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## “MEN, WOMEN, AND CHILDREN STARVING”: ARCHAEOLOGY OF THE DONNER FAMILY CAMP

Kelly J. Dixon, Shannon A. Novak, Gwen Robbins, Julie M. Schablitsky,  
G. Richard Scott, and Guy L. Tasa

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*In spring of 1846, the George and Jacob Donner families and some 80 traveling companions began their overland trek to California. When the party ascended the Sierra Nevada in late October, a snowstorm forced the group to bivouac. At this point, the train became separated into two contingents; the larger party camped near Donner Lake and the smaller group—including the Donner families—settled at Alder Creek. Though written accounts from the Lake site imply many resorted to cannibalism, no such records exist for Alder Creek. Here we present archaeological findings that support identification of the Alder Creek camp. We triangulate between historical context, archaeological traces of the camp, and osteological remains to examine the human condition amid the backdrops of starvation and cannibalism. A stepped analytical approach was developed to examine the site's fragmentary bone assemblage (n = 16,204). Macroscopic and histological analyses indicate that the emigrants consumed domestic cattle and horse and procured wild game, including deer, rabbit, and rodent. Bladed tools were used to extensively process animal tissue. Moreover, bone was being reduced to small fragments; pot polish indicates these fragments were boiled to extract grease. It remains inconclusive, however, whether such processing, or the assemblage, includes human tissue.*

*En la primavera de 1846, las familias de los George y Jacob Donner y 80 compañeros de viaje comenzaron su camino a pie hacia California. Cuando el grupo ascendió el Sierra Nevada en Octubre, una tormenta de nieve le forzó a pasar la noche a la intemperie. En ese punto, el conjunto se tuvo que separar en dos contingentes; el grupo más numeroso acampó cerca del Lago Donner y el más pequeño -incluyendo a las familias Donner- se asentó en el Arroyo Alder. Aquí presentamos hallazgos arqueológicos que apoyan la identificación del Arroyo Alder. Triangulamos entre el contexto histórico, indicios arqueológicos del asentamiento y restos osteoarqueológicos con el trasfondo de la inanición y canibalismo. Para examinar las fragmentarias muestras óseas del yacimiento (n = 16,204) se desarrolló un enfoque escalonado analítico. Los análisis macroscópicos e histológicos indican que los emigrantes consumían ganado bovino doméstico, caballo y perro, y obtenían algo de caza silvestre, incluyendo ciervo, conejo y roedores. Las armas afiladas fueron utilizadas para trabajar el tejido animal. Además, el hueso fue reducido a pequeños fragmentos; la cerámica pulida indica que estos fragmentos fueron hervidos para extraer la grasa. Queda inconcluso, sin embargo, si tal proceso, o la muestra, incluye tejido humano.*

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A train in the mountains! Men, women, and children starving! [McGlashan 1940 (1880):111].

**I**n the decades leading up to the American Civil War, thousands of settlers colonized the American West. Among the emigrants were the George and Jacob Donner families. They left their homes in Springfield, Illinois, in April of 1846 to pursue lush farmland and healthy, prosperous lives in pre-Gold Rush California. On route, the Donners merged with other contingents, ultimately

forming the famous “Donner Party.” Their collective fame, however, would result from being trapped in the Sierra Nevada by an early winter storm and having cannibalized the dead to survive (Bryant 1848; Hardesty 1997; Johnson 1996; McGlashan 1940 [1880]; Stewart 1988 [1936]; Thornton 1986 [1849]).

Over the years, the story of this wagon train has become a legendary part of the powerfully imagined American West (e.g., White 1991). The col-

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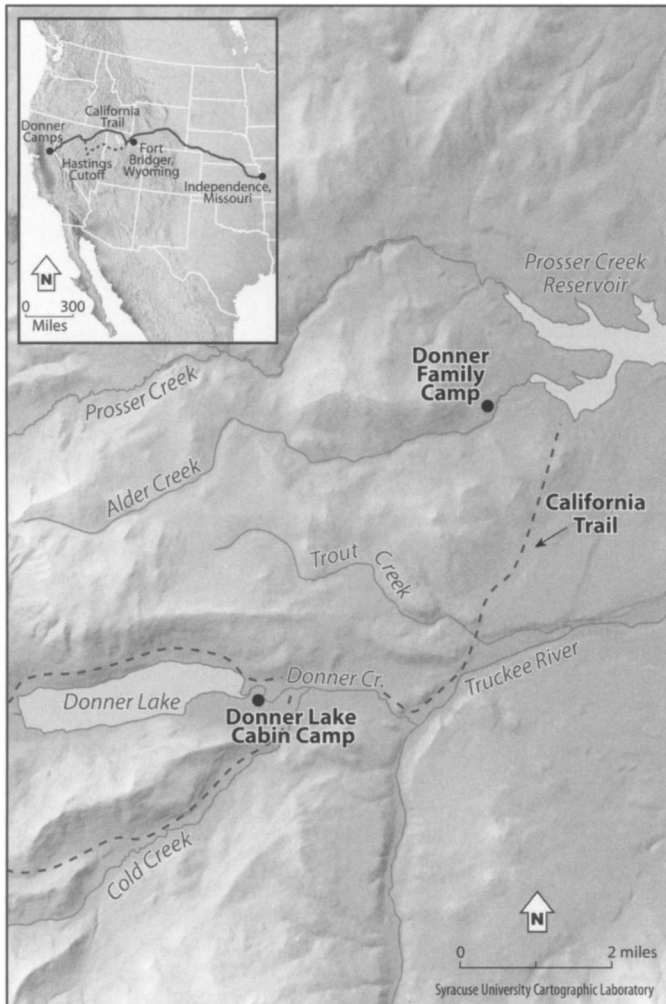
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**Figure 1.** Map identifying the locations of both the cabin encampment at Donner Lake and the Donner family camp in the Alder Creek meadow in the vicinity of Truckee, California; inset shows the Donner Party route, the Hastings Cutoff, and the location of the snowbound camps in northern California's eastern Sierra Nevada. Courtesy Joseph Stoll, Syracuse University, Cartographic Laboratory.

lective narrative of the Donner Party has, moreover, been simplified into a popular tale of overland emigrants who became cannibals. This abridged history lesson fails to consider the diversity in the daily lives of men, women, and children beyond “what” they were eating. In fact, few are aware that the Party was separated into two distinct camps—the “cabin camp” at Donner Lake, and the “Donner family camp” at Alder Creek (Figure 1). At each camp, the emigrants had to negotiate distinct demographic, social, and environmental conditions.

Here we focus on the lesser known and smaller camp at Alder Creek where 20 people, including

George and Jacob Donner’s families and their drovers, became snowbound for nearly five months. Though the larger Donner Lake site has been recognized for generations, the ephemeral nature of the Alder Creek camp has hindered its identification (see Hardesty 1997:57–59). Thus, the first objective of our study was to unequivocally identify the camp at Alder Creek. Our second goal was to compare archaeological evidence and historical accounts to help elaborate on the more mundane activities of daily life in the camp. Our third objective was to identify archaeological and skeletal signatures of a starvation diet, which may or may not

include human tissue. This final objective proved to be challenging given the small size of the bone fragments. As a result, a stepped analytical approach was used to study the assemblage.

Using a technique developed for lithic debitage analysis, the recovered bone was passed through 1" to 1/8" nested screens. Next, because of the fragmentary nature of the bone, attempts at identifying the remains were made through macroscopic and microscopic methods.<sup>1</sup> Finally, we examined butchering and cooking scars to assess the types and intensity of processing used in this starvation context. Though the stepped approach will not answer all questions about behavior at Alder Creek, when the osteological findings are integrated with the historical and archaeological record, we might better understand the events that took place amid the backdrops of starvation, cannibalism, and survival.

Given the range of evidence available, we present a pragmatic approach to the Donner Party story. Such an approach is influenced by Saitta (2007:31–32): "Reading the past depends upon a dialectical, recursive, back-and-forth movement between theory and data, between ideas about human sociality and the archaeological record's materiality" (see also De Cunzo and Herman 1996:8–11; Knapp 1992:3; Orser 2004:226). In this investigation, we tack between historical texts, archaeological traces of the camp, and the osteological remains. To establish the first line of evidence, we summarize the historical accounts of life and death at Alder Creek.

### Life and Death at Alder Creek

Sixteen members of the George and Jacob Donner families left their farms in Springfield, Illinois, on April 14, 1846, and headed to California (Mullen 1997:37–39; Stewart 1988 [1936]:14–16). Accompanied by the Reeds, the families traveled to Independence, Missouri, where some 2,700 other travelers and over 500 wagons would head west that year. The mass of emigrants split into smaller groups, and, by the end of May, the Donners and Reeds joined the "Russell Party," 49 wagons guided by Captain William Russell (Hardesty 1997:9–10). In mid-July, near the Little Sandy River in Wyoming, the Donner and Reed families joined eight other families and a number of teamsters to

form the "Donner Party." What followed was a series of unfortunate choices and bad luck.

First, there was an ill-advised decision to take a shortcut—the Hastings Cutoff (Hastings 1845). This "shortcut" took the party through rugged and uncharted terrain, resulting in a fatal delay. Exhausted from cutting trail through the Wasatch Mountains, the emigrants then proceeded to cross the Great Salt Lake desert, during which many of the cattle stampeded in search of distant water; the party was forced to cache wagons and supplies (Hawkins and Madsen 1990; Rarick 2008:69–75). Further west, while traveling along the Humboldt River in northeastern Nevada, Indian attacks depleted the remaining livestock (Rarick 2008:94–95). These misfortunes left livestock and people "well-nigh exhausted, and their slender stock of provisions nearly consumed" (McGlashan 1940 [1880]:33). Even before ascending the Sierra Nevada, the stressed contingent had fragmented along family, class, and ethnic lines (Hardesty 1997:10; Houghton 1911:32; Stewart 1988 [1936]:18).

The George and Jacob Donner families formed their own contingent, whose travels would again be disrupted. During their ascent of the eastern Sierra Nevada, George's wagon broke an axle, and while making repairs, George cut his right hand; the wound quickly became infected, rendering George an invalid (McGlashan 1940 [1880]:202; Stewart 1988 [1936]:164). By the time repairs were complete, an early winter storm hit on October 28, 1846 (McGlashan 1940 [1880]:56). The group decided to make camp along Alder Creek, nearly a mile off the Emigrant Trail. Here 20 people, including the Donner families, the recently widowed Doris Wolfinger, and the teamsters, erected tent-like shelters for a temporary stop (Hardesty 1997:54; McGlashan 1940 [1880]:62, xxxivn12, 135; Weddell 1945:73–77). The emigrants would remain stranded at this location for over four months.

Details of these snowbound months are the least documented of the entire Donner Party saga. A few historical accounts describe activities at Alder Creek, including the diaries of Patrick Breen and James F. Reed. Their families were part of a larger group of 60 emigrants, which included the Foster, Graves, Keseberg, and Murphy families. This group traveled ahead of the Donner families and stopped to camp in three rustic cabins along the shore of Donner Lake, some seven miles up the trail (Mullen

1997:188–189; Stewart 1988 [1936]:106). Primarily dedicated to describing the group's circumstances, the Breen's diary also reports occasional travel between the Donner Lake and Alder Creek camps (Hardesty 1997:55; McGlashan 1940 [1880]). Their references to Alder Creek mainly take note of the grim situation at that camp and the possibility of survival cannibalism.<sup>2</sup>

Other accounts about Alder Creek were written years after the ordeal and consist of reminiscences and letters written by the Donner children (e.g., Houghton 1911; McGlashan 1940 [1880]) and a teamster, John Baptiste Trudeau (King and Steed 1995). Leanna Donner App, George Donner's daughter, who was 12 years old during the entrapment, recalled that snow was falling as the families made camp at Alder Creek. Leanna's account indicates that the snow came on so suddenly that there was not enough time to build a cabin, so they had to pitch tents (McGlashan 1940 [1880]:63).<sup>3</sup>

Another of George Donner's daughters, Georgia Donner, who was only four years old at the time, later recalled:

The hides were boiled, and the bones burned down and eaten. We tried to eat a decayed buffalo robe, but it was too tough, and there was no nourishment in it. Some of the few mice that came into camp were caught and eaten. Some days we could not keep a fire, and many times during both days and nights, snow was shoveled from off our tent and from around it that we might not be buried alive [McGlashan 1940 [1880]:91].

After enduring months of cold and damp conditions, and numerous attempts to find livestock buried in snowdrifts, four men died. By early March of 1847, accounts indicate that the Donners had exhumed bodies from the snow and cannibalized them (e.g., Thornton 1986 [1849]). Yet, Breen's diary entry on February 26 is ambiguous: "The Donners told the California folks that they commence to eat the dead people 4 days ago, if they did not succeed that day or next in finding their cattle then under ten or twelve feet of snow & did not know the spot or near it, I suppose they have done so ere this time" (Johnson 2004:18; Teggart 1910).

