

# *UTAH ARCHAEOLOGY*

*Volume 12*



*A Publication of*  
Utah Statewide Archaeological Society  
Utah Professional Archaeological Council  
Mountain West Center for Regional Studies, Utah State University  
Utah Division of State History

# **UTAH ARCHAEOLOGY 1999**

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# UTAH ARCHAEOLOGY

## 1999

Editors: Steven Simms, Utah Professional Archaeological Council  
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1999

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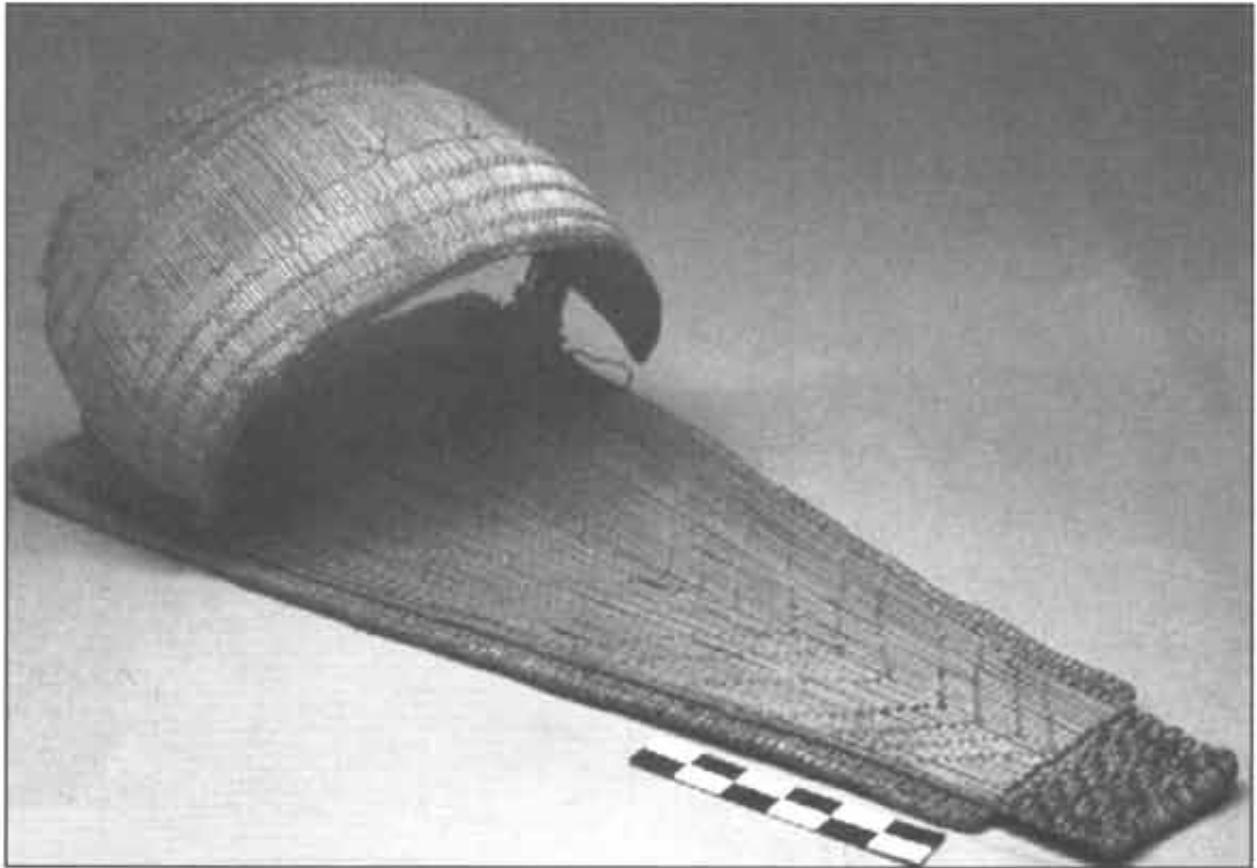
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*About the cover: Featured throughout this issue are selected items from the newly acquired Dathan Collection at the Utah State University Museum of Anthropology. Utah Archaeology gratefully acknowledges the assistance of Mandi Larsen, Museum Curator, for preparing the collection for use by the journal. Photographs are by Laura Patterson.*



*Woven Cradle Board With Visor*  
*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*

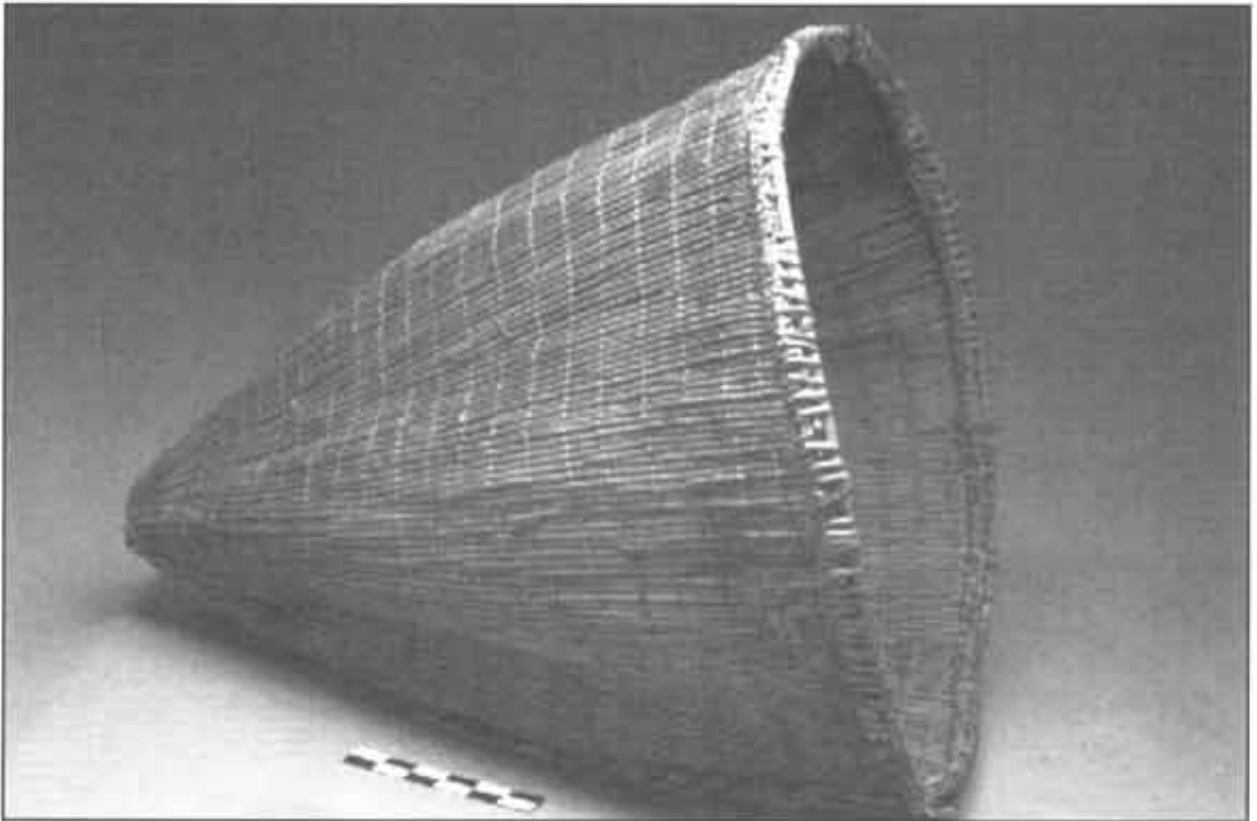
## Message From the Editors

The 1999 issue marks the twelfth year of *Utah Archaeology*. We are the third in a succession of editors, and acknowledge the members and officers of the Utah Statewide Archaeological Society and the Utah Professional Archaeological Council, as well as the previous editors, for their efforts to keep the fires burning. We scanned previous "messages from the editors" and found the one from the very first issue of the journal in 1988 to be as appropriate today as it was then. Founding editors Joel Janetski and Steven Manning wrote:

"The purpose of the publication is to disseminate information about historic and prehistoric archaeological research in Utah to the public, the avocationalist and the professional . . . the editors encourage submittals by professionals and amateurs written in a style appropriate for public consumption, but with professional constraint and documentation . . . Both communities being served need to participate in this series if it is to be viable; the amateurs cannot assume that the volume will automatically fill up through the apparently continual generation of data by professionals, and the professionals must see this publication as an acceptable alternative to writing for the traditional journals. If we are going to have a good publication, all must participate."

Well said gentlemen!

Steven Simms, editor for UPAC  
Randy Jones, editor for USAS



*Burden Basket*  
*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*

## New Form for the Formative

**Jacquelyn Massimino**, Department of Anthropology, University of Utah, Salt Lake City, UT 84112  
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*Analysis of 343 radiocarbon dates associated with the Fremont archaeological complex fails to support the findings of Talbot and Wilde's (1989) earlier study when realistic confidence levels are employed. Instead of a pattern punctuated by "peaks" and "valleys", our analysis produced variations of simple normal function: more or less uniform increase in frequency to a single peak, followed by a decline in frequency. No evidence was found for significant temporal breaks in any of the histograms. The study also considers the interpretation of radiocarbon determinations, specifically the relationship between hearth contexts and behavior, and possible implications for radiocarbon data patterns.*

### INTRODUCTION

For nearly five decades, radiocarbon dates have provided the temporal scale for exploring the prehistory of the Americas. Reliance on this dating method has resulted in the analysis of thousands of radiocarbon samples, and it has become increasingly common to investigate broad patterning in dates related to particular archaeological complexes through the use of frequency histograms (e.g., Berry 1982; Berry and Berry 1986; Gerlach and Mason 1992; Talbot and Wilde 1989). Temporal and spatial patterns evident in those histograms are then used to argue for migration, change in land-use patterns or in prehistoric population densities.

In the eastern Great Basin, the publication of Talbot and Wilde's radiocarbon-based analysis, "Giving Form to the Formative: Shifting Settlement Patterns in the Eastern Great Basin and Northern Colorado Plateau" (1989), created an impact on perspectives concerning Fremont temporal variability (e.g., Geib and Fairley 1992; Grayson 1993; Hockett 1998; Janetski 1997). The term Fremont refers to the Formative archaeological complex found primarily in central and northern Utah. The Fremont appear to have practiced a variable strategy of hunting, gathering, and farming, and have been studied extensively since Earl Morss (1931) first coined the term from his explorations along the Fremont River in the late 1920s (see Madsen and Simms 1998 for a recent summary of the Fremont). Continued research has generated more than six hundred dates associated with suspected Fremont sites (Massimino and Metcalfe 1996).

Talbot and Wilde's study was based on an examination of approximately 427 dates, including 38 tree-ring dates. Of these, 61 radiocarbon dates were obtained from a large Fremont village they had excavated, Five Finger Ridge located in central Utah (Talbot et al. 1995). The remaining dates were subdivided into two sets based on the presence or absence of substantial architecture. When these dates were arrayed in frequency histograms, the results



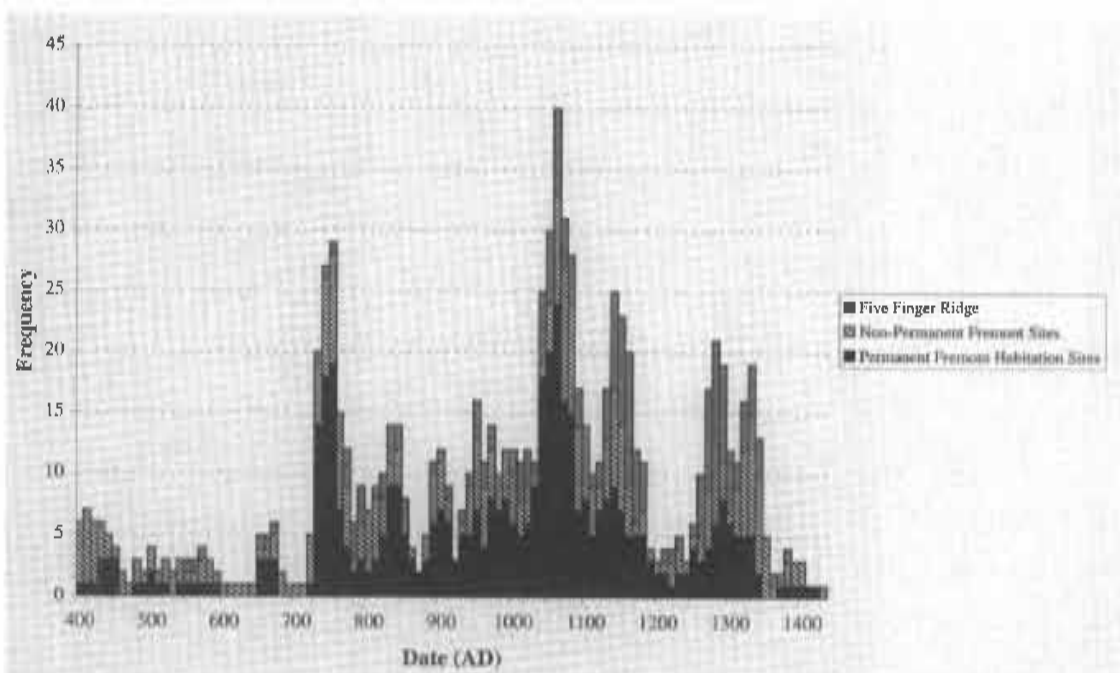


Figure 1. Modified version of the Talbot and Wilde graphs (1989). Histogram constructed using midpoints and 30 year range. Samples from Five Finger Ridge, other permanent habitation sites, and non-permanent Fremont sites.

were multimodal and consistent between the three data sets (Figure 1). Talbot and Wilde interpreted this patterning as reflective of temporal changes in Fremont settlement patterns. More specifically, they argued that the temporal variation directly related to occupational intensity (peaks) versus increased mobility (valleys). They then subdivided the Fremont span into seven periods based on the periodicity evident in their histograms and examined the spatial distribution of Fremont sites within each period.

The present study revisits the chronology of the Fremont, including an examination of some of the assumptions underlying Talbot and Wilde's analysis and interpretations. Three aspects of their study are troublesome: 1) it was not clear how they selected the dates included in their study; 2) they employed a uniform 30 year confidence interval for constructing the frequency distributions; and 3) their interpretation that peaks evident in the histograms represented periods of high human settlement activity is poorly supported. Each of these issues is addressed below.

#### SOURCES AND SELECTION CRITERIA

The current analysis is based on a pool of radiocarbon dates associated with sites in the eastern Great Basin and northern Colorado Plateau regions of Utah, constituting the primary, although not entire, Fremont area (available dendrochronology dates are not included). Relevant date lists were consulted (i.e., Barnes 1985; Madsen and Rowe 1988; Marwitt and Fry 1973; Spangler 1995), as well as dates provided by Talbot and Wilde's study. Other sources included the journal *Radiocarbon*, site reports and related notes, and various radiocarbon lab reports.



When possible, each date was traced to its original source to better evaluate whether to include it in the sample. Not surprisingly, this project required a considerable amount of time. Radiocarbon dates produced since about mid-1995 are not contained in this study.

Because of the unevenness in practices associated with the recovery, analysis, and reporting of radiocarbon dates, we followed the example of others and developed a set of criteria for excluding dates from our sample (e.g., Berry 1982; Shott 1992; Williams 1989). In order to remove dates of uncertain utility, it was necessary to compile and assess relevant information about each date, including site number, location, and type; uncalibrated radiocarbon date; lab number and type of analysis; material dated; provenience; investigator; and excavation procedures. Dates with the requisite information were then processed through a set of individual criteria. Some were arbitrary, such as limiting coverage to sites within the state of Utah and dates falling between 500 and 1750 B.P. Other criteria were not arbitrary, specifically the critical assessment of the nature of the sample and its archaeological context. Only dates from primary contexts, defined as discrete, formal features (e.g., hearths, burials and structural elements) were utilized. Acceptable sample materials included wood, charcoal, plant materials, bone, corn, textiles and leather. In addition, all dates from directly dated artifacts, such as corn, textiles and moccasins, were incorporated regardless of context. Radiocarbon dates that were ambiguous with respect to one or more of these criteria were excluded from this analysis. Although many radiocarbon dates are available from general structural floor and fill contexts, as Schiffer (1987:266) and others have noted, it is often impossible to unambiguously identify the processes or behavioral events responsible for the deposition of dated material recovered from these contexts. Investigators may have few options when collecting datable samples, but because of the contextual ambiguity, dates derived from general floor and fill contexts were eliminated (specifically identified construction materials were included).

Approximately 56 percent of the 619 dates originally considered were retained, resulting in a total of 343 radiocarbon dates in the sample investigated here.<sup>1</sup> The sample includes dates from 115 sites (206 dates from the eastern Great Basin, 137 from the northern Colorado Plateau), with primary site types categorized as structural-habitation (58 sites, 214 dates), cave-rockshelter (22 sites, 47 dates), granary-isolated (6 sites, 8 dates), and open-ephemeral occupation (29 sites, 74 dates). After Talbot and Wilde (1989:7), the presence of relatively labor intensive structures such as pithouses and surface domestic structures was followed to distinguish structural-habitation sites from more ephemerally occupied sites.

The uncalibrated radiocarbon ages and sigmas for the selected radiocarbon dates were coded as input data files for CALIB (Rev. 3.0.3c for Macintosh), a computer program that calibrates radiocarbon dates into calendrical dates (Stuiver and Reimer 1993). The resulting one sigma and two sigma calibrated age range(s) obtained from intercepts (Method A) and calibrated age(s) were entered into a computer spreadsheet that automatically rounded each range date to the nearest 10 years, and calculated the median calibrated ages for samples with three or five ages, or the average for samples with two or four calibrated ages.

From these data, utilizing 10 year increments, frequency distributions were developed using the computer spreadsheet. Note that the age range of A.D. 50 - 100 includes increments 50 - 59, 60 - 69, 70 - 79, 80 - 89, and 90 - 99. For comparison with Talbot and Wilde's analysis, based on a uniform 30 year range, the 10 year increment containing the calculated age (actual age if only one was calculated by CALIB or the median/average if more than one) and the 10 year increment on either side were included. The frequency distributions were not weighted to compensate for differences in the size of the standard errors associated with the individual radiocarbon dates (see Berry and Berry 1986).

### EFFECTS OF CALIBRATION

Using calibrated dates creates considerable concern because the calibration routine might introduce periodicity into the data set simply as a consequence of the uneven relationship between calendar and radiocarbon ages during the period of interest. Figure 2 illustrates this relationship based on the bidecadal tree-ring data set employed by CALIB. To explore this possibility, an artificial data set was constructed consisting of five radiocarbon dates for each ten-year increment between 500 and 1750 B.P., the time range considered in this study. Each date was given an uncertainty of  $\pm 50$  years. CALIB was then used to calibrate the dummy data set and the two sigma results were plotted (Figure 3). The line in the graph demonstrates the uniform character of the uncalibrated data set; the histogram illustrates the results of calibration. A slight shift occurs in the calibrated frequency distribution to more recent periods, and calibration obviously introduces some periodicity, especially the spike centered at around A.D. 300. However, the magnitude of the periodicity is clearly not sufficient to account for the significant fluctuations observed in Talbot and Wilde's results (Figure 1).

### FREMONT HISTOGRAMS

As noted earlier, Talbot and Wilde employed a 30 year range for all radiocarbon dates included in their study. For comparison, a histogram was constructed based on the same range, but using the current sample of 343 radiocarbon dates (Figure 4). The same general multimodal character is present, although the largest peak occurs about 50 years earlier than in Talbot and Wilde's study. This shift may simply be the consequence of calculating the average ages differently. Talbot and Wilde calculated it as the midpoint of the calibrated 95 percent confidence level (following Klein et al. 1982), CALIB calculates it as the actual intercept(s) with the calibration curve.

It is important to note that the average calibrated 68 percent confidence interval for the radiocarbon dates in the sample data set is 141 years; the average calibrated 95 percent confidence interval is 281 years. Clearly, a 30 year range has a very poor chance of bracketing the actual age of the sample, as Talbot and Wilde themselves noted (1989: Footnote 1). Using the average values as an example, there is only about a one in six chance that the actual date will fall in the 30 year range, or perhaps better stated, there is about a five in six chance that the actual date falls outside the 30 year range.

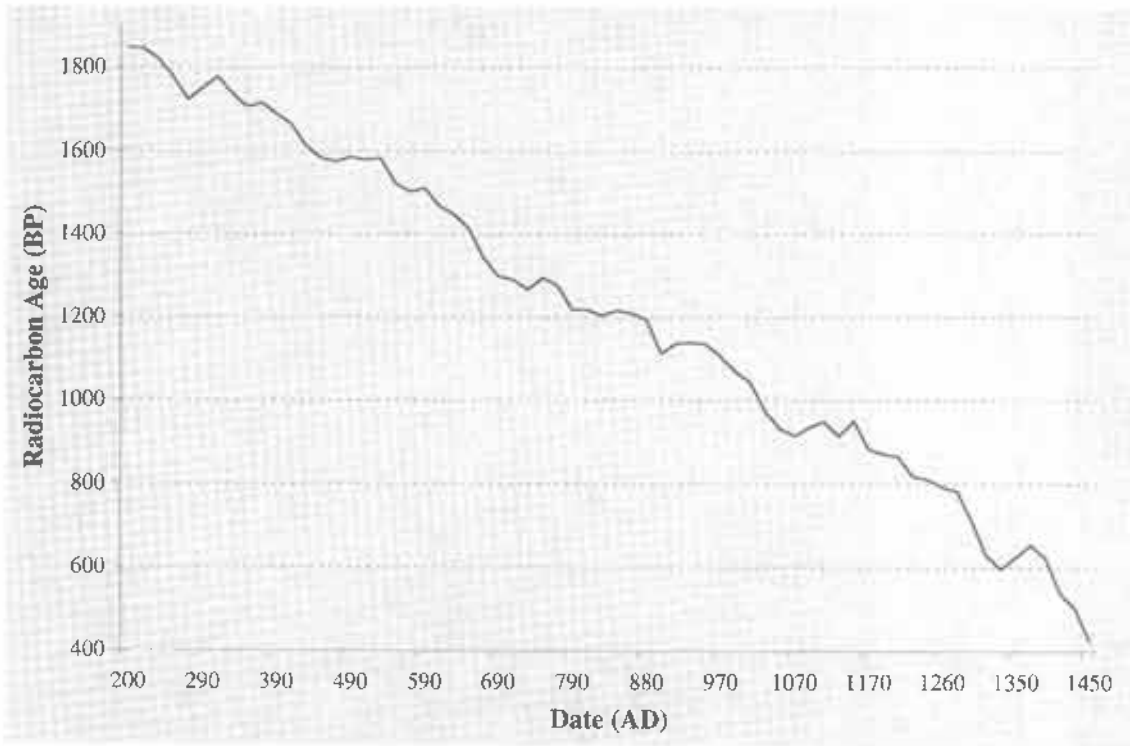


Figure 2. Calibration curve from bidecadal data used by CALIB for the period between AD 200 and AD 1450.

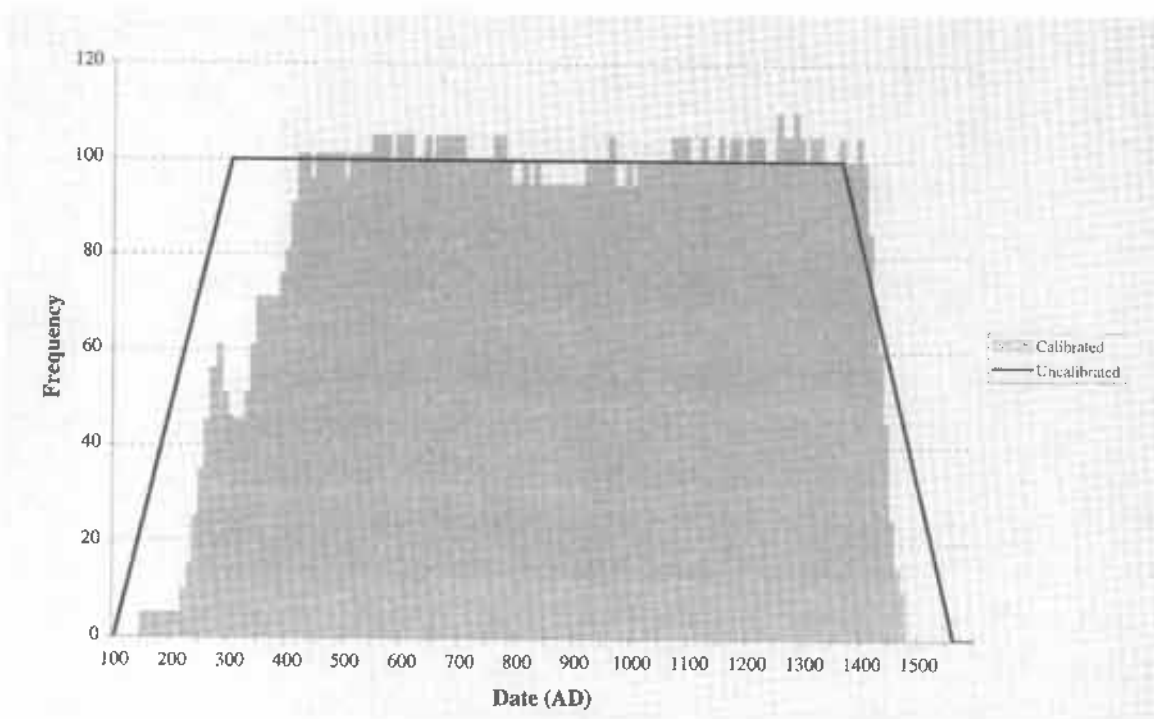


Figure 3. Histogram and line graph illustrating the effects of calibration on the artificial data set. Line graph illustrates the results of calibration.

Figure 5 shows the frequency distribution of the sample radiocarbon dates employing 68 percent confidence intervals. Note that the pronounced peaks and valleys have disappeared, and its shape is unimodal with a maximum frequency at about A.D. 1000. With reliance on a 68 percent confidence interval, there is about a two in three chance that the actual date lies within that range for each date.

As indicated in the histogram in Figure 6, based on 95 percent confidence intervals, much of the "terraced" appearance associated with Figure 5 is eliminated. This is probably the most relevant histogram for portraying the radiocarbon chronology of the Fremont archaeological complex. It mirrors the conventional wisdom that the Fremont more or less gradually increased through time to attain a maximum presence between A.D. 900 and 1150, and then precipitously declined after about A.D. 1150-1200.

