Structural Wood Documentation and Dendrochronology in SE Utah: Tree-Ring and AMS Dates from Cedar Mesa

Canyonlands Natural History Association
Project 2016 Discovery Pool Grant (#16-05-BLM)
(partnered with the BLM)

Final Report

Thomas C. Windes

305 Richmond Drive, SE

Albuquerque, NM 87106-2239

windes@unm.edu

12 February 2018

Introduction

At the request of the BLM (Monticello Office) to continue our work on Bureau of Land Management (BLM) land in the Beef Basin-to-Cedar Mesa region in southeastern Utah, west of Blanding, the wood project crew, led by the author, continued to document structural wood in threatened prehistoric sites and some historic sites on Federal lands. As part of this effort, we retrieved core samples from the structural wood for tree-ring dating to help refine the regional chronology of the settlement and its abandonment primarily in the twelfth-and thirteenth-centuries. The majority of the sites studied were located in the cliffs of the regional canyons, which sheltered many intact and semi-intact structures, primarily constructed in the AD 1100s and 1200s. The majority of sites have never been tree-ring sampled for dating; thus the present work provided an idea situation to help refine the regional chronology, preserve samples from the structures (also used for paleo-climatic reconstructions), as well as to provide detailed mapping and other documentation to many of the more intact sites, which had received little scientific attention. In addition, it provides the BLM with detailed base-line information regarding the complexity and condition of the sites and the material found on them. For this CNHA grant, funding covered costs of the analyses of the many tree-ring samples collected during the course of our work in 2016. The Laboratory of Tree-ring Research in Tucson is the only facility that analyzes tree-ring samples for the entire Southwest.

We worked in several canyons across Cedar Mesa with a focus on the Slickhorn-Point Lookout canyon systems (**Figure 1**), along with limited work along Butler Wash. Under the direction of cultural resource archaeologists, Cameron Cox and Don Simonis, from the Monticello District Office of the BLM, our goals are primarily to investigate and document sites and areas suffering from the impacts of heavy visitation, looting, and natural deterioration. Some exposure to the elements is common for many of these sites, thus they typically are suffering from natural degradation from weather and insect infestation, affecting their structural integrity, along with the loss of other unsheltered perishable items.

The wood project crew is made up of numerous volunteers from all over the country, many with decades of experience working with the author on sites across the Southwest. Their numbers vary over the course of the work depending on their schedules and the area in which we were working. Much of our previous field work was similar to our BLM work: we have worked in many national parks and monuments, including extensive work in Natural Bridges NM, Chaco Culture NHP, Mesa Verde NP, Aztec NM, Montezuma Castle NM, Pecos NHP, Tonto NM, and in many historic structures throughout northern New Mexico. The 30 volunteers who helped on the project, including those on return trips to sites to help finish the recording. **Personnel:**

Eileen Bacha (Youngstown, OH)
Pam Baker (Moab, UT)
Quent Baker (Moab, UT)
Kay Barnett (Cortez, CO)
Ben Bellorado (Tucson, AZ)
Cory Breternitz (Phoenix, AZ)
Blayne Brown (Tucson, AZ)
Katherine Earp (Las Vegas, NV)
Cliff Evans (Albuquerque, NM)
Christine Gilbertson (Duncan, British Columbia)
Leigh Grench (Moab, UT)
Vaughn Hadenfeldt (Bluff, UT)
Ray Hanson (Myrtle Creek, OR)
Donelle Huffer (Tucson, AZ)
Winston Hurst (Blanding, UT)
Claire Jones (Austin, TX)
Peg Kaiser (Oakland, MD)
Nicole LeBrun (St. Paul, MN)
Dave Manley (Durango, CO)
Clay Mathers (Albuquerque, NM)
Richard Moeller (Santa Fe, NM)
Jamie Schubert (Sacramento, CA)
Robert Shelley (Draper, UT)
Justin Smith (Austin, TX)
Criss Swaim (Albuquerque, NM)
Marty Thomas (Moab, UT)
Darrell Thomas (Moab, UT)
Sarah Thorn (Boulder, CO)
Connor Windes (Wheat Ridge, CO)
Madeline Windes (Wheat Ridge, CO)

Methodology

Our work involves documenting every piece of structural wood at a site except for the roof closing splints and wood fragments (especially badly split and weathered pieces), which includes numerous attributes of each piece of wood: its size, species, condition, context, origin, harvest treatment, damage, whether it was sampled, etc. Those elements that appear in condition to generate cutting or near-cutting dates are sampled and the 5/8" diameter drill hole plugged with a wooden dowel and field number. Some species will not date, however, and these are documented but not sampled (i.e., cottonwood, sycamore, and brush elements), including elements that appear to have too few growth rings for dating (<30 rings). These samples also help preserve the paleo-environmental and fire histories of the region for future research.