In the end, only 41 of the original group of 81 emigrants who ascended the Sierra Nevada survived (Hardesty 1997:15–18; Johnson 1996:294–

298; McGlashan 1940 [1880]:143–146; Stewart 1988 [1936]:197–206). Three-quarters of the survivors were women and children (Grayson 1990; see also Grayson in Hardesty 1997). Of the families at Alder Creek, only 11 of the 21 emigrants survived; all were children or teenagers who were guided out of the mountains by three of the four relief parties in late February or early March of 1847.

Despite the high number of deaths, survivors only briefly mention the treatment of human remains. In her memoirs, Eliza Donner Houghton (1911:74–75) recalled that at Alder Creek, bodies were buried by the snow and therefore frozen and inaccessible: "the many snowfalls of winter were banked about them (dead bodies) firm as granite walls, and in that camp was neither implement nor arm strong enough to reach their resting places." The rescue parties, however, described disturbed graves and scattered body fragments. All of the rescuers who were on the scene assumed that those at the Alder Creek camp resorted to cannibalism to survive their final month of entrapment (Johnson 1996; McGlashan 1940 [1880]; Mullen 1997:293; Scott et al. 2006; Stewart 1988 [1936]:193, 215–216). The press and popular accounts sensationalized these descriptions: "a woman sat by the...body of her husband, who had just died, cutting out his tongue; the heart she had already taken out, broiled and eat" (*California Star*, 10 April 1847). At the same time, another account (e.g., Bryant 1848) suggested that the fourth relief party found George Donner's body undisturbed when they arrived in mid April; they reported that they gave him a proper burial, though their descriptions do not include specifics or the exact location.

### Archaeological Investigations at the Alder Creek Camp

Although historical accounts do not specify the location of the Alder Creek camp, several references suggest that it lay at least one mile north of the Overland Emigrant Trail.<sup>4</sup> In the late nineteenth century, a member of the second relief party, Nicholas Clark, and one of the cabin site survivors, W.C. Graves, prepared an account with C.F. McGlashan, asserting that the encampment lay in the Alder Creek meadow over a mile north of the Overland trail (McGlashan 1940 [1880]:xxxv

n.12). Later, during the early twentieth century, P.M. Weddell (1945) consulted with McGlashan himself, and outlined the evidence confirming the Alder Creek location. Weddell relocated what he thought was the campsite and marked its location with wooden signs. Though multiple sources agree that the Alder Creek meadow is where the Donner families camped, none of the early searchers were able to locate physical evidence supporting their claim.

Excavations in the early 1990s identified a concentration of historic artifacts as a likely camp site; Hardesty referred to this area as the "meadow locale" (Hardesty 1997:69–71; Schablitsky and Dixon 2003; see also Hardesty and Lindström 1990; Markley 1993, 1999).<sup>5</sup> Hardesty believed that these artifacts were not sufficient to identify the camp as belonging to the Donner Party, and evidence of a fire hearth was needed to solidify the site's affiliation (Hardesty 1997:110–111). Therefore, he concluded that he could not unequivocally link this mid nineteenth-century campsite specifically to the Donner family (e.g., Mullen 1997:195).

Hardesty's concern, in part, was that the Alder Creek encampment would prove too ephemeral to discern in the archaeological record. While the Donner Lake site was occupied by 60 individuals and included wooden structures, the Alder Creek camp contained only 20 people in two sleeping tents (one for the Jacob Donner family and one for the George Donner family). At some point, one tent became saturated and was abandoned for another one on dry ground (McGlashan 1940 [1880]:63). Thus, we might expect to find traces of at least three sleeping tents, one of which had a brush annex that was purportedly used to house a cooking fire (e.g., Hardesty 1997:60–62).

In 2003, the meadow was surveyed with ground-penetrating radar (GPR) and, although no historic-period anomalies were identified, we did relocate Hardesty's 1990 excavation units (Schablitsky and Dixon 2003). We opened four 1 x 1 m test units immediately to the west and recovered small bone fragments, numerous historic artifacts, and a thin deposit of gray-colored ash. This ash represented residue from a discrete hearth located two meters south (Figure 2).<sup>6</sup> The hearth was an oval-shaped (1 x .50m) grayish-black stain that held deposits of burned and calcined bone and concentrations of charred wood atop a thin layer of fine, powdery ash.

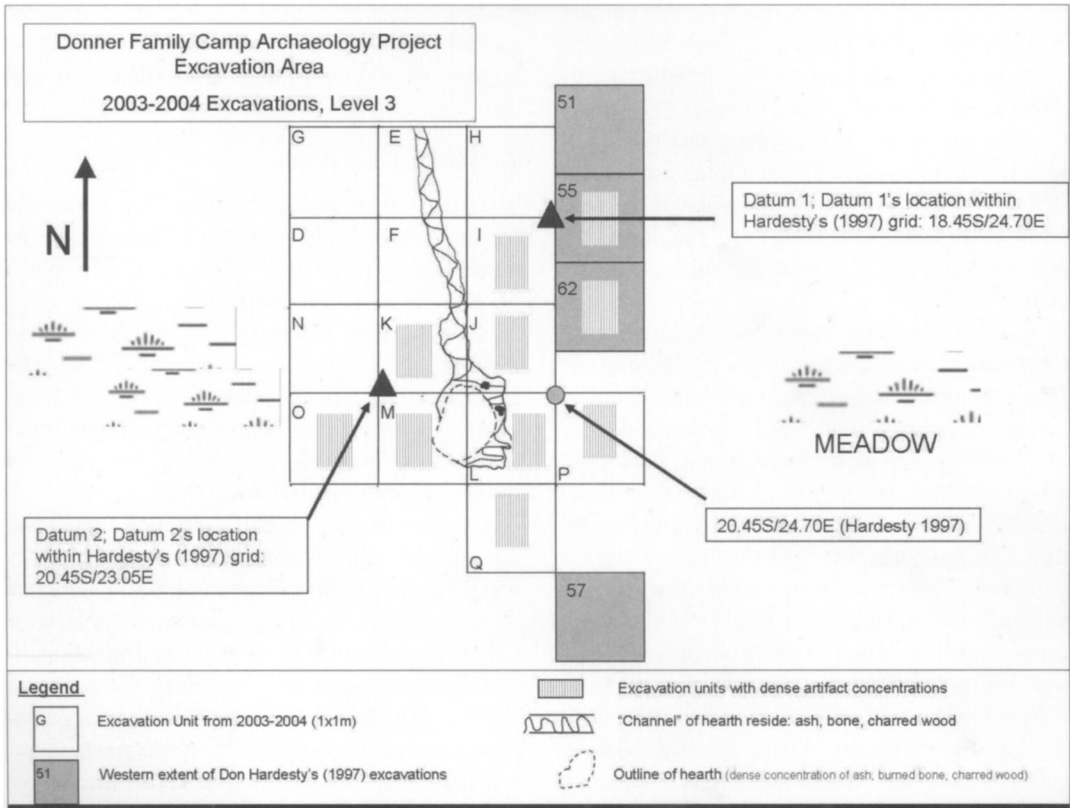
Surrounding the hearth were hundreds of artifacts, including ceramic and bottle fragments, clothing buttons, wagon hardware, writing slate, and lead shot.

### *The Artifact Assemblage*

The Alder Creek artifact assemblage was extremely fragmentary, possibly due to trampling during camp occupation (e.g., Nielson 1991; see also Dibble et al. 1997; Savelle 1984:517), the result of salvaging and looting after the party's rescue (McGlashan 1940 [1880]:257), or a combination of both. The artifact chronologies overlap in the decade of the 1840s (Figure 3), providing a temporal confirmation to accompany the geographic provenance of the Alder Creek site (Dixon 2006).

Oxen shoes, wagon hardware, horse tack, and other ferrous objects dominate the assemblage by weight and frequency. Such items are trademarks of the Overland Trail and help situate the Alder Creek site within a context of mid-nineteenth-century overland travel (e.g., Buck 1994; Dixon 1996a:181).<sup>7</sup> Domestic activities were apparent around the hearth as well. Glass fragments represent lamp globes, condiments, and pharmaceutical bottles. Because medicines are noted among the "recommended" materials overland emigrants were told to pack for their journey (Hardesty 1997:77; Stewart 1962:119), it is not unusual to find evidence of these therapeutics on the overland trail (Novak 2008:152). Ceramic sherds we recovered were small, fragmented, frost-pitted, and represent unscalped blue shell-edge plates and sprig-painted ware, including a sprig-painted creamer (Figure 3, inset).<sup>8</sup> Personal possessions recovered from the Alder Creek camp include writing slate fragments,<sup>9</sup> a tiny blue glass bead, and buttons.<sup>10</sup>

Though these mundane details of domestic life are not mentioned in historical accounts, reports of searching for cattle and game are prevalent (Hardesty 1997:55; Stewart 1988 [1936]:262).<sup>11</sup> Indirect evidence of hunting included lead shot and other firearm-related items (Scott 2005). Two pieces of spent lead shot could represent misfires in camp, but they also may have been fired into game, removed, and discarded at the site. The presence of lead bars or ingot fragments, as well as poorly cast or puddled bullets, indicate that bullet casting was undertaken in camp. Poorly formed bullets, however, do not fly accurately, even in smoothbore



**Figure 2.** Excavation grid showing our recent areas of excavation, as well as those of Hardesty (1997). The hearth residue was visible as a distinct gray, ashy stain (as indicated by the "channel" outline across the excavation grid), full of charred wood and calcined bone. Shaded units show relatively higher glass, lead shot, and nail weight to count ratio as compared to other units.

muskets—a fact that may explain some of the emigrants' problems in procuring game (Scott 2005:12).

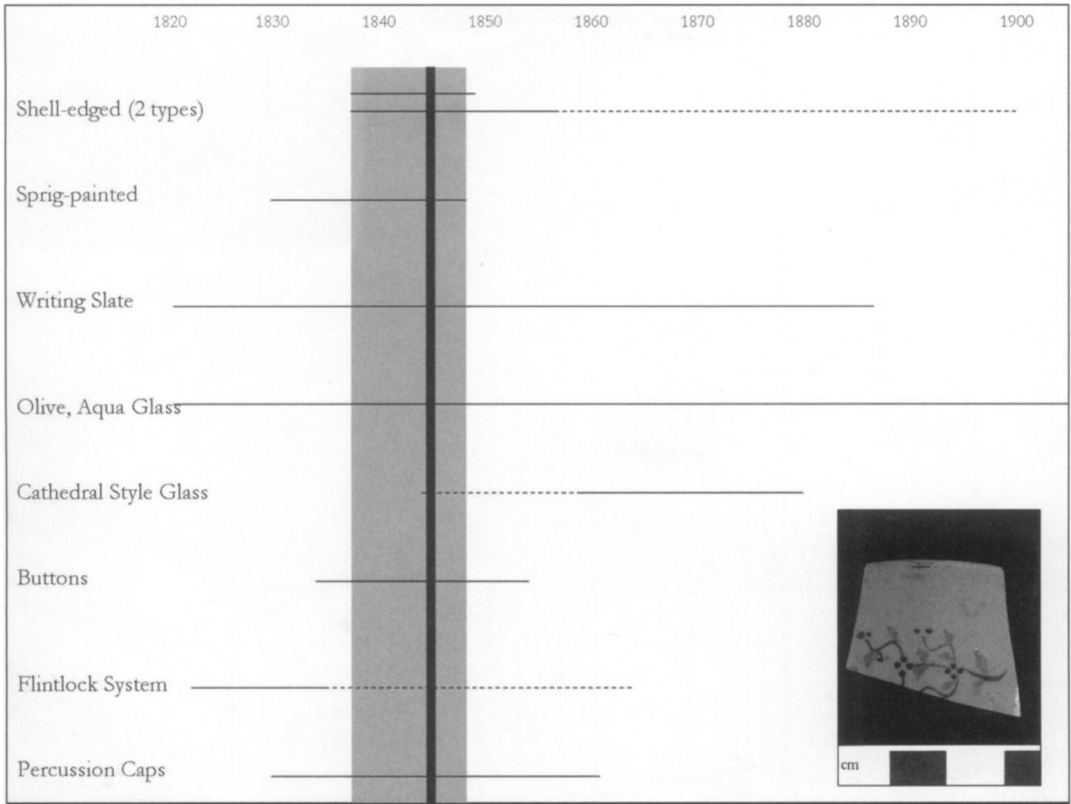
#### *Artifacts and Site Structure*

Overland campsites in the Sierra Nevada usually yield very sparse archaeological deposits (Dixon 1996b), since they were occupied only overnight or for a few days at most (e.g., Owens 1991). At Alder Creek, by contrast, excavations have shown that within the 121 ha (300 ac) setting, the "meadow locale" was a distinct archaeological site. This site covered 9 x 10 m, had historic deposits 40 cm deep, and contained discrete concentrations of nineteenth-century domestic artifacts, lead shot, and highly processed bone.

