | 6–1 | 14 | 0.85 | 0.45 | 0.57 | 0.46 | 0.10 | 0.39 | 0.41 | 0.80 |
|  | 7–2 | 9 | 0.99 | 0.63 | 0.95 | 0.88 | 0.75 | 0.74 | 0.74 | 0.73 |
|  | 8–3 | 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 9–4 | 2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 10–5 | 3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 11–6 | 3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 12–7 | 5 | 0.60 | 0.41 | 0.99 | 0.78 | 0.95 | 0.71 | 0.98 | 0.98 |
|  | 13–8 | 5 | 0.98 | 0.95 | 0.99 | 0.78 | 0.97 | 0.66 | 0.99 | 0.98 |
|  | 14–9 | 6 | 0.86 | 0.77 | 1.00 | 0.91 | 0.98 | 0.68 | 1.00 | 0.96 |
|  | 15–10 | 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 16–11 | 3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 17–12 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 18–13 | 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 19–14 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 20–15 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  |  |  | **Anomaly** | **Shift1** | **Shift2** | **Shift3** |
| Locality | Window (ka) | N | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
|  | 21–16 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 22–17 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 23–18 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 24–19 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 25–20 | 0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Southern | 25–0 | 33 | 0.95 | 0.94 | 0.93 | 0.87 | 0.87 | 0.98 | 0.82 | 0.88 |
|  | 5–0 | 7 | 0.83 | 0.72 | 0.74 | 0.79 | 0.68 | 0.78 | 0.92 | 0.64 |
|  | 6–1 | 7 | 0.80 | 0.54 | 0.94 | 0.98 | 0.92 | 1.00 | 0.97 | 0.81 |
|  | 7–2 | 6 | 0.64 | 0.63 | 0.14 | 0.28 | 0.14 | 0.28 | 0.17 | 0.31 |
|  | 8–3 | 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 9–4 | 5 | 0.92 | 0.76 | 0.60 | 0.63 | 0.90 | 0.70 | 0.87 | 0.91 |
|  | 10–5 | 7 | 0.90 | 0.42 | 0.76 | 0.36 | 0.81 | 0.29 | 0.72 | 0.39 |
|  | 11–6 | 8 | 0.91 | 0.51 | 0.74 | 0.34 | 0.80 | 0.29 | 0.82 | 0.57 |
|  | 12–7 | 9 | 0.95 | 0.67 | 0.91 | 1.00 | 0.91 | 0.94 | 0.91 | 0.67 |
|  | 13–8 | 10 | 0.53 | 0.28 | 0.81 | 0.90 | 0.76 | 0.94 | 0.81 | 0.91 |
|  | 14–9 | 9 | 0.66 | 0.39 | 0.91 | 1.00 | 0.91 | 0.99 | 0.91 | 0.98 |
|  | 15–10 | 5 | 0.98 | 0.58 | 0.60 | 0.49 | 0.59 | 0.53 | 0.60 | 0.73 |
|  | 16–11 | 5 | 0.98 | 0.63 | 0.60 | 0.48 | 0.58 | 0.60 | 0.61 | 0.74 |
|  | 17–12 | 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 18–13 | 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 19–14 | 6 | 0.64 | 0.80 | 0.59 | 0.69 | 0.58 | 0.61 | 0.87 | 0.95 |
|  | 20–15 | 8 | 0.76 | 0.92 | 0.98 | 0.96 | 0.95 | 0.83 | 0.98 | 0.86 |
|  | 21–16 | 7 | 0.65 | 0.49 | 0.80 | 0.69 | 0.80 | 0.79 | 0.86 | 0.50 |
|  | 22–17 | 7 | 0.57 | 0.51 | 0.80 | 0.67 | 0.82 | 0.74 | 0.83 | 0.58 |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **Anomaly** | **Shift1** | **Shift2** | **Shift3** |
| Locality | Window (ka) | N | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
|  | 23–18 | 7 | 0.66 | 0.47 | 0.87 | 0.78 | 0.87 | 0.78 | 0.86 | 0.76 |
|  | 25–20 | 6 | 0.34 | 0.25 | 0.69 | 0.88 | 0.69 | 0.88 | 0.80 | 0.61 |

**Table S2.** *Neotoma cinerea* fossil localities from 40,000 yr to 10,000 yr and references shown in Figure 1A.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Site Name | Latitude | Longitude | Age Range | Reference(s) |
| Medicine Lodge Creek | 44˚25' | -107˚50' | 11,001–11,011 | (Walker, 1987) |
| Deer Creek Cave | 41˚75' | -115˚37' | 11,680–11,127 | ( Ziegler, 1963; Heaton, 1985) |
| Upper Sloth Cave | 31˚87' | -104˚75' | 13,360–12,939 | ( Van Devender et al., 1975; Logan and Black, 1979; Harris, 1985) |
| Smith Creek Cave | 39˚33' | -114˚08' | 14, 004–10,472 | (Bryan, 1979; Mead et al., 1982; Mead et al., 1992) |
| Marmes Rockshelter | 46˚62' | -118˚20' | 14,170–10,191 | (Gustafson, 1972; Lyman and Livingston, 1983; Sheppard et al., 1987) |
| Danger Cave | 40˚62' | -114˚00' | 15,332–11,779 | ( Jennings, 1957; Madsen, 1980; Scott et al., 1983; Currey et al., 1984; Grayson, 1988) |
| Shelter Cave | 32˚18' | -106˚60' | 15,332–11,417 | ( Stock, 1932; Harris, 1977, 1985; Thompson et al., 1980) |
| Bell Cave | 41˚75' | -105˚37' | 16,048–11,417 | ( Zeimans and Walker, 1974; Walker, 1987) |
| Wilson Butte Cave | 42˚77' | -114˚22' | 17,474–11,341 | ( Gruhn, 1961; Crane and Griffin, 1966; Lundelius et al., 1983) |
| Haystack Cave | 38˚37' | -107˚12' | 18,140–14,008 | (Emslie, 1986) |
| Potosi Mountain Midden 2 | 36˚00' | -115˚38' | 19,625–13,854 | (Mead and Murray, 1991) |
| Connley Cave No. 4 | 43˚25' | -121˚00' | 21,286 –10,305 | (Bedwell, 1973; Grayson, 1979) |
| Site Name | Latitude | Longitude | Age Range | Reference(s) |
| Kokoweef Cave | 35˚42' | -115˚50' | 23,956–11,417 | (Goodwin and Reynolds, 1989; Reynolds et al., 1991) |
| Samwel Cave | 40˚92' | -122˚23' | 25,600–19,603 | (Harris, 1985; Feranec et al., 2007) |
| Crystal Ball Cave | 39˚00' | -113˚00' | 27,608–11,417 | (Heaton, 1985) |
| January Cave | 50˚19' | -114˚52' | 27,721-11,417 | (Burns, 1990) |
| Little Box Elder Cave | 42˚62' | -105˚62' | 28,734–10,421 | (Anderson, 1968; Indeck, 1987; Walker, 1987) |
| Hidden Cave | 39˚37' | -106˚50' | 30,041–11,417 | (Grayson, 1985; Thomas, 1985; Thompson et al., 1986) |
| Conkling Cavern | 32˚25' | -104˚50' | 30,041–11,417 | (Harris, 1977, 1985; Smartt, 1977) |
| Dark Canyon Cave | 32˚25' | -104˚50' | 20,041–24,084 | (Harris, 1977, 1985) |
| Dry Cave | 32˚37' | -104˚48' | 35,407–12,757 | (Harris, 1970, 1980, 1984, 1985, 1987) |