In additional, to-scale maps are made of the site and complex individual structures, such as intact kivas, with a surveying compass (Ushikata) or an alidade and plane table. These maps are later drafted with ink on mylar sheets for archival purposes and later digitized with the labeling, as seen in this report. We also, if possible, record all artifacts on the site, including tallies of all the ceramics, chipped stone, ground stone, and any other rare items. Reports and scanned field maps are provided to the BLM and the Utah state record archives, and previous site reports updated (see Windes 2012, 2013, 2014, 2015, 2018). Rock art was documented by Pam and Quent Baker, and Leigh Grench and Dave Manley, although many of these sites were also done by Sally Cole with her rock-art recording project in the 1990s.

We provide documentation of the sites in the form of to-scale, detailed instrument-mapped site plans (including individual to-scale detailed maps of any intact architectures), tallies of all cultural materials when possible, and maps and inventories of the structural wood elements as well as the various other features at the site. A number of the structural elements are tree-ring sampled to help build and refine the presently sparse chronology of the Puebloan occupation in southeast Utah during the AD 1100 and 1200s, which aids the research community in defining the Puebloan settlement and abandonment of the region.

Tree-ring Dating

The large number of volunteers provided much assistance to this program but it is the high costs of the tree-ring analyses that the CNHA grant helps to cover. The recent results herein provide the first chronometric dating for the sites investigated, although the past marginal and erratic precipitation conditions unfortunately prevented dating many of the tree-ring specimens. In the Slickhorn Canyon system, first surveyed in the 1960s by the Lipe and Matson's Cedar Mesa Project, almost all of the habitation and other large sites have now been mapped, documented, and sampled for tree-ring analyses (but many of these are still in the analyses pipeline at the lab). No tree-ring samples had been previously taken in Slickhorn before the wood project, which now provide some chronological information to compare with other canyon systems, such as well-dated nearby Grand Gulch, where past dating was far more successful. The recently-received tree-ring results produced 45 dates from the 144 samples submitted (31% success), which is within the range of normal laboratory dating success. But this is skewed by the very good results from the intact kiva at Pickett Fork and from Room 2 at Target House where nearly 50% of the sample dated, but little else dated from the sites. Otherwise, we were often lucky to obtain 10 to 20 percent success from many of the southern Cedar Mesa sites because of the use of undateable cottonwood and erratic tree-growing conditions posed by the drier climate across the southern part of Cedar Mesa (**Figure 1**) for the heavily used local juniper and piñon. Nevertheless, the limited results have been extremely useful, especially given the typically sparse cultural material found at many of the sites, where even cross-ceramic dating is often difficult.

