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Archaic-Age Architecture in Northwest Colorado

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Abstract
Archaic-era hunter-gatherers in the Wyoming Basin—which extends across southwest Wyoming and northwest Colorado—built domed or conical architectural features, with some exhibiting far more substantial construction than others. These structures are often archaeologically preserved as large elliptical basins, defined by charcoal-stained sediment that filled habitation footprints after abandonment. Many of these basins, or house pits, are probably residential remains, although some may have had other uses. The recent discovery of 32 house pits in Colorado's Yampa Valley in the Sand Wash Basin has expanded the regional dataset, increasing our understanding of Archaic-era lifeways in northwestern Colorado. These discoveries further demonstrate the highly variable nature of Archaic-era structures, reflecting the adaptability of a mobile lifestyle to a specific place and time. Archaic-era use of these features in northwest Colorado occurred between about 8100 and 3755 cal B.P., demonstrating the usefulness of such shelters across a wide range of climate regimes. The greatest numbers were built between 6800 and 6000 cal B.P., coinciding with the mid-Holocene thermal maximum, when the residential settlement pattern grew more restricted, centering on water, food, and shelter resources. As the warm, arid climate ameliorated after 5500 cal B.P., use of such shelters began to decrease, demonstrating a return to higher residential mobility with greater availability of resources in the cooler, wetter climate. A comparison of Yampa Valley house pits with northern Wyoming Basin house pits indicates that Archaic-era people utilized similar structures as part of a highly adaptable mobile lifestyle for thousands of years across the Wyoming Basin.

Keywords: House pits; basin houses; Wyoming Basin, Northwest Colorado, Archaic

The goal of the research reported in this article is to broaden our understanding of Archaic-era inhabitants of northwest Colorado through investigation of their architecture. For much of the twentieth century, the idea of prehistoric architecture in Colorado largely conjured images of Ancestral Puebloan ruins such as Mesa Verde in southwestern Colorado. However, energy-related development during the mid-1980s in the Wyoming Basin revealed large charcoal stains possibly indicative of architectural features. Investigation and radiocarbon dating identified many of these buried stains, which are often elliptical in plan view and basin-shaped in profile, as the remains of structures dating to the Northern Colorado River Basin's Archaic era (9350 to 1900 cal B.P.; 8350 to 1950 ^{14}C yr B.P.). Investigation of these structures has furthered our knowledge of hunter-gatherer architecture, chronology, pit feature use, seasonality, length of site occupation, and residential settlement pattern.

This article summarizes recently discovered remains of 32 architectural features or rooms in such features[1] in Colorado's Yampa River Valley

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dating between *ca*. 8101 and 4935 cal B.P. (7285 to 4360 ^{14}C yr B.P.). We examine these remains within the context of similar Archaic-era features in the Sand Wash Basin (*n*=15) and the greater Wyoming Basin (*n*=117). These features, known as house pits, are the footprints of conical or domed structures, many of which were probably hunter-gatherers' homes. Although evidence of a superstructure is rarely preserved, the footprints of these structures range from rectangular to circular in plan view and from shallow to deep in profile. The variability preserved in these structural remains reflects the mobility of a foraging people, in contrast to the more uniform shelters built by horticulturalists anchored to their food production locales in other parts of Colorado. Each Archaic-era house pit represents a shelter created for a specific time and place on the landscape, with individual design characteristics indicative of season, resource availability, functional need, and anticipated length of stay.

Background (1984–1999)

In *Colorado Prehistory: A Context for the Northern Colorado River Basin*, Reed and Metcalf (1999:80) noted that one of the major changes regarding knowledge of the Archaic era since the time of the previous regional context documents (Grady 1984; Guthrie *et al.* 1984; Reed 1984) was the "widespread recognition of formal and informal habitation structures during the period." Archaic architecture was little known in the early 1980s, but by 1999, the use of pit and basin structures was widely recognized as a defining characteristic of regional Archaic cultures, with these features firmly established as a part of Archaic-era lifeways by roughly 6250 ^{14}C yr B.P. To distinguish these features from more ephemeral residential evidence, Reed and Metcalf (1999:80) wrote that there must be "some evidence of labor investment in the structures, and the structures themselves [should] appear to have been for long-term as opposed to temporary use." Still, the interpretations of these pit or basin structures varied among researchers (e.g., Black 1991; Shields 1998). Did they represent long-term housing that characterized an important change in Archaic lifeways and mobility? Did they represent relatively short-term single-use habitations? Or did they represent relatively short-term structures used repeatedly as part of seasonal transhumance? Reed and Metcalf (1999:81) argued that differences in the investment made in housing could offer important insights into site function, local subsistence, and food storage; in fact, these differences might serve as basic measures of mobility, with the greater labor investment of formal houses potentially indicating decreased mobility and longer-term use of an area.

Among the pit or basin structures known from the northern Colorado River basin, Reed and Metcalf (1999:80) recognized the "basin house" defined by Wm. Lane Shields (1998) as the most numerous and "perhaps the most important" house type in the region. To define the type, Shields drew on a sample of excavated structures from a four-state region that focused largely on Colorado and Wyoming. He (1998:63) defined basin houses as exhibiting a number of specific traits and observed that the feature type "[varied] along almost every dimension that can be examined." Table 1 lists Shields's basin house criteria.

As of 1999, it was still unclear how well other house types recorded in the context area (Conner and Langdon 1983; Euler and Stiger 1981; Gooding and Shields 1985; Horn *et al.* 1987; Metcalf and Black 1991; Pool 1997; Wheeler and Martin 1984) meshed with Shields's basin house concept, but many appeared to represent more substantial structures than those defined by Shields. Reed and Metcalf expected that varying house forms and construction methods would continue to be identified as new discoveries were made, but they "hoped that some pattern [would] emerge regarding the use of pole-and-mud construction methods" (Reed and Metcalf 1999:81).

One direction Reed and Metcalf proposed for future research involved the investigation of trends in patterns of residential mobility. Assuming higher elevations were favored during lowland drought and less favored during glacial advances, Reed and Metcalf (1999:172) suggested that the nature of high elevation housing might reflect these climatic changes by being either more seasonal or more substantial during a specific climatic interval. The other research questions compiled by Reed and Metcalf for regional Archaic-era habitation structures were few and fairly general. Given the state of the data at the time, the most important research goal was simply gathering additional information

Table 1. Shields's (1998:63–64) basin house criteria.

- Irregular perimeters.
- An overall roughly oval to elliptical shape. Vaguely circular or subrectangular, and simply irregular shapes are also likely.
- A shallow basin, or depression, across entire house.
- Low walls, due to the basin, with shallow and changing slopes. Often the wall cannot be defined along a portion of the perimeter.
- Undulating floors that generally trend in the paleo-slope direction.
- Internal features. These can be numerous and they often occur along or near the perimeter. Perimeter subfeatures are frequently responsible for the irregular shapes. The internal features will very seldom be postholes as usually defined.
- Adjacent or nearby external features. "Nearby" is meant to be approximately one meter.

from structural sites to better understand the range of variation in housing types.

