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ARTICLES

BOOK REVIEW

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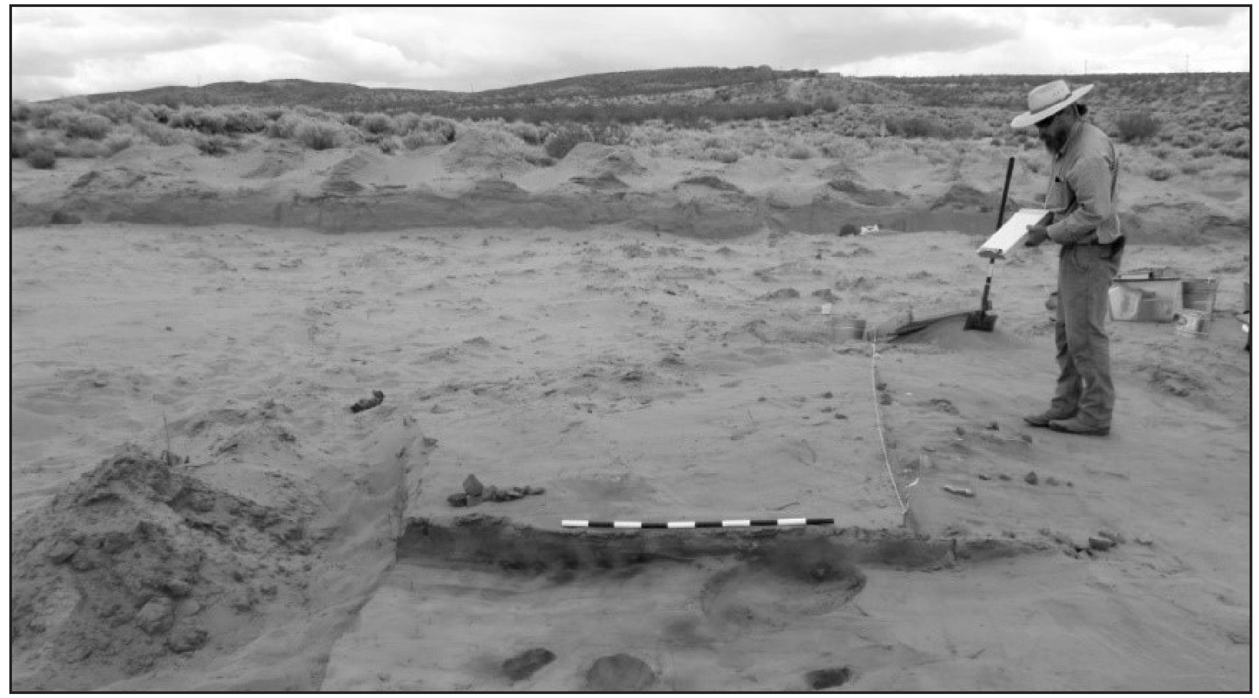

No. 1

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Authors submitting manuscripts are requested to follow the Society of American Archaeology (SAA) style. The most recent version of the SAA Style Guide can be found online at www.saa.org. Articles must be factual with some archaeological application. We seek submissions from authors affiliated with government agencies, cultural resource management firms, museums, academic institutions, and avocational archaeologists equally.

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5. Book Reviews: Reviews of current publications that are broadly relevant to archaeology of Utah.

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Tables, Figures, and Illustrations:

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2017

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The **Utah Division of State History** invites you to join the

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Utah Division of
State History

Preface

Kenneth L. (Kenny) Wintch
SITLA Lead Staff Archaeologist

The theme of this year's edition of *Utah Archaeology* is archaeological research resulting from cultural resource management (CRM) on the approximately 3.4 million acres of state school and institutional trust lands (aka, state trust lands) found in Utah. 2017 marks twenty-five years since CRM really began on state trust lands, as 1992 was the year I joined the Division of State Lands and Forestry (DSLF) as their first archaeologist. Just two years later (during early 1994) the legislature transferred all authority for management of state trust lands to a new and completely separate state agency named the School and Institutional Trust Lands Administration (SITLA). Management authority has remained with SITLA since 1994.

It has clearly been a good thing that CRM for state trust lands was won by the public circa 1990–1991 (cf. Wintch 2008). No doubt hundreds, if not thousands of historic and archaeological sites have been saved from unnecessary destruction via the process of identification and evaluation for significance, the process which is really at the heart of CRM as we know it. Other benefits have also resulted: The community of trust land managers and beneficiaries, as well as legislators and others have come to understand that CRM on state trust lands is not nearly the burden they thought it was a quarter century ago. In addition, a culture of stewardship has evolved within SITLA during the last decade or so which extends to the "hardening" and interpretational development of certain historic and archaeological sites and site complexes. Each such site development project includes partnerships with a variable mix of other entities including non-profits and public interest groups, agencies and municipal entities. But the benefit of greatest relevance to this volume of *Utah Archaeology* is that an oversized amount of good research has resulted from CRM on state trust lands. This volume offers four such examples of that research. In each case SITLA has either wholly funded or at least partially funded the investigation being reported, or has otherwise caused the investigation to occur (via the agency's ongoing process of CRM on all state trust lands).

The lead article by Simms is perhaps the most important article to be presented in this journal since O'Connell (1993). I am grateful to Professor Simms for offering it for publication in this volume – because of its importance and relevance to current method and practice, but also because it was (at least in part) a product of SITLA's land sales program (which is discussed in the next major section). The identification and excavation of the Indian Corral site was driven by the proposed sale of the state school trust section on which the site is located. "Looking for Houses" should be read and taken to heart by ***everyone*** involved in the practice of CRM or any other type of archaeology being conducted in Utah and the American west. It's that important.

The next article, by Roberts et al., is more limited in areal scope, but only slightly less important in terms of its illustration of how CRM, when done well, is undeniably expanding our vision of history, whether that history be pre- or post-Columbian. In addition to being relevant to some fundamental issues in the American Southwest (such as the nature and timing of the transition from foraging to farming) it is also a good example of how good management of the archaeological record can go hand-in-hand with good research. Case in point: Roberts et al. discuss early on how it is beneficial for "...investigations...be phased to accommodate the development of research questions and to properly budget the costs." Specifically, what Roberts and her colleagues are referring to here is a three-stage process of investigation that SITLA and HRA, Inc. Conservation Archaeology (HRA) have symbiotically developed over the past two decades – especially when dealing with sites in sand sheets. This process is inherently flexible and works well for any sort of *intensive* undertaking (i.e., an undertaking that, by its very nature, is more likely to have an adverse effect on historic properties [i.e., "significant" or National Register-eligible historic and archaeological sites]). This three-stage investigation process is designed to provide the agency with the information it needs for undertaking management (and long-term site management), while also informing the next stage of research to the greatest extent possible – all while not over-consuming the site (or sites) in the project area (cf. Wintch 2011, Seddon et al. 2011). It's all about *balance*. If nothing else, CRM is – or at least should be – a balancing act that does not over-consume the in situ archaeological record, does not under-sample that record given its research significance, does not unnecessarily delay agency business, and gives the taxpayer (or the beneficiary in SITLA's case) an appropriate and justifiable cost for the work being proposed or required by us archaeologists. I would humbly offer that each agency archaeologist should do his or her best to effect a system that strikes such a balance for your agency, its undertakings and mission.

Additionally, the second article by Roberts et al. is a great example of the importance of methods. Especially field methods. During the course of my career field methods in CRM have hardened into standardized recipes that are rarely deviated from, rarely assessed for their appropriateness or efficacy. This needs to change. Good archaeology is not just about the questions we ask, it's also about the methods we use. The right data cannot be gathered unless the appropriate methods are used. Like ideas about cultural process and change, methods are a dynamic thing that should be assessed and considered in formulating a research plan – whether the plan be for surface survey, evaluative testing or final data recovery. Field methods are ideas that should be considered, tested and refined not unlike aspects of archaeological theory. As Roberts et al. show, the full range of methods (from using trackhoes with flat-bladed buckets to "chunking" out hearth fill with a trowel instead of scraping it out) should be open to assessment and refinement. Archaeological methods matter, they end up conditioning the results we achieve. Good research outcomes don't happen without good methods. CRM has as much potential to contribute to the development of archaeological methods as it does the ability to contribute to archaeological theory, or expand our base of knowledge about the archaeological record.

Both the second article Roberts et al. and the third article, by Nash, results from SITLA's "development" program (which is also discussed in greater detail in the next major section) –albeit in different parts of the state, and much different development projects. The research presented by Roberts et al. results from numerous residential and commercial real estate transactions in southwest Utah, while Nash's research was driven by a large energy-infrastructure development farther north, near Delta, Utah. Nash's article is important in its own right, and represents a solid taphonomical and theoretical contribution. But it also an important empirical contribution to what we know about the culture history of the Fremont adaptation to the lower Sevier River Basin. This is a great example of, as a good friend of mine characterized it, "CRM going the extra mile." I couldn't agree more. I am gratified that the project proponent, as well as Dr. Nash's employer at the time and Dr. Nash himself (in reverse order, of course) all assented to my request to include this article in this special edition of *Utah Archaeology*.

Last but not least, the fourth article by Simms et al. presents an important empirical contribution for a set of sites in the heart of the Virgin Branch Ancestral Puebloan culture area. In addition, in classic Simms fashion, that same article contains a discussion of an interesting – and rather illuminating – archaeological experiment that was conducted as part of that particular field school investigation. Experimental archaeology matters as well, and is one of those things that needs to be supported and conducted whenever possible and appropriate. When done well it pays valuable dividends, indeed. I thank Professor Simms for offering this article for inclusion because, like the first article, this overall investigation was primarily driven by SITLA's land-sales program (see below). That divides the four articles evenly between the two SITLA revenue-production programs that, by virtue of their inherently *intensive* undertakings, end up driving research investigations which contribute substantially to our understanding of the human history of Utah. I am grateful to the contributors of all four articles and wish there had been space and time to include many more. But these four will do nicely.

Program History vs. Research Context

When former *Utah Archaeology* Journal Editor Chris Merritt asked me some time ago to assemble and guest-edit this edition of the journal, part of the understanding was that I would contribute some sort of history of the trust lands' CRM program. *Numerous* failed attempts at such a history convinced me of its limited interest to this audience and, more importantly, its limited relevance to providing developmental context for the four research articles that follow. Ergo, the intention of the remainder of this preface is to help you understand how and why so many CRM-driven research investigations occur on trust lands, and explain why they occur with greater frequency per-acre of land than any other category of government-held land in Utah.

To begin with, at its most basic level SITLA's singular mission is to manage a multi-million-acre statehood land grant for the exclusive financial benefit of 11 beneficiaries that were named in the Utah Constitution and the Utah Enabling Act of 1894. The largest beneficiary – by far – is public education (*aka*, grades K-12, administered by the Utah Office of Education). The ten other beneficiary institutions include the University of Utah, Utah State University, and eight other, smaller institutions (see https://trustlands.utah.gov/in-your-community/beneficiaries/ for details about all 11 beneficiaries). State trust lands are not considered "public" lands in that they were granted by the federal government to the state in January 1896 specifically and exclusively to provide financial support for the 11 beneficiaries – ***not*** the public-at-large, or the general interest of the public-at-large. The state has typically allowed the public to recreate within generally accepted limits on state trust lands. But ultimately, if public recreation (or any other public purpose) conflicts with an opportunity to generate revenue from a given piece of trust land, case law demands that SITLA decide in favor of the revenue production opportunity. The relationship between the state (i.e., SITLA) and each beneficiary is that of a trustee-to-its-beneficiary, where the trustee has an *exclusive* fiduciary duty to the beneficiary. This is a very well-defined legal relationship that has been honed by hundreds of years of case law which substantially limits the range of options available to the trustee – who must reasonably and demonstrably perform in the best financial interests of the beneficiary. The consequence for not doing so is that the trustee may be sued by the beneficiary for non-performance. This, in itself, is fundamentally different than the "public trust" doctrine that most governmental land-managing agencies operate under. You may think of it an archaic concept in this day and age (as I did before coming to work for state trust lands), but the reality is that it is basically constitutional-level law, bolstered and affirmed by deep case law, that very much structures reality for the land-grant trustee. This is especially true when you have an engaged, perpetually underfunded major beneficiary (like public education in Utah). This constitutionally mandated, legally defined mission (cf. *Utah Code Ann*. 53C and *Utah Admin. Code* R850) also conditions SITLA's business model and general modus operandi, which in turn conditions the specific nature of many of the undertakings that occur on state trust lands (see below). Combine this reality with the fact that there are no truly broad environmental decision-making process laws contained in Utah code (e.g., the National Environmental Protection Act [NEPA]) and you have an inherently more business-friendly, private-land-like process than you do with any other kind of government land – especially "public" land that must be managed according to "public trust" doctrine. The basic, primary mission of SITLA, combined with the social environment of a still-developing state like Utah, makes for a more development-friendly climate at SITLA than at any other government land-managing entity in Utah. This, in turn means that more – and different types – of development take place on state trust lands than any other kind of government land in Utah.

While many of the undertakings that SITLA authorizes (e.g., powerlines, pipelines, renewable energy facilities, fluid and non-fluid mineral exploration and production, etc.) are the exact same kind of undertakings that occur on the federal public domain (i.e., BLM and USFS lands) or on other types of state land (e.g., state sovereign land or wildlife management areas), there are two fundamentally different undertakings that take place on state school and institutional trust lands. The first is, of course, the state's long-standing habit (i.e., since statehood) of selling variable amounts of raw, undeveloped land each year; mostly at auction. This is the program that drove the investigations reported by Simms in "Looking for Houses" (at least in part) and by Simms et al. in the fourth article. To put in perspective the amount of land that has been sold by SITLA and its predecessors (going back to 1896), I am told that about a third of the current amount of private land in Utah was once state trust land, and that most of this corpus was sold within the first quarter-century after statehood as part of the state's focus on developing its economy and tax base (Kevin S. Carter, personal communication circa 2002). The sale of government-held land on a regular basis is unique to SITLA and its predecessors here in Utah (compared to other forms of government land). As discussed by Wintch (2008), the issue of statutory compliance (or rather, the lack thereof) for the sales of state trust land were what led to the legal and public conflict that ultimately resulted in DLSF acceding to the public's demand for CRM on state trust lands. But since then a newer – and potentially more lucrative – form of land sales has been created by SITLA since 1994, involving complicated transactions that serve to create residential, commercial and industrial developments that are rather intensive in nature and usually quite extensive in scope and acreage. This is the second type of undertaking that is unique to SITLA, and is the program that drove the research reported here (largely) by Roberts et al. and Nash, respectively (i.e., the second and third articles in this volume).

This newer, more complicated transaction formula has evolved into an entire revenue-production group within the agency. Most often this formula involves SITLA partnering with private capital interests that commit to putting private money toward creating infrastructure in the land, infrastructure like streets, curb and gutter, utilities and sewer connections – all of which raise the value of the land for residential, commercial or industrial purposes. When the resulting individual house lots, for example, get sold into private ownership SITLA and its private business partner share in the proceeds, and a greater return ends up being provided to the beneficiary of that land. Most of the "development group's" land is located on the edge of burgeoning towns in Utah like St. George, Eagle Mountain / Saratoga Springs, Moab, Price and Tooele. These "development" undertakings are what really sets SITLA apart from other agencies in terms of producing an outsized amount of excavation- and data recovery-driven research. No other government agency I am aware of actively seeks to partner with private development concerns in order to install infrastructure on otherwise undeveloped land under its jurisdiction (or use beneficiary money to "capitalize" the land in the absence of private partners).

When SITLA works with private developers to create an entirely new, extensive residential subdivision (e.g., Coral Canyon in Washington City, Utah) this sort of *intensive* undertaking tends to drive a full range of archaeological investigations – from intensive inventory to complete archaeological data recovery (which usually takes the form of archaeological excavations like those summarized by Roberts et al.). This sort of intensive development of hundreds of acres at a time is really not much different than the creation of a brand new reservoir where none has existed before (e.g., Jackson Flat Reservoir in Kane County [Roberts 2018]). Similarly, because neither state or federal code require that any sort of CRM inherently attaches to private land, the sale of state trust land into private ownership without reservation to the contrary would mean that there is a loss of control over the fate of significant historic and archaeological sites by virtue of that sale; both federal regulation (i.e., 36 CFR 800) and SITLA's cultural resource rules (*Utah Admin. Code* R850-60) are quite clear that this loss of protective control would constitute an adverse effect to those significant historic and archaeological sites. Ergo, SITLA considers the sale of raw land, whether on a negotiated basis or at auction, to be a similarly intensive undertaking that needs a higher standard of care during the CRM process than many less intensive undertakings. While sale of state trust surface estate does not inherently result in final and complete mitigative investigations (thanks to the agency's use of protective deed covenants), it may result in such an investigation IF the purchaser wants to release the deed covenant attached to his instrument of sale. The point here is that the nature of both the land sales program and the newer "developments" have resulted in a far greater number of very intensive undertakings on state trust land, which in turn results in a far greater number of research-oriented investigations occur on state trust lands than on other state or federal lands, compared to the size of the land base held by that agency in Utah.

I do not know if more inventories per-acre occur on state trust lands compared to other state or federal lands. But I do know that plenty of inventories take place on state trust lands, as well, as result of the public's demand, circa 1990–1991, for CRM to start happening as a matter of course on state trust lands. The same basic process of identification, evaluation and consideration of effect takes place on SITLA-managed lands that occurs on any truly "public" land when an undertaking is proposed. Similarly, when a significant (i.e., National Register-eligible) site is identified on state trust lands, and the undertaking can be adjusted to avoid or otherwise minimize effects to that significant site, then that's what happens (just as it so often happens on BLM or other federal land). The touchstone of SITLA's overall policy has always been – and hopefully, always will be – Bill Lipe's (1974) *Conservation Model for Archaeology*. Do the best research you can on those sites that the agency determines must be destroyed by the undertaking, but do your best to preserve – and try your best to understand and empirically document – everything else that consultation agrees is "significant" (*aka*, eligible for the NRHP).

Again, I would offer that hundreds, if not thousands of sites on state trust lands have been saved from unnecessary destruction thanks to the addition of CRM on state trust lands and the professional functionality of the agency's program in the 25 years since then. That success has been borne of survival, as longevity of the program was far from guaranteed in 1992; and still isn't. Survival bears fruit; one of those fruits is acceptance by folks who started out seeing you as some sort of bureaucratic parasite – and thus, someone who is not to be trusted. But SITLA's CRM program's survival is living proof that if you roll up your sleeves, show that you genuinely care and are willing to work hard on your client's

/ employer's behalf, then you will be accepted as a member of the team. It's just a matter of time. Initially DSLF and SITLA managers and the beneficiaries were unconvinced that the CRM "experiment" forced on them by the public was going to work. They were unsure and unconvinced that it was truly something they could do, at minimal cost, while still fulfilling the agency's singular mission – creating optimal financial support for the trust beneficiaries. The CRM program's success in showing that the primary mission could still be fulfilled, at a reasonably low (if not minimal) cost, and without undue delay led to survival of the program, which led to the program's acceptance. That's not to say that SITLA's CRM program could not be undone, especially for cause. But sincerity, integrity and professionalism count for quite a lot, and tend to lead to survival and even longevity.

Other tangible benefits – beyond program survival and acceptance of its employees – may well come with longevity, as well. These are likely to be a bit different in the case of each agency, but I would humbly offer that they are likely in the case of each agency, if not at least possible. In the case of the Trust Lands Administration, this tangible benefit came in the form of a culture of stewardship that was quite unlikely during the 1990s, but which was conceived and was able to gain traction sometime after 2000. This culture of stewardship would likely not have happened had there not been great success since 1994 (when SITLA was created and given the sole purpose of optimizing revenue for the beneficiaries). Overall success by any given person, agency, entity or organization has a way of softening hearts and allowing for reasonable largesse. But the evolution and growth of an overall stewardship-friendly culture at SITLA allowed for its CRM program to propose the construction of appropriate stewardship-driven infrastructure at certain historic and archaeological sites as a way of "hardening" those sites against various threats and thus, giving those sites a better shot at longevity. The first such project was at a world-famous petroglyph site in Nine Mile Canyon known as the Great Hunt Panel. The major threat to that site was the location of the road, which was immediately adjacent to the site – so close, in fact, that everyone was concerned about a wayward semi-tractor running into the panel. SITLA worked with Carbon County to move the road, then with other partners like the Nine Mile Coalition and others to create a structured visitation experience complete with wooden fencing and interpretive signage. Thereafter, in the autumn of 2015 SITLA partnered with Friends of Cedar Mesa to structure visitation the Cave Towers site near Mule Canyon on Cedar Mesa. In addition this project effectively removed trash and clutter from the site, provided for organized parking and camping away from the site, and to interpret the site – all the while informing visitors about state trust lands and inculcating Visit With Respect practices when visiting this site and other archaeological sites. Later that autumn SITLA partnered with the Emery County Historical Society and the Utah Division of State History to sign, interpret and structure visitation at the Spirit Railroad Complex, the favorite part of an abandoned railroad grade between Castle Dale and Woodside, Utah that was partially constructed in 1881 but never finished. In March of 2016 SITLA partnered with the Utah Rock Art Research Association, Utah State Parks and Recreation and the Division of State History to clean up, interpret and structure visitation at the Temple Mountain Wash Pictograph Panel near Goblin Valley State Park (cf. Boomgarden 2017 for more information about all these projects). The most recent such project is at Coal Bed Village, a large Ancestral Puebloan village site in San Juan County that is threatened far more by erosion than by unstructured visitation. Here SITLA is partnering with the Division of State History, Brigham Young University, Weber State University and the Natural Resources Conservation Service to ameliorate the erosional threats to the site, while also partnering with Friends of Cedar Mesa to structure visitation at the site and again, impart to visitors important Visit With Respect principles and practices.

Importantly, each such project is different, and is tailored to the site in question and the natural and cultural forces that threaten the site. Each such archaeo-stewardship development project has an interpretive component specific to that site (usually one or more signed kiosks), but all have the additional purpose of informing the public about state trust lands. The point is not to create a certain visitation experience so much as it is to contain or minimize threats to the site in question (Boomgarden 2017) and to inform and educate the visiting public.

Again, the very concept of *stewardship* was anything but possible during the 1990s, because of the inherent metamorphosis that trust lands management was undergoing. But the agency's success of the 1990s and early 2000s – success that was facilitated and enabled by having a functional CRM program that allowed for the public's demand for historic and archaeological conservation on state trust lands to be continually realized – allowed for the general realization that stewardship was perhaps something that could be afforded, something that was not antithetical to the agency's primary mission, and was something that could be abided and implemented on an appropriate scale. The "take-away" here is that the fruit of CRM survival on state trust lands has had an unexpected benefit, that benefit being the ability to focus an appropriate level and type of development toward a handful of very important but threatened sites on state trust lands.

In closing, I would again offer that it has clearly been a good thing for the archaeological record of Utah that CRM was won by public demand circa 1990–1991. That gift of CRM has been carried forward to this day through professionalism, diligence, hard work and stamina. Beyond the multitude of sites saved from unnecessary destruction, and the handful of other sites made more secure by stewardship development, there has been an oversized amount of good research that has taken place on state trust lands. The four articles that follow result from some of that research. I humbly thank the authors for their contributions to this special volume.

Acknowledgments: I would be remiss if I did not credit others who have contributed to the DSLF-SITLA CRM program's survival and success. First, agency management in general deserve at least a slice of the credit, and certain agency managers deserve quite a lot of it. In the beginning, lay co-workers and public volunteers (mostly avocational archaeologists) aided greatly in helping me accomplish fieldwork. Since 1998 a cadre of archaeologists have helped share the burden as agency employees; I owe them all a debt of thanks, indeed. In order of hiring date these include full-time, variably long term employees like Kristine Curry, Margo Memmott, Christine Horting, Corinne Springer, Michael S. Berry, Kelly Beck, Joel Boomgarden, Lisa Beck, Monson Shaver and Jennifer Springer, as well as full-time temporary employees like Shannon Arnold Boomgarden, Bonnie Bass, Jacki Rabb and Christopher Parker; and of course the hard-working, part-time, temporary interns like Ellyse Simons and Ryan Saltzgiver.

I wish to also thank former journal editor Chris Merritt for inviting me to guest-edit this volume; as well as current journal editor David Yoder for his patience with me, again. As usual, this preface benefitted from the helpful review of a handful of my peers; especially Steve Simms, who has been an awesome writing coach (even if I haven't been such a great student). I owe them all a debt of thanks. Finally, as always, any errors in fact, logic, prose or presentation belong entirely to me. I am indebted to everyone who has been mentioned here, and to some who have not. Thank you every one.

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Looking for Houses: Making Whole the Lithic Scatter of the American Desert West

Steven R. Simms
Utah State University

"there are no known cases among modern hunter-gatherers where shelter is not fabricated in residential sites (or anywhere hunter-gatherers plan to sleep), regardless of the expected occupational duration, and only in rare instances are sites of any kind produced by hunter-gatherers where no shelter is provided for the occupants." Binford (1990)

Archaeological sites with standing log or brush structures, often called wickiups, are rare in the American Desert West relative to lithic scatters, pithouse villages, and even cliff dwellings. The rarity of wickiup sites arises from their fragility. The inevitability of erosion and wildfire ensures that wickiup sites will, in only a few centuries, become "just another lithic scatter". At first glance this may provoke a call to arms for preservation of this fragile resource. All of the standing wickiup sites we see now will soon meet their inevitable end as lithic scatters. In another sense however, it is the life cycle of wickiup sites that makes them valuable. They present an opportunity to explore relationships between perishable housing and non-perishable debris.

Wickiup sites are one facet of the ethnoarchaeological study of site structure because they represent residential activity. When structures are not in direct association with surface lithics, their exclusion from the boundaries of the site area restrict the interpretation of the site to the lithics alone. Structures such as wickiups, and hence residential activities, gain relevance in the context of the ubiquitous lithic scatter of the American Desert West – by far the most common archaeological site recorded. Some lithic scatters do indeed yield surface evidence for structures, such as depressions or rock alignments. Others yield surface evidence of hearths, and structures may be nearby, albeit not necessarily close to the most dense areas of lithic debris. Further, structures can be difficult to detect even with excavation. The vast majority of lithic scatters however, yield no indication of residential structures at all, yet archaeologists are increasingly aware that structures once existed somewhere on or near the vast majority of lithic scatters. This realization enlivens the potential of the common lithic scatter so familiar to archaeologists working in the Desert West.

Here I enlist two examples of wickiup sites in Utah, one with standing structures and one where structures were not evident on the surface, but found through excavation. These examples are the basis of comparison to other wickiup sites, and to several large projects in Cultural Resource Management archaeology (Figure 1). In each example employed here, research design included a consideration of the ethnoarchaeological concept of site structure; the organization of site features and assemblages in space and their relationship to behaviors that created the site over time.

Over the past several decades, the study of standing wickiup sites and the method and theory of archaeological site structure help make the lithic scatter whole. The results of this effort include greater attention to wickiup sites and increased efforts to locate residential structures. The effort is not without its caveats, and surely there has been a loss of innocence, but results of the application of site structure are most apparent in an increase in the size and extent of sampling at lithic scatters necessary to adequately evaluate the nature of site assemblage composition, as well as greater attention to the relationships between assemblages, features, and past human behaviour. The effort provokes suggestions for research design, field tactics, sampling, and scaling; all germane to an efficient extraction of knowledge in a CRM environment that is largely cost-driven.

The ethnoarchaeological analysis of standing wickiup sites and the application of site structure to lithic scatters makes a larger theoretical contribution as well. Site structure studies indicate that the archaeological attributes of forager residential behaviour is responsive to the tyranny of circumstance, and is thus potentially cross-cultural. Attention to this larger issue contributes to a general theory of behavior of foraging societies, behaviour that varies by circumstance and context (sensu O'Connell 1995).

Both the methodological and theoretical issues should be reflected in research design, and considered in management policy and regulations regarding lithic scatters. The approach advocated here, and the examples, potentially shape our ability to interpret the most common site type of all.

Site Structure, Wickiup Sites, and Lithic Scatter Archaeology

Ethnoarchaeological studies of site structure are well-known to archaeologists and inform our treatment of lithic scatters. Classic studies show, among other things, habitation structures may in or near other activity areas represented by discard such as lithics, or separated by significant distances (e.g. Binford 1987, 1991; Fisher and Strickland 1991; Gamble and Boismier 1991; Jones 1993; O'Connell 1987; O'Connell et al. 1991; Yellen 1977)James O'Connell (1993) detailed the implications of site structure for lithic scatter archaeology in the Great Basin of the western United States some years ago.

The inventory of standing wickiup sites continues to grow, yet with few exceptions (e.g., Greubel 2005) most reports of such sites focus on issues of local and recent culture history (e.g., Baker 2003, Martin 2016). In addition to these legitimate interests standing wickiup sites are also important because their study is ethnographic. This is not because of the involvement of informants, but because ethnography is the capture of a singular opportunity that is lost with the passage of time. Research design for wickiup sites should be framed in terms of archaeological method and theory that is cross-temporal and cross-cultural in addition to matters of recent culture history or the relevance of such sites to the narratives of living indigenous peoples. The management of such sites should take these larger values into account. In this way, wickiup sites can serve as ethnoarchaeological proxies to further inform all of us who investigate the ubiquitous lithic scatter, regardless of time period and local ethnic, cultural, and historic qualities.

Two contrasting wickiup sites in Utah that I excavated with students at Utah State University in 1999 and 2003 serve as examples of the incremental contributions arising from a search for houses on otherwise mundane lithic scatters. The sites represent two phases of the life cycle of wickiup sites. The Indian Corral site (42CB1916) has evidence of above-ground structures and the Orr Springs site (42TO384) does not. Subsurface structures were nevertheless found at Orr Springs, using methods given credence by studies at wickiup sites with standing structures. This exercise yields tangible and in some ways, mundane suggestions for finding wickiups at lithic scatters, but also provokes an argument that researchers and cultural resource managers should consider the method and theory potential of wickiup sites in addition to their parochial values.

Figure 1. Region showing location of sites and study areas discussed in text.

Indian Corral and Orr Springs are hardly the only wickiup sites reported in the West. Substantial examples, such as the Colorado Wickiup Project (Martin 2016, Martin et al. 2005a, Martin et al. 2005b), and the documentation of archaeological signatures among the foragers of the Southwest hidden behind the strong archaeological patterns of Puebloan farmers (Seymour 2009; 2017) signal the value of these kinds of sites. The exercise of looking for houses may be less about finding houses as it is about directing attention to the larger problem of making lithic scatters at least more whole than they were before.

I illustrate progress in this effort with examples from large-scale CRM projects in the Great Basin and northern Colorado Plateau regions (Figure 1): the Kern River 2003 Expansion Project, a natural gas pipeline in southwest Utah (Reed et al. 2005; Stettler and Seddon 2005:107–111), the TransColorado Natural Gas Pipeline in southwest Colorado (Reed et al. 2001), and the Little Boulder Basin project in northeast Nevada (Cannon 2010). All of these projects were well-funded and their research designs explicitly included site structure – the organization of site features and assemblages in space and their relationship to behaviors that created the site over time. Collectively the projects include sites with standing wickiups, evidence of collapsed wickiups, and structures found through excavation. Importantly, there are examples where concerted efforts to find structures were unsuccessful, but an interest in the organizational structure of assemblages and features improved the understanding of the archaeology.

The Indian Corral and Orr Springs Wickiup Sites

The Indian Corral wickiup site (42CB1916) is on Utah School and Institutional Trust lands on the West Tavaputs Plateau in central Utah (Figure 1). The site is a lithic scatter with two wickiups evident by remnant structural timbers. One structure features a single leaner pole against a juniper tree, anchored by sandstone slabs lodged in the crotch of the tree to hold the structure together. A second structure was recognized only by two "hanging leaners", the upper remnants of structural poles entombed in a juniper limb crotch nearly three meters above the ground (Figure 2). The Indian Corral site exhibits attributes often found at standing wickiup sites elsewhere in the region that collectively contribute to identifying structures where no surface evidence of structures remains.

The Orr Springs wickiup site (42TO384) is on the U.S. Army Dugway Proving Ground located in the Great Salt Lake Desert in northwest Utah (Figure 1). The site is a lithic and ground stone scatter with no surface evidence of structures. Limited, but targeted excavation located two subsurface structures, one in a situation that may elude standard excavation methods (Figure 4). Orr Springs serves as an example where structures not evident on the site surface are found by employing knowledge learned at sites with standing structures and the study of site structure.

Excavation at both sites employed ¼ inch mesh screen, and artifacts were tabulated for each one meter square of excavation. The goal was to expose horizontal areas, identify features in relation to use-surfaces, and to produce artifact density distribution maps of a general scale. Excavations were a small fraction of each site and field methods were designed to develop site significance, not to mitigate proposed adverse effects.

Indian Corral

This site with two standing wickiups was found and excavated by students from Utah State University in 2003 (Figure 2). It was subject to limited excavation and study for a potential land sale. Surrounded by old growth pinyon-juniper woodland at 7,645 feet on the West Tavaputs Plateau, the site occupies a flat at the confluence of two small drainages with a spring nearby. Tree ring analysis indicates that the large pinyon and juniper trees germinated in the early 17th century, reaching maturity by the 19th century. No historic artifacts were found.

The site yielded 450 items of lithic debris, and 43 stone tools including two Desert Side-notched point bases, two Elko corner-notched bifaces, two hammerstones, an abrader, a graver, and cores. Thirteen whole and fragmentary ground stone artifacts were found. Debris occurred in two concentrations across a 3,885 m^2 site (.13 items/m^2)

Low artifact density and high assemblage diversity is common to many, but not all standing wickiup sites (Simms 1989, Table 4). In some cases, the most dense lithics are tens of meters or more distant from the area of structures, and hence of unknown affiliation with the structures. However, large distances between lithic reduction activities behaviourally associated with habitations is documented in ethnographic cases (O'Connell 1987 and O'Connell et al 1991). Regardless of the variable association of lithic debris and structures, two classes of artifacts do commonly occur with structures: grinding stones and hammerstones. Significantly, hammerstones

Figure 2. Structure 1 at right with leaner pole made of a bent-over juniper. Anchor rocks visible in tree. Andrew Ugan kneels at the hearth outside Structure 1 door. Structure 2 at left and Amy Gudmundson sits within the inferred interior of the structure. The two "hanging leaners", remnants of structural poles, hang vertically in the center of the tree near the lower limit of needles.

are more difficult to recognize when they do not occur with more readily identifiable lithic debris, raising the potential for under-recording during surveys.

Structure 1 incorporates a 15 cm diameter juniper tree trunk, stripped of bark and bent over to wedge into a large living juniper to form a structural timber. Two sandstone slabs (20 x 30 cm each) hold the timber in place against the live juniper, and the limbs are in the early stages of entombing the timber. Lichen growth on the sandstone slabs post-dates their placement into the tree crotch, indicating some time depth to the structure. The absence of bark and considerable weathering precluded dating of the bent-over juniper used as a structural timber. Excavation revealed a saucer-shaped depression below the structural timber. The depression is 2.75 meters in diameter and a maximum of 10 cm deep. Four metate fragments, three chert cores and small lithic debris are scattered in an ashy area along the east to northwest rims of the depression. Sandstone slabs rest near the support tree along the south edge of the depression. These patterns, along with the discovery of a 40 cm diameter x 7 cm deep fire hearth located 1.5 meters west of the depression indicate that structure 1 opened to the west. A large ashy area extended downslope from the hearth, spread by sheet wash along a shallow micro-drainage running west of structures 1 and 2. Ethnographic cases such as the Great Basin Culture Element Distributions (Steward 1941, 1943, Stewart 1941) and measurements at other wickiup sites in the American West indicate that when houses do not contain interior hearths, a hearth is likely to be within 1–3 m from the entrance to the structure.

Structure 2 is only 3.5 m away from structure 1, and is identified by two "hanging leaners," the upper remnants of structural poles nearly three meters above the ground and engulfed in a limb crotch of a 400+ year old juniper tree. A steeper slope and erosion around structure 2 may explain why there is no well-defined depression marking this structure. However, two hammerstones were within the inferred area of the structure interior and numerous lithics occur along the north edge; signatures of structures. No hearth is evident where it would be expected west of the structure, only scattered ashy sediments, but erosion from the same microdrainage that scattered the hearth outside of Structure 1 is more pronounced near Structure 2 suggesting the faint ash may be the remnants of a hearth west of the structure.

A 90 m^2 block of contiguous excavation was opened around the structures with cultural deposits ranging from 3–10 cm in depth. Forest duff with loose sand rests above a single cultural stratum of loose silts, sands, and gravels, with a culturally sterile substratum of decomposing bedrock below. The density distribution map of lithic debris found in subsurface contexts shows that in some areas, the density of lithics was substantial (Figure 3), significantly exceeding the density of .13 items/m^2 observed on the site surface, and much higher than the .4 items/ m^2 surface density in the vicinity of the structures. The assemblage composition is consistent with residential occupation; point and biface bases inside the structures, late-stage lithic reduction, ground stone artifacts and spall, hammerstones, and finished tools such as scrapers. A leaf-shaped biface was made of obsidian sourced to Wild Horse Canyon, Mineral Mountains, western Utah - a distance of 250 km. A few burned bones of artiodactyls and lagomorphs were found.

Orr Springs

First recorded in 1984, this site was excavated by students from Utah State University in 1999 to help evaluate site significance. The site is a lithic and ground stone scatter on a flattened ridge at an elevation of 5,150 feet. The ridge fingers south from the Cedar Mountains affording a vantage of the expansive desert floor below. A spring is in a ravine flanking the site and the area is sparsely vegetated in juniper with little understory. The remnants of a brush corral and an early barbed wire corral suggest indigenous residents may have had an association with 19th century Euro-American ranches in the area, but no historic artifacts were found and it may be that the corrals are not associated with the Native American occupation (Figure 4).

The site encompasses 700 m^2, with an average artifact surface density of .13/m^2, identical to the density at the Indian Corral site and consistent with other wickiups reported in the West when artifact densities are recorded. A sample of 27 wickiup sites from Colorado, Nevada, and Utah revealed artifact densities .03–1 item/m^2 with most sites between .1–.5 items/m^2 (Simms 1989: Table 4). Surface inspection of the Orr Springs site identified 62 lithic flakes, two informal projectile point fragments (arrow-sized), and a scraper. Twenty-three ground stone artifacts and fragments were found, as well as several suspected hammerstones.

There are no surface indications of structures at Orr Springs. Excavation began with a 1 m wide exploratory trench where lithic debris was evident on the surface. Stratigraphy consisted of 1–2 cm. of blow sand, and 2–8 cm. of loose sands, gravels and artifacts below that, underlain by a culturally sterile substratum of compact sands and silts that transitions to decomposing bedrock. Hearth 1 was encountered in the test trench and excavation was expanded to explore a clearing among the juniper trees for activity areas (Figure 4). The clearing yielded a relatively uniform scatter of lithic debris, mostly secondary flakes, and the remnants of charred juniper stumps. These can be significant because charred juniper stumps may result from cutting logs for structures and thus creating the clearing (Figure 5). Two live juniper trees adjacent to this clearing were selected for sampling to locate buried structures.

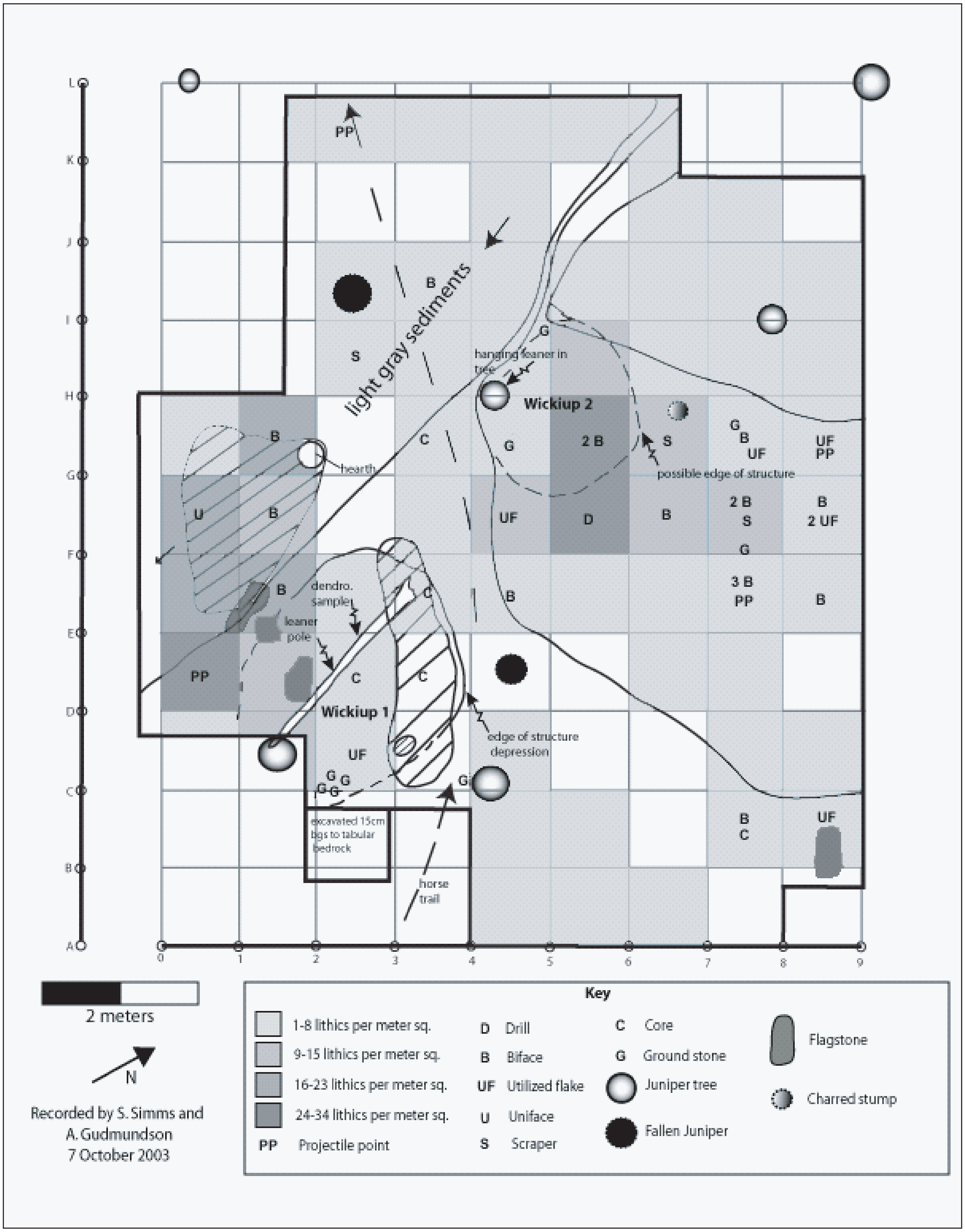

Figure 3. Indian Corral site map.

Figure 4. Orr Springs site. Structure 1 is at right, under tree behind Andrew Williamson sitting. Structure 2 is under tree visible above Kerry Thompson with shovel. Area between and behind the individuals is activity area with charred juniper stumps.

Structure 1 was found by expanding the block excavation in the clearing toward the nearest juniper. After removal of 10 cm of juniper duff, and the sediments below, excavation revealed a saucer-shaped depression up to 15 cm deep adjacent to the 4.5 m tall tree. The floor of the depression yielded a large rock, hammerstones, ground stone, a projectile point base, and two smooth river pebbles with parallel incisions. The structure would have opened toward the clearing that yielded the artifacts and the remnant burned juniper stumps. No hearth was found within Structure 1, but Hearth 1 was 4.5 m to the west.

Structure 2 was located on the opposite side of the clearing 6.25 meters away from Structure 1. Structure 2 was enveloped within a 3.5 m high juniper whose branches hugged the ground to form an impenetrable clump over 5 meters in diameter. The tree may be up to 500 years old. Ethnographic photos and experience at standing wickiup sites suggest that sometimes a young tree is employed to anchor a structure. The lower limbs on one side of a tree are removed to accommodate the structure, something observed at wickiup sites in Colorado (Greubel 2001, Martin et al. 2005). After abandonment and as the structure collapses, new limbs grow. To test for this possibility, the tree was denuded on the side facing the clearing that yields the charred juniper stumps, Hearth 1, and the artifact scatter. In the course of de-limbing the tree we found earlier branches that had been broken and chopped off leaving the scalloped marks made by stone tools. This suggests wickiups too old to expect remnant structural timbers may still be found by careful inspection of trees at sites even when the trunk is obscured by secondary branch growth.

After delimbing the tree, a 1 m wide test trench placed adjacent to the tree trunk revealed the 30 cm diameter Hearth 2, situated within a saucer-

Figure 5. Orr Springs Structure 2. Hearth is in trench in front of Andrew Williamson and the edge of the structure is marked by rocks at the far end of the trench. A cache of 49 gray chert flakes and two bifaces of the same material is among the rocks. The tree was delimbed by the inhabitants, and the modern tree had to be delimbed to create access for the excavation.

shaped depression 4 m in diameter and up to 11 cm deep (Figure 5). One edge of the depression was flanked by large rocks, likely supports for the wall of Structure 2. A concentration of 49 flakes of gray quartzite and two large leaf-shaped bifaces of the same material was found cached among these rocks along with a projectile point, scrapers, and a hammerstone. The key to locating this structure was the placement of the exploratory trench adjacent to the tree trunk - not adjacent to the exterior of the branches as they exist today. The 1 m x 5 m long trench was sufficient to clearly define the characteristics of the structure.

A total of 53 m^2 was excavated at Orr Springs (Figure 6). As at the Indian Corral site, most of the artifacts were outside of the structures. The subsurface density of lithic debris averages 4

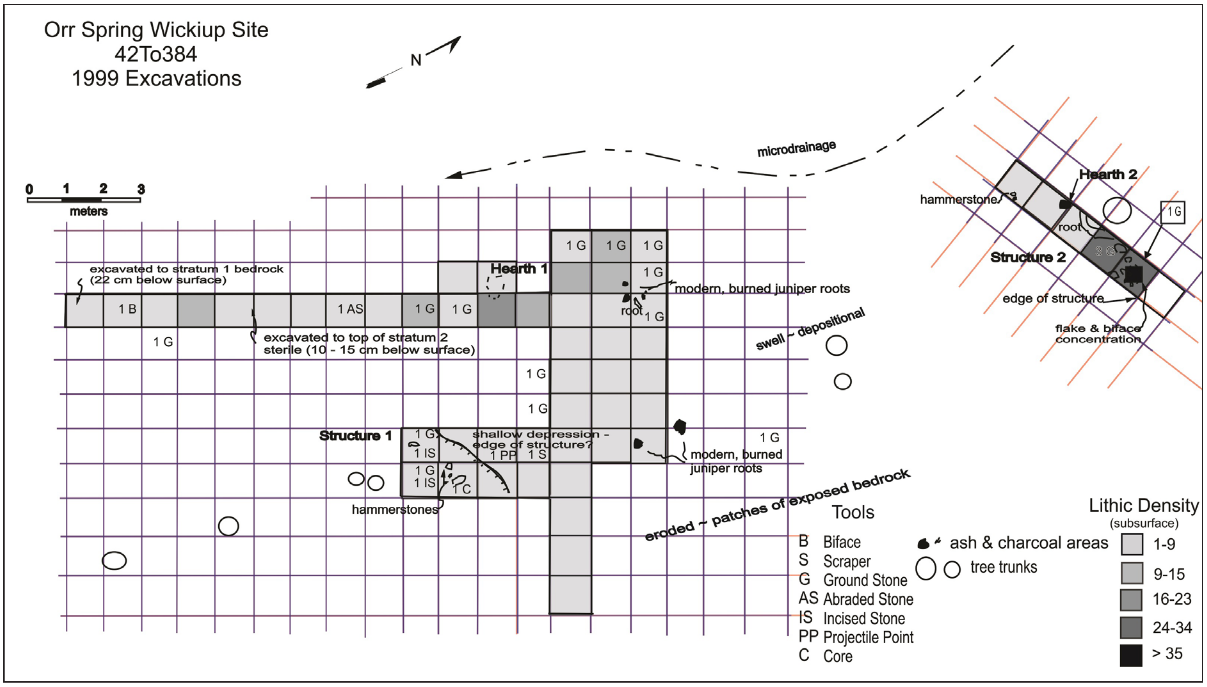

Figure 6. Orr Springs Site Map.

items/m², and the range is mostly 1–9 items/m², the same as at Indian Corral. Both sites exhibited low surface densities of artifacts (.13/m²), and a relatively diverse assemblage indicating residential activities. Again, perhaps the most telling artifact association is the co-occurrence of grinding stone fragments, hammerstones, projectile point bases, and other tools/fragments. The cleared area at Orr Springs between the two structures contained only a light scatter of lithic debris. Significantly, Orr Springs yielded burned juniper stumps, perhaps from aboriginal logging activities to provide timbers for the wickiups. This parallels the findings at the Bustos site in eastern Nevada (Simms 1989).

Comparisons and Implications

For the past 35 years I have been on a quest to find light, perishable housing to complement the thousands of lithic scatters I have seen. The early studies of site structure discussed previously were the initial stimulation for the quest, but the subsequent accumulation of standing wickiup sites and attempts by archaeologists to apply site structure is what makes possible the notion of making the lithic scatter whole.

My journey began in 1982 with the unexpected discovery of what was in the A.D. 1000s a light brush structure, a wickiup, at a Fremont site in the Sevier Desert of Utah (Simms 1986). The journey continued at a site in northern Utah, where again, faint structures were found via large block excavations, a method that was relatively rare at that time on featureless open sites in the Desert West (Simms and Heath 1990)

The faint remnants of structures at these sites prompted four seasons of ethnoarchaeological field work at Bedouin tent encampments in Jordan to explore the relationship between portable (perishable) housing and archaeological signatures (Simms 1988; Simms and Russell 1996). The search simultaneously appealed to Great Basin lithic scatters with standing wickiups. These served as ethnoarchaeological proxies in the quest to find the structures that no longer exist. Many lithic scatters are almost certainly mislabelled “open sites” as if foragers were just wilderness campers who used housing only sparingly (Baker 1993:47). The Great Basin quest led to the case of the Bustos wickiup site near Ely, Nevada, a spectacular pine nut camp of the late 18th to early 19th century and discovered in 1985 by Rab and Debbie Bustos, Ely-based horse packers who were also avocational archaeologists (Simms 1989).

Dramatic growth in the western United States and the consequent cultural resource management archaeology provides opportunities to apply the lessons of site structure, evidenced by papers such as "What Can Great Basin Archaeologists Learn from the Study of Site Structure? An Ethnoarchaeological Perspective" (O'Connell 1993) and the inclusion of explicit sections on site structure in more and more cultural resource management reports. This effort increased the number of standing wickiup sites (Indian Corral and Orr Springs were small CRM projects) and provided the opportunity to apply site structure theory on large, well-funded projects such as the Kern River 2003 Expansion Project (SWCA Environmental Consultants and Alpine Archaeological Consultants), the TransColorado Natural Gas Pipeline (Alpine Archaeological Consultants), and the Little Boulder Basin Project (SWCA Environmental Consultants). Comparisons among the sites referred to here and from these projects can speak to several issues relevant to improving the recognition of housing at lithic scatters where the structures have seemingly vanished as well as to the broader matter of accurate identification of assemblage composition.