**Table S3.** Midden data used in our study. Analyses were restricted to only include intact indurated middens, and further limited middens to only those with an estimated mean body mass of at least 325g to ensure all populations represent *Neotoma cinerea* and not possibly other *Neotoma* species (Smith et al., 2009). Latitude (Lat.) and Longitude (Long.) of the midden locality are given. Ages designated “0” indicate modern records.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Allen Canyon | UT | 37˚47' | -109˚35' | 2195.00 | 11310.00 | 200.00 | 13,161 | 347 | -13.59 | 1.96 | (Betancourt, 1984) |
| Arco Hills | ID | 43˚39' | -113˚08' | 1926.00 | 2400.00 | 185.00 | 2,451 | 351 | 1.34 | -0.23 | (Smith and Betancourt, 2003) |
| Arco Hills | ID | 43˚39' | -113˚08' | 1926.00 | 3315.00 | 150.00 | 3,550 | 418 | 1.32 | -0.43 | (Smith and Betancourt, 2003) |
| Arco Hills | ID | 43˚39' | -113˚08' | 1926.00 | 3880.00 | 140.00 | 4,299 | 329 | 1.17 | 0.80 | (Smith and Betancourt, 2003) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 0.00 | 25.00 | 0 | 419 | N/A | N/A | (Betancourt and Davis, 1984) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 1960.00 | 120.00 | 1,907 | 455 | 0.83 | 0.17 | (Betancourt and Davis, 1984) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 2780.00 | 120.00 | 2,889 | 396 | 1.20 |  | (Betancourt and Davis, 1984) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 5550.00 | 130.00 | 6,337 | 442 | 0.88 | 0.20 | (Betancourt and Davis, 1984) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 8290.00 | 150.00 | 9,274 | 345 | 1.57 | -0.30 | (Betancourt and Davis, 1984) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 9460.00 | 160.00 | 10,732 | 479 | -2.48 | 0.43 | (Betancourt and Davis, 1984) |
| Atlatl Cave | NM | 36˚05' | -107˚59' | 1910.00 | 10080.00 | 140.00 | 11,650 | 516 | -8.71 | 7.70 | (Betancourt and Davis, 1984) |
| Beaver Creek Canyon | MT | 46˚47' | -111˚52' | 1169.23 | 192.00 | N/A | 196 | 342 | -0.27 | 0.20 | (Norris, 2006) |
| Beaver Creek Canyon | MT | 46˚47' | -111˚52' | 1169.23 | 356.00 | N/A | 419 | 394 | -0.25 | 0.11 | (Norris, 2006) |
| Beaver Creek Canyon | MT | 46˚47' | -111˚52' | 1169.23 | 1570.00 | N/A | 1,455 | 363 | 0.68 | -0.35 | (Norris, 2006) |
| Bird's Eye Canyon/Creek | WY | 43˚23' | -108˚05' | 1645.00 | 90.00 | 45.00 | 45 | 491 | N/A | N/A | This study |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 405.00 | 100.00 | 453 | 501 | -0.22 | -0.16 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 1930.00 | 80.00 | 1,872 | 504 | 0.62 | -0.29 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 3058.00 | 38.00 | 3,281 | 533 | 2.77 | 0.40 | (Mead et al., 1991) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 12420.00 | 210.00 | 14,340 | 513 | -2.91 | -1.72 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 14910.00 | 100.00 | 17,924 | 565 | -11.73 | -0.26 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 15250.00 | 100.00 | 18,492 | 597 | -12.48 | 1.31 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 16490.00 | 170.00 | 19,610 | 607 | -13.49 | 0.28 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 17910.00 | 110.00 | 21,237 | 543 | -17.75 | 0.45 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 18480.00 | 100.00 | 22,101 | 542 | -16.63 | -0.53 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 20050.00 | 160.00 | 23,948 | 560 | -21.25 | 0.24 | (Mead et al., 1991) |
| Bison Alcove | UT | 38˚44' | -109˚30' | 1317.00 | 20680.00 | 140.00 | 24,653 | 582 | -19.53 | 0.00 | (Mead et al., 1991) |
| Brokenback Canyon | WY | 44˚06' | -107˚25' | 1569.23 | 2095.00 | 75.00 | 2,067 | 357 | 1.97 | -0.30 | (Lyford et al., 2003) |
| Brokenback Canyon | WY | 44˚06' | -107˚25' | 1581.00 | 2200.00 | 60.00 | 2,212 | 381 | 1.46 | 0.60 | (Lyford et al., 2003) |
| Brokenback Canyon | WY | 44˚06' | -107˚25' | 1763.08 | 3144.00 | N/A | N/A | 347 | N/A | N/A | (Lyford et al., 2003) |
| Brokenback Canyon | WY | 44˚06' | -107˚25' | 1769.00 | 887.00 | N/A | N/A | 355 | N/A | N/A | (Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Cook's Canyon | WY | 43˚59' | -107˚14' | 1784.62 | 2695.00 | 75.00 | 2,794 | 446 | 0.95 | -0.42 | This study |
| Cook's Canyon | WY | 43˚59' | -107˚14' | 1895.38 | 4620.00 | 90.00 | 5,336 | 379 | 0.85 | 1.01 | This study |
| Cook's Canyon | WY | 43˚59' | -107˚14' | 1969.23 | 500.00 | 65.00 | 526 | 360 | -0.17 | 0.22 | This study |
| Coyote Hills | NM | N/A | N/A | N/A | 13830.00 | 165.00 | 16,114 | 332 | -13.77 | -0.47 | (Holmgren et al., 2003)  |
| CR | UT | N/A | N/A | N/A | 0.00 | N/A | 0 | 372 | N/A | N/A | This study |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2021.00 | 0.00 | 25.00 | 0 | 527 | N/A | N/A | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2029.00 | 0.00 | 25.00 | 0 | 498 | N/A | N/A | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 1495.00 | 60.00 | 1,377 | 537 | 0.11 | -0.54 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 1985.00 | 50.00 | 1,929 | 345 | 1.06 | -0.95 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 2255.00 | 50.00 | 2,279 | 409 | 1.19 | -0.63 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 2945.00 | 70.00 | 3,105 | 415 | 1.28 | -0.90 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 4650.00 | 85.00 | 5,374 | 392 | 0.46 | 0.86 | (Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.00 | 8455.00 | 75.00 | 9,471 | 440 | 1.41 | 0.30 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.77 | 4100.00 | 60.00 | 4,607 | 344 | 0.26 | 0.61 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2030.77 | 9100.00 | 70.00 | 10,247 | 329 | 0.29 | 0.77 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2049.23 | 579.00 | 40.00 | 506 | 414 | -0.16 | -0.18 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2061.54 | 2170.00 | 70.00 | 2,170 | 375 | 1.68 | 0.32 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080.00 | 1990.00 | 70.00 | 1,937 | 355 | 1.11 | -0.86 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 410.00 | 50.00 | 474 | 453 | -0.21 | -0.18 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 1630.00 | 70.00 | 1,521 | 544 | 0.92 | -0.64 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 2610.00 | 50.00 | 2,737 | 575 | 0.87 | 0.39 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 2630.00 | 60.00 | 2,747 | 504 | 0.85 | 0.29 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 10180.00 | 140.00 | 11,851 | 375 | -15.97 | 1.20 | (Lyford et al., 2003) |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 35170.00 | 710.00 | 40,494 | N/A | N/A | N/A | (Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Dutch John Mountain | UT | 40˚57' | -109˚25' | 2080 | 23120.00 | 190.00 | 27,743 | N/A | N/A | N/A | (Lyford et al., 2003) |