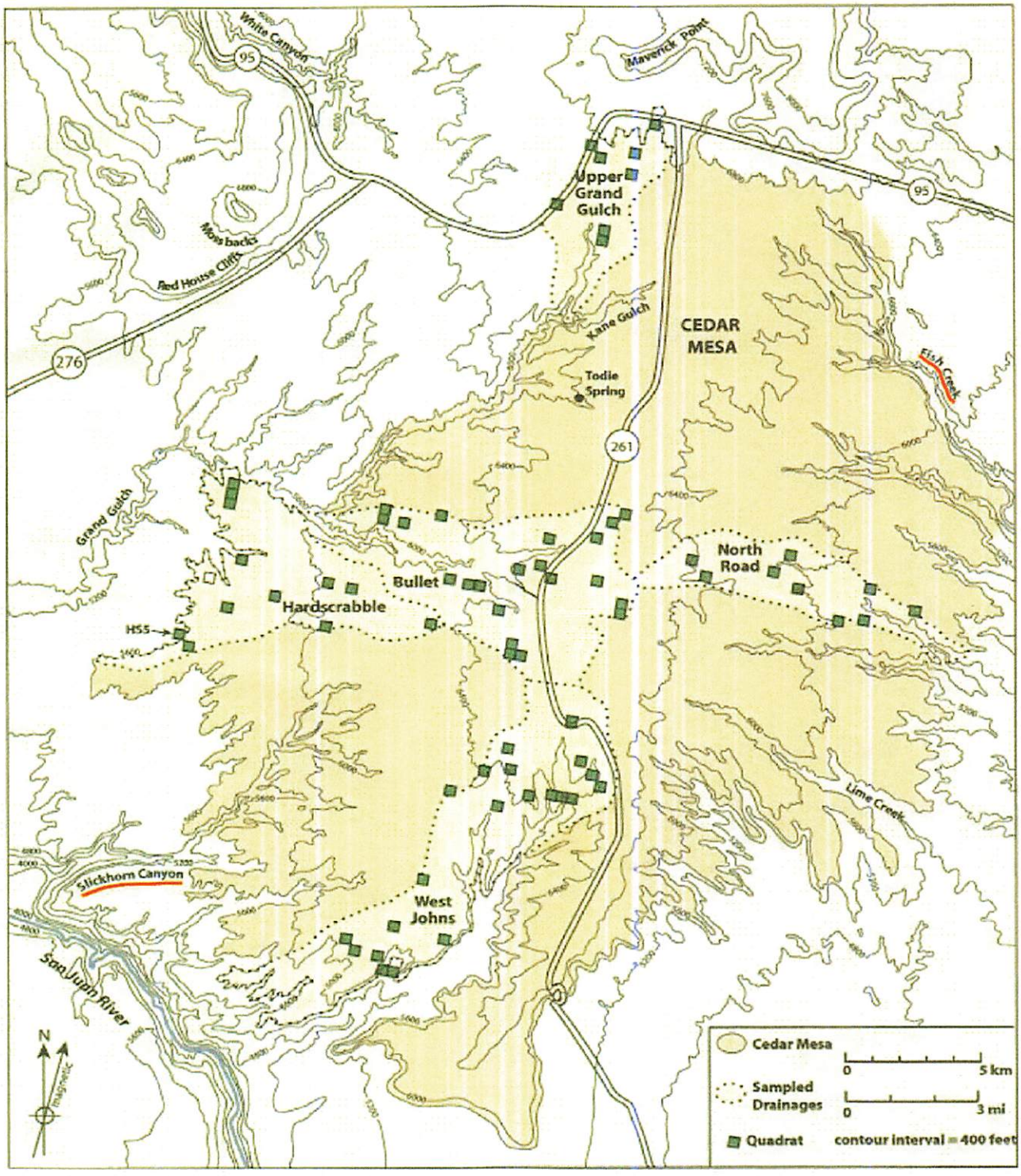

Figure 1. Cedar Mesa, SE Utah. Green square quadrats sampled by Lipe and Matson in the 1970s. Our work focused on the areas near Fish Canyon in the northeast and in the Slickhorn Canyon system to the southwest. Grand Gulch lies to the middle-west north of Slickhorn.

Radiocarbon Dating

Recently, however, a new radiocarbon dating technique has been useful when used in coordination with the tree-ring dating, although it is still in its calibration stage. A low energy plasma radiocarbon sampling (LEPRS) system has been set up at the Museum of New Mexico's Office of Archaeological Studies (OAS), Santa Fe, by Martin Rowe and Eric Blinman (PlasmaC.Lab@state.nm.us), which produces radiocarbon dates like those generated by any other ^{14}C sample-preparation techniques (Rowe et al. 2017). Among its advantages, however, it allows collection and sampling of carbon in a stepwise fashion, such as sampling the different accumulation layers of ceiling carbon from the earliest to latest in sooted rock shelters, of which there are a number in the research area where we have worked that may yield deep-time use results. This technique may also be useful in dating the soot from cooking vessels and other related sources of sooting. While the CNHA funding did not cover this newer analysis, it is included especially because of its overlap with the tree-ring results from 4-Shield House, which contains much wood but yielded a paucity of tree-ring dates.