New Data (2000–2015)

Since publication of the northern Colorado River basin context in 1999, 32 Archaic-age architectural features on 12 sites have been documented in northwest Colorado's Yampa Valley. All were identified in the same utility corridor as the 1992–1993 Colorado Interstate Gas Uinta Basin Lateral (UBL) project. That project produced 15 of the features in Shields's (1998) original delineation of basin houses; they also were discussed in the 1999 context. The 32 new features were found during data recovery for the Piceance Basin Expansion (PBE), the Rockies Express (REX), and the Piceance Basin Lateral (PBL) projects, which share the same corridor for much of their length (figure 1). The portion of northwest Colorado containing these 32 architectural features and the 15 features previously summarized by Shields (1998) is considered the study area, with the features entirely within the Sand Wash Basin, the southernmost extension of the Wyoming Basin.

Shields (1998:66) specifically noted that the core area in which most basin houses have been excavated corresponds with the Wyoming Basin physiographic region (Fenneman 1931:133–149). Largely located in Wyoming, the Wyoming Basin is composed of smaller basins including the Green River Basin, the Great Divide Basin, the Washakie Basin, the Hanna Basin, the Shirley Basin, the Laramie Basin, the Wind River Basin, and Colorado's Sand Wash Basin. Uplifts and arches such as the Rock Springs Uplift and the Casper Arch separate these basins and are included in the larger physiographic region. Whether the prevalence in the Wyoming Basin is tied to prehistoric settlement patterns, differential preservation, or the amount of development in this area—with its corresponding archaeological work—is currently unknown.

This article examines data from 47 house pits found in the study area (table 2) and compares them to data from a larger sample of 117 Archaic-age architectural features on 63 sites in the northern Wyoming Basin, compiled from a number of syntheses specific to Wyoming house pits (Buenger 2011; Buenger and Goodrick 2015; Harrell *et al.* 1997; Hoefer 1987; Larson 1997; Rose 2008; Smith 2003; Smith and McNees 2011; Waitkus and Eckles 1997). All architectural features in both datasets are considered to represent structures built by Archaic-era people practicing a foraging lifeway. Although the degree of mobility may have varied throughout the era, the hunter-gatherers who built these structures were far more mobile than horticulturalists (Metcalf 2011a; Metcalf and Reed 2011; Metcalf and McDonald 2012). Thus, these structures differ in many ways from house pits associated with more sedentary occupations in places such as the greater Southwest.

In order to be included in the dimensional and chronometric discussions below, the architectural features in each dataset had to satisfy specific requirements. In order to be part of the sample subjected to design analysis, Archaic-era house pits had to have been completely or nearly completely excavated in order to provide full dimensional data. A total of 164 structures met these criteria

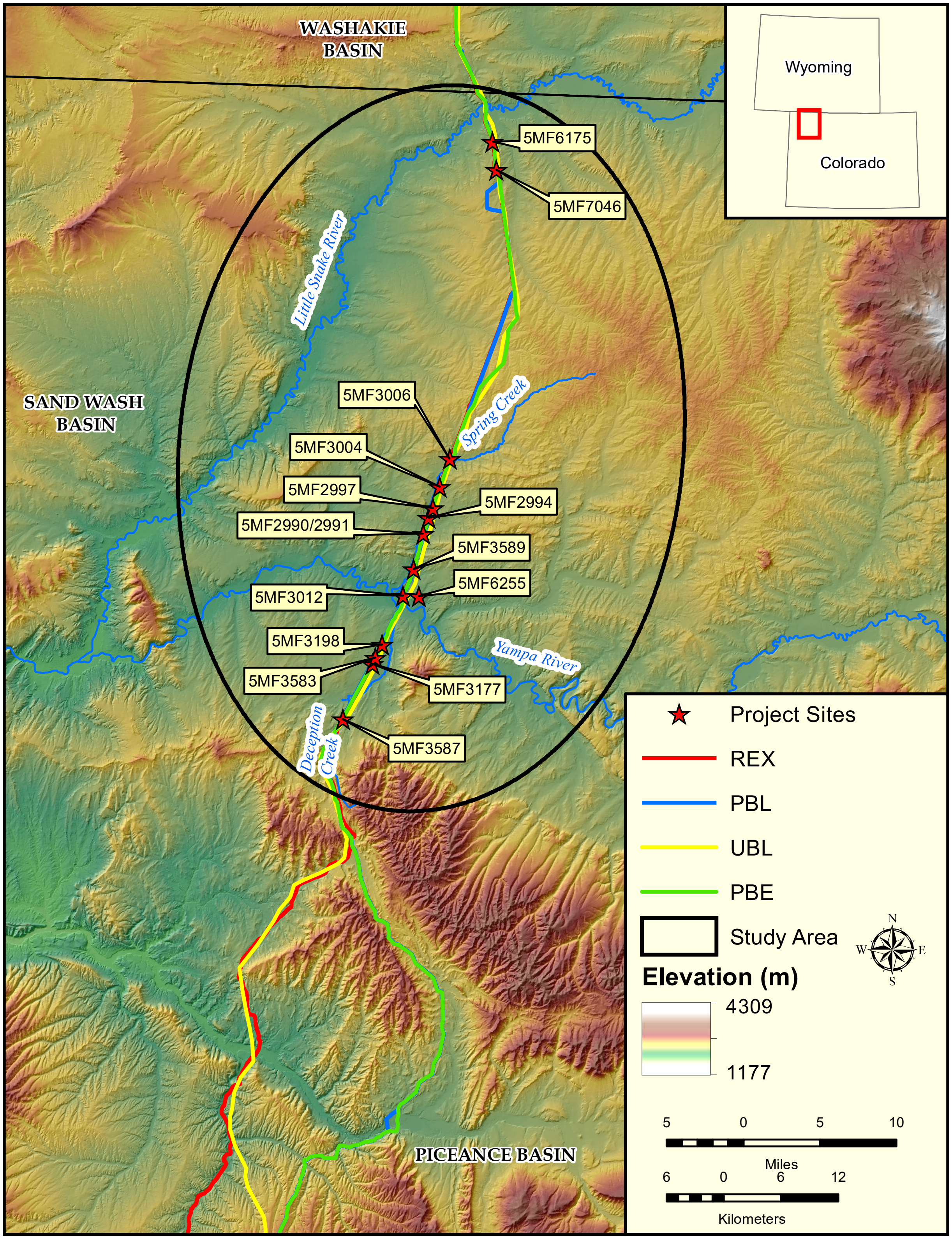

Figure 1. Study area sites with Archaic-era architecture.

Table 2. Study area sites and Archaic-era architectural features.