Site Structure at Standing Wickiup Sites

The Bustos site featured five standing log structures in such pristine condition that it seemed only the people were absent. The structures contained over 100 juniper logs; a near match to a count of charred juniper stumps that created an aboriginal clear cut in the forest. A partially cut juniper tree with a hand-held stone ax lying at its base revealed that the trunk and exposed roots of each tree were set ablaze, likely repeatedly (Simms 1989:6, Figure 3). Trees were felled by chopping away the charred wood, leaving stone ax impressions on the logs and stumps.

The Bustos structures were 5–10 meters apart from each other. The distance between the structures at the Indian Corral site is 3.5 meters, 6.25 meters at the Orr Springs site, and 9 meters apart at the Simpson Wickiup site in Colorado (Greubel 2001). These sites are all short term camps, albeit used repeatedly. Ethnoarchaeology of Hadza and !Kung short term residential camps reports house spacing between 4–7 meters (Yellen 1977, O'Connell et al 1991). Considering that hunter-gatherer camps can be hundreds of thousands of square meters in size, the spacing among structures, or clusters of structures can be much larger than the above cases. The Colorado Wickiup Project (Martin 2017) documented late 19th century Ute refugia sites with excellent preservation. The Decker Big Tank Wickiup Village (Martin 2017:54) encompasses 50,000 m^2 with distances of 40, 70, 175 meters between wickiups and clusters of wickiups.

An intriguing characteristic of many, but not all wickiups is the low density of lithic debris in and immediately around the structures; about .1 item/m^2 at Bustos, Indian Corral and Orr Springs. While finished tools may be less common than one might expect, tool curation removes finished tools, while discard near the residence adds broken tools. This, along with the higher frequency of hammerstones and grinding stones, creates high assemblage diversity and low artifact density.

Our attention is naturally drawn to prominent lithic scatters with thousands of artifacts, some over 100 items/m^2. These may be well away from residential structures, and may or may not be in behavioural association. Such lithic scatters often exhibit low assemblage diversity resulting from final tool reduction and retooling.

The presence of stone features at sites can also draw attention away from the unspectacular and low density of artifacts suggesting structures. At Bustos there were eight stone rings used to cache pinyon pine nuts. At the Musick Lodge in

Colorado, there was the spectacular stone Eagle Trap only 100 meters from the wickiup, but 30 meters above on a rocky prominence (Martin 2107:133). Given these distractions, had the wickiup structures not been present, the portion of sites such as these that contained the wickiups may not have been recorded, let alone considered candidates for excavation.

Lithic debris is a standard alert to archaeological survey teams of an impending site, yet the discontinuity between the Bustos structures where the people lived and the majority of the surface debris was startling. The Bustos case recalls a story told by David Hurst Thomas about ethnoarchaeologist Richard Gould's excavation at a Tolowa site in northwest California. "Gould once asked some Tolowa to look at his ongoing archaeological excavation . . . digging under the then-standard assumption that habitation areas are best located by looking for surface concentrations of artifacts and midden deposit. . . he was unable to locate any prehistoric house remains . . . the Tolowa informants were quite amused: Them old-timers never put their houses in the garbage dump. They don't like to living in their garbage any more than you would" (Thomas 1999:166).

These experiences imply that thousands of lithic scatters in the western United States may contain evidence of houses and consequently, habitation, that go unnoticed because of our methods, and also because those methods tend to be institutionalized given the pressures to make cultural resource management standardized and efficient

I do not chide. Archaeologists know the lesson of Gould's Tolowa informants. We also have some lessons from additional wickiup sites, in some cases ones that contrast with the findings at the Bustos site and other such sites recorded prior to 1990. A stark example is the Simpson Wickiup Site (5SM2425) in southwest Colorado. The site features two standing wickiups and was studied as part of a large-scale energy project enabling a significant investment in field and lab analysis. As such it is an exemplary case of the application of site structure in addition to the traditional interests in culture history (Greubel 2001:125–133). In contrast to Bustos and some other wickiup sites, surface artifacts are common at Simpson with dozens of items per meter square in and around the structures. In fact, one of the structures was used as a lithic workshop. Artifact density distribution and microrefuse analysis show secondary refuse disposal, cleaning, and task segregation. Consistent with other wickiup sites, assemblage diversity was high. The Simpson Wickiup site reminds us that in some cases, structures will be in close association with artifacts.

Our concern here however is not with locating structures where they are obvious, either because there is evidence a structure is present, such as a depression, or because they are found through our habit of placing excavation in the areas of highest surface artifact density. It is cases where structures are segregated from debris that present challenges for finding the structures – cases of low artifact density and high assemblage diversity near the habitations, with the most obvious surface debris located elsewhere. In the absence of some guidelines to help find houses where there is discontinuity between surface remains and structures, archaeologists tend to remain stymied despite our loss of innocence about such relationships – we continue to dig where we find artifacts on the surface.

Indeed, since most archaeology occurs in the context of cultural resource management, proposals to random sample large areas, or expand excavations from features to areas with little or no surface evidence may create tension with clients, and even agency personnel. All parties are subject to economic justification and the spectre that excavation itself is an adverse effect. The result is that thousands, even tens of thousands of lithic scatters remain less than whole in the absence of attempts to devise our archaeological samples to increase the chances of finding the residential evidence to make such sites at least more whole than they are now. We have found however, there is a benefit to this exercise beyond the mere identification of housing – the matter of assemblage composition.

Applying Site Structure

Applications of site structure from three large cultural resource management projects expand our knowledge of wickiup sites, illustrate successful explorations for housing, and unsuccessful searches that nevertheless increase understanding of sites. Together these cases hold lessons for research design and field tactics.

Examples in southwest Colorado were studied by archaeologists during the Trans-Colorado Natural Gas Pipeline project in 1997–98 (Reed et al. 2001). The Simpson Wickiup site (5SM2425) features two standing wickiups and abundant artifacts. While the structures at the Simpson site were obvious, the studies of assemblage composition, size sorting, and microrefuse show the characteristics of the non-perishable evidence that can often be associated with perishable structures (Greubel 2001:125–133).

Excavations at the Schmidt site (5MN4253) exposed 642 m2 and a suite of light habitation structures spanning two millennia. The earliest structures date to 400 B.C. – A.D. 420, and were found by excavating in areas of fire-cracked rock. Another occupation between A.D. 880–1160 yielded only hearth features; an example where structures were not found despite opening up a large excavation block of 375 m^2. The latest occupation at the site dating to A.D. 1440–1838 includes subtle surface evidence that structures were present, but they had to be defined through excavation.

Examples in southwest Utah were studied by various archaeologists and organizations over the course of nearly three decades because they lie within an energy corridor – the Intermountain Power Project and Kern River Natural Gas pipelines passing through western Utah.

Investigations at the Crucible site (42WS1579) track the history of site structure ethnoarchaeology and illustrate how field tactics and the understanding of the site changed, and did not change over the years. The initial recording of the site in 1983 described it as a "large campsite" covering 17,500 m^2. A single 50 x 50 cm test was excavated. The site was resurveyed in 1984 and the boundaries expanded to 64,000 m^2. A 17 m^2 block exposed subsurface features. The site was recorded again in 1989, but no changes in interpretation were made. A planned natural gas pipeline caused the site to be intensively studied in 1990. The site area was enlarged to 135,000 m^2 and 43 m^2 were excavated, along with two backhoe trenches. Subsurface hearths were found, and dated to A.D. 1300–1570. The site was interpreted similarly to the original recording in 1983, as "periodic campsites". In 2001 another natural gas pipe was to be laid parallel to the first and this led to even larger excavations. The site boundary remained similar to that identified in 1990, but over 150 m^2 were exposed in four blocks. Hearths and thermal features were found, but no definitive evidence of structures.

As the site boundaries were enlarged over the years and the size of excavations increased, the subsurface sample nevertheless remained essentially nil because of the sheer size of the site. Even if the maximum excavated sample in 1990 had been applied to the original 17,500 m^2 site area as measured in 1983, the sample would have been a mere .01%. The investigations over the years located features and developed a degree of chronology, and the sample size enabled a greater understanding of assemblage composition, but the site interpretation remained "campsites".

The nearby Monkey's Paw site (42WS1460) also dates to the Late Prehistoric/Protohistoric period. Excavations there in 2001 exposed 113 m^2 in five areas of the site. Like the Crucible site, there were hearths, thermal features, and artifact assemblages indicative of residential camps. The extensive examination at the Monkey's Paw site also produced a more comprehensive understanding of assemblage composition, one that included primary and secondary disposal. The sample suggested a broader array of activities than found at the Crucible site, the activities were spatially segregated, and the occupations may have been longer term.

Neither site yields clear evidence of structures, but the act of looking for houses and the consequent investigations at these sites shows that even when structures resist explicit identification, some lithic scatter sites can be made more "whole" (Schweitzer et al 2005: Chapters 15 and 17; Stettler and Seddon 2005:107–111).

A final example shows an unexpected consequence of the application of site structure, one that arises from a failure to find houses. The Little Boulder Basin in northeast Nevada is a 50 km^2 area subject to surface gold mining, and is another case where a well-funded cultural resource management environment enables an intensive evaluation of a sizable area. Site structure as developed in ethnoarchaeology as well as the findings at standing wickiup sites in the Great Basin shaped research design in this case from the beginnings of the project in the 1990s (Schroedl 1995 1996, 1997; Schroedl and Coulam 1996; Tipps 1996, 1997) and continued to do so over a decade later (Seddon and Clark 2010). The Little Boulder Basin is a case where, "Despite years of heroic effort, no structures have been identified on any sites of any time period" (Seddon and Clark 2010:240), yet the application of site structure and the exercise of making the lithic scatter whole leads to a fundamental message for archaeological method and theory in this case.

The application of site structure to the Little Boulder Basin sites revealed an extremely simple site structure and only three site types: 1) a generalized camp, 2) a site type with a greater emphasis on tool production and repair, and 3) a type with a greater emphasis on botanical and faunal processing. The findings stimulated a critical evaluation of the method and theory behind site typologies (Seddon and Clark 2010:209–241). The influential dichotomy of foragers and collectors of Binford (1980) and the distinctions between field camps, locations, and different kinds of base camps was challenged. A review of site typologies applied to forager societies in the American Desert West found that they were so particularistic and subject to an assumed need to split sites into ever finer units that they were empirically indefensible. Indeed, site classification had become an end rather than a means.

Researchers in the Little Boulder Basin initially attempted to apply these complex site typologies, but were unable to adhere to their own stated guidelines, resulting in inconsistent site classifications (Seddon and Clark 2010:219). The solution was found in a new approach to the evaluation of site variability, one with less emphasis on categorical assignments of whole sites based on the presence or absence of traits, and greater attention to frequency relationships among classes of archaeological remains such as feature diversity, debitage density, tool density, ground stone density, and faunal richness

The search for houses in the Little Boulder Basin was stimulated by site structure studies, yet produced no evidence for houses. Yet the exercise exposed a flaw in the categorical, trait list conceptualization of site type. The presence or absence of structures is itself a trait often employed to assign site type. In terms of many traditional site typologies this practice risks the use of perishable, and hence difficult to detect housing as negative evidence to then cut to the chase and assign site function.

The findings at Little Boulder Basin contrast with Indian Corral, Orr Springs, and Bustos where despite the fact that houses were not closely associated with high densities of surface debris, they were detectable with excavation, and provided additional information about the sites. Perhaps the more significant contributions however, are the spatially extensive and larger samples stimulated by site structure studies. These improve the understanding of assemblage composition by increasing the chances of sampling primary as well as secondary disposal. Perhaps the most significant consequence is a fundamentally new approach to site type - one focused on variability rather than the presence of absence of traits. These studies made the lithic scatter more whole (Cannon 2010).

Recommendations

Looking for houses is only one element of site structure, but it symbolizes a lesson of ethnoarchaeology: discontinuity between the material remains typically recovered by archaeologists and material remains actually produced by the people living at sites promotes incomplete interpretations, if not incorrect interpretations. Archaeologists know this, but given that the lithic scatter is by far the most common form of site, the problem is by nature pervasive. The cases described here illustrate the problem and hold implications at two levels: specific, tangible recommendations to search for perishable housing at lithic scatters, and the broader issue of how the application of site structure increases our understanding of assemblage composition.

Archaeologists working in the Great Basin and other areas of the desert west became aware of ethnoarchaeology in the 1980s. In 1993 ethnoarchaeologist James O'Connell was invited by a regional journal to provide some direction to this effort and writes:

> Prehistoric site structure is commonly seen as a promising source of information about past human behavior. Ethnoarchaeological studies indicate that research on site structure may require costly adjustments in conventional approaches to data recovery, with no commensurate increase in real knowledge except under narrowly defined circumstances, none of which are common in the Great Basin. Nevertheless, it should still be pursued whenever possible, partly to assess the validity of predictions based on ethnoarchaeological analogies, partly (and probably more importantly) as a means of controlling differences in assemblage composition related to the widespread practice of size sorting and secondary refuse disposal (O'Connell 1993:7).

What have we learned and where do we go from here? Here are some observations about field tactics to improve our search for housing, and through that search, our documentation of assemblage composition at lithic scatters.

Artifact Density, Assemblage Diversity, and Disposal Patterns

The density of non-perishable debris, especially lithics, may be low in structures and in household activity areas, either because some activities are segregated or because of secondary disposal. Archaeologists are more accomplished at finding structures when they are in proximity to high densities of debris on the site surface – we tend to excavate where artifacts occur on the surface. The cases where few objects are near habitations or activity areas are more likely to elude us given the field methods that continue to be typical.

Such failure is not inevitable because at some sites, especially in the presence of primary disposal, features will be associated with debris. Examples include the Simpson Wickiup site where abundant debris occurs in and around standing structures, and the Schmidt site where subsurface structures occur in proximity (but not necessarily in behavioral association) to surface debris.

At wickiup sites with variable artifact densities, low artifact density should not be used prematurely to conclude that no features are present. An evaluation of size sorting may be useful, with small items occurring in and around structures, even if only a few larger items are also present.

Burned tree roots and stumps, some with marks from stone axes, may indicate aboriginal logging. Forager structures often incorporate trees, and may require modification of trees to discover centuries later. For instance, Structure 2 at the Orr Springs site was not adjacent to the tree as it exists now, but was adjacent to a young tree that was delimbed to accommodate the structure. The detection of Structure 2 would not have been possible without exposing the tree trunk to investigate the trunk and to accommodate excavation. Of course, indicators such as aboriginal delimbing and burned stumps apply only to lithic scatters up to a few centuries old.

Another recurrent theme at standing wickiup sites is the presence of ground stone and hammerstones – the latter often expedient and difficult to identify as artifacts, especially in isolation. The same may be said of manuports/camp rock, and in some cases fire-cracked rock. These types of artifacts do not always indicate structures, but in the cases we have, this is a common association.

Field Practices to Find Houses and Evaluate Site Structure

Ethnoarchaeology demonstrates that exposures must be large in order to identify patterns of site organization – on the order of 102–103 meters of contiguous excavation (O'Connell 1993). Where surface remains appear in clusters then more than one or two clusters must be sampled at these scales in order to identify patterns in the distribution, size, or internal organization of sites. Such large scales are daunting to those who devise research designs and scopes of work for compliance cultural resource management excavations on all but the largest and best funded projects. However, the findings at the sites discussed here stimulate some optimism. The Indian Corral site is 2,262 m^2 of which 90 m^2 were excavated to produce a clear picture of the area of structures. This is only 4% of the site, but approaches the recommendation of 102 meters of exposure. The Orr Springs site occupies 700 m^2 with a 53 m^2 block excavated. This is half the recommended size despite the increase in sample size to 8% of the site.

Ethnoarchaeological data that I collected at Bedouin tent camps in Jordan between 1986 and 1994 compared site structure at inhabited tent camps with abandoned Bedouin tent camps. When armed with the pattern recognition provided by the inhabited camps, an archaeological Bedouin tent camp could be identified with a 10% sample, or a 200 m^2 block excavation at a camp covering 2,000 m^2 (Simms and Russell 1996).

While every site will present different challenges, the application of site structure studies to wickiup sites should steadily improve the ability to recognize household areas and structures with samples under 10%. The large CRM projects described here generally sampled at far lower percentages, despite significant efforts to apply the lessons of site structure.

One tool important to an evaluation of site structure is a density distribution map of the site surface to inform testing or excavation strategies. Density distribution maps are best produced during survey and not later so they can influence the excavation research design and the scope of work specifications. Simple methods and even sketch maps are useful if they show the relationships among different kinds of debris so these can be compared to ethnographic and archaeological cases. My review of over 300 site forms on wickiup sites in the Great Basin and Rocky Mountain regions spanning the past 35 years finds only about three dozen site maps that yield information amenable to site structure analysis. We are likely doing better than before, but there remains room for improvement.

The construction of such maps does not mandate piece plotting and this was recognized early on (O'Connell 1993:21). Indeed, the goal should be to find the appropriate scale of mapping in relation to sample size. Highly precise techniques, such as total station points for every surface item seems to be an increasingly common form of recipe archaeology. For an initial analysis of site structure and assemblage composition, such automated field practices may sacrifice sample size, yet produce spurious results despite the illusion of meticulous precision. At early stages of investigation, seeing the big picture with coarser recording, such as counts and size frequencies per meter square, and larger sample sizes, would better serve the development of subsequent research design that may in turn prescribe increased precision and painstaking, expensive recording. This point gains relevance in light of the trend toward hyper-intensive recording on extremely small sample sizes mandated by regulatory paralysis or sheer weight of habit in scopes of work and excavation plans written prior to fieldwork. These practices may lead to *spurious meticulism*.

The approach to excavation is also informed by site structure studies. The common practice of scattering samples of 1 m x 1 m or smaller sondages keyed to lithic scatters found on the surface will likely only sample more lithic debris. This technique will indeed determine the presence of subsurface artifacts, but contiguous context is better for recognizing larger, but subtle features such as structures, and post hole patterns, as well as primary and secondary disposal indicated by size sorting.

The cultural resource management examples described here show that progress is being made. However, some excavations continue to leave the impression that they are conducted with painstaking and hence expensive precision because of the understanding, or perhaps only the fear, that archaeology destroys as it proceeds. The preservation ethic that deems excavation an adverse effect is rooted in genuine threats to the archaeological record. But this ethic does not vitiate the fact that the archaeological record is valuable because of the knowledge it contains – and that knowledge can only be gained through an investigation of the record.

The trade-offs between sample size and precision in survey, mapping, and excavation are important both in terms of the time and cost of field archaeology and in terms of the quality of the interpretation. Perhaps counter-intuitively, greater precision, and painstaking excavation may actually not lead to the best science when it comes to gaining purchase on the overall assemblage composition at forager sites that can be extremely large and varied in the distribution of remains visible at the surface. Assessing assemblage composition in these cases demands that large samples outweigh precision. Site structure experience suggests that precision may often be rendered impotent when small sample sizes fail to evaluate the nature of primary and secondary forms of disposal at the site in the first place. Without this information there is no way to know if the sample reflects the assemblage composition resulting from past human behavior, or merely reflects the assemblage composition of the small sample the archaeologists so painstakingly excavate. One thing seems clear. Without a search for site structure, the excavator will have no means of knowing. The trade-off between sample size and precision is a practical, economic matter, but also a scientific matter of significant import.

Conclusions

The limited and dwindling resource of lithic scatters with standing structures in the Desert West presents two opportunities, one that flows from the other. First, attention to such sites enlists them in the service of archaeological method and theory for investigating lithic scatters where no structures are evident – the most common form of archaeological site. Second, this exercise holds important implications for matters of theory and paradigm.

Standing wickiup sites are valuable precisely because their life cycle of decomposition makes them ethnoarchaeological proxies. They should be studied as such in addition to the tendency to interpret such sites only in terms of recent culture historical issues. The more abstract and scientifically ambitious potential of these sites continues to be unrealized.

The act of looking for houses yields both success and failure, but the current inventory of such sites prompts recommendations that can increase success. The mere act of looking for houses is beneficial for other reasons, regardless of whether houses are found. The application of site structure directs attention to survey, mapping, and excavation techniques that improve the size and quality of samples that are crucial to a defendable and accurate assessment of assemblage composition at forager sites in the American Desert West that are often large and ephemeral. The cultural resource management projects exemplified here bear this out.

The ethnoarchaeological analysis of standing wickiup sites and the application of site structure to lithic scatters makes a larger theoretical contribution as well. Site structure studies indicate that significant archaeological characteristics of forager residential sites are shaped not by culture historical particulars; whether the group was Shoshone or Ute, or whether a site was used in the Archaic period or the Late Prehistoric period. Rather, patterns of site structure reflect behavioral context produced by the tyranny of circumstance, and is thus potentially cross-cultural. This fact makes such sites amenable to analysis without appeal to agency, intent, cultural badges, identity, or historical vicissitude. As such they serve as analogies of process and provide archaeologists the tools to model past cultures for which there is no historical analogy. Looking for houses and site structure further develop a general theory of behavior of foraging societies, behaviour that varies by circumstance and context (sensu O'Connell 1995). This prospect will hopefully continue to influence research design, but also needs to be absorbed into management policy to a greater degree. In this way, we meet the regulatory requirements to serve science by helping to make the most common form of archaeological site in the American Desert West at least more whole than it was before. ■

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Piecing Together the Past One Hearth at a Time: An Archaic Period Synthesis for Southwestern, Utah

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St. George and its surrounding communities represent one of the fastest growing population centers in southern Utah. The development of housing and infrastructure to support this growth has resulted in dozens of data recovery projects to mitigate the impacts to the area's important archaeological sites. Many of these projects were funded by State and local agencies, such as the School and Institutional Land Administration (SITLA) and the Washington County and Kane County Water Conservancy Districts. Regional syntheses have not kept pace with these investigations and recent projects like SITLA's Warm Springs development area has produced dozens of data points on Archaic period adaptations. To make the most of these data recovery efforts HRA, Inc. Conservation Archaeology (HRA) has pioneered new methods that allow us to mechanically remove the sterile overburden covering large buried components without damaging the data they contain. This is a vast improvement over the small windows into the past that hand excavation methods, particularly in rockshelters, yielded. This paper has two goals, first to synthesize information from Pre-Formative sites excavated in southwestern Utah and second, to demonstrate that even small data recovery projects contain data points that can be used to understand past occupation patterns.

CULTURAL RESOURCE MANAGEMENT AND NEW EXCAVATION METHODS

Rich Talbot and Lane Richens' (2009) discovery that intact cultural deposits lay deeply buried, and even stratified, in the Sand Hollow Reservoir project's sand dunes, opened a new window into our understanding of the region's past. Before this finding, the Archaic period in Washington County was unknown and largely extrapolated from rockshelters excavated outside the county and from surface artifact scatters associated with temporally diagnostic projectile points. Regional culture histories (Altschul and Fairley 1989; Spangler 2001; Walling et al. 1986) typically invoked Jennings' (1953) Desert Archaic concept, which relied on Archaic chronologies developed from rockshelter excavations located elsewhere in the eastern Great Basin and northern Colorado Plateau. Stratigraphic sequences from Cowboy Cave (Jennings 1980) in Wayne County, Sudden Shelter (Jennings et al. 1980) in Sevier County, and O'Malley and Conaway shelters (Fowler et al. 1973) in eastern Nevada formed the basis of regional prehistories. Until Janetski (Janetski and Wilde 1989, Janetski et. al 2013) reported on test excavations at Antelope Cave and Rock Canyon Shelter (Janetski and Wilde 1989; Fisher et al. 2013), located just south of Washington County in the Arizona Strip, virtually no Archaic sites had yielded radiocarbon dates relevant to the region (Figure 1). Even the large Quail Creek Reservoir project yielded no dates earlier than 800 B.C. The Navajo McCullough Transmission line and the first Kern River pipeline projects hailed the start of a new era of CRM data collection, yet these projects also failed to identify well-dated Archaic occupations in Washington County.

During the Archaic period, settlement systems are believed to have included numerous camping and stopping places for resource gathering and processing that changed throughout the year. Many of these stops were in open camps, and

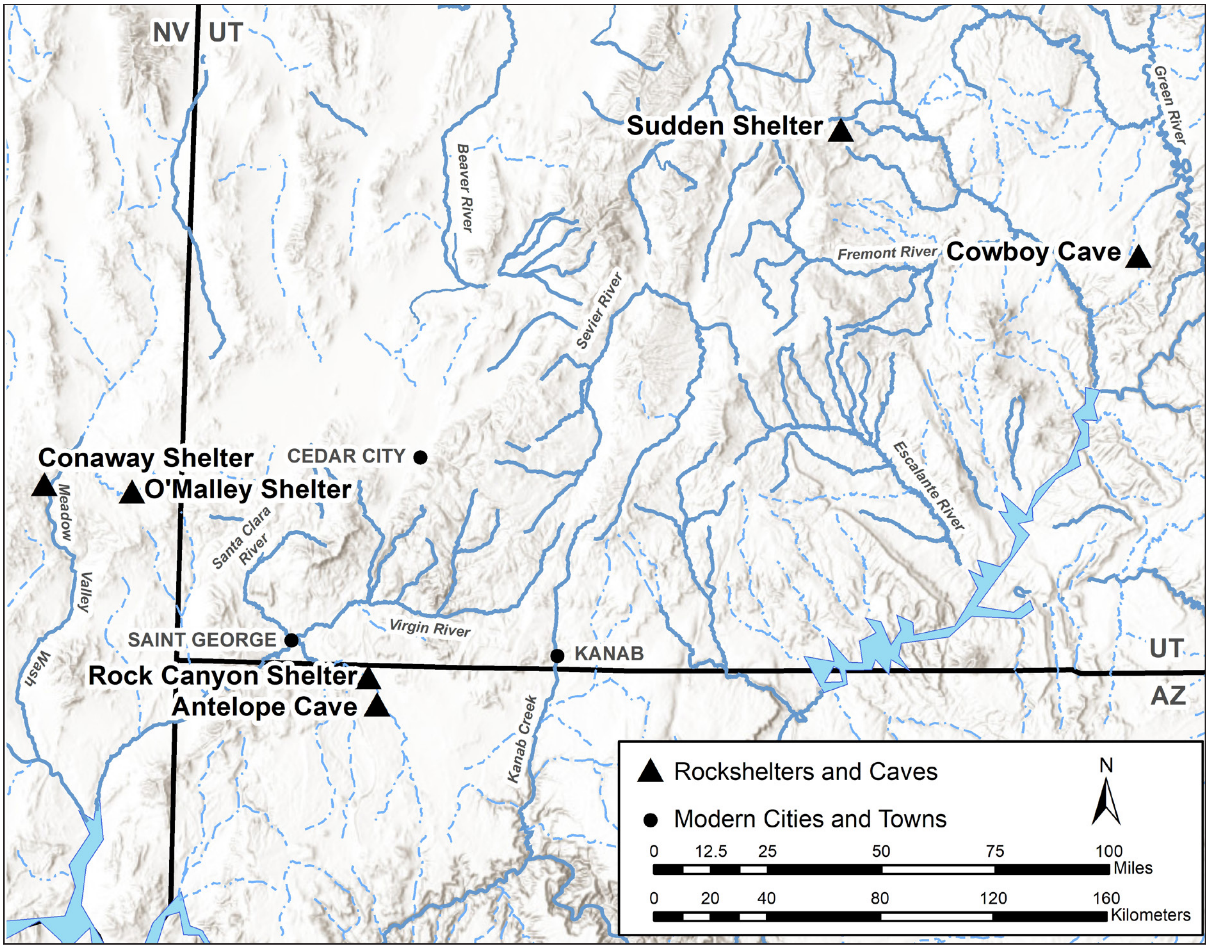

Figure 1. Rockshelters excavated in the region before 1990.

some were tethered to more permanent locales. The large rockshelters probably represented one stop in an entire settlement system. For example, Antelope Cave in northwestern Arizona was a communal jackrabbit hunting and processing site located on the travel route to pine nut and hunting camps located north of the Grand Canyon. Sudden Shelter and Cowboy Cave were hunting or seed gathering and processing locales frequented during the spring, summer, or early fall. Within these settlement systems the locations of the winter camps are largely unknown. Locating the winter camps is difficult because many of these sites either lack buried cultural deposits or they are complex palimpsests that represent hundreds, or even thousands of years of camping activities. Projectile point typologies allow us to link surface artifact scatters into broad temporal periods; however, without radiocarbon dates from hearths, temporary shelters, or other cultural features the resource processed cannot be discerned. Furthermore, prehistoric activities that did not leave projectile points in the archaeological record are rendered chronologically invisible.

Because many recent data recovery investigations have focused on drainages for reservoirs and sand dunes or sheets for housing or resort developments, open sites in largely unexplored resource patches are providing pieces of the settlement system puzzle in a host of new settings. To locate buried intact

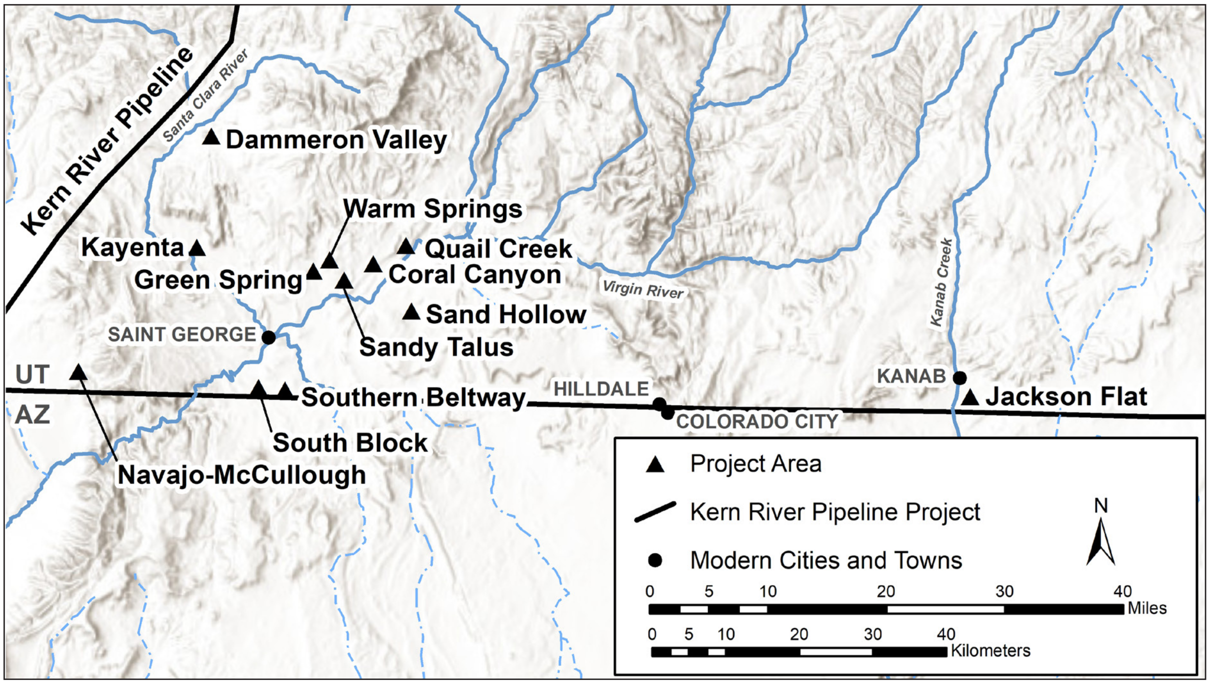

Figure 2. Project areas discussed in this report.

cultural deposits in these open sites, and investigate them in a cost-effective manner, CRM firms have found that a backhoe or track hoe is a mandatory part of the archaeologists' tool kit. The use of mechanized equipment to locate prehistoric activity surfaces has led to the discovery that deeply buried components, which contain hearths and temporary habitation structures, are frequently preserved in these sites. Even active geomorphological settings, such as sand sheets and alluvial deposits, can contain stratified sequences of prehistoric occupations. These discoveries have led CRM companies and agencies in two directions. First, systematic mechanical trenching is often required where soils have accumulated rapidly over periods of time that are relevant to prehistory, and second, investigations must be phased to accommodate the development of research questions and to properly budget the costs.

REFINING REGIONAL CULTURE HISTORIES

The remainder of this paper will focus on what we have learned since 1990 about southwestern Utah's pre-Formative occupants and the transition to farming. Most of the data reviewed below was accumulated during CRM investigations in Washington, Iron, and western Kane counties. While this discussion synthesizes the recent data recovery projects in the region (Figure 2) it should not be considered exhaustive. Our goal is to summarize the major projects and in the process highlight the numerous survey and data recovery projects that HRA has undertaken for SITLA under the direction of Kenny Wintch. These projects have involved the survey of over 10,000 acres in Iron, Kane, and Washington counties and the phased data recovery investigations at over fifty prehistoric sites. HRA's projects incorporated in this synthesis include the Coral Canyon (Roberts and Eskenazi

2006; Roberts and Ahlstrom 2003), Dammeron Valley (Landon 2017), Kayenta (Ahlstrom et al. 2000), Sandy Talus (Harper et al. 2011), South Block (Eskenazi and Roberts 2010, 2011), and Warm Springs (Eskenazi and Roberts 2008; Landon and Roberts 2018) development projects (Figure 2). Projects also discussed that were under the direction of SITLA and various other Federal, state, or local agencies are the Jackson Flat Reservoir project in Kanab, Utah (Roberts 2018); the Sand Hollow Reservoir and associated commercial development projects (Talbot and Richens 2009; Winslow 2010), the Southern Beltway, and various smaller reservoir and development projects in Hildale and Colorado City (Nielson 1998). These projects are briefly summarized and then their data are synthesized chronologically in the sections that follow.

A REVIEW OF RECENT CRM PROJECTS IN SOUTHWESTERN UTAH

Between 1998 and 2006 HRA recorded, tested, and excavated 24 prehistoric sites during two phases of fieldwork at the Coral Canyon development area north of Washington City (Roberts and Ahlstrom 2003, Roberts and Eskenazi 2006). The project area was located between 3,100 and 3,300 ft. in elevation and the vegetation was dominated by sage and black brush. The first phase of fieldwork included the excavation of 16 archaeological sites and the second phase focused on eight prehistoric sites. Radiocarbon dates from hearths buried in sand sheets suggest that occupation of the area began around 5400 B.C. The artifacts, faunal remains, and macrobotanical evidence indicate that project area, located in sand dunes surrounding two small springs, were used for hunting of small mammals, wild seed processing, and tool stone procurement. Coral Canyon's prehistoric residents built ephemeral brush structures during two periods of occupation. These periods were the Late Archaic (3000 to 2000 B.C.) and between A.D. 1300 and 1700. HRA learned that site structure increased in complexity through time (Roberts and Eskenazi 2006). Use of the sand sheet resource patches was most intensive during the Late Archaic period before 2000 B.C. and again during the Southern Paiute period.

Research conducted at Sand Hollow by the Office of Public Archaeology (OPA) at Brigham Young University (BYU) and Bighorn Archaeological Consultants was also focused in sand sheets in the Hurricane Basin. In the 1820 acre project area survey, testing, and excavation was completed for the Washington County Water Conservancy District prior to the construction of the Sand Hollow Reservoir (Talbot and Richens 2009:4–5). The project area was located just southwest of Hurricane, UT and 2–4 miles south of the Virgin River floodplain at an elevation that ranged from 3,000–3,200 ft. Vegetation was dominated by sage and grasses. Thirty-two total sites were recorded, and 23 sites were subject to data recovery. Radiocarbon dates obtained from the features ranged from 5,600 B.C. to the A.D. 1900s; however the majority of the features dated from 4,000 B.C. – 200 B.C. and A.D. 1500+ (Talbot and Richens 2009:245). As in the Coral Canyon project area, the excavated features demonstrated longer term use of the resource patches between 1300 and 300 B.C. Results from the more than 120 processed macrobotanical samples and dozens of pollen samples suggest that wild plants and animals were the focus of subsistence activities, and there were no pollen or seeds from cultigens except in a single habitation feature investigated during the phase reported by Winslow (2011).

Winslow (2011) reported on OPA and Bighorn's final season of fieldwork in the Sand Hollow area for the Sand Hollow Resort Development Project. This project area covered almost 1,000 acres located less than half a mile south of the Virgin River at an elevation of 3,100 ft. Sixteen archaeological sites that were occupied intermittently between 4690 B.C. and A.D. 1400 were recorded and excavated by Bighorn and OPA (Winslow 2010:438). Numerous rock-lined hearths and temporary structures were excavated many with ground stone fragments, suggesting that most of these sites served as wild resource procurement camps. In addition to the camps, 14 habitation structures and possible structures were reported. Some of the structures dated to the Late Archaic period and may have served as base camps (Winslow 2010:452). The area was used fairly consistently by Archaic, Virgin Branch, and Southern Paiute peoples with no discernible hiatus through time for wild plant and small animal procurement. Perhaps due to the project area's location near the Virgin River floodplain, Formative period sites were better represented here than in the previous Sand Hollow project. In general, the area was used for hunting and foraging during the Archaic Period, and hunting, foraging, and agriculture during both the Formative and Late Prehistoric periods (Winslow 2010:456).

HRA's data recovery investigations in the in the Warm Springs development area led to the discovery that the project area contained a substantial Archaic and Basketmaker II occupation that included evidence of farming, pithouses and numerous earlier ephemeral structures and hearths (Eskenazi and Roberts 2008; Landon and Roberts 2018). The Warm Springs project area was located at an elevation of 2,800–3,200 ft. north of I-15 in Washington City, and vegetation was dominated by sage. Like Coral Canyon and Sand Hollow, many of the sites were located in sand dunes near springs and intermittent drainages. During a second phase of data recovery John Jorgensen of Desert Mesa Construction used a track hoe to strip off the sterile overburden and exposed Late Archaic and Basketmaker II activity surfaces that covered an area of over 3,600 m (Landon and Roberts 2018).

At the Sandy Talus development area located just north of Washington City on the south side of I-15 HRA conducted the first phase of data recovery at several Archaic camps located in sand dunes and at a Pueblo II habitation site that contained linked storage rooms and pithouses (Harper et al. 2017).

Between 2009 and 2012 HRA, OPA, and Bighorn Archaeological Consultants conducted data recovery investigations at 10 archaeological sites that were impacted by construction of Jackson Flat Reservoir (Roberts 2018). The project was funded by the Kane County Water Conservancy District and the Army Corps of Engineers. Kenny Wintch of SITLA directed the various phases of data recovery investigations and coordinated with the agencies and Tribes. The project area was located just south of Kanab, in Kane County, Utah on the eastern edge of the Kanab Creek floodplain. Combined, the archaeological sites contained over 60 major features that spanned the last 6,000 years of prehistory. The period of most intensive use occurred between the Early Agricultural (1300 B.C.) through Pueblo I (A.D. 900) periods. Most of the project's habitation features were radiocarbon dated using cultigens (when present) from well controlled contexts such as pithouse hearths or floors.

Other projects discussed in this paper are the Dammeron Data Recovery project near the town of Veyo by HRA for SITLA (Landon 2017), and the Kern River Pipeline Project that traversed the western edge of Utah from Salt Lake City to California (Reed et al. 2005). The report of the Kern River investigations included a summary of all radiocarbon dates in the region and synthesized excavation data in southwestern Utah. It also established an obsidian hydration chronology for several sources in the region. Antelope Cave and Rock Canyon Shelter, located just south of the Utah border in northeastern Arizona, were excavated and reported by Janetski et al. (2013). These rockshelters were located at an elevation of 4,600 ft. in sage flats (Antelope Canyon) and rocky canyon settings (Rock Canyon Shelter).

Paleoindian Period (13,000 – 8000 B.C.)

The oldest radiocarbon dated artifact recovered from the region is a stemmed obsidian point collected during excavations for the Southern Parkway. A luminescence date on the soil associated with the point yielded a date range

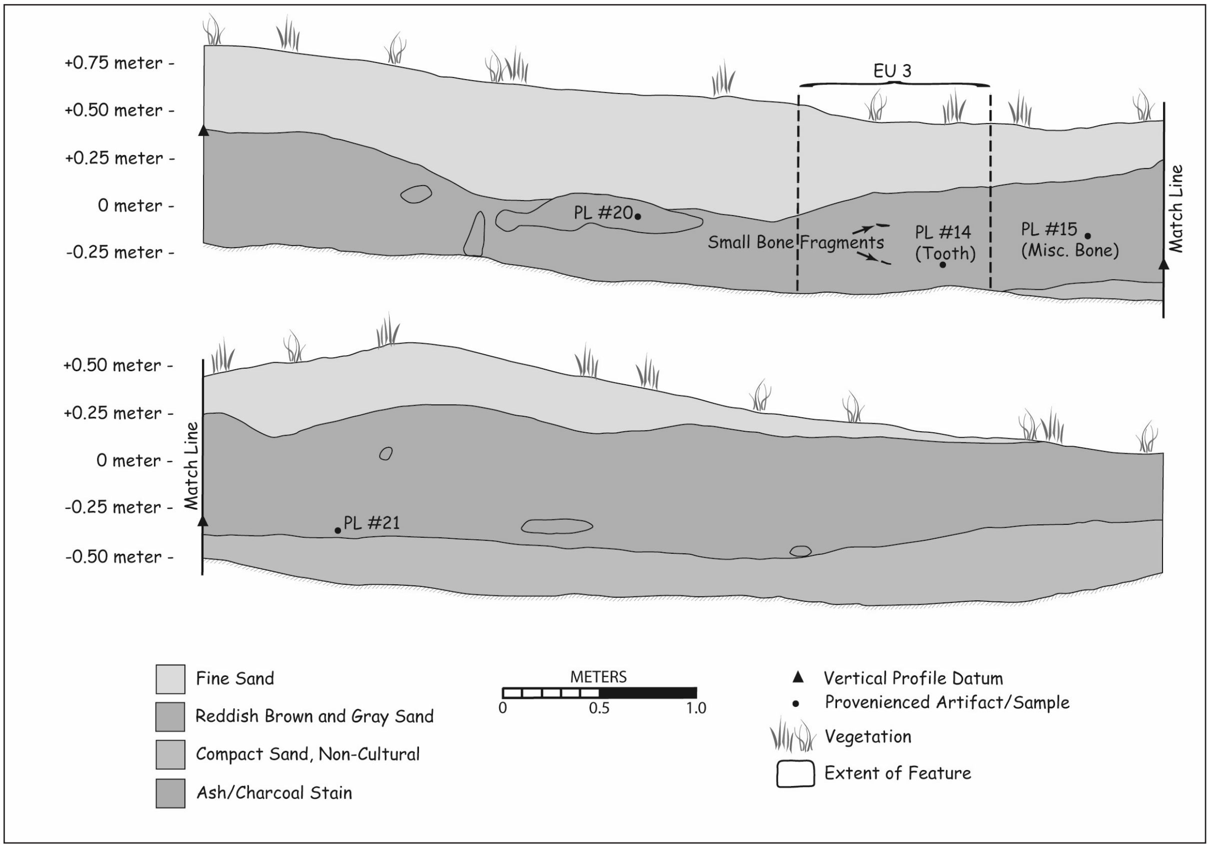

Figure 3. Profile showing Feature 1 in the east wall of Backhoe Trench 1 at 42Ws4478.

of 12,700–9900 B.C. The obsidian was traced to the Topaz Mountain Source (Nelson and Holmes 1979) of Utah, a distance of about 150 miles north of St. George.

Site 42WS4478, which was test excavated by HRA in the Warm Springs project area, contained evidence of extinct Pleistocene fauna, charcoal or staining from decomposed organic material, and artifacts (Eskenazi and Roberts 2008) (Figures 3–5). Unfortunately, no direct association was made between the artifacts and the Paleoindian-age charcoal features excavated during HRA's limited first phase of investigations. This may change in the future if additional data recovery investigations become necessary.

HRA recorded 42WS4478 in the Warm Springs project area in 2004 as a sparse scatter of 10–25 flakes with hammerstone and ground stone artifacts located atop and extending down the east slope of a prominent ridge or knoll. Three hand units and five backhoe trenches were excavated across the site during a first phase of data recovery (Eskenazi and Roberts 2008). In one of the hand units seven arbitrary levels were excavated to a maximum depth of 73 cm bd. Non-human bones were found throughout all levels, and one exceptionally large tooth was encountered in Level 6. This tooth (Figure 5) was identified by Don DeBlieux at the Utah Geological Survey as a third mandibular molar of an extinct Pleistocene camel (*Camelops sp.*). Some pockets of dark soil and ash were present in Level 7 along with a few non-human bones that appeared to be burned. Eckerle (Eskenazi and Eckerle 2008) noted that the geology of the site indicated the presence of an interdunal pond or spring in Mill Creek Valley ca. 15,000 years ago, which would have supported such fauna.

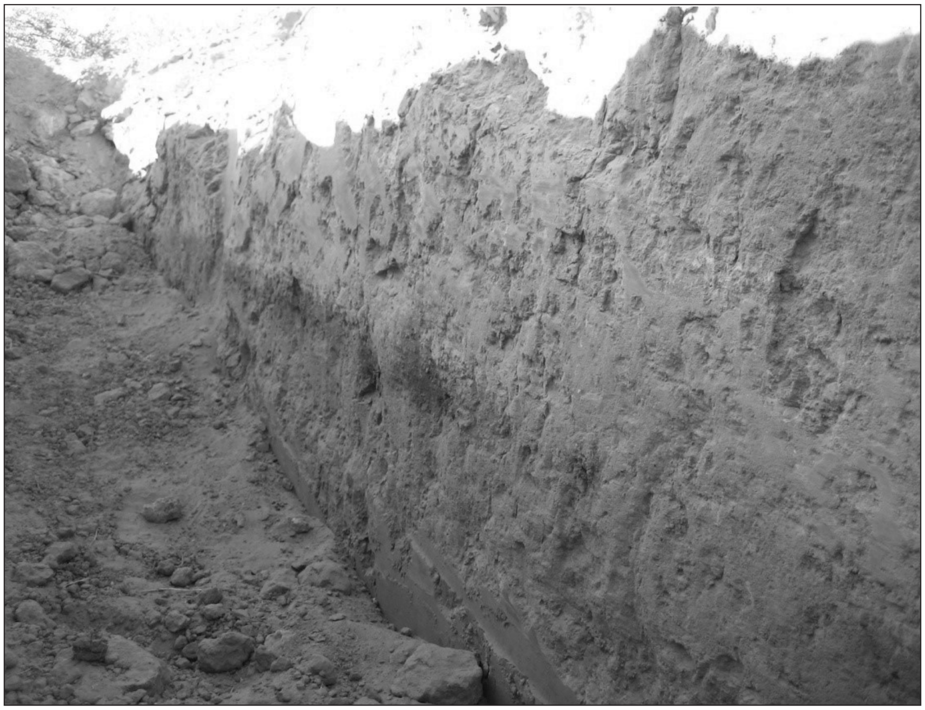

Figure 4. Photo of Feature 1, visible in the east wall of Backhoe Trench 1 at 42Ws4478.

Figure 5. Photo of Feature 1, visible in the east wall of Backhoe Trench 1 at 42Ws4478.

In the five backhoe trenches six features were encountered that consist of amorphous charcoal stains. Two charcoal samples were collected from Backhoe Trench 1, Feature 1 (Figures 3 and 4). These samples were combined and sent to Beta Analytic for an AMS date. The 2-sigma calibrated date range of the combined sample was 13,920 to 12,480 B.C. (BP 15,870 to 14,440; Beta 221249); however no artifacts were clearly associated with the stains or the camel tooth (Figure 5). A second radiocarbon date was obtained and processed from Feature 6, which was visible in the west wall of Backhoe Trench 1 as a 45 cm long gray ash stain located 20 cm below the ground surface and 50 cm above Feature 1. No artifacts, FCR, or charcoal was clearly associated with this feature. A soil sample collected from this feature and submitted to Beta Analytic for AMS dating yielded a 2-sigma calibrated date range of 5870–5660 B.C. (Beta 222007). Additional research may yield insight in the origin of these stains and make possible connections between the artifacts and Pleistocene fauna.

Obsidian hydration rates and projectile point styles suggest that several lithic scatters in the South Block project area were possibly associated with the Paleoindian or the Early Archaic periods. A Silver Lake projectile point was collected from the surface of site 42WS5004 (Eskenazi and Roberts 2011) along with more recent point types. The obsidian hydration dates recovered from non-diagnostic flakes were consistent with the more recent projectile points and support evidence of multiple components. Test excavations conducted at the site during a first phase of data recovery demonstrated that the site was likely deflated.

As part of the South Block data recovery investigations, HRA submitted obsidian artifacts for hydration and sourcing analysis from NRHP-eligible sites subjected to data recovery, and also from the ineligible sites and two isolated occurrences (Eskenazi and Roberts 2011). Most of the obsidian was collected from small lithic scatters situated on the edge of on high prominences with a commanding view of the broad valleys to the south of St. George. The Panaca Summit/Modena Area source dominated the utilized obsidian sources with 92 percent of the sourced obsidian originating from this area. The remaining eight percent was distributed across nine other sources from Nevada and Utah, including an unknown source, which represented four percent of the total. The source and hydration data are presented in Table 1 and there do appear to be some patterns in rind thickness that correlate with the obsidian sources.

The Modena source was utilized through time, as the broad range of rim measurements (4.4–10.3) show (Table 1 and Figure 6). Conversely, the Wild Horse Canyon obsidian has wider rim measurements, suggesting it been exposed for longer. Although Wild Horse obsidian tends to hydrate at a faster rate than Modena obsidian, rinds of over 11 microns, were rare in the Kern River assemblages, and they may indicate Early Archaic or even Paleoindian occupations (Seddon 2005) in the South Block project area.

The observation that the thickest rinds were associated with Wild Horse Canyon obsidian takes on additional significance when one considers the recent discovery that Milford Flat, located just to the east of the source, contains a unique concentration of both Clovis and Stemmed point sites (Mullins et al. 2009). Intensive surveys in the Wild Horse Canyon source (Eskenazi and Roberts 2013) and adjacent valleys suggest the area was the focus of intensive use, probably for exploiting large game herds, during the Paleoindian and Early Archaic periods (Eskenazi and Roberts 2013; Mullins et al. 2009). Eskenazi and Roberts (2013) documented a rind thickness of 9 microns from a Clovis point made of Wild Horse obsidian and collected in the Mineral Mountains. Many of the Paleoindian sites identified in the region by Mullins et al. (2009) are retooling locales and possible campsites.

Early Archaic (8,000–5,000 B.C.)

During the Early Archaic period excavated sites were small resource processing camps that included ephemeral structures, large roasting

Table 1. Obsidian Sourcing and Hydration Data from South Block Sites.

Site (42WS)	Catalog No.	Artifact Type	Source	Rim 1 (+/- 0.1) μ
3993	1	Parowan Point	Modena	4.4
4834	1	Flake	Modena	4.6
5004	38	Flake	Modena	5.9
4838	1	Flake	Modena	6.4
4837	1-Jan	Flake	Black Rock Area	6.5
4837	2-Jan	Flake	Modena	6.6
4832	271	Flake	Modena	6.8
4839	1	Flake	Modena	6.9
5006	39	Utilized Flake	Rock Canyon I	6.9
4834	2	Biface	Modena	7.5
4835	2-Jan	Flake	Modena	8
IO 179	1	Flake	Modena	8.5
4833	5	Flake	Kane Springs	8.6
4833	18	Flake	Modena	9.3
4837	1-Feb	Biface	Modena	9.8
4835	3-Jan	Flake	Modena	10.3
4838	2	Biface	Wild Horse Canyon	12.3
4832	214	Utilized Flake	Wild Horse Canyon	12.4
4833	47	Flake	Wild Horse Canyon	13.2
4832	138	Flake	Wild Horse Canyon	14.1
4832	337	Biface	Wild Horse Canyon	14.2

pits, and hearths. The use of rocks for heating and cooking plants and animals was common and ground stone typically consisted of one hand manos and grinding slabs. Flaked stone technology was dominated by biface production, and projectile types, when recovered, are predominantly Side-notched types. Small mammals appear to have been the focus of animal procurement and processing activities. Due to poor pollen and seed preservation in sand dunes, we have minimal data on the types of plants processed.