Sooted rock shelters, cavates, and caves have long served mankind for tens of thousands of years and yet are seldom recognized as having potential for understanding temporal use of such shelters. Indeed, research in such caves in the United States typically ignore even the presence of sooted ceilings (e.g., Bullen 1942; Cressman 1956; Frison 1965; Loud and Harrington 1929; and Over 1936), even those that are subject to contentious argument over periods of human occupation(s), such as at New Mexico's Sandia Cave (e.g., Bliss 1940a, 1940b; Hibben 1941; Thompson 2012). Earlier investigators were more apt to mention the presence of sooted structures and shelter ceilings (e.g., Fewkes 1909:5, 10, 16; 1911:39, 53-54, 56, 58; 1919:39; Judd 1926:99, 116-117) but this seems to have fallen out of favor for reporting. Yet, there are a few examples where sooting has been considered a cultural resource worth investigation (e.g., Bennington et al. 1962).

A Summary of the Dated Sites

42SA 5795 (Perfect Kiva, Slickhorn Canyon)

Two previously sampled sites funded by an earlier grant from the CNHA (Windes 2014) later yielded samples from ladder poles (**Table 1**; all tables are listed at the end of the paper, page 31). Although we obtained twelve cutting tree-ring dates from Slickhorn's Perfect Kiva (42SA 5795) between AD 1206 and 1229 from previous work not covered here, we were later given permission to sample the kiva's ladder that is now at the Edge of the Cedars Museum, Blanding, Utah. This ladder was removed by the BLM in the 1980s and replaced with a replica ladder to prevent further wear-and-tear from visitation and to ensure that it wouldn't be stolen. Interestingly, the two poles of the ladder dated later than the presumed terminal construction of the kiva and adjacent living room at AD 1229 (the latest dates from the sample) with both juniper poles dating at AD 1242B (bark cutting dates). The ladder poles were collected from trees during their non-growing season (i.e., during the fall or winter of 1242 or early in 1243). Presumably, this ladder was a replacement after the initial kiva ladder failed to be serviceable. But even this ladder is missing rungs, and some of which appear to have been replaced historically.

2SA 29513 (Blue Man/Square Kiva, Slickhorn Canyon)

This site, covered by Windes (2014) during our first season, is located down canyon from Perfect Kiva. It consists of two components. The upper ledge is dense with small features, most of which have been removed in prehistoric times. None of the wood (mostly cottonwood; *Populus* sp.) on this ledge is datable nor are there any ceramics except for three plain gray sherds; this component is probably Basketmaker or Pueblo I, although

a few masonry features suggested that it might have later served as a place of use and refuge for the occupants located along the talus base of the lower cliff face.

The later component, marked with Pueblo II and early Pueblo III ceramics (**Table 2**), exhibits a nearly intact square kiva and four rooms. There is much wood in the kiva but otherwise, structural wood is rare. We initially took 14 samples, none of which dated. A re-visitation provided a few additional samples, including three poles, possibly from a ladder, resting vertically against the roof where a hatchway might have been located. The southern edge of the roof is missing, where it is most exposed to the elements, so that a hatchway could not be identified. Two of the poles were *Populus* sp., but the juniper pole dated at AD 1257+v, a near cutting date, the only tree-ring date from the site (**Table 1**). Given the tree-ring date, it is surprising not to have seen any Mesa Verde B/w sherds although there may have been some in the few unclassified McElmo/Mesa Verde B/w sherds. The rooms to the west of the kiva may be associated with the Pueblo II ceramics as they are built with upright slabs and some masonry. The large room attached to the east side of the kiva, has a single large viga (which failed to date) spanning its walls close to the cliff face, and the small granary nearby, probably relate to the late occupation.

42SA 5819 (4-Shield House, Point Lookout Canyon)

This is one of the most complex sites in the Slickhorn system with two occupational components in the late 1000s/early 1100s and in the mid AD 1200s. The site consists of 16 rooms, including a burned kiva, spread along about 250 m of perilous cliff-ledge, overlooking a deep, narrow canyon (**Figure 2**). Midway along the ledge are two cavates with deeply sloping natural floors on which high masonry retaining walls were built across the front and filled behind with deposits to provide a level work area. Each cavate had a small unsooted jacal storage structure built at the back, which were built against the previously densely-sooted back ceilings. Neither cavate exhibits obvious thermal features, although they may be buried by fill.