| Fishmouth Cave | UT | 37˚25' | -109˚38' | 1520.00 | 0.00 | 25.00 | 0 | 378 | N/A | N/A | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚38' | 1520.00 | 0.00 | 25.00 | 0 | 389 | N/A | N/A | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚38' | 1546.00 | 0.00 | 25.00 | 0 | 333 | N/A | N/A | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚39' | 1585.00 | 3550.00 | 60.00 | 3,839 | 343 | 0.74 | 0.39 | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚39' | 1585.00 | 9700.00 | 110.00 | 11,106 | 342 | -4.40 | 0.65 | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚39' | 1585.00 | 10540.00 | 300.00 | 12,392 | 380 | -16.27 | 0.62 |  (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚39' | 1585.00 | 12770.00 | 140.00 | 14,873 | 409 | -13.05 | 0.39 | (Betancourt, 1984) |
| Fishmouth Cave | UT | 37˚25' | -109˚39' | 1585.00 | 13800.00 | 320.00 | 16,098 | 480 | -13.74 | -0.47 | (Betancourt, 1984) |
| Hidden Mouth Cave | ID | 43˚57' | -113˚26' | 2255.00 | 3160.00 | 80.00 | 3,379 | 446 | 1.84 | 0.56 | (Smith and Betancourt, 2003) |
| Hidden Mouth Cave | ID | 43˚57' | -113˚26' | 2255.00 | 3555.00 | 85.00 | 3,845 | 456 | 0.74 | 0.39 | (Smith and Betancourt, 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Hidden Mouth Cave | ID | 43˚57' | -113˚26' | 2255.00 | 3985.00 | 85.00 | 4,446 | 468 | 0.36 | 0.44 | (Smith and Betancourt, 2003) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 1020.00 | 40.00 | 935 | 340 | 0.84 | -0.82 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 1200.00 | 50.00 | 1,119 | 341 | 0.28 | 0.69 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 2025.00 | 775.00 | 2,009 | 408 | 1.72 | -0.61 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 3480.00 | 40.00 | 3,745 | 336 | 1.34 | 0.35 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 8675.00 | 235.00 | 9,698 | 399 | 1.84 | -0.06 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 10255.00 | 180.00 | 11,989 | 396 | -15.23 | -1.25 | (Madsen et al., 2001) |
| Homestead Cave | UT | 41˚00' | -113˚00' | 1406.00 | 11168.00 | 208.00 | 13,027 | 438 | -9.56 | 0.48 | (Madsen et al., 2001) |
| Inyan Kara Drainage | SD | 44˚49' | -104˚79' | 1280.00 | 153.00 | 36 | 145 | 376 | -0.08 | 0.45 | (Norris et al., 2016) |
| Twin Creek | WY | 42˚40' | -108˚30' | 1876.92 | 380.00 | 80.00 | 436 | 342 | -0.23 | -0.14 | (Lyford et al., 2003) |
| Twin Creek | WY | 42˚40' | -108˚30' | 1886.15 | 100.00 | 0.50 | 150 | 432 | -0.10 | 0.44 | (Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Twin Creek | WY | 42˚40' | -108˚30' | 1907.69 | 99.30 | 0.74 | 169 | 413 | -0.17 | 0.44 | (Lyford et al., 2003) |
| Twin Creek | WY | 42˚40' | -108˚30' | 1907.69 | 1930.00 | 50.00 | 1,873 | 449 | 0.65 | -0.39 | (Lyford et al., 2003) |
| Little Belt Mountains | MT | 46˚51' | -110˚18' | 1575.38 | 377.00 | N/A | 438 | 339 | -0.23 | -0.14 | (Norris et al., 2016) |
| Little Belt Mountains | MT | 46˚33' | -110˚27' | 1600.00 | 368.00 | N/A | 430 | 380 | -0.24 | -0.14 | (Norris et al., 2016) |
| Lower Canyon Creek | WY | 44˚02' | -107˚20' | 1581.00 | 1280.00 | 50.00 | 1,222 | 361 | -0.35 | -0.28 | (Lyford et al., 2003) |
| Lower Canyon Creek | WY | 44˚02' | -107˚20' | 1581.00 | 1740.00 | 50.00 | 1,650 | 385 | 1.00 | 0.59 | (Lyford et al., 2003) |
| Lower Canyon Creek | WY | 44˚02' | -107˚20' | 1581.00 | 1880.00 | 45.00 | 1,822 | 384 | 0.66 | 0.29 | (Lyford et al., 2003) |
| Lower Canyon Creek | WY | 44˚02' | -107˚20' | 1593.00 | 1635.00 | 70.00 | 1,527 | 377 | 0.96 | -0.56 | (Lyford et al., 2003) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 1690.00 | 50.00 | 1,588 | 381 | 0.98 | -0.40 | (Smith and Betancourt, 1998) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 3110.00 | 60.00 | 3,334 | 346 | 2.31 | 1.16 | (Smith and Betancourt, 1998) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 10020.00 | 70.00 | 11,502 | 426 | -5.12 | -2.16 | (Smith and Betancourt, 1998) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 12090.00 | 100.00 | 13,887 | 424 | -7.56 | 0.24 | (Smith and Betancourt, 1998) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 15540.00 | 180.00 | 18,750 | 414 | -11.89 | -0.60 | (Smith and Betancourt, 1998) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 16460.00 | 100.00 | 19,574 | 487 | -13.80 | -0.25 | (Smith and Betancourt, 1998) |
| Lyman Lake | AZ | 34˚50' | -109˚50' | 1880.00 | 16480.00 | 90.00 | 19,594 | 466 | -13.48 | -0.25 | (Smith and Betancourt, 1998) |
| Medicine Lodge Canyon | WY | 44˚19' | -107˚32' | 1640.00 | 4810.00 | 90.00 | 5,549 | 349 | 1.23 | -0.87 | (Lyford et al., 2003) |
| Miller Creek | WY | 44˚50' | -104˚70' | 1213 | 795.00 | 32.00 | 709 | 382 | -0.10 | 0.34 | (Norris et al., 2016) |
| Perry Park Golf Course | CO | 39˚26' | -104˚99' | 2011.00 | 210.00 | 50.00 | 230 | 451 | -0.31 | 0.11 | This study |
| Perry Park Golf Course | CO | 39˚26' | -104˚99' | 2011.00 | 1420.00 | 60.00 | 1,320 | 467 | -0.02 | -0.47 | This study |
| Pictograph Cave | ID | 43˚41' | -113˚20' | 1900.00 | 3970.00 | 85.00 | 4,427 | 394 | 0.45 | 0.47 | (Smith and Betancourt, 2003) |