The earliest cultural feature that has been radiocarbon dated in the study area was a habitation structure (Component 20, Feature 20-1) excavated in a sand dune during the Sand Hollow Reservoir project in the Hurricane Basin (Talbot and Richens 2009). The structure consisted of a shallow sub-rectangular basined depression with ash staining. The preserved portion measured 2 m in diameter, and the structure lacked internal features, but was associated with four possible postholes. A 2-sigma calibrated date range of 5,705–5,511 B.C. was obtained from the stained soils within the structure. Artifacts associated with the feature included a large quantity of debitage, an Elko Side-notched point base, two biface fragments, a hammerstone, and 15 pieces of ground stone including a mano and slab metate fragments, and bones from small mammals (Talbot and Richens 2009). Pine pollen levels were higher at this time than during subsequent periods, and the pollen samples processed from this period suggest that the vegetation regime was more abundant in the past than today (Talbot and Richens 2009:266).

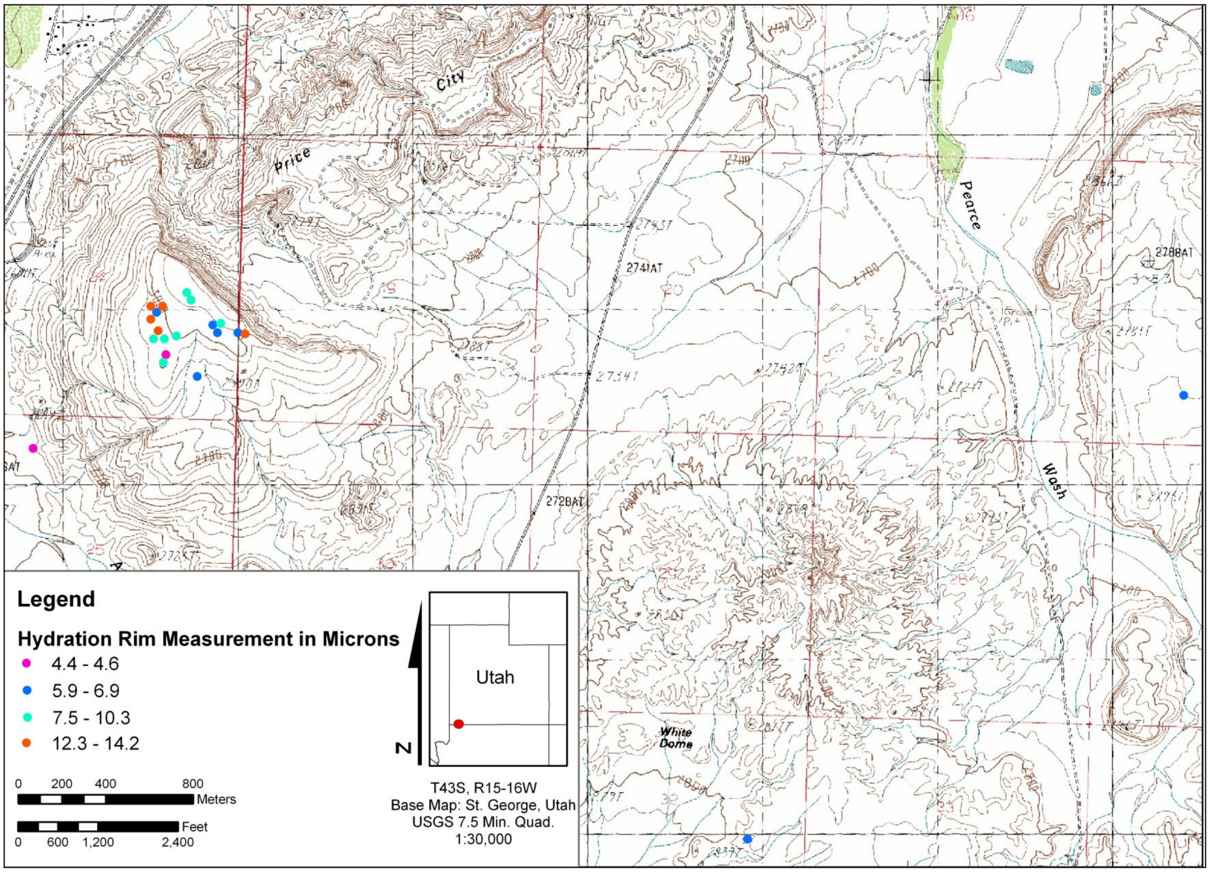

Figure 6. Hydration rim ranges found in the South Block obsidian samples.

Roberts and Eskenazi (2006) excavated two Early Archaic sites located in sand dunes in SITLA's Coral Canyon development area in the St. George Basin north of Washington City. The sites contained hearths, nested roasting pits, and churn zones. An ashy churn zone from 42WS1221 yielded a 2-sigma radiocarbon date range of 5,450–5,210 B.C. and Feature 7, a probable hearth, in that same site, was radiocarbon dated to 5,330–5,070 B.C (all dates provided in this paper are 2-sigma calibrated date ranges). A second site, 42WS1222, contained a hearth that dated to 5,200–5,180 B.C. and a series of nested thermal features (Figure 7) that were radiocarbon dated to 5,060–4,840 B.C. These features were associated with lightly used ground stone, chert debitage, and charred bone; however, projectile points were rare. Small mammals and very small mammals dominated the faunal assemblage. The pollen and macrobotanical samples did not produce significant evidence of economic plants.

Sites investigated during the Kern River Pipeline project, which traverses the western edge of Washington County (Reed at al. 2005), contained few components older than 3,500 B.C.; however, a table of dates compiled for this project for the eastern Great Basin indicates a spike in radiocarbon dates around 6,000 B.C. and another between 3,500 and 2,500 B.C. during the Middle Archaic period (Reed et al. 2005: Figure 5-1). Regional data suggest that groups were highly mobile, and they practiced a generalized hunting and gathering subsistence strategy. Reed at al. (2005) observed that the importance of ground stone during this period indicates an emphasis on seed processing, and small mammals were the focus of hunting activities. The artiodactyl index derived from the Kern River sites, and from

Figure 7. Feature 6, nested thermal features at an Early Archaic component at 42WS1222 in Coral Canyon.

other sites excavated in the eastern Great Basin, demonstrate an increase in large game hunting over time (Reed et al. 2005: Figure 5-3). In other words, large game hunting becomes increasingly important in the Late Archaic and later Formative periods in the eastern Great Basin.

Middle Archaic (5,000–3,000 B.C.)

This period corresponds to a climate regime considered warmer and drier than today. Despite the drier conditions the archaeological record suggests that populations continued to increase and expand into resource patches throughout the region.

Rock Canyon Shelter and Antelope Cave (Janetski et al. 2013) contain evidence of long term and consistent use that began during this period. Other open sites, particularly in sand dunes, have yielded a wealth of new data on this period from excavations in the Coral Canyon, Jackson Flat Reservoir, Kayenta, Sand Hollow, Sandy Talus, and Warm Springs project areas (Ahlstrom et al. 2000; Eskenazi and Roberts 2008; Harper et al. 2017; Landon and Roberts 2018; Roberts 2018; Roberts and Ahlstrom 2003; Roberts and Eskenazi 2006; Talbot and Richens 2009) in Washington and Kane counties.

Site 42WS1219 in Coral Canyon contained a deposit of culturally stained soil (Feature 12) found in the site's North Area on the lowest surface exposed by mechanical stripping (Roberts and Ahlstrom 2003). The dated sample consisted, at least in part, of mesquite charcoal and produced a calibrated date range of 4355–4220 B.C. A small quantity of debitage was recovered at this level, but no projectile points or other tools.

Sand Hollow Components 8, 10, 11, and 12 in the Dune Area yielded calibrated date ranges that fell between 4,000–2,500 B.C. (Talbot and Richens 2009). Like at Coral Canyon, none of these components yielded diagnostic projectile points (Talbot and Richens 2009: Table 5.1).

Small mammals and birds were the focus of subsistence activities at these components; however, plant processing of cheno-ams, and possibly cactus and cattail, is also documented by the macrobotanical and pollen samples processed. None of the components contained formal habitation structures, but possible shade features, hearths, use areas and roasting pits were common. The wild plant and faunal data analyzed suggest that small mammals and birds were processed in the hearths and roasting pits. Flotation and pollen samples processed from some of the features indicate that fuel consisted of saltbush and wood from the rose family, and cactus, grasses, and cheno-ams were likely processed. Grinding slabs and manos were used to process plants and animals and associated tool assemblages remained small.

During a second Sand Hollow data recovery project reported by Winslow (2011) only one feature dated to this period, and unlike the first data recovery effort, none of the features dated to the Early Archaic. The single Middle Archaic date reported by Winslow was from site 42WS3552 in a concentration of FCR with a date range from this feature was 4,690–4,460 B.C.

The Middle Archaic Period was represented in the Warm Springs project area (Landon and Roberts 2018) by a structure and thermal feature at the Cutbank Site (42WS4465) and Stratum III at the Churned Zone Site (42WS4718). The date range for these two components was 3,530 – 3,370 B.C. and both components were buried deeply in the caliche stratum. The Middle Archaic contexts had a relatively high proportion of pressure flakes (33 percent) compared to the other time periods (21.1 percent in Late Archaic contexts contexts). Stratum III at 42WS4718, which likely dated to the Middle Archaic or earlier, also had a larger proportion of pressure flakes (33.8 percent) than the Late Archaic/Basketmaker II stratum above it (23.6 percent). It is unclear whether this difference in the assemblages reflects human behavior, or natural processes such as smaller flakes being moved down to deeper contexts via bioturbation. In addition to the flaked stone debitage, 11 flaked stone tools were recovered and analyzed from Middle Archaic contexts. These included a core, four early stage bifaces, five mid-stage bifaces, and a scraper. As with many of the other Middle Archaic excavated sites, no projectile points were associated.

In the Warm Springs project area one habitation feature was encountered at the Cutbank site, and only a portion of the structure was preserved due to wash erosion (Figure 8). The oval feature (Feature 14) measured 2.4 by 2.8 m and the floor was dish-shaped, and curved up to the prehistoric surface. The lowest point in the floor was around the hearth. There was no evidence for preparation at the wall juncture, such as stone slabs or plaster, and little evidence of the superstructure was preserved. Two likely postholes were encountered in the west half of the feature. One posthole was located near the southwest wall, and a second was identified about halfway between the wall and the hearth. The structure contained a centrally located hearth that measured 65 cm in diameter and was 6 cm deep. It was round and dish-shaped and contained two large stones placed on the feature's western edge. Tools associated included bifaces in various stages and grinding slabs. FCR was used in the hearth; however, no seeds or plant remains were associated. Faunal remains recovered represented small mammals.

The Jackson Flat Reservoir project near Kanab, Utah has yielded perhaps the largest concentration of features dating to this period. Site 42KA6164, Locus 1 contained four habitation features that were occupied during two intervals between 4,900 and 4,600 B.C. The more recent structures consisted of two oval surface structures that measured 5 by 4 m, and contained multiple interior and exterior hearths. One of these structures was built over a smaller round and shallow pithouse (Figure 9). The older structure, and a similar one located several meters to the south, measured 3–4 m in diameter and the floor was dug approximately 10–20 cm below the prehistoric surface.

Figure 8. Photo of Feature 14, a structure at the Cutbank Site in the Warm Springs project area, facing south.

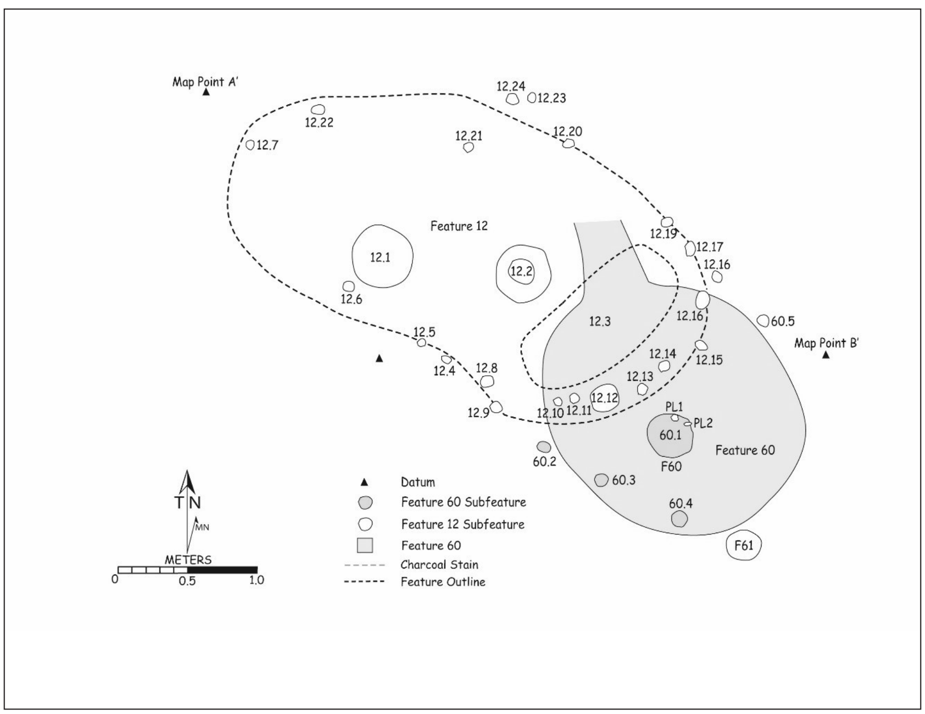

Figure 9. Drawing of Middle Archaic habitation Features 12 and 60 at Locus 1, Rodent Ridge, in the Jackson Flat Reservoir project area.

The single diagnostic projectile point associated with the component was an un-typed side-notched dart point. Other artifacts include a small assemblage of debitage, a one-handed mano, a grinding slab, and biface fragments. Hearths in the two surface structures contained juniper cones hinting that juniper branches may have been burned in both of these features. In addition, an unknown nut shell and one seed fragment were recovered from the fill of one of the oval structure's hearths. Another interior hearth in one of the older circular structures contained six chenopod seeds. Faunal remains suggested that jackrabbits and small mammals may have been the focus of animal procurement activities.

Three other sites in Jackson Flat (42KA6163, 6166, and 6167) contained additional evidence of repeated short term use between 4,000–3,400 B.C. The components consisted of hearths and dark midden deposits that were likely formed through repeated construction of roasting pits. Ground and flaked stone artifacts were present at these sites, but diagnostic project points were rare. Faunal remains in flotation samples and elsewhere consisted primarily of rabbits and small mammals.

In the synthesis of the eastern Great Basin for the Kern River project, Reed et al. (2005) saw few changes in settlement or subsistence strategies during this time period. Sites contained small hearths and bifacial technology continued to dominate flaked-stone assemblages. Our data support these conclusions and demonstrate a subsistence focus on small mammal and Cheno-am procurement. Habitation features are typically oval brush shelters, and they varied in size from just over 2 m to almost 5 m in length. Most of the features were surface structures or shallow pithouses, and some contained multiple hearths. Storage features have not been reported, but thermal features including roasting pits with FCR are common. It is possible that some of the roasting pits, and particularly those located in structures, functioned as warming pits, rather than open hearths for cooking or food processing. However, this is a hypothesis that requires further testing and research. Projectile points are rarely associated with radiocarbon dated Middle Archaic components, and when present they are typically side-notched varieties. Ground stone assemblages are dominated by one hand manos and grinding slabs. Small animals, as well as plants, were likely ground as the faunal remains are often highly fragmented.

Late Archaic (3,000–1,000 B.C.)

During the Late Archaic period the Sand Hollow area appears to have been an important resource patch for seed collection and animal procurement. Half of the dates on the 30 described components in the Dune Area fall between 2,900 and 1,000 B.C. (Talbot and Richens 2009: Table 5.3), and over one-quarter of the dates fall between 1,300–800 B.C. Within these ranges Talbot and Richens see two specific clusters of dates that suggest periods of intensive occupation including 2,917–2,714 B.C. and 2,573–2,478 B.C. This more intensive use of Sand Hollow's sand dunes is consistent with increased regional precipitation between 3,000–2,400 B.C. (Talbot and Richens 2009:269).

Many of the components served as residential camps, seasonal residences, and long-term residences as indicated by the presence of shallow pithouses and brush structures associated with robust artifact assemblages (Talbot and Richens 2009). Large animal procurement was more common during this period than during the two earlier periods, and grasses, leafy greens, cactus species, and Cheno-ams were the focus of plant species processed. No cultigens or pollen from cultigens were associated with these features. The more intensively used loci contained a variety of artifact types that included ground stone, projectile points, bifaces, drills, and other tools. Diagnostic projectile points clearly associated with these components included McKean Lanceolate, Elko Side-notched, and Gypsum types. Throughout the Sand Hollow Archaic occupation all but one piece of obsidian (N=56) was obtained from the Panaca Summit/

Modena source. This hints that the foraging groups were tethered to the St. George Basin and their territory did not extend far beyond the Modena obsidian source located 70 miles to the northwest.

The most substantial structure excavated during the first Sand Hollow project (Talbot and Richens 2009)—Structure 20-5—was located in the dune area in Component 20. A 2-sigma calibrated date range of 1,370–1,013 B.C. was obtained from charcoal, and the oval semi-subterranean structure measured 4.7 by 3.9 m. The deepest point in the basin-shaped floor was 80 cm below the prehistoric surface. A scatter of FCR and ground stone covered the compacted sand floor and artifacts associated included an Elko Side-notched point, a biface, scraper, two hammerstones, a utilized flake, and a bone awl. A hearth and a roasting pit were located in the floor of the structure and three possible postholes were identified. One was located near the structure's center and two were placed around the structure's perimeter. Eleven pollen samples processed from the floor of the structure contained evidence that grass seeds were processed and sage was used to build the structure. Charred goosefoot seeds were collected from the hearth. Despite the plentiful evidence of economic plants processed in the structure, no evidence of cultigens was present.

Winslow (2011) reported on OPA and Bighorn Archaeological Consultants's second Sand Hollow excavation project for the Sand Hollow Resort Development Project. Three possible brush shelters (Features 38, 90, and 137) and four thermal features associated with the Late Archaic occupation were excavated at sites 42WS3554 and 3559. Feature 38 yielded a date range of 2,130–1,900 B.C. from a habitation feature that was a circular charcoal stain. The structure measured 2 m in diameter and it lacked a hearth or postholes. A pollen sample collected from this feature contained starches that indicated that barley/rye, wild potatoes, and maize were processed. No mention in the report was made of associated artifacts or other materials. Feature 137 measured 4 by 4.9 m and was a shallow basin-shaped charcoal stain, which also lacked a hearth or postholes. Two manos were recovered from the floor of the feature and maize starch and grass pollen were reported from one of these manos. No other artifacts were mentioned in the feature description. Feature 137 was occupied sometime between 1,370 and 1,080 B.C., and a third habitation feature, Feature 90, was occupied between 1,400 and 1,130 B.C. Feature 90 consisted of a circular basin-shaped charcoal stain that measured 1.5 m by 90 cm. Because of its size it was identified as a possible brush shelter, and it was associated with debitage, bone, and ground stone, but lacked a hearth or postholes. A pollen sample from the feature yielded cattail, grasses, and "cultivated beans." Since none of these features contained hearths or postholes, their identification as habitation features should be considered tentative. Furthermore, without actual burnt cupules, cobs, or pollen from cultigens, it is our opinion that the starch evidence should be considered "possible" evidence of early agriculture until maize starch identification techniques are widely accepted. Maize starch identification techniques are still under development, and the presence of starch cultigens should be verified by additional analysts.

Coral Canyon's sand dunes also yielded evidence of a shift to greater site permanence including brush shelters (Roberts and Eskenazi 2006). Sites 42WS1221 and 1222 both contained hearths, abundant ground stone, and at 42WS1221 a well preserved brush shelter with a deep interior hearth located near the entry. An AMS date on charcoal from this shelter (Feature 1) produced a date range of 2,460–2,200 B.C. The excavated feature measured 3.5 by 1.8 m in diameter, and was approximately 10–15 cm deep (Figures 10 and 11). Eight shallow postholes were identified around the perimeter of the dark stain. The fill of the structure was dark and ashy with flakes and a few pieces of ground stone and faunal bones. The floor was uncompacted sand, and it was defined during excavation only by the disappearance of the feature fill. When excavated, the structure

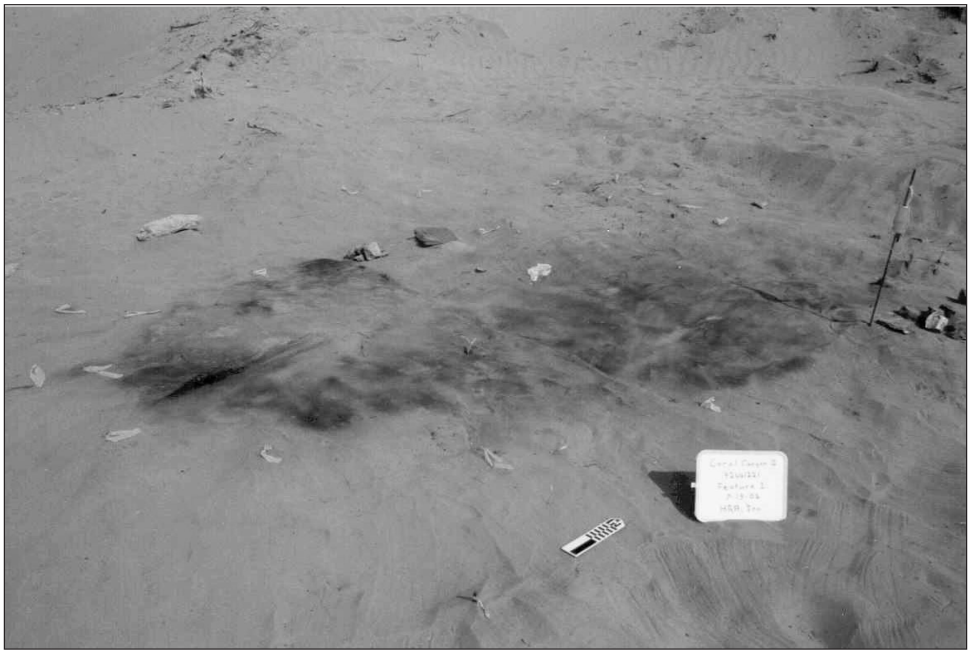

Figure 10. Brush Shelter (Feature 1) at 42WS1221, before excavations. Note the post holes indicated by pink flagging.

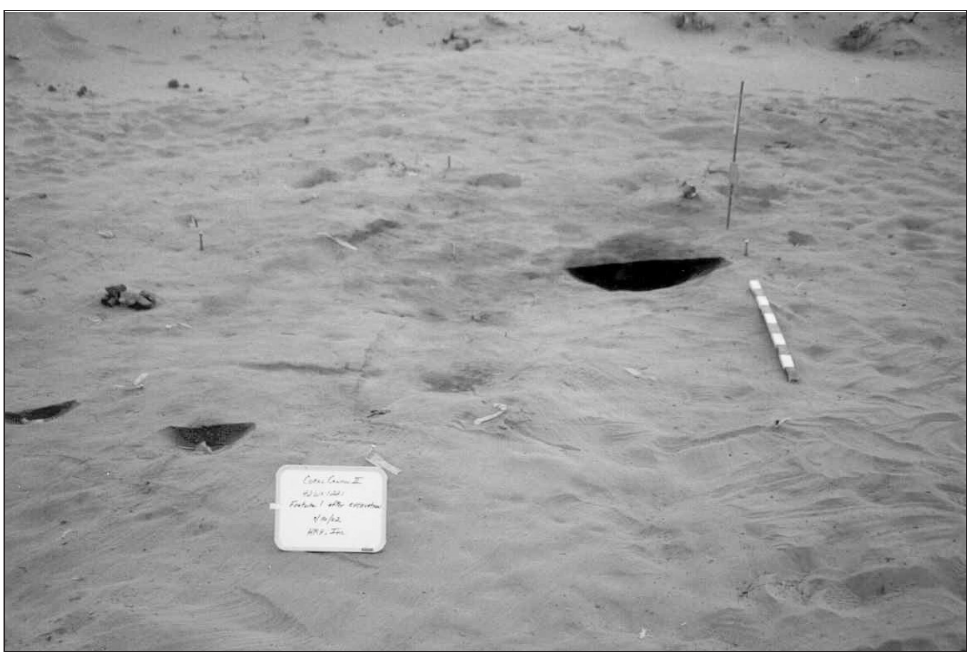

Figure 11. The brush shelter (Feature 1) at 42WS1221 after excavation with the hearth half excavated. The postholes are marked by pink flagging.

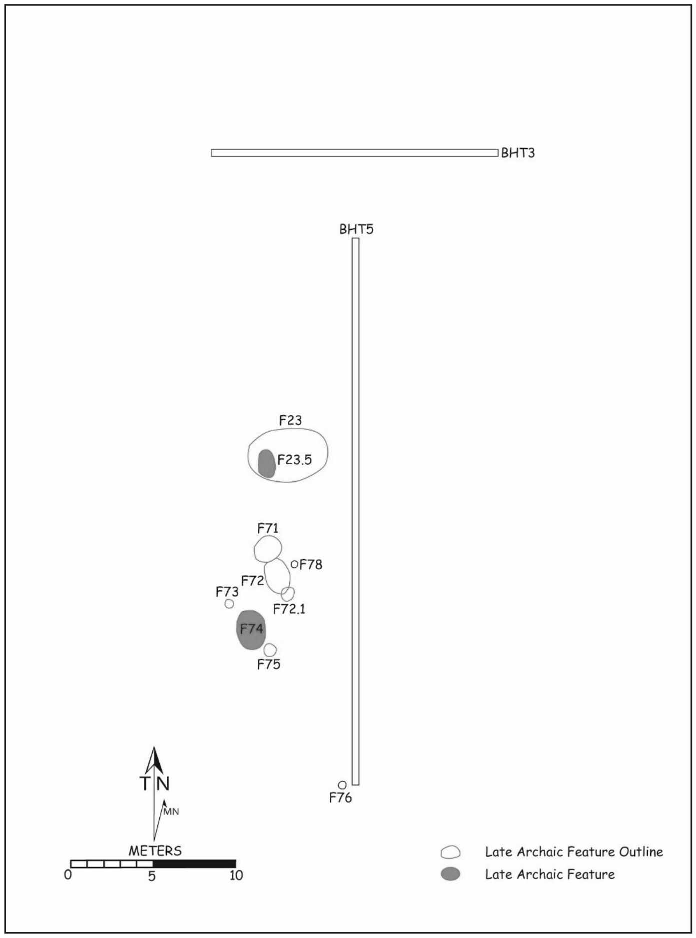

Figure 12. Plan map of 42WS1748, Locus 2, with Late Archaic features labeled in red (solid features were radiocarbon dated).

was a shallow oval-shaped basin. An opening at the north end was indicated by an indistinct sloping edge of the stain and a cluster of artifacts and fire-cracked rocks. No projectile points or other tools were recovered from the fill or floor of the feature.

A macrofloral sample taken from the hearth of Feature 1 suggests that creosote wood was burned as fuel. Two additional flotation samples from the fill and hearth lacked economic plants or seeds; however, the high frequency of sagebrush pollen indicated that the structure may have been made of sagebrush in the mid to late summer when this plant blooms. The fill of the hearth contained a burned jackrabbit bone and the charred structure fill contained calcined small mammal bones.

Three sites in the Warm Springs project area contained components that dated to the Late Archaic period. Locus 1, at the north edge of the Mill Creek Site (42WS1748) contained over 20 roasting pits and hearths, and Locus 2 at the southern end contained brush shelters and thermal features (Figure 12) (Landon and Roberts 2018). At least part of Stratum II at the Churn Zone Site (42WS4718) dated to the Late Archaic period. The brush shelters at the Mill Creek Site were ephemeral, poorly preserved structures, some of which were churned to the point that postholes or even floor hearths were no longer identifiable (Figures 13 and 14).

Thirty-seven flaked stone tools were recovered and analyzed from Late Archaic contexts. These

Figure 13. Photo of Feature 74, a structure at 42WS1748, west half excavated, facing east.

included five cores, five hammerstones, one multi-tool, one pulper, four early stage bifaces, ten mid-stage bifaces, three late stage bifaces, one scraper, one drill, three projectile point fragments, two Elko Corner-notched projectile points, and one Elko Eared projectile point. Quartzite dominated the lithic debitage assemblage, rather than chert used during the earlier period. Warm Spring's Late Archaic ground stone assemblages were large and dominated by grinding slabs and one hand manos. Based on the faunal and paleoethnobotanical data, as during the Middle Archaic, people camped along Mill Creek during the late spring to early summer to trap rabbits and gather chenopod seeds and/or greens during the lean time of year.

Locus 2 of the Mill Creek Site in the Warm Springs project area was located in the southeastern half of the site in a hummock above Mill Creek. This locus contained 15 distinct features, including four shallow brush shelters, several thermal features, and other stains and churn zones. The brush shelters were built in a row, likely one after another, and the thermal features were interspersed between the structures (Figure 12). Two of the structures were radiocarbon dated (Feature 23.5 and 74) and both yielded calibrated date ranges of 1,260–1,050 B.C. The structures varied from 2–3 m in length and were typically oval. They ranged in depth from 10–35 cm and three contained one or two hearths. The hearths were often associated with FCR scatters and were shallow basins that measured approximately 50 cm. Postholes were found in two of the features and no evidence of cultigens was identified in the large flotation samples processed.

A second recent SITLA project that HRA conducted north of the St. George Basin in the Dammeron Valley at the base of the Pine Valley Mountains yielded relevant data on the Late Archaic period (Landon 2017). The project area was located at an elevation of 4,600 feet above sea level east and southeast of the Veyo Volcano. Two of the sites investigated yielded obsidian and projectile points that suggested the sites were used for processing quartzite into bifaces from the area's numerous quartzite outcrops. Site

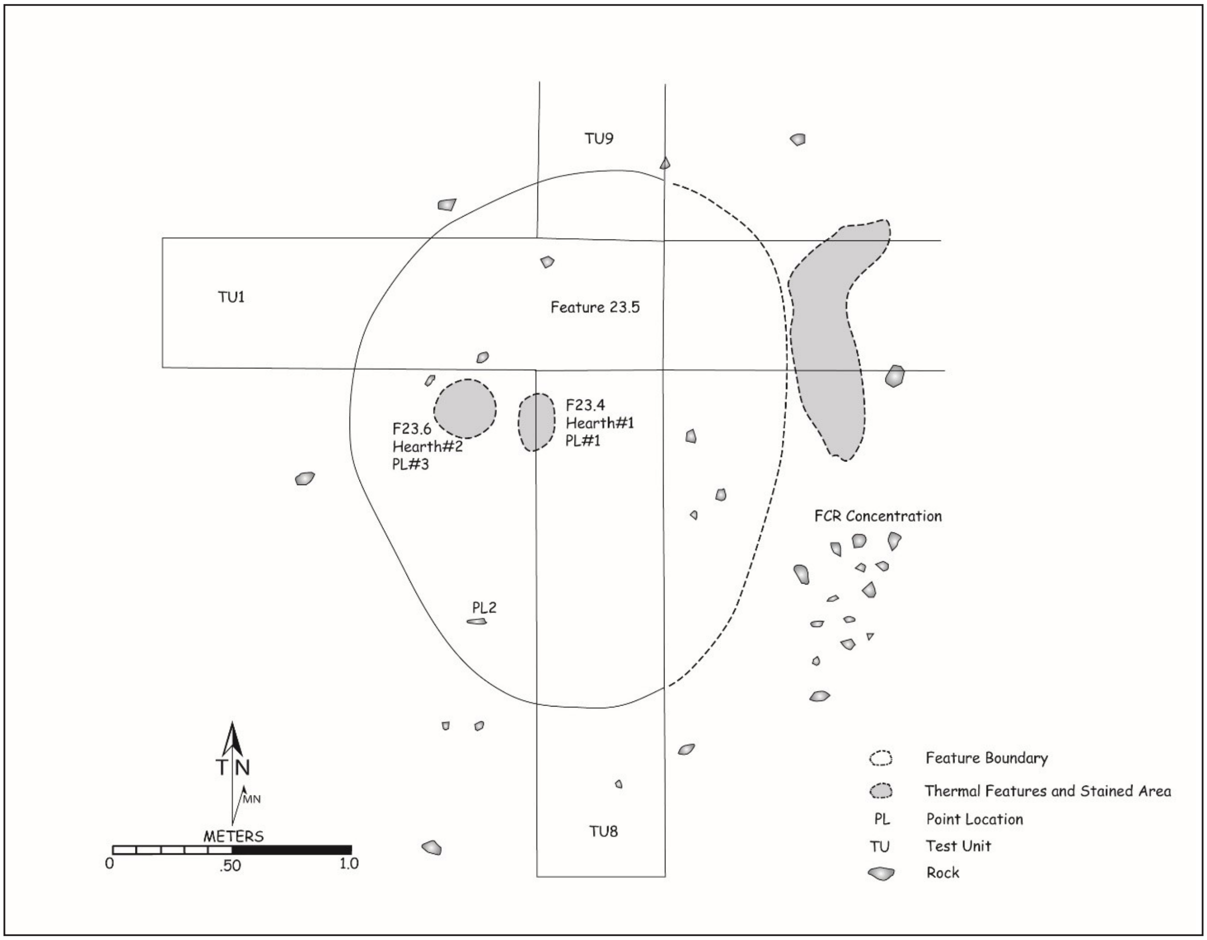

Figure 14. Plan view map of Feature 23.5, a structure at 42WS1748, Locus 2.

42WS4822 also contained a large oval-shaped pithouse that is unique, and possibly built during the Late Archaic period, but unfortunately could not be securely radiocarbon dated.

The structure was a large, deep, oval pithouse that was located in the center of site 42WS4822. The structure's pit measured 7.8 m east-west by 3.1 m north-south, and 2.85–3.05 m deep (Figure 15). The pit was excavated during construction through the caliche substrate and the underlying clay down to a few cm above a natural gravelly stratum (Figure 16). There were two "end chambers" excavated into the west and east walls of the feature, undercutting the caliche. On the northwest corner of the structure, there was a trench built prehistorically into the caliche that did not extend all the way down to the clay stratum. The caliche here appeared to be thicker and significantly less friable than the caliche on the south and east walls, suggesting that they may have intended to dig a more circular structure, and ended up creating more space by tunneling under the caliche, instead. The feature fill consisted of three strata that were very similar in appearance (Figure 16). The uppermost, Stratum III, was brown sandy loam that was moderately compacted (more than the duff layer but less than the undisturbed soil below the duff). Stratum II was similar to Stratum III, but included microlaminae, suggesting that it might have been less bioturbated than the stratum above it. Stratum IV was similar to Strata II and III, but had more gravel and evidence of caliche formation.

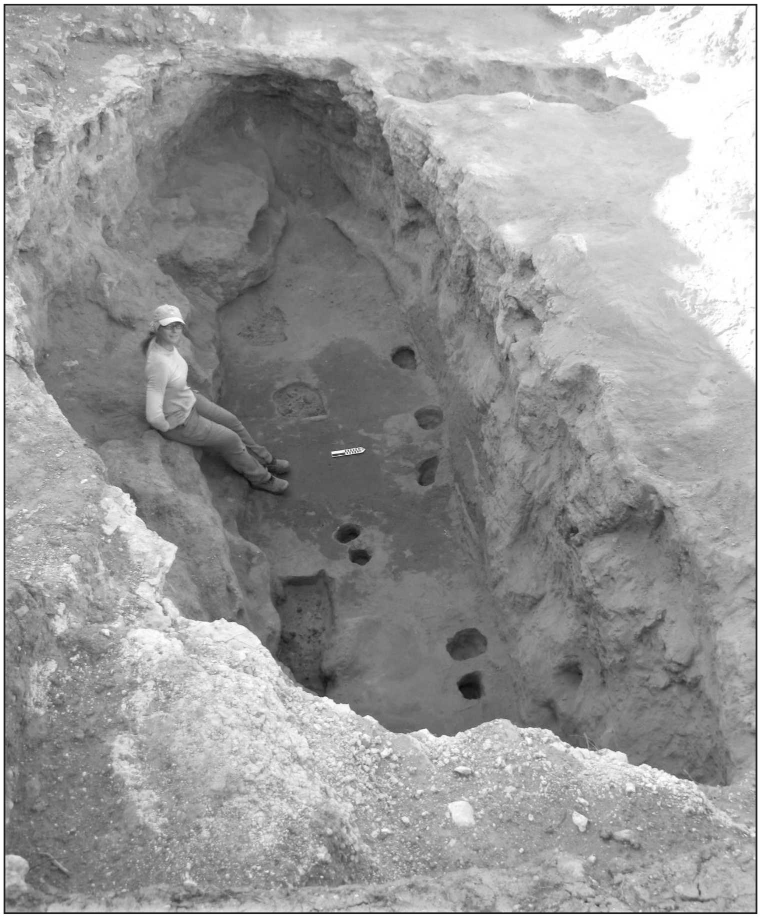

Figure 15. Photo showing the pithouse, Feature 1 at 42WS4822, with the floor features excavated, facing west. Note the postholes along the north wall across from the beam sockets located in the wall behind Amanda Landon

The superstructure was held up by four large beams that were inserted into beam sockets in the southern wall and supported by posts along the northern wall. The beam sockets were large (20 cm in diameter) and located directly across from post holes in the structure's floor. There were also two post holes in the center-east of the structure, which may have helped directly support the roof or the beam that was inserted into socket. The floor postholes sat directly on the semi-cemented gravel bedrock located below the clay and sand layers of the substrate. The floor was built directly onto the clay substrate, just above the sandy, gravelly semi-cemented stratum just below it. There was a thin layer of black and white sand sitting on top of the floor. Besides the post holes, there were three floor features, all of which were pits that had been cleaned out prior to abandonment. None contained charred soil, ash, or charcoal and the flotation samples from these features yielded no charcoal. Twenty-eight quartzite flakes and one mid-stage quartzite biface were found in the floor fill. All stages of reduction were represented in the lithic debitage. Only flaked stone, no ground stone or other artifact types, was found in the floor fill.

The structure apparently was cleaned out just prior to abandonment. The floor pits, one or more of which may have been a hearth, were cleaned out and filled with sand, and any large artifacts

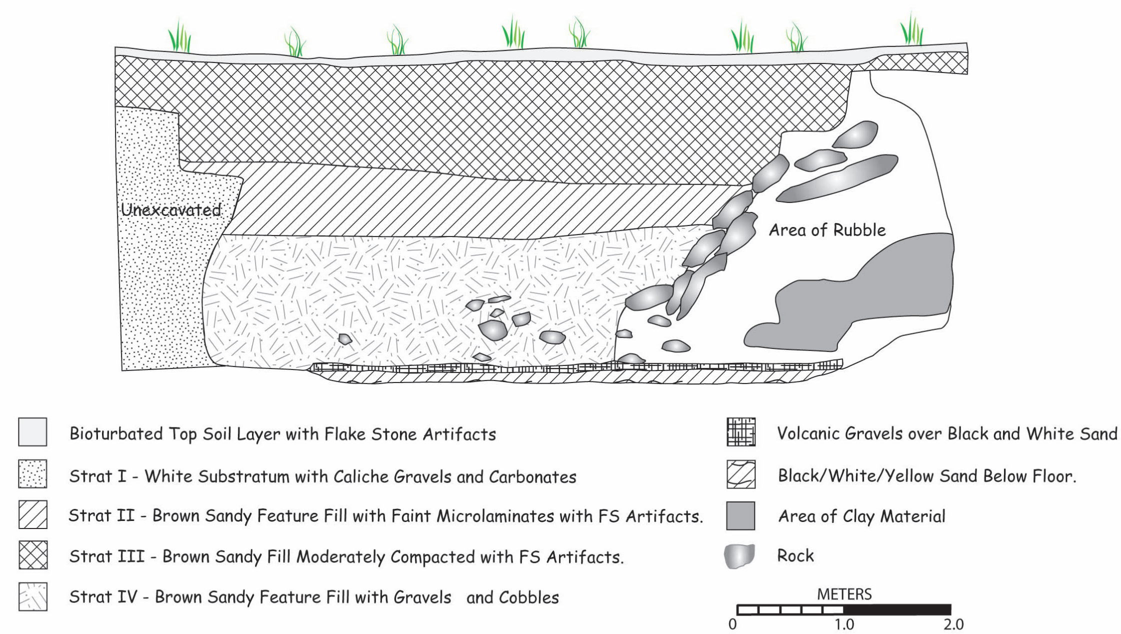

Figure 16. Profile through the center of Feature 1 looking at the south wall showing the natural and cultural strata encountered during excavation.

on the floor were likely removed. Shortly after abandonment, just long enough for 10–20 cm of soil to blow in, the northeastern wall and eastern chamber collapsed, filling the eastern third of the structure with mixed rubble, clay substrate, caliche blocks, and stained structure fill. Soil continued blowing in. The roof may have collapsed after the pit had nearly completely filled in, as suggested by the large quantities of quartzite flakes and tools around the outside of the structure and about 60 – 100 cm below the modern ground surface in the pit. People may have been flintknapping on and around the roof while they lived in the pithouse.

The fill and overburden covering the structure contained 1,384 pieces of mostly quartzite debitage, and 18 flaked stone tools including three early stage quartzite bifaces, 10 mid-stage quartzite bifaces, a scraper, a Gypsum point, a chopper, and a hammerstone. Of these tools, 72.2 percent of them (n=13) were located in the upper levels above 140 cmbs (270 cmbd), the same depth at which lithic debitage counts dropped. These data support the conclusion that people were sitting in the depression left by the pithouse after it filled part way or filled and the fill settled. After the structure filled back in, the area was visited again during the Late Prehistoric period, as evidenced by radiocarbon dates on bone from a bone awl and faunal bone recovered from the general fill that was radiocarbon dated and yielded a calibrated date range of A.D. 1300 – 1430. Over time, the pithouse fill was heavily bioturbated by rodents. During the excavation, we found modern rodent nest debris, such as sagebrush stems and coils of grass, in the screen even as deep as floor level.

Dating the pithouse proved difficult. Landon (2017) collected macrobotanical samples from two stained areas in the general pithouse fill and two of the floor pits. The samples yielded no plant remains, carbonized or uncarbonized. Because the fill was so heavily churned, and the bone fragments were floating far above floor level, we decided to date the sub-floor sand to determine how long it has been since it was last exposed to light. William Eckerle of Western GeoArch Research accompanied us to the site to collect a horizontal core of the sand from the side of the test unit that was excavated into the floor. The core was sent to Tammy Rittenour of the Utah State University Luminescence Laboratory for Optically Stimulated Luminescence (OSL) dating (Landon 2017: Appendix C). The analysis yielded a date of 49.9 ± 6.1 ka (USU1995), or the about 49,900 ± 6,100 B.P. (Late Pleistocene). This pre-dates the arrival of humans to North America by at least 30,000 years. Next Landon submitted the obsidian flakes from the entire site, and the adjacent sites, for both sourcing and hydration analyses. All of the flakes from 42WS4822 came from the Panaca Summit (Modena Area), and had rind measurements that placed them in Seddon's (2005:Table 24-16 c) "Confidently Archaic" interval.

Other lines of evidence that point to the Late Archaic period for the construction of the feature include the Gypsum point located about 10 cm below the surface and floating above the pithouse, and the lithic debitage assemblage, which was nearly 100 percent quartzite. When compared to the well-controlled Warm Springs lithic assemblages, the Late Archaic components there were dominated by quartzite (Landon 2017). The oval shape of the feature also supports a Late Archaic date; however, there are indications that the builders of the feature may have originally attempted to make the feature more rounded and gave up their efforts due to the thickness of the caliche. Although the floor of the feature remains undated, we suspect that it was constructed sometime before the introduction of pottery technology and most likely during the end of the Late Archaic period.

At the southeastern edge of our study area, both Antelope and Rock Canyon rock shelters served as base camps for hunting throughout the Late Archaic period (Janetski et al. 2013). Jackrabbits were the focus of these hunting activities at Antelope Rockshelter and larger mammals at Rock Canyon shelter, which was located in a rocky canyon setting (Fisher et al. 2013; Janetski et al. 2013). At the Jackson Flat project area one site, 42KA6163, yielded a date of 3,600–3,400 B.C. from a large roasting pit buried under a heavily bioturbated midden deposit containing hearths, ground stone, flaked stone tools, and evidence that it was occupied intermittently until 1,700–1,500 B.C. Lanceolate and leaf-shaped dart points were recovered from this midden. We believe that this site likely served as a short-term camp and processing locale for jackrabbit communal hunt that was used for hundreds of years, or possibly intermittently for thousands of years.

The synthesis of this period for the Kern River report (Reed et al. 2005) findings mirror those of Warm Springs, Sand Hollow, Coral Canyon, and Jackson Flat, namely that sites in the eastern Great Basin increase in number during this period, and both thermal features and FCR were more common. Our data suggest that habitation features are more prevalent and substantial. Reed et al. (2005) also observed a shift in hunting focus to larger game; however, in the St. George Basin and Kanab area, this shift is evident only in Sand Hollow and Rock Canyon Shelter.

EARLY AGRICULTURAL PERIOD (1,000–300 B.C.)

Traditional Interpretations

Until recently, the transition to agriculture in the region was not well understood (Altschul and Fairley 1989:100–101; Lyneis 1995:207) and most of the investigated sites with early maize were in rockshelters or caves. Probably the first person to closely examine the transition to agriculture was Berry (1982). He identified a gap in the radiocarbon record around 3,000 years ago, and proposed that San Pedro migrant farmers migrated northward into the unoccupied eastern Great Basin and northern Colorado Plateau. Perhaps the most cited analysis is Matson's (1991) review of the Archaic literature and summarization of the origins of southwestern agriculture. More recently, Spangler (2001) examined the Archaic to Basketmaker transition in the Grand Staircase and Escalante National Monument. As have Geib (1996), Janetski (1993), McFadden (2011), Roth (2016), and Talbot (1998) for the Basketmaker II transition in the Virgin Branch or Fremont regions of southern Utah.

Talbot's synthesis focused on the Basketmaker II architecture and components excavated during the Reservoir project in Hildale (Nielson 1998), plus nine other Basketmaker sites including the Little Jug Site (Thompson and Thompson 1978), Hog Canyon Dune (Schleisman and Nielson 1988), Rock Canyon Shelter (Janetski and Wilde 1989), Antelope Canyon Rock Shelter (Janetski and Wilde 1989), Conaway Shelter (Fowler et al. 1973), the Navajo-McCullough project sites (Moffit et al. 1978), and Cave DuPont (Nusbaum 1922). As he correctly noted in his synthesis, many of these sites were excavated before the use of flotation methods were in general use, and none of the radiocarbon dates were obtained on cultigens.

Despite these shortfalls, Talbot concluded that the Virgin area inhabitants played an active role in the initial Archaic to Formative transition. Maize was present by the first century B.C. and Basketmaker II occupations consisted of "pithouse habitations, in small village settings, by the second or third century A.D., if not earlier" (Talbot 1998: 8.19). He observed a significant cultural transition to pithouse occupancy during the first two or three centuries A.D. when subsistence evidence indicates a shift to agriculture. Later in the Basketmaker II period Talbot observed that pithouses became larger, were rounded, and often had slab-lined hearths or benches. Talbot concluded his review by suggesting that

> the Virgin Anasazi emerged at least in part from an in-migration of early Basketmakers into the Virgin region…At one extreme, we might see the Basketmakers as maize-dependent invaders, outcompeting the *in situ* Late Archaic groups economically or otherwise-perhaps by sheer numbers and established settlement- with the latter groups forced to choose between adaption to the invaders or to abandonment of the area. At the other extreme it is possible to conceive of small groups of Basketmakers gradually and peacefully moving into the region, coinhabiting with, and sharing the resources formerly exploited only by Late Archaic peoples (Talbot 1998: 8.24).

Talbot also suggested that the Virgin area was ideally suited for this early Basketmaker development and he created phase divisions for the period that included the Vermillion Phase (300 B.C.– A.D. 1) coequal to the White Dog Phase in the San Juan area, the Moapa Phase (A.D. 1–400) represented by the Lolomai and Grand Gulch phases to the east. The Reservoir site and DuPont Cave represented this period. He also proposed the Mt. Trumball Phase (A.D. 400–600); which represented the Basketmaker II-III transition and the use of unfired pottery.

Janetski (1993) summarized the Basketmaker II period data from the southern Fremont area and portions of the Virgin Branch culture area in the eastern Great Basin and northern Colorado Plateau. He found that early houses were circular to oval in plan, fairly shallow, and basin-shaped. Some were roofed with poles and brush, and others had central posts and leaners. Many also had entryways or entry chambers. Early Fremont houses contained central clay-rimmed hearths, and houses were shallower early in the period and got deeper toward the later part. Bell-shaped storage pits were used commonly for storage, and maize was ubiquitous. The earliest maize in Utah was recovered from a bell-shaped pit in the Elsinore Burial site located south of Richfield. Radiocarbon dates on maize demonstrate that corn was present in the region by 175 B.C. (Janetski 1993: 236). The bow and arrow arrived in Utah and the eastern Great Basin by A.D. 300; and possibly earlier, around A.D. 200, in the eastern part of the state. These data led Janetski to conclude that the transition to agriculture was a gradual shift from hunting and gathering to farming and the Fremont adaptation followed the Anasazi pattern.

Geib (1996:61) produced a thorough and detailed review of the early Basketmaker sites in the Glen Canyon area of Utah and northern Arizona. His compilation of radiocarbon dates on maize indicated that maize farming began after A.D. 1. However, since many of these maize samples came from sites in upland settings, he acknowledged that they may provide a biased picture of the early history of maize in this region. Geib concluded that the Early Agricultural period in Glen Canyon probably fell into the interval from 400 B.C. to A.D. 500. His synthesis also contained a comprehensive discussion of the cultural associations of these pre-ceramic farming groups including their perishable and nonperishable artifacts, rock art, and burials. He found that the cultural affiliations of early maize farmers in the Glen Canyon region were likely diverse and consisted of at least two cultural traditions that represented "nascent Fremont" and "White Dog Basketmaker" groups of the Western Basketmaker II (Matson 1991). Spangler's (2001) excellent and detailed synthesis mirrored Geib's observations. Furthermore, Spangler noted that:

> The radiocarbon dates associated with residential architecture in the study area correspond generally with the first radiocarbon dates for maize horticulture in the region. However, at least three of the Terminal Archaic pithouses so far documented in the study area appear to have been associated with the procurement of wild resources, not domesticated cultigens (Spangler 2001: 503).

Recent Investigations at Early Agricultural Sites

Excavations at open sites in the Sand Hollow, Warm Springs, and the Jackson Flat Reservoir project area have provided new insights into the origins of agriculture in the region. Unlike the earlier excavated sites, hundreds of flotation and pollen samples have now been processed from the dozens of cultural features excavated and many of the radiocarbon dates were processed on maize. Each of these project areas also contained substantial Late Archaic components with structures, thermal features, and associated artifact assemblages, and early habitation structures associated with radiocarbon-dated maize. Most of the sites with buried components were located in sand dunes adjacent to springs, marshy meadows, or major drainages. Although we now have a detailed record of the transition in terms of architecture, flaked stone, and ground stone artifacts, unfortunately, none of these sites contained perishable artifacts for comparison to Cave DuPont and the region's other basketry and sandal assemblages.