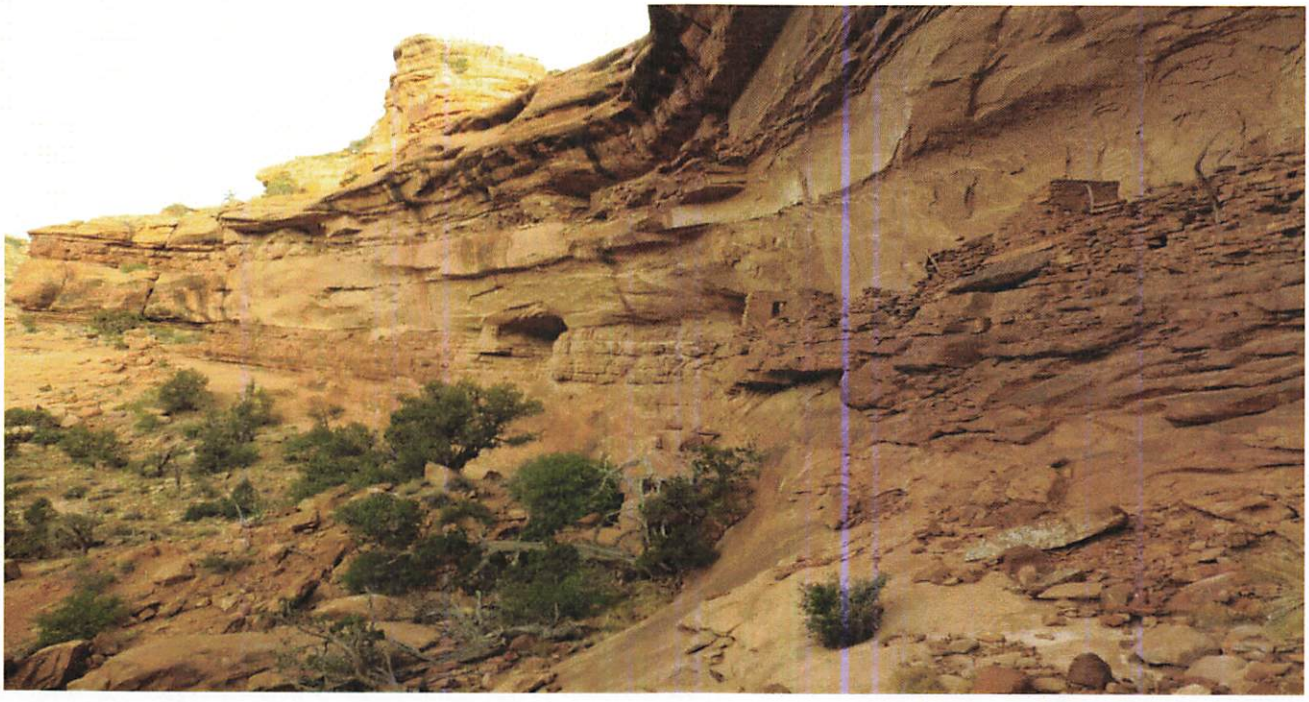

Figure 2. 42SA 5819, 4-Shield House. Site spans entire photo left-to-right. Photo by C. Gilbertson 2014.

There is a surprising lack of artifacts from the site, limiting reliance upon ceramic dating. Datable structural wood is also in limited supply, yet the few dates achieved greatly help to anchor the chronology of the latest

occupation. In addition, recent opportunities to radiocarbon some cavate soot and corncobs from the site provide additional chronological material to the site history.

The Plasma-chemical radiocarbon analyses by the Office of Archaeological Services of ceiling soot from the East Cavate (**Figure 3**) ceiling at the site provides another layer of understanding for the Puebloan occupation of the site, which architecture and tree-ring dates mark as mostly constructed in about AD 1260. Cultural material in the form of ceramics and chipped stone was sparse but the few ceramics mark a Mesa Verdean AD 1200s occupation, leaving little earlier cultural evidence other than the cavate sooting to mark the presence of an earlier use or occupation of the site.

Two of the 4-Shield House ledge structures yielded tree-ring cutting dates at AD 1259 and 1260 (**Table 3**), while the East Cavate, which yielded the ^{14}C soot dates, produced tree-ring dates of AD 1252+B from a retaining-wall jacal post and of an AD 1207 non-cutting date from one of an upper level row of tie logs. Among a mass of lower wall horizontal tie logs, a single non-cutting date was produced of AD 969++vv but which is considered a near cutting date in the field by the author but both samples reveal the densely packed rings at the end of the growing sequence ("++"), indicative of dead or dying trees. But an AD 1259++vv date from a dying or dead tree when it was cut, was not weathered but fresh-looking, and exhibited bark along with two other associated lintels (which failed to date) in the barrier-wall doorway into the East Cavate. This dates's context and similarity to the adjacent late dates in the adjacent East Cavate indicates to the author that it is a cutting or near-cutting date for the construction of the barrier wall.