| Pictograph Cave | ID | 43˚41' | -113˚20' | 1900.00 | 4050.00 | 140.00 | 4,539 | 369 | 0.49 | -0.46 | (Smith and Betancourt, 2003) |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1490.00 | 1785.00 | 80.00 | 1,706 | 419 | 0.77 | 0.52 | (Lyford et al., 2003) |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1490.00 | 3190.00 | 80.00 | 3,409 | 389 | 1.70 | 0.44 | (Lyford et al., 2003) |
| Pryor Mountains | MT | 45˚07' | -108˚38' | 1500.00 | 490.00 | 70.00 | 521 | 335 | -0.16 | 0.20 | (Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1518.00 | 1660.00 | 50.00 | 1,510 | 345 | 0.88 | -0.71 | (Lyford et al., 2003) |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1518.00 | 3285.00 | 75.00 | 3,507 | 357 | 1.29 | 0.30 | (Lyford et al., 2003) |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1524.00 | 1160.00 | 70.00 | 1,071 | 403 | 0.60 | 0.43 | (Lyford et al., 2003) |
| Pryor Mountains | MT | 44˚08' | -108˚38' | 1554.00 | 2370.00 | 75.00 | 2,393 | 458 | 1.42 | 0.41 | (Lyford et al., 2003) |
| Redbird Canyon | SD | 43˚79' | -104˚02' | 1470.77 | 344.00 | 68.00 | 396 | 439 | N/A | N/A | (Norris et al., 2016) |
| Redbird Canyon | SD | 43˚79' | -104˚02' | 1492.31 | 1090.00 | 38.00 | 999 | 419 | N/A | N/A | (Norris et al., 2016) |
| Redbird Canyon | SD | 43˚79' | -104˚02' | 1520.00 | 196.00 | 68.00 | 179 | 515 | N/A | N/A | (Norris et al., 2016) |
| Redbird Canyon | SD | 43˚81' | -104˚00' | 1560.00 | 0.00 | N/A | 0 | 374 | N/A | N/A | (Norris et al., 2016) |
| Redbird Canyon | SD | 43˚81' | -104˚00' | 1560.00 | 2580.00 | 38.00 | 2,725 | 520 | N/A | N/A | (Norris et al., 2016) |
| Redbird Canyon | SD | 43˚81' | -104˚00' | 1560.00 | 3554.00 | 37.00 | 3,849 | 482 | N/A | N/A | (Norris et al., 2016) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 455.00 | 70.00 | 500 | 366 | -0.17 | -0.21 | (Smith and Betancourt, 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 645.00 | 65.00 | 621 | 434 | -0.15 | -0.31 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 795.00 | 65.00 | 713 | 362 | -0.09 | 0.34 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 1950.00 | 75.00 | 1,894 | 332 | 0.77 | -0.76 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 2100.00 | 85.00 | 2,075 | 381 | 1.98 | -0.30 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 2770.00 | 75.00 | 2,864 | 374 | 1.19 | -0.20 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 3180.00 | 80.00 | 3,399 | 435 | 1.76 | 0.45 | (Smith and Betancourt, 2003) |
| Rocky Canyon | ID | 43˚40' | -113˚20' | 1798.00 | 3925.00 | 85.00 | 4,367 | 362 | 0.76 | 0.34 | (Smith and Betancourt, 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1274.00 | 460.00 | 65.00 | 504 | 376 | -0.16 | -0.18 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1274.00 | 915.00 | 65.00 | 830 | 330 | 0.37 | -0.08 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1274.00 | 1880.00 | 70.00 | 1,819 | 338 | 0.67 | 0.29 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1274.00 | 2860.00 | 75.00 | 2,976 | 447 | 1.11 | 0.14 | (Lyford et al., 2002; Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1274.00 | 3285.00 | 90.00 | 3,509 | 348 | 1.30 | -0.30 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1311.00 | 1795.00 | 70.00 | 1,718 | 375 | 0.73 | 0.45 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1311.00 | 3340.00 | 75.00 | 3,571 | 344 | 1.45 | -0.78 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1372.00 | 1515.00 | 70.00 | 1,398 | 371 | 0.25 | -0.27 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1372.00 | 9740.00 | 90.00 | 11,162 | 331 | -4.21 | -1.00 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1402.00 | 1160.00 | 65.00 | 1,070 | 403 | 0.60 | 0.43 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1402.00 | 1570.00 | 70.00 | 1,454 | 384 | 0.68 | -0.35 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1402.00 | 4440.00 | 90.00 | 5,057 | 334 | 1.52 | 0.49 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1524.00 | 1415.00 | 65.00 | 1,317 | 360 | -0.02 | -0.47 | (Lyford et al., 2002; Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1582.00 | 3180.00 | 60.00 | 3,398 | 368 | 1.76 | 0.45 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1582.00 | 3210.00 | 80.00 | 3,428 | 390 | 1.64 | 0.37 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | 1591.00 | 2665.00 | 75.00 | 2,771 | 343 | 0.87 | -0.34 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | N/A | 450.00 | 50.00 | 501 | 435 | -0.17 | -0.21 | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | N/A | 26720.00 | 250.00 | 32,007 | N/A | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Southern Bighorn Mountains | MT | 45˚02' | -108˚15' | N/A | 27050.00 | 4290.00 | 32,082 | N/A | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| T Hill | WY | 43˚39' | -108˚12' | 1440.00 | 18190.00 | 710.00 | 21,629 | 430 | -18.16 | -1.23 | This study |
| T Hill | WY | 43˚39' | -108˚12' | 1440.00 | 18300.00 | 690.00 | 21,767 | 388 | -16.86 | -0.90 | This study |
| Ten Sleep Canyon | WY | 44˚03' | -107˚30' | 1957.00 | 1145.00 |  | 1,054 | 431 | 0.70 | 0.53 | (Lyford et al., 2003) |