The earliest dates on corn from these recent excavations were recovered from the southern edge of a large habitation site, Eagle's Watch (42KA6165), located in the Jackson Flat Reservoir project area in Kanab, Utah (Roberts 2018). A calibrated date range of 1,310–1,120 B.C. was obtained from maize collected from the base of a large bell-shaped pit built in the center of a small pit structure. This date is substantially earlier than the earliest maize dates recovered from the Warm Springs and Sand Hollow project areas, or for that matter elsewhere north of the Colorado River. Perhaps, even more significant is the contrast between the Early Agricultural component at Eagle's Watch and Jackson Flat's Late Archaic component at nearby 42KA6163 (Locus 2). This Late Archaic site was occupied intermittently between 3,635 and 1,525 B.C. and consisted of a heavily bioturbated midden deposit with artifacts and FCR. Near the base of the midden a large shallow roasting pit and small hearths were discovered and excavated.

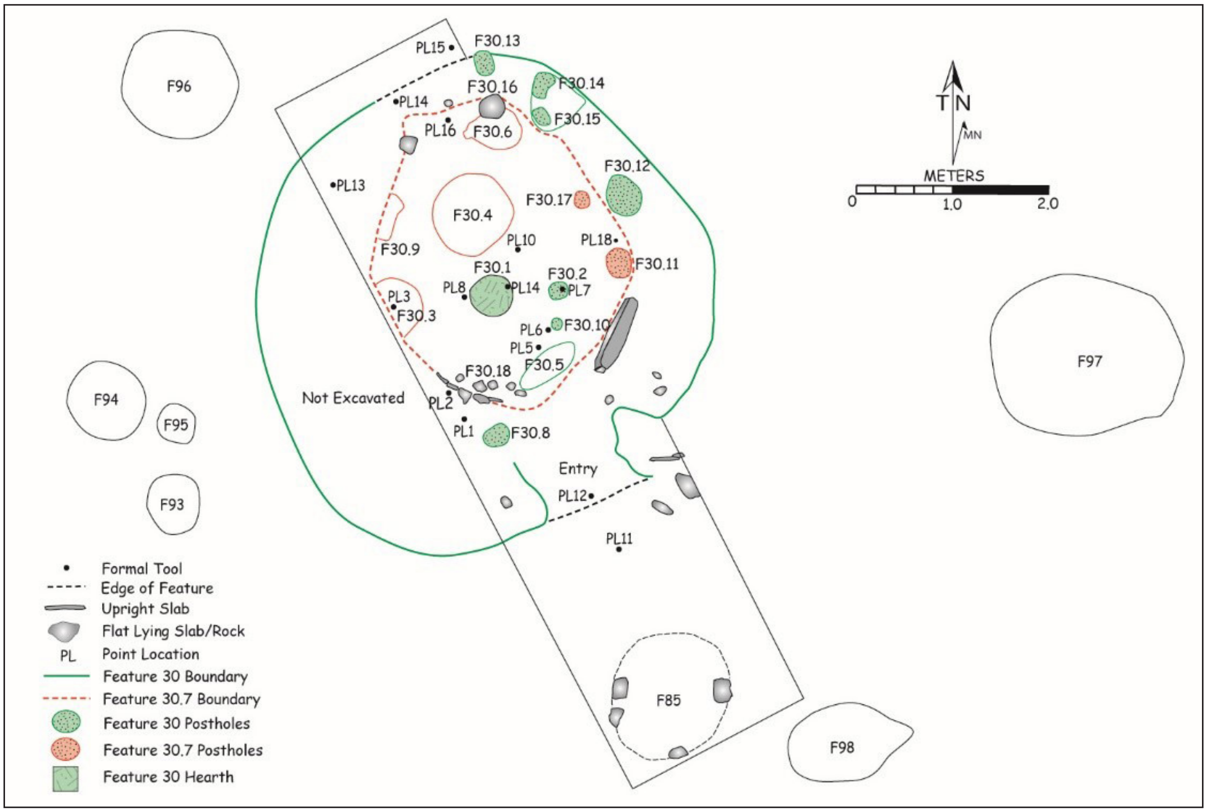

Figure 17. The Early Agricultural Component at Eagle's Watch, Locus 2 in the Jackson Flat project area.

Projectile points were dominated by lanceolate style and leaf-shaped dart points, and other tools included numerous bifaces, scrapers, and grinding slabs. Wild plants were processed in roasting pits and included *Chenopodium* seeds and jackrabbits. Despite an intensive search to locate habitation features, none were identified.

In contrast, the Early Agricultural Component at nearby Eagle's Watch, Locus 2, consisted of a substantial deep pithouse (Feature 30) surrounded by seven extramural features (Figure 17). The extramural features included two large bell-shaped storage pits (Features 94 and 96), a circular shallow slab-lined pit (Feature 97), a rock-filled pit (Feature 85), two hearths, and two small pits of unknown function (Features 95 and 98). Maize cupules and cobs plus seeds from chenopod-amaranth, brome grass, dropseed grass, and purslane were recovered from the six samples processed from the floor, hearth, and bell-shaped pit inside the pithouse. These macrobotanical suggest maize had a higher ubiquity rate in this component than in samples associated with the later Basketmaker II-III contexts (200 B.C.–550 A.D.).

A 2-sigma calibrated date range of 920 to 810 B.C. was obtained on maize and *Fabaceae* collected from the pithouse's central hearth. An earlier date range of 1310 to 1120 B.C. was obtained from maize recovered from the base of the pithouse's bell-shaped pit. The 5 m diameter pithouse was 30–40 cm deep, contained a central hearth, and numerous postholes around the perimeter and in the center. It had likely been remodeled, and the older date obtained from the bell-shaped pit in the structure's floor was associated with this older and smaller structure

(Feature 30.7) that had the bell-shaped pit in the center.

A large and diverse flaked stone tool assemblage was recovered near the floor (in floor or roof fill) or in contact with of the floor of the larger pithouse. Artifacts included an Elko/San Pedro projectile point, a drill made from a similar point, a graver, a polished chalcedony ornament, a bone flesher, and a stone paint pallet, a trough metate fragment, a turquoise object that had been ground on two sides, and a small turquoise cylinder disc bead. The adjacent shallow pits contained several ornaments and artifacts including a Cortaro-like biface, two bone awls, a bone flesher, two spire-lopped *Olivella* beads, one small end-ground *Olivella* bead, one small ring *Olivella* bead, three bone cylinder beads, two green chrysoprase elliptical barrel bead, and debitage. This large and diverse array of ornaments and tools is unique for this time period in the Southwest.

In the Warm Springs and Sand Hollow project areas near St. George the earliest dated maize falls within the first two centuries A.D. and this maize was recovered from formal pithouses. Both structures resembled earth lodges like the Early Agricultural pithouse in the Jackson Flat project area. These round structures measured 5 m in diameter, contained hearths, central posts, and large artifact assemblages. In the Warm Springs sites this shift is particularly evident since dozens of hearths and brush structures occupied prior to A.D. 30, lacked evidence of cultigens and the structures conformed to Late Archaic pattern; namely oval-shaped brush shelters surrounded by numerous hearths and roasting pits. The data from these smaller and more ephemeral brush shelters support a subsistence strategy focused on wild plants and small mammals. Unlike the first pithouses with maize, all of the Late Archaic brush shelters contained small artifact assemblages that lacked diversity.

If one discounts Sand Hollow's evidence of earlier cultigen starches, then the oldest maize from that project area was obtained from a substantial pithouse (Winslow 2010). Like Warm Springs, the Sand Hollow project area's numerous dated thermal features, activity areas, and brush shelters spanned the Late Archaic and Formative periods, yet the earliest association with maize came from the floor fill of a formal pithouse (Feature 79) at site 42WS3544, Area 9. A cob fragment recovered from the structure's floor yielded a 2-sigma calibrated date range of A.D. 130–240. Two other radiocarbon dates processed on wood collected from this feature yielded slightly earlier calibrated date ranges of 30 B.C.–A.D. 260.

The Warm Springs' Feature 79 pithouse was 20–30 cm deep, circular, and measured 5 m in diameter (Figure 18). It contained a central circular hearth, adobe melt along the structure's edge, five postholes, and two possible postholes. The postholes were placed around the edges and at least two were located near the center of the structure. Several manos and metates recovered from the structure yielded cattail and grass pollen. It is not clear why additional macrobotanical samples were not processed from the floor or hearth of this structure to verify the presence of maize. Since only the dated maize sample was collected and no maize pollen was recovered from the feature it is difficult to be certain that the site's occupants were farming the nearby Virgin River floodplain. With that said, this structure is the earliest in Sand Hollow features associated with cupules or cobs, and the pithouse, unlike the earlier structures, conformed to the shape and size of the Jackson Flat and Warm Springs structures

Numerous other sites in the Sand Hollow project areas contained thermal features and artifact assemblages that dated to the early Basketmaker II period, before A.D. 100; however, they were more temporary and resembled Late Archaic and Middle Archaic structures. Two possible structures (Features 142 and 143) were occupied during the early Basketmaker II period between 380 and 100 B.C. in Area 11 of 42WS3544. Both features were circular charcoal stains that measured 3 m in diameter and lacked hearths or postholes. A mano recovered from one

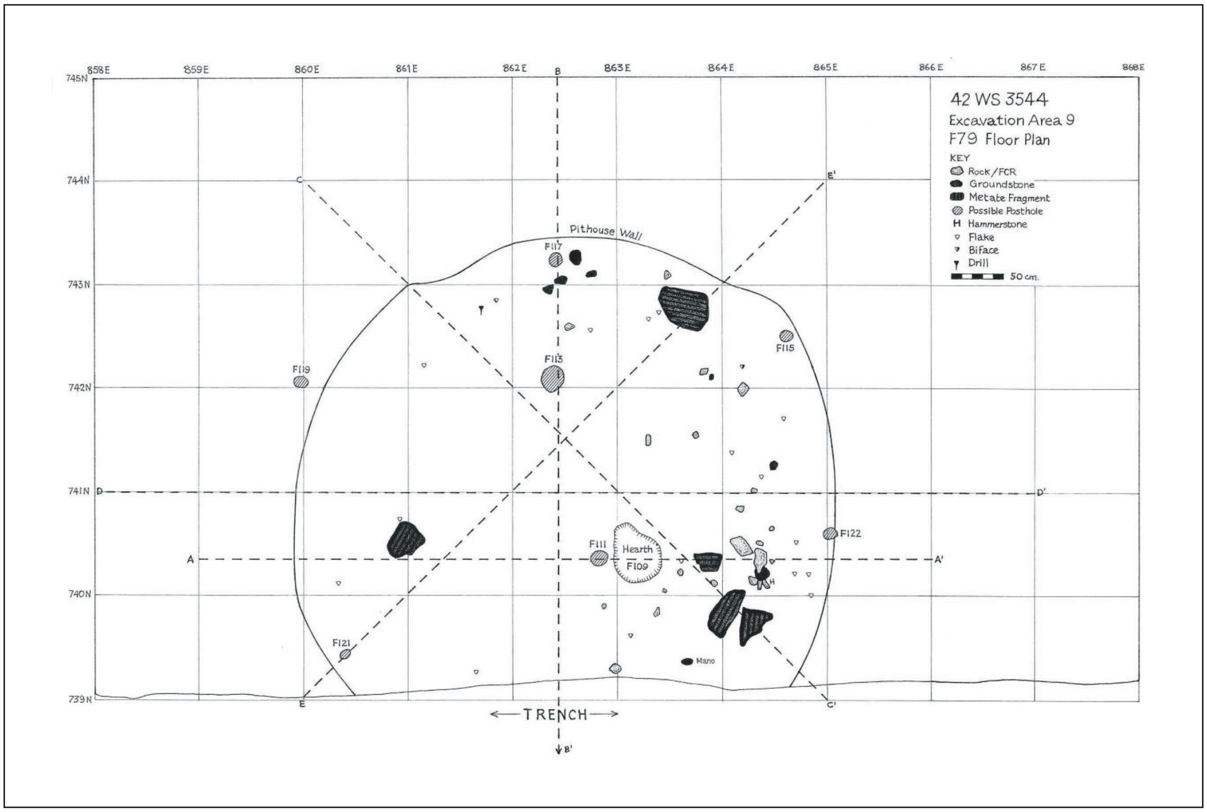

Figure 18. Feature 79/86 a pithouse associated with maize from Sand Hollow (from Winslow 2010: Figure 17).

of the structures was submitted for a pollen wash that indicated wild seeds had been processed.

The Warm Springs components occupied between 900 B.C. and A.D. 30 included an activity area with hearths at the Cut Bank Site, a brush shelter and churn zone at the Brillo Site, and at least two ephemeral structures at Locus 1 at the Mill Creek Camp (Landon and Roberts 2018). No evidence of maize was recovered from any of the numerous soil samples processed from the features that pre-dated the first evidence of maize in the Warm Springs project area recovered from the Obsidian Cache Pithouse site.

Sometime between A.D. 130 and 240, the Obsidian Cache pithouse was built at the southern end of the Warm Springs project area, between Mill Creek and just north of a permanent spring (Figures 19–21). The Green Spring rockshelter site (Westfall et al 1987) was located less than a mile to the west under a sandstone outcrop. Maize kernels and pollen were recovered from multiple contexts within the Obsidian Cache pithouse. This site likely contained additional extramural features; however, only the pithouse was completely excavated. Since the pithouse, and most of this site, were located on private land HRA excavated the pithouse *pro bono* with the help of volunteers. The pithouse measured 5 m in diameter, it was at least 20–30 cm deep, circular, and constructed with four central posts and leaner posts around the periphery (Figure 21). The structure's central hearth was unlined and steep-sided, and it was filled with ash.

Bryce and Roberts (2014) compared the primarily Elko Corner notched projectile points from the Obsidian Cache site to projectile points from five Basketmaker II sites in the Four Corners. These five sites consisted of three single

Figure 19. Obsidian Cache Pithouse after excavation of the southwestern quadrant and before mechanical removal of the overburden.

Figure 20. The Obsidian Cache Pithouse after the overburden was mechanically removed and the top of the structure's burnt fill was exposed, facing east.

Figure 21. Obsidian Cache Pithouse after excavation. Note the central hearth (in front of the small arrow) and four main postholes.

occupation open air habitations on Cedar Mesa including the Leicht, Pittman, and Veres sites; Sand Dune Cave; Kin Kahuna, an extensively occupied open air habitation site both on the Rainbow Plateau; and Darkmold, a habitation site in Ridges Basin of southwest Colorado. In addition, data from two sites, Boomerang and Bent Oak shelters, on Comb Ridge, southeast Utah were also included. The combined collections consisted of 85 projectile points.

Ten attributes were compared including five quantitative—neck width, maximum, minimum, and average notch opening, and width to thickness ratios—and five qualitative—percussion and pressure flaking patterns, notch placement, base form, and cross section. Each attribute was compared between the regions using Chi Square tests with a significance level of 0.05, or 95 percent confidence level. The Obsidian Cache site showed similarities to all of the compared Basketmaker II sites; however, for the quantitative measurements, the Obsidian Cache site showed the most similarity with Ridges Basin, in Colorado, and the least similarity with Cedar Mesa, in southeast Utah. The outcomes for the qualitative measurements results differ, with the greatest similarity between the Obsidian Cache site and the Cedar Mesa area of southeast Utah. Bryce interpreted this to mean that projectile point manufacturing techniques were similar between the St. George Basin and Cedar Mesa, although the resulting forms differed slightly, showing the greatest affinity with the Ridges Basin forms.

In summary, in all three project areas that contained extensive Late Archaic components—Jackson Flat, Sand Hollow, and Warm Springs—the first maize cobs, kernels, or cupules were recovered from substantial pit structures, rather than roasting pits, hearths, or earlier brush shelters. Although the Archaic structures' hearths and extramural features were heavily sampled for cultigens, only wild plants were recovered. The contrast between the habitation features used before and after maize is present is dramatic, and major innovations in architecture and artifact assemblages accompanied maize use.

Because of the dramatic differences evident in all three three project areas, we infer for the following reasons that these first farmers represent a population intrusion, rather than a local Archaic development. First, architecture shifts from oval brush shelters to "true" pithouses. In the Warm Springs, Sandy Hollow, and Jackson Flat project areas the first farmers built round, rather than oval or irregular structures (Figure 22), and these structures were consistently larger. All measured 5 m in diameter, and used four central posts with leaners rather than poles placed around the structure's circumference and joined at the top. Furthermore, the floors in all three structures were excavated at least 20–40 cm below the prehistoric surface, rather than the 10–20 cm depth of the earlier structures.

Second, as Matson (1991) observed elsewhere in the Southwest, projectile points shift from Gypsum/Gatecliff Contracting Stem to San Pedro/Elko Corner-notched types. During the first Sand Hollow investigations components that dated between 2000 B.C. to 300 B.C. and lacked cultigens typically did not have any projectile points or they were associated with Elko Side-notched, Elko Eared, and Gypsum types (Talbot and Richens 2009:188). At Jackson Flat the Late Archaic site was associated with lanceolate dart points. At Warm Springs three of the points were Elko Corner-notched, one was Elko-Eared, and one was a Gypsum point, and most were recovered from the work areas surrounding features. While Elko-corner notched points were associated with the Warm Springs Late Archaic components, Gypsum points are never associated with the Early Agricultural structures, and only rarely with Basketmaker II habitations (none were recovered from the 17 Basketmaker II pithouses excavated during the Jackson Flat project [Roberts 2018]). The quantities of projectile points found in the Late Archaic and Early Agricultural structures also shifted, from none or few points in the Late Archaic period to several at the Obsidian Cache pithouse and the Early Agricultural structure at Eagle's Watch in Jackson Flat. This observation is more difficult to gauge in the second Sand Hollow investigations because the report does not provide detailed artifact associations for many of the features. There may also have been a shift in the Warm Springs area from a hunting focus of small mammals to larger species such as deer, sheep, and antelope. In the Warm Springs project area the dominant tool-stone also changed from chert and quartzite during the Late Archaic period to obsidian in the Obsidian Cache Pithouse site.

Third, formal storage technology, in the form of bell-shaped pits, was associated with the earliest maize from Eagle's Watch. A bell-shaped pit was first built in the floor of the first pithouse (Figure 23) and there were also two large bell-shaped pits located next to the pithouse (Figure 24). No storage features were reported at any of the Sand Hollow sites, in either project area; however, it is possible that the sand dunes were not suitable locations for storage, and maize if grown there, was stored in nearby outcrops or overhangs. Because only the pithouse at the Obsidian Cache Pithouse site was excavated, we do not know if storage structures were used. However, since sandstone outcrops are located nearby, we feel it is likely that storage features were built under outcrops or shelters, rather than in the sand dunes.

Lastly, the first pithouses associated with maize contained a larger and greater variety of tools than earlier Archaic brush shelters. Floor assemblages in the pithouses consisted of numerous ground stone tools, plus bone awls, spatulas, beads made of bone, shell, and stone, drills, and projectile points. Eagle's Watch pithouse was even associated with a trough metate fragment and pigment grinding stone. The larger artifact assemblages associated with these substantial structures provide evidence for less

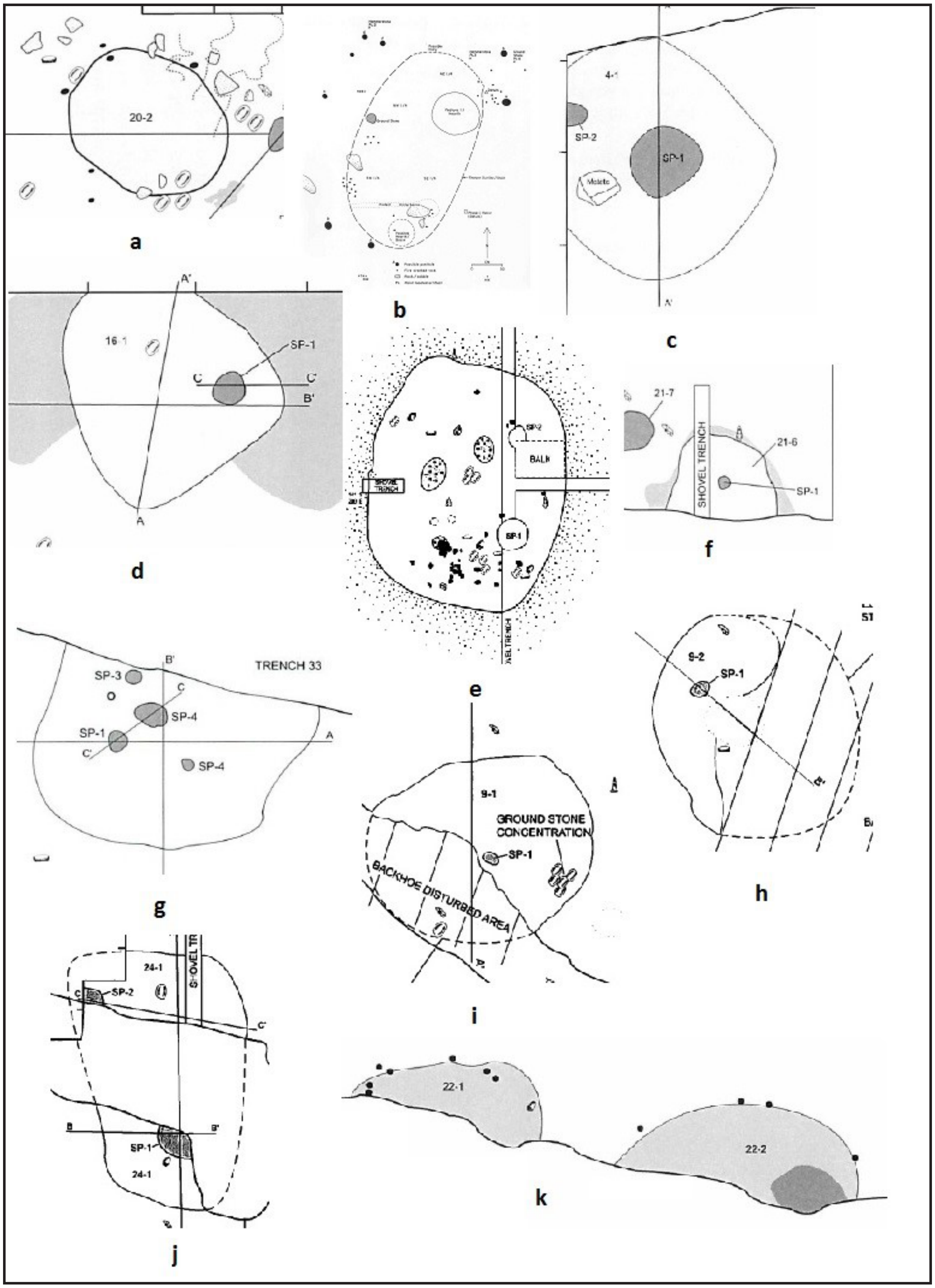

Figure 22. Plan maps of Late Archaic structures from the Sand Hollow and Coral Canyon II projects: (a) Sand Hollow Feature 20-1, (b) Coral Canyon Feature 1, and Sand Hollow Features (c) 4-1, (d) 16-1, (e) 20-1, (f) 21-7, (g) 23-1, (h) 9-2, (i) 9-1, (j) 24-1, (k) 22-1 and 22-2 (Roberts and Eskenazi 2006: Figure 4.10; Talbot and Richens 2002: Figures 5.6, 5.11, 5.25, 5.49, 5.67, 5.68, 5.80, 5.82, and 5.86).

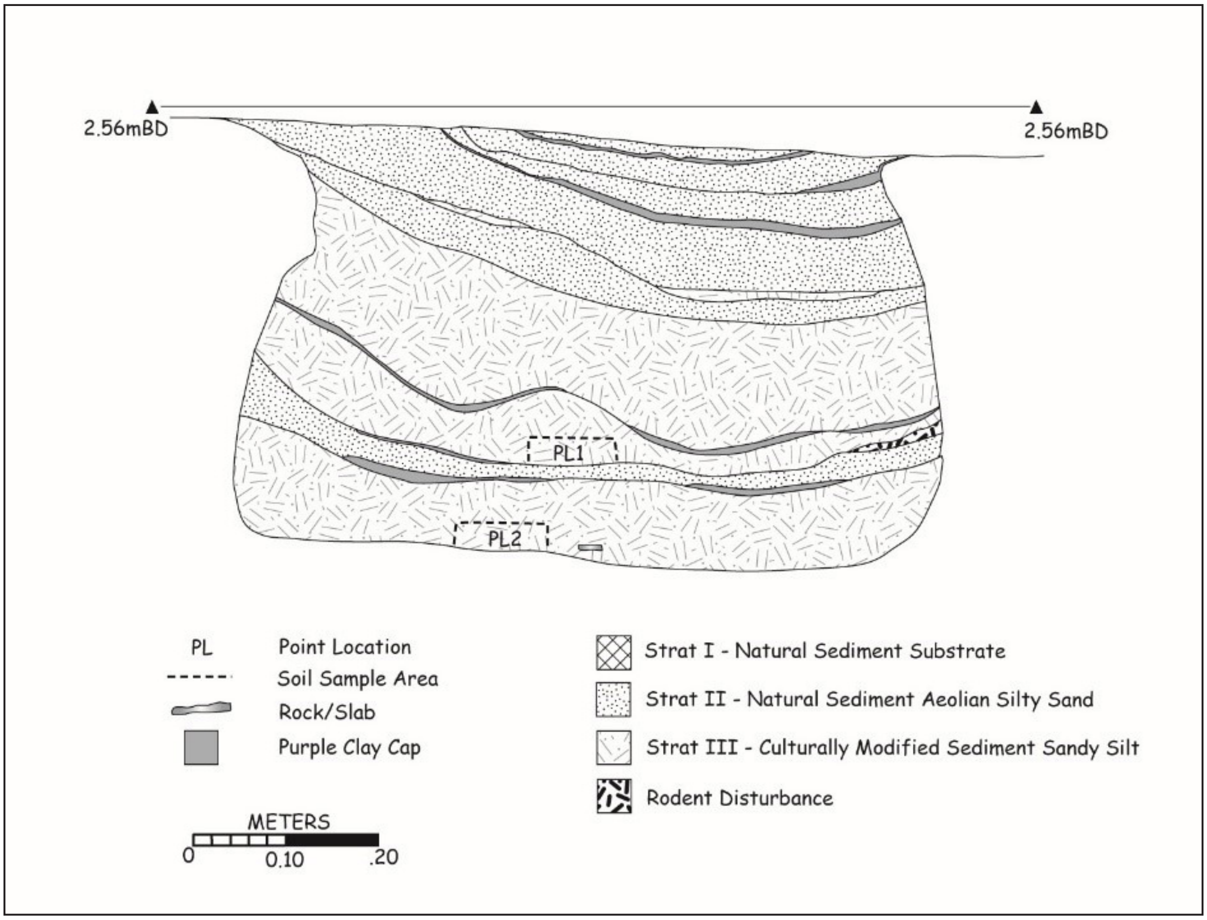

Figure 23. Profile of bell-shaped pit 30.4 in the floor of pithouse Feature 30.7 at Eagle's Watch. Maize from PL 2 was radiocarbon dated.

settlement mobility than the earlier Late Archaic groups.

Where did these first farmers migrate from, and what do we know about the Late Archaic populations after the arrival of farmers? Matson (1991) and Berry (1982) agree that the Western Basketmakers, which include the Virgin Branch, likely developed from a migration of San Pedro farmers from northern Mexico or southern Arizona. Although Berry's model was tethered to the idea that the eastern Great Basin and northern Colorado Plateau was abandoned around 2,500 years ago, Matson proposed that the San Pedro migration occurred several hundred years earlier. Matson believed that since early corn was related to the lowland Chapalote form that the dependency would have begun in the Basin and Range area where it could have been planted in the region's lowland floodplains. The maize would have been gradually acclimated to the lower areas of the Plateau, and then eventually it would have been adapted to direct rainfall farming in the higher areas of the Plateau where soils were deep.

We believe that this pattern can be reconstructed from our data. The San Pedro farmers settled the Jackson Flat project, perhaps they traveled up the Colorado River from southern Arizona, following suitable flood plains in the Mohave Desert where mesquite groves provided a secondary reliable food source. This would have taken these San Pedro groups into

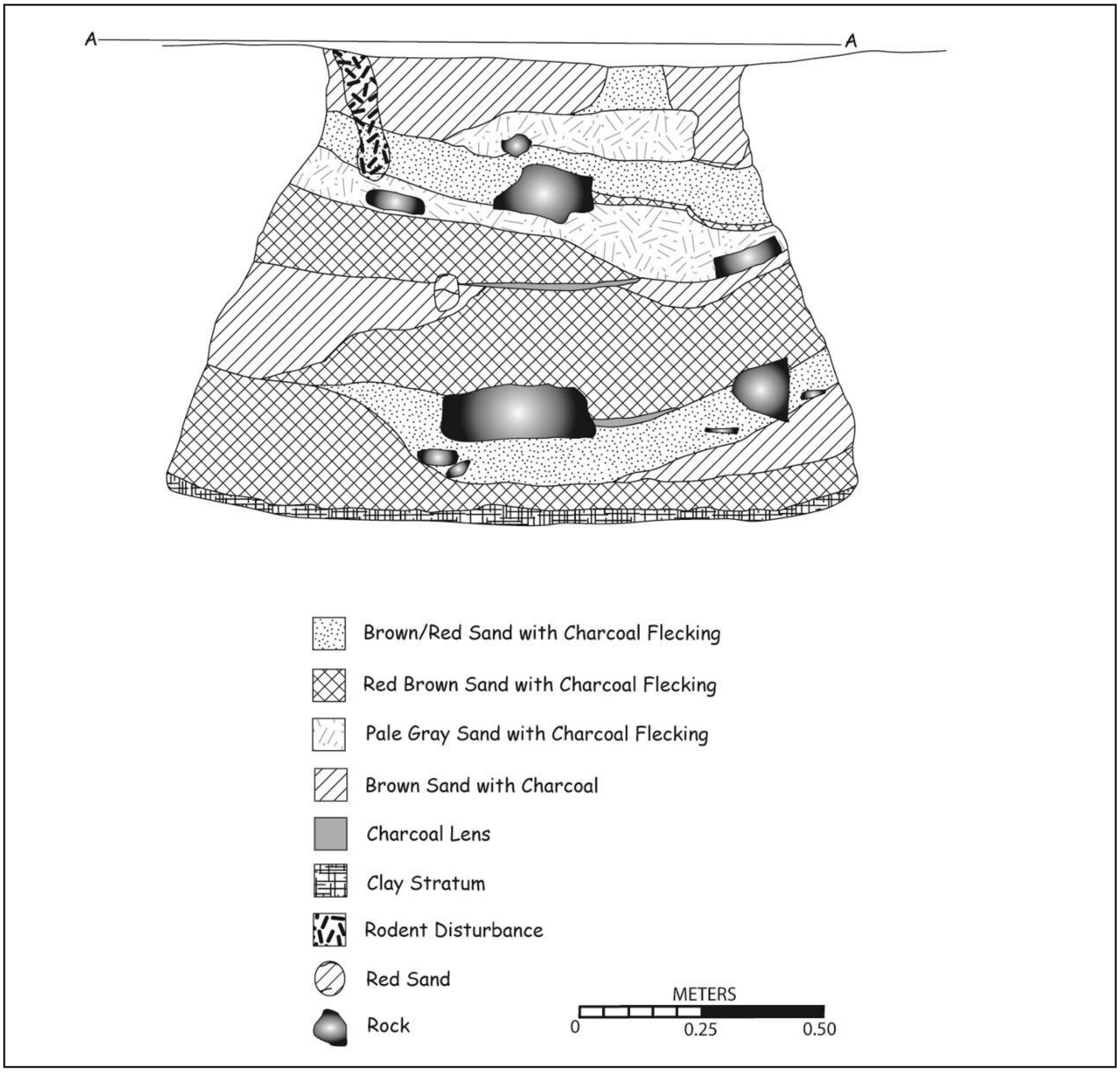

Figure 24. A extra-mural bell-shaped pit (Feature 94) excavated in the Early Agricultural component at Eagle's Watch.

southern Nevada and southwestern Utah. We have recovered the earliest date on maize in Kanab, rather than these areas, perhaps due to sampling biases, but we know that farming was practiced along Las Vegas Wash in southern Nevada by 200 B.C (Ahlstrom 2008). The Basketmaker II pattern was firmly established in the Moapa Valley of southern Nevada by the first century A.D. and populations were large by the second century (Winslow and Blair 2003). Furthermore, Basketmaker II type two-rod-and-bundle basketry was recovered from a cache rockshelter, Firebrand Cave in southern Nevada, has been radiocarbon dated to 1900–1100 B.C. (Blair and Winslow 2006; Webster and Jolie 2011).

The Jackson Flat dates are substantially earlier and fit the San Pedro pattern as described by Matson (1991). In other words, the oldest date of 1300–1100 B.C. was recovered from maize collected from a bell-shaped pit built in the floor of a small pithouse. This structure was expanded and remodeled sometime between 1100 and 900 B.C., and then the project area was abandoned until 200 B.C. Perhaps these first farmers moved elsewhere in the Kanab area until populations expanded and Eagle's Watch was reoccupied. When Basketmaker groups returned to the Jackson Flat project area, between 200 B.C. and A.D. 500, over 17 structures were built at seven different archaeological sites in the Jackson project area. Gradually, storage facilities changed from bell-shaped pits to large slab-lined pits and the overall storage capacity increased dramatically. Houses also underwent changes, as they increased in size, depth, and complexity. By the end of the Basketmaker II period an oversized pit structure was built in the center of Eagle's Watch adjacent to a cemetery (Roberts 2018).

ARCHAIC PERIOD SYNTHESIS

Sourced obsidian flakes (Wild Horse Canyon source) and projectile points (Topaz Mountains) indicate that the region's first Paleoindian occupants were likely affiliated with populations located a considerable distance to the north of the St. George Basin in the Milford Flats and Sevier Desert areas of western Beaver County. We know little about these early groups except that lithic scatters, associated with Clovis, Stemmed, and other Paleoindian points, are concentrated in that region, and extensive use was made of Wild Horse Canyon obsidian and other nearby sources. The presence of numerous fluted points hints that Paleoindian groups hunted large mammals that lived in the region's grassy valleys and along Pleistocene lakes.

The first habitation structures in southwestern Utah date to the Early Archaic Period, and sand sheets were the focus of known activities. A single incomplete structure was excavated during the first Sand Hollow project (Talbot and Richens 2009). It was a sub-rectangular brush shelter that measured at least 2 m in diameter and contained a small assemblage of flaked and ground stone. Several components, containing churn zones, hearths, and nested thermal features that date to this period were also excavated in the Coral Canyon project area. Projectile points are rare in these components and the focus of subsistence activities was small mammals and cheno-ams.

Sites occupied during the Middle Archaic Period include habitation features that have been reported in the Jackson Flat, Warm Springs project area, and Sand Hollow project areas. The structures consisted of oval or circular brush shelters that were built on the prehistoric surface or slightly below (5–15 cm). Most of the structures contained one or more hearths. The well-preserved surface structures located in the Jackson Flat project area were quite large (5 m by 4 m), and contained multiple hearths or warming pits in the interior and exterior. Poles were placed around the structures' perimeters and probably joined at the top. The subsistence focus on cheno-ams and small mammals, particularly rabbits, continued during this period and projectile points are not clearly associated with any of the excavated structures or other features. Ground stone assemblages during this period consist of lightly used grinding slabs and one-handed manos. Since none of these Middle Archaic sites contained temporally diagnostic projectile points, this suggests that without radiocarbon dates, these occupations are virtually invisible.

During the Late Archaic period populations increased substantially in the Warm Springs, Coral Canyon, and Sand Hollow project areas. The Sand Hollow project area was used extensively for hunting of small and large game, and for the collection of cheno-ams and grass seeds. The archaeological evidence suggests that small family groups moved to the sand sheets during the late spring and late summer to gather wild plant seeds and greens and hunt small mammals. Brush shelters were made of sage, and they typically measured less than 4 m in length, and were oval or sub-rectangular and generally shallow. Greens were cooked in rock-filled roasting pits in the Warm Springs project area, and grass seeds were processed in the Warm

Springs and Sand Hollow area. Large game was hunted in greater numbers in Sand Hollow area than in the other project areas investigated. Rabbits and small mammals continued to be the focus of hunting activities in the Jackson Flat, Coral Canyon, and Warm Springs project areas. Most of the Late Archaic components contained extramural features, such as hearths and roasting pits, outside the brush shelters. No storage pits have been reported in any of the excavated sites except for one possible pit in a Late Archaic component in the Jackson Flat project area (Locus 2 at 42KA6163), that may in fact be modern. In well-controlled contexts Elko-eared and Gypsum points dominate the Late Archaic assemblages.

In the Jackson Flat Reservoir project area, the first farmers stored maize and other seeds in bell-shaped pits between 1300 and 800 B.C. The earliest dates on maize in the St. George Basin are much later, namely A.D. 100–200 at both the Warm Springs and Sand Hollow project areas. In Kanab and the St. George Basin these components are situated near wet marshy meadows along small side drainages of Kanab Creek and the Virgin River. The shift to farming appears to have occurred suddenly and was associated with formal pithouse architecture consistent with a four-post superstructure framework rather than the less permanent brush shelters used before 30 B.C. Projectile points shift to Elko Corner-notched/San Pedro dart points and they are usually recovered from the floors of the habitation features.

Before the four-post pithouses were constructed no cultigens or maize pollen (other than starches and one pollen sample at Warm Springs) were identified in the hundreds of features that were excavated, dated, and sampled for both pollen and macrofloral remains. The timing of the appearance of these early farmers occurred several hundred years earlier in the Kanab area than in the St. George Basin. We offer two possible explanations for this delay. The first is that it is related to sample size. If the first agricultural populations were represented by a small migrant group then the probability of locating their habitations is also small. The second is that the original colonization effort was focused in the Kanab area and Kanab Creek's wet marshy meadow, and until populations expanded to levels that the Kanab drainage could no longer support, splinter groups did not migrate west into the St. George and Hurricane Basins until much later.

The dramatic nature of the shift in architecture—from oval or sub-rectangular brush shelters to rounded earth lodges—accompanied by changes in storage behavior, and complex floor artifact assemblages containing numerous projectile points and exotic ornaments, suggests that these first farmers were not local groups who incorporated farming into a foraging lifeway. This observation is consistent with Berry (1982), Matson (1991), and Talbot (1998) belief that migrant farmers settled the region and became the Western Basketmaker. Although Roth's recent synthesis of the agricultural beginnings of the Southwest support the gradual incorporation of cultivated plants, the evidence from southwestern Utah supports a more rapid shift. Our data do lend support to Matson (1991), Berry (1982), and Talbot's (1998) inferences that the Western Anasazi of Arizona and Utah represented immigrant San Pedro/Cochise groups from southern Arizona or northern Mexico. The association of exotic ornaments, including turquoise, shell, and green beads, with the earliest component at Eagle's Watch is unique and raises new questions. This discovery of early corn north of the Colorado River and substantially west of the previously known sites is a game-changer, and it adds new dimensions to migration-versus-diffusion agriculture models.

CONCLUSION

Archaeological Methods and Subsistence Strategies

Prior to the 1990s few excavations in Washington County recovered and processed large flotation samples from thermal features and structure floors. We learned during our Coral Canyon projects that pollen and seed preservation are typically poor because of the abrasive action of sand grains. As a result, older contexts contain fewer seeds than more recent ones. During our most recent data recovery project in the Warm Springs project area Landon and Roberts (2018) collected and processed larger and more numerous macrobotanical samples in an effort to glean some data from older contexts that are poorly preserved. A total of 53 large soil samples recovered from 45 contexts (341 liters of soil) (mostly hearths) were collected and analyzed resulting in two patterns. The first is the use of roasting pits for roasting greens, rabbits, and parching seeds. The second is use of chenopods and wild rabbits during the Middle and Late Archaic, and at the end of the Late Archaic period tansy mustards, grasses, and wild rabbits were more important (Landon and Roberts 2018). New methods, for example starch identification, hold great promise, and when verified may provide information on the initial use of maize in the region.

Locating Buried Cultural Deposits in Open Settings

Another important finding of this synthesis is that diagnostic projectile points were rarely recovered from Middle Archaic contexts in the open sites excavated. Sand Hollow produced more Early and Late Archaic projectile points, but the Middle Archaic period components excavated in all three project areas were not typically associated with temporally sensitive projectile points. This renders Middle Archaic sites virtually invisible without extensive subsurface excavations to locate and radiocarbon date thermal features and structures. Many have noted a decrease in Middle Archaic radiocarbon dated components, which we suggest is a function of visibility (Berry 1981; Geib 2012). There is also a shift from rockshelters to open sites in sand dunes.

The use of new methods to explore buried cultural deposits in sand dunes and other settings is changing our understanding of the Archaic period and the transition to farming. Large numbers of small features, excavated across the landscape can be radiocarbon dated and combined to further our understanding of the past. New methods including mechanical trenching and overburden stripping (Roberts and Herr 2011), flotation of large soil samples from hearth features, and dating techniques including OSL, obsidian hydration, and direct dating of maize have expanded the number of well-dated cultural features available for comparison. The use of mechanical equipment to locate and expose large areas of buried cultural deposits has resulted in the discovery that the region's inhabitants made and occupied surface and shallow pit structures throughout the Archaic period.

Some of the important conclusions we can now draw from these data are that there are no obvious occupation gaps throughout the Archaic Period in southwestern Utah. If habitations and other types of features are used as a proxy for population growth, then it is clear that their numbers increased steadily over time. The assertions that populations decreased during the Middle Archaic and the region was abandoned at the end of Late Archaic maybe a function of population estimates derived primarily from radiocarbon dated rockshelters located in upland settings, above 5,000 ft. on the northern Colorado Plateau (Sudden Shelter 7400 ft. and Cowboy Cave 5,800 ft.). Our summary demonstrates that populations located below 5,000 ft., along the Colorado River's major tributaries, continued to increase and thrive. Most of the sites included in our synthesis are situated in sage flats or valleys and often in sand dunes. Perhaps upland large game populations became stressed during the Middle Archaic period, which was warmer and drier than today and prehistoric groups switched their focus to small game. Technological innovations, for example rabbit nets, accompanied by increasing populations, may have made communal rabbit drives the emphasis of hunting activities. Or, perhaps population levels reached a point where group hunting activities became feasible. This could account for the dearth of projectile points and the prevalence of ground stone. Because rabbit meat is low in fat, the bones were typically ground on slabs and boiled to extract the fat. Lastly, our data suggest that the shift to farming was sudden and probably represents migrant groups, from the south, as Matson and others have suggested. ■

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Settlement-Subsistence Strategies and Economic Stress Among Fremont Groups in the Sevier Desert

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Archaeological investigations at four sites in the Sevier Desert of western Utah indicate a change in Fremont use of dunal environments after A.D. 1000, with settlement-subsistence strategies shifting from short-term logistical processing camps focused on collecting seeds and hunting small game to seasonal residential occupations where intensive jackrabbit processing occurred. The post-A.D. 1000 settlement-subsistence practices represent a departure from the emerging pattern of Fremont use of sand dunes, and may be a result of resource depression and economic stress caused by increasing human populations. Evidence of decreased residential mobility and a decline in foraging efficiency after A.D. 1000 suggests families may have been forced to intensify foraging in the agriculturally marginal sand dunes of the Sevier Desert because more favorable farming locations were unavailable due to population growth.

Fremont culture developed in the eastern Great Basin and on the northern Colorado Plateau with the introduction of maize during the first century AD. Although maize was central to Fremont socio-economic systems (e.g., Bettinger 2002:4; Talbot 2004:87), Fremont culture can be characterized by behavioral variability in adaptive strategies (Barlow 2002, 2006; Coltrain and Leavitt 2002; Coltrain and Stafford 1999; Madsen 1989; Madsen and Simms 1998; Nash 2012). The diversity of Fremont behavior is represented, in part, by Fremont use of dunal environments in the western deserts of Utah, where short-term occupations containing ephemeral brush structures are associated with the collection of plant resources and small-game hunting. Fremont sites recently excavated by Desert West Environmental, LLC (DWE) fall into this emerging pattern of use of dunes during the Fremont period.

In 2015, DWE excavated Scorpion House (42MD3406), the Bunny Massacre site (42MD3775), the Visquine Burrito site (42MD3776), and the Trench Mania site (42MD3777) in advance of the proposed development of a brine storage pond at the Sawtooth NGLs, LLC (Sawtooth) facilities north of Delta, Utah (Figure 1 and 2). Located in the Sevier Desert of western Utah, the Sawtooth sites represent Fremont use of the dunal environment spanning nearly the entire Fremont period. Fremont use of this area prior to A.D. 1000 consisted of short-term occupations associated with collecting plant resources and hunting small game, which is consistent with other known sites representing Fremont dune occupations. However, after approximately A.D. 1000, Fremont use of the area intensified, as indicated by the presence of pit structures, extensive midden deposits, a large storage pit, and an abundance of highly fragmented jackrabbit bones. The evidence gathered during the 2015 data recovery investigations suggest that changes in the settlement-subsistence strategies after A.D. 1000 were a result of resource depression and economic stress caused by increasing human populations. The Sawtooth sites add to the understanding of Fremont behavioral variability

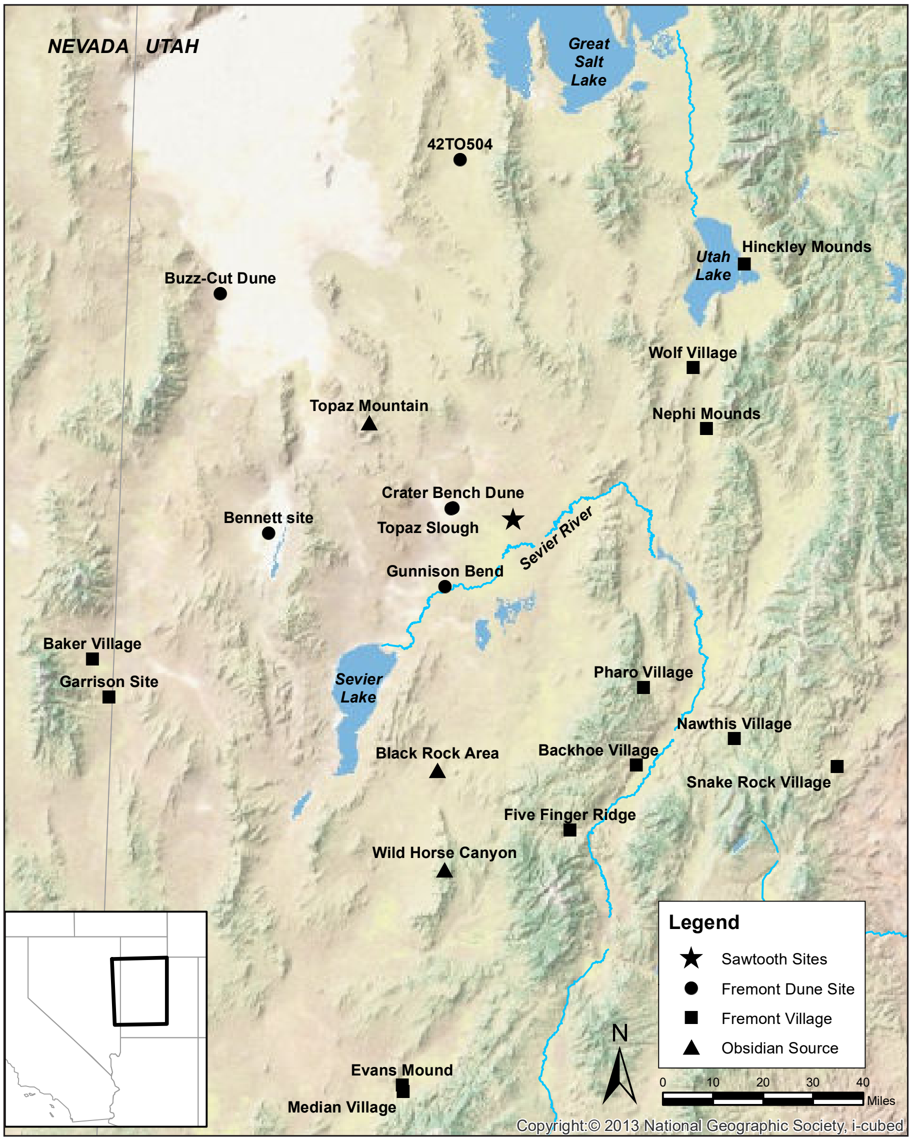

Figure 1. Location of Sawtooth Sites in relation to select Fremont sites and obsidian sources.

by providing a case of intensified use of dunal environments not previously documented in the region.

Background

The Sawtooth sites are situated at an average elevation of 4,650 ft and are located approximately six miles north of the Sevier River and 10 miles west of the Old River Bed that once connected the Sevier Lake Basin to the Great Salt Lake (Figures 1 and 2). The project area was once covered by Pleistocene Lake Bonneville; however, by the time that Lake Gunnison was separated from Lake Bonneville around 12,000 B.P., the water had fallen to 4560 ft, approximately 10 miles west of the project area. As the lake receded, sand dunes formed along the receding beaches and now cover the project area. Interspersed among the dunes are more deflated areas where the alluvial Pleistocene Lake Bonneville deposits

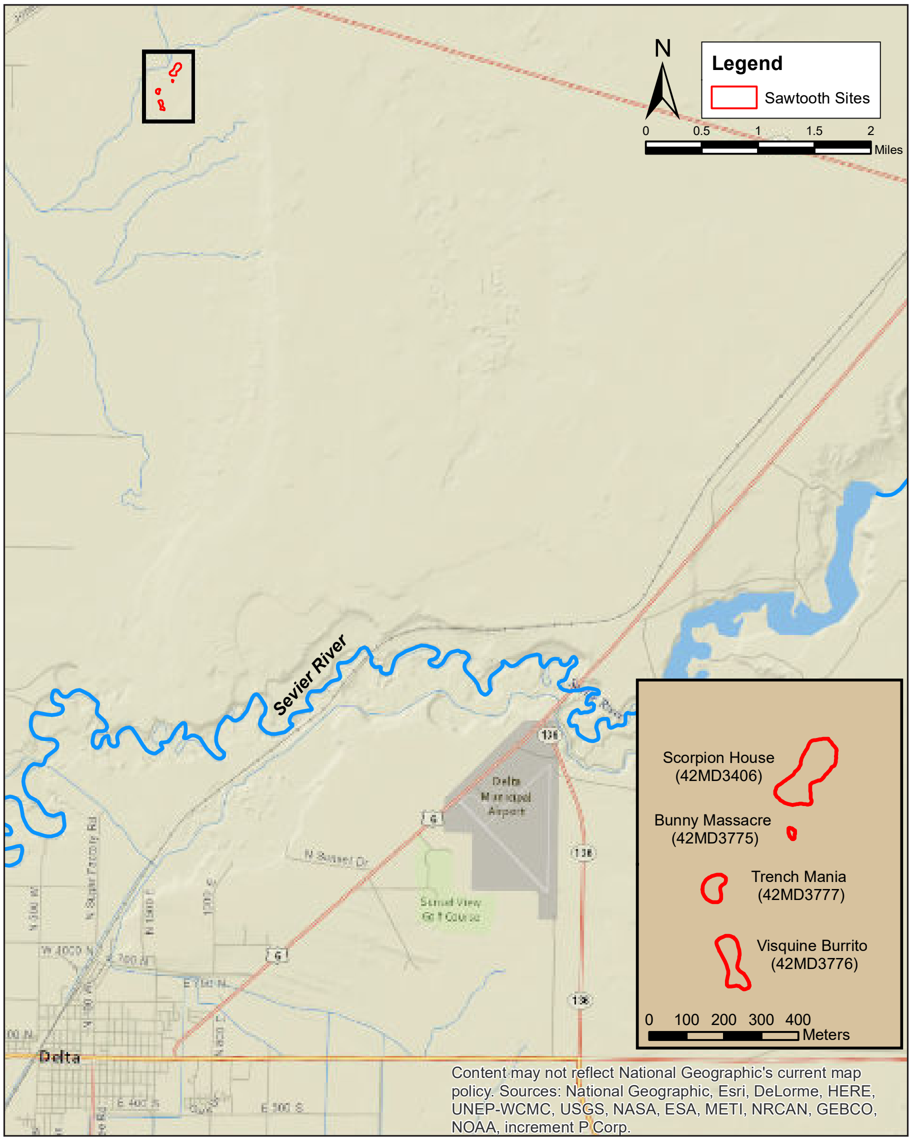

Figure 2. Location of Scorpion House (42MD3406), Bunny Massacre site (42MD3775), Trench Mania site (42MD3777), and Visquine Burrito site (42MD3776).

are either exposed on the present ground surface or just below the surface.