This suite of artifacts, moreover, differs from neighboring late nineteenth-century sites in the general area, which include historic sawmills and wood-

cutting camps occupied by Chinese immigrants (e.g., Dixon 1996a, 1996b). These labor camps contain industrial hardware related to milling and wood-cutting, construction materials such as window glass, brick, and late nineteenth-century ceramics, both domestic and imported from China. They rarely or never yield evidence of highly processed bone, lead shot, oxen shoes, shell edge ware, or sprig ware. In addition, typical overland camps in the region may contain the discards of travel, such as oxen shoes, but typically do not have the abundance of domestic debris and wagon-related artifacts that have been discovered in the Alder Creek camp (Dixon 1996b:33, 71–74). While the variety of domestic artifacts sets this site apart from others in the area, their association with intensively butchered bone, including that of cattle and horse, furnishes compelling evidence of the site's history.

Clearly, only a fraction of the camp has been



**Figure 3.** The Alder Creek assemblage's artifact chronologies overlap during the decade of the 1840s, as shown by the vertical lines; the Donner Party's ordeal occurred in 1846–1847; inset is aim sherd from a sprig-painted creamer, as recovered from the Donner Party's Alder Creek camp. Courtesy Ronald M. James, photographer.

identified, and it is very likely that more remnants of the camp are still undiscovered. Our excavations revealed no evidence of sleeping tents consistent with those described by Elitha Donner; Elitha reported that these were built by leaning poles against a tree and covering them with pine boughs. Leanna Donner's description of a brush annex constructed for a cooking fire (McGlashan 1940 [1880]:63), however, is consistent with our findings. Our excavation in and around the hearth revealed a large quantity of intensively processed bone. In addition, artifacts, including lamp glass fragments, lead shot and sprue, ceramic vessel sherds, and writing slate, were scattered in the immediate vicinity of the hearth. The food remains and domestic artifacts suggest that this was a domestic space. These objects were not found beyond two meters west of the hearth feature, suggesting a makeshift structure formed a boundary

that limited the spread of debris (Schablitsky 2006). The broken artifacts extending east of the hearth suggest trampling in a traffic area, such as a shelter opening, that faced east; records report that at least one of the Alder Creek shelters was described as facing east to catch the morning sun (Houghton 1911:62).

Thus, a possible explanation for the hearth and surrounding deposits is that the area served as the camp "cooking fire," housed within a brush annex. While the sleeping tents noted by Leanna Donner were probably used more or less exclusively for sleeping, the brush annex would have been a place for social gathering. Frances Donner Wilder, who was about six years old when her family was stranded at Alder Creek, later recalled such social gathering, including a poignant image of Tamzene Donner telling the children Bible stories and brushing their hair to pass the time (Rarick 2008:126).



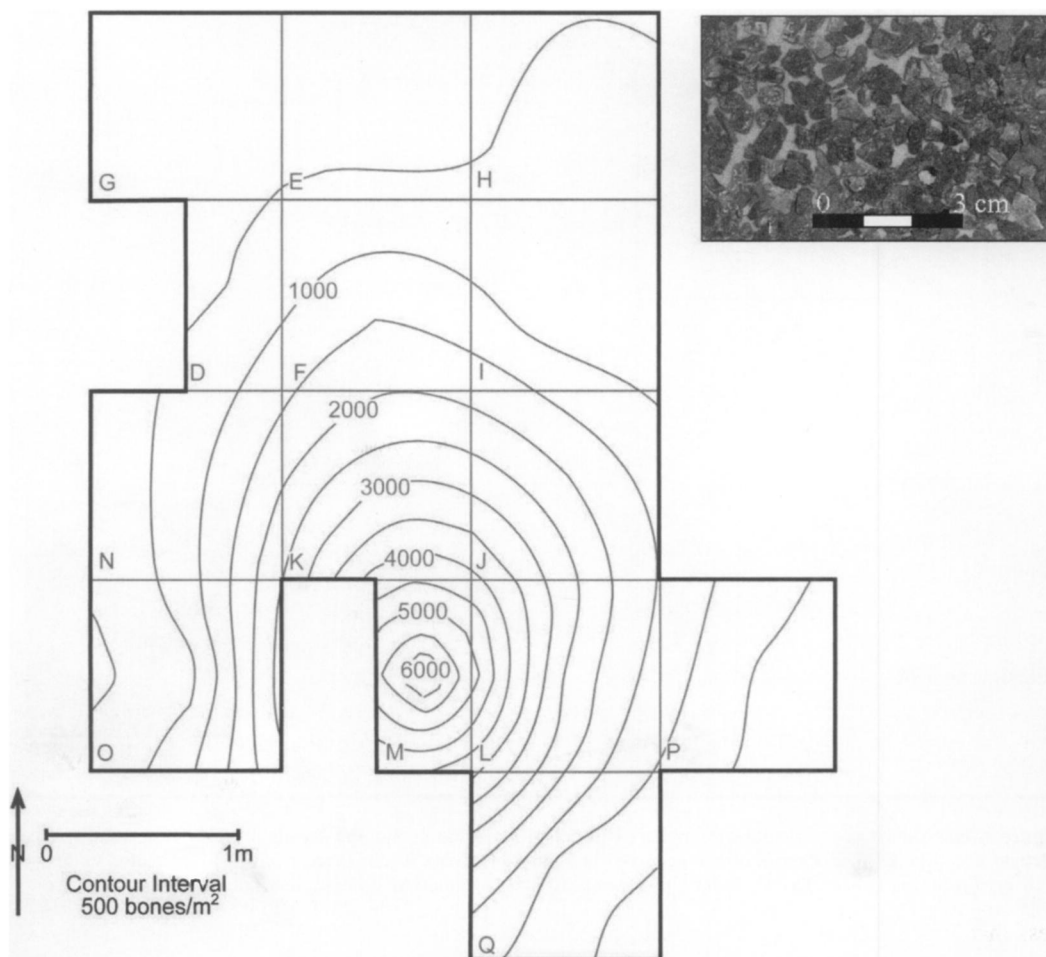


Figure 4. Bone density (bones/m<sup>2</sup>) map of the Donner family campsite excavations; inset is 1/4" fraction of the bone recovered from the Alder Creek camp. Courtesy Guy Tasa, photographer.

### The Bone Assemblage from the Alder Creek Camp

Using the highly fragmented bone assemblage to understand what and how food was being processed, cooked, and consumed requires a different form of inquiry. Here we use a stepped approach, first quantifying and classifying the bone fragments, then using visual and histological analyses to identify species, and finally examining processing scars to evaluate evidence of butchering and cooking at the camp.

Bone was recovered from all 14 excavation units with the highest density of bone near the hearth (Figure 4). A total of 16,204 bone fragments (2281.14 g or 5.03 lbs) were recovered from the

2003–2004 excavations at the Alder Creek Camp.<sup>12</sup> The burned and fragmentary condition of the bone made identification and quantification challenging. We quantified the entire vertebrate faunal assemblage using the number of identifiable specimens per taxon (NISP) (see Grayson 1994), and each bone was weighed on a Metler balance to the nearest 1/100th of a gram. The high degree of bone fragmentation thwarted our attempts to estimate the minimum number of individuals of each taxon, but we used other variables, including bone condition and fragment size, to describe the condition of the bone assemblage (Tasa 2006).

The sheer number of fragments precluded the measurement of the length of individual pieces and even prevented other more efficient methods for

Table 1. Distribution of Bone by Size Grade.

| Screen Size/Grade | Count  | %Count | Weight (g) | %Weight |
|-------------------|--------|--------|------------|---------|
| 1" (G1)           | 0      | 0.0    | 0.00       | 0.0     |
| ½" (G2)           | 58     | .3     | 136.28     | 6.0     |
| ¼" (G3)           | 2,132  | 13.2   | 993.46     | 43.5    |
| ⅛" (G4)           | 14,014 | 86.5   | 1,151.71   | 50.5    |
| Total             | 16,204 | 100    | 2,281.45   | 100     |

Table 2. Identified Skeletal Elements from the Donner Family Campsite.

| Element            | Count  | %    | Weight (g) | %Weight |
|--------------------|--------|------|------------|---------|
| Unidentifiable     | 14,108 | 87.1 | 1,257.35   | 55.1    |
| Long bone fragment | 2,046  | 12.6 | 976.05     | 42.8    |
| Tooth fragment     | 18     | <1.0 | 2.43       | <1.0    |
| Articular/other    | 33     | <1.0 | 45.60      | 2.0     |
| Total              | 16,204 |      | 2,281.45   |         |

determining bone fragment size (cf. Outram 1998, 2001). The approach used in this analysis borrowed techniques from mass analysis of lithic debitage—specifically, sifting the recovered bone assemblage through nested screens of 1", ½", ¼", and ⅛" (e.g., Ahler 1989). This procedure sorted the assemblage into fragment size classes that helped indicate the overall degree of fragmentation in the series.

Roughly 86 percent of the recovered bone was retained in the ⅛" grade screen (the fragments' maximum diameters are smaller than roughly ¼" in size), 13 percent were retained in the ¼" grade, and less than 1 percent were retained in the ½" grade (no pieces fell into the 1" grade screen) (Table 1). Much of the bone had characteristics typical of heating when the bone was fleshed or green (e.g., Gejvall 1969:470; Shipman et al. 1984), including transverse and longitudinal fractures, checking, curvature, and warping (e.g., Binford 1972:376). It was clear that the fragmentary nature of the bone assemblage was due in large part to the effects of burning.

When possible, remains were identified by skeletal element and to the lowest taxonomic level using the Oregon State Museum of Anthropology's comparative collection and relevant texts (e.g., Brown and Gustafson 1979; Gilbert 1973; Lawrence 1951; Olsen 1964; Schmid 1972; Sisson and Grossman 1953). Most of the fragments, however, were not identifiable to skeletal element (87 percent), though long bone-shaft fragments (12.6 percent), tooth fragments (<1 percent), and articular/other (<1 percent) were evident (Tables 2 and

3). Although identification to the level of genus or species was preferred, even determinations of higher taxonomic categories can provide useful information that otherwise would not be available (Brown and Gustafson 1979:vi). The fragmentary nature of the recovered fauna, however, necessitated using additional identification levels, particularly simple bone/animal size classes (Table 4). These assignments were made primarily on the basis of overall bone fragment size, cortical bone thickness, preserved shaft curvature, and shaft thickness and in comparison with reference collections.<sup>13</sup>

The range of fauna expected in this assemblage included animals native to the eastern Sierra Nevada as well as domesticates accompanying the Donner Party. Mammalian fauna in the region include mountain sheep, antelope, mule deer, elk, bobcat, mountain lion, river otter, spotted and striped skunk, badger, wolverine, mink, weasel, fisher, martin, raccoon, grizzly bear, black bear, gray fox, kit fox, red fox, wolf, coyote, porcupine, muskrat, beaver, squirrels, marmot, mountain beaver, white-tail and black-tail jackrabbit, snowshoe hare, pygmy rabbit, desert cottontail, Nuttall's rabbit, and mice. Historical sources report domesticated animals along on the journey included cattle (oxen), horses, and dogs. At some point, all of these animals could be considered likely food options.

A single bone was visually identified as *Bos taurus* (domestic cow) based on a nearly complete lateral malleolus (*os maleolare*). Fifteen fragments

Table 3. Summary of Identified Vertebrate Species at the Alder Creek Camp.

| Description/Common Name |                                   | NISP   | %NISP | Weight (g) | %Weight |
|-------------------------|-----------------------------------|--------|-------|------------|---------|
| Mammalia                |                                   |        |       |            |         |
| Artiodactyla            |                                   |        |       |            |         |
| Artiodactyla            | Even-toed ungulates               | 15*    | <1.0  | 4.10       | <1.0    |
| <i>Bos taurus</i>       | Domestic cow                      | 1      | <1.0  | 4.83       | <1.0    |
| Class II Mammal         | Rodent-sized mammals              | 1      | <1.0  | .05        | <1.0    |
| Class III Mammal        | Rabbit-sized mammals              | 3      | <1.0  | .48        | <1.0    |
| Class IV Mammal         | Dog-sized mammals                 | 15     | <1.0  | 4.01       | <1.0    |
| Class V Mammal          | Deer and human-sized mammals      | 2,067  | 12.8  | 1,020.87   | 44.7    |
| Class VI Mammal         | Elk, horse, and cow-sized mammals | 3      | <1.0  | 5.96       | <1.0    |
| Class X Mammal          | Unidentifiable mammals            | 13,562 | 83.7  | 1,228.87   | 53.9    |
| Unidentifiable          |                                   | 537    | 3.3   | 12.41      | <1.0    |
| Total                   |                                   | 16,204 |       | 2,281.45   |         |

\*seven specimens strongly suspected to be deer (*Odocoileus sp.*).

Table 4. Mammalian Size Classes (modified after Thomas 1969 and Schmitt 1988).

| Size Class | Weight       | Examples                            |
|------------|--------------|-------------------------------------|
| Class I    | <100 g       | meadow mice, shrews                 |
| Class II   | 100-700 g    | squirrels, chipmunks, gophers       |
| Class III  | 700 g – 5 kg | rabbits, hares, skunks              |
| Class IV   | 5–25 kg      | coyote, bobcat, dog                 |
| Class V    | 25–225 kg    | deer, bear, sheep, antelope, humans |
| Class VI   | >225 kg      | elk, horse, cow, bison              |
| Class X    | N/A          | unidentifiable                      |

were identified to the order Artiodactyla (even-toed ungulates including cow, deer, sheep), and these consisted mostly of tooth enamel fragments. Of these, seven specimens are likely *Odocoileus sp.* (deer).