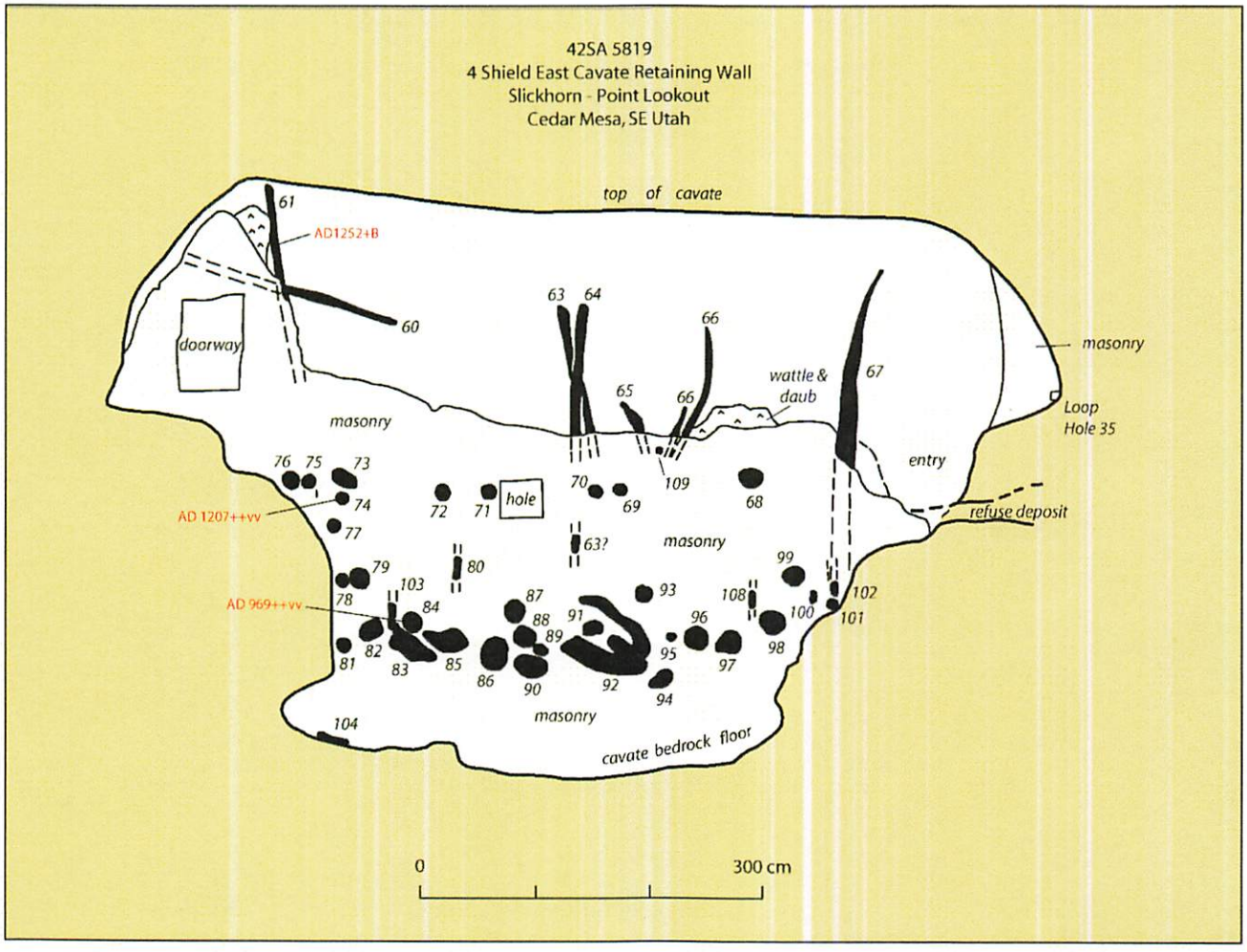

Figure 3. 42SA 5819 4-Shield House, East Cavate retaining wall with tree-ring dates.