| Titus Canyon | CA | 36˚49' | -117˚08' | 582.00 | 2427.00 | 37.00 | 2,523 | 334 | 1.20 | 0.50 | (Smith et al., 2009) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Titus Canyon | CA | 36˚49' | -117˚08' | 582.00 | 10720.00 | 66.00 | 12,697 | 357 | -18.10 | -0.58 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚50' | -114˚04' | 1015.00 | 3781.00 | 42.00 | 4,150 | 420 | 1.34 | 0.18 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚50' | -117˚04' | 1030.00 | 14085.00 | 40.00 | 16,459 | 421 | -14.74 | 0.00 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚50' | -117˚04' | 1030.00 | 14013.00 | 76.00 | 17,261 | 407 | -13.43 | -0.80 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚50' | -117˚04' | 1030.00 | 16768.00 | 96.00 | 19,991 | 529 | -13.90 | -0.61 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1114.00 | 19760.00 | 80.00 | 23,612 | 327 | -18.67 | 4.08 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1154.00 | 7987.00 | 47.00 | 8,861 | 397 | 2.14 | -0.48 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1154.00 | 13273.00 | 73.00 | 15,456 | 342 | -13.70 | -0.16 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1190.00 | 11406.00 | 60.00 | 13,255 | 483 | -13.31 | -2.36 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 1310.00 | 15.00 | 1,265 | 325 | -0.16 | -0.43 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 16340.00 | 50.00 | 19,457 | 404 | -13.51 | -0.35 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 17740.00 | 100.00 | 21,004 | 446 | -16.71 | -0.06 | (Smith et al., 2009) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 17660.00 | 120.00 | 22,018 | 590 | -17.21 | -0.44 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 20020.00 | 120.00 | 23,919 | 503 | -21.17 | -0.08 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1200.00 | 20710.00 | 160.00 | 24,701 | 355 | -19.20 | -0.67 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1220.00 | 3433.00 | 37.00 | 3,713 | 390 | 1.41 | 0.37 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1220.00 | 4116.00 | 39.00 | 4,677 | 371 | 0.10 | 0.37 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1249.00 | 24340.00 | 200.00 | 29,116 | 471 | N/A | 0.00 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1249.00 | 26080.00 | 230.00 | 31,318 | 549 | N/A | 0.00 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1249.00 | 28070.00 | 210.00 | 33,439 | 464 | N/A | 0.00 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1249.00 | 28120.00 | 210.00 | 33,491 | 420 | N/A | 0.00 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚04' | 1249.00 | 24340.00 | 200.00 | 29,116 | 471 | N/A | N/A | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1250.00 | 15056.00 | 84.00 | 18,274 | 470 | -12.51 | 0.49 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1250.00 | 15331.00 | 84.00 | 18,413 | 456 | -12.39 | 0.00 | (Smith et al., 2009) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Titus Canyon | CA | 36˚51' | -117˚03' | 1250.00 | 15295.00 | 45.00 | 18,544 | 430 | -13.28 | 0.30 | (Smith et al., 2009) |
| Titus Canyon | CA | 36˚5' | -117˚03' | 1345.00 | 21690.00 | 100.00 | 26,100 | 512 | N/A | N/A | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚50' | -117˚03' | 1345.00 | 19400.00 | 120.00 | 23,092 | 532 | -16.91 | 1.69 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚50' | -117˚03' | 1345.00 | 21690.00 | 100.00 | 26,100 | 512 | N/A | 0.00 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚50' | -117˚02' | 1400.00 | 10065.00 | 25.00 | 11,618 | 372 | -6.96 | 5.38 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚49' | -117˚00' | 1559.00 | 8642.00 | 65.00 | 9,628 | 380 | 1.36 | 1.69 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚49' | -117˚00' | 1559.00 | 8749.00 | 49.00 | 9,751 | 378 | 1.77 | 0.25 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚49' | -117˚00' | 1576.00 | 7976.00 | 47.00 | 8,849 | 392 | 2.04 | -0.48 | (Smith et al., 2009) |
| Upper Titus Canyon | CA | 36˚49' | -117˚00' | 1576.00 | 8543.00 | 49.00 | 9,522 | 398 | 1.17 | 0.33 | (Smith et al., 2009) |
| Western Bighorn Mountains | WY | 44˚20' | -107˚43' | 1787.69 | 989.00 | N/A | 909 | 338 | 0.64 | -0.88 | (Norris et al., 2016) |
| Western Bighorn Mountains | WY | 44˚19' | -104˚44' | 1840.00 | 972.00 | N/A | 894 | 326 | 0.50 | -0.55 | (Norris et al., 2016) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Western Bighorn Mountains | WY | 44˚22' | -107˚33' | 1855.38 | 1700.00 | 50.00 | 1,600 | 482 | 1.02 | -0.40 | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚22' | -107˚33' | 1883.08 | 4630.00 | 90.00 | 5,348 | 333 | 0.67 | 1.00 | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚22' | -107˚33' | 1892.00 | 225.00 | 40.00 | 253 | 400 | -0.30 | -0.09 | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚22' | -107˚33' | 1892.00 | 1100.00 | 40.00 | 997 | 420 | 1.01 | 0.62 | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚15' | -107˚37' | 2129.23 | 1997.00 | N/A | N/A | 362 | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚18' | -107˚36' | 2153.85 | 1072.00 | N/A | N/A | 374 | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚18' | -107˚36' | 2154.00 | 921.00 | N/A | N/A | 430 | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚18' | -107˚36' | 2154.00 | 1121.00 | N/A | N/A | 367 | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Western Bighorn Mountains | WY | 44˚18' | -107˚36' | 2209.23 | 2401.00 | N/A | N/A | 384 | N/A | N/A | (Lyford et al., 2002; Lyford et al., 2003) |
| Locality | State | Lat. | Long. | Elev. (m) | 14C | 14C SD | Age1 | Mass est. (g) | Est. Temp. (˚C) | Max. Temp. Shift (˚C) | Collected / Measured By |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1367.00 | 2750.00 | 75.00 | 2,843 | 407 | 1.16 | -0.33 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1416.00 | 2710.00 | 80.00 | 2,807 | 461 | 1.03 | -0.49 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1416.00 | 3430.00 | 80.00 | 3,682 | 409 | 1.50 | 0.58 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1416.00 | 3590.00 | 60.00 | 3,890 | 344 | 0.60 | 0.18 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1421.00 | 1970.00 | 75.00 | 1,915 | 427 | 0.92 | -0.89 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1431.00 | 3260.00 | 80.00 | 3,480 | 415 | 1.42 | 0.47 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1431.00 | 3590.00 | 80.00 | 3,890 | 372 | 0.60 | 0.18 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12' | 1455.00 | 375.00 | 45.00 | 442 | 480 | -0.23 | -0.14 | (Jackson et al., 2002; Lyford et al., 2003) |
| Wind River Canyon | WY | 43˚34' | -108˚12'' | 1455.00 | 767.00 | 43.00 | 691 | 460 | -0.06 | 0.31 | (Jackson et al., 2002; Lyford et al., 2003) |