As a check of the robusticity of the patterning present in Figure 6, an additional histogram based on 95 percent confidence intervals was constructed. This illustration represents all 619 radiocarbon dates originally compiled, including those eliminated from the sample data set because of failure to pass the screening criteria (Figure 7). Clearly, the patterning is extremely robust; Figure 7 differs in small details, especially after about A.D. 1400, but it shares all of the general characteristics evident in Figure 6.

A small spike, occurring about A.D. 1370, is present in all three histograms, suggesting a possible anomaly in the general patterning. The dates producing the spike range represent multiple sites that are not restricted to a particular region of Utah. The spike appears to be an artifact of calibration, one unanticipated by the calibration of the artificial data set discussed earlier. There is a fairly strong fluctuation in the calibration curve about A.D. 1370 that produced the void between the main body of the frequency distribution and the spike (see Figure 2).

The sample was also coded to allow sites in the Colorado Plateau to be distinguished from those in the Great Basin. Using 95 percent confidence levels, Figure 8 illustrates the frequency distribution for radiocarbon dates from the Great Basin, while Figure 9 represents the distribution from the Colorado Plateau. The distribution of dates from the Great Basin closely mirrors that for the sample as a whole, perhaps because the majority of the dates are from the Great Basin (206 versus 137). The pattern of radiocarbon dates from Colorado Plateau sites is distinguished by a more symmetrical appearance, and attains its peak between approximately A.D. 700 and A.D. 1000.

The difference in the shapes and timing of the peaks evident in the Great Basin and Colorado Plateau histograms appear to be real, that is they do not appear to be the result of sampling error. Although we are unaware of any statistical techniques for assessing the significance of differences between histograms constructed using confidence intervals, the fact that the smaller sample is still sizable, 137 dates for the Colorado Plateau, suggests that sample size is not implicated. This appears to represent a demographic shift, albeit one less abrupt and less complete than has been suggested for specific regions within the Fremont area (e.g., Spangler 2000).

Figure 10 illustrates the frequency distribution of dates associated with structural sites in both the Great Basin and Colorado Plateau. The distribution of dates is also very similar to the pattern evident for the complete sample. Figure 11 displays the frequency distribution for dates associated with non-structural sites, primarily rockshelters and small ephemerally occupied sites. It too roughly corresponds to that for the complete sample.

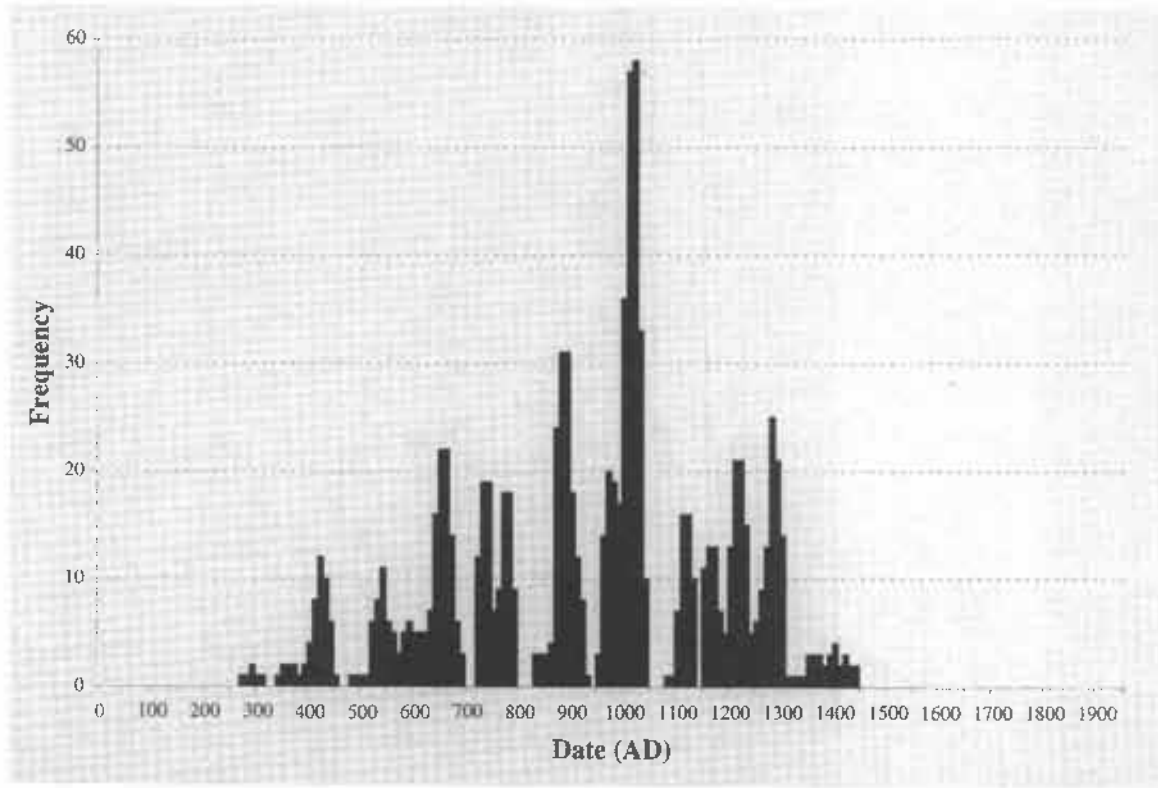


Figure 4. Histogram of the frequency distribution of the sample dates based on intercept age(s) and 30 year ranges.

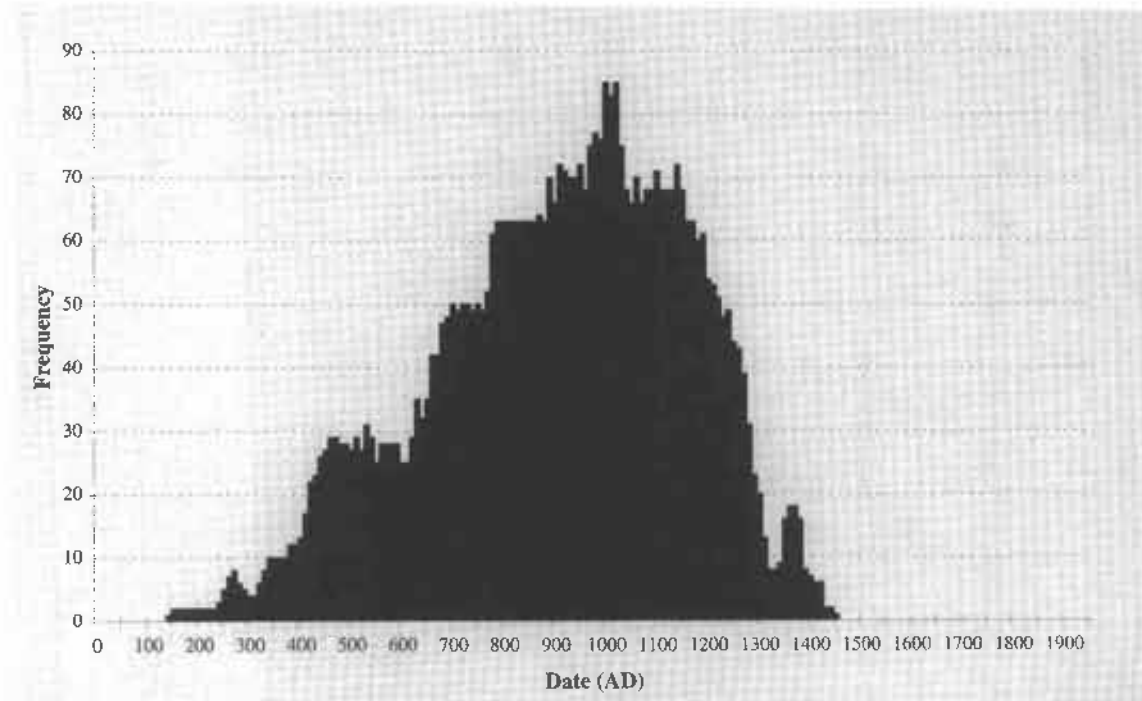


Figure 5. Histogram of the frequency distribution of the sample dates based on calibrated 68 percent confidence intervals.

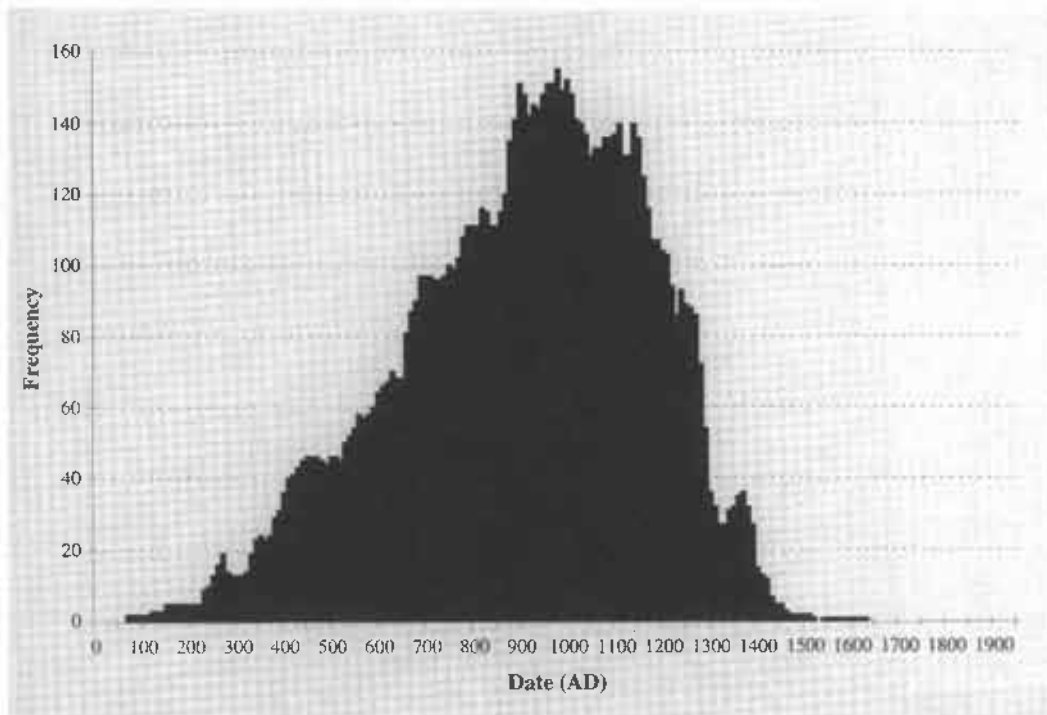


Figure 6. Histogram of the frequency distribution of the sample dates based on calibrated 95 percent confidence intervals.

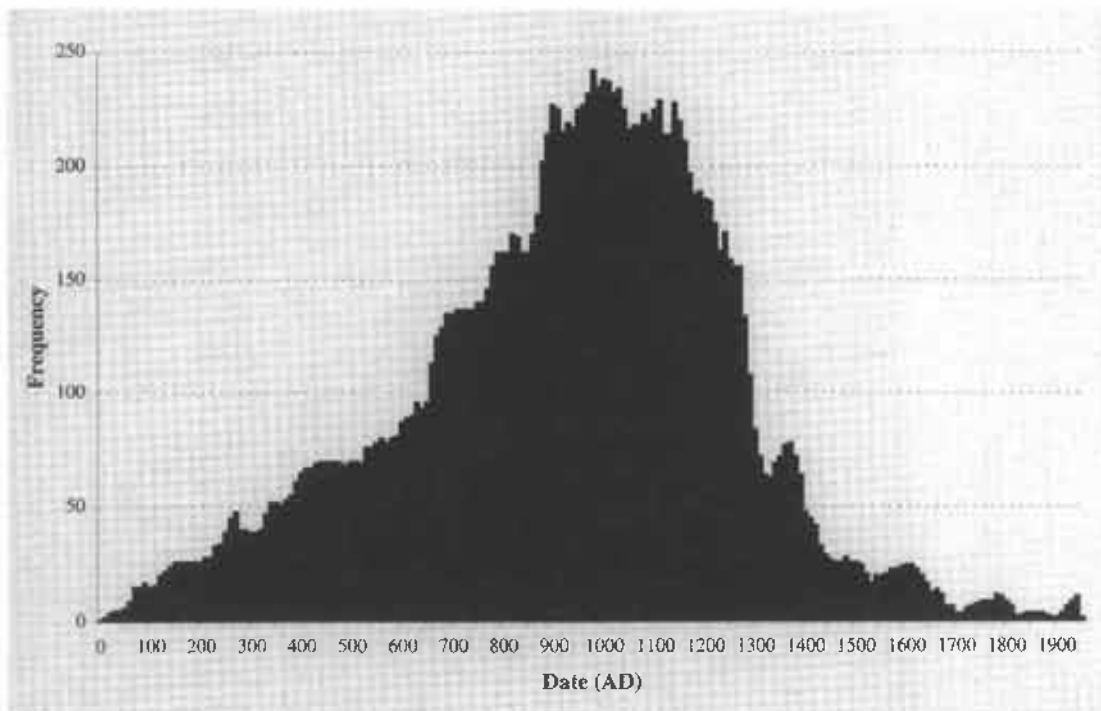


Figure 7. Histogram of the frequency distribution of all compiled dates, including those eliminated from the sample, based on calibrated 95 percent confidence intervals.

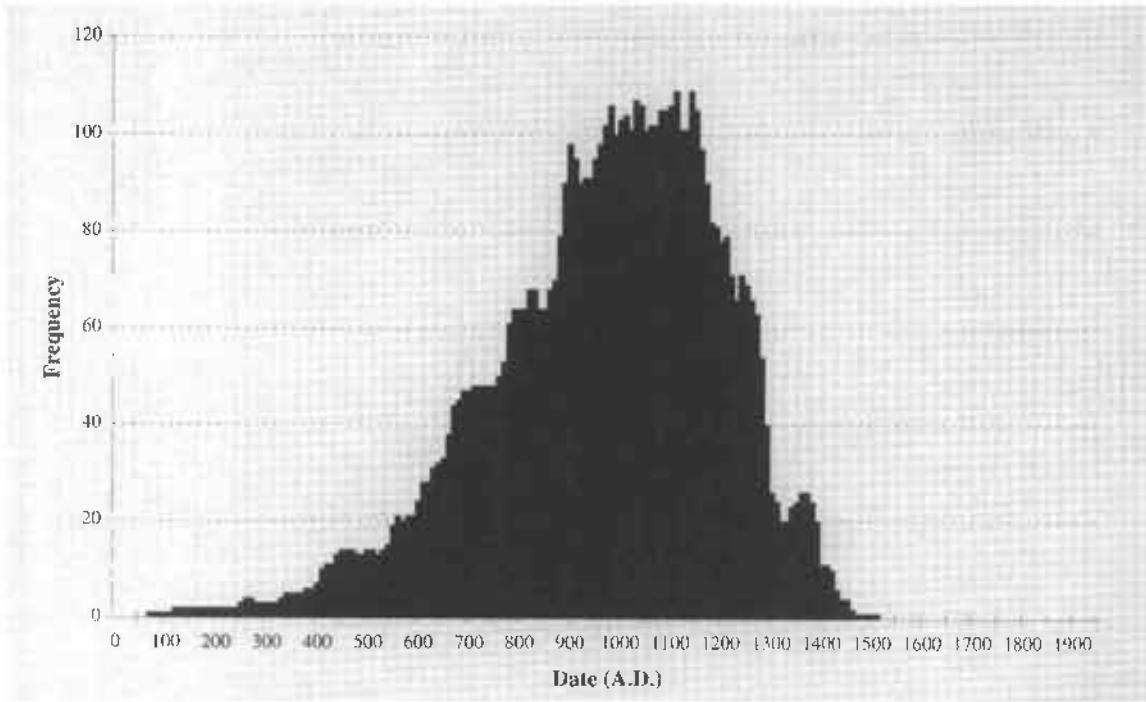


Figure 8. Histogram of the frequency distribution of sample dates from eastern Great Basin sites based on calibrated 95 percent confidence intervals.

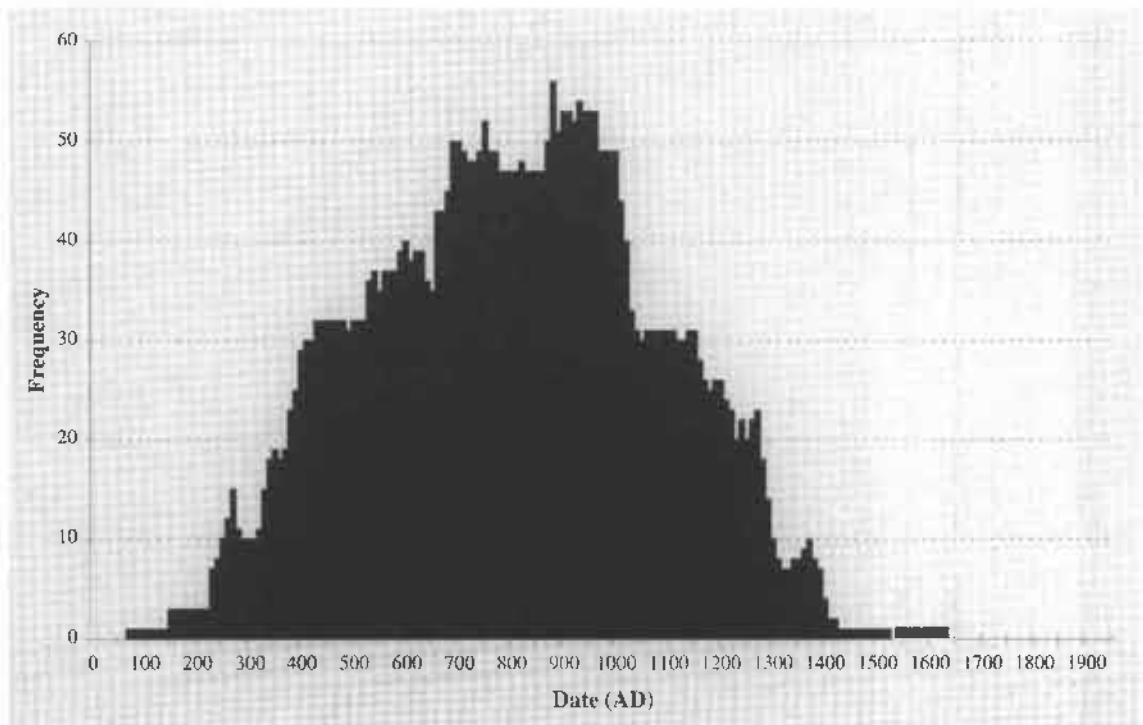
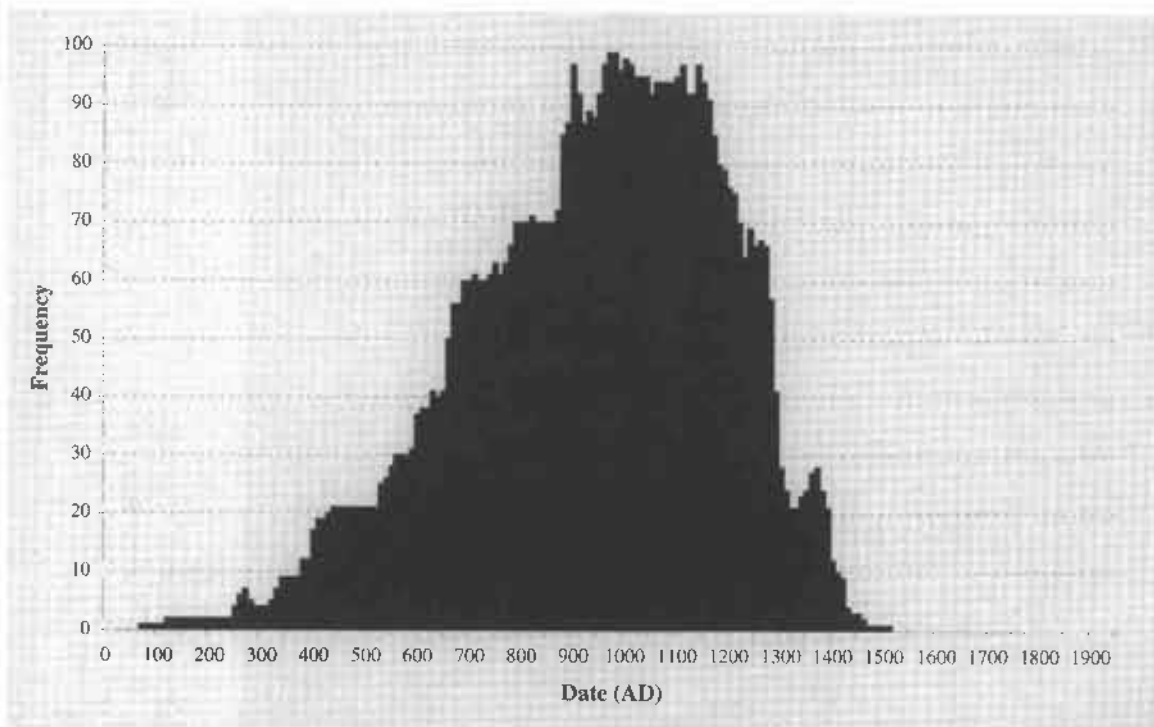
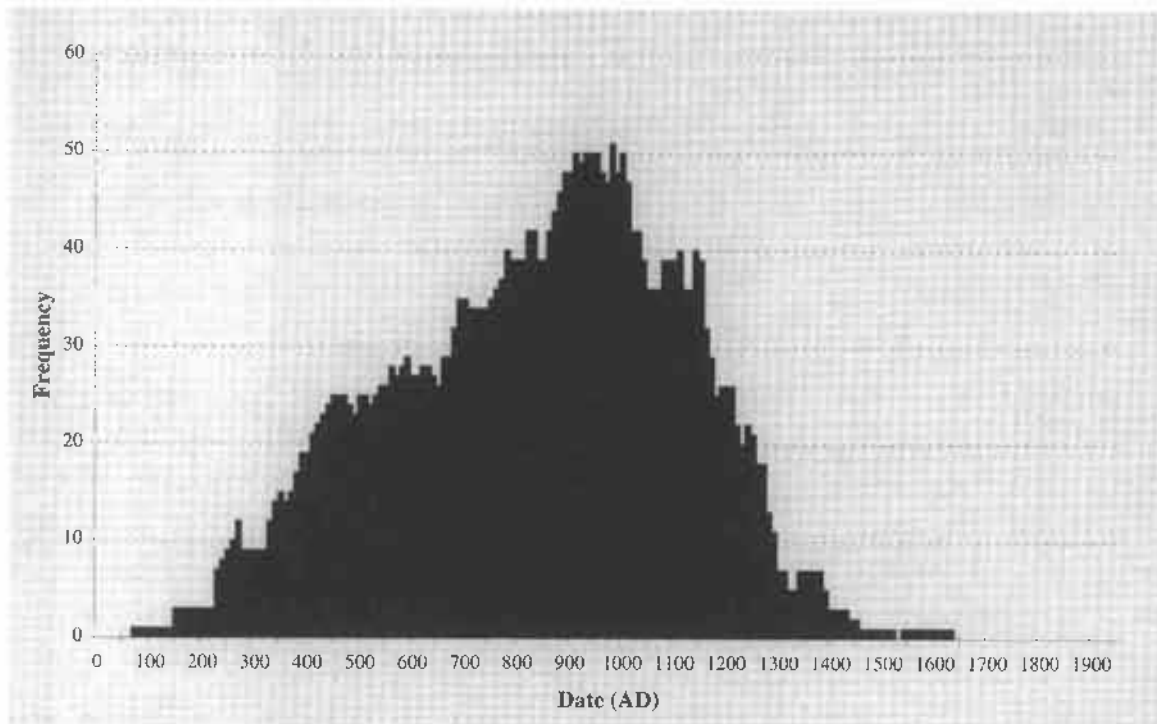


Figure 9. Histogram of the frequency distribution of sample dates from northern Colorado Plateau sites based on 95 percent confidence intervals.





**Figure 10.** Histogram of the frequency distribution of sample dates from all sites with substantial structures. Histogram based on calibrated 95 percent confidence intervals.



**Figure 11.** Histogram of the frequency distribution of sample dates from rockshelter and open sites lacking substantial structures. Histogram based on 95 percent confidence intervals.

Simply stated, when realistic estimates of the statistical uncertainties associated with radiocarbon dates are incorporated into frequency distributions for Fremont sites, numerous peaks and valleys are absent. Consequently, there are no obvious temporal units, other than time itself, for investigating changing settlement patterns. There is certainly no support for Talbot and Wilde's seven period division.

### EXPLORING CONTEXT AND BEHAVIOR

In contrast to the descriptive comparisons of frequency distributions, interpreting the patterning in those frequency distributions is more complex. Numerous authors (e.g., Dean 1978; Schiffer 1986; Smiley 1985) have described multiple sources of error possible in the interpretation of radiocarbon dates. A common concern is age bias related to the old wood problem. Schiffer (1986) argued that reliance on dead wood could result in dates significantly older than events of archaeological interest, and advocated the collection of samples from annual plant materials or small diameter branches. Consequently, site reports that attempt identification of sample material have increased in number (e.g., Billat and Talbot 1994; Greubel 1996; McKibbin 1992; Truesdale 1993). However, in the current study, the majority of samples were processed before much attention was given to potential old wood problems and few reports include sample descriptions beyond charcoal.

Despite reservations about the potential for age overestimation related to woody materials, the practice of gathering charcoal from interior and exterior hearths remains a standard for dating purposes. Excavators preferentially target hearths because they represent primary contexts with a secure functional association. In addition, hearths tend to be readily identifiable and relatively common in residential sites. Because of their function, they also tend to be associated with well preserved organic material. Of the 343 dates contained in the sample, approximately 43 percent are derived from material recovered from hearths. This constitutes the largest contextual category in the sample and represents a substantial contribution to the patterning in the earlier histograms.

In considering the interpretation of hearth-related radiocarbon dates, a promising approach can be found in Shackelton and Prins's (1992) behavioral model of wood collection and use. This model attempts to monitor the tradeoff between the quality of fuel material and the travel distance required for its collection. While high quality fuel (dead, dry wood) might be available in the immediate vicinity when a site is first occupied, as the length of occupation increases so does the distance required to obtain high quality fuel. At some point, depending on abundance and rate of use, lower quality fuels, such as shrubs and branches from live trees, will be substituted. These should consist of locally available resources because reliance on less desirable materials is more economical than traveling the distance needed to gather higher quality fuel. Quite simply, this model suggests the old wood problem will impact temporary camps substantially more than permanent settlements.