Although seemingly desolate, sand dunes trap moisture and promote plant growth making dunal environments a good source of desert plants with small seeds, as well as small game such as hares and rabbits (Simms 1986:212). The importance of dunal environments is evident from the discovery of light brush, wickiup-type structures at several Fremont sites dating to between A.D. 400–1300, including 42TO504 (Smith 1994), the Bennett site (42MD1052) (Shearin 1995), Buzz-Cut Dune (42TO1059) (Madsen and Schmitt 2005), Crater Bench Dune (42MD3285) (Yoder 2013), Gunnison Bend (42MD3014) (Yoder 2013), and the Topaz Slough site (42MD742) (Simms 1986) (Figure 1; Table 1). Yoder (2014) has provided an excellent summary of these sites and has shown that dunal environments played an important role in Fremont subsistence and

Table 1. Botanical and Faunal Remains Indicative of Human Use at Fremont Dune Sites with Structures.

Site	Approximate Dates	Maize	Botanical Remains	Faunal Remains
42TO504	A.D. 600–900	1 Cob	Cheno-ams, Peppergrass seeds (*Lepidium* sp.), Reed (*Phragmites*)	None
Bennett site (42MD1952)	A.D. 600–1300	1 Kernel	Cheno-ams	None
Buzz-Cut Dune (42TO1459)	A.D. 900–1150	None	Pickleweed (*Allenrolfea* sp.)	[Total n=552] 321 Jackrabbit/ Lepus-sized, 83 Rodent (variety of species), 18 Artiodactyl (deer, bighorn sheep, antelope), 1 Cottontail, 2 Bird
Crater Bench Dune (42MD32385)	A.D. 450–650	None	Cheno-ams, Bulrush (*Scirpus*), Saltbush (*Atriplex*)	None
Gunnison Bend (42MD3014)	A.D. 800–1100	1 Kernel	Saltbush (*Atriplex*), Cheno-ams, Ricegrass (*Achnatherum hymenoides*), Dropseed grass (*Sporobolus*), Little Barley grass (*Hordeum pusillum*), Bulrush (*Scirpus*), Sunflower (*Helianthus*)	[Total n=55] 8 Leporidae (hares and rabbits), 5 Cottontail, 1 Jack- rabbit, 3 Rodent, 10 Small Mammal, 1 Duck, 2 Common Teal, 1 Medium Bird, 22 Vertebrate
Topaz Slough (42MD742)	A.D. 1000–1300	1 Cob	Chenopodiaceae (likely greasewood [*Sarcobatus*] or saltbush [*Atriplex*])	[Total n=123] Jackrabbits, Snakes, Ground Squirrels, 1 Vole, 1 Large Mammal, 2 Unidentified Specimens

land use practices. Detailed site descriptions are available in either the original sources or Yoder's (2014) summary for detailed site descriptions, but in general these sites are characterized by relatively light artifact assemblages containing debitage, projectile points, gray ware ceramics, and ground stone as well as multiple types of features, including thermal features, small pits, and activity areas, all found in relatively close proximity to ephemeral habitation structures (Yoder 2013:164, 167). Ephemeral, light brush structures identified at Fremont dune sites typically averaged 2 to 3 m in diameter by 5–15 cm deep, and some were associated with daub (Yoder 2013:164; Yoder 2014:69–70; Smith 1994:55). Most of the structures had no internal features, although structures at Buzz-Cut Dune and Topaz Slough contained hearths (Madsen and Schmitt 2005:59–71; Simms 1986:208). Yoder (2014:70) notes that more substantial structures may have been present at the Bennett site, where two habitations were described as "potential pit structures" (Shearin 1995:3); however, the features were only partially excavated, and no further details were given.

Subsistence activities focused on the collection and processing of plant resources, particularly small seeds (Table 1). Macrobotanical and pollen samples from the Buzz-Cut Dune site were dominated by pickleweed seeds (Madsen and Schmitt 2005:131), and small seeds from the cheno-ams group dominated samples from 42TO504 (Smith 1994:60), Topaz Slough (Simms 1986:212), Crater Bench Dune (Yoder 2013:165), Gunnison Bend (Yoder 2013:165), and the Bennett site (Shearin 1995). Other species identified during macrofossil analyses included peppergrass, bulrush, ricegrass, dropseed, little barley grass, sunflower, and cattail. Maize was also present in small amounts at a few of the sites and has been interpreted by the reporters as food stores transported to the sites rather than food production at the sites. Site 42TO504 (Smith 1994:62) and Topaz Slough (Simms 1986:211) each contained a single carbonized corn cob, while the Bennett site (Yoder 2013:160) and Gunnison Bend (Gabler et al. 2013:271) each contained a single charred maize kernel (Table 1).

Faunal remains were only recovered from three Fremont dune sites containing brush structures, namely Gunnison Bend, Topaz Slough, and Buzz-Cut Dune (Table 1). The faunal assemblages from each of these sites was dominated by hares (*Lepus* sp.) and rabbits (*Sylvilagus* sp.), comprising 45% of the bone from Gunnison Bend (Gabler et al. 2013:268), the majority of bone from Topaz Slough (Simms 1986:12), and 58% of the bone from Buzz-Cut Dune (Madsen and Schmitt 2005:123). Madsen and Schmitt (2005:125) note that the overall paucity of faunal remains at Buzz-Cut Dune is surprising given the rather intensive use episodes represented by features and artifacts on the site. Although, the paucity of bone is lamented at Buzz-Cut Dune, no faunal bone was recovered from either 42TO504 (Smith 1994:64) or Crater Bench Dune (Yoder 2014:64).

In addition to small seeds and jackrabbit bones, the presence of significant quantities of fire-cracked rock (FCR) is typical of Fremont dune sites (Yoder 2014:67–68). At Buzz-Cut Dune, for instance, Madsen and Schmitt (2005:41, 53) noted that the wealth of FCR was the most salient feature of the site, which contained thousands of pieces of FCR as well as at least twenty concentrations. Likewise, Topaz Slough contained numerous FCR concentrations (Simms 1986:208), and thousands of pieces of FCR were scattered across the surface of Crater Bench Dune (Yoder 2014:63). Fire-cracked rock was also reported at 42TO504 (Smith 1994:53) and the Bennett site (Yoder 2014:66); however, no FCR was present at Gunnison Bend (Yoder 2014:67). The abundance of FCR suggests food processing was an important activity at these sites (Yoder 2013:163).

The evidence presented above indicates Fremont use of dunal environments included short-term occupations between a few days to a few weeks, focused primarily on collecting and processing plant resources (mostly small seeds), and secondarily for small-game hunting (mostly hares and rabbits). Yoder (2013:167) notes that "the habitation structures suggest stays long enough to make such an investment worthwhile, but as all are the remains of light, brush wickiup-type features, length of stay was not long enough to justify more-substantial architecture. Only a small number of secondary features are present, and the lack of significant storage features further indicate short occupations." The nature of these sites has forced the question of how these Fremont dune sites so obviously focused on foraging are related to Fremont village sites. Investigations into each of the above-mentioned sites has sought to define whether they represent logistical groups from more sedentary farming villages, full-time foragers interacting symbiotically with farmers, farmers who periodically acted as foragers when farming failed, or some other combination of settlement and subsistence practices that have come to characterize Fremont behavioral variability.

Theoretical Context

Archaeologists have long recognized the Fremont had a mixed subsistence economy that included hunted and gathered foods as well as agricultural products; however, extreme variability in perceived settlement-subsistence strategies has been the source of much debate as researchers have attempted to define Fremont culture (e.g., Barlow 2002; Berry 1972; Madsen 1980, 1982; Madsen and Lindsay 1977; Madsen and Simms 1998; Marwitt 1979; Nielson 1978; Rudy 1953; Simms 1986; Steward 1936; Talbot 2004; Wormington 1955). Fremont sites have indicated that rather than a consistent diet or mobility strategy, "diversity is a hallmark of the Fremont" (Barlow 2006:92). For instance, sites such as Evans Mound and Baker Village have the characteristics of sedentary or semi-sedentary agricultural villages, whereas sites such as Buzz-Cut Dune and Topaz Slough may represent foraging/farming strategies with high residential mobility (Ambler 1966; Berry 1972; Dodd 1982; Hockett 1998; Madsen and Schmitt 2005; Simms 1986; Wilde and Soper 1994).

The discovery of temporary structures at Topaz Slough provided Simms "one missing piece of the puzzle" in his Fremont adaptive diversity model by providing evidence that some Fremont groups may have become mobile during portions of the year or during years of inadequate horticultural production (Simms 1986:206). Similarly, Madsen argued that "a single individual may well have lived the entire range of variation, from full-time farmer in a settled village to full-time mobile hunter-gatherer, in the space of a few years" (1989:27–28). Other possible adaptive strategies posited by Simms (1986) in his model included local foraging to supplement horticultural production at sedentary sites and co-existence of full-time hunter-gatherers alongside horticulturalists. Madsen and Simms (1998) later developed their ideas further in the Fremont Complex model, which was based on four "contexts of selection" including *behavioral options*, *matrix modification*, *symbiosis*, and *switching strategies* (1998:277–291).

The context of *behavioral options* is the notion that neither farming nor foraging is inherently a better subsistence strategy, but that the pursuit of one or the other is a function of local decision making by groups presented with available options (Madsen and Simms 1998:280–282). According to this line of thought, maize farming is "the outcome of a series of forager decisions made at various points throughout the growing season. The aggregate of these decisions result in individuals, households or communities being classified as foragers or farmers, or something in between" (Barlow 2006:97). *Matrix modification* is a subset of changing behavioral options and "emphasizes the impact the appearance of farming has on the settings in which foragers and farmers lived, and on how change in these selective contexts affected the decisions people made" (Madsen and Simms 1998:283). An example of this is Janetski's (1997) study on the Fremont impact upon large game populations in which he concluded that declining foraging efficiencies was ultimately a result of resource depression due to increasing human populations. Madsen and Simms (1998:284) argue that the spread of farming can therefore be "a disruptive force modifying the matrix of selection" since variability in the production of cultigens can ultimately affect the availability of high-ranked wild resources thereby limiting subsistence options.

The contexts of *symbiosis* and *switching strategies* are probably the more well-known aspects of the Fremont complex model. Madsen and Simms (1998:285–288) posit that symbiotic relationships between farmers and hunter-gatherers, consisting of trade in both subsistence resources and exotic items, may account for some Fremont behavioral variability. They also suggest that this variability may result from "the temporary movement out of farming into foraging, and vice versa, by group fission and fusion" (Madsen and Simms 1998:288). Madsen and Simms (1998:289) note that switching strategies in this way is a risk management strategy when foraging may be a more favorable option than continued effort at farming.

The adaptive diversity and Fremont complex models have been enlisted on numerous occasions to understand Fremont use of dunal environments in western Utah. Following development of the adaptive diversity model by Simms (1986) to explain Fremont use of the Topaz Slough site, Smith (1994:62–65) argued that site 42TO504 in Skull Valley provided a similar example of Fremont adaptive variability. Smith stated that the site represented repeated occupation of "one tiny spot in a vast area of seeming sameness" (1994:64) to collect seeds near water and *Phragmites*, and he concluded that Fremont occupants of the site "were either exclusively mobile collectors, trading for corn, or a task group dispatched from a settlement that had partial reliance on horticulture" (1994:65). Similarly, Madsen and Schmitt (2005) applied the Fremont complex model to the Buzz-Cut Dune data, which indicated a focus on collecting pickleweed seeds. They concluded that the low return rate of pickleweed seed collecting suggests a switching strategy between farming and foraging would likely not be attractive unless both the farming and foraging options produced equally low return rates. Instead, Madsen and Schmitt (2005:135) argued that the Fremont occupation at Buzz-Cut Dune may be the result of foragers who had a symbiotic relationship with farmers, given that the suite of artifacts recovered from the site consisted of "material remains both obtained and produced outside the central farming area and obtained in trade with the farmers." Yoder (2013) also focused on material culture in addressing the question of whether Gunnison Bend and Crater Bench Dune were occupied by full-time foragers or task groups from farming villages. Although data from Crater Bench Dune were inconclusive, he tentatively concluded that Gunnison Bend was likely used by task groups from more-sedentary farming villages (Yoder 2013:174).

In Yoder's (2013:169–173) report on Crater Bench Dune and Gunnison Bend, he outlined several criteria for assessing the level of mobility among groups, including production investment of ceramics and ground stone, obsidian sourcing, and the presence of maize. Yoder (2013:169–170) reviews research suggesting an inverse relationship between the degree of ceramic investment and the relative mobility of groups, with reduced investment indicative of higher mobility and increased investment indicative of lower mobility. He notes, however, that application of this theory has produced mixed and inconclusive results in many instances including his own analysis of ceramics from the Gunnison Bend site. For instance, analysis of maximum temper size suggested low investment in ceramic production and a higher level of mobility, while wall thickness and surface preparation both indicated high investment and therefore low mobility (Yoder 2013:170). Therefore, while potentially useful, production investment of ceramics should be combined with other criteria in determining level of mobility. Similar to ceramics, low production investment of ground stone (e.g., slab metates) is typically expected among highly mobile foragers or at sites representing logistical use, whereas more-sedentary farming populations are more likely to use larger, heavier ground stone that requires greater production investment (Yoder 2013:170–172). Obsidian sourcing provides another basis for evaluating mobility (Yoder 2013:172–173). In general, lithic assemblages produced by highly mobile foragers are expected to reflect a more diverse range of obsidian sources than those of more sedentary farming groups. Although sedentary populations can obtain obsidian from distant sources through trade and other means, mobile hunter-gatherers have a larger foraging radius than sedentary farmers and therefore encounter a greater number of obsidian sources. Finally, Yoder (2013:173) suggests that the presence of maize at a site may be more indicative of use by a farmer task group than by mobile full-time foragers; however, he cautions that small amounts of maize at a site may result from foragers gaining access to agricultural products through contact with farmers. In addition to these criteria, expected indicators of reduced residential mobility include high investment architecture, deep trash deposits, storage features, and diverse and abundant artifact and faunal assemblages (Janetski 2007; Kelly 2001; Yoder 2005; Young 1996).

Kelly (2001) used archaeological data from the western Great Basin to examine factors that affect a group's level of mobility. He concluded that "changing regional configurations of food resources and subsequent changes in the returns from different foraging activities play a role in determining whether a foraging group chooses to take advantage of an option to reduce their residential mobility" (Kelly 2001:290). In other words, foragers choose to reduce residential mobility only if moving to another location is more costly. He stressed that changes in the use of one resource area is a function not only of changes in that resource patch but also of changes in the alternatives to that resource patch (Kelly 2001:303). High costs of mobility can therefore be a product of a variety of factors including food distribution, return rates, terrain, climate, and population density. Thus, "sedentism results when the cost of mobility is so high relative to the return rate of the current resource area that sedentism, even with its attendant lowered return rates due to resource depletion, is a better option" (Kelly 2001:290). Foraging efficiency is therefore an important indicator of settlement and subsistence options available to a group.

Optimal foraging theory provides a framework for studying foraging efficiency and identifying factors that affect settlement and subsistence options (Bettinger 1991:83–111; Kelly 1995:73–110). Prey choice models, such as the diet breadth model, have been particularly useful in studying changes in foraging efficiency. In the diet breadth model, available food items are ranked according to the net energy produced per unit of extraction time, that is, the amount of energy captured less the amount of processing time needed to extract that energy, often termed handling time (Bettinger 1991:84–86). According to this model, the highest-ranked food item should always be taken when encountered, and items are added to the diet in order of decreasing rank (i.e., net rate of return) as the search time for higher ranked resources increases (Bettinger 1991:87). Diet breadth can therefore be used to evaluate a group's foraging efficiency and economic welfare. A number of sources provide post-encounter return rates for Great Basin resources (e.g., Simms 1987; Zeanah 2000); however, ethnographic and experimental analyses of post-encounter return rates typically show positive correlations between prey body size and return rates indicating that larger animals (such as deer and elk) nearly always produce higher return rates than smaller animals (such as hares and rabbits) (Broughton 1995; Broughton et al. 2011; Hawkes et al. 1982; Hill et al. 1987; Simms 1985, 1987; Winterhalder 1981).

In California and the Great Basin, prey choice models have been used to investigate resource intensification. These studies have identified a trend of decreasing foraging efficiency in subsistence economies of Late Holocene foragers caused by resource depression resulting from human population growth (Bettinger 1991; Broughton 1994a, 1994b, 2002, 2004; Cannon 2000; Grayson 1991). Janetski (1997), for instance, attributed a decline of artiodactyl populations across the Fremont area to human population increase. Similarly, high elevation sites in the White Mountains of California indicate a dramatic decline in relative abundance of large mammals after about A.D. 800 that appears to result from population growth (Bettinger 1991; Grayson 1991). Bettinger (1991) notes a change in the settlement-subsistence system around A.D. 600 from short-term hunting camps to villages in the alpine zone, and states that the emergence of alpine villages is concurrent with a decrease in the abundance of mountain sheep through time relative to lower-ranked yellow-bellied marmots. Bettinger (1991) argues that the appearance of alpine villages is a result of resource intensification in response to regional population growth, which decreased return rates of lowland subsistence activities to the point where it became cost-effective to use alpine plants and other costly resources such as pinyon and small seeds.

In addition to prey choice models, use of central-place foraging models also inform foraging efficiency and settlement-subsistence options. While prey choice models predict that human foraging efficiency and diet breadth respond to the abundance of higher-ranked resources, these models assume foragers search through a relatively homogenous or fine-grained habitat pursuing and processing prey along the way; therefore, the cost of transporting resources is assumed to be zero (Orians and Pearson 1979). The prey choice model does not account for the fact that many hunters travel far from central places (e.g., residential bases) to hunt and transport prey back to such locations for consumption. Central-place foraging models, on the other hand, suggest that "the further a forager travels from camp, the more restricted his or her choice of resources must become" since "the distance from a residential camp at which a forager can procure resources at an energetic gain is limited by the returns rates of those resources" (Kelly 1995:133–134). Foragers should therefore choose camp locations with the highest return rates after transport. Zeanah (2000) used the central-place foraging model to test Bettinger's (1991) interpretation of alpine land use in the White Mountains. After calculating and comparing transportation costs of upland and lowland resources (particularly tansymustard and mountain sheep), Zeanah (2000:13) concluded that "post-1350 B.P. villagers chose alpine residential locations under circumstances that pre-1350 hunter-gatherers with the option of basing elsewhere would have foresworn as unprofitable." He notes that under low population densities, pre-village hunter-gatherers could choose to move residentially among lowland camps, but that at higher population densities lowland camps were already occupied forcing villagers to camp at alpine locations (Zeanah 2000:13).

The models and concepts discussed above are used here to understand how each of the Sawtooth sites were used during the Fremont period and why Fremont use of the dune environment intensified after A.D. 1000. If the changes in Fremont settlement-subsistence strategies at the Sawtooth sites are a result of resource depression and economic stress caused by increasing human populations, then decreases in residential mobility and foraging efficiency are expected to have occurred between earlier and later Fremont occupations (see Janetski 1997 and Kelly 2001). To test this hypothesis, datasets from the Sawtooth sites are compared to identify indicators of reduced residential mobility in Fremont sites dating after A.D.1000, and data from the faunal assemblages are used to determine whether they indicate a decline in foraging efficiency after A.D. 1000.

Sawtooth Site Excavations

Data recovery at the Sawtooth facilities resulted in the discovery of four Fremont sites, including the Trench Mania site (42MD3777), the Visquine Burrito site (42MD3776), Scorpion House (42MD3776), and the Bunny Massacres site (42MD3775). The project was guided by data recovery plans developed prior to site excavations (McNees 2015; Hutmacher 2015), and the project results were reported in technical format by Nash and Hutmacher (2019).

Trench Mania Site (42MD3777)

Situated on the northern end of a north-south trending dunal ridge, the Trench Mania site consisted of a diffuse charcoal and ash-covered activity area and two thermal features (Figures 3–5). Excavations included 20 backhoe trenches, mechanical stripping of sediments down to the prehistoric use surface, and eight 1 x 1 m test units. The activity area consisted of a 55 cm-thick deposit of lightly stained, ashy- and charcoal-stained silty sand spanning a 48 x 23 m area. The

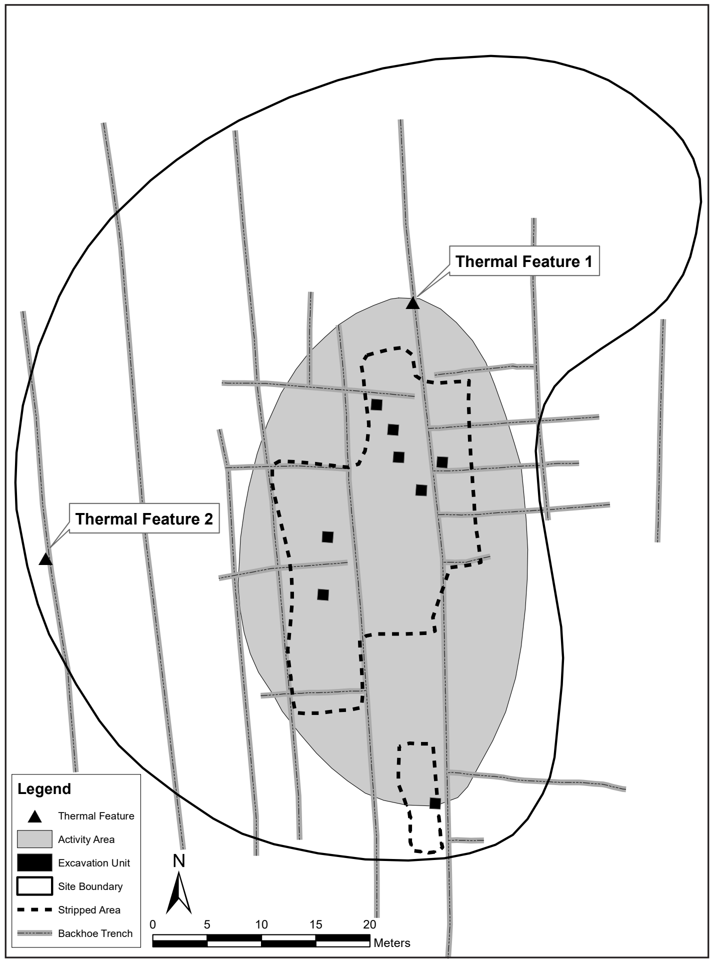

Figure 3. Trench Mania site (42MD3777) plan map.

two thermal features were unlined, basin-shaped charcoal stains that measured 50 cm in diameter. A charcoal sample from Thermal Feature 1 returned a radiocarbon date of A.D. 1015–1155, while a charcoal sample from Thermal Feature 2 dated to A.D. 415–560 (Table 2).

Although a few artifacts were recovered from Thermal Feature 1, the majority of artifacts were recovered from the undated occupation lens. The artifact assemblage consisted of debitage, an Eastgate Expanding-stem projectile point, a variety of other chipped stone tools, gray ware sherds, and one shale bead (Table 3). The small faunal assemblage from the site consisted entirely of hare/rabbit (leporid) and small mammal specimens (Table 4), and a single flotation sample from Thermal Feature 2 contained cottonwood/willow (*Populus/Salix*) charcoal (Table 5; Jones 2016).

The features and artifact assemblage suggest the Trench Mania site was used during the Fremont period for brief occupations focused on the collection and processing of plant and small mammal resources.

The artifact assemblage of the activity area is surprisingly diverse, containing a wide variety of tools typically used in processing plants and animals. Also, the exploitation of local wetlands is suggested by the presence of cottonwood/willow wood.

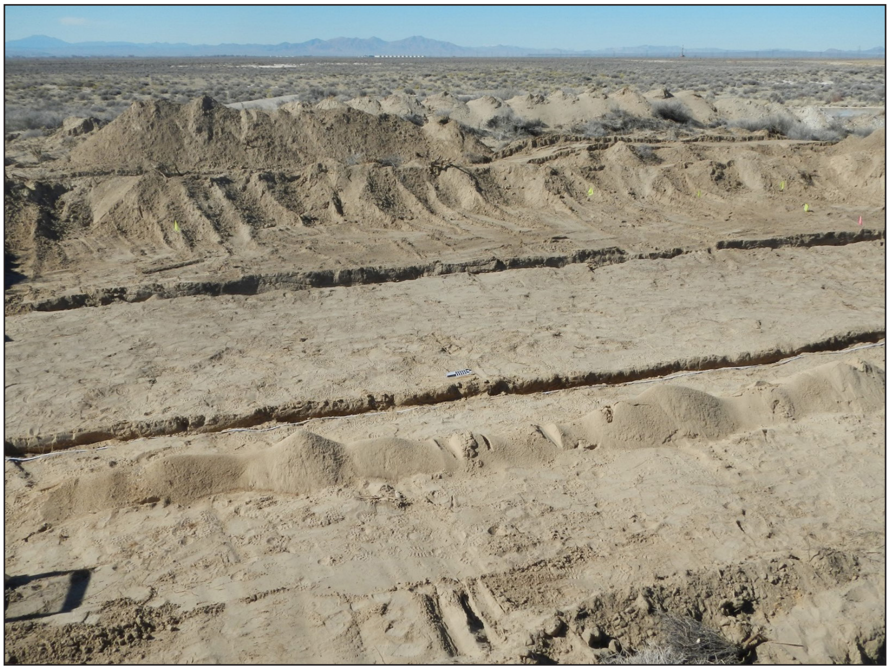

Figure 4. Trench Mania site (42MD3777) overview photo, looking west.

Figure 5. Trench Mania site (42MD3777) overview photo, looking south.

Table 2. Radiocarbon Dates from the Sawtooth Sites.

Site No.	BETA No.	Material	Provenience	^{14}C Age B.P.	2 Sigma Calibration	Intercept(s)
42MD3406	431904	Charcoal	Structure 4, Floor 3	920 ± 30	A.D. 1025–1190	A.D. 1150 A.D. 1080 A.D. 1050
42MD3406	431897	Charcoal	Structure 2, Roof Beam	920 ± 30	A.D. 1025–1190	A.D. 1150 A.D. 1080 A.D. 1050
42MD3406	431898	Charcoal	Structure 3, Hearth	940 ± 30	A.D. 1020–1165	A.D. 1145 A.D. 1140 A.D. 1120 A.D. 1095 A.D. 1045
42MD3406	431903	Charcoal	Structure 2, Floor Pit	940 ± 30	A.D. 1020–1165	A.D. 1145 A.D. 1140 A.D. 1120 A.D. 1095 A.D. 1045
42MD3406	431900	Charcoal	Structure 1, Posthole 2	940 ± 30	A.D. 1020–1165	A.D. 1145 A.D. 1140 A.D. 1120 A.D. 1095 A.D. 1045
42MD3406	431899	Charcoal	Structure 1, Hearth	960 ± 30	A.D. 1020–1155	A.D. 1035
42MD3406	431901	Charcoal	Midden 2	960 ± 30	A.D. 1020–1155	A.D. 1035
42MD3406	431902	Charcoal	Midden 3	970 ± 30	A.D. 1015–1155	A.D. 1030
42MD3406	431905	Charcoal	Structure 2, Hearth	1070 ± 30	A.D. 895–925 A.D. 940–1020	A.D. 985
42MD3406	431893	Wood Artifact	Structure 4, Floor Pit	1090 ± 30	A.D. 890–1015	A.D. 975
42MD3775	431911	Charcoal	Thermals Feature 3	820 ± 30	A.D. 1165–1265	A.D. 1220
42MD3775	431910	Charcoal	Thermal Feature 4	880 ± 30	A.D. 1045–1095 A.D. 1120–1220	A.D. 1165
42MD3775	431909	Charcoal	Midden	910 ± 30	A.D. 1030–1210	A.D. 1155
42MD3775	431912	Charcoal	Thermal Feature 2	900 ± 30	A.D. 1035–1215	A.D. 1155
42MD3775	431913	Maize	Storage Pit	900 ± 30	A.D. 1035–1215	A.D. 1155
42MD3776	431906	Charcoal	Structure	1170 ± 30	A.D. 770–905 A.D. 920–965	A.D. 885
42MD3776	431908	Charcoal	Activity Area	1250 ± 30	A.D. 675–780 A.D. 790–870	A.D. 770 A.D. 740 A.D. 725

Table 2. Continued.

Site No.	BETA No.	Material	Provenience	^{14}C Age B.P.	2 Sigma Calibration	Intercept(s)
42MD3777	431894	Charcoal	Thermal Feature 1	970 ± 30	A.D. 1015–1155	A.D 1030
42MD3777	431896	Charcoal	Thermal Feature 2	1570 ± 30	A.D. 415–560	A.D. 535 A.D. 490 A.D. 465 A.D. 460 A.D. 435

*Radiocarbon dates include both C-14 and AMS dates.

Visquine Burrito Site (42MD3776)

The Visquine Burrito site was situated along the western side of a large north-south trending dunal ridge. Eleven backhoe trenches, mechanical stripping of sediments down to the prehistoric use surface, and hand excavations revealed an activity area with high quantities of FCR and an ephemeral structure (Figures 6–8). The activity area consisted of a 10–20 cm thick layer of charcoal-stained sand and FCR covering an area approximately 10 m in diameter. The structure was completely exposed in plan view but only the west half was excavated as per the data recovery plan. Measuring approximately 3 m in diameter and 10–15 cm deep, the structure consisted of a lightly-stained lens covered by a 5–10 cm thick layer of daub that extended beyond the stain to cover a 5.5 x 3 m area. The structure did not have a central hearth; however, one posthole was identified. Two charcoal samples from the structure and the activity area date the site to between A.D. 675–965 (Table 2).

The artifact assemblage included debitage, gray ware sherds, ceramic spindle whorls, and one slab metate fragment (Table 3). The faunal assemblage consisted almost entirely of leporid and small mammal specimens (Table 4). A single flotation sample from the structure contained saltbush (*Atriplex*) and Rosaceae (rose family) wood (Table 5; Jones 2016).

The ephemeral structure, radiocarbon dates, and artifact assemblage suggest short-term occupation of the Visquine Burrito site during the Fremont period. Site activities appear to have focused on collecting and processing plant resources, as indicated by the presence of FCR and ground stone. The faunal assemblage indicates small game hunting was another focus of activities at the site.

Scorpion House (42MD3406)

Situated in semi-stabilized sand dunes, Scorpion House consisted of one roasting pit, four nested circular pit structures with associated hearths and floor pits, two middens within the structure complex, and one midden on the site surface (Figures 9–13). Excavations at Scorpion House included mechanical stripping of sediments down to the prehistoric use surface and hand excavations. The structure complex was completely exposed in plan view but only the southern half of the structure complex was excavated as per the data recovery plan. However, because of project construction schedule and budget constraints, the southern half of Structures 1 and 2 were not completely excavated. Instead, these two structures, as well as Middens 1 and 2, were exposed in two hand trenches centered on the structure complex. The hand trenches consisted of an east-west trench measuring 4 x 0.5 m and a north-south trench measuring 3 x 0.5 m. Midden 1 was sampled with nine 1 x 1 m test units, and the roasting pit was completely excavated.

The roasting pit was an unlined, circular, basin-shaped stain measuring 2 x 1.5 x 0.5 m

Table 3. Summary of Artifacts from the Sawtooth Sites.

Provenience	Debitage	Flake Tools	Projectile Point	Biface	Graver	Scraper	Abrader	Hammerstone	Core	Ground Stone	Ceramics	Spindle Whorls	Bead	Faunal Bone	**Total**
Trench Mania Site															
Activity Area	114	4	1	10	3	7	1	2	1	-	30	–	1	27	**201**
Thermal Feature 1	16	1	–	–	–	–	–	–	–	–	–	–	–	2	**19**
Subtotals	*130*	*5*	*1*	*10*	*3*	*7*	*1*	*2*	*1*	*0*	*30*	*0*	*1*	*29*	**220**
Visquine Burrito Site															
Structure	29	–	–	–	–	–	–	–	–	1	6	–	–	108	**144**
Activity Area	26	–	–	–	–	–	–	–	–	–	8	2	–	130	**166**
Subtotals	*55*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*14*	*2*	*0*	*238*	**310**
Scorpion House															
Structure 1	–	–	–	–	–	–	–	–	–	–	–	–	–	4	**4**
Structure 2	4	–	–	–	–	–	–	–	–	–	7	–	–	222	**233**
Structure 3	14	–	–	–	–	–	–	1	–	–	2	–	–	132	**149**
Structure 4	66	3	–	2	–	–	–	–	–	–	51	–	4	445	**571**
Midden 1	3	–	–	–	–	1	–	–	1	1	7	–	–	536	**549**
Midden 2	25	1	1	1	–	–	–	–	–	–	46	–	–	1,525	**1,599**
Middens 1 and 2	–	–	–	–	–	–	–	–	–	–	-	–	–	381	**381**
Midden 3	37	–	–	1	–	–	–	1	–	–	13	–	–	511	**563**
Roasting Pit	4	–	–	1	–	–	–	–	1	–	17	–	–	8	**31**
Subtotals	*153*	*4*	*1*	*5*	*0*	*1*	*0*	*2*	*2*	*1*	*143*	*0*	*4*	*3,764*	**4,080**

Table 3. Continued.

Provenience	Debitage	Flake Tools	Projectile Point	Biface	Graver	Scraper	Abrader	Hammerstone	Core	Ground Stone	Ceramics	Spindle Whorls	Bead	Faunal Bone	Total
Bunny Massacre Site															
Thermal Feature 1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	**1**
Thermal Feature 2	–	–	–	–	–	–	–	–	–	–	–	–	–	16	**16**
Thermal Feature 3	–	–	–	–	–	–	–	–	–	–	–	–	–	4	**4**
Thermal Feature 4	–	–	–	–	–	–	–	–	–	–	–	–	–	3	**3**
Thermal Feature 5	–	–	–	–	–	–	–	–	–	–	–	–	–	16	**16**
Storage Pit	47	1	–	–	–	–	–	–	–	–	14	–	–	726	**788**
Midden	9	1	–	–	–	–	–	–	–	–	24	–	–	709	**743**
Subtotals	*56*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*38*	*0*	*0*	*1,475*	**1,571**
Totals	**394**	**11**	**2**	**15**	**3**	**8**	**1**	**4**	**3**	**2**	**225**	**2**	**5**	**5,506**	**6,181**

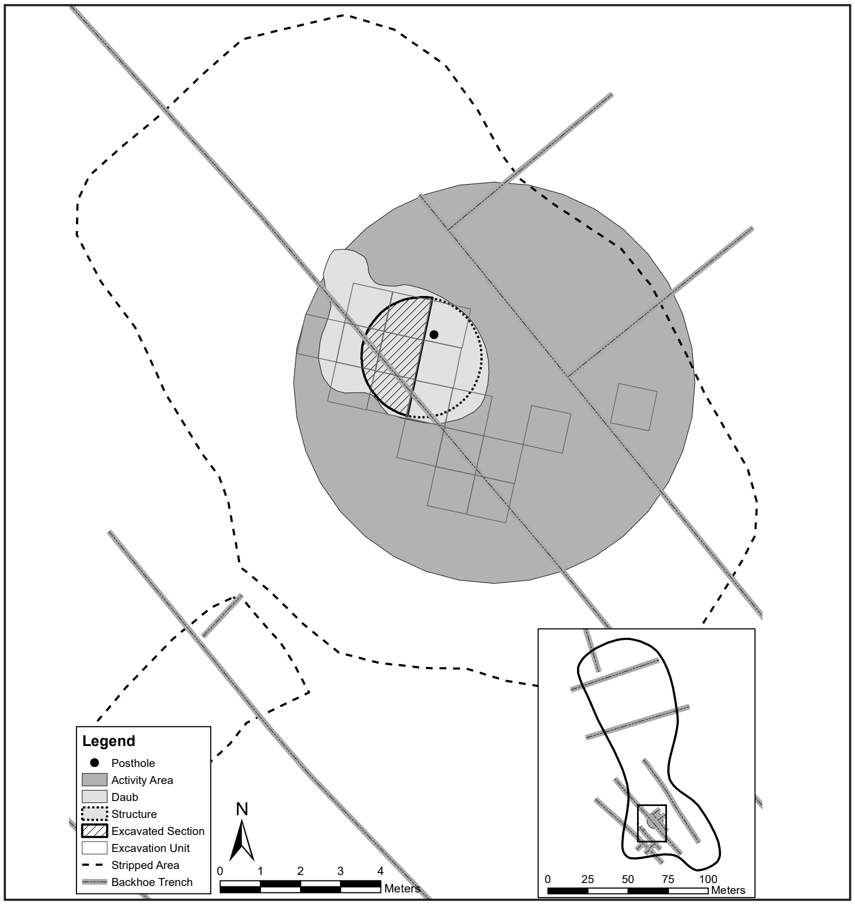

Figure 6. Visquine Burrito site (42MD3776) plan map.

and was located two meters north of the structure complex (Figure 9). The feature fill consisted of charcoal-stained consolidated silty sand that contained a variety of artifacts including debitage, stone tools, gray ware sherds, and small mammal bones (Tables 3 and 4).

The structure complex consisted of consecutive periods of use and abandonment over a relatively brief time during the latter part of the Fremont period between approximately A.D. 1000–1150 (Table 2). Structure 1 represented the earliest occupation of the site, with subsequent occupations represented by floors and associated features within the confines of Structure 1 (Figures 10–11). Structure 1 measured approximately 3.3 m in diameter by 1 m in depth and had vertical to slightly basined walls. The lower half of the structure was constructed into a natural clay horizon; therefore, the walls and floor were clay but were otherwise unprepared. The floor of Structure 1 was exposed only by the two hand trenches, which revealed a central hearth measuring 50 cm in diameter and two centrally located postholes (Figures 10–11). Two radiocarbon assays from the hearth and one of the postholes dated the structure to A.D. 1020–1165 (Table 2). A flotation sample from the hearth yielded saltbush, juniper (*Juniperus*), and cottonwood/willow charcoal as well as an unidentified seed (Table 5; Jones 2016). The limited extent to which Structure 1 was excavated resulted in the recovery of only four leporid bones (Tables 3 and 4).

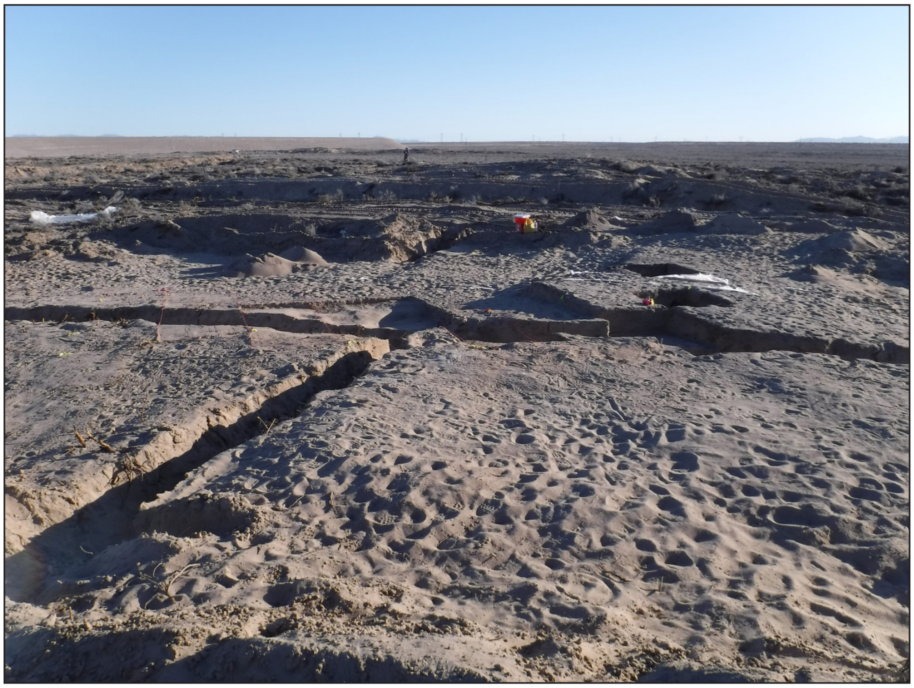

Figure 7. Visquine Burrito site (42MD3776) overview photo, looking northeast.

Figure 8. Structure at Visquine Burrito site (42MD3776), looking east.

Table 4. Faunal Remains from the Sawtooth Sites.

Provenience	Leporidae	Lepus sp.	Sylvilagus sp.	Cricetidae	Thomomys sp.	Dipodomys sp.	Phasianidae	Colubridae	Medium mammal	Small mammal	Microtine mammal	Unidentified mammal	Medium bird	Small bird	**Total**
Trench Mania Site															
Activity Area	2	15	1	–	–	–	–	–	–	9	–	–	–	–	**27**
Thermal Feature 1	–	–	–	–	–	–	–	–	–	2	–	–	–	–	**2**
Subtotals	*2*	*15*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*11*	*0*	*0*	*0*	*0*	**29**
Visquine Burritto Site															
Structure	18	5	1	–	–	–	–	–	–	84	–	–	–	–	**108**
Activity Area	17	3	5	–	–	2	–	–	–	103	–	–	–	–	**130**
Subtotals	*35*	*8*	*6*	*0*	*0*	*2*	*0*	*0*	*0*	*187*	*0*	*0*	*0*	*0*	**238**
Scorpion House															
Roasting Pit	–	–	–	–	–	–	–	–	–	8	–	–	–	–	**8**
Structure 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**
Hearth	3	1	–	–	–	–	–	–	–	–	–	–	–	–	**4**
Structure 2	40	35	–	–	–	2	–	–	–	97	–	–	–	–	**174**
Hearth	4	11	–	–	–	–	–	–	–	30	–	–	–	–	**45**
Floor Pit	-	3	–	–	–	–	–	–	–	-	–	–	–	–	**3**
Structure 3	20	30	–	–	–	–	–	–	–	81	1	–	–	–	**132**
Structure 4	51	44	3	1	–	1	–	–	–	286	–	–	–	–	**386**
Floor 1	27	15	–	–	–	–	–	–	–	14	–	–	–	–	**56**
Floor 3	–	–	–	–	–	–	–	–	–	-	–	–	–	–	**0**
Posthole	–	–	–	–	–	–	–	–	–	1	–	–	–	–	**1**
Floor Pit	–	–	–	–	–	–	–	–	–	2	–	–	–	–	**2**
Midden 1	57	222	–	–	–	1	–	–	–	256	–	–	–	–	**536**
Midden 2	297	464	–	–	1	1	–	–	1	746	13	–	1	1	**1,525**
Middens 1 and 2	79	143	–	–	–	–	–	–	–	156	2	–	1	-	**381**
Midden 3	103	91	–	–	–	–	–	–	–	316	1	–	–	–	**511**
Subtotals	*681*	*1,059*	*3*	*1*	*1*	*5*	*0*	*0*	*1*	*1,993*	*17*	*0*	*2*	*1*	**3,764**

Midden 1 was overlaying the Structure 1 floor and was capped by the Structure 2 floor (Figure 10). This midden deposit consisted of charcoal-stained consolidated silty sand that appears to have been deposited rapidly in a single event given the absence of any micro strata of blow sand or other sediments. The rapid deposition suggests Midden 1 may represent ceremonial closure of Structure 1 at the time of its abandonment. This midden may, therefore, consist of cultural material accumulated during the occupation of Structure 1. Artifacts recovered from Midden 1

Table 4. Continued.

Provenience	Leporidae	Lepus sp.	Sylvilagus sp.	Cricetidae	Thomomys sp.	Dipodomys sp.	Phasianidae	Colubridae	Medium mammal	Small mammal	Microtine mammal	Unidentified mammal	Medium bird	Small bird	**Total**
Bunny Massacre Site															
Storage Pit	209	130	8	–	–	1	1	1	–	344	2	29	–	1	**726**
Thermal Feature 1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Thermal Feature 2	4	1	–	–	–	–	–	–	–	11	–	–	–	–	**16**
Thermal Feature 3	–	–	–	–	–	–	–	–	–	4	–	–	–	–	**4**
Thermal Feature 4	–	–	–	–	–	–	–	–	–	3	–	–	–	–	**3**
Thermal Feature 5	2	1	–	–	–	–	–	–	–	13	–	–	–	–	**16**
Poshole	–	1	–	–	–	–	–	–	–	-	–	–	–	–	**1**
Midden	182	114	4	–	1	12	–	–	1	333	6	56	–	–	**709**
Subtotals	*398*	*247*	*12*	*0*	*1*	*13*	*1*	*1*	*1*	*708*	*8*	*85*	*0*	*1*	**1,476**
Totals	**1,116**	**1,329**	**22**	**1**	**2**	**20**	**1**	**1**	**2**	**2,899**	**25**	**85**	**2**	**2**	**5,507**

included debitage, chipped stone tools, a one-hand mano, and gray ware sherds (Table 3). The faunal assemblage consisted entirely of leporid bones and small mammal bones (Table 4).

Structure 2 was slightly basin shaped, 90 cm deep, and measured approximately 3.2 m in diameter with a thin, prepared clay floor measuring 3 mm in thickness and a central hearth measuring 60 cm in diameter (Figures 10–11). In the southwest quadrant of the structure was a clay-filled floor pit measuring 60 x 40 x 9 cm, and in the southeast quadrant of the structure three burned roofbeams and a bundle of carbonized sticks were found on the floor (Figure 11). The roofbeams measured 30–50 cm in length and were 5–10 cm in diameter. The bundle of carbonized sticks was located underneath the roofbeams as numerous sticks laying parallel to one another in a tight, linear concentration measuring 35 x 10 x 3 cm. The bundle consisted primarily of sagebrush (*Artemisia*) and rabbitbrush (*Chrysothamnus*) twigs, although a few fragments of saltbush wood were present as well as a single reed (cf *Phragmites*) fragment and one carbonized caryopsis from little barley (*Hordeum pusillum*) (Table 5; Jones 2016). The plant species comprising the bundle are all known to have been traditionally used by Native American groups for either food or medicine. Additional macrofossil analysis on a flotation sample from the hearth identified juniper, pine (*Pinus*), and oak (*Quercus*) charcoal, as well as seven maize (*Zea mays*) cupules and a single small plant spine (Table 5; Jones 2016). The faunal assemblage consisted almost entirely of leporid bone and small mammal bones (Table 4). Debitage and gray ware sherds were also recovered from the structure (Table 3). A radiocarbon date from charcoal in the hearth dated to A.D. 895–1020, while two radiocarbon dates on charcoal from the floor pit and a roof beam dated to A.D. 1020–1190 (Table 2). The date from the hearth is earlier than dates from Structure 1, which is stratigraphically older; therefore, the hearth date likely represents an old wood problem. Disregarding the older date

Table 5. Botanical Remains from the Sawtooth Sites.

Provenience	Maize	Macrobotanical	Pollen
Trench Mania			
Thermal Feature 2	None	Cottonwood/Willow (*Populus*/*Salix*)	N/A
Visquine Burrito			
Structure	None	Saltbush (*Atriplex*), Rosaceae (rose family)	N/A
Scorpion House			
Structure 1 Hearth	None	Saltbush (*Atriplex*), Juniper (*Juniperus*), Cottonwood/Willow (*Populus*/*Salix*), Unidentified seed	N/A
Structure 2 Stick Bundle	None	Sagebrush (*Artemisia*), Rabbitbrush (*Chrysothamnus*), Reed (*Phragmites*), Little Barley (*Hordeum pusillum*)	N/A
Structure 2 Hearth	7 Cupules	Juniper (*Juniperus*), Pine (*Pinus*), Oak (*Quercus*)	N/A
Structure 3 Hearth	None	Gooosefoot (*Chenopodium*) seed, Oak (*Quercus*), Rosaceae (rose family)	N/A
Bunny Massacre			
Thermal Feature 2	8 Cupules	Saltbush (*Atriplex*)	N/A
Thermal Feature 4		Goosefoot (*Chenopodium*) fruit, Saltbush (*Atriplex*)	N/A
Thermal Feature 5	3 Cupules	Saltbush (*Atriplex*)	N/A
Storage Pit	2 Cobs, 3 Cupules	Saltbush (*Atriplex*), Sagebrush (*Artemisia*)	Cheno-ams, Poaceae (grasses), Pickleweed (*Allenrolfea*), Greasewood (*Sarcobatus*), Sagebrush (*Artemisia*), Juniper (*Juniperus*), low-spine Asteraceae (ragweed and goldenrod)
Ceramic Sherds from Midden	None	N/A	Cheno-ams, Poaceae (grasses), Desert Buckwheat (*Eriogonum*), Prickly Pear (*Opuntia*), Willow (*Salix*), Narrowleaf Cattail (*Typha latifolia*), Sagebrush (*Artemisia*), low-spine Asteraceae (ragweed and goldenrod)

places occupation of Structure 2 between AD 1020–1190.