1 Age is in calendar years

**Table S4.** Comparison of different radio-carbon calibration methods on Q1 (Were populations able to cope equally well, as demonstrated by presence, during warmer or cooler temperatures and warming or cooling events over the late Quaternary?) and Q2 (Did the ability of populations to remain extant (persist) vary with position within their modern geographic range?). Bold text indicates a difference between the two methods: Fairbanks (Fairbanks et al., 2005) and IntCal (Reimer et al., 2013).

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Temperature Anomaly | Temperature Shift |
|  |  | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| Locality | Window (ka) | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal |
| All | 25–0 | <0.001 | <0.001 | <0.001 | <0.001 | 0.39 | 0.74 | 0.84 | 0.64 |
|  | 5–0 | 0.80 | 1.00 | 0.37 | 0.96 | 0.96 | 0.76 | 0.68 | 0.93 |
|  | 6–1 | 0.63 | 0.79 | 0.36 | 0.64 | 0.77 | 0.76 | 0.60 | 0.99 |
|  | 7–2 | 1.00 | 0.93 | 0.99 | 0.74 | 0.20 | 0.22 | 0.07 | 0.33 |
|  | 8–3 | 0.95 | 0.98 | 0.43 | 0.78 | **0.04** | **0.10** | **0.01** | **0.22** |
|  | 9–4 | 0.28 | 0.74 | 0.08 | 0.33 | 0.20 | 0.67 | 0.07 | 0.25 |
|  | 10–5 | 0.98 | 0.91 | .92- | 0.42 | 0.82 | 0.28 | 0.55 | 0.06 |
|  | 11–6 | 0.88 | 0.97 | 0.53 | 0.83 | 1.00 | 0.98 | **0.76** | **0.02** |
|  | 12–7 | 0.31 | 0.68 | 0.37 | 0.49 | 0.84 | 0.06 | **0.79** | **0.02** |
|  | 13–8 | 0.97 | 0.90 | 0.88 | 0.72 | 0.95 | 0.26 | 0.90 | 0.10 |
|  | 14–9 | 1.00 | 0.66 | 0.79 | 0.48 | 1.00 | 0.45 | 0.83 | 0.24 |
|  | 15–10 | 0.96 | 0.92 | 0.60 | 0.55 | 0.99 | 0.65 | 0.86 | 0.40 |
|  | 16–11 | 0.99 | 0.28 | 0.79 | 0.19 | 0.95 | 0.77 | 0.81 | 0.47 |
|  |  | Temperature Anomaly | Temperature Shift |  |
|  |  | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| Locality | Window (ka) | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal |
|  | 17–12 | 0.79 | 0.43 | 0.97 | 0.28 | 0.95 | 0.71 | 0.91 | 0.62 |
|  | 18–13 | 0.55 | 0.91 | 0.80 | 0.74 | 0.65 | 0.71 | 0.66 | 0.73 |
|  | 19–14 | 0.47 | 0.12 | 0.53 | 0.17 | 0.98 | 0.25 | 0.98 | 0.40 |
|  | 20–15 | 0.17 | 0.64 | 45 | 0.44 | 0.94 | 0.61 | 0.78 | 0.50 |
|  | 21–16 | 0.08 | 0.90 | <0.001 | <0.001 | 0.48 | 1.00 | 0.73 | 0.71 |
|  | 22–17 | 0.66 | 0.67 | 0.60 | 0.55 | 0.64 | 0.81 | 0.36 | 0.55 |
|  | 23–18 | 0.69 | 0.19 | 0.66 | 0.21 | 0.76 | 0.78 | 0.37 | 0.67 |
|  | 24–19 | 0.71 | 0.75 | 0.35 | 0.90 | 0.52 | 0.50 | 0.34 | 0.43 |
|  | 25–20 | 0.21 | 0.56 | 0.10 | 0.35 | 0.72 | 0.68 | 0.62 | 0.83 |
| Northern | 25–0 | <0.001 | <0.001 | 0.001 | <0.001 | 0.32 | 0.76 | 0.66 | 0.52 |
|  | 5–0 | 0.33 | 0.95 | 0.13 | 0.93 | 0.99 | 0.96 | 0.95 | 0.64 |
|  | 6–1 | 0.71 | 0.92 | 0.49 | 0.90 | 0.88 | 0.99 | 0.90 | 0.79 |
|  | 7–2 | 0.53 | 0.23 | 0.28 | 0.08 | 0.84 | 1.00 | 0.56 | 0.91 |
|  | 8–3 | 0.16 | 0.04 | **0.20** | **0.04** | 0.46 | 0.99 | 0.33 | 0.71 |
|  | 9–4 | 0.63 | 0.78 | 0.52 | 0.71 | 0.41 | 0.85 | 0.19 | 0.68 |
|  | 10–5 | 0.78 | 1.00 | 0.71 | 1.00 | 0.41 | 0.79 | 0.19 | 0.59 |
|  | 11–6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 12–7 | 0.31 | 0.35 | 0.23 | 0.26 | 0.43 | 0.56 | 0.21 | 0.32 |
|  | 13–8 | 0.71 | 0.75 | 0.61 | 0.66 | 0.46 | 0.59 | 0.23 | 0.36 |
|  |  | Temperature Anomaly | Temperature Shift |
|  |  | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| Locality | Window (ka) | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal |
| All | 14–9 | 0.94 | 0.90 | 0.92 | 0.87 | 0.56 | 0.62 | 0.32 | 0.40 |
|  | 15–10 | 0.67 | 0.63 | 0.56 | 0.52 | 0.55 | 0.67 | 0.43 | 0.56 |
|  | 16–11 | 0.27 | 0.24 | 0.21 | 0.19 | 0.69 | 0.76 | 0.48 | 0.56 |
|  | 17–12 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 18–13 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 19–14 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 20–15 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 21–16 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 22–17 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 23–18 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 24–19 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 25–20 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Central | 25–0 | <0.001 | <0.001 | 0.002 | <0.001 | 0.94 | 0.80 | 0.59 | 0.50 |
|  | 5–0 | 0.89 | 0.42 | 0.90 | 0.84 | 0.41 | 0.98 | 0.22 | 0.55 |
|  | 6–1 | 0.85 | 0.08 | 0.45 | 0.21 | 0.57 | 0.99 | 0.46 | 0.74 |
|  | 7–2 | 0.99 | 0.11 | 0.62 | 0.33 | 0.95 | 0.92 | 0.88 | 0.54 |
|  | 8–3 | 0.37 | 0.16 | 0.16 | 0.35 | 0.84 | 0.47 | 0.57 | 0.61 |
|  | 9–4 | 0.05 | 0.38 | 0.07 | 0.48 | 0.15 | 0.96 | 0.07 | 0.80 |
|  | 10–5 | 0.98 | 0.99 | 0.83 | 0.99 | 0.59 | 0.11 | 0.21 | 0.08 |
|  |  | Temperature Anomaly | Temperature Shift |
|  |  | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| Locality | Window (ka) | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal |
|  | 11–6 | 0.99 | 0.95 | 0.89 | 0.92 | 0.81 | 0.08 | 0.33 | 0.05 |
|  | 12–7 | 0.60 | 0.99 | 0.41 | 0.98 | 0.99 | 0.09 | 0.78 | 0.11 |
|  | 13–8 | 0.98 | 0.38 | 0.95 | 0.31 | 0.99 | 0.12 | 0.78 | 0.15 |
|  | 14–9 | 0.86 | 0.14 | 0.77 | 0.15 | **1.00** | **0.05** | 0.91 | 0.09 |
|  | 15–10 | 0.81 | 0.25 | 0.60 | 0.36 | 0.98 | 0.17 | 0.95 | 0.23 |
|  | 16–11 | 0.62 | 0.46 | 0.32 | 0.22 | 0.93 | 0.79 | 0.88 | 0.59 |
|  | 17–12 | **0.51** | **N/A** | **0.40** | **N/A** | **0.90** | **N/A** | **0.81** | **N/A** |
|  | 18–13 | **0.51** | **N/A** | **0.40** | **N/A** | **0.87** | **N/A** | **0.76** | **N/A** |
|  | 19–14 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 20–15 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 21–16 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 22–17 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 23–18 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 24–19 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
|  | 25–20 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Southern | 25–0 | 0.95 | 0.43 | 0.94 | 0.33 | 0.43 | 0.50 | 0.95 | 0.27 |
|  | 5–0 | 0.83 | 0.11 | 0.72 | 0.23 | 0.93 | 0.97 | 0.66 | 0.63 |
|  | 6–1 | 0.80 | 0.54 | 0.54 | 0.80 | 0.79 | 0.82 | 0.55 | 0.55 |
|  | 7–2 | 0.64 | 0.75 | 0.63 | 0.73 | 0.79 | 0.75 | 0.09 | 0.63 |
|  |  | Temperature Anomaly | Temperature Shift |
|  |  | KS Test | Wilcoxon Signed-Rank Test | KS Test | Wilcoxon Signed-Rank Test |
| Locality | Window (ka) | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal | Fairbanks | IntCal |
|  | 8–3 | 0.65 | 0.67 | 0.47 | 0.23 | **0.05** | **0.72** | **0.01** | **0.24** |
|  | 9–4 | 0.92 | 0.41 | 0.76 | 0.11 | 0.20 | 0.56 | 0.07 | 0.32 |
|  | 10–5 | 0.90 | 0.82 | 0.42 | 0.28 | 0.82 | 0.34 | 0.55 | 0.14 |
|  | 11–6 | 0.91 | 0.97 | 0.51 | 0.72 | 1.00 | 0.42 | 0.76 | 0.08 |
|  | 12–7 | 0.95 | 0.88 | 0.67 | 0.98 | 0.98 | 0.31 | 0.95 | 0.07 |
|  | 13–8 | 0.53 | 0.68 | 0.28 | 0.59 | 1.00 | 0.42 | 0.86 | 0.22 |
|  | 14–9 | 0.66 | 0.74 | 0.39 | 0.56 | 1.00 | 0.86 | 0.61 | 0.38 |
|  | 15–10 | 0.98 | 0.48 | 0.58 | 0.76 | 0.99 | 0.35 | 0.59 | 0.,44 |
|  | 16–11 | 0.98 | 0.10 | 0.63 | 0.40 | 0.89 | 0.40 | 0.59 | 0.50 |
|  | 17–12 | 0.41 | 0.25 | 0.30 | 0.45 | 1.00 | 0.40 | 0.87 | 0.43 |
|  | 18–13 | 0.23 | 0.78 | 0.37 | 0.88 | 0.82 | 0.82 | 0.55 | 0.89 |
|  | 19–14 | 0.64 | 0.70 | 0.80 | 0.49 | 0.96 | 0.65 | 0.85 | 0.58 |
|  | 20–15 | 0.76 | 0.70 | 0.92 | 0.69 | 1.00 | 0.96 | 0.84 | 0.66 |
|  | 21–16 | 0.65 | 0.89 | 0.02 | 0.01 | 0.87 | 0.92 | 0.91 | 0.55 |
|  | 22–17 | 0.57 | 0.76 | 0.51 | 0.96 | 0.88 | 0.40 | 0.60 | 0.35 |
|  | 23–18 | 0.66 | 0.52 | 0.47 | 0.57 | 0.95 | 0.64 | 0.64 | 0.78 |
|  | 24–19 | 0.66 | 0.54 | 0.33 | 0.63 | 0.85 | 0.69 | 0.55 | 0.75 |
|  | 25–20 | 0.34 | 0.92 | 0.25 | 0.99 | 0.72 | 0.87 | 0.62 | 0.75 |