The remaining bone was too fragmentary to be classified beyond the taxonomic level of class (Mammal) and size (Table 5). Most of the bone was found to be from medium-large animals such as deer, human, or bear. The problem of bone shrinkage from burning (e.g., Shipman et al. 1984), however, points to a potential bias in that larger animals might mistakenly be classified into smaller-sized categories. The remaining bone assemblage included 13,562 pieces identified simply as “mammal,” and 537 unidentifiable pieces (Table 5). Because of this high degree of fragmentation, we turned to bone histology in an attempt make further taxonomic identifications.

### Bone Histology and Species Identification

In this part of the study, we tried to elaborate on what animal species were in fact represented in the bone assemblage; we also wanted to establish whether there was any evidence of human bone among what we interpret as food remains. Histomorphometry<sup>14</sup> can easily and accurately discriminate human long bone fragments from other large-bodied mammals (Cattaneo et al. 1999; Dittmann 2003; Owsley et al. 1985), but these techniques are less useful for discriminating between nonhuman mammals. Qualitative examination of bone tissue types and distribution can also be used to identify human bone (Mulhern and Ubelaker 2001; Owsley et al. 1985; Whyte 2001) and to sort the nonhuman component into family-level categories, albeit with greater margin for error (Enlow 1962; Enlow and Brown 1956, 1957, 1958; Foote 1916; Frank et al. 2002; Hidaka et al. 1998; Locke

Table 5. Summary of Identified Vertebrate Species at the Alder Creek Camp.

| Description/Common Name                     | ½" Mesh (G2) | ¼" Mesh (G3) | ⅛" Mesh (G4) |
|---|--------------|--------------|--------------|
| Mammalia                                    |              |              |              |
| Artiodactyla                                |              |              |              |
| Artiodactyla Even-toed ungulates            |              | 6            | 9            |
| <i>Bos Taurus</i> Domestic cow              | 1            |              |              |
| Class II Mammal Rodent-sized mammals        |              |              | 1            |
| Class III Mammal Rabbit-sized mammals       |              | 1            | 2            |
| Class IV Mammal Dog-sized mammals           |              | 5            | 10           |
| Class V Mammal Deer and human-sized mammals | 56           | 1,419        | 592          |
| Class VI Mammal Elk and cow-sized mammals   |              | 3            |              |
| Class X Mammal Unidentifiable mammals       | 1            | 696          | 12,865       |
| Unidentifiable                              |              |              | 537          |
| Total                                       | 58           | 2,130        | 14,016       |

2004; Martin and Burr 1989; Mori et al. 2003; Skedros et al 1997). Qualitative methods are based on phylogenetic differences in the histological structure of bone—the morphometry, arrangement, and life history of an animal's bony tissue—rather than novel or unique types of bone (Martin and Burr 1989).<sup>15</sup> These qualitative differences in tissue type and distribution were used to distinguish mammalian families in our sample.

Only 85 long bone fragments could be sampled for this analysis due to poor preservation and the fragmentary nature of the assemblage. The sample was self-selecting in that we chose all fragments that could withstand processing and sectioning. Not surprisingly, only fragments from the ½" and ¼" fractions were suitable and they consisted of 10 bones in size Class IV, and 75 bones in size Classes V and VI.<sup>16</sup> This sample represents 23.4 percent of the 362 bones with evidence of processing scars, .04 percent of the total number of long bone fragments, .04 percent of the total sample of Class V and VI bone fragments, and .005 percent of the total assemblage from the Donner campsite.

### Methods

Given the burned condition of the sample, we used a protocol developed for calcined and fragile archaeological bone specimens (Maat 1987). The thin sections were examined using a transmitted light microscope under 40 to 100 × final magnification. The osteons were examined directly through the microscope and using the micrographs. A .5 mm scale was calibrated and digitally placed

on the images. These images were imported into Photoshop XS (Adobe registered trademark) and converted to grayscale. The mid-range contrast, light, and dark ranges were also adjusted to provide maximum visibility of the microstructure. For archival purposes, the sections were permanently mounted onto glass slides using Entellen.

Sections were examined for the presence of lamellar and laminar bone, and for primary and secondary osteons. The entire cross section of the bone was evaluated, including the periosteal and endosteal surfaces, and the interior architecture. When secondary osteons were present, digital micrographs were imported into ImageJ (National Institute of Health software) for histomorphometrics. After calibrating the scale, measurements were recorded for all intact osteons and Haversian canals visible in the field (2.15 x 1.61 mm). For each sample, we recorded the number of features measured per specimen, minimum and maximum diameters, the mean measure (and standard deviation) for each feature in each individual, and the number of canals per mm<sup>2</sup>.

Bone samples were evaluated for the presence of human specimens first. Quantitatively, human bones can be distinguished by osteon and Haversian canal diameters as well as the number of osteons per mm<sup>2</sup>. Quantitative, morphometric considerations useful for discriminating humans from other mammals have been described by forensic scientists and archaeologists (Cattaneo et al. 1999; Dittmann 2003; Mori et al. 2003; Owsley et al. 1985). To build on the published literature (Catta-

Table 6. Osteon and Haversian Canal Diameters from Published Sources (Cattaneo et al. 1999 and Dittman 2003) and from this Study (Robbins and Hanks 2006).

|                        | Min Osteon ( $\mu\text{m}$ ) | Max Osteon ( $\mu\text{m}$ ) | Min HC ( $\mu\text{m}$ ) | Max HC ( $\mu\text{m}$ ) |
|------------------------|------------------------------|------------------------------|--------------------------|--------------------------|
| Cattaneo et al. 1999   |                              |                              |                          |                          |
| Human                  | 277                          | 353                          | 58                       | 77                       |
| Non-Human*             | 223                          | 297                          | 34                       | 45                       |
| Dittman 2003           |                              |                              |                          |                          |
| Human                  | 174                          | 281                          | 33                       | 50                       |
| Horse                  | 158                          | 205                          | 26                       | 33                       |
| Cow                    | 121                          | 157                          | 18                       | 23                       |
| Robbins and Hanks 2006 |                              |                              |                          |                          |
| Human                  | 244                          | 506                          | 56                       | 74                       |
| Cow                    | 52                           | 163                          | 9                        | 38                       |
| Deer                   | 67                           | 143                          | 17                       | 29                       |
| Elk                    | 108                          | 157                          | 14                       | 30                       |

\*Non-human sample in Cattaneo et al. (5) consisted of 5 cows, 6 sheep, 1 horse, 1 dog, and 1 cat

Note: Horses have osteon diameters that are greater than those of deer and cows, but less than the human range. Deer and cow overlap but the range of variation present in deer long bone osteon dimensions is greater than that present in cattle.

neo et al. 1999; Cuijpers 2006; Dittmann 2003; Hidaka et al. 1998; Skedros et al. 1997), we compared histomorphometric values from 10 adult human femora ( $n = 200$  osteons measured) (Robbins and Hanks 2006). We also processed unburned bone samples from several modern fauna: elk, bear, deer, cow, antelope, pig, and coyote. The cow, antelope, elk, pig, and coyote had plexiform bone and no secondary remodeling.<sup>17</sup> The bear had plexiform bone with sporadic primary osteons.

Secondary osteons and their central canals are significantly larger in adult humans than in other large mammals likely to be in this assemblage, including horses (*Equus*), cows (*Bos*), and deer (*Odocoileus*) (Table 6). Adult human osteons commonly range in diameter from 174–506  $\mu\text{m}$ ,<sup>18</sup> and Haversian canal diameters range in size from 33–100  $\mu\text{m}$  (Cattaneo et al. 1999; Dittmann 2003; Owsley et al. 1985). Secondary osteon density in long bones is usually one to two Haversian canals per  $\text{mm}^2$ . Osteon diameters, particularly the minimum diameters, are on average smaller in horses (158–223  $\mu\text{m}$ ), deer (67–165  $\mu\text{m}$ ), and cows (79–250  $\mu\text{m}$ ), which can have as many as 20–30 Haversian canals in a square millimeter. Minimum Haversian canal diameters are similarly smaller in horses (24–54  $\mu\text{m}$ ), deer (17–29  $\mu\text{m}$ ), and cows (9–23  $\mu\text{m}$ ).

Using measurements of the minimum and maximum diameters of osteons and their central canals, human long bone fragments can be discriminated

from nonhuman fragments with a high level of precision (Cattaneo et al. 1999). The major qualitative difference distinguishing human from nonhuman mammalian long bone fragments is a predominance of large, densely packed, overlapping, Haversian systems (Dix et al. 1991; Enlow 1962; Enlow and Brown 1956, 1957, 1958; Foote 1916; Frank et al. 2002; Hidaka et al. 1998; Locke 2004; Martin and Burr 1989; Mori et al. 2003; Mulhern and Ubelaker 2001; Owsley et al. 1985; Skedros et al. 1997; Ubelaker 1989; Whyte 2001). Primary lamellar bone is only commonly found as new bone apposition at the periosteal surface (or outer circumference) (Enlow and Brown 1958), although occasionally there are pockets of lamellar bone at the endosteal surface or in regions of the cross-section that have yet to be remodeled. Primary banded osteons have not been documented in large regions of adult human bone and similarly, the presence of plexiform bone makes it very unlikely that a particular bone fragment belongs to a human (Mulhern and Ubelaker 2001). In a long bone fragment the size of an adult human, the presence of plexiform bone would indicate that the bone is not human.

The nonhuman component of the Alder Creek sample was evaluated to discriminate between different species of artiodactyls (even or two-toed, hoofed animals, such as cows and deer) and perisodactyls (odd-toed hoofed animals such as horses). Young horses are expected to show large areas of

primary osteons, banded primary osteons, and "budding" at the periosteal surface (Enlow and Brown 1958; Mulhern and Ubelaker 2001; Mori et al. 2003). Budding refers to the way in which the primary osteons appear as they form adjacent to plexiform regions (Currey 2002). Nonhuman primates can also have large areas of primary osteons in some skeletal elements (Enlow and Brown 1958), though the incidence is rare among human adults. It is also rare to see banding in adult humans (3.3 percent of individuals) and, if present, banding generally occurs only in an isolated row within the periosteal lamellar region (Mulhern and Ubelaker 2001).

Deer can be identified by the presence of secondary osteon remodeling<sup>19</sup> sandwiched between layers of circumferential lamellae or plexiform bone (Enlow and Brown 1958; Mulhern and Ubelaker 2001; Owsley et al. 1985; Ubelaker 1989). Cows and oxen also have well-organized plexiform tissue, with large lamellar regions up to 200  $\mu\text{m}$  in diameter (Currey 2002), which persists through most of their adult life (Mori et al. 2003). In older bovines, secondary osteons can develop near the endosteal surface, eventually remodeling the entire surface (Enlow and Brown 1958; Mori et al. 2003). Secondary osteons in cows have few lamellae, and relatively few osteocytes. They also tend to have a thick osteoid perimeter around the Haversian canal when compared to those of deer and horses.

Using these characteristics of bone biology, we developed specific criteria for taxonomic identification. Our criteria for assigning a bone sample to the "human" category include the following: (1) lack of plexiform bone, (2) substantial amount of secondary osteon remodeling, (3) Haversian canal diameters between 30–100  $\mu\text{m}$  for secondary osteons, (4) secondary osteon diameters of 175–500  $\mu\text{m}$ , and (5) an average of 1 or 2 secondary osteon canals per  $\text{mm}^2$  bone surface.

We identified horse (*equid*) based on the presence of (1) large fields of primary or secondary osteons, arranged in bands circumferentially within annulations of lamellar bone; (2) evidence of budding; and (3) banded secondary osteons with dimensions in the range of equids.