Site	Project	House Pit Designation	Primary Reference
5MF2990[a]	UBL	Feature 62	McDonald *et al*. 2000
		Feature 63A	
		Feature 68	
		Feature 2	
5MF2990[a]	PBE	49 House	Pool 2011
		44 House	
		39 House	
		59 House	
		HM House	
		NN House	
5MF2991	UBL	Structure 3	Rood and McDonald 2000
		Structure 18, North Room	
		Structure 18, South Room	
		Structure 41	
5MF2994	REX	Structure 1	Pfertsh 2009
5MF2997	PBE	North Block House	Metcalf 2011b
		Lepus Lodge	
		Elk House	
5MF3004[a]	UBL	Feature G	McDonald and Späth 2000
5MF3004[a]	REX	Structure 1 (Feature 2)	Mullen and Pfertsh 2009
5MF3006	PBL	Feature 08-03	Landt 2014
5MF3012	PBL	Feature 3173+00	Greubel 2014
		Structure 1	
5MF3177	UBL	Feature 2B (Structure 1)	Graham and McDonald 2000
		Feature 8 (Structure 2)	
		Feature 9 (Structure 3)	
5MF3198	REX	Structure 1	Greubel 2009a
5MF3583	PBE	House 1	Williams 2011
		House 2	
5MF3587	REX	Feature 1	Greubel 2009b
		Feature 46	
5MF3589	UBL	Structure 3	McDonald 2000
		Structure 8	
		Structure 11	
5MF6175	REX	Structure A	Moore 2009
		Structure B, Room 1	
		Structure B, Room 2	
5MF6255	PBE	Feature 15, main	Slaughter 2011
		Feature 15, anteroom	
		Feature 17	
		Feature 18	
5MF7046	PBL	4720+80	Reed 2014a
		Room 1, main	
		Room 1, Room 4, antechamber	
		Room 2	
		Room 3	
		Room 5	

[a] Site investigated during two different projects.

but not all of these structures necessarily met the criteria to be included in the chronometric analysis. Supplementary Dataset A provides data on the house pits included in the design analysis. Archaic-era house pits selected for the chronometric analysis had to have ages produced by radiocarbon dating of charred material, specifically charcoal rather than organic sediment. A total of 94 structures met these chronometric criteria but not all of these structures necessarily met the criteria to be included in the design analysis. Supplementary Dataset B provides data on the house pits included in the chronometric analysis.

Subsets of study area features have previously undergone detailed examination in Shields's master's thesis (1998), in an Archaic architecture synthesis for the UBL/REX/PBE projects (Pool and Moore 2011), and most recently in a prehistoric architecture synthesis for the PBL project (Landt 2018; Landt and Reed 2014). Investigations of architectural features at the same sites or in similar site settings over two decades have resulted not only in the addition of many new features to the database but, equally importantly, have allowed refinement of existing data through new methodologies and improved scientific sampling as well as the continued reworking and updating of research questions.

Terms, Definitions, and Criteria

Descriptive Terminology

Shields studied the largest sample of hunter-gatherer habitation features in Colorado and Wyoming available at the time and he readily acknowledged that numerous differences existed within his "basin house" type. He (1998:63) attributed this structural variation to "differences in construction materials, individual use of space within the structures, the number of people inhabiting them, the duration of use, and the season of occupation," among other factors. Earlier researchers had documented a similar range of variation but had captured it using differing terminologies or typologies (Black 1991; Hoefer 1987; Larson 1997; Larson and Francis 1997; Thompson *et al.* 1996).

With substantial expansion of the original regional dataset, researchers have continued to refine the terminologies used to recognize these differences. Some have updated the characteristics of Shields's basin houses to distinguish between enclosed architectural features and outdoor work areas in naturally confined spaces (Miller 2005; Pool 2005; Reed *et al.* 2008). This feature type, as updated, continues to be used to describe both deep, formal features and shallow, informal features (Landt and Reed 2014; Reed 2015). Others have maintained a distinction between deeper, more formal features that are classified as "housepits" and smaller, shallower stains that are called "basin houses" (Goss and Davis 2001; McNees 2005:88). Most frequently, however, the terms "house pit" or "housepit" are generically employed to classify all Wyoming Basin hunter-gatherer habitation features (Buenger 2011; Buenger and Goodrick 2015; Pool 2015; Pool and Moore 2011; Smith 2003; Smith and McNees 2011); the two-word phrase "house pit" is used in this article.

Function

Although use of the term "house pit" implies that this feature type served as a residence, classification usually relies only on morphological attributes, such as size and shape, rather than on direct evidence of domesticity. Classifying features as potentially residential solely on the basis of morphology is insufficient if the intent is to study domestic use of enclosed spaces (Pool 2005:238). The presence or absence of artifact types indicative of domestic functions, such as decorative items and bone tools, could be incorporated into a refined definition of a house pit and help to distinguish specific domestic feature types as well as to aid in understanding site function and duration of occupation.

Different or additional functions beyond residential use are possible. Some researchers have argued that structures represented by these large features could also have been the remains of workshops (Reed 2014a), kitchens (Harrell *et al.* 1997), or cache or storage locations (Larson 1997; McDonald 1999), as some contain a number of interior features that would have been useful for such purposes. For instance, McDonald (1999) classified a tool-filled pit inside a study area feature as a raw material cache, but identification of such use depends on the pit contents remaining intact and not being removed. Larson (1997:362) suggested there might be different seasonal uses of house pits, with a residential focus during the warm season when resources were collected and, later in the cold season, functioning as habitations with stored resources or simply storerooms. Identifying storage features can be challenging: Rose's (2008) recent investigations of the use of features for food storage inside Wyoming house pits demonstrated that neither lack of burning nor size and shape of interior features proved to be reliable methods of identifying storage pits. Additionally, storage locations have often been documented closer to procurement areas than to residential bases, and placement of storage caches away from habitation areas has been argued as a means of protecting food from other groups or animals (Binford 1990:145; Pool and Moore 2011:87–88). Until food storage areas can be defined with greater confidence, use of these features as food caching locations remains an untested hypothesis.

Definition

As used in this article, the definition of a house pit is considered analogous to Reed and colleagues' (2008) updated basin house definition, shown in table 3, which added several possible characteristics to Shields's (1998) criteria discussed earlier.

A house pit is considered to be the footprint of a domed to conical structure that was supported by wooden poles or braces. Direct archaeological evidence of superstructures is seldom encountered, but postholes, post rests, berms, or benches can be indications of their existence and provide clues to their nature. Postholes and post rests have been found in house pits in the study area (Greubel 2009b; Moore 2009; Rood and McDonald 2000), as have exterior berms or benches (Greubel 2009b; Slaughter 2011). Some footprints may reflect formal excavation into deep deposits to provide insulation against the cold; shallow footprints may be the result of trampling or cleaning inside a free-standing wikiup-like structure that gives minimal shelter during warmer months. House pit floors may have been covered with mats, hides, stripped bark, grass, or prepared mud or clay, but evidence of these coverings is only rarely found (Reed *et al.* 2008). Roof and wall coverings may have sometimes been hides, but they are usually assumed to have been mud-covered vegetation based on small pieces of daub or microbotanical materials that are sometimes associated. Evidence supporting this assumption has been found at a few regional sites (Greubel 2009b; Metcalf and Black 1991; Moore 2014; Reed 2014b). Baked or burned clay fragments that may have been roof or wall material were associated with only one house pit in the study area, Feature 1 on site 5MF3587 (Greubel 2009b). In addition, the recovery of a pine phytolith at site 5MF7046 may point to the use of pine boughs as a structure covering at this site; pine is not, and has not been, native to the site, and none of the excavated thermal features used pine as a fuel source (Reed 2014a).

Geographic Patterning

Study area house pit sites occur in four distinct areas, as limited by the route of the utility corridor (figure 1). They cluster along Deception Creek, the Yampa River, Spring Creek, and above the Little Snake River, all within the Yampa drainage system (table 4). Specifically, Pool and Moore (2011:55) observed that most of the house pit sites in the

Table 3. Reed and colleagues' (2008) updated basin house criteria.