Related archaeological research (Kohler and Matthews 1988) indicates that residents of some Anasazi villages faced restricted fuel availability. This study shows patterned changes in the use of fuel materials, documenting decreased reliance on pinion and juniper and an increased reliance on burning of shrubs and cottonwoods. The authors concluded the situation resulted from a combination of agricultural practices and other activities that severely reduced the availability of local fuels.

Behavioral models are a promising start to predicting the types of fuels that might be expected in hearths associated with different site types, but considerable work remains to develop and test them in ethnographic contexts. The predictions provided by these models may prove especially useful in light of the observation that various ethnographic societies burn fires in hearths for prolonged periods. In addition to warmth and light, fire is necessary for numerous tasks, including cooking, resource processing and equipment maintenance. Repeated burning requires frequent cleaning to remove the accumulated ash and charcoal, although data on the frequency of hearth cleaning is extremely rare in the ethnographic literature. Simms (1988:208) notes that among modern Bedouin, hearth contents will only represent the last day or two of occupation at a site. Hearths are frequently cleaned and can hardly be used to characterize long-term camp activities. O'Connell observed that weekly cleaning of hearths is the norm for both the Alyawara of central Australia and the Hadza of east Africa (James F. O'Connell, personal communication, 1998).

If the practice of frequent hearth cleaning applies to the prehistoric past, and there is no obvious reason to believe it should not, then charcoal recovered from hearths will represent only those materials burned in the final days of hearth use. In cases representing relatively long occupations, the combination of economically influenced fuel collection practices and regular hearth cleaning suggests that the probability of anomalous dates caused by old-wood samples is likely small.

Evidence of these behavioral practices creates implications for what is actually being measured by frequency distributions of radiocarbon dates for a particular region or archaeological complex. Distributions have generally been inferred to somehow relate to one or more population parameters. Berry (1982:120), for instance, cautiously interpreted radiocarbon date frequency distributions, stating they "simply depict changes in the relative probability of occupation through time; they are not to be interpreted as population indices." Talbot and Wilde (1989:7) are less cautious, stating that for histograms from Fremont sites with substantial architecture, "We assume that peaked clusters of dates are indicative of population increases, habitational intensity, and aggregation into larger settlements throughout the Fremont region. We also assume that periods of population decline or dispersal can be seen in the valleys between peaked clusters, when few dated remains occur".

Conceptually at least, dates from hearths relate to the abandonment of that feature, and for interior hearths probably the abandonment of their associated structures. For relatively short-term occupations, especially given the comparative precision of radiocarbon dates, the date will be a reasonable estimate of the time of occupation. However, dates from interior hearths in sites occupied for relatively long periods are probably best interpreted as estimates of when the individual structures were abandoned.

In some respects, it is unfortunate that peaks and valleys evident in the histograms presented by Talbot and Wilde disappear when realistic confidence intervals are employed. Regarding the meaning of these peaks and valleys at sites with substantial architecture, they noted, "One might expect the patterns of dates from non-permanent sites to reflect their occupation during times of few dates in permanent sites". Figure 2c [Figure 1 here] shows that this is not the case, however, a fact that poses an interesting problem for future research (Talbot and

Wilde 1989:7). Given the argument developed here, we expect exactly the temporal co-occurrence observed in their graphs for permanent and non-permanent Fremont sites, although to explore this possibility further would require careful sampling and much higher-resolution radiocarbon dating techniques than are currently available.

### CONCLUSION

In 1989, Talbot and Wilde published the results of their analysis of temporal and spatial patterning in radiocarbon dates associated with the Fremont archaeological complex. They concluded there were significant patterns in both dimensions and provided behavioral explanations for that patterning. The goals of the present study were to: 1) reassess that patterning using a data set that included radiocarbon dates analyzed after the publication of their work, and 2) investigate the influence of several assumptions underlying both their analysis and interpretations.

The frequency distributions of calibrated radiocarbon dates produced in this study using realistic confidence intervals are essentially unimodal and sharply contrast with the multimodal histograms provided by Talbot and Wilde (1989). When the sample data set was used to construct a histogram using the 30 year range employed by Talbot and Wilde, a multimodal pattern very similar to their histograms was evident. It appears that reliance on a 30 year range introduces considerable periodicity into the frequency distributions. However, because radiocarbon dates represent a statistical estimate of the actual date of interest, the true confidence intervals for specific dates are significantly more reliable. Considerable effort was devoted to tracking down the details of individual dates in order to reliably include or exclude them from the sample, based on a set of criteria established at the start of the study. However, at the scale of investigation presented in this paper, this culling was unnecessary. The general patterning evident in the histogram based on the 343 date sample is essentially identical to that provided by the larger, uncultured set of 619 dates.

Talbot and Wilde argue that the peaks evident in their histograms for structural sites indicate periods of high occupational intensity. While possibly true, when dates from hearths compose a significant proportion of the dated samples, another interpretation is that the peaks actually indicate periods of abandonment. Given the available evidence, albeit very limited in scope, technologically simple societies clean the ash and charcoal from their hearths frequently. For short term occupations, the corresponding radiocarbon date reflects the occupation of the site; as the span of occupation lengthens, the date will increasingly represent the time when the site was abandoned. The results of this study match decades of conventional wisdom about the temporal characteristics of the Fremont: the archaeological tradition grew gradually to reach a maximum presence around A.D. 900 and then precipitously declined after A.D. 1150 - 1200. This is also true for Great Basin sites. However, the histogram for sites on the Colorado Plateau differs in significant elements: it is more symmetrical and the peak begins and ends earlier, ranging from about A.D. 700 to A.D. 1000. None of the cases examined, however, demonstrated significant temporal breaks in the radiocarbon frequency distributions that argued for further investigation.

## ACKNOWLEDGMENTS

We appreciate all who generously responded to requests for radiocarbon data and information, especially Joan Coltrain, Jerry Spangler and Rich Talbot. We also thank Kevin Jones and Evelyn Seelinger for assistance at the Utah Division of State History, and Michael Massimino for help with computer spreadsheets. Michael Berry, Steven Simms and an anonymous reviewer provided useful comments during the review process. An early version of this paper was presented in a poster session at the 1996 Great Basin Anthropological Conference.

## NOTES

1. A list of the sample dates may be obtained from the senior author.

## REFERENCES CITED

- Barnes, A.  
1985 Radiocarbon Data from the Northern Colorado Plateau. In *Sisyphus Shelter*, edited by J. Gooding and W. L. Shields, Appendix 1, pp. 149-163. Cultural Resources Series No. 18, Bureau of Land Management, Colorado State Office, Denver.
- Berry, M. S.  
1982 *Time, Space and Transition in Anasazi Prehistory*. University of Utah Press, Salt Lake City.
- Berry, C. F. and M. S. Berry  
1986 Chronological and Conceptual Models of the Southwestern Archaic. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by C. J. Condie and D. D. Fowler, pp. 253-327. Anthropological Papers No. 110, University of Utah Press, Salt Lake City.
- Billat, S. E. and R. K. Talbot  
1994 *Box Lodge: A Seasonal Fremont Habitation Site on the Sevier River Plateau near Greenwich, Utah*. Brigham Young University Museum of Peoples and Cultures Technical Series No. 94-2, Provo.
- Dean, J. S.  
1978 Independent Dating in Archaeological Analysis. In *Advances in Archaeological Method and Theory*, vol. 1, edited by M. B. Schiffer, pp. 223-55. Academic Press, New York.
- Geib, P. R. and H. C. Fairley  
1992 Radiocarbon Dating of Fremont Anthropomorphic Rock Art in Glen Canyon, South-Central Utah. *Journal of Field Archaeology* 19:155-168.
- Gerlach, C. and O. K. Mason  
1992 Calibrated Radiocarbon Dates and Cultural Interaction in the Western Arctic. *Arctic Anthropology* 29:54-81.
- Grayson, D. K.  
1993 *The Desert's Past: A Natural Prehistory of the Great Basin*. Smithsonian Institution Press, Washington, D.C.
- Greubel, R. A.  
1996 *Archaeological Investigations of 11 Sites Along Interstate 70: Castle Valley to Rattlesnake Bench*. Alpine Archaeological Consultants, Inc., Montrose, Co. Ms. on file, Utah Division of State History, Salt Lake City.
- Hockett, B.  
1998 The Sociopolitical Meaning of Faunal Remains from Baker Village. *American Antiquity* 53:537-564.

Janetski, J. C.

- 1997 Fremont Hunting and Resource Intensification in the Eastern Great Basin. *Journal of Archaeological Science* 24:1075-1088.

Klein, J., J. C. Learman, P. E. Damon, and E. K. Ralph

- 1982 Calibration of Radiocarbon Dates: Tables Based on the Consensus Data of the Workshop on Calibrating the Radiocarbon Time Scale. *Radiocarbon* 24:103-50.

Kohler, T. A. and M. H. Matthews

- 1988 Long-Term Anasazi Land Use and Forest Reduction: A Case Study from Southwest Colorado. *American Antiquity* 53:537-564.

Madsen, D. B. and D. Rowe

- 1988 Utah Radiocarbon Dates I: Pre-1970 Dates. *Utah Archaeology* 1:52-57.

Madsen, D. B. and S. R. Simms

- 1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12:255-336.

Marwitt, J. P. and G. F. Fry

- 1973 Radiocarbon Dates From Utah. *Southwestern Lore* 38(4):1-9.

Massimino J. and D. Metcalfe

- 1996 *Peaks and Valleys: Fremont Chronology Revisited*. Poster presented at the 25<sup>th</sup> Great Basin Anthropological Conference, Kings Beach, CA.

McKibben, A.

- 1992 *The Questar North-South Pipeline: Final Report on Archaeological Investigations*. Metcalf Archaeological Consultants, Eagle, Co. Ms. on file, Bureau of Land Management, Vernal, UT.

Morss, Noel

- 1931 *The Ancient Culture of the Fremont River*. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 12, No. 2. Harvard University, Cambridge.

Schiffer, M.B.

- 1986 Radiocarbon Dates and the Old Wood Problem: The Case of the Hohokam Chronology. *Journal of Archaeological Science* 13:13-30.

- 1987 *Formation Processes of the Archaeological Record*. University of New Mexico Press, Albuquerque.

Shackleton, C. M. and F. Prins

- 1992 Charcoal Analysis and the Principle of Least Effort: A Conceptual Model. *Journal of Archaeological Science* 19:631-637.

Shott, M. J.

- 1992 Radiocarbon Dating as a Probabilistic Technique: the Childers Site and Late Woodland Occupation in the Ohio Valley. *American Antiquity* 57:202-230.

Simms, S. R.

- 1988 The Archaeological Structure of a Bedouin Camp. *Journal of Archaeological Science* 15:197-211.

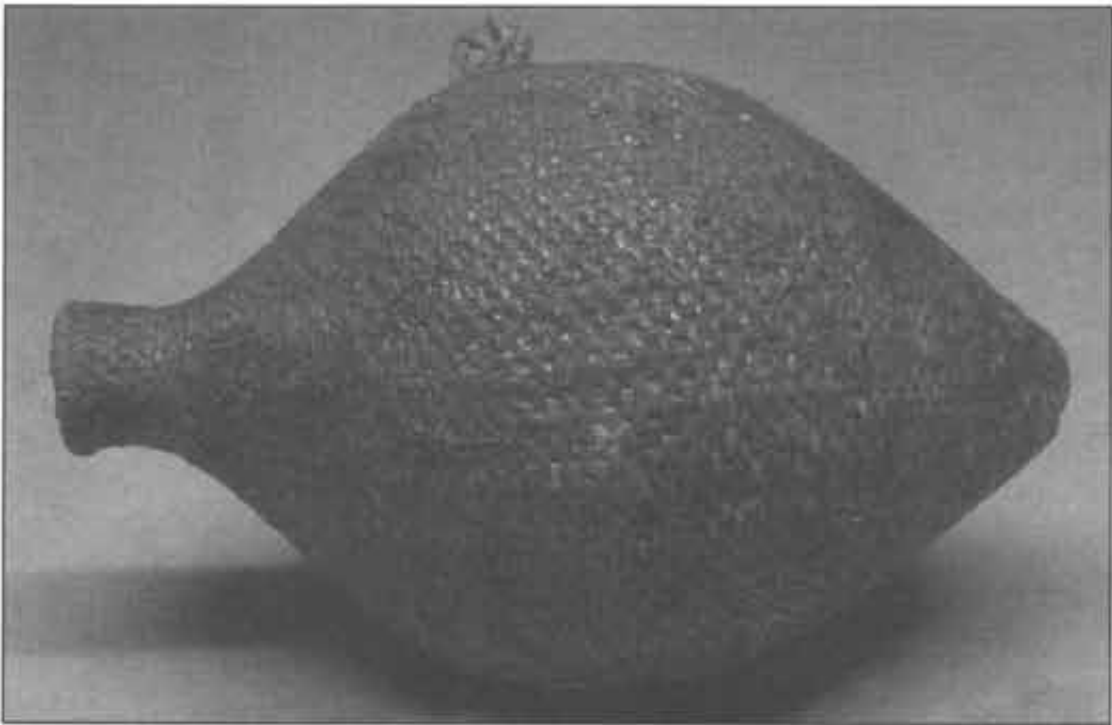
Smiley, F. E.

- 1985 *The Chronometrics of Early Agricultural Sites in the Northern Southwest: Approaches to the Interpretation of Radiocarbon Dates*. Ph.D. dissertation, University of Michigan, Ann Arbor. University Microfilms, Ann Arbor.

Spangler, J. D.

- 1995 *Paradigms and Perspectives: A Class I Overview of Cultural Resources in the Uinta Basin and Tavaputs Plateau*, vol. 2. Uinta Research, Salt Lake City. Ms. on file, Utah Division of State History, Salt Lake City.

- 2000 Radiocarbon Dates, Acquired Wisdom and the Search for Temporal Order in the Uintah Basin. In *Intermountain Archaeology*, edited by D. B. Madsen and M. D. Metcalf, pp. 48-68. University of Utah Press, Salt Lake City, in press.
- Stuiver, M. and P. J. Reimer  
 1993 Extended 14C Database and Revised CALIB Radiocarbon Calibration Program. *Radiocarbon* 35:215-230.
- Talbot, R. K. and J. D. Wilde  
 1989 Giving Form to the Formative: Shifting Settlement Patterns in the Eastern Great Basin and Northern Colorado Plateau. *Utah Archaeology* 2:3-18.
- Talbot, R. K., L. D. Richens, J. D. Wilde, J. C. Janetski, and D. E. Newman  
 1995 *Clear Creek Canyon Archaeological Project, Volume Four: Excavations of Open Habitation Sites*. Brigham Young University Museum of Peoples and Cultures Technical Series No. 95-8, Provo.
- Truesdale, J. A.  
 1993 *Archaeological Investigations at Two Sites in Dinosaur National Monument: 42UN1724 and 5MF2645*. Selections from the Division of Cultural Resources No.4, Rocky Mountain Region, National Park Service, Denver.
- Williams, E.  
 1989 Dating the Introduction of Food Production into Britain and Ireland. *Antiquity* 63:510-521.



*Pitch-Lined Water Jug*

*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*



## Ceramics and Mobility: Assessing the Role of Foraging Behavior and Its Implications for Culture-History

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*Recent studies of Great Basin ceramics have focused on the relationships between mobility and degree of investment in ceramic manufacture (e.g., Bright et al. 1998; Janetski 1998; Simms et al. 1997). These studies have shown that a high degree of residential mobility results in decreased investment of time and energy in the production of ceramic vessels, but have not tied this pattern to factors influencing mobility itself. We assume that degree of residential mobility is a result of foraging opportunities and decisions, and hypothesize that sedentism and consequent investment in ceramic technology should be greater where the structure of the resource base favors foraging for longer periods. Comparisons of ceramics from residential camps within the Great Salt Lake (GSL) wetlands to those from sites in Utah's west deserts and the Little Boulder Basin Area (LBBA) provide a test of this hypothesis. Investment in ceramic manufacture is highest in the GSL region, where foraging opportunities are available nearly year-round, and so residential moves are less frequent. Ceramic investment is lower in the more seasonal environments of the west deserts and LBBA. These results have implications for understanding variation in the timing of the appearance of low investment ceramics within the Great Basin.*

### INTRODUCTION

Ceramics in the Great Basin have a long tradition as cultural-historical markers. Notable examples from the eastern Great Basin include the use of compositional and morphological variation to define regional subvariants among the Fremont (Madsen 1977; Marwitt 1970) and the use of ceramic types as ethnic markers (e.g., Butler 1979, 1983; Lyneis 1994; Madsen 1975; Plew 1979). Brownwares, for example, are frequently referred to as "Shoshoni Ware" and have been associated with the spread of Numic speakers out of California and into the Great Basin (Janetski 1990; Lyneis 1994; Madsen 1975). Brownware sherds are thought to appear earlier in the western Great Basin and later in the east, a position which has some support based on thermoluminescence dating of the sherds themselves (Rhode 1994). This hypothesized late arrival in the east has often been associated with the end of the Fremont period and the arrival of Shoshoni Ware taken as an indication of population migration and replacement (e.g., Madsen 1975).

More recent work with eastern Great Basin ceramics has tried to add to the established cultural-historical perspective by addressing the behavioral implications of variability in ceramic manufacture. This work focuses on the relationship between mobility and degree of investment in material culture (e.g., Bright et al. 1998; Janetski 1998; Simms et al. 1997; also see Whalen 1994:70-91). These studies recognize that a high degree of residential mobility poses a different set of constraints on ceramic manufacture than a lower one. Both the amount of time and

energy invested in producing ceramic vessels, and the variety of vessel types and production technology produced, may be much more limited in the highly mobile case, and initial tests of this proposition seem to bear it out (Bright et al. 1998; Janetski 1998; Simms et al. 1997).

These studies measure ceramic investment through analysis of commonly described ceramic variables such as temper particle size, wall thickness, and surface preparation. While putting time and effort into controlling these variables is one form of investment in itself, greater investment can also include the effort required to maintain a tool kit such as paddles and anvils used to create thin walls, or polishing stones to smooth surfaces. Greater investment is further represented by producing a wide variety of specific vessel forms rather than one or only a few multipurpose pots (Arnold 1999). To the extent that greater residential mobility imposes constraints on ceramic use-life and one's ability to transport a diverse assemblage and tool kit, it should favor lower investment.

In the case of Bright et al. (1998) and Simms et al. (1997), analysis of investment was carried out by dividing ceramic sites into groups reflecting differing levels of mobility. These groups were then compared with variables considered to be indicative of greater or lesser investment in ceramic manufacture. The assignment of sites to different categories, however, was based on aspects of a site's non-ceramic assemblage size and variability, and there is little discussion of the underlying cause of the differences in mobility being characterized.

The analysis presented here represents an initial attempt to deal with this issue. We argue that degree of residential mobility should be strongly influenced by foraging opportunities and that this will be reflected by investment in ceramic manufacture. In particular, we suggest that there are regional differences in foraging opportunities between the Great Salt Lake (GSL) wetlands area, the more arid environment of western Utah, and the Little Boulder Basin Area (LBBA) of north-central Nevada (Figure 1).

In the section that follows, we discuss why the GSL region represents the area with the greatest potential for sedentism and the LBBA area the least. We then present the study methodology and show that investment in ceramic manufacture is largely consistent with our predictions: ceramics from the GSL area show the highest level of investment, those from the LBBA the lowest, and those from western Utah something intermediate. We conclude by discussing the implications of these findings for understanding prehistoric behavior and its relationship to established culture-history.

### FORAGING, MOBILITY, AND ENVIRONMENT

David Zeanah has employed a central-place foraging model in the Carson wetlands and surrounding desert environments in western Nevada to predict mobility and settlement patterns (1996). We apply Zeanah's model here, acknowledging climatic fluctuation across space and time, but assuming similarity in relationships between wetland and desert environments.

Three strengths of Zeanah's model are its fine-grained approach, its attention to men's and women's foraging options, and its attention to conflicts of interest between the sexes (Zeanah 1996:284-296). It assumes that seasonal mobility and settlement pattern operate to optimize foraging returns for both sexes, predicts that central places

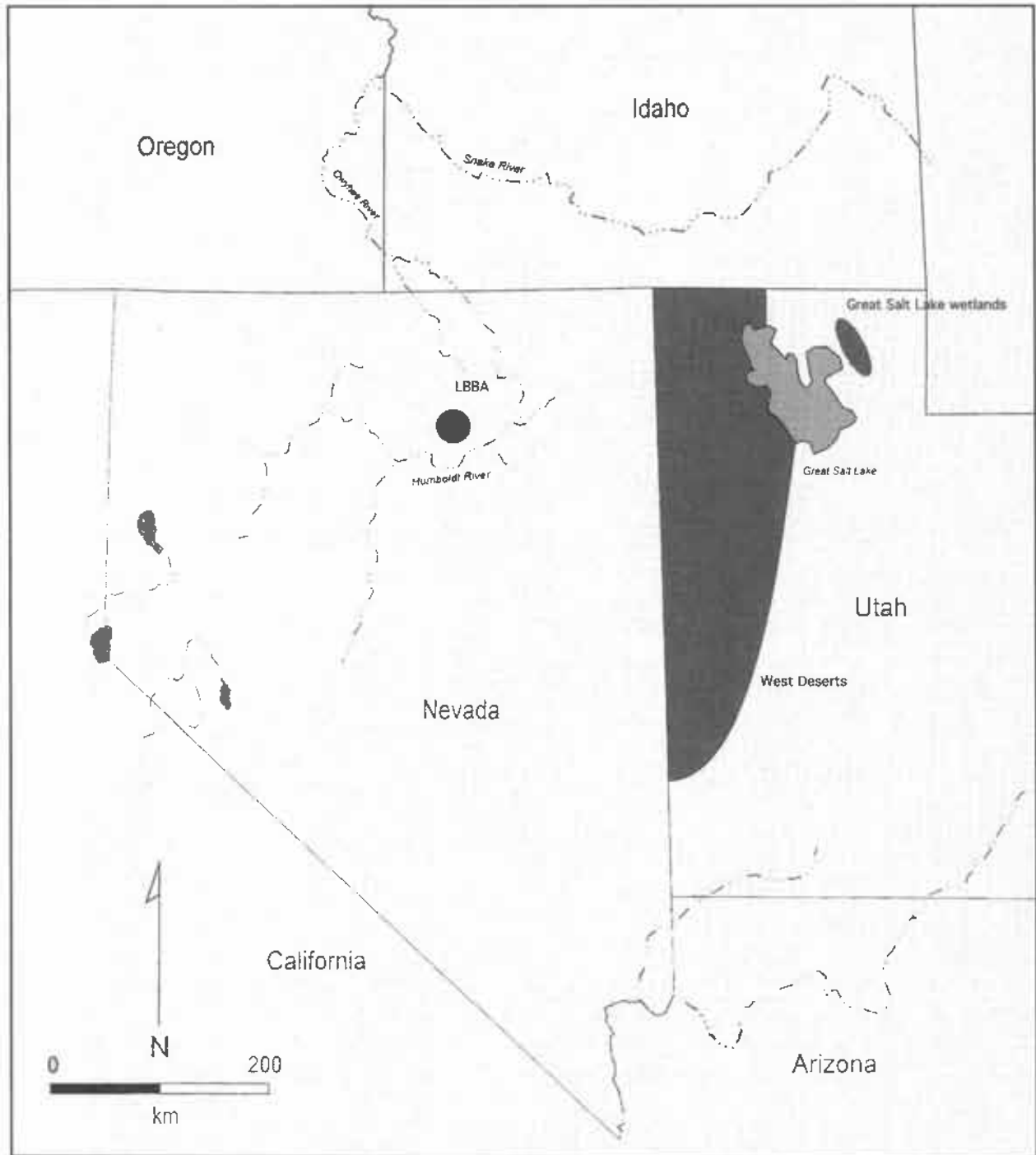


Figure 1. The Great Basin, showing the Great Salt Lake wetlands, west deserts, and LBBA.

should usually be located in women's best foraging areas, and predicts that men should forage logistically from them (Zeanah 1996:291-351, 371-374). Tests of predictions against the archaeological record show that most predictions are met.

Wetlands habitats are predicted to be occupied year-round. In all seasons, marshland habitats rank highest or among the highest for women's resources (Zeanah 1996:Tables 6.9 and 6.10). These locations also provided men simultaneous opportunities to forage logistically. The same situation holds in the Great Salt Lake, where marshes are sandwiched between the Wasatch Front and the Great Salt Lake (cf. Yesner 1981 and citations therein), and precipitation, run-off, river systems, and lake fluctuations feed a large standing marshland.

This is unlike Utah's west deserts. Zeanah's model predicts that desert and montane environments (with the exclusion of badlands and playas) ought to see seasonal exploitation. Resources in these areas are available for only limited times and are often patchy in their distribution (Zeanah 1996:153-243), a situation that probably holds in Utah's west deserts as well. Precipitation is more scarce in the deserts than in the wetlands, and water is patchily distributed. With the exception of a few locations, like Fish Springs, it is also ephemeral. Wide, resource-poor salt flats, mud flats, and playas separate isolated mountain ranges. In these environments, women are predicted to move at least seasonally from habitat to habitat, while men forage logistically at various distances from camp (Zeanah 1996: Tables 6.9 and 6.10). This prediction of low residential mobility in marshland environments relative to desert environments is also consistent with Kelly (1995:111-160) and we predict that ceramics from the GSL wetlands should show higher investment than sherds from the west deserts.

We further predict that ceramics from the LBBA should reflect the lowest investment of all. Data suggest that occupation of the LBBA occurs mainly in late spring and early summer. Flotation samples from LBBA sites are dominated by seeds that are typically available in May, and perhaps early June (Coulam 1996). Modern climatic data suggest that snow melt and run-off from winter-heavy precipitation provide an increase in water during this season, flowing in three ephemeral drainages (BLM 1991). Only one small spring provides relatively reliable water the rest of the year.

Local foragers, then, probably did not rely as heavily on LBBA resources during the other times of the year. We think they exploit the area for only a short, limited season, and in a highly mobile way. This point is underscored by the fact that archaeology in the LBBA has been driven by mining operations, and encompasses only a few square kilometers. Thus the definition of the LBBA corresponds to mining interests, not foraging interests. The LBBA is only a seasonal snapshot of what must surely have been a broader round, and artificially culls potential locales of lower residential mobility in neighboring habitats. For example, one might expect evidence of lower residential mobility to the east of the LBBA, along Maggie Creek. Steward observed a winter village occupation there (1938:Figure 11, 152-164). This permanent water source flows south to the Humboldt River, where more villages were observed. Pinyon pinenuts, an ethnographic Great Basin food staple, are not available in the area. The nearest

pinyon stands people may settle around are along the west side of the Ruby Mountains (Steward 1938:157), about 100 km away. So, while local foragers may experience low residential mobility in other places during other parts of the seasonal round, the archaeological evidence suggests they do not while in the LBBA.