Deer (*cervid*) bone had the following attributes: (1) the plexiform bone had lamellar sheets of smaller diameter (75–125  $\mu\text{m}$  wide) than those of cows (175–250  $\mu\text{m}$ ), (2) if remodeling occurred

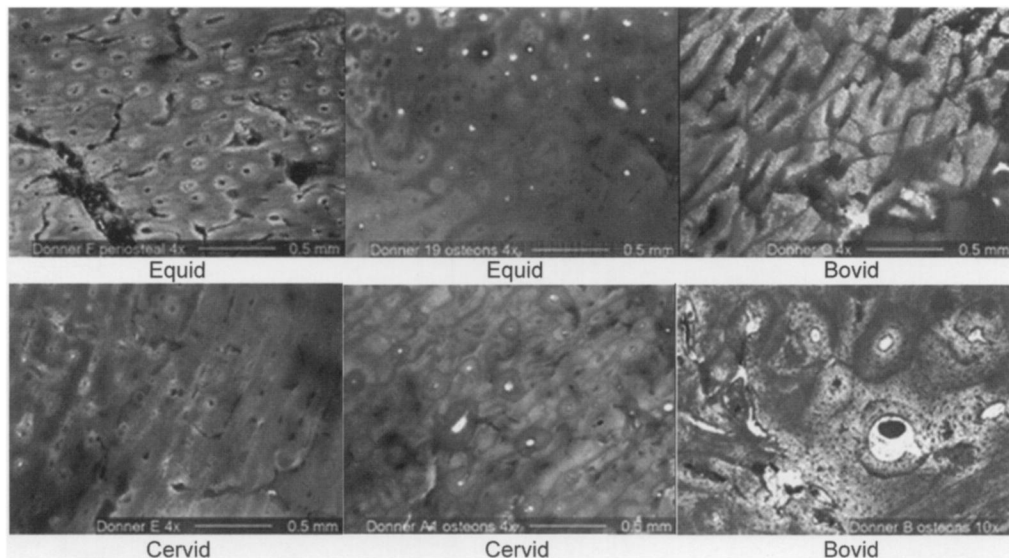
such that the highest concentrations of (and the oldest) secondary osteons were sandwiched between plexiform regions at the periosteal and endosteal envelopes, and (3) osteons were within the dimensions excepted for deer.

Cow (*bovid*) bone was identified based on (1) large areas of plexiform bone with a widely spaced plexus of canals (lamellar regions 175–250  $\mu\text{m}$  wide); (2) secondary remodeling with sporadic, large secondary osteons; (3) relatively large osteocytes arranged in a few circumferential lamellar sheets; and (4) the presence of a thick layer of osteoid around the Haversian canal.

### *Species Identification*

All specimens in the Alder Creek sample had features inconsistent with human bone, including large regions of plexiform tissue, banded osteons, and/or averages of 10–40 osteons per  $\text{mm}^2$ . All osteon diameters were limited to a range of 48 to 250  $\mu\text{m}$ . Haversian canal diameters were 5 to 55  $\mu\text{m}$ . Except for one sample, the results fall outside the minimum range expected for humans (osteons 175+  $\mu\text{m}$  and Haversian canals 30–75  $\mu\text{m}$ ). In terms of qualitative features, none of the sample demonstrated the tightly packed, overlapping osteon pattern expected in human bone tissue except for one fragment that was from a size Class IV mammal (discussed below). Based on quantitative and qualitative expectations outlined above, no human remains could be conclusively identified in our sample of large mammalian long bone fragments.

Given these findings, we proceeded to sort bone fragments into categories at the taxonomic level of the family using qualitative assessment of the primary bone tissue architecture (Figure 5). Of the total sample ( $n = 85$ ), 12 (14.1 percent) individuals had primary and/or secondary banded osteons, and 61 (71.8 percent) individuals had plexiform bone and/or secondary remodeling. Among the bone in the latter category, 32 (37.7 percent) had plexiform bone and secondary osteons with large lamellar sheets (> 200  $\mu\text{m}$  in width), large osteocytes, and thick osteoid perimeters. Based on our qualitative rubric, we estimate that there are 12 horse, 29 deer, and 32 cow bone fragments in this sample. There were two additional samples in size Class V that could not be assigned a taxonomic category because the microstructure had been obliterated by diagenesis.



**Figure 5. Donner Party long bone histology.** Specimens were evaluated in a blind experimental design and labeled by letter. If there were no secondary osteons present in the sections for analysis, taxa were qualitatively identified using the criteria outlined in the text as horse, deer, or cow. Courtesy Gwen Robbins, photographer.

We also examined 10 fragments (11.8 percent) from size Class IV. For this portion of the analysis, we were looking for very young human infant bones and thus the rubric for identifying the bone as human was different. Human infant long bones are comprised primarily of lamellar woven bone, and secondary remodeling occurs beginning late in infancy, during the second or third year of life (Goldman et al. 2009). Thus, a size class IV long bone fragment, comprised primarily of lamellar woven bone, would be consistent with humans.

Three of these Class IV bone fragments had diagenesis that prevented examination. Six bone fragments in this category had primary lamellar bone that was not woven bone and therefore not diagnostic of humans. These nine fragments may have come from any of the following animals that are in size Class IV and would have been active in the Sierra Nevada: gray kit, and red fox; wolf, coyote, dog, porcupine, muskrat, and beaver.

One size Class IV fragment with butchering marks had a total bone cross-section diameter of 5 mm. Histological analysis demonstrated the bone had undergone diagenesis, but it was possible to image the surface using reflected light. The poor quality of the resulting image made histomorphometrics impossible. Qualitatively, this bone demonstrated dense Haversian remodeling, with

secondary osteons present across the entire cross-section. This bone tissue type is inconsistent with a human long bone fragment. Although the diameter of this fragment is consistent with a human infant < 1 year old, we would expect little to no remodeling at this age. Based on the bone cross section diameter and qualitative features, we can tentatively attribute this bone to either the *canid* or *leporid* family (Enlow and Brown 1958; Frank et al. 2002; Hidaka et al. 1998; Hillier and Bell 2007). It is possible that the bone fragment could have derived from the one domesticated dog, Uno, that we know accompanied the party, but this speculation is based solely on the size category.

Our analysis suggests that nonhuman animal tissue was intensively processed at Alder Creek. All taxa identified are consistent with historical accounts of domesticated and wild mammals present in the area. We cannot, however, determine how many individuals are represented or how old the animals were. Moreover, we cannot determine the proportion of the diet comprised by these different species. Yet our findings do provide a descriptive account of the *variety* of animals present in the bone refuse at Alder Creek. Our results indicate that some of the bone fragments from Alder Creek belonged to horse, deer, and cattle. In the 85 out of 16,204 fragments from the Donner Party campsite

Table 7. Bone Type and Frequency Represented in Alder Creek Sample.

| Bone Type       | # Fragments | %    |
|-----------------|-------------|------|
| Long bone       | 443         | 65.8 |
| Joint           | 109         | 16.2 |
| Rib             | 25          | 3.7  |
| Cranial         | 16          | 2.4  |
| Flat bone       | 74          | 11.0 |
| Trabecular bone | 6           | .9   |
| Total           | 673         |      |

that we examined, there were no long bone fragments that exhibited microstructure consistent with human bone.

### Skeletal Signatures of Bone Processing

A total of 673 bone fragments from the 2003 and 2004 excavation assemblage ( $n = 16,204$ ) were examined macro- and microscopically for butchering and processing scars. The sample was randomly selected from the 16 excavation units and hearth feature, though only those fragments retained on the  $\frac{1}{4}$ " grade screen were included in the analysis. Most of the fragments were from long bones, though joints, flat bones, ribs, cranial bones, and unidentifiable flat and trabecular bone fragments were also present (Table 7).

Quantitative and qualitative analyses followed standards developed for skeletal collections where cannibalism was suspected (Owsley et al. 1995; Turner and Turner 1990, 1995, 1999; White 1992).<sup>20</sup> The number of cuts, chops, percussion scars, and saw marks were documented for each fragment. Burning was scored for presence, degree and location, and heat-associated defects (such as exfoliation, warping, and pot polish). Fracture margins were coded for time of fracture (perimortem and/or postmortem), which is indicated by the margin shape and characteristics (e.g., crushing, peeling, shearing). The maximum length of each fragment was measured and the width was taken at the fragment midsection, perpendicular to the length. Illustrations were produced of the processed bones to detail the location, size, and number of processing scars, as well as the sequence of processing (e.g., cut before burned) when possible. Scanning electron microscopy (SEM) was used to document trauma and processing on select samples.

### Butchering and Processing Damage

There was extensive human-induced modification in the Alder Creek bone sample. There was little evidence, however, for weathering, and no indication of carnivore activity. Sharp-force trauma, blunt-force trauma, and thermal alteration were responsible for the processing scars. Sharp-force trauma is indicated by cut marks, chop marks, and saw marks, while blunt-force impact produced percussion pits. The majority of bone fragments were calcined from burning, and pot polish was prominent in the sample.

Cut marks are present on 11 percent of the 673-fragment sample. A total of 319 discrete cuts were identified, though the number of cuts per fragment varies. The majority of cuts were narrow, short, and shallow (Figure 6, Table 8), suggesting that the tool used for butchering had a thin, beveled edge, similar to that found on hunting knives. Chop marks were identified on 9 percent of the fragments, although the range per fragment was less variable than that of cuts. Chop marks, produced by a hacking motion, are characterized by a slice of bone being removed on one surface, and wastage or chipping on the opposite surface (Figure 7). Within the sliced surface, microstriae run perpendicular to the kerf floor, indicating the blade's direction and angle as it penetrates the bone. The chop marks in the sample are shallow with only minor wastage. This morphology indicates the use of a thin blade, such as a butcher or bowie knife, rather than a hatchet or axe (Alunni-Perret et al. 2005; Dirkmaat et al. 2008; Reichs 1998).

While the cuts and chops could have been created by the same type of tool, a saw was also used to process bone at Alder Creek. Saw marks have the lowest frequency of all processing scars at the site, with only 16 of these lesions identified on two percent of the fragments. In addition to the square groove or kerf profile that is so characteristic of saw marks (Symes et al. 1998), we also observed evenly spaced striae along the margins of cuts. The morphology and striae indicate that the saw blade was quite narrow and had teeth approximately 1 mm apart.

Finally, the sample has a very high frequency of percussion pits. The morphology of the pits indicates that the tip of a knife was used with a stabbing motion to produce the scars (Thompson and Inglis 2009). Though a blade tip created such



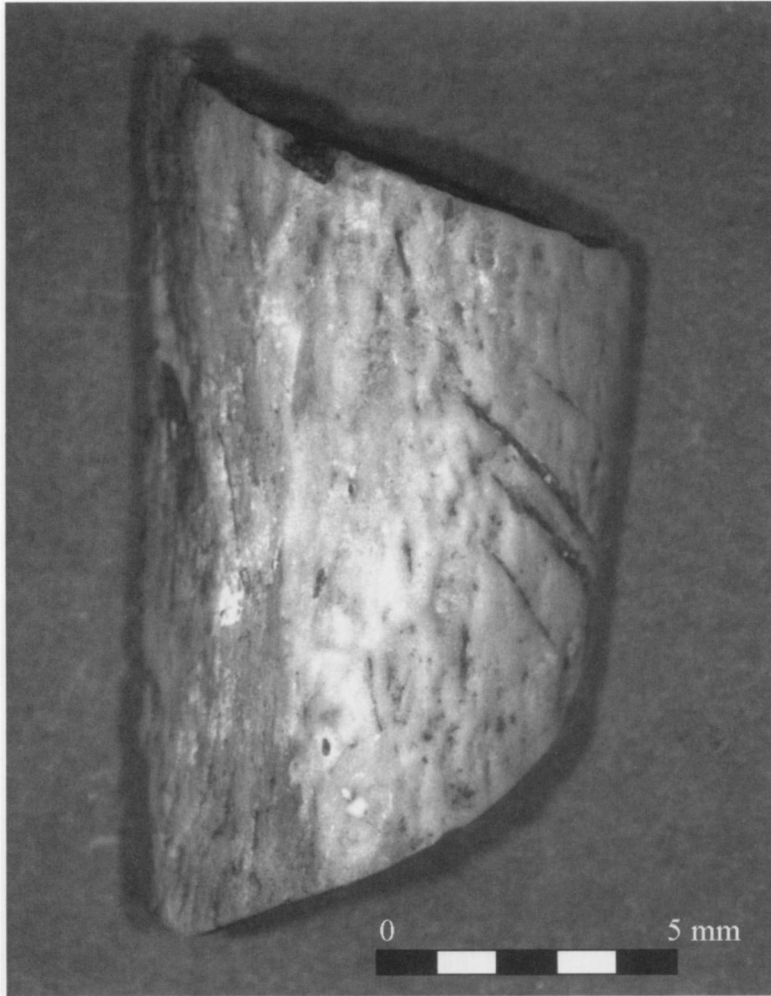


Figure 6. Cut marks in bone fragment from the Alder Creek camp. Courtesy Shannon A. Novak, photographer.

lesions, the resulting pits are considered blunt-force rather than sharp-force trauma because of the slow velocity and collapse of the surrounding bone under tension and compression (Symes et al. 2002). A total of 234 percussion pits were found on 16 percent of the sample (Figure 8). When more than one pit was present on a fragment, the lesions often appeared in clusters, indicating multiple stabbing strikes.

#### *Thermal Alteration*

Nearly all of the 673 samples had some form of thermal damage, and most of the fragments had a portion that was calcined (95 percent). Pot polish is seen on nearly half of the bone sample (Figure

9). Most fragments with pot polish show abrasion facets on the margins, though a significant amount of polish is seen on the cortical and medullary surfaces. In a number of cases, the pot polish crosses a perimortem fracture, indicating that boiling occurred after the bone was fractured.