- Patterning in plan view and profile where an unconformity between the interior and undisturbed exterior can be discerned.
- Superstructure debris largely confined to the interior.
- Sufficient floor area to allow at least one person to recline (generally more than 2 m in diameter).
- Patterned arrangement of postholes around the structure's perimeter.
- Interior pit features.
- Differential artifact and ecofact distribution between the interior and exterior areas.
- Underrepresentation of larger size grades of debitage on the floor surface or within the occupation zone, evidencing cleaning activities.

UBL/REX/PBE corridor were discovered in two clusters along a 16.5-mile long segment. One cluster was along Deception Creek, from the southern edge of the Yampa River southward to near the base of the Danforth Hills, and the other cluster was on the west-facing terraces of Spring Creek, north of the Yampa River. This specific geographic patterning might be attributed to both prehistoric settlement patterns and the valley's depositional environment.

Although the sample is confined to a narrow corridor, this corridor bisects the Yampa River Valley on a north-south axis. The clustering of house pits along permanent streams in the Yampa Valley likely reflects a residential settlement pattern focusing on water sources. Such patterning on or near permanent water has previously been noted as a characteristic of most Wyoming Basin house pits (Larson 1997). Only two house pit sites were not situated directly along the Yampa River or its permanent tributaries. The Mouse House site (5MF6175 [Moore 2009]) and the Sudden Storm site (5MF7046 [Reed 2014a]) are both perched on slopes south of the Little Snake River, each possibly situated above the cold air pool on their respective valley floors.

In addition to distance from water, specific depositional environments in the Yampa Valley may also have played an important role in house pit site location. Locales with sandy, well-drained sediments would have represented an amenable setting in which to erect architecture. These same locales would have been attractive to a broad range of flora and fauna, which would have offered ready food and shelter resources. Following site abandonment, the study area house pits were preserved by their favorable depositional settings, which protected them from erosional forces. Although degree of preservation would have varied with specific climatic conditions, the plethora of Archaic-era house pits identified in the Yampa Valley compared to other locations in the Sand Wash Basin may be due in part to the favorable depositional environment for preservation of stratified archaeological deposits in the valley relative to other locales. In their discussion of the soil and stratigraphic record of the UBL/REX/PBE corridor, Metcalf and McFaul (2011:12) provided "an idealized composite landscape cross-section" illustrating depositional settings that were associated with buried cultural materials (figure 2). Various study area house pits were discovered in settings such as those shown, including the Deception Creek dune fields (e.g., 5MF3177), the sand sheet-draped alluvial T3 terrace in Spring Creek (e.g., 5MF2990), and the slopes above river valley floors (e.g., 5MF7046).

House Pit Design Analysis

The following discussion briefly summarizes Archaic-era house pit shape and size as well as

Table 4. Geographic attributes of study area house pit sites.

Site	Major Drainage	Prominent Landform Type	Elevation
5MF2990	Yampa River (Spring Creek)	Stream terrace	1,871 m (6,140 ft)
5MF2991	Yampa River (Spring Creek)	Stream terrace	1,871 m (6,140 ft)
5MF2994	Yampa River (Spring Creek)	Stream terrace	1,887 m (6,190 ft)
5MF2997	Yampa River (Spring Creek)	Stream terrace	1,896 m (6,220 ft)
5MF3004	Yampa River (Spring Creek)	Stream terrace	1,923 m (6,310 ft)
5MF3006	Yampa River (Spring Creek)	Stream terrace	1,942 m (6,370 ft)
5MF3012	Yampa River	River terrace	1,817 m (5,960 ft)
5MF3177	Yampa River (Deception Creek)	Stream terrace	1,890 m (6,200 ft)
5MF3198	Yampa River (Deception Creek)	Stream terrace	1,865 m (6,120 ft)
5MF3583	Yampa River (Deception Creek)	Stream terrace	1,890 m (6,200 ft)
5MF3587	Yampa River (Deception Creek)	Stream terrace	1,896 m (6,220 ft)
5MF3589	Yampa River (Spring Creek)	Stream terrace	1,850 m (6,070 ft)
5MF6175	Little Snake River	Valley slope	1,932 m (6,340 ft)
5MF6255	Yampa River	River terrace	1,817 m (5,961 ft)
5MF7046	Little Snake River	Valley slope	1,975 m (6,480 ft)

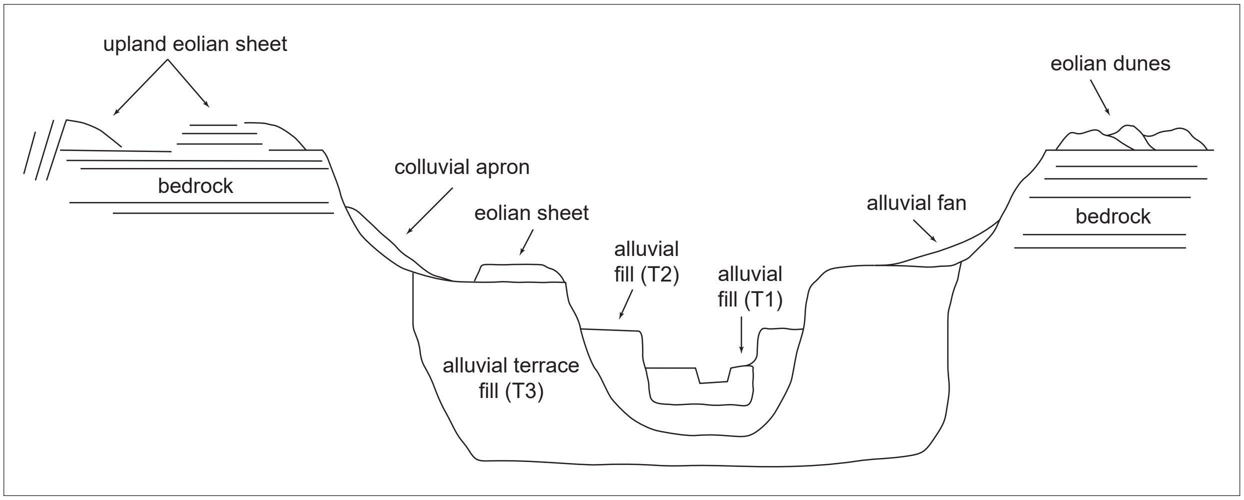

Figure 2. Idealized UBL/REX/PBE corridor landscape schematic of depositional settings with buried cultural materials (adapted from Metcalf and McFaul 2011:Figure 6).

the methods and metrics used to describe them. Summary data are then presented that incorporate those methods and metrics from both the study area and the Wyoming datasets. The 15 study area sites include 47 house pits that were either completely excavated or sufficiently exposed that their measurements could be estimated with confidence. The Wyoming dataset includes 63 sites containing 117 complete or nearly complete house pits. Given variation in house pit shape, condition, and amount exposed, it is not easy to set a measurement standard that is equally applicable to all 164 structures. Using a consistent methodology for metric documentation of house pits, however, makes results between different studies and different regions comparable. The methods used in this section generally follow those used in Landt and Reed (2014) and Pool and Moore (2011).