**References:**

Anderson, E., 1968. Fauna of the Little Box Elder Cave, Converse County, Wyoming: the Carnivora. University of Colorado Studies Series in Earth Science 6.

Bedwell, S.F., 1973. Fort Rock basin. University of Oregon Books, Eugene.

Betancourt, J.L., 1984. Late Quaternary plant zonation and climate in southeastern Utah. Great Basin Naturalist 44 1-35.

Betancourt, J.L., Davis, O.K., 1984. Packrat middens from Canyon de Chelly, northeastern Arizona: paleoecological and archaeological implications. Quaternary Research 21, 56-64.

Bryan, A.L., 1979. Smith Creek Cave. In: Tuohy, D.R., Rendall, D.L. (Eds.), The archaeology of Smith Creek Canyon, eastern Nevada. Nevada State Museum Anthropological Papers, pp. 164-251.

Burns, J.A., 1990. Mid-Wisconsinan vertebrates and tehir environment from January Cave, Alberta, Canada. Quaternary Research 35, 130-143.

Crane, H.R., Griffin, J.B., 1966. University of Michigan radiocarbon dates XI. Radiocarbon 8, 256-285.

Currey, D.R., Atwood, G., Mabey, D.R., 1984. Major levels of Great Salt Lake and Lake Bonneville, 73 ed. Utah Geological and Mineral Survey Map.

Emslie, S., 1986. Late Pleistocene vertebrates from Gunnison County, Colorado. Journal of Paleontology 60, 170-176.

Fairbanks, R.G., Mortlock, R.A., Chiu, T.-C., Cao, L., Kaplan, A., Guilderson, T.P., Fairbanks, T.W., Bloom, A.L., Grootes, P.M., Nadeau, M.-J., 2005. Radiocarbon calibration curve spanning 0 to 50,000 years BP based on paired 230Th/ 234U/ 238U and 14C dates on pristine corals. Quaternary Sceince Reviews 24, 1781-1796.

Feranec, R.S., Hadly, E.A., Blois, J.L., Barnosky, A.D., Paytan, A., 2007. Radiocarbon dates from the Pleistocene fossil deposits of Samwel Cave, Shasta County, California, USA. Radiocarbon 49, 117-121.

Goodwin, H.T., Reynolds, R.E., 1989. Late Quaternary Sciuridae from Kokoweef Cave, San Bernardino County, California. Bulletin of the Southern California Academy of Sciences 88, 21-32.

Grayson, D.K., 1979. Mount Mazama, climatic change, and Fort Rock Basin archaeofaunas,. In: Sheets, R.D., Grayson, D.K. (Eds.), Volcanic activity and human ecology. Academic Press, New York.

Grayson, D.K., 1985. The paleontology of Hidden Cave: birds and mammals. In: Thomas, D.H. (Ed.), The archaeology of Hidden Cave, Nevada. Anthropological Papers of the American Museum of Natural History, pp. 125-161.

Grayson, D.K., 1988. Danger Cave, Last Supper Cave, and Hanging Rock Shelter: the faunas. Anthropological Papers of the American Museum of Natural History 66.

Gruhn, R., 1961. The archeology of Wilson Butte Cave, south-central Idaho. Idaho State College Museum, Occasional Papers 6.

Gustafson, C.E., 1972. Faunal remains from the Marmes Rockshelter and related archaeological sites in the Columbia Basin. Washington State University, Pullman.

Harris, A.H., 1970. The Dry Cave mammalian fauna and late pluvial conditions in southeastern New Mexico. Texas Journal of Science 22, 3-27.

Harris, A.H., 1977. Wisconsin age environments in the norther Chihuahuan desert evidence from the higher vertebrates. In: Wauer, R.H., Riskind, D.H. (Eds.), Transactions of the symposium on the biological resources of the Chihuahuan Desert Region, United States and Mexico. National Park Service and Transactiosn and Proceedings Series, pp. 23-52.

Harris, A.H., 1980. Two new species of late Pleistocene woodrats (Cricetidae: Neotoma) from New Mexico. Journal of Mammalogy 65, 560-566.

Harris, A.H., 1984. Two new species of late Pleistocene woodrats (cricetidae: Neotoma) from New Mexico. Journal of Mammalogy 65, 560-566.

Harris, A.H., 1985. Late Pleistocene vertebrate paleoecology of the west. University of Texas Press, Austin, TX.

Harris, A.H., 1987. Reconstruction of Mid-Wisconsin environments in southern New Mexico. National Geographic Research 3, 142-151.

Heaton, T.H., 1985. Quaternary paleontology and paleoecology of Crystal Ball Cave, Millard County, Utah: with emphasis on the mammals and the description of a new species of fossil skunk. Great Basin Naturalist 45, 337-390.

Holmgren, C.A., Peñalba, M.C., Rylander, K.A., Betancourt, J.L., 2003. A 16,000 14C yr B.P. packrat midden seires from the USA-Mexico Borderlands. Quaternary Research 60, 319-329.

Indeck, J., 1987. Sediment analysis and mammal faunal remains from Little Box Elder Cave, Wyoming. University of Colorado, Boulder.

Jackson, S.T., Lyford, M.E., Betancourt, J.L., 2002. A 4000-year record of woodland vegetation from Wind River Canyon, central Wyoming. Western North American Naturalist 62, 405-413.

Jennings, J.D., 1957. Danger Cave. University of Utah, Departments of Anthropology, Anthrological Papers.