This processing sequence is similar to that observed by White (1992) in mixed human and animal deposits at the prehispanic pueblo of Mancos. The frequency of pot polish in our study, however, is seven times greater. We suspected that a difference in the type of cooking pot may have played a role. In the prehispanic American Southwest, cooking pots were ceramic; among historic period European-American pioneers, we know that

Table 8. Butchering and Processing Scars in Alder Creek Sample.

| Scar Type       | Fragments |         |       |
|-----------------|-----------|---------|-------|
|                 | (n = 673) | # Scars | Range |
| Cut marks       | 11.4%     | 319     | 1–20  |
| Chop marks      | 8.6%      | 80      | 1–7   |
| Saw marks       | 2.2%      | 16      | 1–2   |
| Percussion pits | 15.9%     | 234     | 1–8   |
| Pot polish      | 47.4%     | —       | —     |

cast iron pots were commonly used on the trail west. To explore the effect of different vessel types, we conducted an experimental boiling study using cast-iron Dutch ovens.

### *Experimental Pot Polish*

Our methods for this study followed White (1992:121), who first developed such an experiment to assess how ceramic cooking vessels might alter and polish bone fragments. In our study, three forelimbs of a mule deer were butchered using a knife, saw, and hatchet. The limbs were first stripped of hide, and the soft tissue removed with a hunting knife. A bone saw was then used to section the bone into 30 to 50 mm tubular sections. These sections were split along the vertical axis with a small hand axe to produce three or four smaller pieces. All marrow was removed and a Dremel® tool was used to engrave an identifying number in the medullary cavity of each piece. The fragments were measured for maximum length

and width, and two images taken; a medullary view and an external cortical view. Twenty-two of the fragments were randomly selected as controls, and the remaining 46 fragments were divided into two Dutch ovens. Each vessel was filled with water to the half-way mark and placed on a Coleman® stove with the burners at full flame for three hours. One pot was stirred for one minute every fifteen minutes, while the second pot was stirred slowly, but constantly, for three hours. The intermittent stirring of the first pot follows White's experiment, while the constant stirring of the second pot was used to assess maximum attrition. In contrast to White, who used a stick for stirring, we used a large metal spoon. In our study, like White's, the water barely reached a boil and a rolling boil was never achieved.

All 46 fragments (100 percent) in our experiment exhibited pot polish, regardless of stirring intensity. These findings contrast with White who reported beveling, rounding, or polish on only 41 (59.4 percent) of the 69 fragments (White 1992:122). Though ceramic vessels are quite abrasive, cast iron pots are apparently even more so. Similar to White, we found polish and beveling was more common on the fragment margins. In addition, we also identified polish facets on the external cortical surface (93.5 percent) and the internal medullary cavity (28.3 percent). In the latter, we suspected that a metal spoon might have left the marks. To test this hypothesis, a two-way chi-square

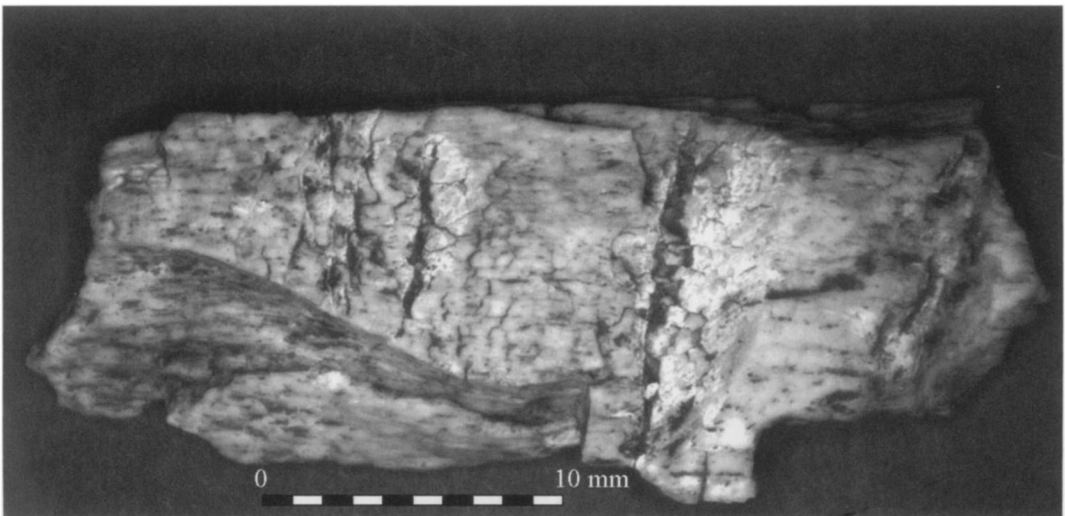


Figure 7. Chop marks in bone fragment. Courtesy Shannon A. Novak, photographer.

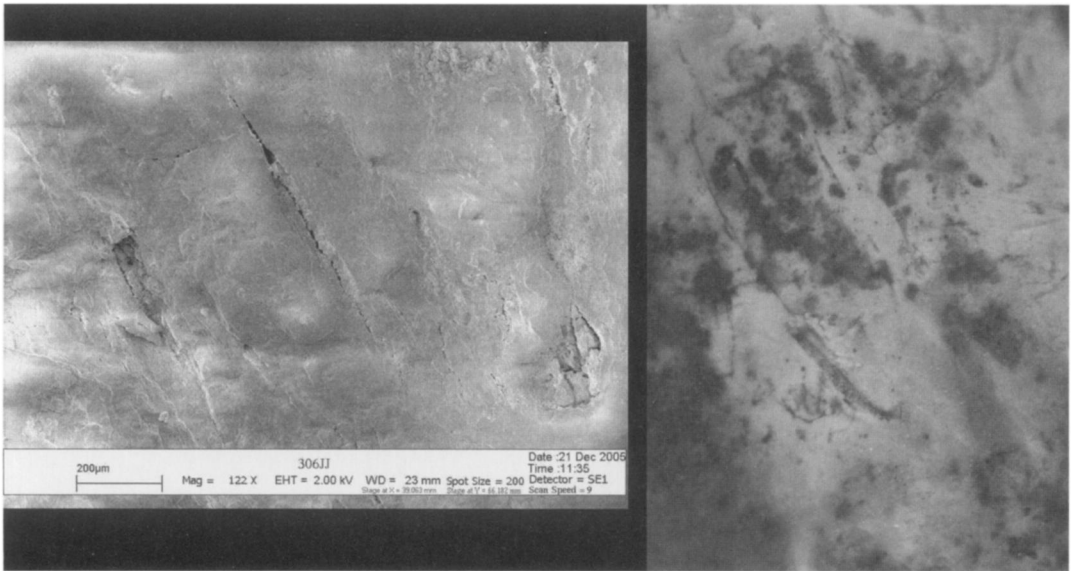


Figure 8. Percussion pits in bone fragment; SEM view (left). Courtesy Shannon A. Novak, photographer.

statistic was computed for polish frequencies in the medullary cavity of fragments that were intermittently stirred and those that were constantly stirred. The difference is statistically significant ( $\chi^2 = 8.685$ ,  $df = 1$ ,  $p = .003$ ), suggesting that contact with the metal spoon may have produced damage to the medullary cavity of the bone. In contrast, the polish on the external cortical surface is not found to be significantly different based on stirring intensity ( $\chi^2 = 3.209$ ,  $df = 1$ ,  $p = .73$ ).

Though these differences—between pots and between studies—help us refine our understanding of pot polish, what may be more important, as White (1992:124) points out, is the “presence of the damage rather than the relative amount.” Our study, furthermore, confirms his prediction that pot polish “will exist along a continuum depending upon the length of cooking time, the amount of grit in the vessel bed load, the roughness of the vessel’s inner surface, and the amount of stirring.” Yet the differences are also intriguing and suggest that there is more work to be done. For example, we were surprised by the amount of metal particulate that adhered to, or was imbedded in, the boiled bone fragments. Similar particulate was also noted in the bone assemblage from Alder Creek. Whether these fragments are from knives, saws, or cooking vessels used by the Donner Party, or from metal

trowels, forceps, and picks used by the archaeologists, remains to be tested with elemental analysis. It is also important to note that, in general, little experimental work has been done on pot polish and more studies are needed to evaluate post-depositional factors, such as water (Denys 2002:475–476) and air (Boyde 1984; d’Errico et al. 1984).

#### *Spatial Distribution of Bone Processing*

Processing and cooking damage is present on 40.7 percent of the Alder Creek bone sample (Table 9). These damaged fragments, however, are not distributed randomly across the site, but are clustered in a number of excavation units. Those units near the hearth, in particular, have some of the highest frequencies of processed bone.

Yet not all *types* of lesions—cuts, chops, saw marks, percussion pits, pot polish—are evenly distributed. When converted to standard z-values, we can see spikes in specific types of processing across the site (Table 10). Units J and J/K, in particular, contain bone fragments with cuts, percussion pits, and pot polish frequencies that are nearly three standard deviations above the site average. If the two units that contain the hearth (M and L) and the four that intersect with the channel of hearth residue (F, I, J, K) are set aside, only excavation unit N con-

Table 9. Fragments with Processing Scars by Excavation Unit (N = 673).

| Unit | Fragments Recovered <sup>a</sup><br># | Fragments Sampled<br># (%) | Cut Marks<br># (%) | Chop Marks<br># (%) | Saw Marks<br># (%) | Percussion Pits<br># (%) | Pot Polish<br># (%) |
|------|---------------------------------------|----------------------------|--------------------|---------------------|--------------------|--------------------------|---------------------|
| D    | 61                                    | 27 (44.3)                  | 6 (22)             | 1 (3.7)             | 0 (.0)             | 1 (3.7)                  | 27 (100)            |
| E    | 64                                    | 32 (50)                    | 2 (6.3)            | 0 (.0)              | 1 (3.1)            | 1 (3.1)                  | 16 (50)             |
| F    | 187                                   | 53 (28.3)                  | 2 (3.8)            | 5 (9.4)             | 2 (3.8)            | 4 (7.6)                  | 9 (17)              |
| G    | 41                                    | 14 (34.1)                  | 1 (7.1)            | 1 (7.1)             | 0 (.0)             | 2 (14.3)                 | 14 (100)            |
| H    | 110                                   | 23 (20.9)                  | 6 (26.1)           | 1 (4.4)             | 1 (4.4)            | 5 (21.7)                 | 10 (43.5)           |
| I    | 64                                    | 30 (46.9)                  | 2 (6.7)            | 5 (16.7)            | 1 (3.3)            | 8 (26.7)                 | 19 (63.3)           |
| J    | 174                                   | 76 (43.7)                  | 7 (9.2)            | 0 (.0)              | 0 (.0)             | 26 (34.2)                | 62 (81.6)           |
| J/K  | 262                                   | 106 (40.5)                 | 19 (17.9)          | 8 (7.6)             | 0 (.0)             | 19 (17.9)                | 36 (34)             |
| K    | 261                                   | 41 (15.7)                  | 3 (7.3)            | 6 (14.6)            | 2 (4.9)            | 7 (17.1)                 | 17 (41.5)           |
| L    | 137                                   | 49 (35.8)                  | 4 (8.2)            | 4 (8.2)             | 2 (4.1)            | 8 (16.3)                 | 29 (59.2)           |
| L/M  | 440                                   | 73 (17)                    | 13 (17.8)          | 13 (17.8)           | 1 (1.4)            | 7 (9.6)                  | 17 (23.3)           |
| M    | 1024                                  | 23 (2.2)                   | 3 (13)             | 3 (13)              | 0 (.0)             | 4 (17.4)                 | 15 (65.2)           |
| N    | 84                                    | 32 (38.1)                  | 5 (15.6)           | 3 (9.4)             | 2 (6.3)            | 6 (18.8)                 | 7 (21.9)            |
| O    | 21                                    | 17 (80.9)                  | 1 (5.9)            | 1 (5.9)             | 1 (5.9)            | 1 (5.9)                  | 3 (17.7)            |
| P    | 36                                    | 32 (88.8)                  | 1 (3.1)            | 3 (9.4)             | 1 (3.1)            | 2 (6.3)                  | 14 (43.8)           |
| Q    | 107                                   | 45 (42.1)                  | 2 (4.4)            | 4 (8.9)             | 1 (2.2)            | 6 (13.3)                 | 24 (53.3)           |

<sup>a</sup> 1/2 and 1/4 inch mesh screen only.