Shape

The shape and size of a house pit can provide considerable insight into site occupation, the influences and constraints on construction, and structure use-life. Plan view shape has been suggested as an indicator of anticipated length of occupation, a possible proxy for resource availability or scarcity, and even as an indicator of the general time period to which the structure dates. Smith (2003:167), for example, argued that circular floor plans are characteristic of structures with lower construction costs that would, conversely, be associated with higher maintenance costs and less flexibility in terms of structure use. In contrast, rectangular structures would have higher construction costs, but they likely could be maintained more cheaply and offer a greater range of uses. Rectangular structures have also been suggested to represent a later development than circular structures (Waitkus and Eckles 1997). Finally, bi-lobed structures, structures with irregular perimeters, and multi-roomed structures could indicate that the occupants had to modify the original space to address a new need, such as creating additional storage space during a time of resource scarcity. By adding on to an existing structure, instead of building a new one, the labor costs of construction could be reduced, while still meeting the new need (Moore 2009:80; Shields 1998).

Profile shape is often cited as the result of the manner in which the structure's basin was formed. Shallow basins with no distinct break between floor and walls may have been created largely through use or cleaning (Larson 1997; Shields 1998), and deep or steep-walled basins likely indicate purposeful excavation of the footprint during construction. Shallow basins might represent expedient structures intended for temporary use, and deep basins probably reflect a more formal construction and a lengthier anticipated occupation.

Dimensions

Length and Width

The inherent challenges in reducing the metric traits of a house pit to an average or single dimension have been discussed in earlier syntheses (Pool and Moore 2011:78; Shields 1998:140, 181). Identified difficulties include discrepancies between primary text descriptions and associated feature plan view maps (Shields 1998:180–181). It is also common for measurements of structures to be incomplete for various reasons; some were only partially excavated, others were overlapped or obscured by later structures, and some have been partially destroyed by erosion or modern development. For these reasons, simple and fairly replicable measurements such as maximum length and width are often used, with researchers acknowledging that even they can be imprecise. Long- and short-axis measurements for length and width are the most commonly used metric, as they are reasonably replicable, especially for structures that are not circular.

Bearing the above factors in mind, table 5 summarizes the length and width data as available from the source literature, with short- and long-axis measurements used when available. The authors did not second-guess axis measurements, as in many cases direct field knowledge of the structure adds credence to the primary literature. It should be noted, however, that the "short-axis" measurement provided by excavators was often found to be perpendicular to the long-axis, regardless of whether or not it was the shortest measurement.

The study area house pits varied in length between 1.69 and 6.00 m, with an average length of 3.78 m. House pits within the Wyoming dataset, in comparison, ranged between 1.84 and 6.00 m in length, with an average of 3.40 m. Although somewhat shorter on average than the study area house pit dataset, the Wyoming dataset house pits are well within ranges observed in previous synthetic analyses. Overall, the ranges in length and width and mean dimensions between the two datasets are quite similar, given that the range of values within each dataset is probably representative of a wide spectrum of house pit construction investment, function, and use. All but two of the study area house pits and three of the Wyoming dataset house pits have sufficient lengths to allow at least one person to recline, meeting or exceeding the 2 m minimum threshold forwarded by Reed and colleagues (2008:434); four of the five that are below this threshold exceed 1.8 m in length.

Depth

Depth of the study area house pits ranged widely, between 15 and 115 cm, with an average depth of 39.8 cm (table 5). With a slightly shallower average depth of 36.8 cm, the Wyoming dataset exhibited an even broader depth range, from 10 cm deep to a 125-cm deep house pit from the Jeffrey City site (48FR2330) documented by Reiss (1990). Surface structures (those with a depth of 0 cm) such as the structures identified at the J. David Love site (48SU4479) were excluded from the analysis (McKern and Harrell 2004; Smith and McNees 2011:304). Some of this variability can be attributed to taphonomic processes (McClelland and Martin 1999) and differing excavation methods, but the extensive depth range represented in these datasets is more likely a reflection of the differences between primary and alternative housing types such as those known from hunter-gatherer ethnographic data (Binford 1990, 2001; Pool and Moore 2011).

Table 5. Summary metric data for study area and Wyoming dataset house pits.

					Area		
Dataset	Measure	Length (m)	Width (m)	Depth (cm)	Elliptical (m^2)	GIS (m^2)	Volume (L)
Study Area	Mean	3.78	2.98	39.8	9.13	9.08	2,567
	Minimum	1.69	1.03	15.0	1.37	1.42	443
	Maximum	6.00	4.90	115.0	23.09	22.30	14,858
Wyoming	Mean	3.40	2.90	36.8	8.08	7.12	2,221
	Minimum	1.84	1.20	10.0	2.24	2.18	259
	Maximum	6.00	5.60	125.0	24.63	17.01	15,839

A few regional structures, such as Medicine House (McGuire *et al.* 1984), with depths greater than 50 cm have been specifically termed "pithouses" by investigators, but most are subsumed under the same feature type classification as other shallower examples. Identification of all these features as "house pits," however, is not meant to imply there is no functional difference between shallow basins formed through trampling and those that are intentionally and deeply excavated. Deeper structures clearly represent increased labor and possibly increased anticipated length of occupation, with depth likely related to variables such as residential mobility, the function of a structure, and seasonality (Reed 2009). For example, house pits on at least two study area sites (5MF3587, 5MF6175) have been proposed as winter occupations, based on evidence of substantial time and labor investment in their construction. Overall, the datasets show a wide continuum of structure depth, with the range reflecting to some degree the various facets of forager lifeways during the Archaic era.

Area

Shields (1998:180–181) critiqued area and volumetric estimates, arguing that the measurements are prone to inflation for a variety of reasons, including difficulty in distinguishing the structure from surrounding sediment. While accurately calculating volume remains an issue, especially for an irregularly shaped three-dimensional basin, area measurements are no more prone to serious error than are length and width measurements. Further, given the increasing attention paid to house pits in Colorado and Wyoming, excavation methods have progressed considerably since the publication of Shields's thesis and reduced the extent of excavator and analyst error.

Area was calculated in two ways for this article. The first, a common method recently used in Pool and Moore (2011) and Reed (2015), was elliptical area (A_E; equation 1). The types of maximum and minimum dimensions used in the calculation of elliptical area were dependent on the metrics provided in the source document. Given the frequent irregularity of the plan view shape of house pits, elliptical area is sometimes an approximation of the area. Its widespread use, however, makes it a metric that is comparable among many datasets. The second method, argued to be much more accurate, was to calculate area through GIS digitization of detailed plan view maps. Although Shields (1998:140) notes discrepancies between textual descriptions of house pits and plan view maps, plan view maps are often the primary source of the data used in the text and are thus potentially a more accurate source of information for some of the descriptive metric data. Easy access to scaled plan view maps, however, can be limited by the availability of primary literature.

Eq. 1 $A_E = \pi(\frac{Maximum\ Dimension}{2})(\frac{Minimum\ Dimension}{2})$

The study area dataset contained 45 house pits for which elliptical area could be calculated. Elliptical area ranged between 1.37 and 23.09 m^2, with an average area of 9.13 m^2. The digitized plan view maps resulted in a GIS area for 37 of the house pits, with areas ranging between 1.42 and 22.30 m^2 and an average area of 9.08 m^2. A t-test was conducted to compare the two area measurement methods, using the 37 house pits for which both metrics were available. The result (t=1.99, df=72; p = 0.05) showed no significant difference between the GIS area (9.08±4.16 m^2) and the elliptical area (9.38±4.42 m^2).