Midden 2 deposits overlaid the Structure 2 floor and were capped by the floor of Structure 3 (Figure 10). One radiocarbon assay from charcoal in the fill dated Midden 2 to A.D. 1020–1155 (Table 2), which falls within the expected date range for this midden given other radiocarbon and stratigraphic data. As with Midden 1, the fill consisted of charcoal-stained

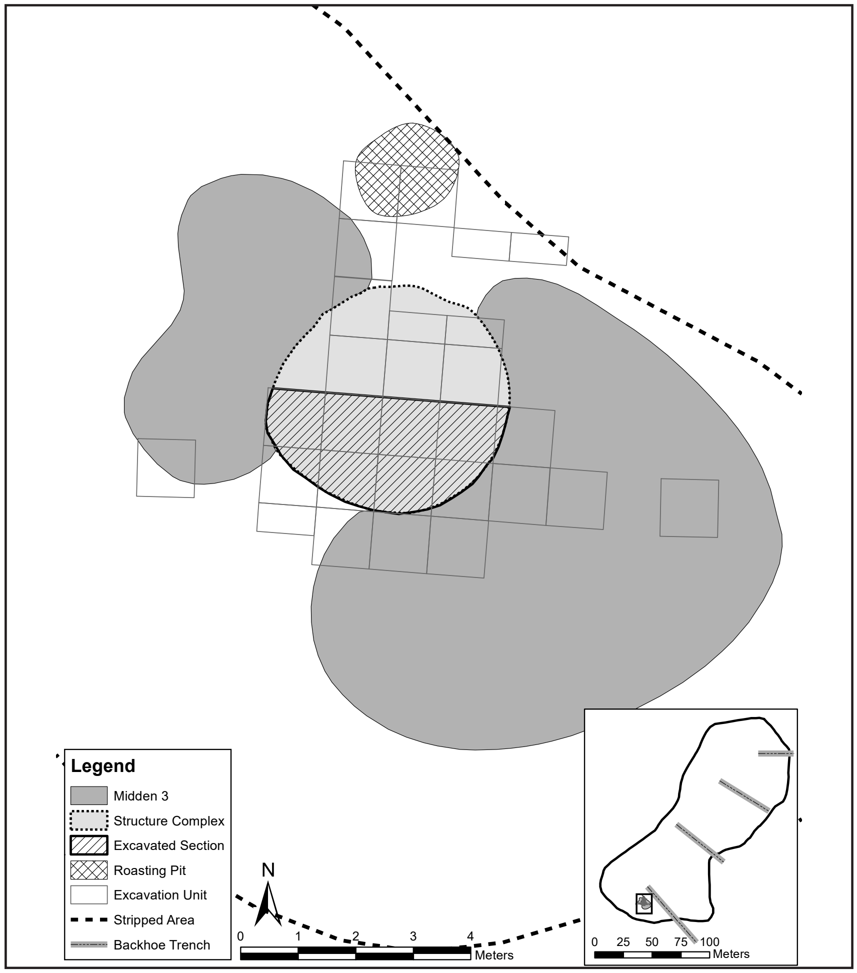

Figure 9. Scorpion House (42MD3406) plan map.

silty sand that appears to have been deposited in a single event, suggesting Midden 2 may represent ceremonial closure of Structure 2 at the time of its abandonment. As such, this midden may contain material culture accumulated during the occupation of Structure 2. The artifact assemblage included debitage, chipped stone tools including an Elko Corner-notched projectile point, and gray ware sherds (Table 3). The faunal assemblage from the midden consisted of over 1500 faunal bones, 99% of which were leporid and small mammal specimens (Table 4).

Structure 3 was basin-shaped and measured approximately 3 m in diameter by 60 cm in depth with a clay floor approximately 5 cm thick and a small hearth slightly off center (Figures 10–11). Charcoal from the hearth dated the structure to A.D. 1020–1165 (Table 2), and a flotation sample from the hearth contained oak and Rosaceae charcoal as well as a single carbonized goosefoot (*Chenopodium*) seed (Table 5; Jones 2016). Over 130 leporid and small mammal bones comprised the faunal assemblage (Table 4), and the artifact assemblage consisted of debitage, gray ware sherds, and a hammerstone (Table 3).

A 10-cm lens of loose, clean sand separated Structure 3 from Structure 4, which was basin-shaped and measured approximately 2.8 m in diameter and 50 cm deep. Structure 4 contained evidence of at least three clay floors (Figure 10),

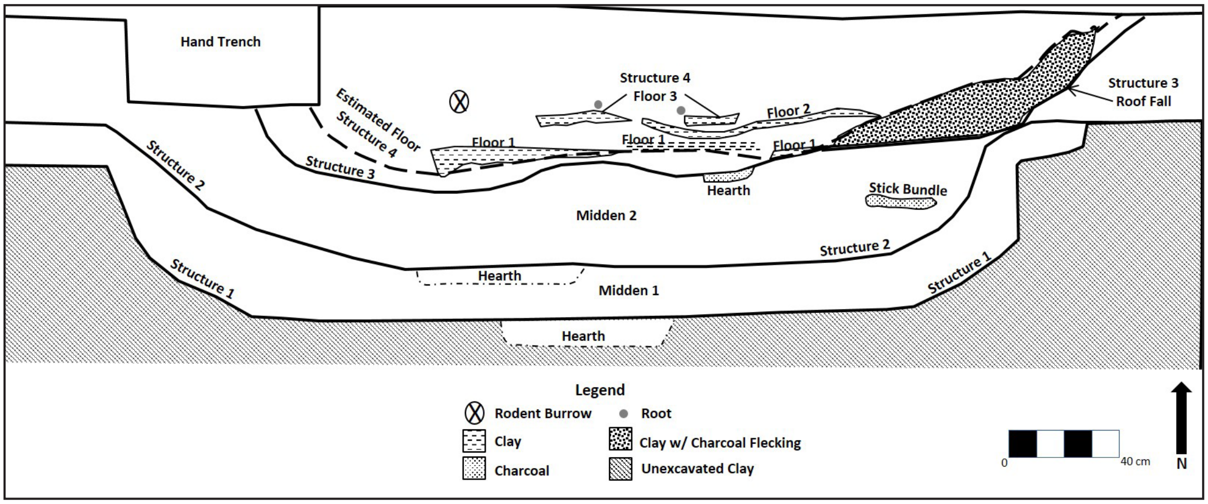

Figure 10. North profile of Structure Complex at Scorpion House (42MD3406).

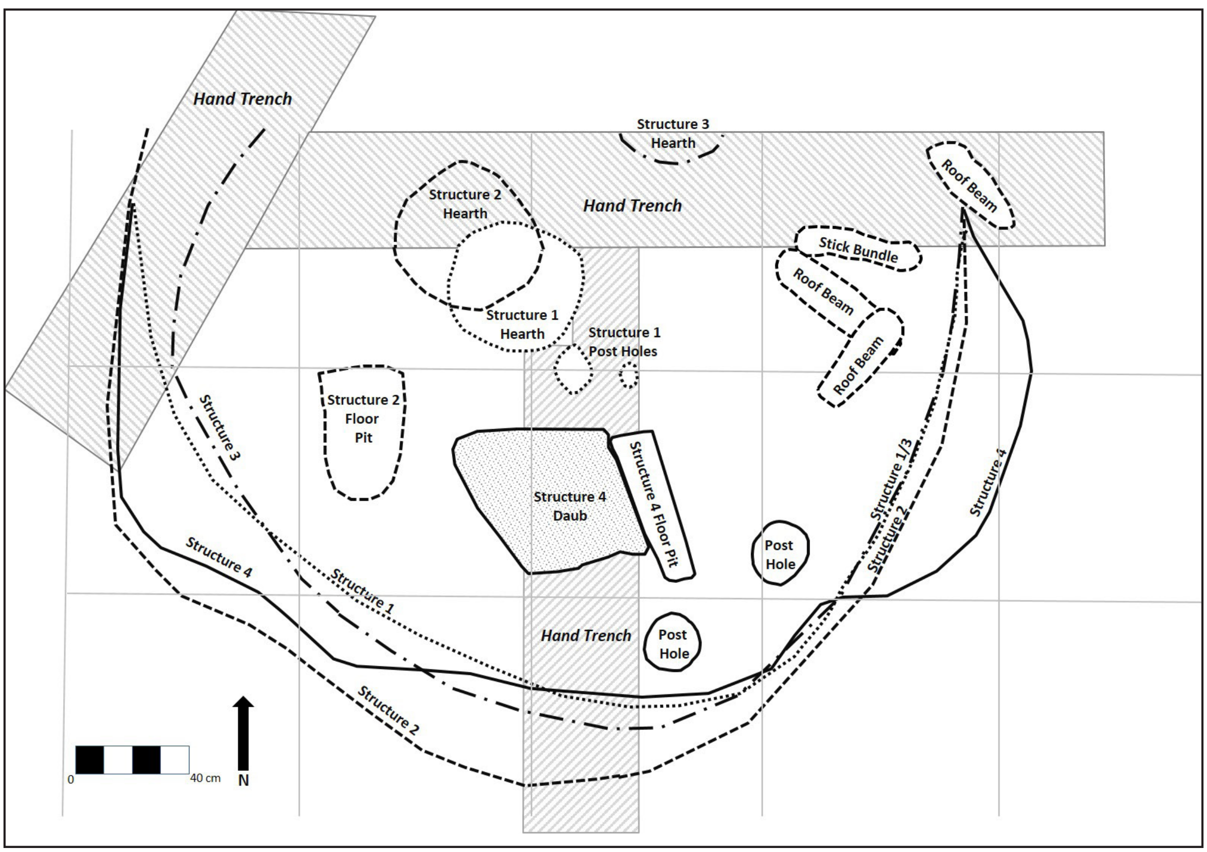

Figure 11. Plan view of Structure Complex at Scorpion House (42MD3406).

Figure 12. Structure Complex at Scorpion House (42MD3406), looking west.

Figure 13. Structure Complex at Scorpion House (42MD3406), looking east.

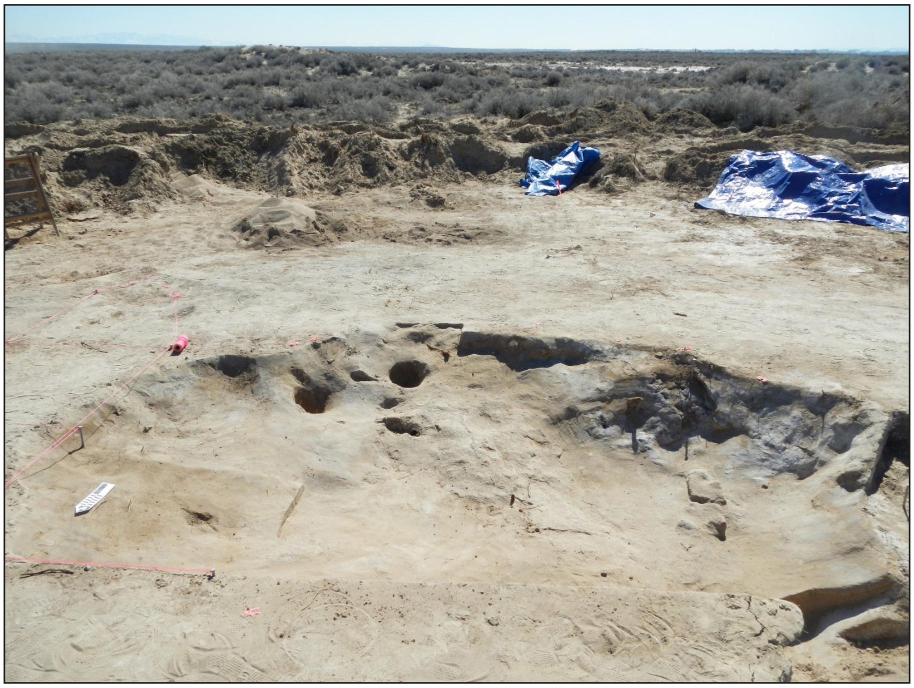

Figure 14. Structure 4 at Scorpion House (42MD3406), looking south.

each of which was covered by a thin lens of red sand. At the center of the structure, Floors 1 and 2 were separated by 5–10 cm of clean sand while Floors 2 and 3 were separated by 2–5 cm of clean sand; however, there was little to no separation of the floors along the edge of the structure. Charcoal from Floor 3 (the uppermost floor) dated final occupation of the structure to A.D. 1025–1190. No hearth was identified in excavated portion of Structure 4, but two postholes and a floor pit were found in the southeast quadrant of the structure (Figures 11 and 14). The floor pit (68 x 18 x 19 cm) had a 5-cm thick cap of daub sitting directly on Floor 3 that extended beyond the pit edges to the west, spanning an area of 60 x 70 cm. Within the floor pit was a relatively straight piece of worked juniper wood with modified ends that tapered to a point (Figure 15). The wood artifact measured 38 cm in length, 4 cm in diameter, and weighed 2.2 grams. The wood was unburned but was laid in a bed of charcoal, which surrounded the wood on all sides. The charcoal only surrounded the wood artifact, while the rest of the floor pit fill consisted of clean silty sand. The wood artifact may have been a prayer stick or digging stick placed in the structure floor as an offering prior to abandonment. Interestingly, the wood artifact yielded the oldest date (A.D. 890–1015, Table 2) at Scorpion House (Table 2). Although the early date may represent no more than an old wood problem, another explanation is that the wood artifact represents a curated item belonging to the family that repeatedly occupied the site over an approximately 150-year period (Table 2). The wood artifact may have had special significance to the family, which may have ceremoniously abandoned the site after their final occupation with the offering of this artifact in the uppermost floor. In addition to the culturally modified piece of wood, the artifact assemblage from Structure 4 included debitage, stone tools, gray ware sherds, and four beads (Table 3). Nearly 450 faunal bones were recovered from the structure, all but two of which were leporid and small mammal specimens (Table 4).

Figure 15. Wood artifact in floor pit of Structure 4 at Scorpion House (42MD3406).

Midden 3 consisted of a 30-cm thick deposit of consolidated sand with clay inclusions that covered a 12 x 8 m area surrounding the structure complex (Figure 9). This midden may represent the accumulation of midden deposits over the course of occupations at Scorpion House. One radiocarbon assay from a piece of charcoal yielded a date of A.D. 1015–1155, which falls within the range of other dates from the site (Table 2). The artifact assemblage included debitage, stone tools, and gray ware sherds (Table 3). A total of 511 faunal specimens were recovered from the midden, all but one of which were leporid and small mammal bones (Table 4).

The features at Scorpion House represent not only repeated occupation of the site but also relatively long duration stays. The extensive midden deposits and the time investment required to construct the pit structures suggest Scorpion House was occupied on at least a seasonal basis, if not longer. Macrobotanical samples indicate the collection and processing of wild seeds, including goosefoot and little barley. Goosefoot seeds are available during the summer and fall (Garrett 1936:60–61), whereas little barley seeds are available during the spring and early summer as well as in the fall and winter during wet years (USDA 1988:121). Scorpion House, therefore, was likely occupied at least during the summer and/or fall, but possibly during spring and winter months, as well. Site occupation during colder months of the year is suggested by the presence of hearths within the structures. In addition to wild plant resources, maize was also present at Scorpion House. Subsistence activities at Scorpion House also included hunting rabbits and hares, which were intensively processed as indicated by the recovery of over 3,700 highly fragmented leporid and small mammal specimens from the site.

Bunny Massacre Site (42MD3775)

The Bunny Massacre site was situated on the western side of a north-south dunal ridge approximately 60 m south of Scorpion House. One backhoe trench, mechanical stripping of

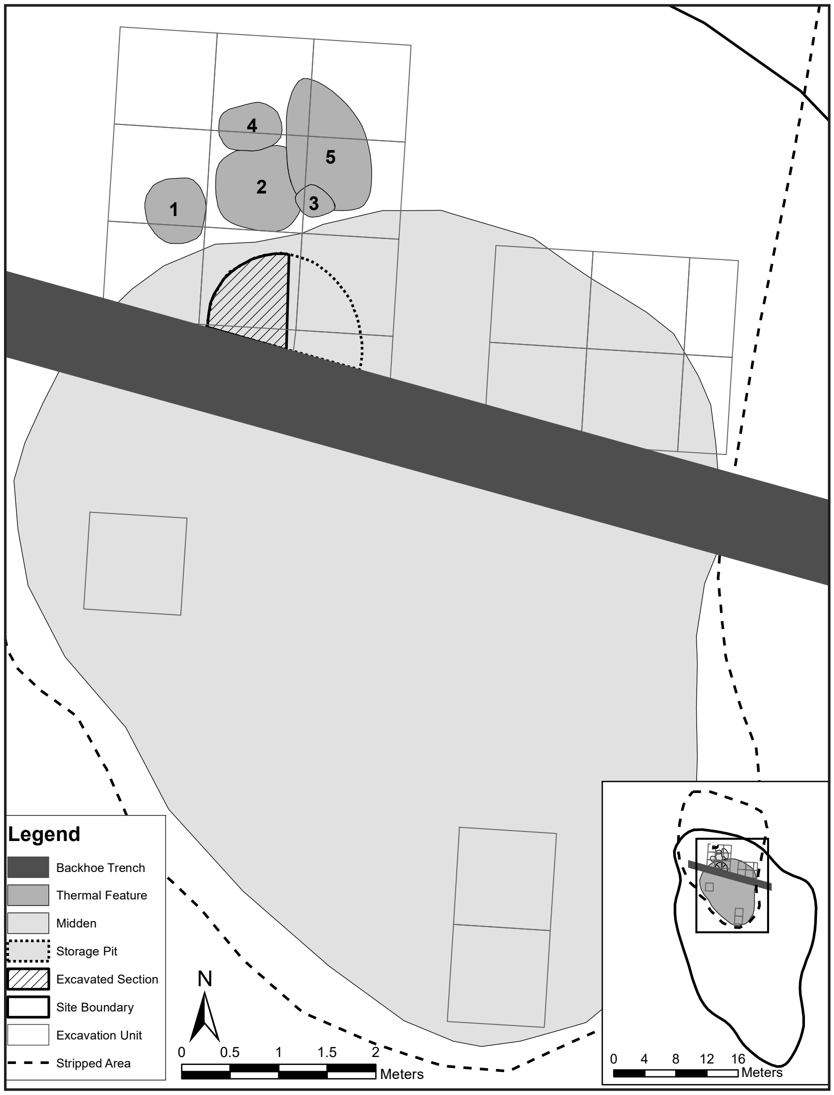

Figure 16. Bunny Massacre site (42MD3775) plan map.

sediments down to the prehistoric use surface, and hand excavations revealed five thermal features, a storage pit, and a midden (Figures 16–19). The thermal features were completely excavated, and the midden was sampled with seven 1 x 1 m test units. The southern edge of the storage pit was destroyed during backhoe trenching, and only the western half of the remaining portion was excavated.

The thermal features consisted of several overlapping, unlined pits measuring between 40–80 cm in diameter with very dark, charcoal-stained silty sand fill (Figures 16–19). Three radiocarbon assays from charcoal in the fill of Thermal Features 2, 3, and 4 suggested repeated use of the site between A.D. 1035–1265 (Table 2). Macrobotanical analyses identified eight maize cupules in Thermal Feature 2 and three maize cupules in Thermal Feature 5, as well as two carbonized *Chenopodium* fruit in Thermal Feature 4 and saltbush charcoal in each of the features (Table 5). All the thermal features also

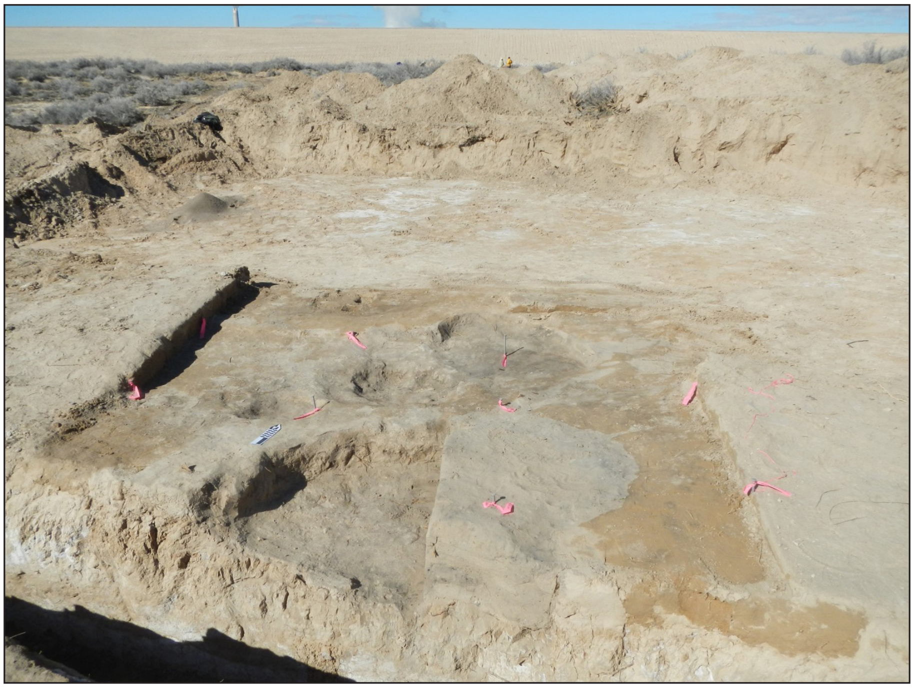

Figure 17. Bunny Massacre site (42MD3775) overview photo, looking north.

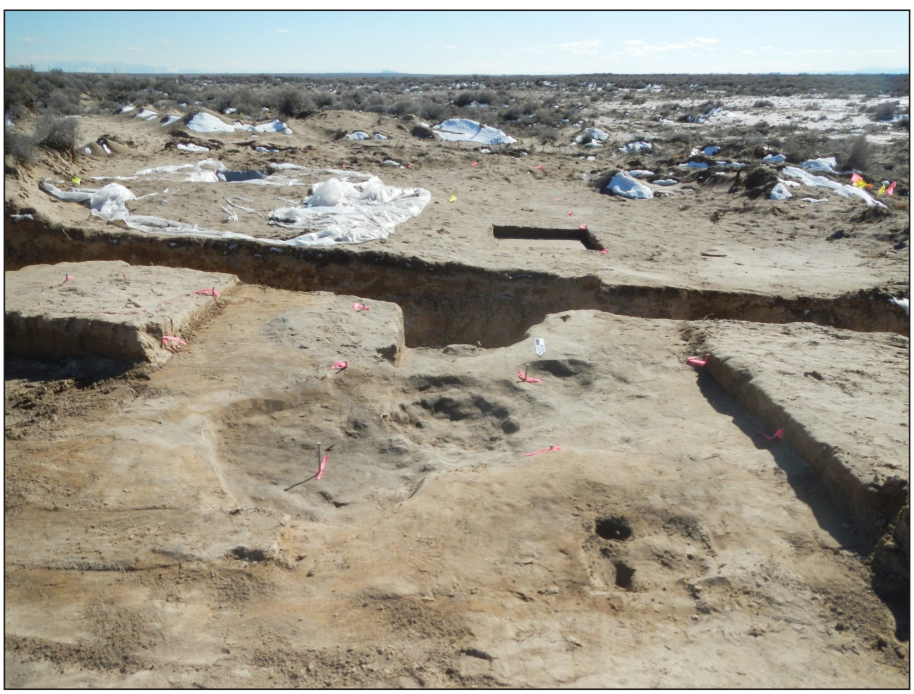

Figure 18. Bunny Massacre site (42MD3775) overview photo, looking south.

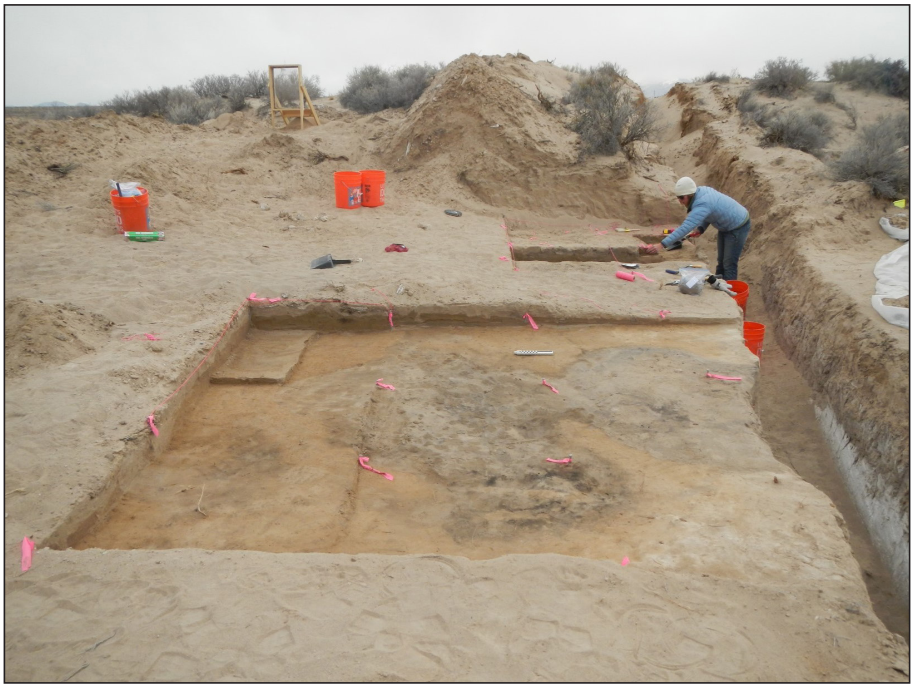

Figure 19. Bunny Massacre site (42MD3775) overview photo, looking east.

contained leporid and/or small mammal bones (Table 4).

The remaining portion of the storage pit measured 170 x 120 x 40 cm and had unlined, vertical walls and a relatively flat unlined floor (Figure 20). The storage pit was constructed in a natural clay horizon; therefore, the walls and floor of the feature were composed of natural clay. The feature fill consisted of charcoal-stained silty sand, which may represent post-storage use as a midden deposit. A single pollen sample from the storage feature included sagebrush, low-spine Asteraceae, cheno-ams, grasses (Poaceae), and juniper as well as slightly elevated levels of greasewood (*Sarcobatus*) and pickleweed (*Allenrolfea*) (Table 5; Jones 2016). Botanical remains also included saltbush and sagebrush wood recovered from a flotation sample as well as two maize cobs and three maize cupules collected during hand excavations (Table 5). A radiocarbon assay from one of the maize cobs yielded a date of A.D. 1035–1215 (Table 2). The faunal assemblage was dominated by leporid and small mammal specimens, which combined comprised 95% of the bone in the assemblage (Table 4). The artifact assemblage from the storage pit included debitage, one retouched flake, and gray ware sherds (Table 3).

The midden consisted of ashy, charcoal-stained silty sand that measured approximately 8 x 6 m and was at least 20 cm deep. A radiocarbon assay from charcoal in the fill dated the midden to A.D. 1030–1210. Over 700 faunal bones were recovered from the midden, 89% of which were leporid and small mammal specimens (Table 4). The artifact assemblage also included debitage, one utilized flake, and gray ware sherds (Table 3). Several gray ware sherds likely representing a single vessel were recovered from the northeast corner of the midden approximately 3 m east of the storage pit. The ceramics and associated sediments were submitted for pollen analysis, which was dominated by sagebrush, ragweed and goldenrod types (low-spine Asteraceae), cheno-ams, grasses (Poaceae), and pine; however, desert buckwheat (*Eriogonum*), prickly pear

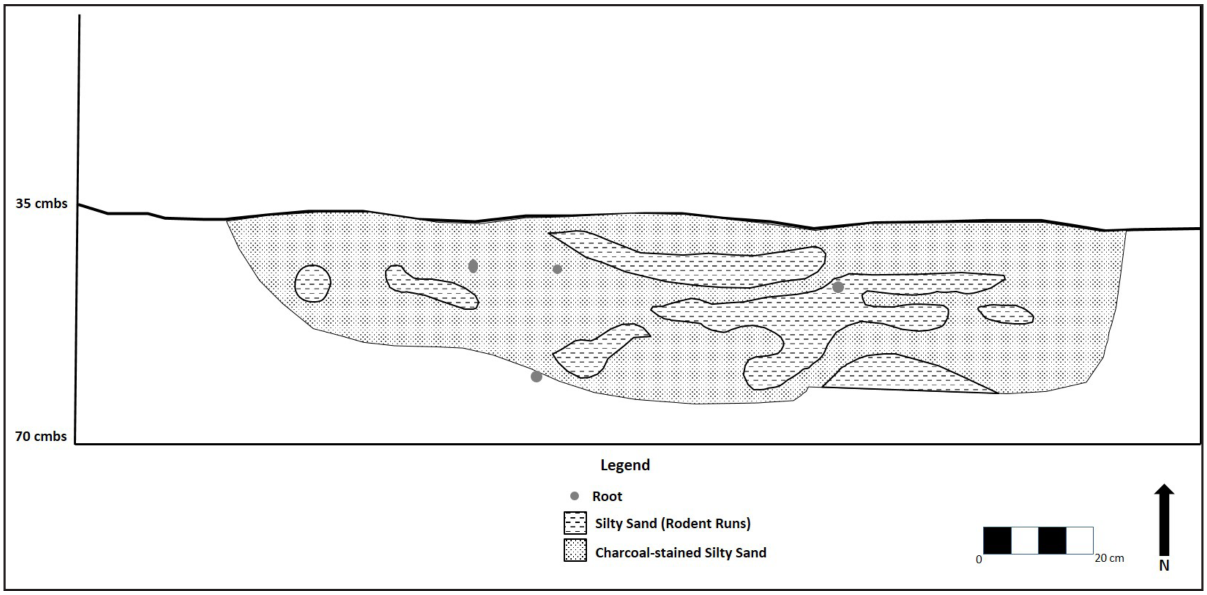

Figure 20. North Profile of storage pit at the Bunny Massacre site (42MD3775).

(*Opuntia*), willow (*Salix*), and narrowleaf cattail (*Typha latifolia*) pollen were also present (Table 5; Jones 2016).

The presence of a large storage feature, an extensive midden, and several overlapping thermal features at the Bunny Massacre site suggests relatively long duration and repeated occupation of the site. Although no habitation structures were encountered, pit structures may be buried in sand dunes immediately surrounding the excavated area, particularly to the north and east, where further investigations were precluded because of time and budget constraints of the project. Macrobotanical and pollen samples indicate the collection and processing of a variety of plant resources, including cheno-ams, pickleweed, desert buckwheat, prickly pear, willow, and cattail. Most of these plant resources are available during the summer and fall. For instance, cheno-ams and desert buckwheat seeds ripen between July and October (Stevens et al. 1996:16; Stubbendieck et al. 1997:303–321), while pickleweed seeds ripen gradually along a stalk over a relatively prolonged period from September through November (Madsen and Schmitt 2005:131). The Bunny Massacre site, therefore, was likely occupied at least during the summer and fall; however, the presence of a storage feature indicates occupation may have extended beyond the seasons of availability for wild plant resources. The discovery of maize at the site further indicates occupation was not inherently restricted to periods of wild resource availability. Hunting leporids was a major focus of subsistence activities at the site. Nearly 1,400 highly fragmented leporid and small mammal bones were recovered and indicate intensive processing of jackrabbits occurred at the Bunny Massacre site.

Summary

Archaeological investigations at the Sawtooth sites indicate a change in Fremont settlement-subsistence strategies after approximately A.D. 1000. Prior to A.D. 1000, the dune environment appears to have been used for the collection and processing of plant resources and hunting small game during short-duration stays as suggested by an ephemeral structure, activity areas, FCR, thermal features, and relatively light artifact assemblages at the Visquine Burrito site and the Trench Mania site. This is consistent with other

Fremont sites identified in dunal environments of Utah's western deserts, where short-term occupations are represented by ephemeral structures associated with collecting seeds and hunting leporids (Yoder 2014). Data recovery at Scorpion House and the Bunny Massacre site, however, indicate that a departure from this emerging pattern of dune use occurred after A.D. 1000.

Beginning around A.D. 1000, Fremont settlement-subsistence strategies in the dune environment intensified. The pit structures at Scorpion House represent greater time investment and longer duration stays than other structures previously documented at Fremont dune sites where, except perhaps at the Bennet site (42MD1052) (Shearin 1995:3), habitation structures consisted of ephemeral light, brush wickiup-type features (Yoder 2013:167). The extensive midden deposits at Scorpion House and the Bunny Massacre site also indicate longer duration stays than at other sites. Furthermore, longer periods of occupation are suggested by the storage pit and possibly the macrobotanical and pollen analyses, which identified a variety of plant resources with varying seasons of availability lasting from late spring through early winter. Therefore, evaluation of the Sawtooth sites against criteria for assessing level of mobility suggests a marked decrease in residential mobility after A.D. 1000 given the presence of a storage feature, high investment architecture, and deep trash deposits at Scorpion House and the Bunny Massacre site. However, other criteria such as obsidian sourcing and level of investment in ceramics were similar at each of the sites.

X-ray fluorescence (XRF) analysis of obsidian from each of the sites suggested little difference in the use of obsidian sources, indicating primary use of the Black Rock Area, followed by Topaz Mountain and then Wild Horse Canyon (Nash and Hutmacher 2019; Skinner 2015). The obsidian sources represented at the Sawtooth sites indicate local embedded procurement and use of obsidian with no evidence for longer distance procurement or exchange activities (Figure 1). This suggests the Visquine Burrito site and the Trench Mania site were not used by full-time foragers, but rather reflects use by less mobile task groups from farming villages. The use of local obsidian sources is also consistent with the seasonal residential occupation observed at Scorpion House and the Bunny Massacre site. The level of investment in ceramics from each of the sites also showed no marked differences; however, ceramics from Scorpion House and the Bunny Massacre site were primarily Sevier Gray (95%) with lesser amounts of Snake Valley Gray and Great Salt Lake Gray whereas the ceramics from the Visquine Burrito site and the Trench Mania site were all Snake Valley Gray (Nash and Hutmacher 2019). The core area of Snake Valley Gray ceramics is southwest of the Sawtooth sites in the Parowan Valley at sites such as Evans Mound and Median Village and extends northwestward to the Garrison site and Bakers Village in Snake Valley (Madsen 1977:1). Logistical use of the Trench Mania and Visquine Burrito sites may therefore have consisted of task groups from farming villages to the southwest. In fact, Madsen and Schmitt (2005:15–16) suggested that Baker Village was part of the social network involving the Buzz-Cut Dune foragers. Connections to farmers in southwestern Utah may be slightly supported by the fact that the Visquine Burrito site has the most obsidian from Wild Horse Canyon (located 30 miles north of Parowan Valley) with 9% (n = 4) of its obsidian coming from that source compared to 3% (n = 2) at Scorpion House and none at the Bunny Massacre site. The recovery of a slab metate from the Visquine Burrito site is also consistent with logistical use of the site, while the maize recovered from Scorpion House and the Bunny Massacre site is consistent with seasonal residential occupation by farming groups, or at least groups with close ties to farmers. In fact, each site had more maize than all of the maize combined from other Fremont dune sites, with seven maize cupules from Scorpion House and a total of 14 maize cupules and two corn cobs from the Bunny Massacre site compared to only two cobs and two kernels from all other Fremont dune sites. Whether or not corn was grown on the Sawtooth sites or imported cannot be determined conclusively; however, the relative abundance of corn compared to other sites and the fact that sand dunes trap moisture and promote plant growth suggests corn may have been grown at Scorpion House and the Bunny Massacre site. Also, if maize was grown at these sites, then hunting leporids would have been facilitated by garden hunting with snares or bow and arrow.

Prior to A.D. 1000, therefore, the Sawtooth sites indicate summer and/or fall logistical use of the dune environment by task groups from farming villages to the southwest, possibly in the Parowan Valley or Snake Valley regions. After A.D. 1000, the sites represent seasonal residential occupation during at least the summer and fall. Subsistence focus at Scorpion House and the Bunny Massacre site remained fairly consistent with expectations for Fremont dune sites given the continued emphasis on collecting wild plant resources, small game hunting, and use of maize. Therefore, comparison of food items included in the diet did not indicate any change in diet breadth and suggested little change in foraging efficiency. However, since processing costs are included in the ranking of food items, the intensive processing of leporids at the late Fremont Sawtooth sites is an indicator of decreased foraging efficiency. The faunal assemblages from the Scorpion House (n = 3764) and the Bunny Massacre site (n = 1476) are much larger than at other sites where faunal assemblages are comparatively small or non-existent (Table 1). Furthermore, considering that the Scorpion House and Bunny Massacre assemblages represent the sampling of a relatively small portion of each site, the actual number of faunal specimens at these two sites was easily an order of a magnitude larger than the combined total of faunal bone recovered from other Fremont dune sites. Although these late Fremont Sawtooth sites had large faunal assemblages, they still consisted almost entirely of leporid and small mammal bone, which combined comprised 97% of the late Fremont faunal assemblages (Table 4). The high level of processing evident among the leporid specimens suggests not only a decrease in foraging efficiency but also economic stress among these Sevier Desert Fremont groups.

Jackrabbit Processing

Jackrabbit (*Lepus* sp.) specimens comprised 99% of the leporid bones identified to the level of genus in the late Fremont faunal assemblage from Scorpion House and the Bunny Massacre site (Table 4). Nearly every type of skeletal element was represented among the jackrabbit specimens, indicating entire carcasses were transported back to the sites; however, the relative abundance of each element varied considerably (Table 6). Variability in skeletal element representation may be caused by post-depositional taphonomic processes or cultural behavior. To assess the level of preservation among the faunal remains, a regression analysis was used to determine the degree of density-mediated destruction present among the jackrabbit specimens (Lyman 1994b). Density-mediated destruction was evaluated by comparing bone density values for black-tailed jackrabbit (*Lepus californicus*) elements provided by Pavao and Stahl (1999) with the frequency of these skeletal elements present in the assemblage (Table 7). The skeletal element frequency was based on standardized NISP (NNISP) values, which were calculated by dividing the number of identified specimens (NISP) by the number of times the element is represented in the body. Null values were removed from the analysis of density-mediated destruction because it cannot be determined whether these represent real absences in the assemblage or are the result of taphonomic processes. Also, standardized NISP values were used instead of minimum number of element (MNE) values since MNE may be a less representative descriptor of relative element frequency than NISP in highly fragmented assemblages (Marshall and Pilgram 1993). The regression analysis indicated a significant, yet

Table 6. Identified Jackrabbit (*Lepus* sp.) Elements from Scorpion House and the Bunny Massacre Site.

Element	NISP	%NISP	n Burned	%Burned
Skull				
Skull fragments	42	5.30	2	4.76
Nasal	2	0.25	–	–
Zygomatic	18	2.27	–	–
Auditory Meatus	1	0.13	–	–
Mandible	25	3.16	2	8.00
Maxilla	15	1.89	–	–
Tooth	36	4.55	–	–
Axial Skeleton				
Atlas	1	0.13	–	–
Axis	3	0.38	1	33.33
Vertebra	69	8.71	1	1.45
Rib	188	23.74	3	1.60
Sternum	6	0.76	1	16.67
Pelvis	2	0.25	–	–
Forelimb				
Scapula	20	2.53	3	15.00
Humerus	26	3.28	6	23.08
Ulna	11	1.39	1	9.09
Radius	21	2.65	4	19.05
Carpal	13	1.64	2	15.38
Metacarpal	38	4.80	6	15.79
Hindlimb				
Femur	17	2.15	1	5.88
Tibia	15	1.89	2	13.33
Fibula	1	0.13	–	–
Calcaneus	8	1.01	7	87.50
Astragalus	8	1.01	7	87.50
Tarsal	4	0.51	–	–
Metatarsal	41	5.18	16	39.02
Metapodials	28	3.54	19	67.86
Phalanges	133	16.79	43	32.33
Subtotals	*792*	*100*	*127*	*16.04*
Long bone fragments	514	39.36	121	23.54
Totals	**1,306**	**100**	**248**	**18.99**

Table 7. Standardized NISP (NNISP) and Bone Density (g/cm3) for Jackrabbit (*Lepus* sp.) Elements.

Element	NISP	NNISP	Density (g/cm³)
Skull			
Mandible, complete	1	0.5	nd
Mandible, proximal	13	6.5	0.10
Mandible, body	7	6.0	0.38
Mandible, distal	4	2.0	0.22
Axial Skeleton			
Atlas	1	1.0	0.14
Axis	3	3.0	0.27
Rib	188	9.9	0.04
Sternum	6	8.0	0.05
Ilium	1	0.5	0.28
Ischium	1	0.5	0.18
Forelimb			
Scapula, complete	1	0.5	nd
Scapula, head	9	5.0	0.24
Scapula, body	10	7.0	0.06
Humerus, complete	1	0.5	nd
Humerus, proximal	6	3.5	0.34
Humerus, shaft	2	1.0	0.17
Humerus, distal	17	9.5	0.26
Ulna, proximal	5	2.5	0.15
Ulna, shaft	1	0.5	0.001
Ulna, distal	5	2.5	0.001
Radius, proximal	7	3.5	0.15
Radius, shaft	4	2.5	0.15
Radius, distal	10	5.5	0.25
Metacarpal	38	4.3	0.12
Hindlimb			
Femur, proximal	10	5.0	0.28
Femur, shaft	6	3.0	0.33
Femur, distal	1	0.5	0.40
Tibia, complete	2	1.0	nd
Tibia, proximal	3	1.5	0.37
Tibia, shaft	8	4.5	0.31
Tibia, distal	2	1.0	0.37
Calcaneus	8	4.5	0.35
Astragalus	8	4.5	0.19
Metatarsal	41	5.5	0.11
Phalanx	133	13.3	0.03

weak, relationship between NNISP and volume density ($r^2 = 0.106$, $p = 0.074$), suggesting that the survivorship of skeletal parts may in part be a result of bone density. However, a closer look at the relative frequencies of the skeletal parts represented in the assemblage suggests cultural taphonomic processes are more likely responsible.

Measures of relative skeletal abundance (RSA) have generally been applied to large mammal specimens to assess butchering and transport strategies; however, Fisher and Johnson (2014) used *Lepus* RSA values to evaluate culinary processing techniques at Antelope Cave. They note that processing techniques can result in a selective increase or decrease in the representation of certain skeletal elements. For instance, the pulverization of bone into meal would result in an absence of selective elements, while long bone fragmentation resulting from marrow processing may affect the NISP of long bones (Fisher and Johnson 2014:315). To evaluate cultural taphonomic processes at the Sawtooth sites, an RSA profile for the *Lepus* assemblage was created using NNISP values that have been converted into percentage values (%NNISP) by dividing each element portion by the part with the highest abundance (skeletal part NNISP/maximum NNISP). The RSA values indicate a disproportionate representation of skeletal elements (Figure 21). Density-mediated destruction is not likely to be entirely responsible since some of the least dense elements have some of the highest %NNISP values (e.g., phalanx, rib, sternum, scapula body), while some elements with high density have extremely low %NNISP values (e.g., distal femur, distal and proximal tibia, ilium). Instead, it is likely that the relative frequencies of the skeletal parts are a result of cultural practices. Moreover, jackrabbit elements do not appear to have been selectively discarded prior to transportation because elements with low economic utility, such as the skull and foot bones, have high %NNISP values (Binford 1978; Metcalfe and Jones 1988).

Ethnographic data indicates that rabbit processing methods included skinning and cleaning, roasting or stewing the meat, extracting marrow from long bones, and pulverizing certain portions into a meal (Fowler 1989; Kelly 1932; Lowie 1924). The amount of energy required and the nutritional benefits returned from each of these processing methods varies greatly, ranging from minimal (roasting whole rabbits) to high (pulverization). Fisher and Johnson (2014) note that small taxa, such as leporids, with high protein to fat ratios are generally roasted or quickly stewed suggesting the amount of energy for more extensive processing generally outweighs the nutritional benefits. Decisions on processing methods, therefore, have implications for the overall subsistence economy. The patterning of burning and fragmentation among the jackrabbit specimens from the Sawtooth late Fremont components indicates processing included marrow extraction from long bones and pulverization of other skeletal elements to provide additional calories and nutrients.

The distribution of burning among faunal remains may be used to determine whether the elements were burned randomly or as a result of cooking and butchering processes (Grayson 1988; Szuter 1994). Random patterns of burning likely indicate post-consumption processes, such as disposal of bones into hearths. Roasting meat for consumption, however, results in non-random patterns of burning since skeletal elements are not uniformly exposed to heat. Meaty portions of the carcass (e.g., femur) are expected to exhibit minimal burning compared to other more exposed elements, such as the distal portions of lower limbs. Hockett and Bicho (2000:719) note, for example, that roasting whole rabbit carcasses over or within coals results in foot bones and the ends of limb bones being charred or calcined in greater frequencies than other bones. Patterns of burning may also be used to identify butchering practices since butchering results in greater exposure of skeletal parts to heat at the location of disarticulation. For instance, if the forelimb were removed at the shoulder joint prior to cooking,

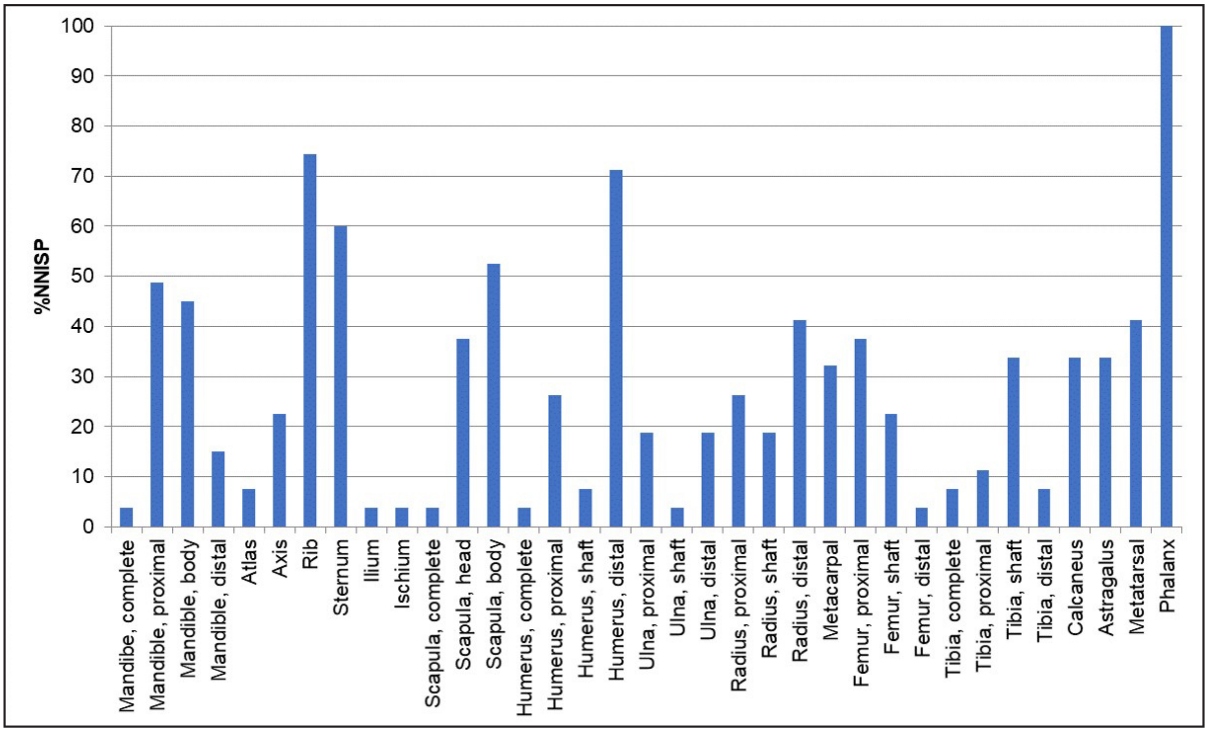

Figure 21. Jackrabbit (*Lepus* sp.) Relative Skeletal Abundance (RSA) values.

there should be a higher frequency of burning on the proximal humerus than the scapular head. Patterned burning, therefore, is a useful method for identifying butchering methods of small taxa, which rarely exhibit cut marks or other indicators of disarticulation.

The distribution of burning among jackrabbit elements in the late Fremont assemblage at the Sawtooth sites is non-random, with higher frequencies of burning among metapodials, phalanges, and unidentified long bone fragments (Tables 8 and 9). Moreover, foot bones (metapodial, phalanx, carpal, astragalus, calcaneus) comprised 40% of the burned bone while non-foot bones comprised 60% of the burned bone (χ^2 = 33.75, $p < .001$; Table 9). In addition to the predominance of burned foot bones, burned elements consisted of skull and axial (vertebrae and ribs) bones as well as the ends of limb bones. There was no significant patterned burning among other elements to suggest disarticulation prior to cooking. Although the observed burn patterns could result from roasting articulated rabbit carcasses, another explanation for this pattern of burning is that meat was stripped from the bones prior to roasting. The degree of burning and fragmentation of the bones supports this latter scenario of cooking stripped meat.

Burned elements were recorded based on the degree (charred, calcined) of burning. Nearly all the burned bone was calcined (90%) rather than charred (Table 9), indicating prolonged exposure to heat. Although bones may become calcined during roasting, burning to this extent is unlikely to occur during culinary processing. Since the majority of burned elements consisted of foot bones that have little economic utility, the feet were likely removed and disposed of in the fire. The feet were likely removed to facilitate stripping the meat prior to cooking. Moreover, possible disarticulation of the forelimb at the elbow joint is suggested by the fact that 19% of radii were calcined and 35% of distal humeri were

Table 8. Totals for Charred and Calcined Bone among Jackrabbit (*Lepus* sp.) Elements.

Element, Portion	NISP	Charred	%Charred	Calcined	%Calcined
Skull					
Skull fragments	42	–	–	2	4.76
Nasal	2	–	–	–	–
Zygomatic, complete	1	–	–	–	–
Zygomatic, fragment	17	–	–	–	–
Auditory Meatus, complete	1	–	–	–	–
Mandibe, complete	1	–	–	–	–
Mandible, proximal	13	1	7.69	–	–
Mandible, body	7	–	–	1	14.29
Mandible, distal	4	–	–	–	–
Maxilla, fragment	15	–	–	–	–
Tooth	36	–	–	–	–
Subtotal	*139*	*1*	*0.72*	*3*	*2.16*
Axial Skeleton					
Atlas, complete	1	–	–	–	–
Axis, complete	1	–	–	–	–
Axis, fragment	2	–	–	1	50.00
Vertebra, fragment	69	1	1.45	–	–
Rib, complete	2	–	–	–	–
Rib, proximal	9	–	–	1	11.11
Rib, fragment	177	–	–	2	1.13
Sternum, fragment	6	–	–	1	16.67
Ilium	1	–	–	–	–
Ischium	1	–	–	–	–
Subtotal	*269*	*1*	*0.37*	*5*	*1.86*
Forelimb					
Scapula, complete	1	–	–	–	–
Scapula, head	9	–	–	2	22.22
Scapula, body	10	–	–	1	10.00
Humerus, complete	1	–	–	–	–
Humerus, proximal	6	–	–	–	–
Humerus, shaft	2	–	–	–	–
Humerus, distal	17	1	5.88	5	29.41
Ulna, proximal	5	–	–	1	20.00
Ulna, shaft	1	–	–	–	–
Ulna, distal	5	–	–	–	–
Radius, proximal	7	–	–	2	28.57
Radius, shaft	4	–	–	–	–

Table 8. Continued.

Element, Portion	NISP	Charred	%Charred	Calcined	%Calcined
Radius, distal	10	–	–	2	20.00
Carpal, complete	13	–	–	2	15.38
Metacarpal, complete	26	1	3.85	–	–
Metacarpal, proximal	11	–	–	4	36.36
Metacarpal, shaft	1	–	–	1	100
Subtotal	*129*	*2*	*1.55*	*20*	*15.50*
Hindlimb					
Femur, proximal	10	–	–	1	10.00
Femur, shaft	6	–	–	–	–
Femur, distal	1	–	–	–	–
Tibia, complete	2	–	–	–	–
Tibia, proximal	3	–	–	1	33.33
Tibia, shaft	8	–	–	–	–
Tibia, distal	2	–	–	1	50.00
Fibula, proximal	1	–	–	–	–
Calcaneus, complete	1	–	–	–	–
Calcaneus, proximal	2	–	–	2	100
Calcaneus, distal	5	1	20.00	4	80.00
Astragalus, complete	4	–	–	4	100
Astragalus, proximal	4	–	–	3	75.00
Tarsal, complete	4	–	–	–	–
Metatarsal, complete	7	–	–	–	–
Metatarsal, proximal	18	1	5.56	7	38.89
Metatarsal, distal	16	1	6.25	7	43.75
Subtotal	94	3	3.19	30	31.91
Misc. Foot					
Metapodials, shaft	13	2	15.38	11	84.62
Metapodials, distal	15	1	6.67	5	33.33
Phalanges, complete	88	1	1.14	17	19.32
Phalanges, proximal	22	3	13.64	9	40.91
Phalanges, shaft	1	–	–	1	100
Phalanges, distal	22	4	18.18	8	36.36
Subtotal	*161*	*11*	*6.83*	*51*	*31.68*
Long bone fragments	514	7	1.36	114	22.18
Total	**1,306**	**25**	**1.91**	**223**	**17.08**

Table 9. Summary of Burned Jackrabbit (*Lepus* sp.) Elements.