Table 10. Z-values for Processing Scars by Excavation Unit (Bold Indicates Frequencies Greater Than 1 Standard Deviation above the Site Mean).

| Unit | Cut            | Chop           | Saw            | Percussion     | Polish         |
|------|----------------|----------------|----------------|----------------|----------------|
| D    | .13471         | -.44137        | -1.22474       | -.91697        | .50132         |
| E    | -.39583        | -1.10342       | .00000         | -.78237        | -.27950        |
| F    | -.49530        | .44137         | <b>1.22474</b> | -.58406        | -.77639        |
| G    | -.59478        | -.88273        | -1.22474       | -.84967        | -.42147        |
| H    | -.26319        | -.66205        | .00000         | -.37856        | -.70540        |
| I    | -.32951        | .88273         | .00000         | .22714         | -.06655        |
| J    | .49945         | -1.10342       | -1.22474       | <b>2.64995</b> | <b>2.98577</b> |
| J/K  | <b>3.48369</b> | <b>1.54479</b> | -1.22474       | <b>1.64044</b> | <b>1.14018</b> |
| K    | -.56162        | <b>1.54479</b> | <b>1.22474</b> | .76554         | -.20852        |
| L    | -.26319        | .22068         | <b>1.22474</b> | .36174         | .64329         |
| L/M  | .36681         | <b>1.98615</b> | <b>1.22474</b> | .49634         | -.20852        |
| M    | .33365         | -.44137        | -1.22474       | -.58046        | -.35048        |
| N    | -.19688        | -.44137        | <b>1.22474</b> | -.31126        | -.91836        |
| O    | -.49530        | -.88273        | .00000         | -.91697        | -1.20229       |
| P    | -.62793        | -.44137        | .00000         | -.44586        | -.42147        |
| Q    | -.59478        | -.22068        | .00000         | -.37856        | .28837         |

tinues to stand out as having frequencies above average for saw marks.

Z-scores show that some kinds of processing scars are more likely to occur with other types of scars. In order to assess this association, we used factor analysis to identify important groups of variables that can be considered as a unit, or factor, thus simplifying the original data. To assess the inter-relationship of processing scar types at the Alder

Creek site, all 673 fragments were coded dichotomously for the presence or absence of each type of processing scar (cut, chop, saw, percussion, polish). Using varimax rotation, the analysis identified three factors that explained 68 percent of the variance. The first factor contained three variables: percussion pits (.75), pot polish (.71), and cut marks (.55). The numbers in parentheses are loadings, indicating the variable’s variance in the factor. This first

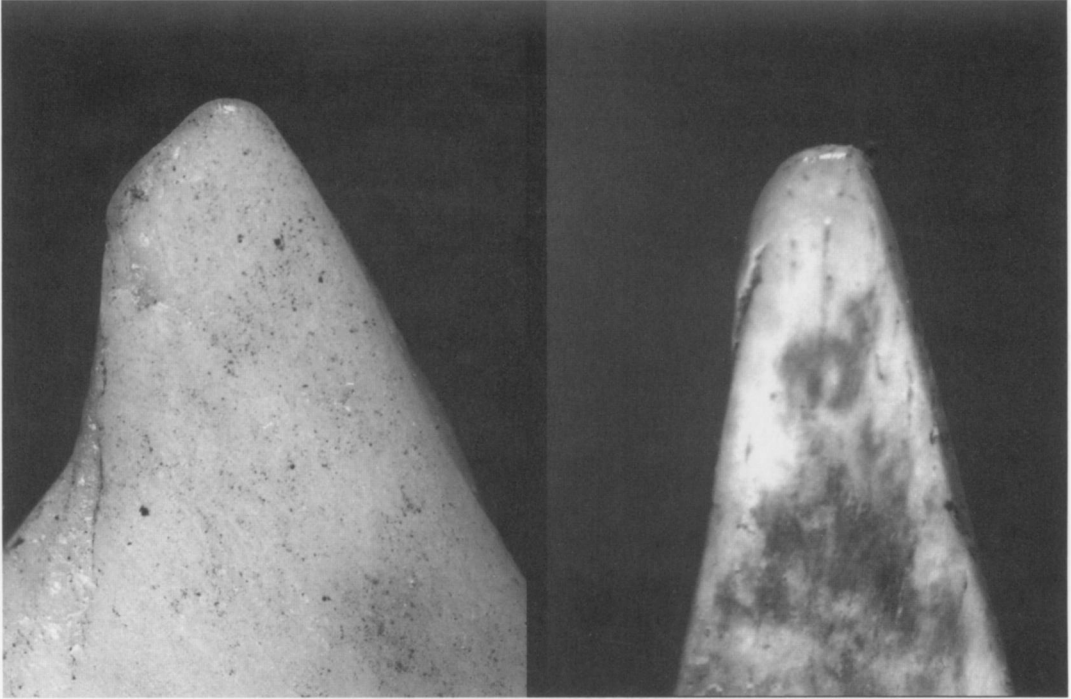


Figure 9. Pot polish on experiment bone fragment (left) and Alder Creek bone fragment (right). Courtesy Shannon A. Novak, photographer.

factor identifies an interesting cluster of processing scars, in that they all tend to be associated with secondary processing and cooking. While cut marks are indicative of soft tissue removal, percussion scars are characteristic of processing defleshed bone to gain access to the medullary cavity (Fernandez-Jalvo et al. 1999).

The second factor identified only a single variable, saw marks (.97), indicating that this processing scar stands alone. The third factor was similar, in that only chop marks (.98) were retained. In contrast to those sorted out by the first factor, the skeletal lesions in these last two factors are more likely to be associated with dismemberment and the initial reduction of the body into smaller and more manageable pieces.

### Discussion

At the Alder Creek site, the osteological and archaeological findings have given us a “glimpse of the material world . . . available from no other source” (Hardesty 1997:80). Yet a more robust interpretation of this world requires a synthesis that compares

material objects, historical records, and osteological evidence. This synthesis began by expanding and elaborating on Hardesty’s (1997:110–111) previous investigations at the “meadow locale.”

Within the meadow, we identified a discrete activity area centered on a hearth. Around and within this hearth were artifacts—wagon hardware, livery tack, lead shot, ceramic and glass vessels, personal artifacts, and lighting devices—consistent with the activities of an emigrant party. Compared with other overland emigrant camps in the area, the number and variety of cultural remains at Alder Creek represent a relatively long-term occupation. Though the artifacts on their own are not unusual in the context of nineteenth-century migration in the American West, what makes them distinct is their association with a bone assemblage containing over 16,000 intensively processed bone fragments. The most parsimonious explanation for this combined evidence is that we have identified the brush annex that housed a cooking fire at the Donner family encampment.

Though behavioral interpretations are challenging to elicit directly from artifacts at the Alder

Creek site, when combined with analysis of the bone refuse, we can better understand the context within which these people struggled to survive. One survival strategy at issue here is, of course, cannibalism. Despite popular accounts, historical sources remain ambiguous about the actual practice of cannibalism at Alder Creek (King and Steed 1995:166–167; McGlashan 1940 [1880]:143–146). Similarly, the archaeological record has yet to yield unequivocal material evidence of such behavior. We found no human burials during excavation, nor did we conclusively identify human bone in the histological analysis; however, the small sample size of 85 fragments simply may not have detected this evidence.<sup>21</sup> Though this work is ongoing, the extremely fragmentary nature of the assemblage precludes histological study of a larger sample at this time.

Another sampling bias may be a result of the taphonomic conditions at the site, including cryoturbation, wet-dry cycles, floral and faunal activity, and acidic soil (pH-value 6.0–6.5) (e.g., Dent et al. 2004). The fact that nearly all of the bone recovered at Alder Creek is burned suggests that unheated bone may not have survived the site's acidic soils. Obviously, human bone or stains from the decay of entire bodies (e.g., Beard et al. 2000) may remain in unexcavated areas some distance from the encampment. Other factors contributing to the lack of human bone, however, are worth exploring. In particular, we suspect that both the length and the social context of the entrapment influenced the distribution and preservation of the bone deposits.

Historical accounts of the Alder Creek camp suggest that cannibalism would have taken place for a short period of time and involved only a small number of emigrants left behind by the initial rescue parties. On February 21, 1847 the first relief party rescued Elitha, Leanna, and the young George Donner, as well as William Hook (Jacob Donner's stepson), Noah James (a teamster), and Mrs. Wolfinger (a widow traveling with the Donners) (McGlashan 1940 [1880]:143). It was at this time that Patrick Breen's diary noted that those who remained behind had threatened to resort to cannibalism if they did not find food (Mullen 1997:203; Stewart 1988 [1936]:193). If no other food sources were found, then we can estimate that no more than 12 people would have been left to rely on human

tissue from late February to mid-March, 1847.<sup>22</sup> During this interval, four of those emigrants were rescued and four died; in mid-March, the last survivor, Tamzene Donner, left her dead husband and hiked to the Donner Lake camp, dying soon thereafter.

Starvation cannibalism, as Rautman and Fenton (2005) argue, should be considered a process rather than a singular event.<sup>23</sup> They illustrate this process by focusing on the historic case of Alferd Packer, who in 1874 cannibalized his five traveling companions while snowbound in the San Juan Mountains of Colorado. In 1989, the murdered men's bodies were excavated and found to have been interred relatively intact. The bodies displayed numerous cutmarks, which were clustered primarily on the postcranial elements near major muscle attachments. "There is clear evidence of relatively complete removal of muscle tissue," write Rautman and Fenton (2005:331–332), "but no evidence of purposeful postmortem dismemberment, disarticulation, burning, bone breakage, marrow extraction, or other forms of processing that would yield additional calories or nutrition from the bodies."

The intensity and type of processing seen at the Packer site could be considered an early stage of survival cannibalism, resulting from a single consumer removing fillets of muscle tissue for a period of less than four months (Rautman and Fenton 2005:333). Thus, we should expect that the number of consumers and the span of entrapment would also influence the evidence for cannibalism at Alder Creek. By the end of February, when the Donner families were faced with cannibalism, the number of people at the camp had dwindled to three adults, two teenagers, and seven young children. That is, a maximum of only a dozen survivors would have been present to subsist for approximately two weeks on human tissue. At this point, since four adult men were already dead and their corpses presumably available for consumption, we might expect an early-stage processing pattern similar to that found at the Packer site. Thus, the evidence for cannibalism at Alder Creek is unlikely to be found on small bits of processed bone, but rather on relatively complete skeletal elements.

There are other interesting differences between the Packer site and the Alder Creek camp. The distinct social contexts, in particular, may have produced quite different archaeological signatures of

starvation cannibalism. While Alferd Packer was the sole survivor after he killed his traveling companions, the Alder Creek site appears to have been a domestic setting, occupied primarily by women and children. Rautman and Fenton (2005:332, 333) note that the butchering pattern at the Packer camp was more characteristic of a “kill site”—where hunters fillet muscle tissue from large animals for immediate consumption—leaving basically intact skeletal elements in anatomical position. This practice contrasts with a more common pattern of disarticulating the limbs prior to meat removal, transport, and further processing.

The bone processing pattern at Alder Creek indicates that the activities around the hearth focused on tissue reduction and preparation for consumption rather than initial butchering. Thus, the lack of complete bones or bodies in our excavation may simply be that we identified a domestic space, not a primary butchering locale. Domestic artifacts found in association with this area provide additional support for this interpretation. We would not, therefore, expect to see whole carcasses or limbs in this living area, regardless of the species being consumed.

In contrast, Alfred Packer, without witness or sanction, seems to have made no attempt to avoid human flesh. He purportedly brutally murdered his fellow prospectors because he was fatigued and there was a lack of game and ammunition (Curry 2002). Even Packer apparently recognized the humanity of his companions, avoiding their gaze by processing the bodies as they lay face down (Rautman and Fenton 2005:336). In stark contrast, there has never been any suggestion of violence at the Alder Creek camp,<sup>24</sup> and it appears that every edible resource was exhausted before human tissue was considered.

Some of these nonhuman resources were elaborated in our study. Histological and morphological analyses demonstrate that the emigrants in the Alder Creek camp consumed cattle, horse, and canid, and supplemented their diet with wild game such as deer, rabbit, and rodents. The skeletal elements of these animals were processed into small bits using saws and thin blades before being further reduced and boiled, as evidenced by pot polish.

Small fragments of animal bone were densely distributed around and within the hearth. These bits

of bone have high frequencies of human-induced modification, most of which is due to secondary processing and cooking. Cut marks, percussion pits, and pot polish are closely linked, either on the same fragment, or spatially. Pits and polish, in particular, have a very close association. This association is especially intriguing when we look to the historical record. For example, at the Donner Lake camp, by January of 1847,

Mrs. Reed, who lived in Brinn’s cabin, had, during a considerable length of time, supported herself and four children, by cracking and boiling again the bones from which Brinn’s family had carefully scraped all the flesh. These bones she had often taken, and boiled again and again, for the purpose of extracting the least remaining portion of nutrients [Thornton in Johnson 1996:73].

Mrs. Reed’s bone boiling to render grease is a familiar strategy reported in other ethnographic and archaeological accounts (Binford 1978; Leechman 1951; Lupo and Schmitt 1997; Outram 2001; Vehik 1977).

Grease extraction is a labor-intensive process that was commonly used during periods of nutritional stress. Boiled bone yields not only grease, which contains calories in the form of lipids, but also trace vitamins and minerals (Church and Lyman 2003). Experimental work has shown that 80 percent of the extractable grease can be rendered in two to three hours from fragments less than 5 cm in maximum dimension (Church and Lyman 2003:1083).

In the archaeological record, diagnostic indicators of grease extraction include bone fractured into small fragments and the presence of pot polish. Brink (1997:272) emphasizes that “grease rendering is the most destructive of all butchering processes” and is “likely the last butchering activity imposed upon an assemblage, thereby imprinting a particular signature over that of previous activities (such as marrow recovery).” This skeletal signature of boiling and grease extraction is clearly apparent in the bone remnants at Alder Creek. Thus, the lengths taken to avoid cannibalism are suggested by the highly processed bone fragments, as well as historical reports of eating boiled rawhide, bone, and strings (King and Steed 1995:168–169; Stewart 1988 [1936]:164).