Elliptical area was calculated for 114 structures within the Wyoming dataset. House pit area ranged between 2.24 and 24.63 m^2, with an average of 8.08 m^2. The GIS area could be calculated for 25 of the house pits and resulted in a range between 2.18 and 17.01 m^2, with an average area of 7.12 m^2. A t-test was conducted to compare the GIS and elliptical area measurement methods. The result (t=2.01, df=48; p = 0.1) showed more variation between the GIS area (7.1±3.08 m^2) and the elliptical area (7.3±3.48 m^2) for the Wyoming dataset, although variation may be related to the small sample size.

When comparing the two area metrics across datasets, it appears that both the elliptical and GIS area measurement methods similarly characterize basin house area. Thus, although elliptical area may not as accurately measure the actual area of a structure, it appears to be a good way to average house pit areas, including those with irregularities in outline. Researchers thus have two valid area measurement options, depending on data at hand.

Volume

Accurately measuring house pit volume remains problematic. House pit floors undulate, may be truncated by pipeline trenches, and might sometimes only be recognized after a portion has been removed. Hemispherical volume is calculated here (V; equation 2), following previous work on house pit volume (Landt and Reed 2014; McKibbin et al. 1989; Pool and Moore 2011), and using the elliptical areas calculated from equation 1. Volume was converted from cubic meters to liters (L) to be more directly applicable to other studies (e.g., Pool and Moore 2011).

Eq. 2 $V = \left(\left(\frac{2}{3}\right)(Depth)(A_E)\right)1000$

Elliptical volume for study area house pits ranged between 443 and 14,858 L, with an average excavated house pit volume of 2,567 L. The Wyoming dataset ranged between 259 and 15,839 L, with an average of 2,221 L. Some extremely shallow house pits were represented in the Wyoming dataset, with nine house pits having volumes smaller than 500 L. Otherwise, the overall range and scale of the house pit volumes for the Wyoming and study area datasets are fairly similar.

Chronology of House Pit Use and Paleoclimate

Although only Archaic-age house pits are examined in this article, this feature type has previously been noted to exhibit a bi-modal chronometric distribution in southwestern Wyoming (Pastor *et al.* 2000). Pastor and colleagues have noted that house pits occurred throughout the Archaic and Formative periods. They were most common from 7350 to 5450 cal B.P. and from 1750 to 1150 cal B.P., corresponding to a portion of Wyoming's Archaic period Opal phase (7300–4800 cal B.P.) and to the Late Prehistoric period Uinta phase (1800–650 cal B.P.). Both episodes occurred during periods of increased warmth and aridity; the first appears to have occurred during the mid-Holocene thermal maximum and the second during the Inter-Neoglacial Drought (Bruder 1993; Reed *et al.* 2008). However, architectural features dating to the Late Prehistoric period in the Wyoming Basin are far less numerous than Archaic-era house pits, with only 24 Late Prehistoric features on nine sites noted in a recent synthesis (Pool 2015). The notably large number of Wyoming Basin house pits that date to the time of the mid-Holocene thermal maximum has been discussed in a number of regional house pit syntheses (Buenger and Goodrick 2015; Landt 2018; Landt and Reed 2014; Larson 1997; Pool 2015; Pool and Moore 2011; Reed 2015; Rose 2008; Shields 1998; Smith 2003; Smith and McNees 2011; Waitkus and Eckles 1997). This section will compare the chronometric distributions of the study area and Wyoming dataset Archaic-era house pits and evaluate trends that are relevant to understanding shifts in lifeways and residential strategies during this era, especially those that might be tied to paleoclimatic changes. Complete chronometric data are provided in Supplementary Dataset B.

Methodology and Sample Selection

Radiocarbon ages in both datasets were calibrated using Calib (Rev 7.02) (Stuiver *et al.* 2014), which provided two-σ ranges (presented in calibrated years before present [cal B.P.]) and calculated a calibrated median probability date. The latter was used in analyses when a single date was needed to evaluate which house pits were included in the Archaic-era datasets, using the calibrated Archaic-era ranges developed for northwestern Colorado (Greubel *et al.* 2014:15; Reed and Metcalf 1999) and for Wyoming (Kornfeld *et al.* 2010; Omvig 2014).

A number of house pits were dated with multiple samples and are associated with more than one age. Some of these multiple samples produced overlapping two-σ calibrated age ranges; those that did not overlap suggest multiple use episodes. Rather than include all house pit ages where more than one is present and thereby more heavily weight intensively dated sites, previous work has characterized house pit dates in several different ways. Methods include providing the full range indicated by the youngest and oldest reported two-σ calibrated ranges (Smith and McNees 2011), the pooled mean of the dated samples (Landt and Reed 2014), or the earliest accepted date (Pool and Moore 2011). Each method has some benefits and some drawbacks. For house pits exhibiting multiple ages, this article utilizes the earliest occupation age (B.P.) and the median probability date (cal B.P.) of the earliest occupation age. Using this method allows identification of the paleoclimatic regime during initial occupation and might provide insight into why these Archaic-era structures were originally built in the region.

Sediment Dates

Organic sediment dates were excluded from the current analysis. Sediment dates are typically understood to provide limits to the date range of an occupation, rather than chronological markers of a cultural event. Sediment dates are representative of the apparent mean residence time of organic materials in the soils; thus, the chronometric assignments are based on the vagaries of the sediment's chemical and physical properties. Radiocarbon dates derived from sediment samples have been shown to provide an imprecise measure of rates of sedimentation, let alone specific cultural events (Campbell *et al.* 1967; Fowler *et al.* 1986; Lee 2009; Mayer *et al.* 2009; Metcalf and McFaul 2006; Scharpenseel and Becker-Heidmann 1992). Specifically for the study area, Metcalf and McFaul (2011:10) provided examples of age differences between sediment-derived and charcoal-derived dates on house pit sites (table 6). The differences are largely due to the permeation of humic acids throughout the soil, which results in dated sediments generally scaling younger than the cultural materials they contain.

Recent work has shown that the discrepancy between sediment and charcoal ages can range anywhere between 26 and 8,000 ^{14}C years (Grimm *et al.* 2009). Sediment type is a factor in the rate of carbon exchange in soils, with those sediments containing higher clay content being less prone to the exchange of organic components with infiltrated younger humus components (Scharpenseel and Becker-Heidmann 1992:545). Depth is also a factor; carbon content routinely decreases with depth, being stored at the highest percentages between the ground surface and 20 to 30 cm below surface (Torn *et al.* 1997). Further complicating matters is that, as soils develop, mineral stability generally increases, resulting in the loss of a sediment's capacity to stabilize soil organic matter and a subsequent decrease in organic carbon (Torn *et al.* 1997:172). Thus, features and structures dated with organic sediment generally present younger-than-actual dates, although this is not always the case. Although the correlation of sediment dates to charcoal dates can help establish the degree of error for sediment dates at a site, they cannot always do so in a uniform or predictable way, even at a single site. When other dating options are not available, bulk sediment dating might be utilized, but the resulting dates need to be discussed and cautiously interpreted with attention to the above constraints. In this article, all sediment dates were excluded from both datasets.

Table 6. Comparison of organic sediment dates with charred material dates from age-equivalent contexts in study area and Wyoming dataset house pit sites (from Metcalf and McFaul 2011:Table 1).