Logan, L.E., Black, C.C., 1979. The Quaternary vertebrate fauna of Upper Sloth Cave, Guadalupe Mountains National Park, Texas. In: Genoways, H.H., Baker, R.J. (Eds.), Biological investigations in the Guadalupe Mountains National Park, Texas. National Park Service, Proceedings and Transactiosn Series, pp. 141-158.

Lundelius, E.L., Jr., Graham, R.W., Anderson, E., Guilday, J., Holman, J.A., Steadman, D.W., Webb, S.D., 1983. Terrestrial vertebrate faunas. In: Porter, S.C. (Ed.), Late Quaternary envrionments of the United States. University of Minnesota Press, Minneapolis, Minnesota, USA.

Lyford, M.E., Betancourt, J.L., Jackson, S.T., 2002. Holocene vegetation and climate history of the northern Bighorn Basin, southern Motana. Quaternary Research 58, 171-181.

Lyford, M.E., Jackson, S.T., Betancourt, J.L., Gray, S.T., 2003. Influence of landscape structure and climate variability on late Holocene plant migration. Ecological Monographs 75, 567-583.

Lyman, R.L., Livingston, S.D., 1983. Late Quaternary mammalian zoogeography of eastern Washington. Quaternary Research 20, 360-373.

Madsen, D.B., 1980. The human prehistory of the Great Salt Lake Region. In: Gwynn, J.W. (Ed.), Great Salt Lake: a scientific, historical, and economic overview. Utah Geological and Mineral Survey Bulletin.

Madsen, D.B., Rhode, D., Grayson, D.K., Broughton, J.M., Livingston, S.D., Hunt, J., Quade, J., Schmitt, D.N., III, M.W.S., 2001. Late Quaternary environmental change in the Bonneville basin, western USA. Palaeogeography, Palaeoclimatology, Palaeoecology 167, 243-271.

Mead, J.I., Bell, C.J., Murray, L.K., 1992. *Mictomys borealis* (northern bog lemming) and the Wisconsin paleoecology of the east-central Great Basin. Quaternary Research 37, 229-238.

Mead, J.I., Murray, L.K., 1991. Late Pleistocene vertebrates from the Potosi Mountain Packrate Midden, Spring Range, Neveada. In: Reynolds, R.E. (Ed.), Crossing the borders: Quaternary studies in eastern California and southwestern Nevada. San Bernardino County Museum Association, Special Publication Redlands, pp. 1124-1126.

Mead, J.I., Sharpe, S.E., Agenbroad, L.D., 1991. Holocene bison from Arches National Park, southeastern Utah. Great Basin Naturalist 51, 336-342.

Mead, J.I., Thompson, R.S., Van Devender, T.R., 1982. Late Wisconsinan and Holocene fauna from Smith Creek Canyon, Snake River Range, Nevada. Transactions of the San Diego Society of Natural History 20, 1-26.

Norris, J.R., 2006. Influence of climate on the modern and late Holocene biogeography of ponderosa pine in the Central Rockies, Department of Botany. Universtiy of Wyoming, Laramie, Wyoming, pp. 1-122.

Norris, J.R., Betancourt, J.L., Jackson, S.T., 2016. Late Holocene expansion of ponderosa pine (*Pinus podersoa*) in the Central Rocky Mountains, USA. Journal of Biogeography 43, 778-790.

Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Brong Ramsey, C., Buck C.E., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hafidason, H., Hajdas, I., Hatté, C., Heaton, T.J., Hoffman, D.L., Hogg, A.G., Hughen, K.A., Kaiser, K.R., Kromer, B., Manning, S.W., Niu, M., Reimer R.W., Richards, D.A., Scott, E.M., Southon, J.R., Staff, R.A., Turney, C.S.M., van der Plicht, J. 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4), 1869-1887.

Reynolds, R.E., Reynolds, R.E., Bell, C.J., Czaplewski, N.J., Goodwin, H.T., Mead, J.I., Roth, B., 1991. The Kokoweef Cave faunal assemblage. In: Reynolds, R.E. (Ed.), Crossing the borders: Quaternary studies in eastern California and southwestern Nevada, San Bernardino County Museum Association, Redlands, pp. 97-103.

Scott, W.E., McCoy, W.D., Shroba, R.R., Rubin, M., 1983. Reinterpretation of the exposed record of the last two cycles of Lake Bonneville, western United States. Quaternary Research 20, 261-285.

Sheppard, J.C., Wigand, P.E., Gustafson, C.E., Rubin, M., 1987. A reevaluation of the Marmes Rockshelter radiocarbon chronology. American Antiquity 52, 118-125.

Smartt, R.A., 1977. The ecology of late Pleistocene and recent Microtus from south-central and southwestern New Mexico. Southwestern Naturalist 22, 1-19.

Smith, F.A., Betancourt, J.L., 1998. Response of bushy-tailed woodrats (*Neotoma cinerea*) to late Quaternary climatic change in teh Colorado Plateau. Quaternary Research 50.

Smith, F.A., Betancourt, J.L., 2003. The effect of Holocene temperature fluctuations on the evolution and ecology of Neotoma (woodrats) in Idaho and northwestern Utah. Quaternary Research 59, 160-171.

Smith, F.A., Crawford, D.L., Harding, L.E., Lease, H.M., Murray, I.W., Raniszewski, A., Youberg, K.M., 2009. A tale of two species: Extirpation and range expansion during the late Quaternary in an extreme environment. Global and Planetary Change 65, 122-133.

Stock, C., 1932. A further study of the Quaternary antelopes of Shelter Cave, New Mexico. Los Angeles Museum Publications 3.

Thomas, D.H., 1985. Integrative synthesis: paleoenvironmental chronology. In: Thomas, D.H. (Ed.), The archaeology of Hidden Cave, Nevada. American Museum of Natural History, Anthropologial Papers, pp. 358-391.

Thompson, R.S., Benson, L., Hattori, E., 1986. A revised chronology for the last Pleistocene lake cycle in central Lahontan Basin. Quaternary Research 25, 1-9.

Thompson, R.S., Van Devender, T.R., Martin, P.S., Foppe, T., Long, A., 1980. Shasta ground sloth (*Nothrotheriops shastense* Hoffstetter) at Shelter Cave, New Mexico: Environment, diet, and extinction. Quaternary Research 14, 360-376.

Van Devender, T.R., Martin, P.S., Phillips, A.M.I., W.G., S., 1975. Late Pleistocene biotic communities from the Guadalupe Mountains, Culberson County, Texas. In: Wauer, R.H., Riskind, D.H. (Eds.), Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region United States and Mexico, Sul Ross State University, Alpine, Texas. United States Department of the Interior, National Park Service Transactiosn and Proceedings Series, pp. 107-113.

Walker, D.N., 1987. Late Pleistocene/Holocene environmental changes in Wyoming: the mammalian record. In: Graham, R.W., Semken, H.A., Jr., Graham, M.A. (Eds.), Late Quaternary mammalian biogeography and environments of the Great Plains and prairies, Illinois State Museum Scientific Papers, pp. 334-393.

Zeimans, G., Walker, D.N., 1974. Bell Cave, Wyoming: preliminary archaeological and paleontological investigatios. Wyoming Geological Survey, Report of Investigations 10, 88-90.

Ziegler, A.C., 1963. Unmodified mammal and bird remains from Deer Creek Cave, Elko County, Nevada. In: Shutler, M.E., Shutler, R., Jr. (Eds.), Deer Creek Cave, Nevada, Nevada State Museum Anthropological Papers, pp. 15-24.