While the three-meter high retaining wall appears to have been built at the same time as several other structures at the site, the earlier date among the 50 horizontal tie-logs that anchor the retaining wall to the sloping bedrock floor behind it may mark an earlier (lower) construction that coincides with the ^{14}C soot dating. Several other tie logs were sampled but did not tree-ring date. Burning centuries-old deadwood of juniper and piñon, found immediately adjacent to the site and in the general area, which composed almost all of the structural wood used in retaining walls at the site, may have produced earlier ceiling soot but the soot clearly predates the visible architecture in the cavate and the latest tree-ring dated elements (e.g., the unsooted retaining wall and the back granary are built against the cavate-sooted walls).

Four corn cobs among dozens in the Room 10 granary at the far west end of the site (**Figure 4**) were also used in the Plasma-chemical analyses. Two distinct cob types based on color and size were noted there, which seemed to have come from two separate uses of the storage room. Basketmaker III rock art directly above the granary and the small, dark-brown corn cobs that looked in poor condition suggested an early BM III use. The larger, light yellow, fresher-looking cobs suggested growth during the PIII use of the granary. But the four sampled dark cobs indicated that all were grown within PII/PIII times. Sample WDCC 1.3 dated the earliest, with a strong calibrated date between AD 1000 and 1200. The other three cobs plotted strongly at about AD 1150 to 1250; an overall mean for the four dates from the two dark cobs is AD 1100±28. The lone dated yellow cob (WYCC 1) yielded two calibrated plot peaks, with the earlier peak between 1215 and 1329 (71% 2-sigma certainty) and the unlikely later peak between 1340 and 1397 (of 24% certainty), with an overall mean date of AD 1240±50.

In addition, a sample of both types of cobs (n=10) from Room 10 revealed highly variable row numbers, of 5, 6, 9, 11, 12, 14, and 15 rows, a sign of crop growth stress (Mollie Toll, ethnobotantist, personal communication 2017)—indicative of poor farming yields.