		Date(s) (^{14}C yr B.P.)		
Site	Project	Organic Sediment	Charred Material	Comments
5MF2990	PBE	4480±80 (cultural level)	5960±50 (F7) 5980±40 (F38)	Bulk sediment age from beneath F1 in 44 House fill; F7 is indoor, F38 is outdoor 44 House.
5MF2997	PBE	4760±60 (F1)	5250±50 (F1)	Samples from the same basin hearth, F1.
5MF3004	REX	4300±50 (F7) 4850±50 (F5)	5650±50 (F9) 6300±40 (F2)	Dates for Component 3; F2 is in a house pit; all other dates outdoor.
5MF3006	REX, PBE	3140±70 (strat) 4880±60 (strat)	4115±25 (cultural level) 5238±25 (cultural level) 5517±20 (cultural level)	Bulk sediment dates bracket Spring Creek Paleosol (SCP); youngest ^{14}C age dates SCP; older ^{14}C ages compare to 4880±60 B.P. context. Note young limiting ages for SCP are probably ca. 3700 B.P.
48SW8842	UBL, PBE	2950±100 (F8)	3750±40 (CL2)	Stratigraphically equivalent positions in Cultural Level 2.

Chronometric Data

A sample of dates from 31 Archaic-era house pits from 11 of the study area sites and 63 Archaic-era house pits from 34 sites in the Wyoming dataset was utilized, excluding bulk sediment dates and utilizing the earliest calibrated median probability ages for house pits with multiple dates. The resulting distribution of these house pits by age largely falls within the ranges specified by Pastor and colleagues (2000) as to when house pits were most frequent, specifically the Settled Archaic period in Colorado which is generally analogous to Wyoming's Opal phase of the Early Archaic period (figure 3).

Paleoclimatic Context

David Rhode and colleagues (2010:81) built a paleoenvironmental framework within which to study Holocene foragers' adaptive strategies to changing climate, using data from the same projects for which most of the study area sites were excavated. They observed that study area peoples were affected not only by paleoclimatic environmental changes, but also by differing rates of plant and animal migrations in response to these changes. For example, they (2010:89–95) detailed the movement across the landscape of Utah juniper, ponderosa pine, and pinyon pine, resources whose changing availability in time and space would likely have altered Archaic-era seasonal rounds. Implying a need for caution in interpretations of early house pits' environmental settings using current vegetation, they noted that "only within the last 6000 to 5000 years did plant communities, as we know them today, become established" (Rhode *et al.* 2010:95).

Rhode and colleagues' paleoenvironmental framework defines "climate intervals" (CI), which characterize general paleoclimatic trends specific to the study area over the past 12,000 years. Reed and Metcalf (2009:113) assigned numbers to each of those climate intervals, which are utilized here. The paleoclimatic reconstruction developed by Rhode and colleagues encompasses all Yampa Valley house pits, with Wyoming's Great Divide Basin forming most of the northern part of their specific study area (Rhode *et al.* 2010:2). Thus, many of

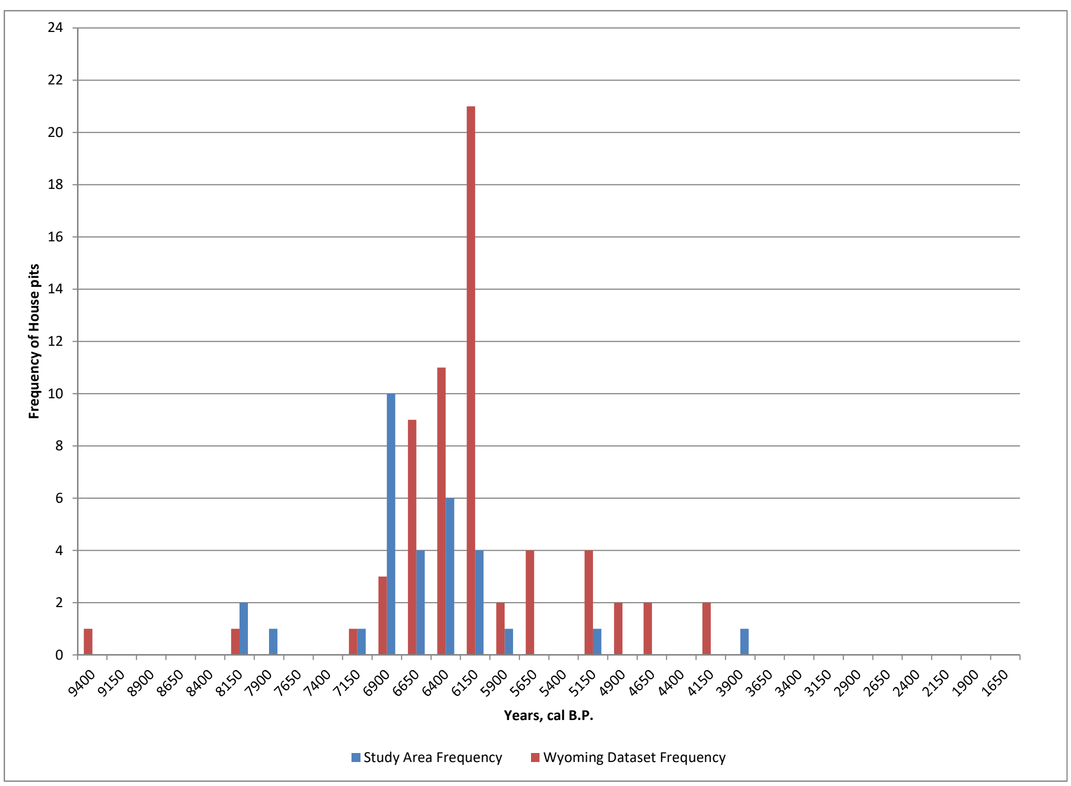

Figure 3. Frequency of Archaic-era study area and Wyoming dataset house pits, per 250-year interval.

the sites in this article are within the region they examined, but a number of the Wyoming dataset house pits discussed in this article are north or east of their focus area. When examining the Wyoming house pit dataset within this framework, it must be understood that, although long- and short-term climate cycles are generally applicable, some specifics of the framework may not directly apply to the microclimates of sites further afield.

As previously discussed, in order to explore the paleoclimatic triggers that might have spurred initial structure construction, the current chronometric house pit datasets were structured so as to reflect initial occupation of these shelters at each site, rather than be influenced by later reuse of architectural features. House pits in the study area and in the Wyoming datasets fell into CI 3 through CI 7 (table 7). Together, climate intervals with charcoal-dated house pits encompass a range from *ca*. 9400 to 2800 cal B.P., extending from near the beginning of Reed and Metcalf's (1999) Archaic-era Pioneer period and Wyoming's Great Divide phase through the early portions of Colorado's Terminal Archaic period and Wyoming's Deadman Wash phase.

The two earliest structures date to CI 3 (*ca*. 9400–8100 cal B.P.). The study area exhibited an increase in seasonality and was drier overall during this interval, following CI 2's already increased aridity and warmer temperatures. Evidence for initial Archaic-era structure use is uncommon in the study area, perhaps as a result of later erosional events (Metcalf and McFaul 2006, 2011), but one Wyoming house pit dates to the beginning of the interval (9210 cal B.P.) and one study area house pit falls at the end (8101 cal B.P.). Construction of these early shelters occurred during a transitional period, documented by adaptive shifts in lifeways between the Late Paleoindian and Archaic lifestyles (Metcalf 2011a). Specifically, Rocky Mountain and Wyoming Basin inhabitants were moving from an upland and valley and basin foraging focus, with evidence of large and small game use and limited processing, to a subsistence pattern that was seasonally dependent on intermountain basin and mountain valley resources, with evidence for use of large and small game, roots and seeds, and cooking and processing (Metcalf and McDonald 2012).