## METHODS

In order to assess the relationship between predicted residence time and ceramic investment we drew on a sample of several thousand sherds analyzed in three different studies (Bright 1999; Bright et al. 1998; Simms et al. 1997). These sherds come from 49 sites: 13 in the GSL wetlands, 27 from western Utah, and 9 from the LBBA of north-central Nevada. All of the ceramic sites in the LBBA are consistent with "residential camps" used in the other studies (Bright et al. 1998; Simms et al. 1997). Categories of residential mobility are based on a site's investment in dwellings and storage facilities, and assemblage size and richness, independent of ceramic assemblages. In order to facilitate comparisons across regions, only sites originally classified as residential camps were selected from the Utah studies. The ceramic sherds for each of these sites were characterized according to three variables.

The first variable was temper particle size. The choice of temper materials and their size is an important component in the performance of ceramic vessels. Finer temper increases resistance to crack initiation as a result of thermal and mechanical stress (Kingery et al. 1986: 768-813; Kirchner 1979:1-12). It also permits the production of vessels with thinner walls, reducing weight and increasing thermal conductivity and thermal shock resistance (Rice 1987: 227). Although a more heterogeneous paste containing larger pieces of temper appears to increase resistance to crack propagation, there are limits. These are set by the difference in rates of thermal expansion between paste and temper material, with such differences being exacerbated by increasing temper size (Rye 1976: 116-118). Thus, finer temper was used as one gauge of investment. Since the critical variable appears to be the maximum particle size, the largest piece of temper was measured to the nearest tenth of a millimeter for each sherd. Smaller values represent greater investment.

The second measurement of ceramic investment was the thickness of the sherd, measured in tenths of a millimeter. Thinner walls offer advantages in terms of weight, resistance to thermal stress, thermal conductivity, and heating efficiency (Braun 1983:118-119). We see thinner sherds as representing greater investment, at least insofar as they represent the production and use of additional technologies to produce them (e.g., paddles and anvils). Although a measure of wall thickness which controls for vessel diameter may be a more accurate gauge of investment (Bright et al. 1998), the use of wall thickness alone has the advantage of being a variable which is widely measured and reported.

The final measure of investment selected was the amount of surface preparation present on the sherds (smoothing, burnishing, polishing, etc.). Whether for purely aesthetic reasons or for more functional ones such as reducing the propagation of subsurface imperfections, increased resistance to abrasion (Skibo and Schiffer 1987:93), and resistance to thermal shock cracking and thermal spalling (Schiffer et al. 1994: 197), smoothing and polishing of the internal and/or external surface of a ceramic vessel represents an increased investment in the artifact on the part

of the potter. Sherds were therefore divided into those with surface preparation and those without. A larger percentage of sherds with surface preparation represents greater investment.

After assessing the sherds for each of the above variables, their mean and standard error were computed within each region using the raw data. Differences between regions for temper particle size were performed using t-tests on log-transformed data in order to reduce skewness. Tests for differences in wall thickness were performed using t-tests on the untransformed data (which were normally distributed), while those for surface preparation were based on a binomial test for differences in two sample proportions.

### RESULTS

Our prediction is that investment in ceramic manufacture should be highest in the GSL area, intermediate in the west deserts, and lowest in the LBBA. Data are largely consistent with this prediction and are summarized in Table 1. The only inconsistent result is that LBBA sherds show greater than expected investment in temper size. All differences are significant at  $p = .01$ .

None of these tests completely meets the assumption of independence, however, since several sherds may have come from the same pot. We do not feel the problem is severe given the number of sites from which the samples were drawn (sherds from different sites are unlikely to be from the same pot) and the fact that all other statistical assumptions have been met. A definitive assessment of the magnitude of the statistical independence problem is currently unknown and we are unaware of any attempt to deal with it in the published literature. In an effort to correct for it, we re-ran the tests using data aggregated by site. Here, regions are compared using averages of investment at sites, not specific sherds. For example, average temper particle size was computed for the sherds from each site in a region. Each site then becomes a single datum point and the average of the values for sites in a region is used to compare one region with another. Although logistical connections between sites would still invalidate the independence assumption, the likelihood of this being a major factor is much smaller.

The results of this exercise are consistent with previous results (Table 2), though statistical significance is not quite as strong due to reduced sample size. Comparisons between the western Utah and GSL sites are as expected ( $p = .08$  across all variables). However, comparisons between the LBBA and western Utah sites show predicted results in only two out of three variables. Again, temper size in the LBBA reflects greater than expected investment.

Finally, since many of the sites from the LBBA contain few sherds, these same tests were run a third time. This time we used only sites with eight or more sherds. The same relationships hold, but again with occasionally weaker significance due to the reduced LBBA sample size ( $n = 4$  LBBA sites with eight or more sherds).

**Table 1.** Investment data from all three regions, using data from each sherd. Temper size data are not log transformed, but all statistical tests were performed on log transformed data.

Region	Temper Size (mm)	Wall Thickness (mm)	Surface Preparation (%)
LBBA	1.30 ± 1.1 (n=281)	5.59 ± 1.3 (n=267)	16.6 (n=315)
West Deserts	1.57 ± 1.0 (n=449)	5.30 ± 1.1 (n=452)	29.9 (n=442)
Great Salt Lake	0.91 ± 0.7 (n=2676)	5.04 ± 1.2 (n=1825)	71.7 (n=2086)

**Table 2.** Investment data from all three regions, using each site's mean values. Temper size data are not log transformed, but statistical tests were performed on log transformed data.

Region	Sites	Temper Size (mm)	Wall Thickness (mm)	Surface Preparation (%)
LBBA	9	1.09 ± 0.7	5.80 ± 1.5	7.4 ± 0.9
West Deserts	27	1.62 ± 0.8	5.33 ± 0.9	37.2 ± 3.6
Great Salt Lake	13	0.96 ± 0.5	4.87 ± 0.4	69.7 ± 2.0

**Table 3.** Differences between gray and brown sherds in the LBBA. All p values ≤ .001. Temper size data are not log transformed, but statistical tests were performed on log transformed data.

Variable	Brown	Gray
Wall Thickness (mm)	5.73 ± 1.3 (n = 234)	5.00 ± 0.9 (n = 56)
Temper size (mm)	1.53 ± 1.1 (n = 257)	0.47 ± 0.4 (n = 58)
Surface preparation	13.0 % (n = 257)	27.6 % (n = 58)



## DISCUSSION

This analysis suggests that variability in ceramics is responsive to individuals' foraging behavior and the way people move about the land. Ceramic variability, then, can be used as a means to discuss behavioral issues in Great Basin prehistory, and compliment attempts at temporal and cultural identification. An interesting application of these ideas concerns the appearance of brownware ceramics discussed in the introduction.

Of all of the ceramics observed as part of this study, brownware ceramics consistently show some of the lowest levels of investment. For example, Bright (1999) reports that brown sherds consistently show less investment than grey sherds within the LBBA. We reproduce these data in Table 3, re-running t-tests on log transformed temper data and applying the appropriate binomial test to surface preparation data. LBBA grey sherds contain finer temper, greater frequency of surface preparation and thinner walls than the brown. All differences are statistically significant ( $p < .001$ ).

A brief review of published data on brown and grey ceramics from several other sites within the Great Basin are consistent with these observations. At the Tosawihi Quarries, 242 sherds include brown and grey paste colors. Brownware was found at six sites and Great Salt Lake Grey sherds were found on two (Schmitt 1992). While not every variable measured in the LBBA case has been measured for these sherds, wall thicknesses of the greys and browns reflect the same pattern seen in the LBBA. Brown sherds range from 4.2 mm to 9.1 mm, while grey sherds range from 4.2 mm to 6.7 mm (averages are reported by site and provenience in the original report). The pooled mean wall thickness for brown ware ( $n = 186$ ) is 6.6 mm and 4.5 mm for greys ( $n = 54$ ; from Schmitt 1992:Table 103). Brownwares show less investment in wall thickness.

In addition to this, Patricia Dean has summarized wall thickness and temper size data for 24 sites in northern Utah, some of which are also included in the western Utah data presented here. She reports that "Shoshoni Ware" in this area bears thicker walls and coarser temper than Great Salt Lake Grey (Dean 1992:40, 68, 72). This is consistent with the differences of investment reported between brown and greywares from the LBBA and Tosawihi quarries.

Two immediate questions concern: 1) the relationship between brown paste colors and low investment and, 2) the relationship between investment and the timing of the appearance of various wares throughout the Great Basin. A tentative answer to the first question concerns the fact that grey paste colors result from firing in a reducing or incompletely oxidizing atmosphere, while brown paste colors usually reflect firing in an oxidizing atmosphere (Rice 1987: Table 11.3). Atmosphere can be controlled to a large extent by the potter, with reducing atmospheres produced by limiting the flow of oxygen (Sinopoli 1991). In this way, firing in a reducing atmosphere can be thought of as greater investment, as the potter must work to control the oxygen flow (see descriptions in Rye 1981). Additionally, reducing atmospheres can produce higher temperatures than oxidizing ones (Rye 1981: 118-119). To the extent that all of this requires more fuel, search and effort getting better-suited fuel, and providing a sealed environment for firing, creating reducing atmospheres represents greater investment. If grey coloration is a result of firing in a reducing atmosphere, then greyware ceramics reflect greater investment by extension.

Reid (1990) provides a possible reason why one would prefer to fire vessels in reducing atmospheres. Firing

in a reducing atmosphere typically produces higher temperatures than in an oxidizing one. Higher temperatures produce more complete vitrification and create a better-suited, sturdier vessel. This permits more intense and/or longer-term use. Individuals experiencing low residential mobility might thus choose to invest more not only in *making* the ceramic vessels themselves, but also in *firing* them at higher temperatures. The end result is a higher quality, longer-lived, and often grey pot. While this idea merits further evaluation, it is certainly amenable to testing.

If brownware ceramics represent a minimal level of investment in ceramic manufacture associated with a high degree of residential mobility, and if that mobility is structured by foraging opportunities and decisions, then we may be able to relate the timing of their appearance to behavioral changes in the archaeological record. Madsen (1975) observes that brownwares (or "Numic" wares generally) appear in eastern Great Basin contexts by late or post-Fremont times. More recently Rhode (1994) shows that brownwares are present in central Nevada by A.D. 800 and their presence is well established in the southern and eastern Great Basin by A.D. 1000.

Given that brownware ceramics represent a very low level of investment likely associated with mobile lifeways, their late appearance in the eastern Great Basin should be no surprise. The periphery of the Great Salt Lake has supported a large marsh and lakeside resource base throughout the late Holocene and should select for reduced mobility and increased ceramic investment. Furthermore, farming was practiced in the northeastern Great Basin from the beginning of the common era until at least A.D. 1350 and possibly later. Farming is clearly associated with a reduced level of mobility and the level of ceramic investment at agricultural sites in the Great Salt Lake wetlands area is the highest of any site type (Simms et al. 1997). As farming falls out of the suite of adaptive strategies, we might expect an increase in residential mobility and the appearance of lower investment brownwares after this time. This behavioral change could occur regardless of, or in concert with, ethnic and/or linguistic replacement.

In contrast, individuals in the southern and central Great Basin may have been faced with a series of foraging options much more similar to those of the LBBA. Like the LBBA, ceramic investment would have varied (i.e., both grey and brownware ceramics may have been produced at different times) according to the constraints imposed by immediate foraging opportunities. Unlike the Great Salt Lake region, these areas lacked the sorts of foraging opportunities required to promote more established, sedentary lifestyles over long time periods. Instead we see mobile foragers occasionally investing only limited effort ceramic production.

A general reading of American Southwest ceramic literature compliments this point. Brownwares appear earliest and are unrelated to the beginnings of food production (Crown and Wills 1995:242). With increasing reliance on corn agriculture and decreasing residential mobility, we see the extension of this continuum through greywares to fine painted wares (e.g., Colton 1956). Painting vessels might be another level of investment. This cultural-historical sequence, then, provokes a working hypothesis about foraging behavior and decreasing residential mobility. Changes in mobility behaviors might happen at different times in different regions, so the changes in ceramic investment production need not be universal or unidirectional. Perhaps the reason painted wares do not show up as much in Utah north of the Colorado River, and appear even less frequently in the rest of the Great Basin, has as much to do with mobility behavior as cultural preference.

### SUMMARY AND CONCLUSIONS

A growing number of studies indicate that residential mobility plays a role in shaping the level of investment in ceramic technology. We add to this work by evaluating a relationship between foraging opportunities, mobility behavior, and ceramic investment. We suggest that the nature of foraging opportunities in certain environments promote more sedentary occupation and demonstrate that investment in ceramic technology varies accordingly. Regions such as the Great Salt Lake wetlands favor more sedentary occupation and show higher levels of investment in ceramic technology while areas such as Utah's west deserts and the Little Boulder Basin Area of Nevada favor more mobile foraging behavior and show less investment.

We also demonstrate that in at least some cases, Great Basin brownwares represent less investment in manufacture than greywares in terms of variables such as wall thickness, temper particle size, and surface preparation. Depending on the content of the clay used, even coloration may be indicative of investment if it results from the atmosphere in which a vessel was produced, and if control over that atmosphere confers the performance advantages cited in the ceramic literature. True, it would be dangerous to simply assume that brownwares equal low investment. Such an assumption would mask the variability one wants to measure and explain. Still, using this information in conjunction with that developed in the analysis of foraging options and ceramic investment, we put forward hypotheses about the general shape of ceramic culture-history and suggest that the appearances (and disappearances) of brown, grey and painted traditions at differing times may be the result of changing foraging and mobility behaviors, potentially without regard for ethnic change.

A simple test is to replicate this study and the others like it at various points in archaeological space and time, measuring investment and controlling for residential mobility. It may be found that brownwares do not always represent lowest investment, but this doesn't matter. The ability to quantify and explain variability in material culture strengthens our understanding of the past specifically, and human behavior generally.

### ACKNOWLEDGMENTS

Ceramic analysis for the Great Salt Lake Wetlands Project was funded by the National Science Foundation (DBS9223227 to S. R. Simms and D. H. O'Rourke) and the U.S. Bureau of Reclamation. The analysis of ceramics from Utah's west deserts was funded by the U.S. Army Dugway Proving Ground (to S. R. Simms). Thanks to Kathy Callister, Dugway Proving Ground, for making the west desert project possible. Also, thanks to Kathy Kankainen, David Madsen, Shannen Robson, and Barbara Walling for helping us find ceramic collections, and for access to them. LBBA ceramic analysis was performed at P-III Associates, Inc., in Salt Lake City, under contracts with various mining companies.

A number of people read and re-read drafts of this article and we thank them for their patience and helpful comments. This applies to all those who provided technical assistance as well. Thanks are also extended to the reviewers and editor. Greg Miller produced the original Figure 1, and Peter Ainsworth helped prepare it.

## REFERENCES CITED

- Arnold, P. J., III  
 1999 Tecomates, Residential Mobility, and Early Formative Occupation in Coastal Lowlands Mesoamerica. In *Pottery and People: A Dynamic Interaction*, edited by J.M. Skibo and G.M. Feinman, pp. 159-170. University of Utah Press, Salt Lake City.
- Braun, D. P.  
 1983 Pots as Tools. In *Archaeological Hammers and Theories*, edited by J. A. Morre and A. S. Keene, pp. 107-134. Academic Press, New York.
- Bright, J. R., S. R. Simms, and A. Ugan  
 1998 *Identifying Residential Mobility and Adaptive Diversity with Plain Ceramics: An Example from Western Utah*. Poster presented at 26<sup>th</sup> Great Basin Anthropological Conference, Bend, Oregon.
- Bright, J. R.  
 1999 Modeling Pottery Manufacture and Use Among Hunter-Gatherers. In *Open Site Archaeology: 1996 Bootstrap Data Recovery Excavations, North-Central Nevada*. Cultural Resources Report Number 5082 9804-01. Little Boulder Basin Series No. 12, edited by A. R. Schrodel, pp. 363-376. Ms. on file Bureau of Land Management, Elko District Office, Elko, NV, and P-III Associates, Inc., Salt Lake City. Bureau of Land Management  
 1991 *Draft Environmental Impact Statement, Betze Project*. United States Department of the Interior, Bureau of Land Management, Elko District Office, Elko, NV.
- Butler, R. B.  
 1983 *The Quest for the Historic Fremont and a Guide to the Prehistoric Pottery of Southern Idaho*. Occasional Papers of the Idaho Museum of Natural History, No. 23. Pocatello.  
 1979 *A Fremont Culture Frontier in the Upper Snake and Salmon River Country?* Miscellaneous Papers of the Idaho Museum of Natural History, No. 18. Pocatello.
- Colton, H. S.  
 1956 *Pottery Types of the Southwest*. Ceramic Series 3C, Museum of Northern Arizona, Flagstaff.
- Coulam, N. J.  
 1996 Plant Utilization in the Little Boulder Basin. In *Open Site Archaeology in the Little Boulder Basin: 1993-1994 Data Recovery Excavations in the North Block Tailings Impoundment Area, North-Central Nevada*. Cultural Resources Report 5039-01-9601, Little Boulder Basin Series 7, edited by A. R. Schrodel, pp. 729-754. Ms. on file, Bureau of Land Management, Elko District Office, Elko, Nevada, and P-III Associates, Inc., Salt Lake City.
- Crown, P. L. and W. H. Wills  
 1995 Economic Intensification and the Origins of Ceramic Containers in the American Southwest. In *The Emergence of Pottery: Technology and Innovation in Ancient Societies*, edited by W. K. Barnett and J. W. Hoopes, pp. 241-254. Smithsonian Institution Press, Washington, D.C.
- Dean, P. A.  
 1992 *Prehistoric Pottery in the Northeastern Great Basin: Problems in the Classification and Archaeological Interpretation of Undecorated Fremont and Shoshoni Wares*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.
- Janetski, J.  
 1998 People, Pots and Perambulations: The Continuing Story in the Eastern Great Basin. Paper presented at the 26<sup>th</sup> Great Basin Anthropological Conference, Bend, Oregon.  
 1990 Ethnicity and Post-Formative Ceramics in the Eastern Great Basin. In *Hunter-Gatherer Pottery from the Far West*, edited by J. M. Mack, pp. 221-227. Anthropological Papers No. 23, Nevada State Museum, Carson City.

- Kelly, R. L.  
1995 *The Foraging Spectrum*. Smithsonian Institution Press, Washington, D.C.
- Kingery, W. D., H. K. Bowen, and D. R. Uhlmann  
1976 *Introduction to Ceramics*. John Wiley and Sons, New York.
- Kirchner, H. P.  
1979 *Strengthening of Ceramics*. Marcel Dekker, New York.
- Lyneis, H. P.  
1994 East and onto the Plateaus? An Archaeological Examination of the Numic Expansion in Southern Nevada. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D. B. Madsen and D. Rhode, pp. 141-149. University of Utah Press, Salt Lake City.
- Madsen, D. B.  
1975 Dating a Paiute-Shoshoni Expansion in the Great Basin. *American Antiquity* 40:82-86.
- Madsen, R. E.  
1977 *Prehistoric Ceramics of the Fremont*. Ceramic Series No. 6, Museum of Northern Arizona, Flagstaff.
- Marwitt, J. P.  
1970 *Median Village and Fremont Culture Regional Variation*. Anthropological Papers No. 95, University of Utah Press, Salt Lake City.
- Plew, M. G.  
1979 Southern Idaho Plain: Implications for Fremont-Shoshoni Relationships in Southwestern Idaho. *Plains Anthropologist* 24(86):329-335.
- Reid, K. C.  
1990 Simmering Down: A Second Look at Ralph Linton's "North American Cooking Pots." In *Hunter-Gatherer Pottery of the Far West*, edited by J.M. Mack, pp. 7-18. Anthropological Papers No. 23, Nevada State Museum, Carson City.
- Rhode, D.  
1994 Direct Dating of Brown Ware Ceramics Using Thermoluminescence and its Relation to the Numic Spread. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D.B. Madsen and D. Rhode, pp. 124-130. University of Utah Press, Salt Lake City.
- Rice, P. M.  
1987 *Pottery Analysis: A Sourcebook*. University of Chicago Press, Chicago.
- Rye, O. S.  
1981 *Pottery Technology: Principles and Reconstruction*. Manuals on Archeology 4. Tarazacum, Washington.  
1976 Keeping Your Temper Under Control: Materials and the Manufacture of Papuan Pottery. *Archaeology and Physical Anthropology in Oceania* 11:106-137.
- Schiffer, B. M., J. M. Skibo, T. C. Boelke, M. A. Neupert, and M. Aronson  
1994 New Perspectives on Experimental Archaeology: Surface Treatments and Thermal Response of the Clay Cooking Pot. *American Antiquity* 59:197-217.
- Schmitt, D. N.  
1992 Ceramics. In *Archaeological Investigations at Tosawih, a Great Basin Quarry. Part 1: The Periphery*, edited by R.G. Elston and C. Raven, pp. 297-302. Ms. on file, Bureau of Land Management, Elko Resource Area, Elko, Nevada, and Intermountain Research, Silver City, Nevada.

Skibo, J. M. and M. B. Schiffer

1987 The Clay Cooking Pot: An Exploration of Women's Technology. In *Expanding Archaeology*, edited by J. M. Skibo, W. H. Walker and A. E. Neilsen, pp. 80-91. University of Utah Press, Salt Lake City.

Simms, S. R., J. R. Bright, and A. Ugan

1997 Plain-Ware Ceramics and Residential Mobility: A Case Study from the Great Basin. *Journal of Archaeological Science* 24:779-792.

Sinopoli, C. M.

1991 *Approaches to Archaeological Ceramics*. Plenum Press, New York.

Steward, J. H.

1938 *Basin-Plateau Aboriginal Sociopolitical Groups*. Bureau of American Ethnology, Bulletin 20. Smithsonian Institution, Washington, D.C.

Whalen, M. E.

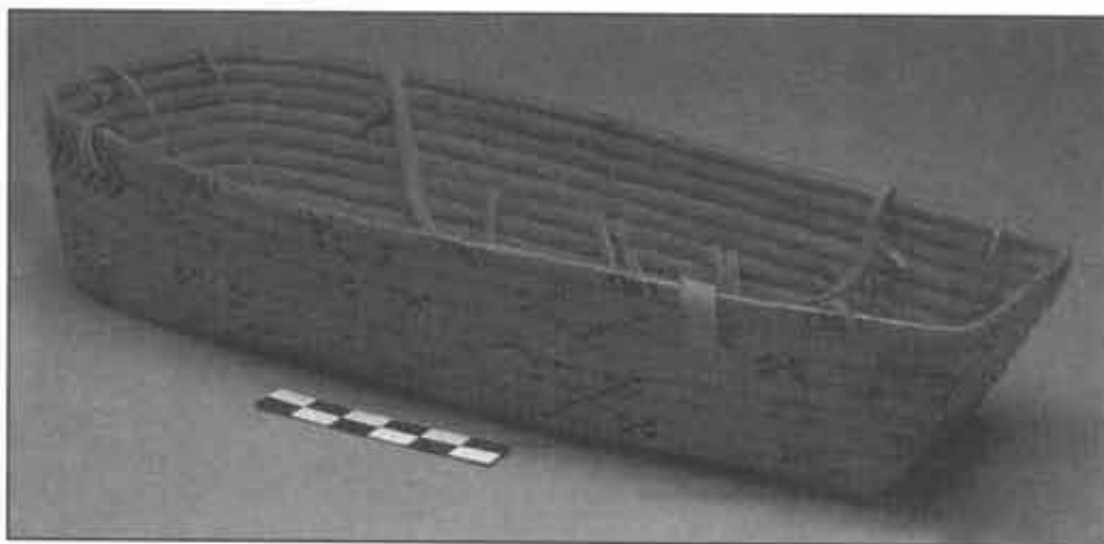
1994 *Turquoise Ridge and Late Prehistoric Residential Mobility in the Desert Mogollon Region*. Anthropological Papers No. 118. University of Utah Press, Salt Lake City.

Yesner, D. R.

1981 Archaeological Applications of Optimal Foraging Theory: Harvest Strategies of Aleut Hunter-Gatherers. In *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*, edited by B. Winterhalder and E. A. Smith, pp. 148-170. University of Chicago Press, Chicago.

Zeanah, D. W.

1996 Predicting Settlement Patterns and Mobility Strategies: An Optimal Foraging Analysis of Hunter-Gatherer Use of Mountain, Desert and Wetland Habitats in the Carson Desert. Vol. 2. Unpublished Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City.