	Charred			Calcined			Total Burned	
Skeletal Portion	NISP	%Charred	%Total	NISP	%Calcined	%Total	NISP	%Total
Skull bones	1	4.0	0.4	3	1.3	1.2	4	1.6
Axial bones	1	4.0	0.4	5	2.2	2.0	6	2.4
Limb bones	1	4.0	0.4	16	7.2	6.5	17	6.9
Foot bones	15	60.0	6.0	85	38.1	34.3	100	40.3
Long bone fragments	7	28.0	2.8	114	51.1	46.0	121	48.8
Totals	**25**	**100**	**10.1**	**223**	**100**	**89.9**	**248**	**100**

burned; no other humerus portions (proximal end or shaft) were burned. Disarticulation in this manner would have facilitated removal of meat and subsequent marrow extraction from the humerus. Processing for marrow extraction is also suggested by the fact that the only other identifiable burned long bone portions consisted of proximal and distal tibia, proximal ulna, and proximal femur elements (Table 8). This may represent snapping of long bone ends to gain access to the medullary cavity and the subsequent disposal of snapped ends into the fire. The abundance of burned long bone fragments, as well as fragmentation patterns in general, further suggest marrow processing and the pulverization of other skeletal elements for stewing and grease extraction.

Compared to the relatively little preparation and energy required to roast whole carcasses or stripped meat, stewing and grease extraction involve intensive processing methods. Stewing and grease extraction not only require the carcasses be disarticulated and chopped into smaller units, but also require additional quantities of fuel and increased technological costs to produce or obtain suitable vessels (Fisher and Johnson 2014). Grease and marrow extraction are also intensive processing methods since they require the initial removal of soft tissues (Lupo and Schmitt 1997). Church and Lyman (2003:1083) found that a great deal of effort is required to get nutrients from grease and marrow extraction, but they conclude that this practice may help groups get nutrients that may not otherwise be available.

Although grease and marrow extraction require intensive processing, bone marrow performs an important function of fat storage in leporids (Gong and Ries 1970; Warren and Kirkpatrick 1978) and has been shown to be an important source of nutrients for human and non-human predators alike (Hockett and Bicho 2000; MacCracken and Hansen 1986). Gong and Ries (1970) found that in European rabbits (*Oryctolagus cuniculus*) about 51% of the rabbit skeletal volume was marrow. More than two-thirds of rabbit marrow was located in the various flat bones and one-third in the long bones. The long bones, however, contained approximately half of the skeletal marrow fat while the non-fatty organic fraction of long bone marrow constituted only one-sixth of that found in the whole animal skeletal marrow. Therefore, while long bones contain the fattiest marrow, nutrients from marrow is also obtainable from other skeletal elements. For instance, a study on the energy (kcal/g) and protein (%) content of small prey for coyotes found that a completely pulverized black-tailed jackrabbit yielded a gross energy value of 3.8 kcal/g and a crude protein value of 50.6% (MacCracken and Hansen 1986:275). Moreover, late Upper Paleolithic hunters at Picareiro Cave in central Portugal added 3 grams of fat per European rabbit carcass to their diet by extracting long bone marrow (Hockett and Bicho 2000). These studies indicate that substantial

Table 10. Degree of Fragmentation among Jackrabbit (*Lepus* sp.) Long Bone Elements.

Element		Degree of Fragmentation						
		>95%		50-95%		<50%		**Total**
Humerus	n (%)	1	(3.8%)	4	(15.4%)	21	(80.8%)	**26**
Radius-Ulna	n (%)	0	(0%)	10	(31.2%)	22	(68.8%)	**32**
Femur	n (%)	0	(0%)	1	(5.9%)	16	(94.1%)	**17**
Tibia-Fibula	n (%)	2	(12.5%)	3	(18.8%)	11	(68.8%)	**16**
Totals	**n (%)**	**3**	**(3.3%)**	**18**	**(19.8%)**	**70**	**(76.9%)**	**91**

energy gains may be obtained from the non-meaty portions of leporids.

Long bones must be fragmented to access bone marrow; therefore, elements containing marrow are expected to be highly fragmented. The completeness of each specimen in the Sawtooth late Fremont assemblage was classified according to whether it was complete (>95% complete), minimally fragmented (50–95% complete), or highly fragmented (<50% complete). The identified jackrabbit long bone elements were dominated by highly fragmented specimens, which comprised 77% of all long bone specimens (Table 10). Femur and humerus elements tended to be more fragmented than the other elements, which is not unexpected as they have larger medullary cavities. Tibia-fibula and radius-ulna elements were dominated by highly fragmented specimens but included more minimally fragmented specimens.

Elements containing marrow are expected to be fragmented more frequently and have higher NISP counts than other elements; however, many jackrabbit elements were highly fragmented (Table 11). Highly fragmented specimens dominate skull elements (67%), axial elements (97%), and scapula specimens (80%). Only foot bones are characterized by greater numbers of complete (52%) and minimally fragmented (17%) specimens, which is not surprising given other evidence that suggests the feet were disarticulated and disposed of in the fire as an early step of processing. Considering the highly fragmented nature of the vertebra and ribs, likely this section of the rabbit was pulverized and consumed; this is consistent with ethnographies describing the process (Lupo and Schmitt 1997). In fact, the dominance of highly fragmented elements in the jackrabbit assemblage suggests that after the meat was stripped, nearly the entire skeleton was pulverized to leach fats and other nutrients through stewing (Fisher and Johnson 2014; Hockett and Bicho 2000; MacCracken and Hansen 1986). The practice of pulverizing and stewing rabbit elements is further suggested by the abundance of unidentified *Lepus* long bone fragments (n=514; 39% of *Lepus* specimens), Leporidae specimens that were too fragmented to identify to the level of genus (n=1,079; 45% of leporid/small mammal specimens), and small mammal remains that likely represent highly fragmented Leporidae specimens (96% of categorized bone) (Tables 4 and 8). Furthermore, the general lack of burning and high fragmentation of the cranium suggests the brain (the fattest organ of the body) may also have been extracted for consumption, providing another source of fat in addition to bone marrow and grease (Tables 9 and 11). Fisher and Johnson (2014) found evidence that rabbit brains were being consumed at Antelope Cave, and other ethnographies of western North America (Beaglehole 1936; Fowler 1989) indicate the brain was extracted for consumption.

In sum, patterns of burning, fragmentation, and relative skeletal abundances suggest whole jackrabbits were transported back to Scorpion House and the Bunny Massacre site and intensively processed for consumption. Processing appears to have included butchering

Table 11. Degree of Fragmentation among Jackrabbit (*Lepus* sp.) Elements.

Element		Degree of Fragmentation						
		>95%		50-95%		<50%		Total
Skull								
Skull fragments	n (%)	–	–	–	–	42	(100)	42
Nasal	n (%)	1	(50.0)	1	(50.0)	–	–	2
Zygomatic	n (%)	1	(5.6)	–	–	17	(94.4)	18
Auditory Meatus	n (%)	1	(100)	–	–	–	–	1
Mandible	n (%)	1	(4.0)	5	(20.0)	19	(76.0)	25
Maxilla	n (%)	–	–	2	(13.3)	13	(86.7)	15
Tooth	n (%)	34	(94.4)	–	–	2	(5.6)	36
Subtotals	*n (%)*	*38*	*(27.3)*	*8*	*(5.8)*	*93*	*(66.9)*	*139*
Axial Skeleton								
Atlas	n (%)	1	(100)	–	–	–	–	1
Axis	n (%)	1	(33.3)	–	–	2	(66.7)	3
Vertebra	n (%)	–	–	1	(1.4)	68	(98.6)	69
Rib	n (%)	2	(1.1)	–	–	186	(98.9)	188
Sternum	n (%)	–	–	–	–	6	(100)	6
Pelvis	n (%)	–	–	2	(100)	–	–	2
Subtotals	*n (%)*	*4*	*(1.5)*	*3*	*(1.1)*	*262*	*(97.4)*	*269*
Scapula	n (%)	1	(5.0)	3	(15.0)	16	(80.0)	20
Foot Bone								
Calcaneus	n (%)	1	(12.5)	3	(37.5)	4	(50.0)	8
Astragalus	n (%)	4	(50.0)	4	(50.0)	–	–	8
Carpal	n (%)	13	(100)	–	–	–	–	13
Metacarpal	n (%)	26	(68.4)	7	(18.4)	5	(13.2)	38
Tarsal	n (%)	4	(100)	–	–	–	–	4
Metatarsal	n (%)	7	(17.1)	5	(12.2)	29	(70.7)	41
Metapodials	n (%)	–	–	3	(10.7)	25	(89.3)	28
Phalanges	n (%)	88	(66.2)	25	(18.8)	20	(15.0)	133
Subtotals	*n (%)*	*143*	*(52.4)*	*47*	*(17.2)*	*83*	*(30.4)*	*273*
Long bone fragments	n (%)	–	–	–	–	514	(100)	514
Totals	**n (%)**	**186**	**(15.3)**	**61**	**(5.0)**	**968**	**(79.7)**	**1215**

into smaller components, pulverization of the rib cage, and fragmenting long bones for marrow access. Likely meaty segments were roasted while fragmented long bones and the rib cage were stewed with wild and cultivated plant resources. Jackrabbit processing appears to have involved at least five steps: (1) remove the feet and dispose of them in the fire, (2) strip meat from the bones and roast the meat for consumption, (3) remove the posterior of the head to extract the brain for consumption, (4) snap long bone ends to remove marrow and dispose of ends in the fire, and (5) pulverize long bones and the axial skeleton to leach fats and other nutrients through stewing.

The intensive jackrabbit processing methods employed at Scorpion House and the Bunny Massacre site may have been necessary given the apparent lack of other high fat resources in the diet, as indicated by the complete absence of any deer or other large mammal remains in the faunal assemblages. Rabbit meat is very lean, consisting of only 6.8% fat compared to cattle (32%), sheep (36%), and pigs (32%) (Lebas et al. 1997). Subsistence economies dependent on rabbits with no other source of fat result in high protein-low fat intake that can lead to extreme fat-hunger known as rabbit starvation, or protein poisoning (Fallon 1999:24). Fremont occupants at Scorpion House and the Bunny Massacre Site, therefore, may have pulverized nearly all skeletal elements for grease and marrow, rather than only processing long bones for marrow, to prevent fat deficiency and protein poisoning when subsisting on low-fat rabbit meat. The brain may have also been consumed, providing another source of much-needed fat. The intensive jackrabbit processing, therefore, suggests economic stress among these late Fremont groups in the Sevier Desert.

Discussion

The notable absence of large mammal bone at the Sawtooth sites is not likely a result of taphonomic issues (such as density-mediated destruction) or data recovery procedures (such as screen size) since large mammal elements have a greater bone density and are larger than leporid specimens. Instead, the predominance of intensively processed leporid bone and the lack of large mammal bone, as well as the shift in settlement systems after A.D. 1000, appears to be a result of socio-economic factors among Sevier Desert Fremont groups at the Sawtooth sites.

According to optimal foraging models, large game species (e.g., deer, bighorn sheep, antelope) are expected to be hunted when available since these typically yield the highest return rates (Broughton et al. 2011; Hawkes et al.1982; Simms 1985, 1987; Winterhalder 1981). When collected *en masse*, however, small-sized prey items can sometimes produce higher returns than large prey captured singly (Madsen and Schmitt 1998). If, for instance, jackrabbit drives provided caloric returns equal to or greater than large game resources, then there may have been little incentive to hunt large game, particularly since hunting large game has a higher risk compared to rabbit drives. Simms (1987:Table 9) notes that the intrapatch encounter rate for jackrabbit drives is 0.6 to 4.9 kg/hr, which is greater than the maximum rates provided for individually hunted deer (0.4 kg/hr) and bighorn sheep (0.7 kg/hr). Therefore, while the post-encounter return rates for jackrabbits may be comparatively lower than that of deer or bighorn sheep, the high encounter rates for communal jackrabbit drives suggest a greater probability of hunting success. As such, this provides a possible explanation for the abundance of jackrabbit specimens in the Sawtooth late Fremont faunal assemblage.

Communal jackrabbit drives are well documented in the Great Basin and Southwest (e.g., Egan 1917; Kelly 1932, 1964). According to ethnographic accounts, these communal hunts typically occurred in the fall and consisted of at least two or three families working together. Although, an abundance of jackrabbit specimens often suggests the practice of communal drives, a large quantity of jackrabbit bones may also represent an accumulation of individually captured animals (Fisher et al. 2013). To identify rabbit drives in the archaeological record, catastrophic mortality profiles and relative skeletal abundances can be used (Fisher et al. 2013; Jones 2006; Klein 1982; Schmidt 1999; Schmitt et al. 2004). Data from jackrabbit populations in Sacramento, California indicate that epiphyseal fusion of the proximal humerus is complete around 11 to 15 months (the fusion timing of other skeletal elements is unknown), and skeletally mature adults are almost never present in frequencies greater than 50% (Fisher et al. 2013:154). If the late Fremont faunal assemblage was a product of communal drives, the resulting death assemblage should approximate the distribution of skeletally mature to immature individuals; however, only one unfused distal radius is present in the Sawtooth assemblages. The very sparse evidence of subadults in the assemblage suggests drives were not a primary method for hunting jackrabbits at the Sawtooth sites. Moreover, faunal assemblages representing communal hunts are typically characterized by skeletal element patterning indicative of butchering and transportation of select body parts (Schmidt 1999; Schmitt et al. 2004). As previously mentioned, however, the rabbit relative skeletal abundances in the late Fremont faunal assemblage are indicative of entire carcasses being transported back to the sites for processing and consumption. Jackrabbits may therefore have been obtained individually by encounter hunting. Madsen and Schmitt (2005:131) argue that even during the best times at Buzz-Cut Dune, the most effective foraging option likely consisted of men hunting jackrabbits while women collected and processed pickleweed seeds. They state that "when jackrabbits are abundant enough to make rabbit drives by both genders viable, then diet breadth models suggest it unlikely that very low-ranked pickleweed seed processing would have taken place.... Because pickleweed collecting does seem to have been a priority throughout all periods, jackrabbit populations may have been too low for rabbit drives to be effective, and the procurement of hares may have been limited to hunting by individuals" (Madsen and Schmitt 2005:131). The identification of pickleweed seeds and other low-ranked plant resources from the Sawtooth sites suggests jackrabbit hunting may also have been done on an individual rather than a communal basis.

Communal jackrabbit hunts, while possible, fail to satisfactorily account for the abundance of jackrabbits in the late Fremont faunal assemblage at the Sawtooth sites; therefore, the complete absence of large game mammals still requires explanation since individual capture of jackrabbits typically provides lower returns than individual capture of artiodactyls. Broughton et al. (2011) present data indicating that the pursuit costs and the probability of failed pursuits for artiodactyls and lagomorphs are at least comparable and likely higher for lagomorphs, indicating post-encounter return rates for individual capture of these two prey types would be largely a function of differences in body size. The data suggest that lagomorphs are generally more difficult to capture than artiodactyls, reinforcing the assumption that lagomorphs provide lower post-encounter return rates than artiodactyls. In fact, Broughton et al. state that "it is difficult to see how prehistoric lagomorph capture success could ever have exceeded that for artiodactyls" (2011:410). Given that lagomorphs have lower post-encounter return rates than artiodactyls, the complete absence of the latter suggests large game hunting was precluded either by high transport costs or availability (i.e., low artiodactyl population levels).

Travel and transport costs between central places and foraging patches influence the economics of hunting behavior and, consequently, the composition of archaeological faunal assemblages (Bayham 1982; Bird and Bliege Bird 2000; Broughton 1999; Cannon 2000, 2003). Maximum transport distance (MTD) is the distance a set volume of a resource can be carried before the caloric expenditure of procuring and transporting the resource is greater than the calories provided by the load. The nearest large game habitat to the project area is the Canyon Mountains, located 26 km to the southeast (Figure 22); therefore, acquisition of deer (*Odocoileus hemionus*) from the Canyon Mountains is assumed when calculating transport costs here. Also, return rates for deer provided by Simms (1987) and Cowan et al. (2012) are used (Table 12). Calculations of transport costs (TC) follow the Jones and Madsen (1989) concept of maximum transport distance but uses Brannan's (1992) model for transport costs (TC) to account for variability in terrain condition. Since exact terrain conditions for every kilometer traveled were unknown, a terrain coefficient (t) of 1.35 was assumed as an average condition somewhere between light brush and heavy brush (Brannan

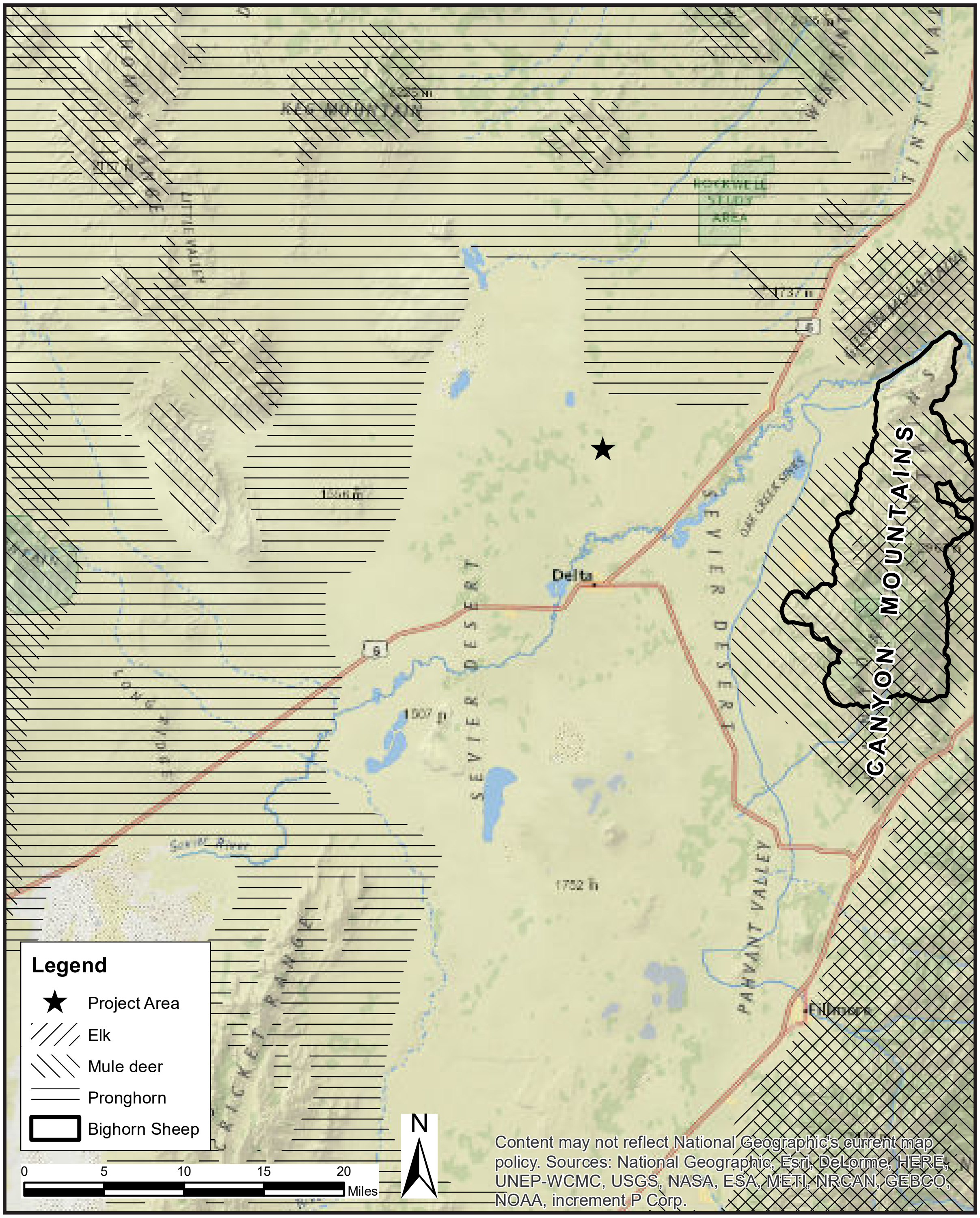

Figure 22. Large game habitats near the project area.

Table 12. Return Rate and Net Calories per Load for Deer (O. *hemionus*).

Resource	Return Rate (kcal/hr)	Kcal/kg	Load Size (kg)	Kcal/Load	Time to Acquire Load (hr)
Deer	17,971–31,450	1,580	30	47,400	2–4

1992:58). Also, a zero percent grade is assumed because the terrain between the project area and the Canyon Mountains is relatively flat; therefore, the caloric cost of walking per km (Ws) is assumed to be 50.6 kcal/km and the caloric cost of carrying 1 kg per km (Ts) is assumed to be 0.4 kcal/km (Zeanah 2000:8; Brannan 1992:57).

Given the above-mentioned data and assumptions, the transport cost (TC) of deer is calculated here as:

$$TC = \sum [dt (Ws + TsL)]$$

where,

d = distance (26 km)

t = terrain coefficient (1.35)

W_s = caloric cost of walking across grade *s* (*s* = 0; 50.6 kcal/km)

T_s = caloric cost of carrying load across grade *s* (*s* = 0; 0.40 kg/km)

L = total weight of one load of resource transported (30 kg)

The total round trip cost of transporting a single 30 kg load of deer from the Canyon Mountains to the project area was calculated to be 3973 kcal, or an average of 152.8 kcal/km. The maximum transport distance (MTD = Net Load ÷ TC) for deer was calculated to be 310 km.

The project area, located only 26 km from the Canyon Mountains, is well within the maximum transport distance (310 km) for deer. The Fremont inhabitants of Scorpion House and the Bunny Massacre site would therefore be expected to hunt large game in the surrounding uplands given the relatively low transport costs. Moreover, Grimstead's (2010) model of travel and transport costs for deer, antelope, jackrabbit, and cottontail obtained between 0–200 km from a central place indicates that large game remains a high-return prey item even with high transport distances. Therefore, the predominance of jackrabbits and the absence of large game at the late Fremont sites cannot be explained by high transport costs. Since large game hunting does not appear to have been precluded by transport costs, another explanation is that artiodactyls were simply not available to hunt.

Janetski (1997) noted a decrease in artiodactyl bone at late Fremont sites that he attributed to a decline of artiodactyl populations across the Fremont area. He compared artiodactyl index values of faunal assemblages from dated Fremont residential sites and demonstrated that a decline in the relative numbers of large game animals occurred between A.D. 500 and A.D. 1300, with Late Fremont period sites indicating a decrease in the use of deer, mountain sheep, and antelope relative to rabbits. Janetski (1997) rejects climate and technological innovation as potential explanations for this trend and argues instead that the trend in Fremont artiodactyl use is best explained as a function of resource depression due to increasing human populations. He notes that a shift in Fremont settlement pattern from occupations on the floodplains to site aggregation at villages located increasingly on ridges began after A.D. 900 and continued into the A.D. 1200s, and that this pattern is evidence people were using more of the landscape through time and that the human population was increasing. Janetski (1997:1085) argued further that since the Fremont farmed maize in addition to hunting that the Fremont who occupied village sites are best modelled as farmer-hunters concerned with both the productivity of their fields and the productivity of their hunting forays. He suggests villages may have been abandoned every few years to maintain maximum yields of both game and maize. Janetski (1997:1085) concluded that the combination of artiodactyl hunting, regular residential moves, and population increase would have ultimately resulted in a gradual decline of artiodactyl populations across the Fremont area. Similarly, Minnis (1985:108) states that during the period of highest population density during the Classic Mimbres period (A.D. 1000–1150) jackrabbit quantities and proportions increased greatly so that jackrabbits were used more than any other single species and artiodactyls were used in low proportions compared with small mammals. The absence of artiodactyls and the abundance of jackrabbits at Scorpion House and the Bunny Massacre site may, therefore, be a result of population growth and resource depression.

The decreased residential mobility at Scorpion House and the Bunny Massacre site may also be indicative of population growth. Kelly (2001:289) argued that "sedentism results when population growth and subsequent population packing raise the cost of residential mobility to an unacceptable level (as it may include displacing another group)." The general pattern of Fremont use of dunal environments is one of relatively high mobility, regardless of whether sites represent residential mobility of full-time foragers or task groups from farming villages. Therefore, Scorpion House and the Bunny Massacre site may represent families forced to reduce residential mobility because higher mobility was not an option due to increasing human populations in the region. The Sawtooth late Fremont seasonal residential sites may represent families forced to intensify foraging in the agriculturally marginal sand dunes of the Sevier Desert because more favorable locations were unavailable due to population growth, as occurred in the White Mountains where higher population densities forced villagers to camp at alpine locations (Bettinger 1991; Zeanah 2000:13).

Conclusion

Archaeological investigations at the Sawtooth sites in the Sevier Desert of western Utah indicate Fremont use of the dune environment changed after A.D. 1000, shifting from short-term logistical processing camps focused on collecting and processing plants and hunting small game to seasonal residential occupations where intensive jackrabbit processing occurred. Decreases in foraging efficiency and residential mobility within an agriculturally marginal environment suggest these changes may have been the result of resource depression and economic stress caused by increasing human populations. Although this may explain the patterns observed at the Sawtooth sites, still in question is why the settlement-subsistence patterns at the late Fremont Sawtooth sites differ from other Fremont habitation sites in dunal environments. Specifically, why are there seasonal residential occupations at Scorpion House and the Bunny Massacre site while all other Fremont dune sites are short-term processing camps?

Chronological differences in site occupation fail to account for the variability in settlement-subsistence strategies. Crater Bench Dune and 42TO504 both date to before A.D. 1000 and, similar to earlier Sawtooth sites, were interpreted as sites representing task groups from farming settlements. However, most Fremont dune sites have date ranges that end after A.D. 1000 and were typically interpreted as representing full-time foragers or forager groups with ties to farmers. For instance, the Topaz Slough site, located 12 miles west of the Sawtooth sites, dates to A.D. 1000–1300 suggesting occupation was contemporary with Scorpion House and the Bunny Massacre site. Differences in seasonal period of occupation also fail to account for the variability in settlement-subsistence strategies since each of the Fremont dune sites appears to have been occupied during the summer and/or fall. Another explanation is that the behavioral variability represents groups with different adaptive strategies that responded differently to population growth and resource depression in the region.

Compared to other Fremont dune sites, Scorpion House and the Bunny Massacre site are more representative of farming groups than of foragers who may or may not have ties with farmers, as has been the standard conclusion. For instance, in addition to pit structures and storage features, there was ample evidence of corn at Scorpion House and the Bunny Massacre site. At Topaz Slough, on the other hand, "the discovery of only one small cob fragment, despite the fact that the entire refuse area was screened (1/4-in. mesh), with a 25 percent sample retrieved for flotation and subsequent macrofossil analysis, suggests this was an isolated find" (Simms 1986:211). The difference in settlement and subsistence patterns between the Sawtooth sites and other Fremont dune sites may therefore be representative of behavioral variability, or adaptive diversity (see Simms 1986), with the late Fremont Sawtooth sites representing farming groups and other late Fremont dune sites representing either full-time foragers or at least groups with a subsistence strategy less reliant on corn, as has been argued.

Despite the behavioral variability represented by these two strategies (farming in the dunes and full-time foraging in the dunes), they may have both arisen because of population growth. Madsen and Simms (1998:290) stated:

> Migrant groups of farmers splitting off from existing farmers was the primary force behind Fremont growth. However, the climatic variability characteristic of the Fremont region, combined with decreased opportunities for horticultural colonization in the parts of the region with the most intensified expression of farming, also led to splitting which produced new groups of Fremont foragers. These new full-time foragers would have been clearly linked to the farmers from whence they came and were also part of the Fremont Complex, not just some unspecified cultural "Other" simply because they did not farm.

Former farmers who chose to adopt a foraging-focused strategy because of population growth that limited available farm land could maintain higher residential mobility by moving into less populated areas, such as the dunal environments in western Utah. One advantage to this strategy would have been greater access to remote areas where resource depression may have been less severe. This may explain why a variety of large game species including deer, bighorn sheep, and antelope were acquired by groups at Buzz-Cut Dune in far western Utah (Table 1; Madsen and Schmitt 2005:123) while no large game species were found at the Sawtooth sites further east. On the other hand, farming groups who chose to intensify activities in agriculturally marginal environments would be expected to maintain closer ties with farming villages, which may be why the Sawtooth sites are found further east than other Fremont dune sites (Figure 1). If Scorpion House and the Bunny Massacre site represent another pattern in the Fremont use of dunal environments, then we can expect to find more seasonally residential occupations in agriculturally marginal locations along the eastern side of Utah's western deserts. Nevertheless, the intensified use of dunal environments at the Sawtooth sites joins the diversity of settlement-subsistence practices that have come to characterize Fremont behavioral variability. ■

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Excavations at Three Ancestral Puebloan Sites Near Kanab, Utah, in 2001 and 2002

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Excavations at three Ancestral Puebloan sites by Utah State University Archaeology Field Schools in 2001–2002 were conducted for the Utah School and Institutional Trust Lands Administration. Each site presented specific research opportunities, and our site reports are organized around research questions. The Pueblo II period Two Bin site (42KA4894) was evaluated for tempo of occupation, the time elapsed before reoccupation, using site formation processes and experimental archaeology of storage bins. The site also highlights the potential for cataloging astronomical orientations of sequentially constructed linear Ancestral Puebloan architectural features for comparison to alignments elsewhere in the Southwest. The Pueblo II period Weeping Juniper site (42KA4895) featured a wickiup-style residential structure, but based on an Ancestral Puebloan floor plan with antechamber/ramp/deflector. The Pueblo I – Early Pueblo II Vermilion Vista site (42KA4896) is a work/storage area featuring an architectural complex including slab-lined bins, hearths, and pits all sheltered by an associated ramada, and representing at least two occupational cycles. The work area may be gender specific to women's activities. This site also speaks to the matter of tempo of mobility in relation to sense of place and social memory.

Three small Virgin Branch Ancestral Puebloan sites were partially excavated by Utah State University Archaeology Field Schools in May and June of 2001 and 2002 (S. Simms P.I.) as part of a cultural resources evaluation by the Utah School and Institutional Trust Lands Administration (SITLA). The East Kanab 40 property is on Shinarump Flats about 17 miles east of Kanab, Utah in pinyon-juniper woodland, at an elevation of 5,400 feet (Figure 1). The parcel was surveyed by Utah State University in August 1999 (Fawcett 2000). Three sites were evaluated as potentially significant, and excavations were proposed to develop the evaluations in the event of a land transfer, and to contribute to knowledge about the Virgin Branch Ancestral Puebloan. The association with a university Archaeology Field School is consistent with the mission of SITLA.

The three sites are within a hundred meters of each other, and rest on flattened ridges overlooking a shallow sandstone wash, not far from a spring. To the north is an arable alluvial flat that captures moisture above the underlying sandstone bedrock. To the south the terrain rises to a sandstone rim. The vegetation is largely Utah juniper with an understory of scattered sagebrush, snakeweed, prickly pear, and yucca. The surrounding area is an archaeological landscape at densities approaching 50 sites per square mile. Survey of Seaman Wash located immediately to the east of the East Kanab 40 property documented 67 Virgin Branch sites (McFadden 1989, 1997).

Each site investigated by Utah State University enabled the investigation of research questions shaped by the findings encountered during survey and excavation. The strategy of investment in

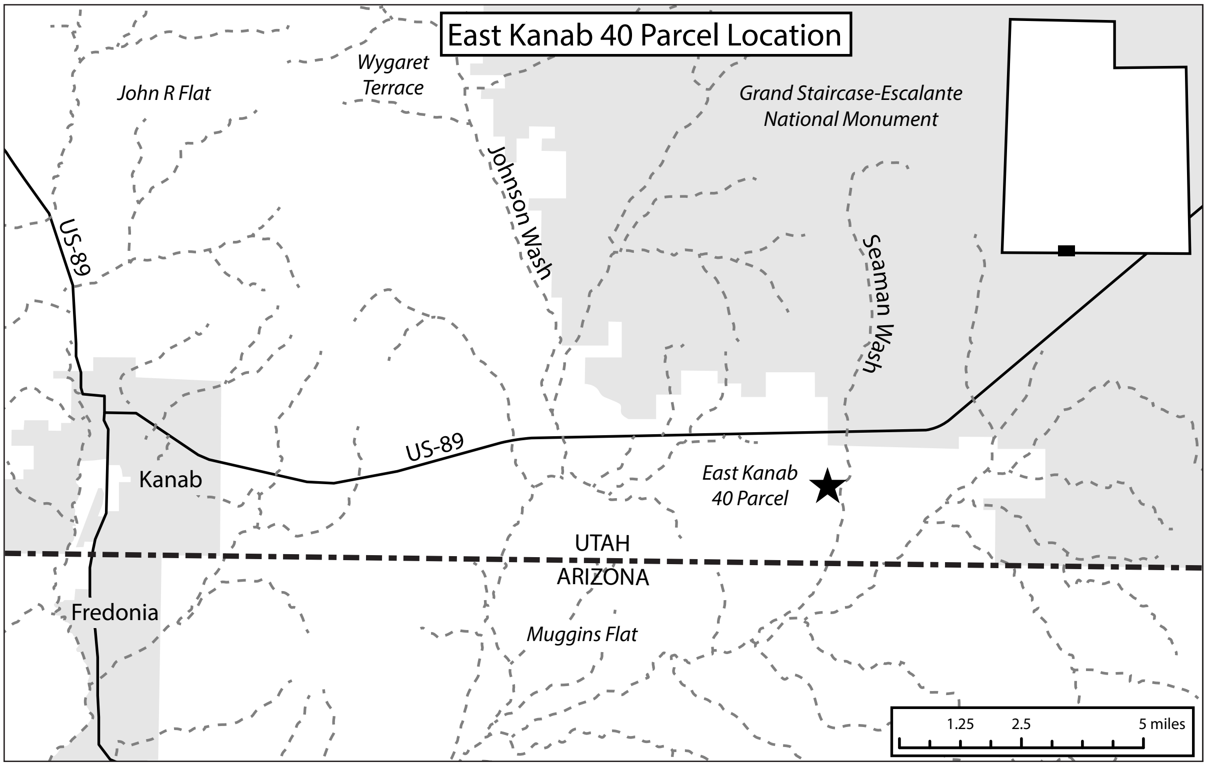

Figure 1. Area map.

subsequent analysis, artifact tabulation, and reporting emphasis vary among the three sites in response to the research questions. Problems investigated and reported here include:

- Ancestral Puebloan sites in this region are often constructed sequentially, and frequently in a linear pattern. Our research explores the tempo of mobility; the duration of abandonments between occupations at sequentially constructed sites. Tempo evaluates the temporal dimension of mobility and brings a processual dynamic that can complement the question of where a group falls on a typological scale ranging from sedentary to nomadic.
- We recorded the orientation of architectural features such as structures and storage bins. We found some variability among sites, and at one site a contrast among different occupations of the same place. Recording of orientations at incrementally constructed sites typical of this region may reveal patterns for comparison to astronomical orientations in other parts of the Southwest. Were such an effort to become common, it may help to gain purchase on one aspect of cosmological beliefs in different times and places in the ancient Southwest. This concept is related to tempo of mobility in that the reuse of sites may be by the same people, or if a period of abandonment is longer, by descendants. Similarity of orientation may be a proxy measure of sense of place and the association of cosmology with constructions of landscape by ancient inhabitants. Contrasts in orientation may signal different traditions and conceptualizations of these matters.
- One site yielded a lightweight, wickiup structure with a Puebloan floorplan motif, and abutting midden. Another site featured an incrementally constructed ramada in association with a typical linear arrangement of slab-lined bins that served as a work/ storage area that was possibly female specific.

Attention to these kinds of features broadens our documentation of architectural variability.

- We applied the well-known middle range theory of site structure, in this case featuring size sorting of floor refuse, and informed by ethnoarchaeology and microrefuse analysis to aid interpretation of the light wickiup structure. Microrefuse analysis was also useful for documenting the activities that occurred on the working floor under the ramada structure.

Summaries of the sites and our findings are:

Two Bin (42KA4894) reflects a Pueblo II chronological sequence beginning with a rectangular subsurface storage bin, a hiatus, and then another rectangular subsurface storage bin aligned with the earlier bin. This was followed by the construction of a masonry structure and associated midden deposits. In addition to documenting the historical sequence, our research strategy aimed to estimate the temporal interval between reoccupations; a facet of mobility conceptualized as the tempo of occupation. Observations of weathering of subsurface storage features after site abandonment and prior to reoccupation were combined with the experimental construction of storage bins like those at the Two Bin site. Our findings suggest that in this case, the tempo of occupation was on a decadal scale. We also offer observations on the value of recording the orientations of architectural features and the implications of these.

Weeping Juniper (42KA4895) is a Pueblo II period site that features a light, wickiup-style circular residential structure constructed on a classic Southwest floor plan including a ramped, southeast-facing antechamber, and stone deflector. A radiocarbon date on charred twigs recovered from the fire hearth date the structure to A.D. 1000–1170. A midden is in association with the structure, and an earlier, subsurface pit indicates a sequence of occupation at this site, but our work focuses on the light structure. The excavation at Weeping Juniper included the analysis of site structure as developed in ethnoarchaeology, specifically artifact size-sorting to aid the identification of the subtle residential structure.

Vermilion Vista (42KA4896) is a work/storage area, possibly female-oriented, and featuring a ramada with what may have been a low stone and adobe wall along the front of the structure creating a covered patio with fire hearths, subsurface pits, and an associated midden. Six slab-lined bins define the north wall of the structure. A midden consisting of an upper and lower layer is separated by sterile sands, and along with superposition, reclamation, and roof collapse from the ramada show that the site was constructed in at least two occupations spanning Pueblo I – Early Pueblo II times. The ramada burned twice during periods of abandonment, perhaps from wildfire, and the collapsed roof fall sealed the relatively clean floor of the structure. Six radiocarbon dates constrain the age of the site to A.D. 600–965, with occupation more likely toward the latter portion of this range. This site complements knowledge from the Two Bin site regarding the tempo of occupation at small Ancestral Puebloan sites where the same individuals, or people with the same memory tradition returned to significant places.

The Two Bin Site (42KA4894)

42KA4894, dubbed the Two Bin site, featured a scatter of lithic and ceramic debris and a concentration of lightly dressed sandstone construction stones suggesting a collapsed masonry structure, possibly with two rooms. Faint ash stains suggest hearths or midden deposits at the site.

Excavations exposed two rectangular, slab-lined storage bins, an above ground masonry structure, and an associated midden deposit. No radiocarbon dates are available for the site, but the architecture, ceramics, projectile points, and several maize macrofossils all point to a Pueblo II occupation in the Virgin Branch tradition (Figures 2 and 3).

Figure 2. Photo of 42KA4894 looking west. Bin 2 at lower center right, Bin 1 center/left center. Scattered rock is Structure 1 debris with north wall of structure fallen at lower right.

Excavation

Trench 1 guided by a series of auger holes proceeded west to east to establish the relationship between the cultural deposits and sterile subsoil (Figure 4). After encountering Bin 1 and Bin 2, and midden deposits above these features, excavation exposed a small portion of floor in the 3 x 9 m, two room masonry Structure 1. The two bins are stratigraphically contemporaneous, but the sequence of construction, use, decay, and deposition of refuse show construction began with Bin 2, followed by a hiatus, the construction of Bin 1, another hiatus, followed by the construction of Structure 1 and deposition of an associated midden.

Bin 1

Bin 1 is a slab-lined storage unit (2 x 1.3 m x .3 m deep. Capacity 22 bushels) originating at the contact of strata II and III. A floor of sandstone flagstones sealed with clay was in an excellent state of preservation. The vertical walls of Bin 1 consisted of sandstone slabs and thin, grayish-white plaster slabs. Erosion was evident around the upper rim of the bin, and the plaster wall slabs had slumped. Many seemed to be missing suggesting reclamation by later occupants. The slab floor was covered by a 2–5 cm thick layer of sterile aeolian sands, indicating the bin stood open for a time after the contents were retrieved. Over that was 20 cm of compacted fill dominated by the disarticulated rubble of the plaster slabs used to line the bin walls. In the upper layers of this rubble were ashy refuse deposits and abundant ceramics and faunal remains. This sequence suggests a formation process where the bin contents were retrieved, aeolian sands were quickly deposited, and then the bin stood open to the elements as the walls collapsed over a significant span of time - years. Later reoccupation of the site deposited refuse into the nearly filled bin – something that could have happened quickly. Some of the wall slabs may have been reclaimed for other uses.

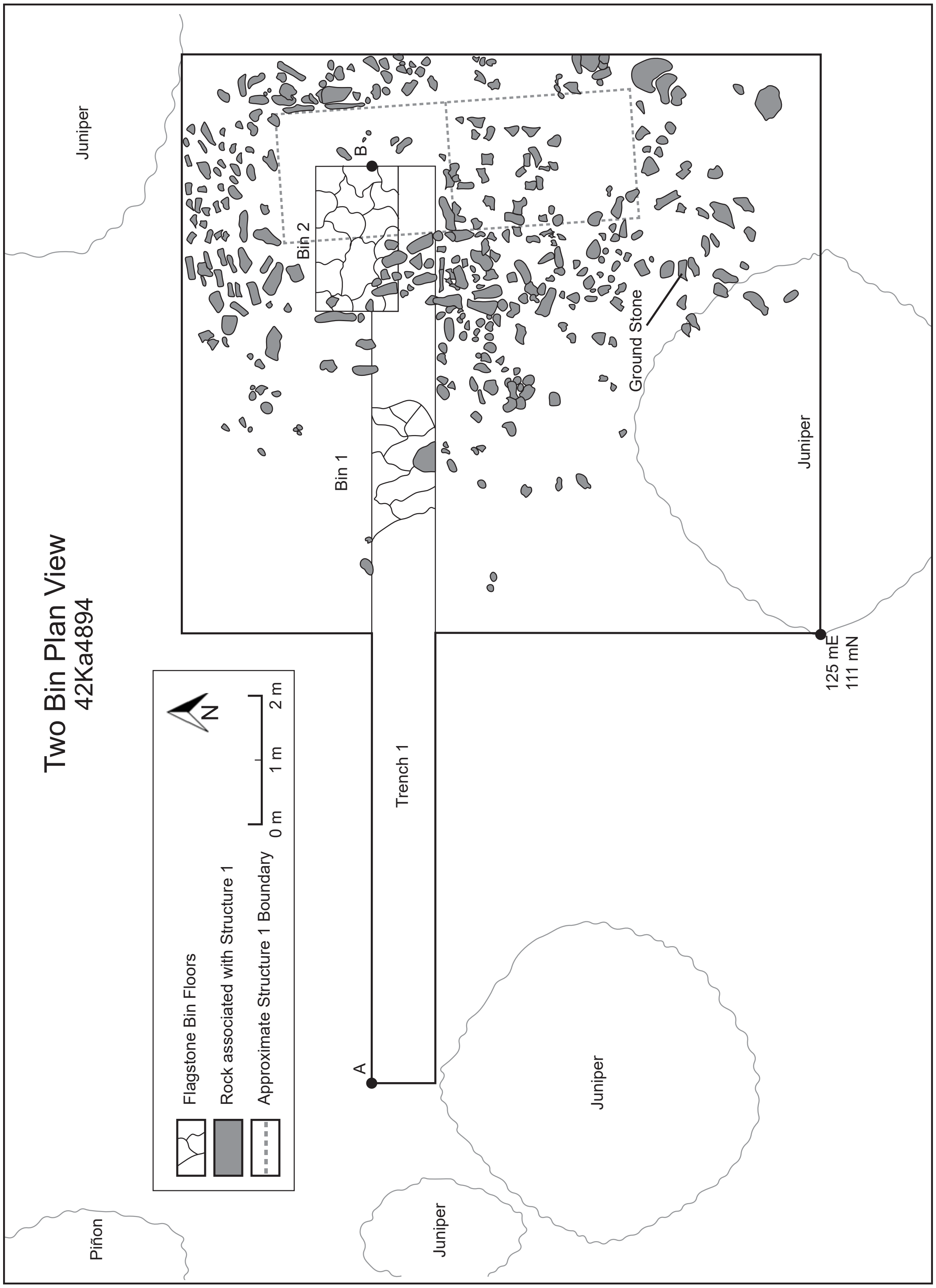

Figure 3. 42KA4894 plan view.

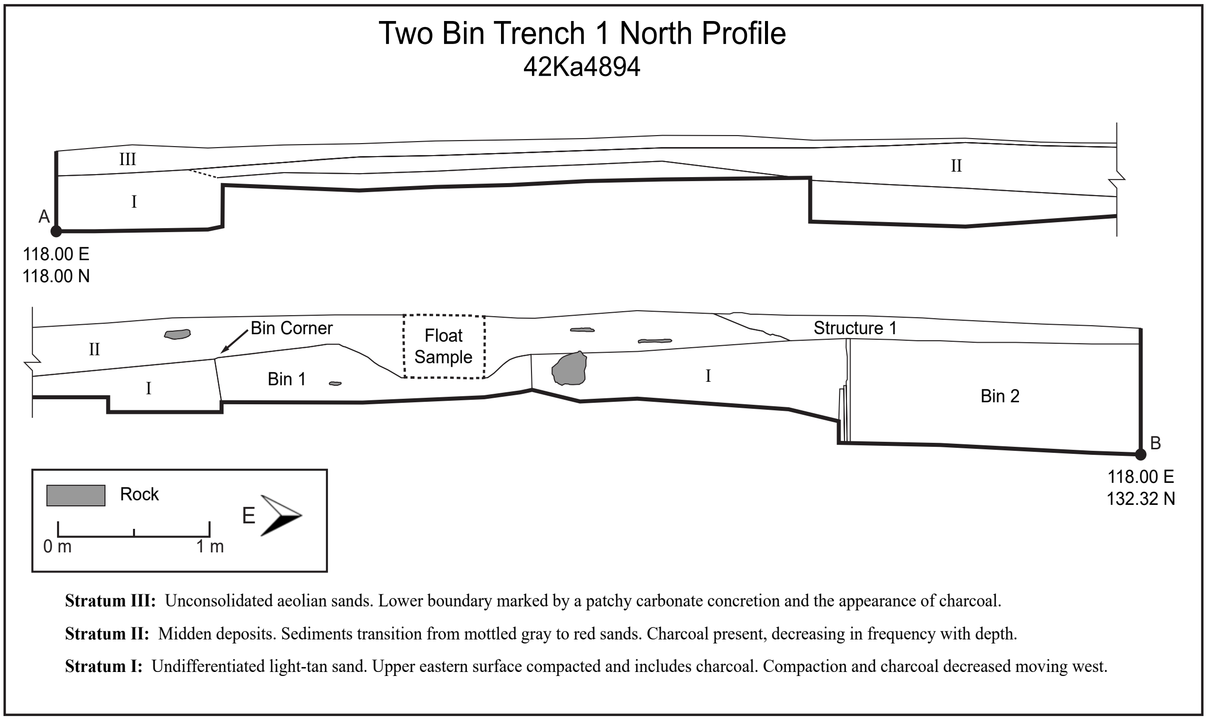

Figure 4. 42KA4894 Trench 1 profile.

Key questions are how long did Bin 1 stand open as the walls collapsed, and how much more time passed before Structure 1 was occupied and the refuse was deposited in the remnants of Bin 1? Answers to these questions would shed light on the duration between reoccupations of this site – the tempo of occupation.

Bin 2

Bin 2 is a slab-lined storage unit (1.9 x 1.3 m x .35 m deep. Capacity 25 bushels), only partially excavated hence the dimensions are estimated. It also originates at the contact of strata II and III. Bin 2 is partially superimposed by the southwest corner of Structure 1 and by midden. The floor of Bin 2 is identical to Bin 1, but unlike Bin 1, a large portion of the vertical walls of Bin 2 remain standing and all are of tabular sandstone in contrast to the use of sandstone and plaster slabs in Bin 1. Also unlike Bin 1, Bin 2 appears to have been enclosed by a masonry collar. The contrasting methods of construction and the fact they do not abut suggests they may not be contemporaneous.

A 1–2 cm thick layer of sterile aeolian sands covers the floor of Bin 2, indicating it stood open for a short interval after the contents were retrieved. This was overlain by a mixture of sands and sandstone cobbles deposited quickly enough that the slab walls of the bin did not have time to slump as was the case in Bin 1. Bin 2 was thus largely filled before the reoccupation of the site associated with Structure 1 and the midden. In contrast, Bin 1 had stood open long enough for the walls to have collapsed, filling it with rubble, yet it was still open for the deposition of midden deposits after Structure 1 was built. Yet by this time Bin 2 was completely buried, and midden was deposited over the filled bin. As with their different characteristics of construction, this formation sequence indicates Bin 2 was constructed prior to Bin 1. The question of how much time passed between construction episodes also speaks to the matter of the tempo of occupation. It may be significant that both bins are constructed on an orientation of 68–70 degrees as is common at Virgin Branch sites.

Structure 1

Structure 1 measures 3 x 9 m with an interior dividing wall oriented west – east (Figures 2 and 3). Parallel scatters of rock associated with fallen walls were evident along the northern edge of the structure and less so along the southern wall. Vertical slabs line the interior in two places. The presence of an interior dividing wall is inferred from an alignment of dressed sandstone blocks, and a vertical slab along this axis. Both the north and south walls collapsed downslope and to the north. No interior features were found, but only a small portion of unpaved floor was exposed amid the abundant rubble and mortar, leaving open the possibility there is an interior hearth(s). The association of the midden with the structure and dirt floor implies a residential function. The orientation of the north and south walls of structure 1 is about 85 degrees, contrasting with the orientation of the bins.

Midden

Trench 1 exposed a layer of ashy sands with significant amounts of decomposed charcoal, along with lithics, ceramics, faunal, and botanical materials. The midden was only excavated within Trench 1, hence its extent is unknown. It is identified as Stratum II in profile (Figure 4). It overlies Bins 1 and 2, and abuts Structure 1, indicating contemporaneity. The profile shown in Figure 4 shows Structure 1 overlying a portion of Stratum II midden, but this is just wall fall collapsing onto the midden.

Artifacts, Faunal, and Botanical Remains

Artifacts

The artifacts recovered from 42KA4894 are summarized in Tables 1 and 2. Flakes and tools represent all materials recovered. The ceramics include all of the material recovered from Bins 1 and 2 and the Stratum II midden. Surface ceramics and those from the surface blow sand are not included. Ceramics from Structure 1 are limited to an area immediately north and south of where Trench 1 passed through the structure where the association with floor contact was clear.

A cursory examination of these tables finds striking contrasts in artifact distributions. Most obviously, the vast majority of the 2,799 flakes and tools recovered were found on the surface, or in the midden and Structure 1. Only 47 pieces of debitage (1.7% of all debitage) came from bins 1 and 2. Bin 2 contains similarly low quantities of other refuse types, consistent with it standing open, eroding, and filling with sands and surface artifact debris, but not refuse-dumping. Bin 1, on the other hand, contains higher quantities of other artifact types, especially ceramics and faunal material, consistent with the bin being open for refuse dumping. The paucity of lithic debitage in Bin 1 remains enigmatic, but could indicate the refuse was from a single or few disposal events that did not include lithic debris.