Nineteen structures were associated with CI 4 (*ca*. 8100–6600 cal B.P.), with a much higher percentage of structures from the study area represented within this interval than the Wyoming dataset (42 percent compared to 10 percent, respectively). At the beginning of this interval, climate in the study area was marked by increased precipitation and cooler temperatures. People continued their seasonally dependent intermountain basin and mountain valley subsistence pattern through the initial portion of CI 4 (Metcalf and McDonald 2012). By 6800 cal B.P., this pattern had developed into central-place foraging (Metcalf 2011a:141), likely with a longer-term residential focus on locations with reliable resources as precipitation levels and temperatures graded toward the mid-Holocene thermal maximum that occurred during the following interval. Fourteen of the 19 structures, 10 from the study area and four from Wyoming, were constructed during the last three centuries of CI 4 (6900–6600 cal B.P.) and probably represented people's initial shift to a longer-term residential pattern in reaction to the changing climate.

CI 5 (*ca*. 6600–5500 cal B.P.) was the Middle Holocene warm and dry period commonly known as the Altithermal. For both datasets,

Table 7. Distribution of study area and Wyoming dataset house pits per climate interval (CI). CI ages taken from Rhode and colleagues (2010).

		Wyoming Dataset		Study Area Dataset	
CI	CI Age Range (cal B.P.)	Number of House Pits	Percent	Number of House Pits	Percent
3	9400–8100	1	*1.6*	1	*3.2*
4	8100–6600	6	*9.5*	13	*41.9*
5	6600–5500	44	*69.8*	15	*48.4*
6	5500–4000	12	*19.0*	1	*3.2*
7	4000–2800	-	-	1	*3.2*
Totals		63	*100.0*	31	*100.0*

more structures were built during this interval than in any other—comprising 48 percent of the study area dataset (*n*=15) and 70 percent of the Wyoming dataset (*n*=44). During this interval, temperatures increased and aridity peaked in the study area (Rhode *et al.* 2010:86). Similar to the end of CI 4, mobility continued to be limited due to the unfavorable environment, with an emphasis on central-place foraging (Metcalf and McDonald 2012).

With the onset of CI 6 (*ca*. 5500–4000 cal B.P.), a pattern of Neoglacial cooling was reestablished in the study area, with precipitation rising once again to near modern levels. Of the 13 structures in this interval, 12 were in Wyoming (19 percent), with seven initially constructed in the middle of the interval between 5000 and 4500 cal B.P. Only one structure in the study area dated to this interval (3 percent). The temporal offset in house pit frequency per climate interval between the two datasets—with the study area dataset numbers peaking in CI 4 and 5 and the Wyoming sample numbers peaking in CI 5 and 6—suggests that microclimates locally varied in their timing or that Wyoming peoples shifted to a more mobile lifestyle during CI 6 more slowly than their southern neighbors. Overall, as climate conditions improved, inhabitants returned to a more mobile lifestyle, based on a number of factors including the sharp drop in the number of house pits. They undertook less plant processing, less use of pit features, and more hunting, as game rebounded from the warm and dry period (Metcalf and McDonald 2012).

Only one structure from the study area dataset fell within CI 7 (*ca*. 4000–2800 cal B.P.). CI 7 was a period of increased aridity in the study area with temperatures slightly above modern levels. Utah juniper extended into Wyoming basins at this time, and pinyon pine reached modern limits in north-central Colorado (Rhode *et al.* 2010:96). Use of the structure fell near the beginning of the interval (3754 cal B.P.), nearly 2,000 years after the next most recent dated residential occupation at the site, during a warmer and drier interval when central-place foraging may once again have been effective. Similar to the earliest Archaic-era house pits, construction of this latest shelter demonstrates that structures were simply one of many Archaic-era versatile technologies that inhabitants pulled from their toolkit when a specific need arose (Metcalf 2011a:142).

Based on these data, shelter construction in Colorado's Yampa Valley and across the greater Wyoming Basin peaked during the mid-Holocene maximum. This timing leaves little doubt that the severe conditions of the mid-Holocene prompted a change in settlement strategies, with conspicuous increases in the building and use of structures during the Settled Archaic period and Opal phase. Roughly 90 percent of structures in each dataset appear to have been initially used during this climate event. Timing of the onset or length of the interval probably locally varied, however, if the number of shelters constructed in different regions can be used as a proxy for maximal thermal conditions. Their remains seem to reflect a central-foraging pattern during this time, with longer-term occupation in particular locations near food, water, and shelter resources. During times of resource scarcity such as the Altithermal, structures may have also increased the visibility of a group's claim to an area with these reliable resources (Eckerle 1997). As cooler and wetter conditions returned to the study area between 5500 and 4000 cal B.P. (CI 6), a longer-term occupation centered on reliable resources may have still offered some advantages or may have been culturally preferred, but the substantially lower number of structures dating to this interval and after appears to demonstrate a return to an earlier pattern of high residential mobility.

Conclusion

In the two decades since Shields's (1998) initial definition of basin houses and their subsequent inclusion in the northern Colorado River basin context (Reed and Metcalf 1999), a substantial number of these features in both Colorado and Wyoming have been added to the Wyoming Basin database. Thus far, Shields's observation that these architectural features were concentrated in the physiographic Wyoming Basin has held true, although their concentration may be the result of the identification of many sites through substantial energy development in that area. Additional research has confirmed initial observations that house pits are highly variable in size, type of construction, and use. Further, as the structures of mobile foragers rather than a settled people, they were created for a specific time and place on the landscape, with individual design characteristics indicative of season, resource availability, functional need, and anticipated length of stay.

In some ways, the Archaic-age house pit data from the Colorado study area at the southernmost edge of the Wyoming Basin seem even more varied and possibly more multifaceted than much of the data for the architectural features to the north. This difference might be attributed to the linear study area bisecting the resource-rich Yampa Valley, whereas the Wyoming house pits are broadly scattered across the marginal environment of the northern Wyoming Basin. It is also possible that the presence of more structures with greater depth, multiple rooms, benches, and three-sided walls may be due to study area shelters serving more often as primary housing than their Wyoming counterparts, which again might be connected to their favorable Yampa Valley location. Alternately, this might simply be attributed to differential preservation, with a greater variety of house pits preserved in the Yampa Valley's favorable depositional environment than in the more eroded northern Wyoming Basin. Importantly, based on the distribution of house pits by climate interval, Archaic-era inhabitants of the study area may have shifted to central-place foraging in response to the mid-Holocene thermal maximum earlier than did northern Wyoming Basin inhabitants, suggesting local variability in the timing of climate changes. No matter the timing of the event, however, these residential sites clearly were vital to hunter-gatherers during the challenging times of the mid-Holocene thermal maximum. However, people constructed shelters both before and after this climate interval as well, suggesting "that the role of houses is not temporally constrained, but instead probably relates to subsistence and mobility" (Metcalf 2011a:151).

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Notes

[1] Architectural feature totals in this article include individual rooms in multi-room architectural features (see table 2).

Supplementary Material

Supplementary Dataset A: House Pit Metric Data

Supplementary Dataset B: House Pit Chronometric Data

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