*Cradle Basket with Leather Straps*  
Courtesy of the Utah State University Museum of Anthropology, Dathan Collection



*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*



## Playa View Dune: A Mid-Holocene Campsite in the Great Salt Lake Desert

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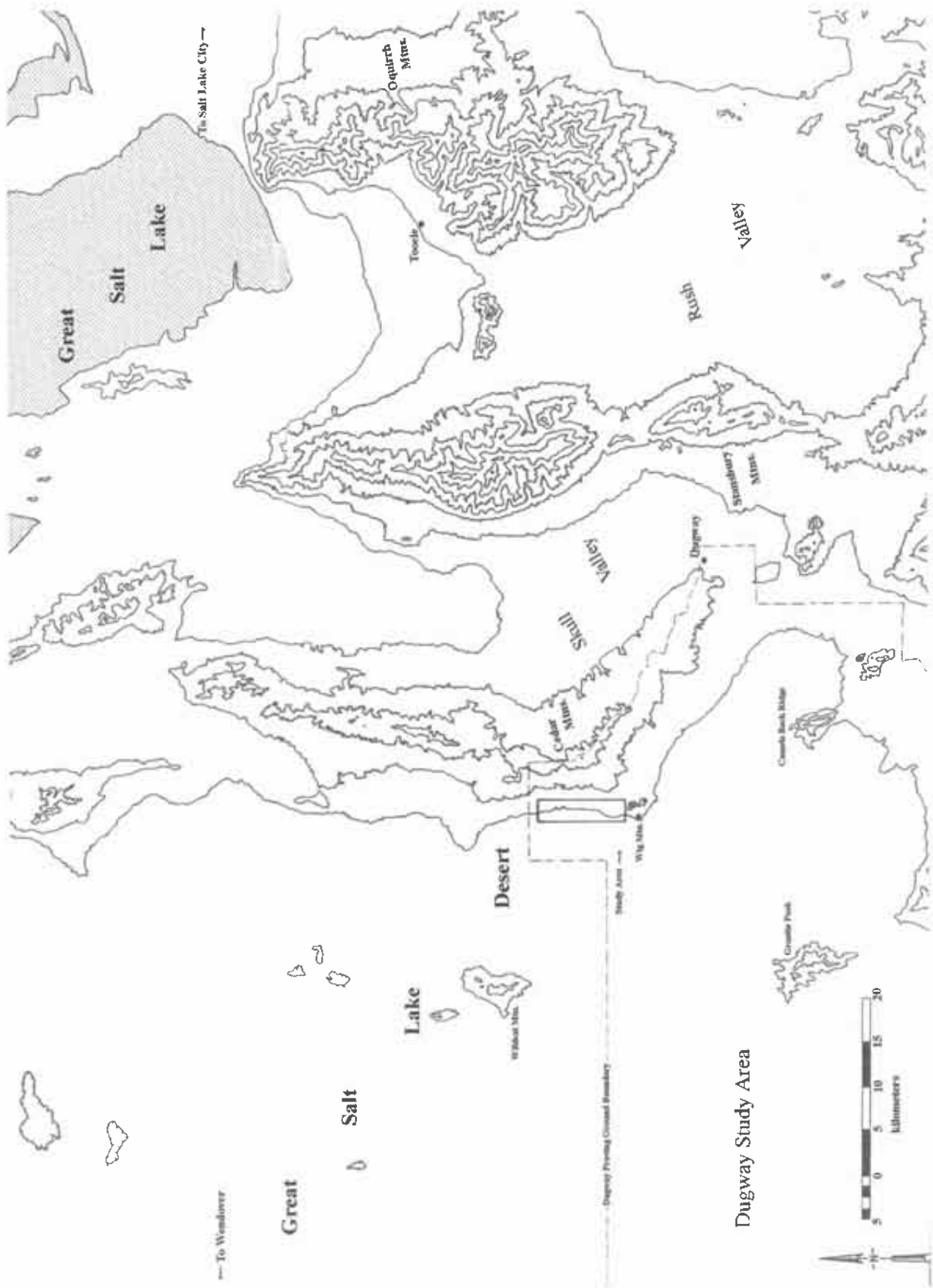
**Dave N. Schmitt**, Utah Geological Survey, Salt Lake City, UT 84114

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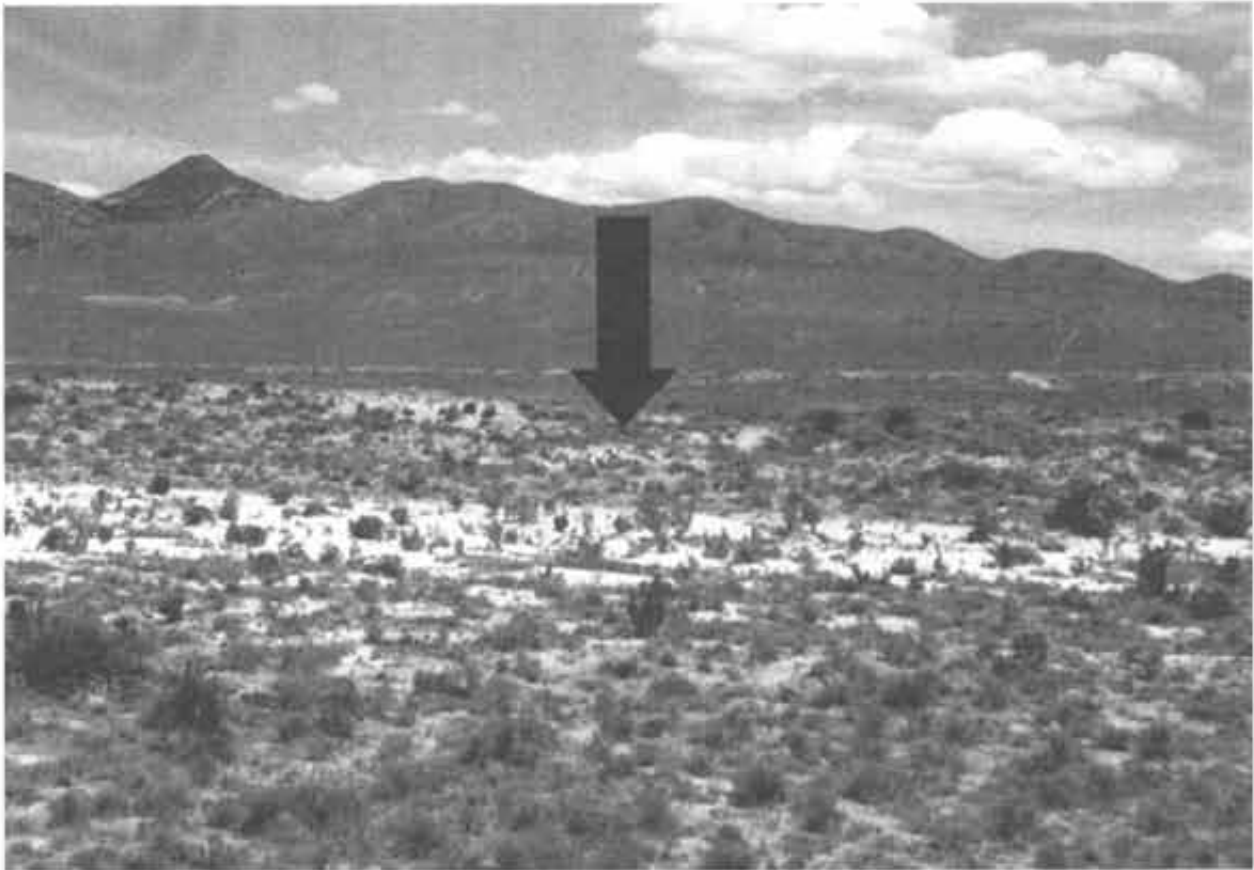
*Test excavations at an extensive site in sand dunes on Dugway Proving Ground in northwestern Utah exposed a short-term camp featuring a use surface, hearths, primary refuse disposal, rabbit consumption, bi-polar core reduction, and large amounts of fire-cracked rock. Parched and charred Indian Rice Grass seeds indicate occupation in the early summer. A Humboldt projectile point is consistent with two AMS radiocarbon determinations ranging between 4,600 - 5,400 B.P. This case also speaks to issues of method and theory in archaeological testing: 1. the spacing among dune blow-outs suggests improvements in the design of testing strategies; 2. test excavation can be part of the assessment of significance, rather than an adverse effect; 3. the test excavations stimulated experimental archaeology on the production of fire-cracked rock that refined estimates of the duration of occupation at Playa View Dune beyond those based on ethnographic analogy and traditional archaeological interpretation.*

Playa View Dune (42To213) is located on the U.S. Army Dugway Proving Ground, and is one of many ancient occupations scattered across extensive sand dunes situated between the playas of the Great Salt Lake Desert and the nearby Cedar Mountains (Figures 1 and 2). Survey of the area and test excavations at Playa View Dune were completed in June and July 1997 by the Utah State University Archaeology Field School. The excavations at Playa View Dune hold implications for studying lithic scatters in sand dunes, and they improve our ability to use fire-cracked rock to infer behavior. The work also suggests that test excavation can improve the determination of site significance during survey and prior to a consideration of "adverse effects".

Excavation identified a camp of about a month or less duration, and dating to the middle Holocene period. A Humboldt-type projectile point found on an occupational surface is consistent with two AMS radiocarbon determinations ranging between 4,600 - 5,400 B.P. Refuse was in primary context and, along with hearths, was deposited upon a desiccated surface within a blow-out among semi-stabilized sand dunes perhaps similar in appearance to the present dune field. Activities at Playa View Dune included bi-polar core reduction probably related to retooling, jackrabbit consumption, and possibly Indian Rice Grass seed-gathering.



Dugway Study Area



**Figure 2.** Overview of Playa View Dune looking east toward the Cedar Mountains. Excavation area 1 at center (arrow).

The excavated fraction (<.02%) of the site represents only one of a dozen major artifact concentrations situated in depressions among the dunes, and reflecting repeated use of the site. Nearby archaeological survey yielded 10 additional sites spanning the mid-to-late Holocene period (Simms 1998). Bassett and Hunsaker (1996) surveyed 32 sites south of Playa View Dune that span the entire Holocene period, but with occupation predominating in the mid-to-late Holocene periods. Foragers would have been attracted to sand dunes because they are concentrated islands of biomass that provide subsurface water, grains, and small mammals.

Playa View Dune (42To213) is located in an interdunal depression measuring 365 m x 175 m. Like many such sites, it appears dramatic upon first encounter by virtue of dense concentrations of lag deposits of fire-cracked rock located in dune blowouts. Lithic debris, often in small numbers, occurs with the fire-cracked rock. Over 100 ground stone artifacts were fire-cracked. We discuss the interpretation of these fire-cracked rock concentrations and combine evidence from the excavation, with survey data reported by Bassett and Hunsaker (1996), and experimental study by Jensen et al. (1999).

The identification of three fire hearths at the ground surface (hearths 1, 3 and 4, Figure 2) indicated the potential for intact subsurface deposits, and this required excavation units to be placed upslope from these, in areas where

**Figure 1 (opposite).** Map of the study area at Dugway Proving Ground, northwestern Utah.

there were few, or no artifacts on the surface. This holds implications for decision-making about test excavations. Findings at the site support

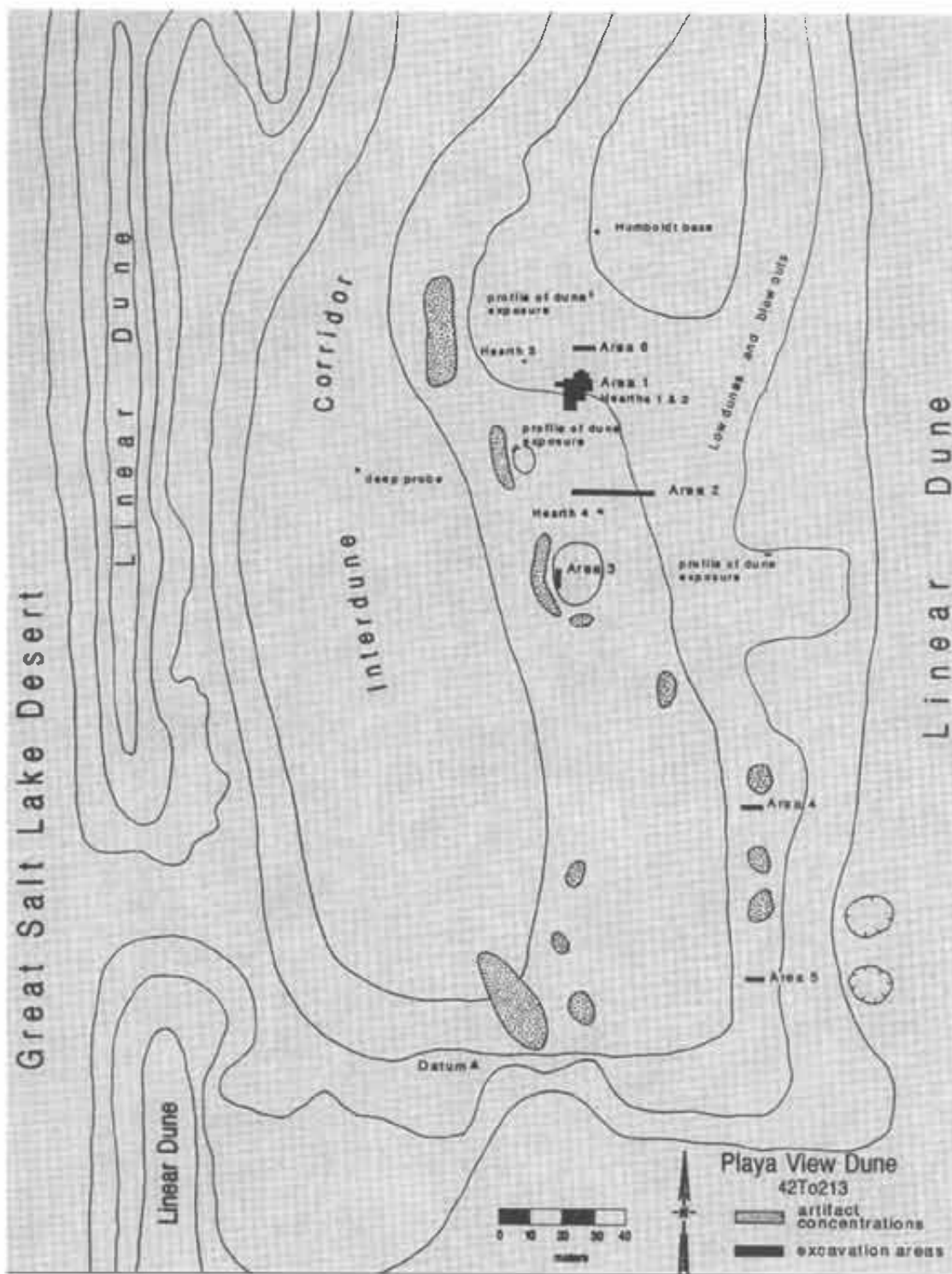


Figure 3. Map of Playa View Dune showing locations of test excavation areas, probe, dune profiles, and artifact concentrations.

an argument for defining "test excavation" in terms larger than 1 x 1 m "units," consistent with ethnoarchaeological findings and recent forager archaeology in the region (e.g., O'Connell 1987, 1993; Simms 1988, 1989; Simms and Heath 1990; Tipps 1993). Assessing the significance of lithic scatters, and the task of managing thousands of such sites deemed "significant" with only a site survey form as evidence, is a daunting task. The work at Playa View Dune suggests that continuing improvements in test excavations can make testing a routine part of the assessment of site significance during or soon after initial survey. Rather than classifying testing as an adverse effect, or something only to be done later, a contemporary approach to test excavation may be an underutilized tool for learning more from lithic scatters while also leading to a more judicious use of the box marked "significant" on site survey forms.

### TEST EXCAVATION AND FINDINGS

#### *Excavation, Stratigraphy, and Occupational Features*

Test excavation area 1 was opened with a 1 m wide trench to search for intact subsurface deposits (Figure 3). Excavation began by bisecting hearth 1, just upslope from a concentration of lithic debris, 2 limestone and quartzite slab metates, and fire-cracked rock. Five additional, 1 m wide trenches (test excavation areas 2-6) examined other parts of the site, each beginning at the upper edge of an artifact concentration and proceeding into the dunes (Figure 3). Two more surface hearths (3 and 4) were collected for flotation and analyzed (Figure 3). Intact subsurface deposits and features were only found in test excavation area 1, and this area serves as the basis of our report. Table 1 lists the subsurface artifacts found in the test excavations.

Excavation in area 1 (Figures 3 and 4) revealed a depositional sequence beginning with culturally sterile aeolian sands labeled stratum 1. We later probed below this level in the floor of the site depression (see "deep probe," Figure 3) and found that stratum 1 was at least 1 m thick and underlain by pre-dune, lacustrine, or palustrine clays and silts.

Table 1. Tabulations of subsurface artifacts in test excavations at Playa View Dune.

Area	Lithics	Ground Stone	Fire-Cracked Rock	Bone	Depth of Cultural Material	Area of Excavation m <sup>2</sup>
1	174	6	1000+	225	see text	56
2	37	0	203	24	0 - 10 cm	26.5
3	3	0	14	0	0 - 10 cm	6
4	1	0	0	0	0 - 10 cm	7
5	4	0	15	0	0 - 10 cm	6
6	0	0	0	0	-	7



Directly overlying stratum 1 is a thin (2 - 3 cm) relatively hard layer labeled stratum 2, upon which the occupation occurred. Stratum 2 is, like stratum 1, composed of medium and fine sands, but is moderately indurated with carbonates. This cemented the sands, producing a firm surface resistant to erosion. The probe and two shovel profiles in the natural dune sediments (Figure 3), revealed that stratum 2 is a natural layer that drapes over the entire dune field. It slopes in some areas, is level in others, and reflects a time when the dune surface was stabilized.

Stratum 2 is relatively level in excavation area 1, and in that area features desiccation polygons. These were lightly weathered before the cracks infilled with aeolian sands prior to and perhaps during the occupation upon this surface. A thin layer (< 1 cm thick) of unsorted, loose sands was found intermittently across the surface of stratum 2. The situation presented to the occupants was a hard, mud-cracked surface, partially covered with a skiff of loose sands and surrounded by low dunes (Figure 5). The crowns of some of the desiccation polygons were ash-stained and charcoal/ash was found in the upper regions of the in-filled cracks, suggesting that much of the cracked surface was exposed to the inhabitants.

Fire hearth 1 was visible at the surface, rested upon stratum 2, and left a faint reddish cast, but little in the way of a depression. Measuring 45 cm x 3 cm thick, hearth 1 contained ashy sands and small fragments of fire-cracked rock. The contents were collected for flotation and analyzed. Hearth 1 may be contemporary with the other features in area 1, but this cannot be demonstrated because it was so close to the surface. Nearby hearth 3 presents a similar problem. Hearths 1 and 3 *may* have been built upon sands present at the time area 1 was occupied, but their spatial proximity may also be deceptive.



**Figure 5.** Test excavation area 1 looking northeast. Individuals show the location of hearth 2 (left) and the southern edge of the refuse area (right). Desiccation polygons characteristic of portions of stratum 2 use area are visible in the foreground.

Stratum 3 covers one area of stratum 2 and represents refuse from hearth activities (Figure 4). Stratum 3 is a 2.5 m x 4 m oval deposit up to 12 cm thick of gray to dark black sands, ash, charcoal flecks, fire-cracked rocks, and burned bone, but few artifacts. Stratum 2 below was not significantly reddened suggesting that stratum 3 was not simply a large hearth. It is more likely the result of small hearths and primary deposition from hearth activities.

Hearth 2 was intrusive to stratum 3, originating at its upper surface. It measures 50 x 60 cm x 12 cm deep, and contains sands blackened by crushed charcoal, charcoal chunks, and ash. The contents were collected, and subject to flotation. Despite the intrusive relationship, hearth 2 may have been created during the same occupation as stratum 3. No sterile cultural material was found separating the upper surface of the stratum 3 deposits from the level of origin of hearth 2. This suggests that hearth 2 may not have been much later than the stratum 3 refuse. Radiocarbon dating (discussed below) shows that there could have been two occupations, but also supports contemporaneity. Hearth 2 certainly was the last event before dunes buried the camp, and it may simply have been the last hearth fired in a sequence of hearths associated with the stratum 3 refuse.

Stratum 4 covers strata 2 and 3, consists of culturally sterile, aeolian sands up to 75 cm thick, and exhibits bedding characteristic of natural dune deposits. Sands located 1 - 2 cm above the contact between stratum 4 and the use surface of stratum 2 were mixed, illustrating trampling by the site occupants. Directly over these are the bedded deposits of stratum 4 that mark the resumption of dune-building after the site was abandoned.

The extent of the area 1 occupation lies within the boundaries of the excavation -- the density of artifacts falls off rapidly near the edges. Test excavation 6 to the north marks the edge of the dune blow-out used for the camp. No subsurface artifacts were found there, the slope increased to 8-18 degrees, and the desiccation polygons characteristic of area 1 were absent. Thus, the area 1 inhabitants camped in a dune blow-out about 15 m in diameter (Figures 3 and 4).

**Table 2.** Radiocarbon dating results and interpretation. AMS determinations on charred seeds of *Oryzopsis hymenoides* (Indian Rice Grass).

Provenience	Sample #	Conventional C14 Age (adjusted to C13/C12 ratio)	Calibrated Age (2 sigma)
Stratum 3 refuse	109854	4500 ± 100 BP	3505-3425 BC 3390-2900 BC*
Hearth 2	109855	4280 ± 90 BP	3090-2605 BC

\* Using Stuiver and Reimer Method B (1993:296), the percent contribution to the probabilities for the range of 3390-2900 B.C. is 95 percent. Thus, it is the most likely of the two ages. The overlap however, between the calibrated age range from the refuse and that from the hearth is 3090 - 2900 B.C., making this the most likely age for the occupation.



### *Chronology*

Two AMS radiocarbon determinations were made on wood charcoal. A single chunk from the stratum 3 refuse was recovered with excellent provenience and a second sample of charcoal chunks and flecks was recovered during the flotation of hearth 2. Both were corrected for C13/C12 ratios calculated relative to the PDB-1 international standard (Table 2).

The sample from the stratum 3 refuse produced two calibrated ranges: 3390-2900 B.C. and 3505-3425 B.C. (Beta 109854). Additional statistical analysis of these results using Stuiver and Reimer Method B: contribution to probabilities (1993:296), shows that the contribution to the total probabilities for the range of 3390-2900 B.C. is 95 percent, making it the most likely age of the stratum 3 refuse, rather than the range of 3505-3425 B.C. The sample from hearth 2 was more straightforward, producing a calibrated range of 3090-2605 B.C. (Beta 109855).

As discussed above, hearth 3 is intrusive to stratum 3, but they may be essentially contemporaneous. The radiocarbon results are typically intriguing, but do not resolve the issue. The age ranges for the refuse and hearth overlap significantly at 3090-2900 B.C., and this is consistent with the stratigraphic evidence that hearth 2 followed quickly upon the heels of stratum 3.

### *Artifacts*

Artifacts recovered from the test excavations are tabulated on Table 1. The stratum 2 occupational surface contained abundant cultural debris. Size analysis was done on over 400 items including all of the lithic debris, flaked stone tools, ground stone, burned and unburned bone. Over 1,000 pieces of fire-cracked rock typically 2-3 cm in size were also found, but not included in the size analysis. The size analysis of the other debris shows that half were > 1 cm and half were < 1 cm. The lack of sorting and the co-occurrence of artifactual debris with discarded fire-cracked rock suggests primary disposal.

The distribution of artifacts and the locations of tools are shown in Figure 4. Tools from stratum 2 include a Humboldt series projectile point of obsidian, an obsidian graver, a side-scraper, an end-scraper, a hammerstone, two bifaces, and a heavily utilized flake. Another Humboldt series point of obsidian and an unidentified point tip were recovered from the site surface (Figure 3). Some of these are illustrated in Figure 6. Five rhyolite ground stone fragments were found in stratum 2 and another came from the stratum 3 refuse.

Stratum 3 was much more restricted in area than stratum 2 and while it was notably darker than stratum 2 with ash and charcoal, it yielded only a few flakes and a ground stone fragment. It did contain considerable fire-cracked rock and animal bone, contributing to the inference that it represents hearth refuse. Stratum 4, the natural dune layer covering the occupation, contained no artifacts.

The lithic debris from area 1 was dominated by secondary and tertiary flakes from bipolar core reduction. The tools imply tasks requiring scraping, cutting, and incising. A few small cores indicate some tool manufacture. By comparison, lithic debris and tools from the site surface in general totaled more than 1,000 items, but the assemblage is consistent with the patterns identified in excavation area 1 with the exception that there were fewer finished tools



Humboldt projectile point  
(obsidian) FS - 36.1



End scraper  
(tan quartzite) FS - 37.1



Humboldt concave base  
projectile point (obsidian) FS - 59.1



Side scraper (off-white quartzite) - FS 23.3



Projectile point tip  
(tan quartzite) - FS 59.2

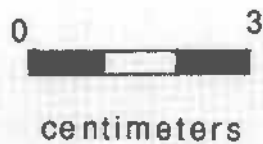


Figure 6. Illustrations of selected artifacts from Playa View Dune.

on the site surface. This discrepancy is probably caused by artifact collecting. Thus, the test excavations did not alter the limited inferences about the site that could be made from the surface debris recorded on a site survey form.

Material types across the site were predominately cherts, especially brown, yellow, and red. These are common in the drainages along the southern slopes of the Cedar Mountains, but may also have come from a large quarry in that area (42To1210). Quartzite was also common and found in gray, yellow-orange, and red colors. The reddish quartzite may have come from a quarry located on the extreme southern tip of the Cedar Mountains (42To1193). A few obsidian flakes were also found, and the graver was made of obsidian, but there was little evidence of working obsidian at the site.

### Faunal Remains

The excavations in area 1 yielded 406 animal bones, and most of these were from the stratum 2 occupational surface and the stratum 3 refuse (Table 3). *Lepus* remains were the most abundant and are represented by a variety of body parts, including cranium and mandible segments, fragmentary long bones, and feet. A modest assemblage of fragmentary artiodactyl-sized limb bones also was recovered and represents the remains of either deer (*Odocoileus* cf. *hemionus*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), or some combination.

Animal remains were most abundant immediately east and southwest of hearth 2 (Figure 4), in the thickest sections of stratum 3. Also, a large aggregate (n = 115) of *Lepus* and *Lepus*-sized bone fragments was retrieved from the southwest corner of the area 1 excavation (Figure 4). These specimens are characteristically stained, pitted, or polished from partial digestion (Schmitt and Juell 1994) and are probably carnivore scat accumulations.

Table 3. Numbers of Identified Faunal Specimens per Taxon/Animal Class Size from Test Excavation Area A.

Species/Size Class	Stratum 2 <sup>a</sup> (floor)		Stratum 3 (refuse)		Hearth 2		Totals		
	Total	Burned <sup>c</sup>	Total	Burned <sup>c</sup>	Total <sup>b</sup>	Burned <sup>c</sup>	Total	Burned	% Burned
<i>Lepus</i> sp.	17	5	5	3	1	0	23	8	35
<i>Lepus</i> -sized	115	73	42	30	21	15	178	118	68
Rodent-sized	-	-	-	-	2	1	2	1	50
Artiodactyl-sized	6	5	3	2	0	0	9	7	78
Unidentifiable	10	2	3	2	0	0	13	5	38
Totals	148	85	53	37	24	16	225	138	61

a. Does not include scatological bone (n=115).

b. Retrieved from soil flotation.

c. Includes all burned, carbonized, and calcined specimens.

Table 4. Results of flotation analysis.