Both the midden and Structure 1 yield numerous debitage and tools, and their proportions are similar: Tertiary flakes (72% of the midden, 63% of the Structure 1) and primary/secondary flakes (6/15% midden; 8/18% Structure 1).

Of the 24 tools and fragments (Table 1), 10 were found on the surface. The others came from Structure 1 (10) and the midden 1 (4). Projectile points include an Eastgate and a Cottonwood Triangular in the midden, and an Elko Corner-notched and Large Side-notched point in Structure 1. The small area of Structure 1 fill produced biface fragments, a unifacial flake, and a drill. The vast majority of these tools were made of local cherts. One large generic projectile point and one biface fragment were produced from obsidian. This varied tool assemblage and the preponderance of secondary and especially tertiary debitage are all consistent with residential occupation.

Of the 144 ceramic sherds from 42KA4894, 82% are plain wares (Table 2). These include North Creek Gray, Virgin Series whiteware, and Virgin Series grayware. The remaining 26 sherds

Table 1. 42KA4894 Lithic Artifact Data

Feature	Primary Flakes	Secondary Flakes	Tertiary Flakes	Flake Tools	Core	Shatter	**Total**
Surface	146	244	1,226	10	2	184	**1,812**
Midden	23	61	289	22	2	23	**420**
Bin 1	0	3	7	0	0	3	**13**
Bin 2	0	5	25	0	0	4	**34**
Structure 1	56	130	458	82	4	64	**794**
Total	**225**	**443**	**2,005**	**114**	**8**	**278**	**3,073**

Table 2. 42KA4894 Ceramics by Feature.

Feature	North Creek Black-on-Gray	North Creek Gray	Virgin Series grayware	Virgin Series whiteware	North Creek Fugitive Red	**Total**
Bin 1	9	50	0	0	2	**61**
Bin 2	0	1	0	0	8	**9**
Structure 1	6	24	23	0	1	**54**
Midden	0	13	2	5	0	**20**
Total	**15**	**88**	**25**	**5**	**11**	**144**

include 15 North Creek Black-on-Gray and 11 North Creek Fugitive Red. As with the lithic debitage, Bin 2 produced only 9 ceramic sherds of which 8 were North Creek Fugitive Red. While three sherds of North Creek Fugitive Red from Trench 1 were provenienced to Structure 1 and Bin 1, the deposition of most of the Fugitive Red pieces in the fill of Bin 2 suggests a single event. Bin 1 produced 61 sherds of mostly North Creek Gray. Structure 1 ceramics were dominated by North Creek Gray and Virgin Series grayware, the latter too faded or undiagnostic to be placed into types.

Faunal Remains

The zooarchaeological assemblage is fragmentary, and 60% are too small to identify to size class (average weight .15 g/specimen). Of the identifiable material, 7.5% comes from artiodactyls or artiodactyls-sized animals and 15.7% from Leporids (jackrabbit and cottontail); both are common components of prehistoric diets throughout the region. Direct evidence of human agency in the form of cut marks or burning is limited; only three identifiable fragments showed evidence of burning, and none had cut-marks. Neither is surprising given the small size of the sample and the degree of fragmentation. Nevertheless, given the cultural context and the fact that the site is open, rather than in a cave or rockshelter, the lagomorph and artiodactyl materials are almost certainly cultural in origin.

Botanical Remains

Ten samples from the midden were floated and only the light fraction of recovered materials was analyzed, given that we did not have occupational floors at this site. All of the samples produced charcoal. Five samples produced Zea mays kernel fragments.

Interpretation and Discussion

The Two Bin site (42KA4894) reflects three occupations featuring small scale storage and possibly residence consistent with Ancestral Puebloan field houses. No chronometric dates are available, but the abundant North Creek Gray, and the less frequent North Creek Black-on-Gray and North Creek Fugitive Red are consistent with Pueblo II occupation. The Virgin Series whitewares are so fragmented or faded that more specific identification is difficult.

The evidence indicates the site accumulated in three events: construction of Bin 2, then Bin 1, then Structure 1 and the midden. Of interest in our research design is the tempo of occupation or the elapsed time between occupations. If this time is short, perhaps a few years or a decade, the site could have been reused by the previous occupants. If reoccupation was on the order of several decades or more, then the site may be known more through social memory. The concept of occupational tempo is one facet of settlement patterns for the Virgin Branch Ancestral Puebloan, and seems worthy of attention.

A working model is that Bin 2 was constructed first, used, opened, and filled largely by natural deposition, both aeolian and slopewash. Bin 2 was virtually clean, with only a few dozen pieces of debitage. Bin 2 had an adobe collar, and while it was somewhat eroded, the collar protected the walls, which remained in good condition. This may have contributed to the filling of the bin by providing a trap, but the erosion and natural deposition we observed seemingly could have been produced in perhaps a decade.

Bin 1 was constructed next, about two meters away from Bin 2, and perhaps significantly, both bins have an orientation between 68–70 degrees. The location of Bin 2 may have been evident to the builders of Bin 1, hence the orientation was replicated. After the contents of Bin 1 were retrieved, it severely eroded with the wall slabs slumping into a jumbled mass. The edges of the feature were sloped and dissected from water and wind erosion. Bin 1 appeared to have stood open for perhaps several years prior to the deposition of ashy refuse that included ceramics, bone, and a small amount lithic debitage.

Structure 1 was subsequently constructed and the midden accumulated during this time. Bin 2 was already filled when Structure 1 was constructed, but Bin 1 would have been evident to the later occupants.

We appeal to experimental archaeology to supplement the evidence from the stratigraphic sequence described above to propose a tempo of occupation for the site. Two experimental bins (Figure 5) were constructed nearby and modeled after the excavated storage bins at 42KA4894. Experimental Bin 1 (EB1) was constructed in June 2002, and EB2 was constructed in March 2003. EB 1 & 2 were left open to mimic the decay of prehistoric bins after their contents were retrieved. The pace of erosion of both bins was monitored through March 2004.

The degree of erosion even over a two year span is dramatic. The cross section of EB 1 (Figure 5) reveals an amalgam of slumped clay from the bin walls, and an overburden of slope wash. EB 2 two is a dramatic palimpsest of collapsed wall slabs with an overburden of slope wash and aeolian sands, all occurring within a year after construction. Both bins show some slopewash, but after only two years the bins were only partially filled, and remained obvious depressions.

The Two Bin site, 42KA4894, illustrates that the tempo of occupation varied. After the contents of bins 1 and 2 were retrieved, they may have collapsed in only a few years. The construction and subsequent erosion of Bin 2 spanned perhaps a decade. Bin 2 may have been evident to later occupants who constructed Bin 1. After Bin 1 was opened, it eroded within a few years, and was then used as a refuse dump. Overall, perhaps a decade or two would have been required to fill the bins to the degree we observed in the excavation.

Setting this in human terms, the use of the same orientation for the bins suggests either the same people or descendants returned. The practice of returning to the same site reflects sense of place and memory culture in practice. The exercise at the Two Bin site suggests that tempo of occupation can be ascertained under some circumstances. It would seem profitable for archaeologists to stay attuned to the investigation

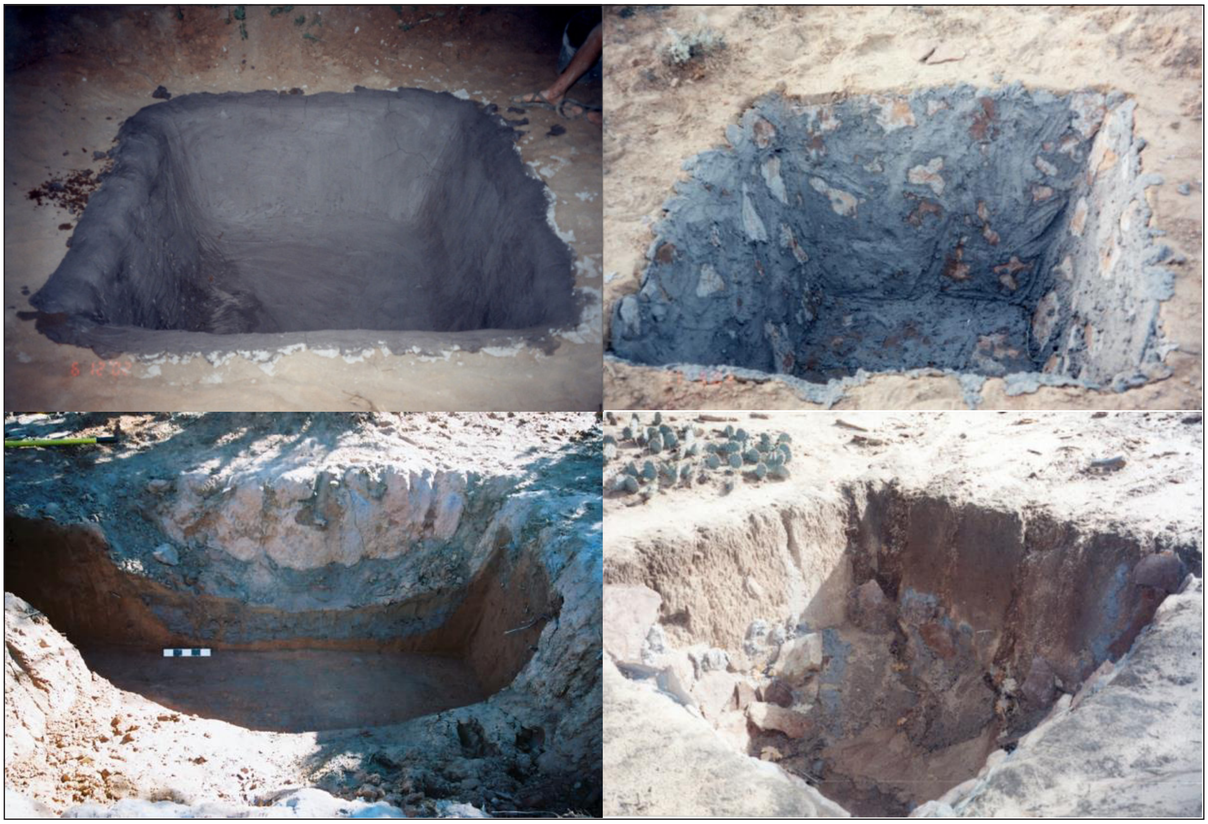

Figure 5. Experimental bins. Top left: Bin 1 (June 2002), top right: Bin 2 (March 2003). Lower left: Bin 1 excavated cross-section (March 2004), lower right: Bin 2 (March 2004).

of the tempo of occupation, because the temporal grain of settlement overcomes the problem with the typological approach to mobility in that people can be both sedentary and nomadic over the life history of individuals.

It is intriguing, albeit somewhat musing to note that the 68–70 degree orientation of the bins approximates a lunar orientation, the lunar minor standstill at 67.1°. Lunar orientation with variation of a few degrees is found in major buildings in some parts of the Southwest, and is one of two major astronomical orientation systems at Chaco Canyon (Lekson 2008:127, 238–239, 293n136, 308n56; Sofaer 1997). The linear arrangement of Virgin Branch storage bins and structures has long been known, but there seems to be little attention to the astronomical aspects of these orientations. Similarities and differences in orientations among Virgin Branch sites could be a window into the cosmological, and hence identity and kin associations of the people.

Years or perhaps over a decade after Bin 1 was used, people returned and built Structure 1, depositing the midden. The orientation of Structure 1 is about 85 degrees, hence closer to a cardinal, solar/equinox orientation, thus contrasting in a structured way from the orientation of the bins. A solar orientation is the other major system evident in the Four Corners Southwest.

Perhaps a worthy line of research would be to catalog astronomical orientations of individual structures, and arrangements of structures at Virgin Branch sites as a possible window into differing cosmological understandings among the people, and to further integrate the Western Pueblo with the world of the ancient Southwest. This might make an excellent project for a Masters thesis.

The Weeping Juniper Site (42KA4895)

42KA4895, named after a weeping juniper, featured a surface scatter of lithic and sparse ceramic debris, a circular depression suggesting a subsurface structure, and an area of ashy sands and fire-cracked rock. Excavations exposed a wickiup-style structure with a hearth but based on a Southwest floor plan, with a deflector and antechamber/ramp oriented to the southeast. Radiocarbon dates the structure to A.D. 1000–1170, and this age is consistent with the small number of ceramics and arrow points from the site. As with the Two Bin Site, the vicinity of Weeping Juniper was heavily occupied, and this light structure may be in association with other features. Auger sampling found patches of ashy sediments up to 30 cm deep in 7 of 16 auger holes along three transects extending up to 20 m south, and upslope from the structure (Figures 6 and 7).

Excavation

A 1 m wide, 17 m long exploratory Trench 1 was excavated north to south to identify site stratigraphy and bisect the depression suspected of being a structure. Stratum I is the compacted sand of sterile subsoil. Probes and augering indicate Stratum 1 overlies bedrock. Stratum II is also compacted sands from 0–12 cm thick, but contains ash, charcoal, and artifacts. The absence of a clear contact between Stratum I and II suggests that occupational debris was deposited on a churned, sandy surface. Stratum III is surface blow sand with artifacts and is 3–12 cm thick.

Trench 1 transected the depression and identified Structure 1. Stratum II, a diffuse midden, extends west and north of the structure, and originates at the edge of Structure 1 where the deposits are thinnest. To the north and downslope from Structure 1 Stratum II thickens to 10–12 cm. and continues throughout the length of Trench 1. No Stratum II midden is found south and upslope from the structure, indicating that the midden, or at least a portion of it is contemporaneous with Structure 1.

Exploratory Trench 2, extended west to east and confirmed that the structure originates at a 3 cm. thick layer of ashy carbonate-cemented sand laminates at the contact between Stratum II (compacted sands) and stratum III (surface blow sand). The bulk of the artifacts occur at this contact. This surface is associated with Structure 1, but also extends south and upslope from the structure entrance suggesting it was an extensive, hard, and cemented occupational surface at the time Structure 1 was used.

Clearing of Structure 1 revealed a sub-circular, saucer-shaped depression 4.6 m x 5 m in diameter and up to 15 cm deep. A ramp/antechamber feature extended toward the southeast and upslope from the depression. A rectangular sandstone slab 25 cm x 20 cm wide was found at the base of the ramp in a direct line to the hearth, suggesting a small deflector; a diminutive representation of a common arrangement in a wide variety of pithouse forms across the Ancestral Puebloan world. The slab had slumped and alluvial wash built up around it at the base of the ramp.

A fire hearth in the center of the depression is 60 cm in diameter x 3 cm deep, and is deflated and smeared, hence the hearth was likely smaller when in use. An AMS radiocarbon date on small twigs of unidentified wood charcoal from the Structure 1 hearth yields an age of A.D. 1000–1170 (cal. 2 sigma, Beta 161625).

The floor of Structure 1 yielded residential debris including hammerstones, a large quartzite chopper, pecking stones, a scraper, a Bull Creek (or Kayenta?) projectile point (Weder and Sammons-Lohse 1981; Geib et al. 2001:218–219), a small basal-tanged point, point fragments, utilized and retouched flakes, and ground stone fragments. Microlithics indicating tooling were found in the heavy fraction of floor flotation samples. Neither the hearth nor floor yielded

Figure 6. Photo of 42KA4895 looking north showing Structure 1. Individual standing near northeast edge of structure with deflector in front of her and deflated hearth to the left/front of her.

identifiable botanical remains probably due to mechanical erosion of the sands. No ceramics were found on the structure floor, thus ceramics cannot speak to its age.

No post holes are evident at Structure 1, and the absence of burned adobe daub suggests only a light superstructure. While the structure appears to be wickiup in morphology, the antechamber/ramp and deflector indicate a Southwest style floor plan.

The stratum II midden abuts and extends downslope to the north of the structure suggesting it is associated. The midden contained ash, lithic debris, but only a single ceramic sherd of North Creek Corrugated.

Only 18 ceramic sherds were recovered from the site including six North Creek Gray, eight St. George Black-on-Gray, the one sherd of North Creek Corrugated, and three unidentified grayware sherds. Four of the sherds were from the outer edges of Structure 1, but their association with the structure is not clear. These include two sherds of St. George Black-on-Gray, one North Creek Gray, and one unidentified grayware sherd. The paucity of ceramics is interesting, but the small assemblage is consistent with the radiocarbon window of A.D. 1000–1170 from the hearth of Structure 1.

A large 1.2 m x 95 cm deep subsurface pit with a conical bottom that filled intermittently with refuse and natural fill lies within the boundaries of Structure 1. Stratigraphically, the pit originates at the same level as the structure. However, a standard juniper charcoal radiocarbon date of 390–100 B.C. (cal. 2 sigma, Beta 161624) from under a sandstone slab 50 cm deep within the pit indicates it predates the structure; albeit old juniper wood may skew the date making the pit

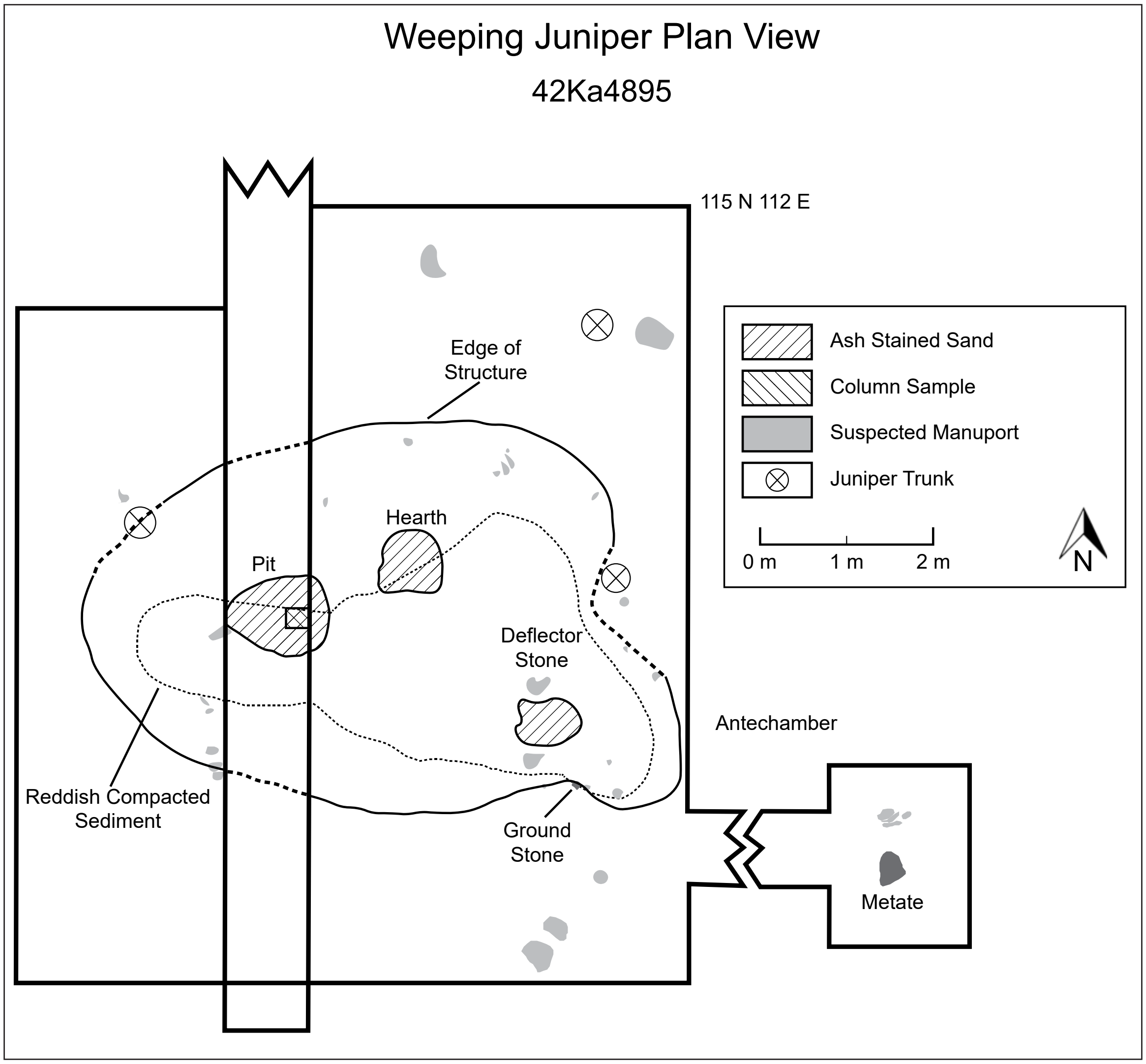

Figure 7. 42KA4895 plan view. Shows portion of Trench 1 (north-south) bisecting Structure 1 and interior features. "Pit" is the dated subsurface pit that is earlier and not associated with Structure 1. Trench 1 is shown collapsed here, but was 17 m long. Exploratory Trench 2 (east-west) is also shown collapsed. It was 13 m long.

younger than this age. This suggests the site was occupied more than once, and the possibility of other features nearby cannot be ruled out, although none were seen in the two exploratory trenches.

Interpretation and Discussion

At the Weeping Juniper site (42KA4895) we initially aimed to sample a portion of a shallow depression that we expected to be a typical pithouse. Instead we found evidence for a lightweight structure: A subcircular saucer-shaped depression 4.6–5 m in diameter, a maximum of 15 cm deep, and an absence of post holes and burned daub. Without debating what qualifies as a pithouse, Structure 1 is similar to wickiup structures across the Great Basin and Rocky Mountain regions with one significant difference. The floor plan is Southwestern with an antechamber/entry ramp, and significantly,

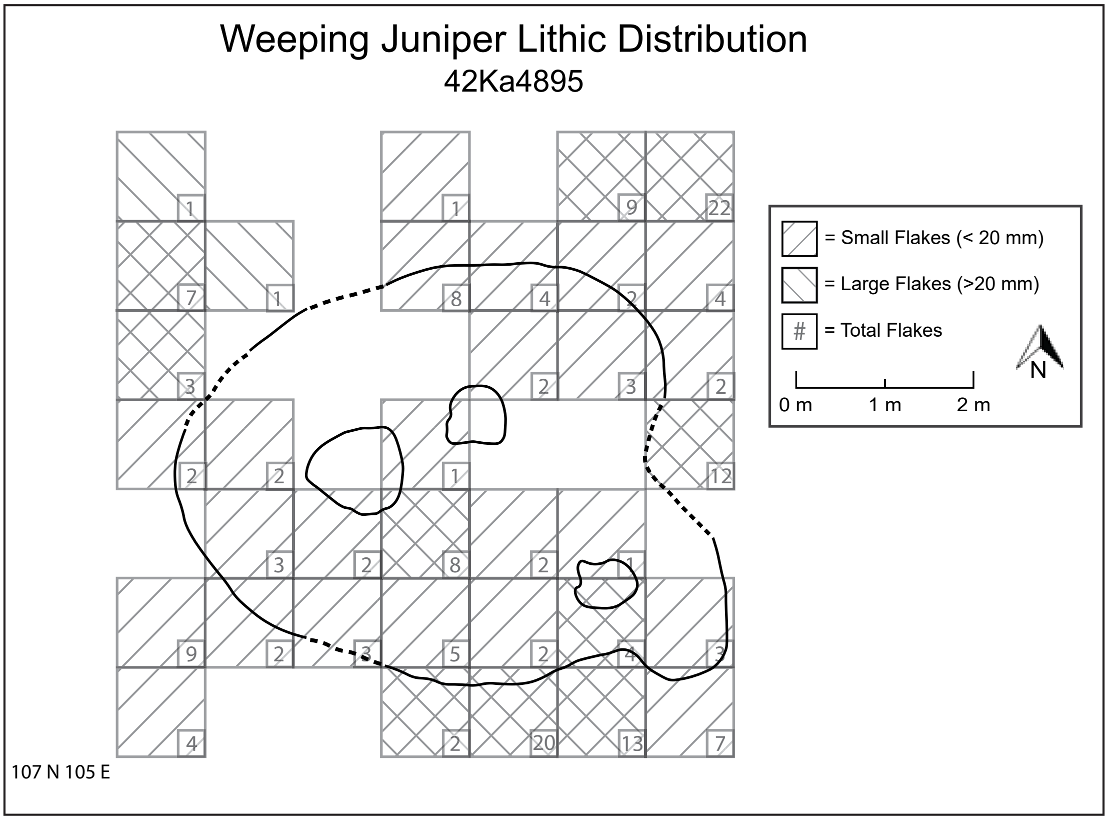

Figure 8. 42KA4895 Size/distribution of lithics on Structure 1 floor and around Structure I at the contact of strata II and III.

oriented toward the southeast. A deflector stone is situated between the antechamber and the hearth. While this seems to be unusual for Virgin Branch sites, the orientation is interesting, and a Southwestern cultural designation for this light structure is consistent with the AMS radiocarbon date of A.D. 1000–1170 taken from the hearth.

An associated midden was found north of the structure. It originated on the same surface, and the midden deposits terminated at the edge of Structure 1 suggesting association of at least part of the midden.

Once inside the perimeter of Structure 1 the artifact assemblage resting on the floor became strongly residential. Lithic debris was absent or small over most of the structure interior, except for a cluster of larger (>20 cm) flakes south of the hearth and another cluster at the base of the antechamber/ramp (Figure 8). Archaeological sites left by foragers practicing some cleaning frequently yield this pattern, as do ethnoarchaeological cases. Larger items such as the hammerstones, pecking stones, and ground stone objects are diagnostic of a household context and such debris is typically found along the perimeter of the structure. Most of the large debris in Structure 1 was indeed concentrated near the west edge farthest from the door. A small cluster of hammerstones and debris was also found at the base of the entry ramp with the larger lithic flake debris. No ceramics were found on the structure floor indicating that if vessels were used, they were removed, and that if a vessel had broken inside the structure, the sherds were removed.

By drawing analogies with forager archaeology, we do not imply that foragers occupied this site. Rather, Structure 1 documents a kind of behavior and architecture Southwestern archaeologists would expect for the Ancestral Puebloan; expedient structures, but nevertheless constructed on the same ideological principles as larger, more permanent pithouses. Little by little such structures are becoming known, but can be difficult to locate or easy to overlook when so many obvious features on Anasazi sites vie for our attention.

The Vermilion Vista Site (42KA4896)

42KA4896 is located on a rise, offering an expansive view north toward the Vermilion Cliffs, hence its name. Closer examination after initial survey discovered what appears to be one element of a large site extending beyond SITLA property lines. Our evaluation focused on a 19 m long structure that was a ramada indicated by abundant roof fall and posts. A low masonry and perhaps jacal wall fronted the structure to the south creating an enclosed, covered patio area. Six slab-lined storage bins are associated with, and were partially underneath the roof of the ramada, marking the northern edge of the structure. The interior work space included four hearths and/or roasting pits, four subsurface/bell-shaped pits, four shallow floor pits with small cobbles and artifacts, and an activity area in front and south of the ramada (Figures 9 and 10).

A midden deposited in two stratigraphic units arcs around the eastern flank of the structure and yielded a bone ornament, several small arrow points, abrader stones, and small to medium sized burned mammal bones. There is evidence for plant food processing, possible manufacture of ground stone and lithic tools, and possibly the pre-firing stages of ceramic manufacture.

The structure, wall, and bins are oriented on a 73 degree axis. Stratigraphy and superposition of features, fill, and the formation of the middens indicate the ramada structure and slab-lined bins were constructed in increments. The structure burned twice, likely from wildfire during abandonments, reflecting the incremental occupation. Six radiocarbon dates across the extent of the structure yield a constraining window of occupation between A.D. 600 and A.D. 965, but occupation is most likely toward the end of this range (see section on Chronology and Table 3). This is consistent with ceramics and architecture indicating occupation during Pueblo I and Early Pueblo II times.

Excavation

An alignment of large, up to 30 x 60 cm, well-dressed masonry blocks guided a test trench and eventual identification of the ramada and associated bins and pits. The ramada burned after at least two occupations, sealing the living surface with roof collapse. This circumstance enabled us to trace the distribution of adobe roof fall into and over various features. The slab-lined bins exhibited superposition, remodeling, reclamation of slabs, as well as a small subsurface pit in one bin filled with ash. The bins also exhibited various forms of natural erosion/collapse, refuse dumping, and the abovementioned roof collapse events. Preservation was not as good along the south side of the structure where the adobe roof fall layer thins and erosion now leaves the structure floor only a few centimeters below the modern blow sand. The low masonry wall along the south edge of the ramada was marked by abundant adobe slump and melt.

The roof of the ramada was supported by a line of posts set about 50 cm from the rear edge, with the roof extending partially over the bins, judging from roof-fall. The burnt, butt ends of six of these juniper posts, ranging from 10–20 cm diameter are preserved in the hardened adobe. Four postmolds were found along the south side of the structure and one was subject to radiocarbon dating of the outer layers of the post (Table 3).

Some postmolds near the eastern end of the structure had no remnant posts, while others to the west had the remains of burned posts. Midden deposits covered some of the eastern,

Figure 9. Photo of 42KA4896. Individuals mark features: at left in bins, in center at hearths and pits, and behind midden in background.

open postholes suggesting posts may have been recycled after the first occupation. Further, the midden east of the ramada was deposited in two stratigraphic units separated by a sterile sand layer implying two occupations of the site. A radiocarbon sample was taken from the lower unit of midden with a date of A.D. 700–900, the early portion of the sites occupational range. Ceramics did not chronologically distinguish between the lower and upper occupations.

The alignment of masonry blocks that initially identified the feature during survey was only one course high, but associated adobe chunks/melt patterns suggests it was a footer wall anchoring an adobe (possibly jacal?) wall to create an enclosed, covered patio area. The morphology of the wall can only be speculated upon, but the volume of adobe debris melted from the wall suggests it was low. This would create a wind break along one side of the ramada. Inside and

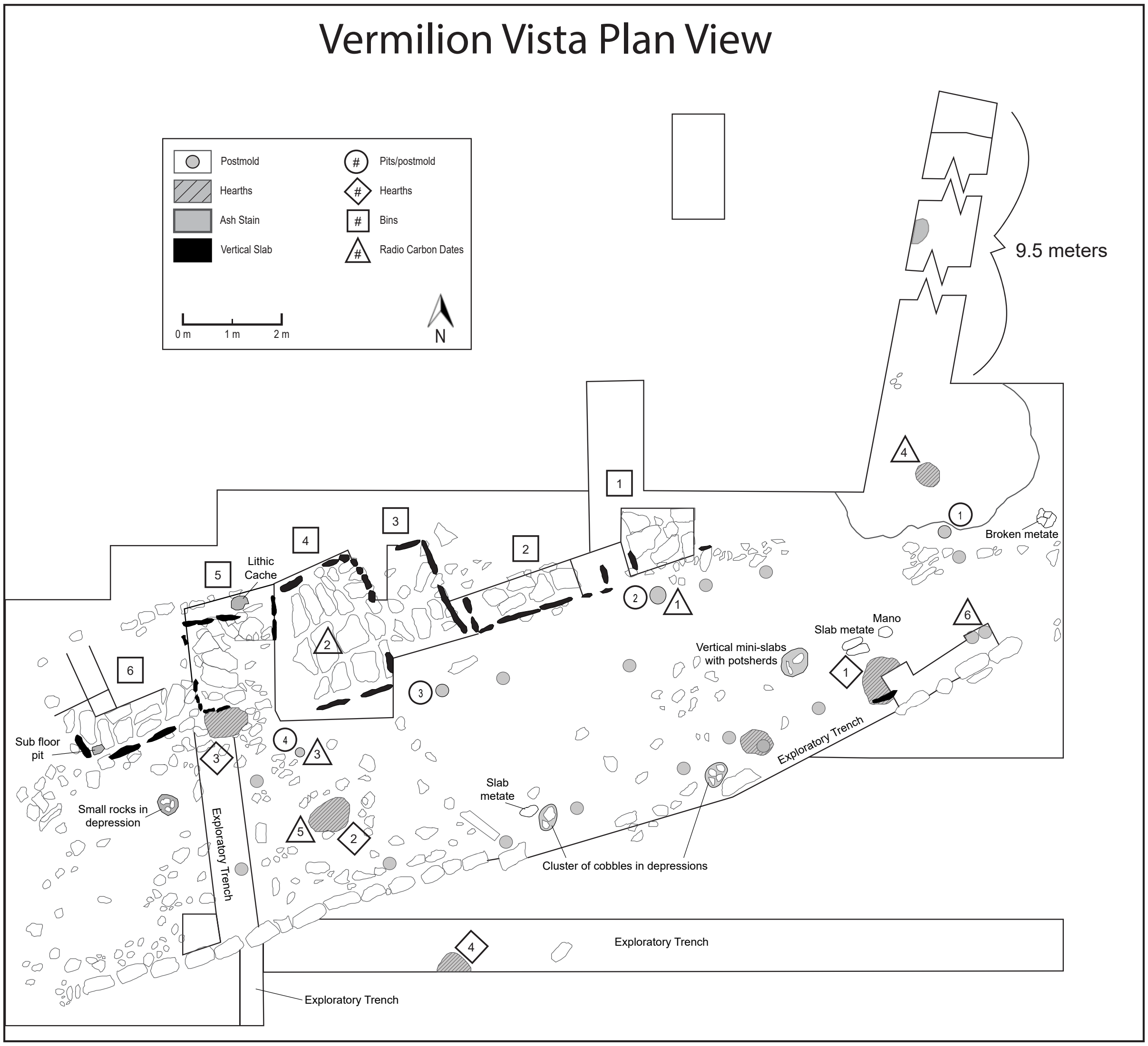

Figure 10. 42KA4896 plan view showing features and locations of radiocarbon samples.

under the ramada was a hard-packed dirt floor with a variety of features and artifacts.

Four bell-shaped pits (30–35 cm maximum diameter x 30–50 cm deep), two of which produced AMS radiocarbon dates on charred maize kernels, seemed to be remodeled from earlier structural post holes as the structure was rebuilt or added to from east to west.

At the front (south side) of the ramada along the edge of the apparent roof line, were two unlined, circular hearths, and one slab-lined hearth, each 60–80 cm in diameter. The slab-lined hearth produced an AMS radiocarbon date on charred maize kernels (Table 3). Two hearths contained ash/charcoal fill, and one was used to dump slurry of a purplish clay typical of the Chinle formation (available less than 5 km away). It also contained large sections of broken vessels suggesting their use and breakage at the ramada or nearby. Other hearths were outside of the structure to the south in what was probably an open-air activity area in front of the ramada.

Table 3. 42KA4896 Radiocarbon Samples and Dates.

Sample	Material	Provenience	13C/12C	Conventional Age (A.D. 1950)	Calibrated Age (2 sigma)
1 Beta 171265	Charred maize kernel	Pit 2	-10.8 o/oo	1250+60BP	A.D. 660–900
2 Beta 171266	Charred maize kernel	Bin 4 floor	-9.2 o/oo	1260+40BP	A.D. 670–875
3 Beta 171268	Charred maize kernel	Pit 4	-8.9 o/oo	1250+40BP	A.D. 675–880
4 Beta 171267	Bone collagen	Lower midden	-18.7 o/oo	1110+40BP	A.D. 700–900
5 Beta 171264	Charred maize kernel	Hearth 2	-10.5 o/oo	1190+40BP	A.D. 720–745 A.D. 760–965
6 Beta 161626	Outer 1/3 burned juniper	Ramada post	-21.0 o/oo	1360+60BP	A.D. 600–780

The north edge of the structure is defined by a linear arrangement of six slab-lined bins. The bins are similar in size (dimensions described below) with a mean capacity estimated at 57 bushels each. The curvilinear morphology of bins 1 and 2 suggest Pueblo I, while bins 3–6 are rectangular, a form more common in Early Pueblo II times. Judging from roof fall, the ramada extended partially over the bins, making them a defacto north "wall" or edge of the structure.

Bin 1

Bin 1 (aligned with Bin 2, but unknown dimensions x .5 m deep) is the easternmost bin, but only partially excavated. The floor was a single layer of slabs. The lower fill consists of ashy sands and occasional charcoal flecks and chunks. No rock rubble was deposited in the bin. Above this level wall slabs were missing suggesting reclamation, but the floor slabs must have already been buried as they are intact. The remaining fill is roof fall.

Bin 2

Bin 2 (2.5 m x 1.3 x .75 m deep) is separated from Bin 1 to the east by a 30 cm baulk. This bin is curvilinear suggesting Pueblo I, and thus implying that the earlier Bin 1 is also Pueblo I.

It also had a single-layer slab floor that had been plastered. Bin 2 stood open after abandonment accumulating clean, aeolian sand that became cemented from ponded water in the open bin. Above that was rock rubble in a sandy fill with some ash/charcoal, but few artifacts. No wall slabs had been reclaimed from Bin 2.

Bin 3

Bin 3 began as a large (3.3 x 1.75 x .5 m deep) slab-lined bin with a single-layer plastered slab floor. It was built immediately west of Bin 2, but employed a separate wall with a 20 cm baulk between bins 2 and 3. Sometime later, a divider of dressed masonry rather than vertical slabs was added and the eastern half of Bin 3 became filled with considerable dressed masonry rubble, but no ashy refuse, and few artifacts. Use of the west half continued, creating Bin 4. Thus Bin 4 is a smaller bin (1.9 x 1.75 x .5 m deep) using the floor of Bin 3. After use, Bin 4 stood open, accumulating 2–4 cm of aeolian sands, and above that sandy fill with rubble, sparse ash, but with charred maize kernels in two places. One sample of these was submitted for AMS radiocarbon dating (Table 3). Some of the westernmost wall slabs were reclaimed and then Bin 4 accumulated abundant stone rubble. Burned roof fall from the ramada collapsed over bins 3 and 4 after they were filled.

Bin 5

Bin 5 (1.9 x 1.8 x .35 m deep) is a slab-lined bin with a double layer plastered slab floor, suggesting remodeling, or simply added rodent-proofing. It abuts Bin 4 to the east and perhaps incorporated some of the missing slabs from the west wall of Bin 4. Some of the floor slabs were burned suggesting one portion of the open bin was used as a hearth. In another portion of the bin clay slurry was deposited onto the sandy, but exposed slab floor. In the northwest corner of the bin was dressed masonry rubble with splotches of clay slurry among the rubble. A few artifacts and hearth-ash deposits also comprised the fill of Bin 5 indicating the bin had been used for various purposes before the roof burned and fell massively into the bin. The roof fall extended across the width of Bin 5, but thinned to the north suggesting the roof only extended partially over the bin. A lithic cache of several hundred flakes was found in a shallow 10 cm diameter pit abutting the outside wall of Bin 5.

Bin 6

Bin 6 (2.75 x 1.8 x .65 m deep) was the last to be built and required a separate pit to be excavated leaving a sterile baulk between earlier Bin 5 to the east. Wall and floor slabs were double thickness in Bin 6. A small bell-shaped pit with a 10 cm opening, bulging to 18 cm and 50 cm deep intrudes into the floor the bin. The pit was filled with homogenous light gray fine ash and sealed with plaster implying a ritual context. Bin 6 then filled with mostly sterile sands, few artifacts and no midden indicating it filled during an occupational abandonment. However, the final overburden covering Bin 6 does not appear to be roof fall suggesting the ramada did not extend over Bin 6, or had already collapsed prior to its construction.

Artifacts, Flotation, Microrefuse

The artifact assemblage on the floor of the structure is dominated by ground stone, with over a dozen metate fragments strewn along the rear edge of the structure near the bins. Small ceramic sherds and small lithic flakes were present, but the floor was relatively "clean." Many of the lithics occurred in the cache of several hundred flakes adjacent to Bin 5. Exotics from the structure floor include a fragment of polished turquoise likely from a jewelry piece. Also several squash seeds and a bean seed that was incised with a "face" motif. These were found in floor deposits under the roof collapse, additional evidence that the structure was abandoned and stood open for a time prior to burning and collapse.

The characteristics of the ground stone assemblage are informative. Eleven small pecking and/or abrading stones were found. A whole two-handed mano was found impaled in the floor and partially buried in melted adobe as if it had been stored in the rafters or was sitting on the roof when the structure collapsed. A large slab metate was found face-down on the floor. Over a dozen mano and metate fragments were scattered along the rear edge of the structure, again near the bins.

Flotation samples yielded material in all hearths and subsurface pits, including lithics, turquoise micro shavings, bone, charred maize, charred pinyon hulls, carbonate mineral chunks, and unidentifiable botanicals too eroded or fragmentary to match with our type collection. Microrefuse from the heavy fraction of sediment/flotation samples from the floor of the structure revealed a high frequency of the same stone used to manufacture the ground stone tools at the site. We would expect such debris from the use of discarded grinding stones as heating stones, producing burned spall. However, most of the microrefuse was not burned or fire-cracked. Control samples taken from the nearby Two Bin and Weeping Juniper sites did not yield the same size and abundance of this type of debris as we found at Vermilion Vista. This, along with the frequent pecking stones suggests that ground stone manufacture was one possible activity at the ramada.

It also seems possible that ceramic production may may have occurred here, based on the clay slurry dumped in the refuse and the abundant abrading stones.

Sherds from the blow sand and the surface at Vermilion Vista are not reported here because of the diversity of sites of widely varying ages in the vicinity. Ceramics reported here include sherds found under the roof fall, from the fill of the bins, and from upper and lower portions of the midden east of the ramada. The most common types are North Creek Gray (N=177), Shinarump Gray (N=287) both consistent with Early Pueblo II occupation, and Washington Black-on-Gray (N=53), indicating Pueblo I occupation. There are three sherds of Tsegi Orange, and five sherds of North Creek Corrugated, one of which was in the upper midden. Restraint may be best in interpreting these eight sherds, in part because they represent 2% of the ceramic assemblage, and because they are inconsistent with six radiocarbon dates placing the site in Pueblo I and Early Pueblo II times.

Chronology

Six radiocarbon dates constrain the occupation between A.D. 600 and A.D. 965. Table 3 identifies the sample data and results, and Figure 10 shows the sample locations. All six ages overlap in a 60 year span from A.D. 720–780. However, Sample 6 was from the outer 1/3rd of a juniper post used to support the ramada, and likely includes a measure of old wood. Considering only the four maize dates and the single bone collagen date, the overlap is A.D. 700–965, consistent with the ceramics and the bin morphology both indicating Pueblo I to Early Pueblo II times.

The presence of a two component midden separated by a thin sterile sand layer argues for two occupations. Radiocarbon sample 4 (Table 3) from the lower midden falls in the early part of the chronology, A.D. 700–900. The ceramics from the midden are overwhelmingly graywares, and there is no statistically significant difference in the ceramic frequencies between the upper and lower midden. The upper midden is superimposed over the burned roof fall of the ramada in the eastern three to four meters of the structure, including over Bin 1. Thus, the first occupation was likely in Pueblo I times and included bins 1 and 2, a ramada, wall alignment, and the lower midden.

The structure floor was devoid of large, or valuable artifacts, suggesting cleaning, but did contain small tools such as the abraders and manos. The site stood open for a time and it is possible that some of the posts were reclaimed because several of the posts near the eastern end of the ramada were missing leaving only postmolds. Then sometime later the ramada burned and the roof collapsed onto the open floor, filling and covering the exposed postmolds.

After another interval of unknown duration, the upper layer of midden was deposited over the roof collapse from the early ramada near its eastern end. This signals a second occupation west of the first, likely Early Pueblo II times. A ramada that was simply an extension of the first was constructed and the rectangular bins 3–6 were added along the same axis as the earlier occupation. The sequence of bin construction, and the reclamation of slabs as the bins were built to the west allows for the possibility of more than one additional occupation, but this remains inconclusive. What is clear is that after the final abandonment, the second ramada burned and collapsed over the remainder of the structure much as it did after the first occupation.

Interpretation and Discussion

The remains at Vermilion Vista represent a work area and storage facility. Indeed, the activities represented in the site features and assemblage composition suggest a women's work area where plant food processing, storage, stone tool manufacture, bead-making, and possible grinding tool and ceramic manufacture occurred. The ramada/work area may have been one element of an Ancestral Puebloan field house supporting labor at nearby agricultural fields.

The residential component associated with the ramada/work area may have been sampled by auger probes and test excavation that located a probable pithouse with a floor about one meter below the surface just east of the midden. The limited excavations there do not provide ceramics or dates for the pithouse so its relationship to the ramada and bins remains unknown.

The ramada, activity areas, and storage facilities at Vermilion Vista are a tangible exhibit of the life of mobile farmers employing a variety of residential bases while moving labor where it is needed (McFadden 1996 and further developed in McFadden 2016:143–144, 172–174). This is the concept of "residential cycling" in the sense of Steadman Upham (1994:123, 131), and further articulated in Simms (2010:59–60, 63, 111). The Virgin Branch Ancestral Puebloan settlement pattern was mobile, not so much nomadic, but featured residential cycling that situated labor onto the land. The location of where labor was needed was structured by the demands of a diversified agricultural system. Residential cycling signals the behavior that occurs on a landscape of apparently sedentary settlements. While the material remains of this kind of system fosters a perception of high mobility, the system was likely much more structured than is captured by the categorical terms of nomadism vs. sedentism (sensu McFadden 1996 and 2016). It is this distinction that raises the significance of the concept of "tempo of mobility" rather than a typological continuum of sedentary to nomadic. Individuals were logistically and socially tethered to a number of communities during their life history and the people traversed a built landscape occupied redundantly by the same people, or by descendants exercising social memory. This was the sustainable farming system of the Ancestral Puebloan; a kin-based "portfolio" of small farmed fields of varying degrees of productivity and risk that could only be managed through the residential cycling of labor. ■

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Coming back to the notes from these sites for this Utah Archaeology write-up so many years later reminded me of how strong the feature system is, and how thankful I am to have experienced the nuance, decision-making, and organization of stratigraphic excavation in the Jesse D. Jennings tradition. It had been some years since I excavated Anasazi sites, and all of my experience was in the Four Corners region. But it may be all the experience with forager archaeology that perhaps brings something out of the box to the excavation of Anasazi sites. Of course, all mistakes of interpretation and presentation are mine. Special thanks to the dozens of students who participated in the 2001–2002 field schools, some who continued in archaeology/anthropology including: Buck Benson, Arie Leeflang, Kandus Linde, Kylie Lower, Leticia Neal, Richard Ralls, Katie Simon, and Silvia Smith. Finally, thank you to the students who contributed to the figures and lab analysis to bring this to publication all these years later: Aaron Larson, Tanner Gittens, and Justin Lish.

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Book Review

"Nine Mile Canyon: The Archaeological History of an American Treasure" written by Jerry D. Spangler. University of Utah Press, Salt Lake City, 2014. ISBN:978-1-60781-226-5

Review by Jaron Davidson

Located near the southern section of the Green River, Nine Mile Canyon has been known as an American treasure because of its pristine, concentrated rock art and archaeological remains. It holds the unofficial title as the "world's longest art gallery" and has a complicated modern history just like its prehistory.

While many books on the topic discuss approaches to interpreting archaeology through theories and methods, Spangler aims to create an understanding of the archaeologically rich Nine Mile Canyon through its historical past, not just the evidence of its prehistory. From the earliest Spanish and Anglo-American explorers to some of the most recent scientific-based surveys and excavations, he describes the changes in perceptions of the canyon's past by both the scientific community and the general public.

As the book is an archaeological history, its structure is chronological. The contribution of early explorers, such as Escalante or John Wesley Powell, are described as well as those of later survey groups and archaeologists. A special focus is placed on the scholars and enthusiasts specifically involved with the archaeology of the canyon. At several times a specific scholar or explorer's history is recounted to give context to their discoveries and interpretations. For example, Spangler includes an expansive summary of Dominick Maguire's upbringing in Vermont and Ogden, Utah, and his legacy of displaying Utah archaeology at the Chicago World's fair. This provides the reader with context to the biases and preconceived ideas which often influenced interpretations of the archaeology in Nine Mile Canyon. Though Spangler does not mention himself, he is among those scholars that have recently contributed to the archaeological research of the canyon.

Among others highlighted are early scholars like Noel Morss and Alfred V. Kidder, who were not only influential in Nine Mile Canyon, but also in American anthropology and archaeology. Later, more "scientific" archaeologists like Julian Steward, or Scott Roberts contributed to the study of this area. With the advent of antiquities laws passed by the state in the 1930's, John Gillin (to whom an entire chapter is dedicated) led the first well-developed excavations during his career in Nine Mile Canyon. Jesse Jennings followed Gillin in systematic research in Utah archaeology and lead the state in a new direction of research with salvage archaeology as a new and growing sector. Volunteer surveyors, from BYU and Carbon County also conducted extensive survey several years later in Nine Mile Canyon and the Tavaputs plateau contributing to the bigger picture of its prehistory. BYU professor Ray Matheny and others, like Polly Schaafsma, first attempted to interpret the "longest art gallery" by analyzing the rock art and comparing it to the rock art throughout the state and the Greater Southwest.

Spangler approaches Nine Mile Canyon's archaeological remains in the last two chapters and general theories regarding the rock art and archaeological record, including ancient chronological complexities, defensive strategies, analogies to the Tahamura in northern Mexico, and how the canyon fits into the context of the region. Research projects that were on-going at the time the book was published include those associated with the Colorado Plateau Archaeological Alliance and Bill Barrett Corporation, however, since this book was published, the Bill Barrett Corporation has pulled out of the Tavaputs Plateau area. This is a recent event that changes much of what Spangler concludes about the canyon. The BBC sold all its mining leases and left archaeologists without the money they had promised. Of course Spangler wrote this book before the BBC abandoned the canyon, but it is an important addition.

Spangler concludes with a pragmatic approach to how we can learn from the archaeology of Nine Mile Canyon. Evidence such as irrigation, granaries, and population estimates shows there were times of short plentiful wet periods as well as periods of drought. He theorizes that because environmental records of ancient droughts may correspond with population decline in the area the Fremont may have become too accustomed to the wet periods. Consequently, he suggests, the Fremont were forced to leave or die. Spangler offers this as a warning for modern populations to be better prepared for climatic changes. This, to me, seems reasonable because the same phenomena occurred in other regions of the greater Southwest.

Throughout Spangler's book there lacks, in my view, a clear synthesis of the complicated prehistory of the canyon. He spends much of the book describing influential men and institutions in the archaeology of Nine Mile Canyon, and does not dedicate much space to current researchers and their interpretations. Throughout the book, he ties historical interpretations to current largely accepted theories such as granaries on cliff sides having been thought to be protective and now thought to be a system of spread storage. But I felt that these were not given in much detail which could be because of the lack of deep investigation that has been done in the canyon.

In many ways much of the book is like Spangler's 2003 *Nine Mile Canyon field guide, Horned Snakes and Axle Grease*, which Spangler coauthored with Donna Spangler. Jerry Spangler used to write for the Salt Lake Tribute, so his writing style caters to the public and avoids scientific jargon.

As an archaeological book, it is refreshingly enjoyable to read. Filled with historical and modern photographs in both black and white and color, this book has much the same feel as *Traces of Fremont* by Simms and Gohier. The content of Spangler's book would be ideal for undergraduates, graduate students, and scholars interested in Fremont history and archaeology in Nine Mile Canyon. Those most interested in the archaeological evidence and its interpretations may find the last two chapters most useful. Overall, readers will find *Nine Mile Canyon* a unique region of Utah and its premiere cultural treasures. ■