## Conclusion

The Donner saga is a well-known event in nineteenth-century western expansion. Why then, conduct another inquiry, especially amid the scholarly critique that archaeological investigations of historic events are merely "an expensive way of finding out what we know already" (Bradley 1987:293)? What we *know*, however, tends to be a simplified narrative that fails to account for the complexity and variability of daily life. While the archaeological record is not fine-grained enough to elicit specific details, new material evidence forces us to slow the narrative, view the historic record within the social context that created it, and to disaggregate families and individuals from a collective.

In this light, the emigrants trapped at Alder Creek contended with conditions quite different from those at Donner Lake. Merely recognizing the fact that there were *two* camps, each having a different demographic and social profile, is a step toward expanding our analysis. While cabins sheltered the inhabitants at the Lake site, improvised sleeping tents provided only limited protection from the elements for the Donners and their drovers. Within the cabins at the Lake site individual families horded, bartered, and traded goods that were cooked and consumed around separate hearths (Stewart 1988 [1936]:165–174). At Alder Creek, however, a cooking fire within a brush annex seems to have served as a more communal setting for preparing and sharing food. Though the artifacts and wagon hardware at the Donner family camp consisted of a typical assemblage not at all unlike other emigrant-era sites (e.g., Hawkins and Madsen 1990), the presence of tea cups, medicine bottles, and writing slates within this space challenge the savage imagery conjured up by the media and popular accounts.

Then there is the bone. Cut, chopped, shattered, boiled, and burned, the skeletal tissue of domestic and wild animals was laboriously processed to extract every last nutrient. Initially, we expected that if human bone was identified in the assemblage, the pattern of consumption might be elaborated so that survival cannibalism could be recognized in other unknown contexts. Like the Packer site, the Donner Family camp, is a "known" case of starvation cannibalism. Yet if, as Rautman and Fenton (2005) argue, cannibalism involves a continuum of actions,

the Alder Creek site has taught us that we must expand our analysis beyond merely processing and consuming the human body. Other animals must also be taken into account, so that we might consider the full spectrum of opportunities and avoidances. Our stepped analysis does not answer all questions about survival or about cannibalism at Alder Creek. We would argue, however, that the pragmatic approach we have used—tacking between historical sources, artifacts, and experimental studies—has broadened our understanding of the human condition in both the recent and distant past.

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## Notes

1. After examining part of the collection, Ripan Mahli, Research Director at Trace Genetics, Inc. observed: “even though the site is relatively young in age, environmental factors such as acidic soils, dry/wet cycle environment, and burn damage caused extensive degradation of DNA at this site” (Mahli 2006; see also Leney 2006).
2. It is important to note that survival recollections were influenced by a unique set of physiological (Kamler 2004, 2006) and behavioral—even delusional—circumstances (Reed 2006).
3. In haste, George’s family erected a “hut like the Indians Wigwam [sic] with an opening at the top for the smoke to escape...short posts were driven into the ground on the inside across which sticks were laid, and on them pine boughs were thickly spread. This arrangement served as comfortable beds when they could be kept dry” (King and Steed 1995:168–169).
4. Of the five available documentary sources consulted, four indicate that the camp was at least one mile off [and northwest of] the Trail (e.g., Jones and Jones 1931; Markle 1849; McGlashan 1940 [1880]:62–63, 67; Stewart 1988 [1936]:106). Only one of these five sources suggests that the Donner families’ supplies were moved from the road “to a little distance to one side [of the road/trail],” and this is the vague recollection of Frances Donner Wilder who was only six years old at the time (Johnson 2004:10). Markle’s (1849) diary notes the Alder Creek camp location as being one mile north of the Emigrant Trail.
5. The artifacts included nineteenth-century ceramics, lead shot, bottle glass, and bone fragments.
6. The hearth residue, composed of ash, charred wood, and calcined bone, extended in a “channel” running to the north and northwest of the hearth. This appeared to be the result of snow melt. A similar phenomenon was reported by Savelle (1984) during examinations of two historic Inuit snow dwellings from the Canadian Arctic. Savelle (1984:518) observed that the refuse on the interior of these houses remained undisturbed until the beginning of summer caused major snow melt to occur; at that time the runoff of melt-water caused the dispersal of refuse, with subtle, but localized topographic conditions creating channels or hollows, where material would concentrate.
7. It is interesting to note that Hardesty did not recover wagon hardware at the Donner Lake site (Hardesty 1997:45, 107–108). This difference is probably due to the fact that wagons were not part of the immediate living context within and around the cabin he excavated. Because there was no time to build cabins at Alder Creek, members of the party had to erect tents and brush shelters (McGlashan 1940 [1880]:63), which they appear to have done nearby to, or with portions of, their wagons. The proximity of wagon hardware, oxen shoes, and horse tack to the hearth suggests a more makeshift nature of the Alder Creek camp than at the Donner Lake site.
8. While various forms of edge wares were used up to 1900 (McAllister 2001), the type of shell edge found at Alder Creek made its appearance in the late 1840s and continued to be manufactured through the 1850s (Miller 1997:121). Sprig-

painted wares were available by the early 1830s, as noted by advertisements from that time (Miller 1997:121–122). Both sprig-painted and shell-edge wares were the least expensive decorated ceramics available during the 1840s, although there were cheaper *undecorated* wares. If the residents of this camp kept more expensive ceramics, they are not reflected in the artifact assemblage. The relative affordability of the site's ceramic vessels contradicts the Donner family's noted prosperity (Stewart 1988 [1936]:14). While the Donners may have been prosperous, these types of ceramics suggest that they traveled with everyday wares. If they had more costly ceramic tablewares, such as porcelain, those materials either did not enter the archaeological record, or may have been salvaged and/or looted after the site was abandoned.

9. Personal artifacts such as the writing slate fragments recovered ( $n = 20$ ; 30.9 g) will not be discussed herein; however, results of research on such objects has been presented elsewhere (e.g., Swords and Dixon 2006; Wyatt et al. 2005). The implications of such objects with regard to normalizing behavior will be discussed in a future publication related to this project.

10. Three brass buttons were located in the vicinity of the hearth. One of the buttons consisted of a brass disk with an eye wire soldered on the back. Such buttons were common on coats from the early nineteenth century (e.g., Osborne 1993). Another button was inscribed with the words, "BEST QUALITY LONDON." This quality mark was used on brass buttons between 1835 and 1855 and was often associated with fasteners worn on dark cloth coats (Luscomb 1967:163). Leanna Donner App, who was 12 in 1847, recalled that the Donners used rubber coats to help waterproof their tent (McGlashan 1940 [1880]:63).

11. It was reported that those entrapped probed the 10–12 foot deep in snow drifts to find buried cattle (Hardesty 1997:55; Stewart 1988 [1936]:262). There were also accounts of hunting ventures, yet these suggest that hunting did not contribute greatly to the party's starvation diet. One member of a rescue party, however, successfully killed a seventy-pound bear cub to augment the meager supply of foodstuffs brought to the Alder Creek camp inhabitants (McGlashan 1940 [1880]:166–169).

12. In 2003, 1,085 fragments (249.69 g) were recovered and in 2004, 15,119 fragments (2,031.45 g) were recovered.

13. Although this method is somewhat subjective, we are confident that the identifications are correct, and, at the most, the assignments could migrate one class up or down. Due to the fact that the assemblage is calcined (which causes shrinkage) we were more likely to underestimate the size of the animal. If not confident about an assignment, the bone was left in the unidentifiable mammal bone category (Class X).

14. This refers to the measurement of compact bone basic structural units and their components. In this case, we used minimum and maximum diameters of the osteons and their central Haversian Canals.

15. See Foote 1916, Enlow and Brown 1956, Martin and Burr 1989, and Hillier and Bell 2007 for a historical perspective.

16. Class IV, V, and VI were included in the analysis to account for extreme levels of fragmentation and warping by postmortem processes of burning, cracking, and cryoturba-

tion.

17. Coyote long bones do undergo secondary remodeling later in life, with secondary osteons of .1734 average diameter (Skedros et al. 1997).

18. Secondary remodeling is a process that increases with age and secondary osteon density is variable. In addition, size of osteons in humans varies with age (but see Pfeiffer 1998). Osteons in older individuals tend to be smaller than those of younger individuals, with more overlapping and fragmentary osteons that have been remodeled (Kerley 1965). Skeletal element is also important as, for example, femoral osteons have a greater diameter than rib osteons (Pfeiffer 1998).

19. Secondary remodeling begins in deer during the first two years of life (Robbins and Whyte, pers. comm. 2010).

20. Cannibalism has long served as an interpretive tool for explaining unusual patterns of bone breakage, modification, and distribution (e.g., Blanc 1961:126; Russell 1987a, 1987b; Weidenreich 1939, 1943, 1951; see also Teleki 1973). Although early claims of this behavior in the prehistoric record were often unsubstantiated (e.g., Binford 1981; Binford and Ho 1985; Russell 1987a, 1987b; Trinkaus 1985), more recent archaeological evidence strongly suggests that cannibalism was a rare but patterned behavior in earlier times. Due in large part to the efforts of Turner (Turner 1983, 1989; Turner and Morris 1970; Turner and Turner 1990, 1999; see also Hough 1902; Morris 1939; Pepper 1920), White (White 1992), and Villa (Villa 1992; Villa et al. 1986, 1988), researchers have developed a list of criteria that provide a "taphonomic signature of cannibalism" for archaeologically derived skeletal remains. These criteria are intended to clearly distinguish cannibalistic activities from alternative behaviors and processes that result in damaged (e.g., perimortem trauma, cut marks, chop marks, gnaw marks, etc.) and randomly distributed human bone assemblages, including violence and warfare, preparation for secondary burial, predator-scavenger activity, and normal geological actions. The taphonomic principles for recognizing cannibalism in the archaeological record developed by Turner and Turner (1999), Villa (1992), and White (1992) have been applied successfully to other sites in the American Southwest (cf. Billman et al. 2000; Hurlbut 2000; Lambert et al. 2000), the Great Basin (Novak and Kollman 2000), the Arctic (Melbye and Fairgrieve 1994), the Pacific (Degusta 2000), and Europe (Cáceres et al. 2007), albeit with some detractors (Bullock 1991; Darling 1999; Dongoske et al. 2000; Ogilvie and Hilton 2000). Moreover, such principles have been applied to extremely old hominine remains from Spain and France (Defleur et al. 1999; Diez et al. 1999; Fernández-Jalvo et al. 1999).

21. The sample size of 85 refers to the histological examination of bone fragments identified as Class IV, V, and VI through macroscopic examination. Macroscopic examination identified an additional 20 fragments (15 Artiodactyla, 1 Bos, 1 Class II, and 3 Class III) that can also be excluded as being human. This means the combined macroscopic and microscopic analyses identified a total of 105 fragments as non-human.

22. After the first relief party departed on February 21, 1847, they left behind 12 emigrants: George (60–62) and Tamzene Donner (45) and their three youngest daughters,

Frances (6), Georgia (4), and Eliza (3); Elizabeth Donner (40) and her children, Solomon Hook (14), and Mary (7), Isaac (6), Samuel (4), and Lewis Donner (2); and the drover John Baptiste Trudeau (16). Then, the second relief party arrived on February 28, 1847 and took three more Alder Creek residents (Solomon Hook and Mary and Isaac Donner), leaving nine emigrants in the Alder Creek camp. The second relief also left two rescue party members (Charles Cady and Nicholas Clark) with the Donners at Alder Creek, but Cady departed around March 3, 1847, taking Frances, Georgia, and Eliza Donner as far as the Donner Lake camp. Hence, by early March 1847, there were only five emigrants left in camp (Tamzene and George Donner; Elizabeth, Samuel, and Lewis Donner; and John Baptiste Trudeau), along with Nicholas Clark, the remaining second relief party member. This number quickly dwindled. Before the mid-March arrival of the third relief party, Elizabeth, Samuel, and Lewis Donner died; Nicholas Clark and John Baptiste Trudeau left the mountains. These details are discussed in McGlashan (1940 [1880]: Chapter 14); see also Johnson (1996; 2004).

23. There are many documented circumstances of survival cannibalism (Petrinovich 2000) in western societies and probably many more that remain undocumented. Circumstances and contexts that resulted in survival cannibalism include shipwrecks (Leslie 1988; Simpson 1984), Arctic exploration (Cookman 2000; Houston 1984; Todd 1961), plane crashes (Lopez 1973; Read 1974), and major famines (Becker 1996; Fisher 1927; Fitzpatrick 1994).

24. There were rumors of Lewis Keseberg, the last survivor at the Donner Lake camp, murdering Tamzene Donner when she reached the Lake camp after leaving her dead husband at Alder Creek (McGlashan 1940 [1880]:216–224; see also Johnson 1996:111–116; Rarick 2008:223–227).

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