Sample	Botanical Remains			Non-Botanical Remains			
	Seed Identification	#	Condition	Bone	Condition	Lithics	Ostracod
Hearth 1 (surface)	<i>Oryzopsis hymenoides</i>	4	unburned	4	charred		
	<i>Sphaeralcea fendleri</i>	3	unburned				
	<i>Psoralea fremontii</i>	1	unburned				
Hearth 2 (area 1)	Unidentified, multiple species	3	unburned	16	charred		1
		8		8	unburned		
Hearth 3 (surface)	<i>Oryzopsis hymenoides</i>	1	charred	5	charred	4	
		1	parched	4	unburned		
		25	unburned				
	<i>Sphaeralcea fendleri</i>	2	unburned				
	<i>Sporobolus</i> sp.	2	unburned				
	<i>Ephedra nevadensis</i>	1	unburned				
	Gramineae (Grasses)	1	unburned				
Hearth 4 (surface)	<i>Oryzopsis hymenoides</i>	10	unburned	15	charred		
	Unidentified, multiple species	11	unburned	5	unburned		

The assemblage of burned bone includes a few superficially burned specimens and large numbers of carbonized ( $n = 41$ ) and calcined ( $n = 70$ ) bone. The latter clearly indicate prolonged exposure to intense heat (e.g., Stiner et al. 1995). With the exception of the carnivore scat, the bones in area 1 are interpreted as human subsistence refuse. The burned condition of many bones may reflect the intentional disposal of food refuse into the hearth. Obviously, the faunal remains found in the test excavations better enable us to assess the significance of the site.

#### **Botanical and Micro-Refuse Remains**

Bulk soil samples were collected from hearths 1-4 at Playa View Dune for flotation processing. A comparative sample from natural dune deposits was retrieved in 1999. Unprocessed samples are curated with the other artifacts.

Samples were processed using a mechanical, froth flotation device. Sample volumes depended on the size of the feature and ranged from 4-6 liters. Recovered seeds were identified as to whether they were charred, parched, or unburned, with parching likely to indicate intentional heating.

Nonbotanical remains include bone, an ostracod, and four pieces of lithic debitage (Table 4). The botanical remains include a variety of unburned specimens, but the sample also includes small, carbonized fragments of unidentified plants (Table 4).

Four liters of sediments from natural dune deposits around area 1 were floated and scanned for carbonized material and seeds. The amount of carbonized material did not approach that of the hearth samples, but tiny flecks of charcoal were found. In addition, burned and unburned seeds of Globe Mallow (*Sphaeralcea*) were found showing that natural introduction of the botanical remains is a possibility.

The identification of Fremont Indigo-bush (*Dalea fremontii*) was unexpected. This species typically occurs in a warm desert shrub community characterized by blackbrush, creosote bush, mixed desert shrub, and (less commonly) pinyon-juniper communities. Today it is found in southwestern Utah (Welsh, et al. 1987). However, several other plant species have recently been observed on Dugway Proving Ground which are not expected to occur there (Robert Johnson, DPG biologist, personal communication 1998). The presence of this species serves as a reminder that the composition of plant communities was potentially different in the past.

Seeds from Indian Rice Grass were by far the most common, but only two were found in parched or burned condition (Table 4). Indian Rice Grass is well-known as an economically important plant in the Great Basin. The seeds typically fruit in June at the elevation of Playa View Dune. The caution that only charred specimens should be considered conclusive evidence of human introduction (Minnis 1981:147) is warranted at Playa View Dune because many of the uncharred seeds are modern in appearance, yet sand dunes tend to subject uncharred seeds to rapid erosion. Furthermore, Indian Rice Grass, like the Globe Mallow found in the samples from natural dune deposits, are present at Playa View Dune today. On the other hand, the occupational deposits in area 1 and the surface hearths providing the flotation samples were intact, preserving the seeds in good condition regardless of whether they were naturally or culturally introduced.

The most compelling evidence for cultural introduction are the two charred/parched Indian Rice Grass seeds from hearth 3. They could have been incorporated as tinder, for consumption, or for preparation for storage. Since the site was occupied many times, seed processing may have been an activity during some of those events. Since the relationship between hearth 3 and excavation area 1 is unknown, the botanical remains are mute. This is an example of test excavation adding relatively little to knowledge about the site gained via survey.

#### WHAT HAPPENED AT PLAYA VIEW DUNE?

The test excavation located a small campsite with hearths and refuse in primary context. The camp was placed upon a deflated surface in the floor of a dune blowout about 15 m in diameter that was surrounded by low dunes. Sand dunes stabilized by vegetation would have been moisture traps for seeds, and this enhanced moisture would have increased the density of seed-bearing forbs, and perennial and annual grasses. Enhanced seed production would have attracted small mammals, and the open vegetation would have been attractive to jackrabbits. Additional resources include small numbers of artiodactyls which could have been procured only a few km from the site, and perhaps Indian Rice Grass seeds. Water is available at springs only a few km away in the Cedar Mountains. The June-bearing rice grass seeds are the only indicators of seasonality, but the samples are not from the area 1 camp. It is reasonable to expect that occupations could have occurred at many times of the year. As for lithic resources, all of

the chert and quartzite toolstones occur in the southern end of the Cedar Mountains within 5-25 km of the site showing that potential sources are nearby.

Refuse in primary context and bi-polar core reduction debris suggests high mobility and short-term occupations of about a month or less based on ethnoarchaeological comparison (e.g., O'Connell 1993 and references therein). The determination of duration of occupation is tricky, even with the amount of ethnoarchaeological research on site structure and refuse disposal. In excavation area 1, the amount of charcoal refuse, and the small size of camp, provoke speculation of occupations much shorter than a month. On the other hand, a study of the rate of production of fire-cracked rock suggests that a substantial amount of cooking occurred there (see Jensen et al., 1999).

The high frequency of jackrabbit bones and paucity of artiodactyl remains are similar to the middle Holocene faunal assemblages collected 35 km southeast of Playa View Dune at Camels Back Cave (Schmitt and Lupo 1999). Jackrabbits were abundant in middle Holocene deposits at Danger and Hogup Caves (Grayson 1988:33-34), but artiodactyl frequencies are lower relative to other periods (e.g., Durrant 1970). Although the "middle Holocene" deposits at Danger and Hogup caves span thousands of years and the complete taphonomic history of most specimens remains unknown (see Grayson 1988, and Hockett 1994), it appears that jackrabbits were not as affected by middle Holocene aridity. Thus, as the abundance of high ranked artiodactyl resources declined during this time, jackrabbits not only continued to be taken, but probably comprised a greater proportion of the diet.

A Humboldt projectile point is consistent with two AMS radiocarbon determinations indicating the area 1 camp was occupied between 5,505-4,600 B.P. The stratigraphic evidence suggests a close temporal relationship between the stratum 3 refuse and hearth 2, the features yielding the two radiocarbon dates. The statistical characteristics of one of the dates suggest a narrower range between 5,090-4,900 B.P.

Test excavations in three other areas of the site found subsurface artifacts (areas 2, 3, and 5, see Figure 3), but no cultural features to indicate the artifacts were in primary context. Surface concentrations of fire-cracked rock and lithic artifacts are common at Playa View Dune, but there is no evidence that any of these small campsites were contemporary.

#### ***Camp Spacing, Dune Spacing, and Test Excavations***

The spacing among artifact concentrations (surface as well as the excavations) at Playa View Dune is relatively consistent at 10-20 m (see Figure 3). We hypothesize that this spacing was determined by the average distance between dune blow outs, a function of wind speed, sand depth, and sediment morphology. Camps would have been placed in the blow outs, and the areas in between would contain little cultural material. Measurements of the spacing between the five blow outs around area 1 today are similar, ranging from 12-23 m.

This observation suggests a strategy for sampling such situations to increase the effectiveness and efficiency of test excavation. After an area with intact features is located, it would be most productive to locate the next excavation 10-20 m away. Closer excavation would likely uncover unoccupied areas between blow outs that were buried under

dune crests. A hint of this relationship was found when test excavation area 6, only 6 m away from the very productive area 1, produced no cultural material. Furthermore, the stratum 2 surface (the occupational surface in area 1), sloped upward in excavation area 6 from 8-18 degrees, indicating the approach of a dune crest where no occupation would be expected.

### ***Fire-Cracked Rock***

Playa View Dune features large amounts of fire-cracked rock; over 4,500 pieces on the surface. No rock occurs naturally on the dunes, thus the preferred rhyolitic rocks had to be transported at least a few hundred meters from the site. Forty-five similar features are reported in the dunes south of Wig Mountain by Bassett and Hunsaker (1996:94-99). Working only with surface remains, they hypothesized that these features resulted from the use of selected sizes of rocks to parch Indian Rice Grass seeds. The study at Playa View Dune adds evidence from an intact, subsurface example of one of these features, and builds upon Bassett and Hunsaker's (1996) investigation using experimental research along a different line of inquiry (Jensen et al. 1999).

The fire-cracked rock at Playa View Dune and the nearby sites is strikingly uniform in size. Two to three centimeters is the *median* size, despite a range of .5 - >10 cm. The mean is 2.1 cm, but reference to the median illustrates the uniformity of the rock sizes in these features. This uniformity was a key motivation leading Bassett and Hunsaker to hypothesize seed parching, since it appeared the occupants were selecting certain sizes of rocks for use at the sites.

With the benefit of test excavation, it was apparent at Playa View Dune that the rock, while found in fire hearths, was most common in the hearth refuse (stratum 3). This suggests that the uniform size of the rocks was less a function of initial selection as it was an indication of their discard size. We hypothesize that the rocks were used for the more typical activities of roasting and boiling foods in baskets. Repeated heating and cooling fragmented the rock to a point where it became more efficient to transport new rock to the site than to continue to use small stones that store little heat.

Experiments show that the rock size typical of these sites does in fact represent the point of negative returns, and that this point is reached after only a few cooking episodes (see Jensen et al. 1999). Thus, the rocks that appear on the archaeological sites in the vicinity of Wig Mountain are small, common, and of uniform size because they reflect the discard from repeated camping episodes in the dunes.

### **IMPLICATIONS FOR TEST EXCAVATION AND SIGNIFICANCE ASSESSMENT**

Intact sites such as Playa View Dune with buried living surfaces and other features do indeed exist in the semi-stabilized sand dunes on the fringes of the Great Salt Lake Desert (Smith 1994). In addition to improving our understanding of Utah prehistory, these sites support the practice of using test excavation for assessing site

significance. They also support certain approaches to test excavation that are in tune with improvements in archaeological method and theory.

Survey and the completion of a site form tends to leave small, ephemeral sites such as Playa View Dune as just another "lithic scatter." Advances have been made in gleaning chronological evidence from surface sites (e.g., studies in Beck 1994), and studies show the benefits of large, "landscape" samples (e.g., studies in Wandsnider and Rossignol 1992). Yet in areas such as the Great Basin where surface archaeology and the lithic scatter are facts of life, archaeologists must generally assign significance using only surface evidence. Over the past three decades, this practice has produced an enormous number of significant sites -- when in doubt, err on the side of significance with the hope that the site may hold some information useful to "science." Yet no amount of sophistication in surface archaeology will replace even limited test excavation.

This presents a conundrum. Excavation per se is destructive, despite the knowledge among archaeologists that it is just one part of an equation that transforms sites into the alternative forms of preservation found in the written word, maps, tables, and photographs. In its purest form, and in some interpretations of cultural resource regulations, preservation is compromised by even the slightest "adverse effect." This presents a tightrope to archaeologists and managers who must balance preservation with the need to decide which sites are significant enough to warrant preservation. Testing programs such as at Playa View Dune, or the series of small tests in nearby Skull Valley by Smith (1994) are just two examples that show the benefits of using contemporary approaches to testing *as part of* the assessment of site significance.

By increasing our knowledge through testing, we not only help assess the significance of particular sites, but elevate the utility of the surrounding survey data. For instance, the fire-cracked rocks so common in the vicinity of Playa View Dune, and whose function had been explored with survey data (Bassett and Hunsaker 1996), could be compared with fire-cracked rock features in primary context. In this way, hypotheses generated from survey data can be tested, and in turn help evaluate the significance and meaning of dozens of other surface sites.

It would have been possible to conclude after site survey that Playa View Dune was significant only because it held the *potential for subsurface deposits* and leave it at that. Labeling sites as significant because they may have "potential," is part of the routine of survey and we cannot fault archaeologists for doing what has become protocol. In the larger sense however, not pursuing such speculations as part of the significance assessment is a default strategy. When the potential for subsurface features is identified, the assessment of significance is perhaps not complete until such speculations are acted upon. The caveat that funding is always inadequate is a given. Also, testing may not yield additional information, as was apparent at Playa View Dune with the lithic assemblage and the botanical remains.

The benefits are great however, of learning the characteristics of a kind of site that may be common over a locale under management. Perhaps testing should be considered part of the designation of significance, not something to go back to after survey of management areas is "completed," or an impact is imminent. Cases such as Playa View Dune report the successes of such an approach -- reporting that is necessary if we are to continue to be



permitted to employ a broader definition and role for testing, and perhaps make it more common in areas where the lithic scatter is king.

The study at Playa View Dune is consistent with recent trends in forager archaeology. First, placing test excavations only in areas where artifacts are most frequent on the surface may fail to locate subsurface features, or will only find more of what was seen on the surface -- typically lithic artifacts. This is exemplified by the findings of the same range of lithic debris in excavation area 1 as occurred on the surface; except for the tools which have typically been removed by artifact collectors. It is admittedly a risky strategy, but managers and field archaeologists must be advocates for test excavations where the characteristics of sites indicate the potential for subsurface deposits, but where the testing strategy opts for placing excavations where there are few or no artifacts on the surface. In this way, we can move beyond the perennial intractability of the ubiquitous Great Basin lithic scatter.

Second, the use of the isolated 1 m x 1 m test excavation remains common despite repeated ethnoarchaeological examples of the need for large exposures (see O'Connell 1993 and references therein). Local examples illustrate the benefit of opening larger areas (e.g., Simms 1990; Simms and Heath 1990), and recent work by Tipps (1993) directs attention beyond the concept of "large," and toward exploration of the "minimal" sizes required to interpret particular site types (see Simms 1988 for an ethnoarchaeological exploration of minimal excavation size for the recognition of behaviorally relevant patterns).

Only .2 of 1 percent of Playa View Dune was excavated, despite the fact that 108.5 m<sup>2</sup> of the site was "tested." Without the excavation of contiguous areas, it would have been difficult to follow the evidence in a way that would lead to the identification of subsurface features. On the other hand, the findings at Playa View Dune suggesting that there are "dead" areas between dune blowouts, show that we can continue to refine the unspecified advice that we simply open large contiguous areas. Playa View Dune would have been wasteful of precious excavation funds had only large blocks been used, expanding them relentlessly until another concentration was found. A strategy cognizant of the structure of the site environment would be most appropriate at Playa View Dune. Of course other contexts will differ, but our point is to continue to take test excavation beyond the adage of "open up large blocks."

While there are indications that forager archaeology in our region is questioning the blessed status we have bestowed upon the 1 m x 1 m "unit," efforts in this direction remain the exception in campsite, lithic scatter archaeology. Yet in areas characterized by lithic scatters and surface archaeology, testing of the relatively few sites likely to yield subsurface features and surfaces greatly elevates the ability to evaluate other sites in the area and increases the value of their data. Testing is part and parcel of the assessment of significance, and perhaps it should be seen as a positive effect on site preservation, not as an adverse effect that compromises preservation.

## ACKNOWLEDGMENTS

This project was supported by the U.S. Army, Dugway Proving Ground and Utah State University. Special thanks to Kathleen Callister and John Martin, Environmental Program, Dugway Proving Ground for their positive approach to Cultural Resource Management. Kathy Callister also provided organizational and logistic assistance crucial to the project. Thanks to the students and volunteers of the 1997 Utah State University Archaeology Field School, and to on-site visitors David Madsen, Kevin Jones, and Bill Fawcett for insightful observations. Thanks to Kathleen Heath for supervising the microbotanical analysis, and to Jill Jensen for so many post-field tasks, including some of the figures. Manuscript reviewers and especially Marina Hall improved this paper. Thanks to David Madsen, of the *Utah Archaeology* Editorial Advisory Board, for handling the review process for this manuscript.

## REFERENCES CITED

- Bassett, E. and L. A. Hunsaker  
 1996 *A Cultural Resource Inventory of Approximately 7,500 Acres in the Wig Mountain Training Area*. Report prepared by Dames and Moore, Salt Lake City for U.S. Army Dugway Proving Ground Environmental Program.
- Beck, C.  
 1994 *Dating in Exposed and Surface Contexts*. University of New Mexico Press, Albuquerque.
- Durrant, S. D.  
 1970 Faunal Remains as Indicators of Ncothermal Climates at Hogup Cave. In *Hogup Cave*, by C. M. Aikens, Appendix II, pp. 241-245. Anthropological Papers No. 93, University of Utah Press, Salt Lake City.
- Grayson, D. K.  
 1988 *Danger Cave, Last Supper Cave, and Hanging Rock Shelter: The Faunas*. Anthropological Papers of the American Museum of Natural History 66(1), New York.
- Hockett, B. S.  
 1994 A Descriptive Reanalysis of the Leporid Bones from Hogup Cave, Utah. *Journal of California and Great Basin Anthropology* 16:106-117.
- Jensen, K., J. Jensen, and C. Clegg  
 1999 Inferring Intensity of Site Use from the Breakdown Rate and Discard Patterns of Fire-Cracked Rock at Playa View Dune. *Utah Archeology* 12:51-64.
- Minnis, P. E.  
 1981 Seeds in Archaeological Sites: Sources and Some Interpretive Problems. *American Antiquity* 46:143-151.
- O'Connell, J. F.  
 1987 Alyawara Site Structure and Its Archaeological Implications. *American Antiquity* 52:74-108.  
 1993 What Can Great Basin Archaeologists Learn from the Study of Site Structure? An Ethnoarchaeological Perspective. *Utah Archaeology* 6:7-26.
- Schmitt, D. N. and K. E. Juell  
 1994 Toward the Identification of Coyote Scatological Faunal Accumulations in Archaeological Contexts. *Journal of Archaeological Science* 21:249-262.

Schmitt, D. N. and K. D. Lupo

- 1999 The Camels Back Cave Faunas. In *The Archaeology of Camels Back Cave*, edited by D. B. Madsen and D.N. Schmitt. Report on file, Utah Geological Survey, and the Environmental Directorate, U.S. Army Dugway Proving Ground.

Simms, S. R.

- 1988 The Archaeological Structure of a Bedouin Camp. *Journal of Archaeological Science* 15:197-211.  
 1989 The Structure of the Bustos Wickiup Site, Eastern Nevada. *Journal of California and Great Basin Anthropology* 11:2-34.  
 1997 Report of Archaeological Excavation and Survey for Environmental Program, U.S. Army, Dugway Proving Ground. Report on file, Utah Division of State History and the Environmental Directorate, Dugway Proving Ground.

Simms, S. R. and K. M. Heath

- 1990 Site Structure of the Orbit Inn: An Application of Ethnoarchaeology. *American Antiquity* 54:797-812.

Smith, S. J.

- 1995 Fremont Settlement and Subsistence Practices in Skull Valley, Northern Utah. *Utah Archaeology* 7:51-68.

Stiner, M. C., S. L. Kuhn, S. Weiner, and O. Bar-Yosef

- 1996 Differential Burning, Recrystallization and Fragmentation of Archaeological Bone. *Journal of Archaeological Science* 22:223-237.

Stuiver, M. and P. J. Reimer

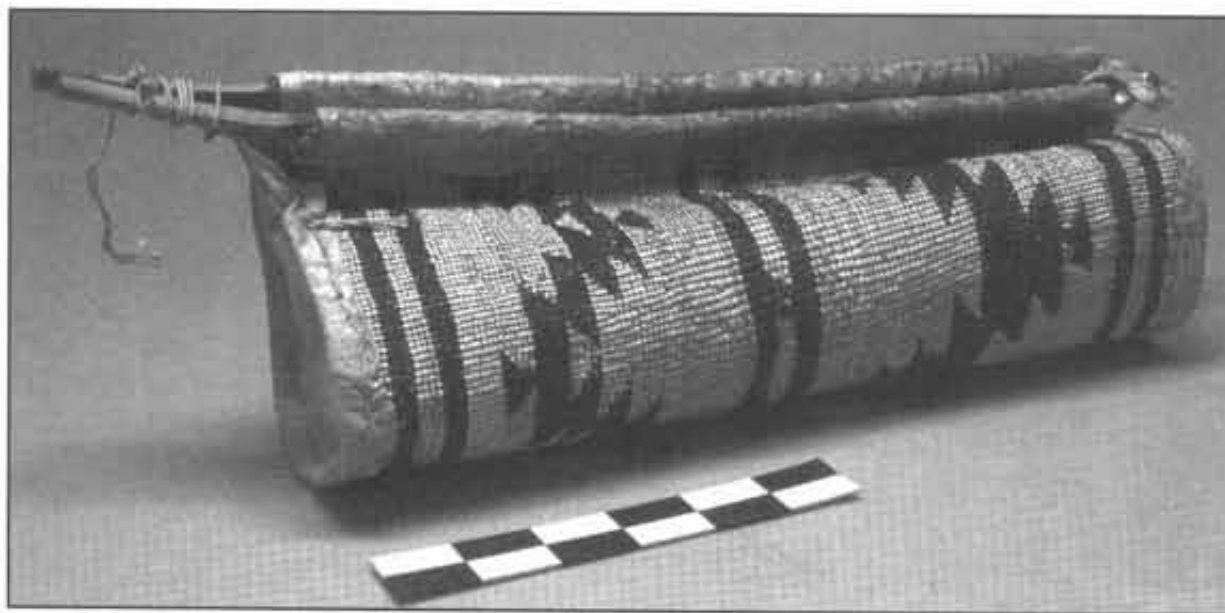
- 1993 Extended <sup>14</sup>C Data Base and Revised CALIB 3.0 <sup>14</sup>C Calibration Program. *Radiocarbon* 35:215-230.

Tipps, B. L.

- 1993 Investigating the Spatial Structure of Lithic Scatter Sites from an Ethnoarchaeological Perspective: Examples from Utah and Nevada. *Utah Archaeology* 6:57-71.

Wandsnider, L. and J. Rossignol (editors)

- 1992 *Place, Time, and Archaeological Landscapes*. Plenum Press, London.



*Woven Purse*

*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*



*Hot Rock Lifter*

*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*

# Inferring Intensity of Site Use from the Breakdown Rate and Discard Patterns of Fire-Cracked Rock at Playa View Dune

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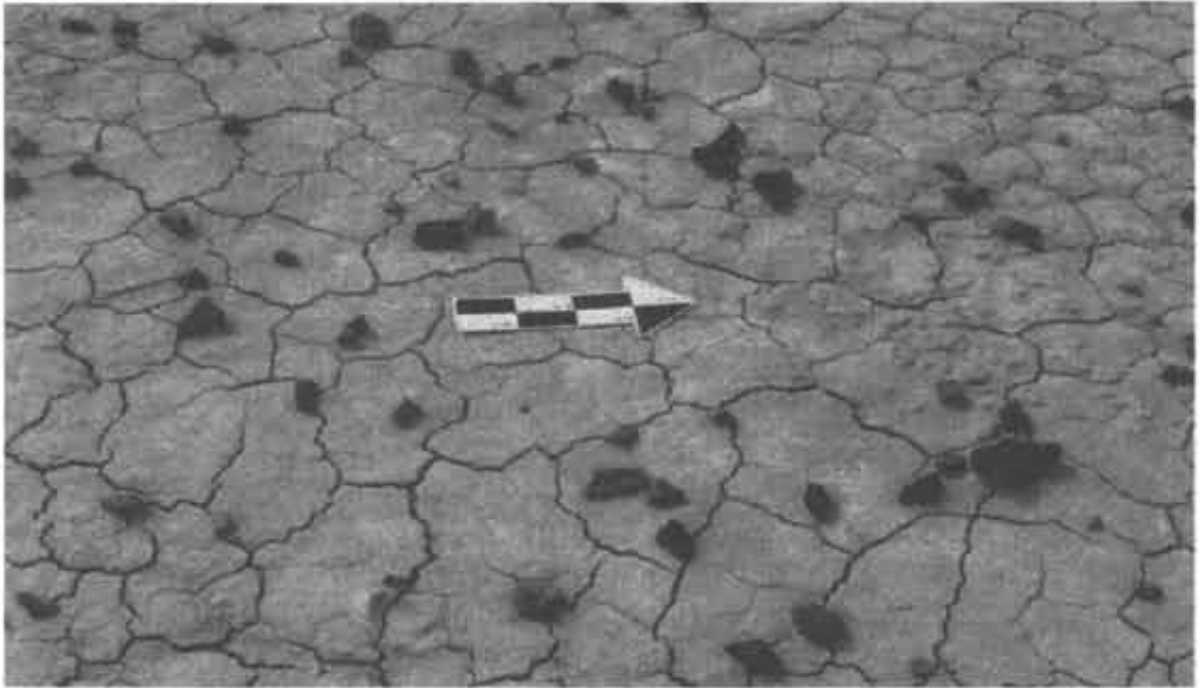
*Large quantities of fire-cracked rock (FCR) were encountered during archaeological survey and excavation of ancient campsites in the Great Salt Lake Desert in Tooele County, Utah. We propose the application of FCR as an indicator of intensity of activity at a site. A series of replication experiments were conducted to develop expectations about the amount of cooking that produces an assemblage of FCR. With five iterations of the experimental cooking cycle, the number of fragments increased by 600 percent and exhibited a 40 percent reduction in their effectiveness as boiling stones. Playa View Dune (42To213) is a short-term campsite occupied for a length of a few days up to a month. An application of the experimentally derived breakdown rate to the FCR assemblage dramatically exceeds our expectations for routine cooking activity over a few days. As the interpretation of duration of occupation increases up to a month, so does the likelihood that the FCR represents routine cooking activity, thus a measure of high or low intensity of activity.*

## INTRODUCTION

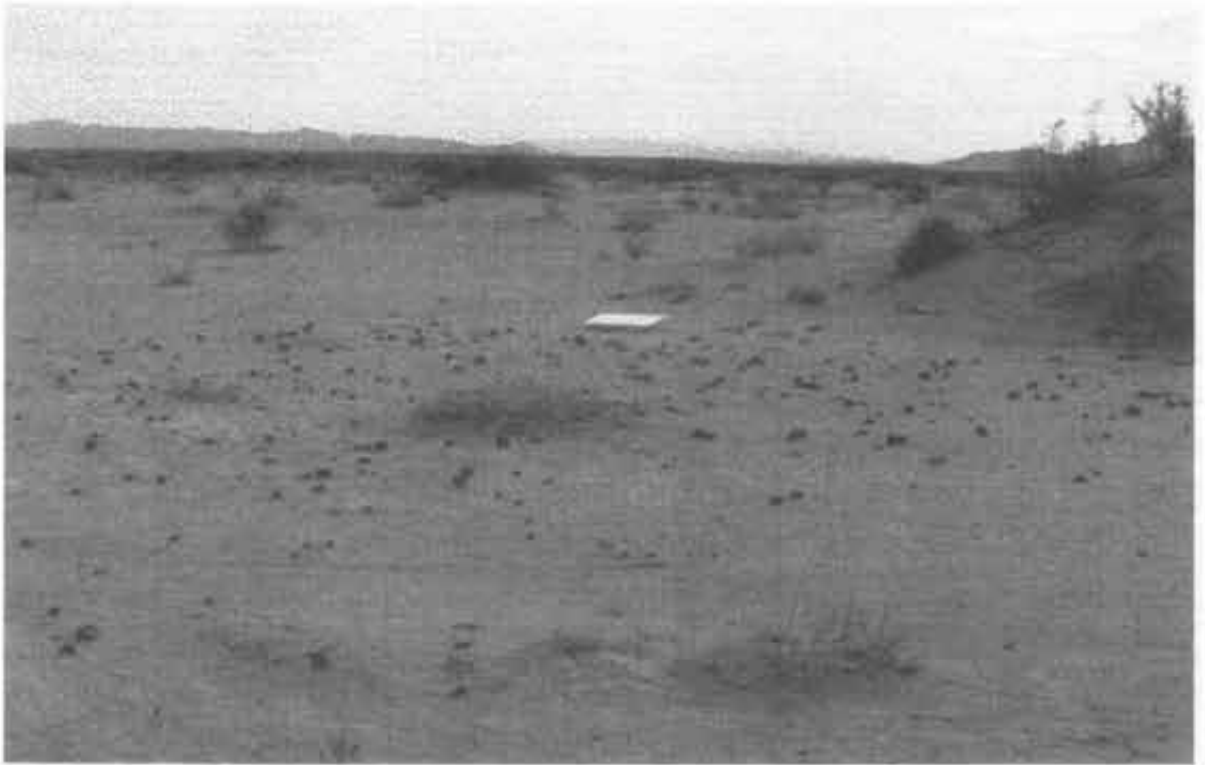
Every archaeologist working in the eastern Great Basin has undoubtedly come across the ubiquitous fire-cracked rock (FCR) scatter (Figure 1). Such features are often given a mere nod on the site form and sometimes disregarded altogether—an omission owing largely to the misconception that no information is available from this class of artifacts. In fact, a growing body of literature on fire-cracked rock studies is available, most addressing the identification and classification of FCR by cooking technique (e.g. Black and Hester et al. 1998; House and Smith 1975; Kritzer 1955; McDowell-Loudan 1983; Pagoulatos 1992; Schalk and Meatte 1988).

While the presence of fire-cracked rock demonstrates that prehistoric people were heating rocks in their fires for cooking activities, it may harbor more significant insights into behavior. One aspect of behavior that may be indicated by the size and quantity of discarded FCR is *intensity of activity*. Several behaviors may produce equal quantities of FCR. For instance, one large group camping for one day may leave the same mark as one small group camping for several days. Similarly, FCR features on deflated hardpan surfaces are likely eroded out of primary context and may represent the cumulative activities of repeated visits over an unknown time span. An intact subsurface deposit, however, may identify a distinguishable event(s) with an inferable duration of occupation, so the amount of FCR debris would indicate the intensity of activity necessary to produce the observed assemblage.

We conducted replication experiments to determine how much time, effort, and resources went into producing an FCR concentration of a given size. We measured the rate at which boiling stones break down through repeated use, and determined the size at which they are no longer effective as boiling stones and thus discarded. The FCR in



**Figure 1a.** Shows the typical size of FCR on archaeological sites in the study area. The scale is 20 cm.



**Figure 1b.** FCR concentration on a deflated surface, a commonly observed depositional setting in the vicinity of Playa View Dune.

an archaeological assemblage can then be associated with an estimate of cooking time required to produce it. By combining this information with the duration of occupation inferred from other archaeological evidence, we are able to assess the intensity of activity that took place at a site.

An example of how FCR can refine our understanding of intensity of site activity can be constructed around Playa View Dune, 42To213 (see Simms et al. 1999). Playa View Dune is a short-term campsite located in a deflated corridor among semi-stabilized sand dunes along the eastern margin of the Great Salt Lake Desert. The dune setting is likely very similar to when it was occupied during the Middle Holocene period. A dozen deflated FCR features were recorded on the surface in depressions between dunes. Sites with similar exposures abound in the study area. Rock does not naturally occur in the sand dunes, so it was necessary to transport any rock used for cooking. Sources of porphyritic rhyolite cobbles, the dominant FCR material represented, occur several hundred meters away in drainages and alluvial fans at the base of the Cedar Mountains.

In contrast to the limited assemblage of other classes of artifacts, FCR was relatively common at Playa View Dune. Over 1000 specimens of FCR were recovered from excavation area 1 alone, compared to 225 bone fragments, 174 lithic artifacts, and 6 pieces of ground stone. When a count of FCR is compared to the counts of other artifacts, and each is independently employed as an indicator of duration of occupation, the lines of evidence seem to contradict each other. Accurate expectations about the rate at which FCR is broken down and subsequently discarded will help to resolve this apparent contradiction by ascribing an estimation of the intensity of activity required to produce this assemblage.

Ethnoarchaeological comparisons indicate the campsites excavated at Playa View Dune were occupied "less than a month" based on primary refuse disposal and bi-polar core reduction debris. The amount of bone, lithic, and ground stone refuse, two hearths, and a limited living surface suggests an even shorter occupation of "perhaps a few days," (Simms et al. 1999). The amount of FCR, when combined with the breakdown rate observed in our replication experiments, suggests far more cooking stones were exhausted and discarded than what would have been produced from a few days of *routine* cooking in a small group. If the two-to-three-day estimate of duration of occupation is correct, then rather intensive cooking would have been required during that time to produce the amount of FCR present in the excavation area. In this case, intensity may refer to either a larger group or a specialized subsistence activity such as preparation of foods for storage. As the interpretation of duration of occupation increases up to a month, so does the likelihood that the FCR represents routine cooking.

### USE AND RE-USE OF HOT ROCKS

The use of hot rocks in various cooking techniques is well documented in ethnographic accounts of the Great Basin, indeed throughout North America. Green pinyon cones were pit roasted to release the seeds. Most root resources and many meats were also roasted in pits with hot rocks and covered with earth until sufficiently cooked, usually overnight (Fowler 1986; Linderman 1957 and Turney-High 1933; both cited in Wedel 1986).

Stone boiling is another common cooking method, used in preparing mush or gruel out of ground seed meal, as well as boiling meats, insects, and shell fish when available (Fowler 1986; Steward 1933). Binford (1978) describes the use of boiling stones for bone grease extraction by the Nunamiut. Large game was sometimes cooked from within by filling the body cavity with water and heated rocks (Fowler 1986). More often, though, stone boiling involved a watertight basket or pit lined with an animal skin, approximately one foot deep and one foot in diameter (Catlin 1973 [1841]; Denig 1930; Kroeber 1908; Turney-High 1937; all references cited in Wedel 1986). Hot rocks were handled with a looped stick that was also used for stirring (D'Azevedo 1986). Specific cooking times are rarely given, but include up to an hour for large caterpillars and presumably less than 10 minutes for most ground seed meals (Steward 1933).

The cooking process subjects rocks to several kinds of thermal stress during both heating and cooling, causing the rocks to crack and reduce into smaller fragments, which are ultimately discarded. At a site like Playa View Dune, the lack of on-site rock sources means that re-use potential is a significant factor in minimizing further acquisition costs. We have included here an overview of those thermal stresses that affect breakdown rate and thus re-use potential. *Thermal shock* is the result of rapid changes in temperature. Rapid heating usually causes hairline cracks to develop on the exterior as it *expands* faster than the center. Many, but not all fragments separate along these fracture lines during heating. Rapid cooling, as in quenching, is mechanically similar to rapid heating but the exterior *contracts* faster than the center. *Thermal fatigue* describes a gradual reduction in the general integrity and strength of the rock due to cyclical exposure to heating and cooling. The rate of temperature change is not a factor in this process (Shalk and Meatte 1988; cited in Black and Hester et al. 1998).

In their stone boiling experiments, Black and Hester et al. (1998) concluded that internal cracks from repeated use gradually reduce the rock's effectiveness in heat transfer, but not enough to cause it to be discarded. The reduction of the *size* of the rock into smaller fragments does, however, reduce its efficiency and re-use potential. Recall that no lithic resources were available at Playa View Dune, so all rock used for cooking would have involved initial transportation costs. The threshold of efficiency where a fragment is discarded rather than reheated is a function of all of these considerations. Interestingly enough, the FCR debris observed at Playa View Dune is of rather uniform size and weight, 2-3 cm and 110 g (1/4 lb.). We hypothesize that FCR of this consistent size occurs throughout the study area because it is the result of discard due to having fallen below the threshold of efficiency. If the FCR in this size range represents discarded fragments, the next step is to develop expectations of the rate at which these discarded fragments are produced.



## REPLICATION EXPERIMENTS

Our primary purpose in conducting these experiments was to develop an initial model that assesses intensity of site activity by knowing the rate at which discarded FCR is produced. Specifically, our goals were as follows:

1. To determine the rate at which boiling stones typically fragment or break down through a series of heating and quenching cycles.
2. To determine the size at which fragments are no longer efficient enough to warrant reuse and are subsequently discarded.
3. To measure the declining efficiency of boiling stones as they break into smaller fragments.

If the rate of breakdown is measurable and consistent, then a model of that rate along with the knowledge of the size at which fragments are discarded enables an assessment of the cooking hours required to produce a given assemblage.

Assume 10 stones, heated for one hour, boiled six liters of water for 12 minutes. If the procedure were repeated five times, those stones would fracture and many of the resulting fragments would be discarded. The procedure for our experiments was designed around such a scenario. We created 10 FCR assemblages through a known and consistent procedure similar to the one described above. By associating FCR that resulted from that procedure with the actual cumulative boil time that it produced, we begin to establish a basis for assessing the FCR observed on an archaeological site.

The first step in the experiment was to test the hypothesis that breakdown reduces the efficiency and re-use potential of boiling stones. Preliminary experiments investigated the effects of the surface area-to-volume ratio on heat retention. Two batches of rocks of equal mass and lithology were prepared. The first consisted of five large cobbles, and the second consisted of 16 smaller cobbles. The second batch clearly represented a greater surface area. The first batch of large stones with less surface area proved to be markedly more effective in their capacity for heat retention. These results indicate that a rock's effectiveness as a boiling stone diminishes with increased surface area and that re-use potential decreases as the breakdown takes place.

Recognizing the complexity of the cooking/boiling process, a number of variables were considered for the replication experiments: rock type, cooking method, time-length of heating, temperature of fire, varying capacities for heat retention, cobble size, and fuel type. Given the necessity of imported lithic resources to the Great Salt Lake Desert sites, we focused primarily on breakdown rate as it affects re-use potential, therefore opting to vary numbers of heating/cooling cycles and keep the other named variables constant.

The constants were defined for the purposes of simplicity and by applicability to the study area. We controlled for the effects of material type and rock composition by exclusively selecting porphyritic rhyolite cobbles for our experiments. This material was selected because it was the most common FCR found in the excavation at Playa View Dune. The specimens were obtained from several different washes within a few hundred meters of that site.

Only cobbles with no damaged cortex were used. We used cobbles ranging in size from 8 to 12 cm in diameter, the average mass of each batch of 10 stones being 10 kg. This size range was simply the median of available cobbles at the sources.

While the cooking/cooling technique may cause subtle variation in the morphology of the FCR, the specimens in our experiments consistently exhibit the most significant cracking and spalling during the first 15 minutes of the first exposure to heat, not during the cooling (quenching). McDowell-Loudan (1983), House and Smith (1975), and Black and Hester et al. (1998) report these same observations. As Black and Hester et al. (1998) point out, since both boiling stones and earth oven stones, "share partial thermal histories, namely sudden or gradual heating in a hearth," it is reasonable to assume that overlap in fracture patterns will exist among various cooling techniques. Although the matter is hardly settled by the FCR literature presently available, we feel there is enough evidence, both in published studies and our own observations, that varying the cooling technique only causes minor variations in appearance and does not substantially affect the rate of breakdown. For this reason, and in the interest of simplicity, only one cooking method was assessed—stone boiling.

#### **Methods: "The Cooking Episode"**

The procedure of heating and quenching an entire batch will be referred to as an individual "cooking episode." The parameters for a single, replicable cooking episode were identified through extensive trial and error tests to determine what procedures are necessary to actually achieve and maintain a boil for approximately 10 minutes. Efficiency was recorded by measuring the maximum boil time produced by an initial batch of 10 stones. The loss of efficiency is evidenced as the same batch with the same overall weight, produces shorter boil times as the number of fragments increases with each iteration. Once the necessary parameters were identified, each batch of rocks underwent five iterations of the cooking episode (Figure 2). Ten data sets were produced using the following methods:

1. A large fire, approximately 1 m in diameter was built, and allowed to burn solidly for at least one hour before adding the rocks. Pre-bundled pinewood was purchased to keep the fuel size and type consistent. Ten rounded cobbles, each having an average mass of 1 kg were then added and positioned as closely to the center of the fire as possible to insure even heating. The rocks were heated for one hour.
2. After one hour of heating, one rock at a time was removed with tongs and added to a bucket of water with an initial temperature of 50°-55° F. A five-gallon plastic bucket contained a water volume of 5.68 liters (1.5 gallons). The water typically boiled after the sixth or seventh stone was added.
3. Each remaining stone was added successively as the water reduced to a simmer. Every new stone tended to extend the boil two to three minutes.



Figure 2a. Demonstration of cooking episode.



Figure 2b. Close-up of rolling boil achieved during cooking episode.

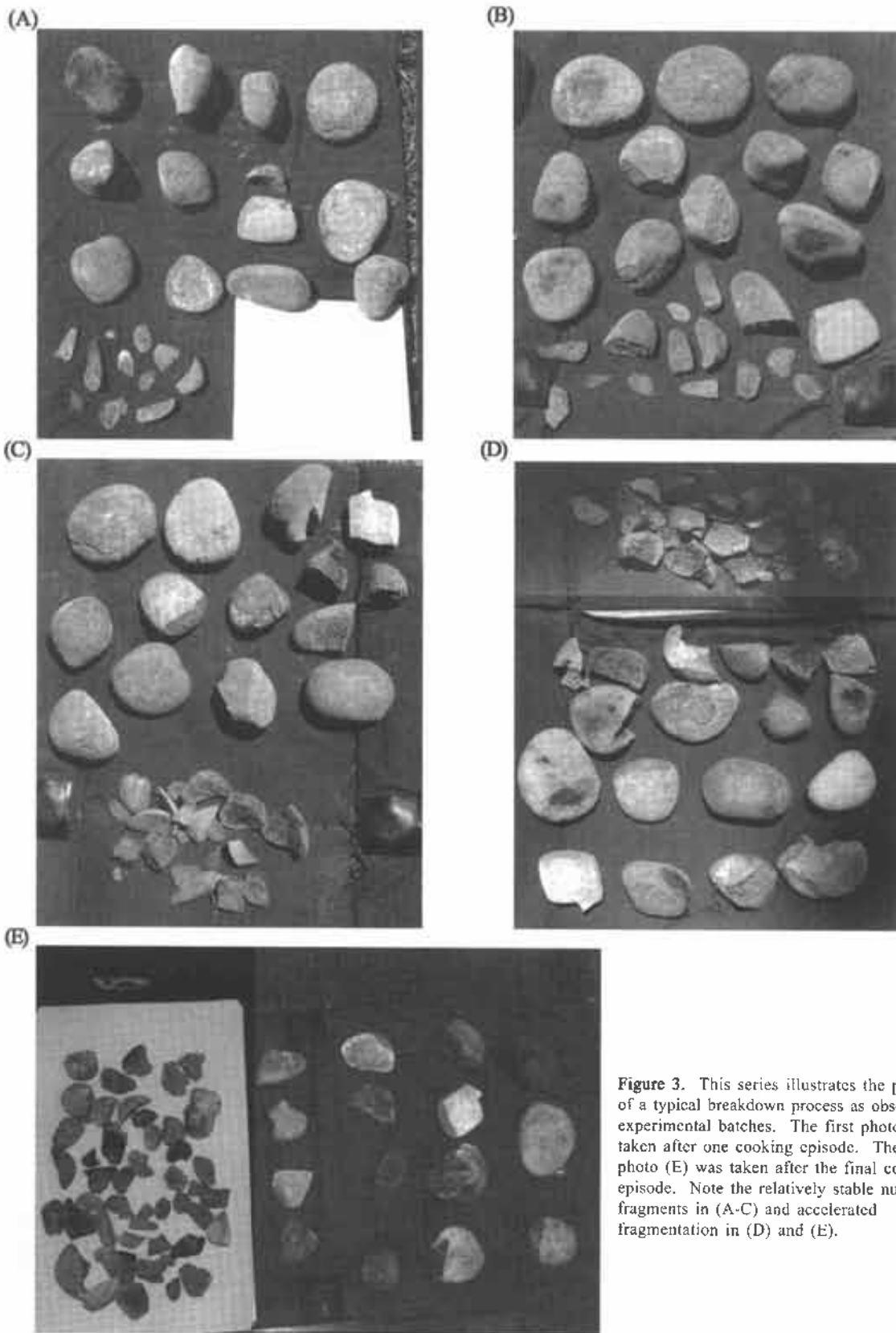
The photo series in Figure 3 (a-e) illustrates the typical breakdown that was observed. Fracturing and some separation of fragments occur during the first cooking episode. During the second and third episodes, however, very little change takes place. One possible explanation for this is that the hairline cracks that form during the initial heating may serve to absorb thermal shock from future iterations. Separation and breakdown along these hairline cracks resumed with the fourth round of cooking episodes. By the fifth and final round, it was evident that the original 10 stones had broken down to the point that they, as a batch, were no longer able to achieve and maintain an effective boil.

Although six of the batches were very consistent with this pattern of breakage over time, the other four did vary. For example, one batch initially sustained multiple hairline fractures, but did not separate into distinct fragments until the third round of cooking. From another batch, two complete rocks shattered into very small fragments during heating in the first cooking episode, all of which were too small to recover and too small to include in future episodes. The other eight rocks in that same batch remained intact and there was very little breakage from the remaining four cooking episodes.

By the fifth and final round of cooking, the average number of fragments in each batch had increased by six times. The initial 10 rocks had broken down into an average of 61 smaller rocks. With each round of cooking, the length of boil these smaller fragments were able to produce steadily decreased. Figure 4 shows the correlation between efficiency (boil time) on the vertical axis and size on the horizontal axis (decreases as number of fragments increases). With further repetitions of the heating/cooling cycle, we can predict that the strength of the correlation would have increased. We limited our experiments to five repetitions because a substantial decrease in boil time was already evident at that point. With the size reduction that occurred in just five cooking episodes, the average boil time produced by the same batch of stones was reduced from 10.5 minutes to 6.1 minutes - a 42 percent reduction in efficiency!

We observed that it requires at least three fragments weighing less than 110 g (1/4 lb.) each to extend the boil even one more minute. This size approximates that of the rocks commonly found discarded on the archaeological sites in the study area (Figure 1). Based on these observations, 110 g was identified as the exclusion point at which fragments would not be used in subsequent cooking episodes. In other words, we found that rocks smaller than 110 g produced a substantial reduction in heat retention ability and it was at this size that they should be discarded.

Figure 5 is a graphical summary of the experiments showing the breakdown rate, indicated by the increased number of fragments with each cooking episode. The overall number of fragments produced by each cooking episode is shown on the vertical axis. As the number of fragments increases, those fragments are necessarily smaller. As the breakdown proceeds, the percentage of fragments in the excluded category increases - that is, rocks smaller than 110 g.



**Figure 3.** This series illustrates the progression of a typical breakdown process as observed in experimental batches. The first photo (A) was taken after one cooking episode. The last photo (E) was taken after the final cooking episode. Note the relatively stable number of fragments in (A-C) and accelerated fragmentation in (D) and (E).

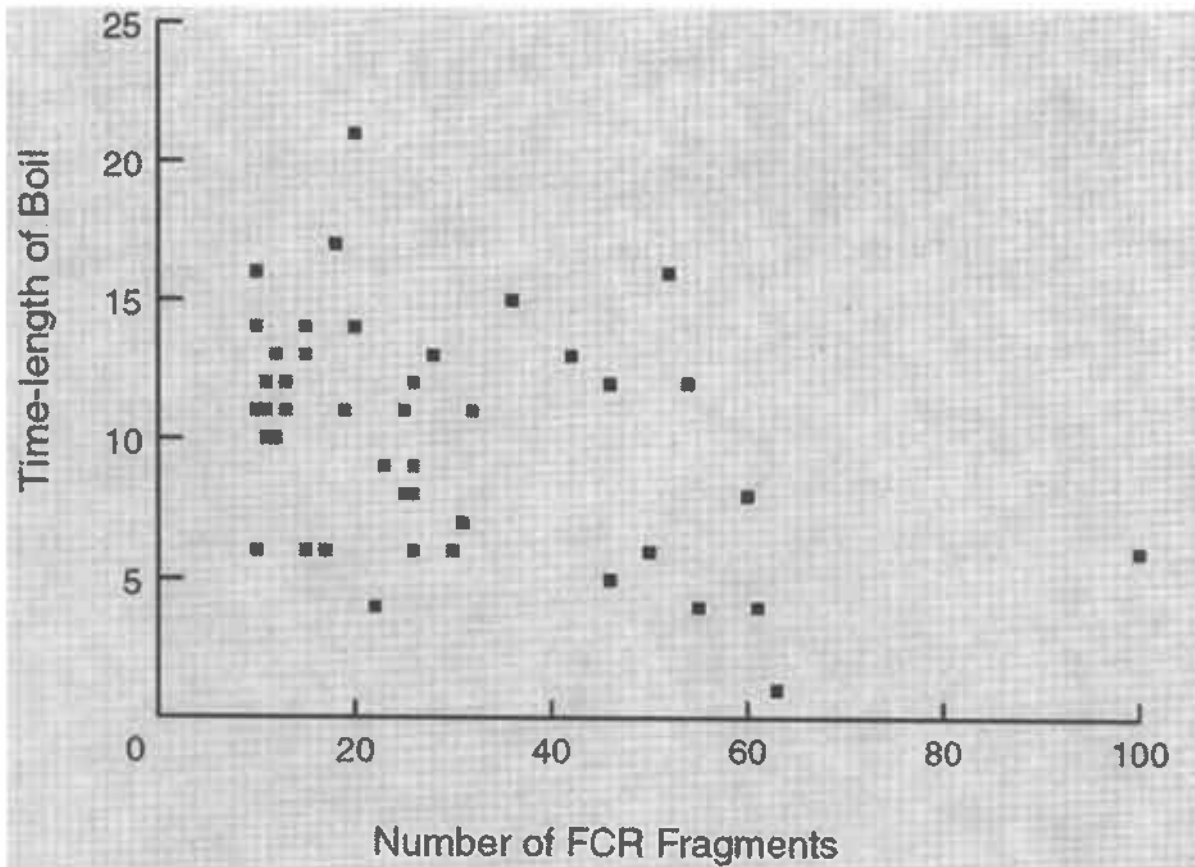


Figure 4. This scattergram illustrates the relationship between size and efficiency. The length of time that FCR fragments are able to boil water (y axis) decreases as the number of fragments (x axis) increases.

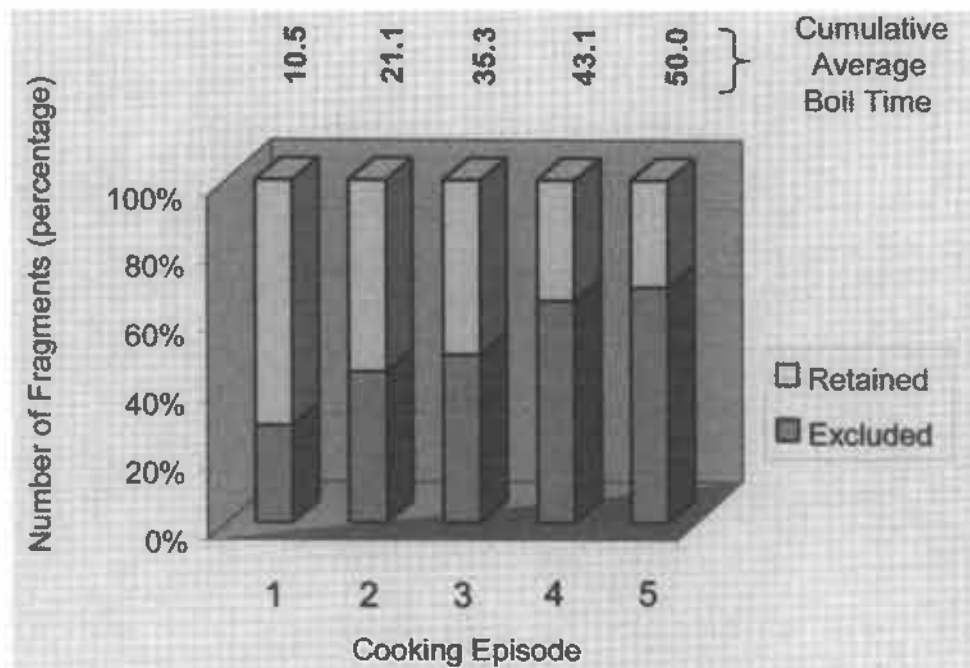


Figure 5. This graph shows the rate of declining efficiency as well as the rate of production of discarded FCR. The number of rocks discarded (< 110 g) increases (y axis) with each cooking episode (x axis). The rocks retained are used in subsequent cooking episodes to produce the cumulative average boil times. Together these provide a frame of reference for assessing how much cooking is required to produce an FCR assemblage, given the parameters employed in this study.

Each round of cooking episodes is also labeled with the cumulative average boil. This illustration of the breakdown process combined with corresponding cumulative boil times provides a frame of reference for generally assessing how much cooking took place at a given site with an FCR assemblage. We started with 100 stones having an average maximum size of 10 cm. We finished with 610 fragments having an average maximum size of 3 cm. The experimental assemblage is the result of boiling water for approximately eight hours, each hour of boil involving approximately six hours of heating.

**Results: What Does This Mean for Playa View Dune?**

With these experiments, an effort was made to develop broad expectations about the amount of cooking activity that goes into the production of FCR. Three measurements were selected to record and convey those expectations: (1) determine the breakdown rate of our rocks, (2) identify the size of fragments which are discarded rather than reheated, and (3) record the decline in efficiency as the fragments approach that threshold. In sum, for every 10 stones started out with, we ended up with 60. Our experimental specimens showed a 40 percent reduction in their efficiency as boiling stones after just five cooking episodes. Much of that decrease is the result of fragments that were excluded because they were too small to be effective as boiling stones. The rapidly fading potential of these stones was most commonly observed at the size of 2-3 cm and 110 g (1/4 lb.), which approximates the size of FCR fragments on archaeological sites in the study area.

The archaeological assemblage certainly was not created under such controlled circumstances, but if it were, the more than 1000 fragments of FCR recovered from an excavated campsite at Playa View Dune would indicate a staggering 13 hours of boiling water, not including the time required to heat the rocks. Multiple lines of evidence were employed in the analysis of excavated materials at Playa View Dune. The resulting interpretation is that of a short-term campsite lasting anywhere from a few days up to a month. By adding to that body of evidence an FCR assemblage that may have taken 13 hours of boiling to produce, the picture begins to come into focus. If the duration of occupation was only a few days, then either there was a larger group to feed and they left relatively little other debris, or intensive cooking activity took place during that short time that exceeded the group's immediate needs. If the excavated area was occupied for a month, then the FCR present may very well reflect routine cooking activities for that length of time.

### THE NEXT STEP

The factors contributing to the formation of FCR assemblages are indeed complex. The experiments were designed around the attributes of the Dugway study area: small campsites that were formed in blowouts within active dune fields, no rock available on-site, and a limited range of rock types employed for cooking. The specimens, parameters, and variables were all designed with this specific site in mind. Several steps can be taken to advance this study and apply it to other cases:

1. Take into account the differential breakdown rates of various rock types found at other sites.
2. Assess the rate of rock fracture due to weathering that continues after cracked, but largely intact FCR is discarded at sites.
3. Experiment with different cooking methods other than just stone boiling to test the hypothesis that different cooling rates have minimal effects on the rate of rock fracture.

Given the large amount of information from numerous experiments by geologists and archaeologists on the breakdown of rocks from fire, our goal was to develop a simplified, initial model that begins the process of linking this information to past human behavior. The model of breakdown rate and knowledge of discard size enables an assessment of how many hours of cooking it would take to produce a given archaeological assemblage of FCR. By itself, this information is limited in potential. However, when combined with other archaeological evidence estimating duration of occupation, it enables FCR to contribute to an understanding of the intensity of site activity.

Although no single source of data can be confidently relied upon for a summary of the site, each one does refine the accuracy and precision of the picture being painted. An estimate of the rate at which FCR is produced and added to the archaeological record will add to the overall understanding of a complex activity area by ascribing to a given assemblage a measure of *intensity of activity*, a picture that more clearly reflects the activities that took place at a site.

### ACKNOWLEDGMENTS

The ideas developed here were born around the campfire during Utah State University's Field School 1997 at Playa View Dune, Dugway, Utah. This study would never have made it through the night without the encouragement and guidance of Steve Simms. Funding and supplemental resources were provided by a grant from the Undergraduate Research and Creative Opportunities program at USU and the Anthropology Program. This research was also supported by an appointment to the Postgraduate Environmental Management Participation Program of the U.S. Army Environmental Center. We also thank the following individuals for their valuable suggestions at various stages of the research and writing: Kathleen Callister, Cultural Resource Management Officer, U.S. Army Dugway Proving Ground; David B. Madsen, Dave N. Schmitt, and Monson W. Shaver, Utah Geological Survey; Margo Memmott and Kristine Curry, Utah Trust Lands Administration; and Jennifer Eisenbarth-Porter, Archaeology Technician, Dugway Proving Ground. An earlier version of this paper was given at the Utah Professional Archaeological Council, May 1998, and a poster was presented in October 1998 at the Great Basin Anthropological Conference in Bend, Oregon.



## REFERENCES CITED

- Binford, L. R.  
1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.
- Black, S. L., T. R. Hester, K. Jolly, C. D. Frederick, J. R. Lucas, J. W. Karbula, P. R. Takac, and D. R. Potter  
1998 Burned Rock as Artifact. *Archaeology Along the Wurzbach Parkway: Module 3 Investigation and Experimentation at the Higgins Site (42BX184)*, Vol. I Studies in Archaeology 27, Texas Archaeological Research Laboratory, The University of Texas at Austin.
- Catlin, G.  
1973 [1841] *Letters and Notes on the Manners, Customs, and Conditions of the North American Indians*. Dover Publications, New York.
- D'Azevedo, W. L.  
1986 Washoe. *Handbook of North American Indians, Vol. 11. Great Basin*. Smithsonian Institution, Washington, D.C.
- Denig, E. T.  
1930 Indian Tribes of the Upper Missouri. *Bureau of American Ethnology, Annual Report 46*.
- Fowler, C. S.  
1986 Subsistence. *Handbook of North American Indians, Vol. 11, Great Basin*. Smithsonian Institution, Washington, D.C.
- House, J. H. and J. W. Smith  
1975 Experiments in Replication of Fire-Cracked Rock. *Arkansas Archaeological Survey 8:75-80*. Publications in Archaeology Research Series.
- Kritzer, K. N.  
1955 *Thermolithofractography: A Comparative Analysis of Cracked Rock from an Archaeological Site and Cracked Rock from a Culturally Sterile Area*. Master's thesis, Ball State University, Muncie, Indiana.
- Kroeber, A. L.  
1908 *Ethnology of the Gros Ventres*. Anthropological Papers of the American Museum of Natural History, New York.
- Linderman, F. B.  
1956 *Plenty-Coups, Chief of the Crows*. University of Nebraska Press, Lincoln.
- McDowell-Loudan, E. E.  
1983 Fire-Cracked Rocks: Preliminary Experiments to Determine Its Nature and Significance in Archaeological Contexts. *The Chesopiean 21(1):20-29*.
- Pagoulatos, P.  
1992 The Re-Use of Thermally Altered Stone. *North American Archaeologist 13(2):115-129*.
- Schalk, R. and D. Meate  
1987 The Archaeological Features. *The Archaeology of Chester Morse Lake: The 1986-1987 Investigations for the Cedar Falls Improvement Project*, edited by R.F. Schalk and R.L. Taylor. Center for Northwest Anthropology, Washington State University, Pullman.
- Simms, S. R., D. N. Schmitt, and K. Jensen  
1999 Playa View Dune: A Mid-Holocene Campsite in the Great Salt Lake Desert. *Utah Archaeology 12:31-49*.
- Steward, J. H.  
1933 *Ethnography of the Owens Valley Paiute*. University of California Publications in American Archaeology and Ethnology, University of California Press, Berkeley.

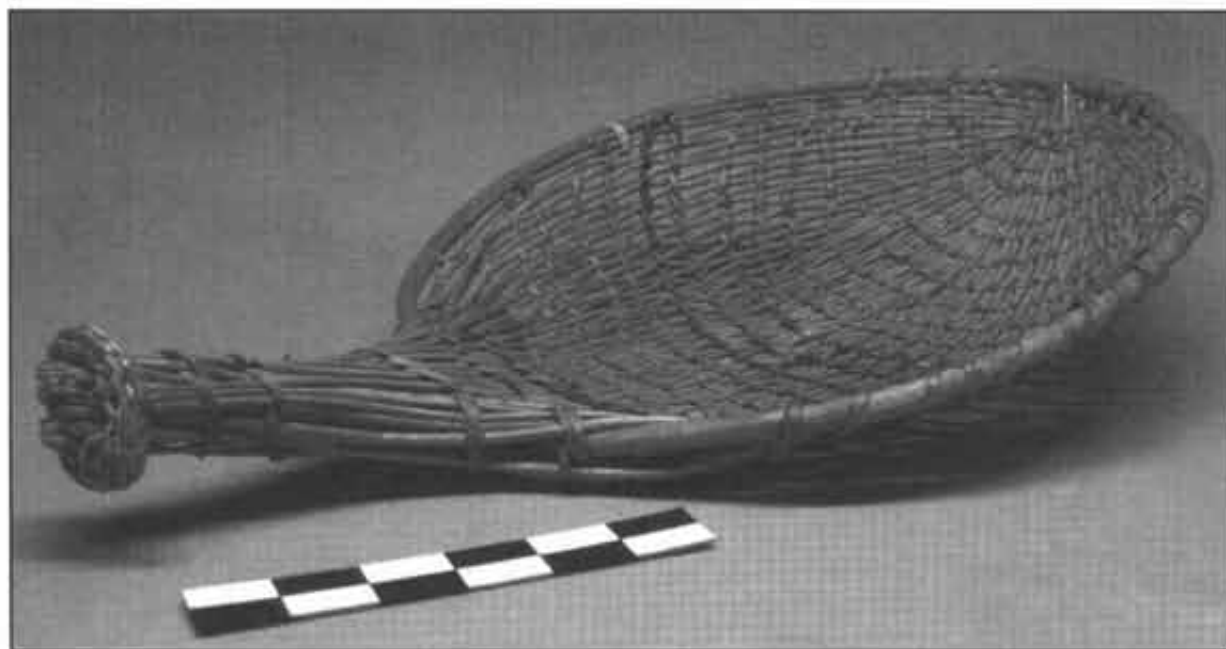
Turney-High, H.

1933 Cooking Camas and Bitter Root. *The Scientific Monthly*.

1937 *The Flathead Indians of Montana*. American Anthropological Association, Memoir 48:127-128.

Wedel, D. L.

1986 Some Thoughts of the Potential of Fire-Cracked Rock Studies in Archaeology. *Wyoming Archaeologist* 29:159-164.



Sieve

*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*

## . . . B o o k R e v i e w . . .

**Excavation of the Donner-Reed Wagons**

by Bruce R. Hawkins &amp; David B. Madsen

University of Utah Press, Salt Lake City. 1999. xiv + 178 pp., 78 illustrations. \$14.95 *softcover***Sonia M. Evans & Timothy D. Evans**, 848 West 400 South, Vernal, UT 84708

The Donner-Reed party of California emigrants is probably most famous for tales of cannibalism related to its winter stay at Donner Lake, California in 1846-47. Less well-known, but of equal interest and historical import, is the party's excursion across the Great Salt Lake Desert of Utah following the little used Hastings Cutoff. Hawkins and Madsen's account of the excavations of the Donner-Reed wagons conducted in 1986 along the Hastings Cutoff provides an insightful look into the journey of the Donner-Reed party, the history of westward emigration via the desolate Hastings Cutoff, and the perspectives and methods of historic archaeology. The Silver Island Expedition was one of a series of archaeological efforts aimed at salvaging prehistoric and historic remains threatened by the pumping of Great Salt Lake waters into the Great Salt Lake Desert.

The book has three major sections: an outline of the issues and questions the project sought to address; chapters fleshing out the historical background associated with California emigration and the use of the Hastings Cutoff; and details of the archaeological procedures, findings, and interpretations of the project.

The Silver Island Expedition sought to determine if there were any surviving remains of Donner-Reed materials, and if so, what these said about the party and their situation. The expedition also sought material evidence to support rumors that the party had buried gold, precious jewels, and entire wagons at the sites.

The book provides detailed historical information about California emigration, the Hastings Cutoff, and previous visits to the Donner-Reed sites. Chapter 2, authored by Gary Topping, serves as a general introduction to the routes used by pioneers moving westward. Topping also recounts the Donner-Reed story, and shows how the Hastings Cutoff was a foolish choice of route.

In Chapter 3, Brigham D. Madsen describes the expedition of Howard Stansbury to the region in 1849-50. This account may at first seem superfluous, but the information it provides is essential to answering the project's guiding questions because it details Stansbury's encounter with the abandoned campsites and artifacts of the Donner-Reed party.

Chapter 4 describes other visits to the sites and provides a timeline that bluntly exposes the virtual destruction of two of the five sites by relic collectors between 1875 and 1962. These "expeditions," were for the most part, well intentioned, but probably destroyed more evidence than any knowledge produced. In a typical account, a 1936

expedition had the stated purpose of recording the Hastings Cutoff sites with photographs and written descriptions. However, what remains of this information was too vague to be of any use to the Silver Island Expedition. The photographs taken to record the sites show no landmarks, making it impossible to discern the exact locations of the sites. Photographs show that this expedition did collect artifacts, however, the location of these is unknown due to lack of proper documentation and storage.

Descriptions of the expedition's procedures and findings follow the context developed in the first two sections of the book. The Silver Island Expedition located five separate wagon sites in the late summer of 1986. As expected, the sites showed the ravages of past collecting excursions that made interpretation difficult and in some cases, impracticable. However, three of the sites, although damaged by looting, yielded data sufficient for interpretation. For example, at sites 42To467 and 42To469, geological specimens from the north and west sides of the Great Salt Lake Desert were found, indicating that Captain Howard Stansbury's scientific exploration party had camped in the area. Several military buttons as well as expended percussion caps found at the two sites indicate the stopover of a military expedition - most likely the Mormon Battalion. Many other artifacts, including bottle fragments, textile fragments, brushes, nails and buckles, are similar to items carried by those using the Oregon Trail.

No evidence, historical or archaeological, was found to support the myth that the Donner-Reed party left gold and jewels in the Great Salt Lake Desert. Hawkins and Madsen note that abandoned valuables from the party are probably limited to the gold coins already known from Donner Pass, California, where the party met its tragic end.

One interesting finding was that of the wagon wheel ruts at site 42To467. The 86 inch wide spacing of the tracks is significantly larger than the 58-59 inch wide tracks common to the period. These were surely made by James Reed's large flamboyant wagon, known to the party as the "Pioneer Palace."

*Excavation of the Donner-Reed Wagons* is a clearly written, informative, and entertaining report. While not providing a great deal of new information because of the damage done by relic-hunters and poor artifact curation, the book succeeds in strengthening evidence available in the historical record. Besides the book's purpose of recording the findings of a salvage archaeology project, it serves as a searing indictment against looting.

. . . . B o o k R e v i e w . . . .

## Man Corn: Cannibalism and Violence in the Prehistoric American Southwest

by Christy G. Turner II & Jacqueline A. Turner

University of Utah Press, Salt Lake City. 1999. 512 pp., 36 halftones and illustrations, two maps. \$65.00 cloth

**Mark Stuart**, 2054 East 6550 South, Uintah, UT 84405

Christy and Jacqueline Turner's new book is sure to be a classic, but a very controversial contribution to the archaeology of the American Southwest. This book is the first to examine prehistoric cannibalism on a regional scale rather than on a site-by-site basis. The title, *Man Corn*, comes from the Nahuatl (Aztec) word "Hacataolli" which means "man corn", a sacred meal of sacrificial human meat cooked with corn.

The book has two stated goals. First, the authors attempt to define and illustrate the characteristics of damaged human bone that they feel reflects the acts of cannibalism in the American Southwest. Second, they attempt to explain why cannibalism occurred there, offering working hypotheses about local, proximate causes.

The Turners are persuasive in arguing that cannibalism existed by presenting all of the evidence that they have been able to amass in a lifetime of taphonomic research. This evidence makes up the largest section of the book – Chapter 3.

The evidence consists of 76 archaeological excavations yielding human skeletal material and that the excavator felt showed signs of violent death and/or cannibalism. The Turners personally analyzed all curated skeletal material whenever possible, unless the evidence presented in the site report was overwhelmingly convincing of cannibalism. The Turners present their findings in a standardized reference handbook style that the layman can understand. One of the strengths of this style is that it allows for inter-site comparison using a consistent set of criteria for assessing violence and cannibalism. The data are also organized chronologically by date of claim, instead of geographically, or by site time period. The intent is to show that from the beginning of Southwestern archaeology, violence and cannibalism have been recognized.

Every claim for cannibalism is evaluated in a site-specific discussion section. Whenever possible, the perimortem damage for each bone assemblage is quantified, tabulated and documented with excellent and copious black and white photography. As suspected, the information for each assemblage could be expanded into a full monograph in its own right. But the Turners' intent was to describe and characterize sites in a uniform fashion, so they can all be evaluated with maximal comparability under one cover.

Out of 76 sites examined, the Turners conclude that 38 of them, represented by 286 skeletons of both sexes and all ages, exhibit cannibalism. From this regional data set, the Turners produce five principle findings about cannibalism in the Southwest. These findings are presented as working hypotheses for future research. Several of these hypotheses are certain to be controversial:

1. Cannibalism can be differentiated from all other forms of bone damage and mortuary practices by a distinctive taphonomic signature (i.e. pot polishing) which matches that seen in bone refuse of large and small game animals processed for consumption. This cannibalism signature is also present in human bone from Mexico where cannibalism is historically documented.
2. Violence in the archaeological record is evident from Basketmaker II times forward. The Turners' taphonomic findings point to a more violent prehistoric Southwest than is commonly recognized. There are a few ethnohistoric indications of cannibalism in the region. Some cases may be starvation cannibalism. The Turners, however, found a correlation of mutilated and cooked charnel deposits with sites in Chaco Canyon, and in or near outlying Chacoan Great Houses during their heyday between A.D. 900-1200. At present, only the Awatovi-Polacco Wash episode is known to have occurred after historic contact in 1539. With Anglo-European contact the practice of warfare, violence and native religion quickly weakens.
3. Southwest cannibalism appears to have originated in Mexico where the practice dates back at least 2,500 years. This practice was introduced to the Southwest by either: a) diffusion, b) Chacoan contact with Mexican people, or c) actual Mexican migration to the American Southwest.
4. By exclusion, correspondence, analogy and distributional evidence, the Turners propose that the majority of Chacoan cannibalism resulted from acts of terrorism combined with ritual, incited by zealot cultists from Mexico and their descendent followers who possessed deadly ceremonial knowledge of Mexican religious and warfare practices. If the Turners are right, then it follows that the strong correlation between Anasazi cannibalism and Chacoan Great Houses points to a Mexican stimulus for the rapid development of the Chaco phenomenon. To support this controversial interpretation the Turners point to a few Southwestern skeletons with dental transfiguration, a common Mesoamerican trait. This includes a high status burial from Pueblo Bonito in Chaco Canyon. The Turners further suggest that these cultists were maniacally concerned with Xipe Totec (Our Lord the Flayed One). This deity is associated with fertility (especially corn) and warfare, and was worshipped through acts of human sacrifice and ceremonial cannibalism. The Hopi spirit-being called "Massaw" has several functional and physical features of Xipe Totec including the legendary association with warfare, human sacrifice, and fertility.
5. The Turners thus explain cannibalism with a model that combines social control, social pathology and ritual purpose within the Chacoan sphere of influence. This harsh and fatalistic world view was carried into the San Juan Basin by immigrants from Mexico and violently imposed on a resident Anasazi population which had previously received only bits and snatches of Mesoamerican culture. The Turners

also explain why these influences did not affect the Hohokam and Mogollon neighbors of the Anasazi. The Hohokam already had a highly centralized society and the Mogollon were too decentralized to impose such a system upon them.

In all, I found the Turners' book to be thought provoking and stimulating as it presented some new views on a much written about, but still little understood, phenomenon in Southwestern archaeology. The Turners acknowledge their interpretations will be controversial. Judging from the amount of newspaper ink already expended on Anasazi cannibalism in recent years, this prediction has already come true.

This book has also stimulated some re-evaluation of skeletal material in the face of potential repatriation of human remains to Southwestern Native American groups. Perhaps in our haste to be politically correct, we are losing much valuable data. Much of the Turners' research could not have occurred if repatriation laws had been enacted years ago. These are questions which have yet to be fully resolved.

I feel the greatest value of this book was the application to human behavior. The extraordinary quality of Southwestern violence and the mounting evidence for cannibalism should make us think more about what individuals did in the past instead of focusing entirely on abstractions such as cultures, traditions, and systems which obscure the actual events that stem from the action of individuals. In closing, I would recommend this book to all.



*Conical Basket*

*Courtesy of the Utah State University Museum of Anthropology, Dathan Collection*



## Prehistoric Warfare in the American Southwest

by Steven A. LeBlanc

University of Utah Press, Salt Lake City. 1999. 400 pages, 70 illustrations and maps. \$34.95 cloth

**Kathleen Heath**, Department of Geography, Geology and Anthropology, Indiana State University, Terre Haute, IN 47809

Southwestern laymen and professional archaeologists will benefit from contemplating warfare through the lens of Steven LaBlanc's *Prehistoric Warfare in the American Southwest*. The book is an excellent descriptive account of Southwestern archaeology and combines a wealth of information under a single cover. The book suffers from repetition and perhaps the author sounds too apologetic for raising the morally sensitive issue of warfare and violence. Nonetheless, LeBlanc produces a long awaited and much needed synthesis of the evidence for prehistoric Southwestern violence and warfare.

The book's eight chapters document the evidence supporting violence and warfare in the Anasazi, Mogollon, and Hohokam areas from the Basketmaker period through historic contact. LeBlanc divides his account of the ancient Southwest into the Early Period (up to 900 A.D.), Middle Period (900-1250 A.D.), and Late Period (1250 - 1500 A.D.).

Chapter 1 is an exhaustive introduction to issues of warfare in general and in the Southwest. LeBlanc briefly presents three previously-derived explanations for warfare: 1) the *scarce resource - carrying capacity model* that argues for competition for limited resources, 2) the *vengeance model* which states that warfare is a "get-even" policy, and 3) the *ritual model* that suggests warfare is controlled by religious ideologies and interests. He dismisses the latter two models and opts for the carrying-capacity, ecologically-based one "as a heuristic model for Southwest warfare" (p. 32). More of a framework than a formal model, it must be stressed that the evidence for the carrying capacity model is not demonstrated in this book.

The point LeBlanc seems to make is that prehistoric warfare is patterned and this patterning will turn out to be explainable. He stresses that warfare in the Southwest was not simply a rise to a peak, followed by a decline. Rather, LeBlanc's Early Period is one of *initial warfare*, followed by a *decline in warfare*, and then an escalation to a period of *intensive warfare* in the Late Period. LeBlanc works from the observation that warfare is probably common throughout the human experience, and then goes on to explore the variable expressions of warfare and violence over time in the ancient Southwest. The interesting question in the Southwest is why there is a decline in warfare in the Middle Period (900-1250 A.D.)

The body of the book (Chapters 2-7) is a well-organized discussion of warfare in the Southwest. In Chapter 2, LeBlanc summarizes archaeological features such as settlement patterns, burned sites, and human remains that may reflect violence and warfare. There is nothing particularly new or innovative here, but his presentation is clear and thorough. Chapter 3 focuses on the artifacts that may represent warfare technology in the Southwest, but ends up being weak simply because the weapons and implements of war may have been used for nonviolent activities such as hunting. The strength of the book lies in Chapters 4, 5, and 6, corresponding to the Early, Middle, and Late Periods. Here, LeBlanc relates the archaeological features and artifacts described in Chapters 2 and 3, with each Southwestern region: Anasazi, Mogollon, and Hohokam. LeBlanc hints at the role of climate and resource change and the difference between inter-and-intra community warfare; but he focuses more on describing warfare than the much more difficult task of explaining it. Finally, in Chapter 7, LeBlanc summarizes how warfare and violence had social and political consequences for migration, alliances, elite classes, and trade - familiar characteristics of the Southwest during the Late Period.

The presentation is not grounded in theory nor does the author set out to test hypotheses. LeBlanc states (pp. 308-309), "My goal for this book was not to test these models, as much as it was to characterize Southwestern warfare." To that end, the author succeeds with flying colors. The book is a good descriptive account of Southwestern archaeology including the evidence suggestive of violence and warfare.

LeBlanc's work doubles as a nice reference work for the prehistory of the Southwest with an excellent summary of site-to-site and region-to-region evidence for warfare and violence. LeBlanc hopes (p. 312) that his is "an initial discussion" that will "spark critiques and refinements." He concludes that warfare has profound consequences for social behavior and should be more seriously considered as a factor in culture change. He supports an ecological model concerned with carrying capacity and population growth as an explanation for why warfare and violence varied over time and from place to place and argues, "this is the most fundamental question facing anthropologists today" (pp. 313-314). But an explanation of why warfare varies through time and space will have to await future studies.

## MANUSCRIPT GUIDE FOR *UTAH ARCHAEOLOGY*

*UTAH ARCHAEOLOGY* is a journal focusing on archaeological research within or relevant to Utah. Articles on either prehistoric or historic archaeological research are accepted and both are equally encouraged. All articles must be factual technical writing with some archaeological application. The journal is sponsored by the Utah Statewide Archaeological Society (USAS); the Utah Professional Archaeological Council (UPAC); the Mountain West Center for Regional Studies, Utah State University; and the Utah Division of State History. The journal is published annually.

Authors submitting manuscripts are requested to follow Society for American Archaeology (SAA) style in text references and bibliography (see October 1992 issue of *American Antiquity*). If you do not have access to a copy of this style guide please contact the editor of *Utah Archaeology*, Steven Simms, for a copy. Authors are requested to submit one hardcopy and one disk copy of their manuscript. A clear statement of exact formats used on disk copy must accompany the submission of the manuscript. The authors are requested to refrain from the use of hard page breaks and margins in order to facilitate final formatting for publication. Manuscripts should be in 10 pt. font, single spaced, and include an abstract if intended for use as an article.

Categories of papers are:

- (1) Articles. Synthetic manuscripts, overviews and reviews of past research are especially encouraged.
- (2) Reports. Shorter, more descriptive manuscripts
- (3) Notes. Short, descriptive manuscripts on new or old data with a minimum of comparative or interpretive discussion.
- (4) Comments. Manuscripts that focus on issues of current interest in *Utah Archaeology* or on previous publications. Comments on previously published works will be submitted to the author of that work for review and reply.
- (5) Book Reviews. Short reviews of current publications pertaining to archaeology in Utah.

All categories of papers are highly encouraged. We seek submissions from government agencies, private agencies and avocational organizations equally.

Authors are responsible for figure and photograph production. Figures and photographs should be of publishable quality, as *Utah Archaeology* will not be held responsible for making them presentable. Authors should submit a hardcopy of all figures and photographs. If desired, a disk copy of figures and photographs may be submitted provided that the format used is clearly stated on the disk.

All submissions will be reviewed by at least two (2) outside reviewers, to be chosen based on manuscript topic. Upon completion of outside reviews the author will be sent reviewers' comments. The final revised edition of all manuscripts will be considered the *final* edition and no further changes will be accepted.

Please submit manuscripts to:

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