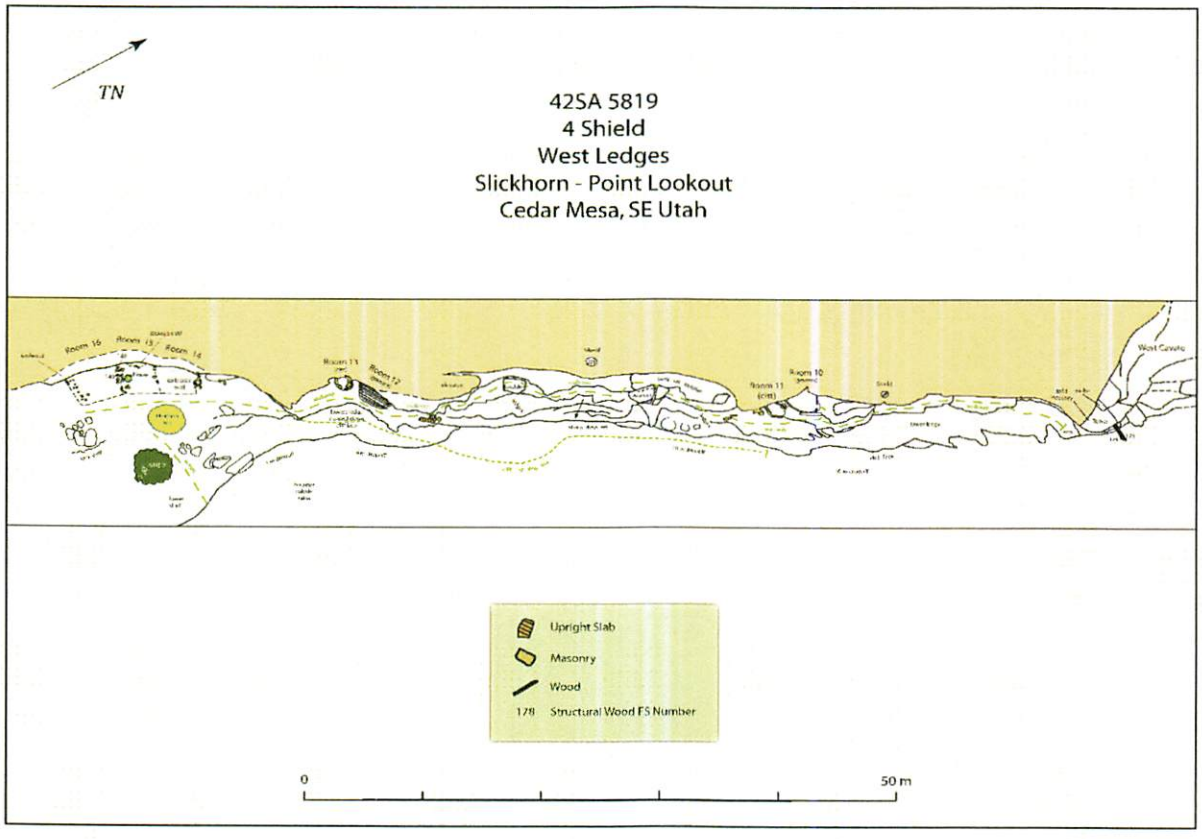

Figure 4. 42SA 5819 4-Shield House western ledge showing Rooms 10-16. Dated samples are from Room 10.

A tree-ring date procured from one of the granary's Room 10 door lintels is AD 1259+B (NBR-1946), which nearly matches another from the isolated wall, entry doorway into the East Cavate. Thus, the overall result places some of the corn cobs temporally similar to the tree-ring dates within the late construction, specifically within Room 10, from which they were recovered, and use of the site in the mid-1200s. But the earlier dated dark cobs must mark corn grown closer in time to AD 1100, which may have been associated with use of the three dismantled masonry Rooms 14-16 tucked under the cliff face at the far southwestern end of the site (**Figure 4**), where several sherds of AD 1000s/early 1100s Mancos Black-on-white were tallied but almost all other ceramics came from the eastern rooms (**Table 4**) and from a small, ashy concentration next to the trail on the flood plain below, near the north side of the wash. Overall, surprisingly little other cultural material was noted for the site despite extensive searching along the base of the cliffs.

The sparse roofing elements in the one kiva have all been burned, as has the inner surface of its eastern outer wall. But no collapsed kiva roofing remains are evident now and two subsequent massive walls built against the inner eastern inner wall attests to renovations that prevented direct entry into the kiva and access along the entire eastern ledge of the site to the two cavates. This may indicate an attack at the site and attempts to make it much more defensible, a period probably post-dating the AD 1260 constructions. This is a known period of conflict (e.g., Glowacki 2006; Kohler et al. 2010; Kuckelman 2002; Lightfoot and Kuckelman 2001; Matson et al. 1988: 225).

42SA 5810 (Citadel West above Slickhorn Canyon)

This site is built under, around, and on top of a large pinnacle of boulders overlooking much of the Slickhorn Canyon system. The site consists of 2 kivas, 12 rooms, and several bound open areas. A shrine-like structure is built on one of the highest levels and two huge, presumably man-made, bedrock cists exist in the top of the largest and highest part of the rock pinnacle next to the remains of a masonry wall (safe access could not be made to the top). The upper reaches of the site provides vast viewsheds of the surrounding region, as far as Navajo Mt. to the southwest, the Henry Mts. to the west and northwest, and into Canyonlands' Needle District to the northwest.

Many of the site's structures are in the open, where the surviving structural wood remains have suffered extensively from weathering, so that few tree-ring samples could be obtained from these. Kiva 1 is sheltered under the gigantic, highest boulder, which protects its 48 juniper structural roofing elements. We sampled 18 of these (NBR-1897 to NBR-1914; **Table 5**) but failed to obtain any dates because of suppressed, erratic, and double growth rings–indicators of stressed tree growth from variable environmental conditions; another sign of the drier conditions that pervade southern Cedar Mesa.

Room 1, a granary, is attached to Kiva 1 on its south side and there was an entry between the two until it was blocked with masonry (**Figure 5**). A doorway on the room's south end provides an additional outside access to its interior. The room's roof was support by two primary beams, crossed with smaller secondaries, some of which were juniper splints. We sampled the two juniper primaries (NBR-1915 to 1916) and the east one dated at AD 1236+L, a cutting date. The other failed to date, showing suppressed and double rings. Across a narrow space and facing Room 1 is another intact granary, Room 2, built in similar fashion, with masonry walls and two small juniper roof primaries (NBR-1917 to 1918); both surprisingly dated: AD 1262vv and 1265v, the latter being a cutting or near-cutting date.

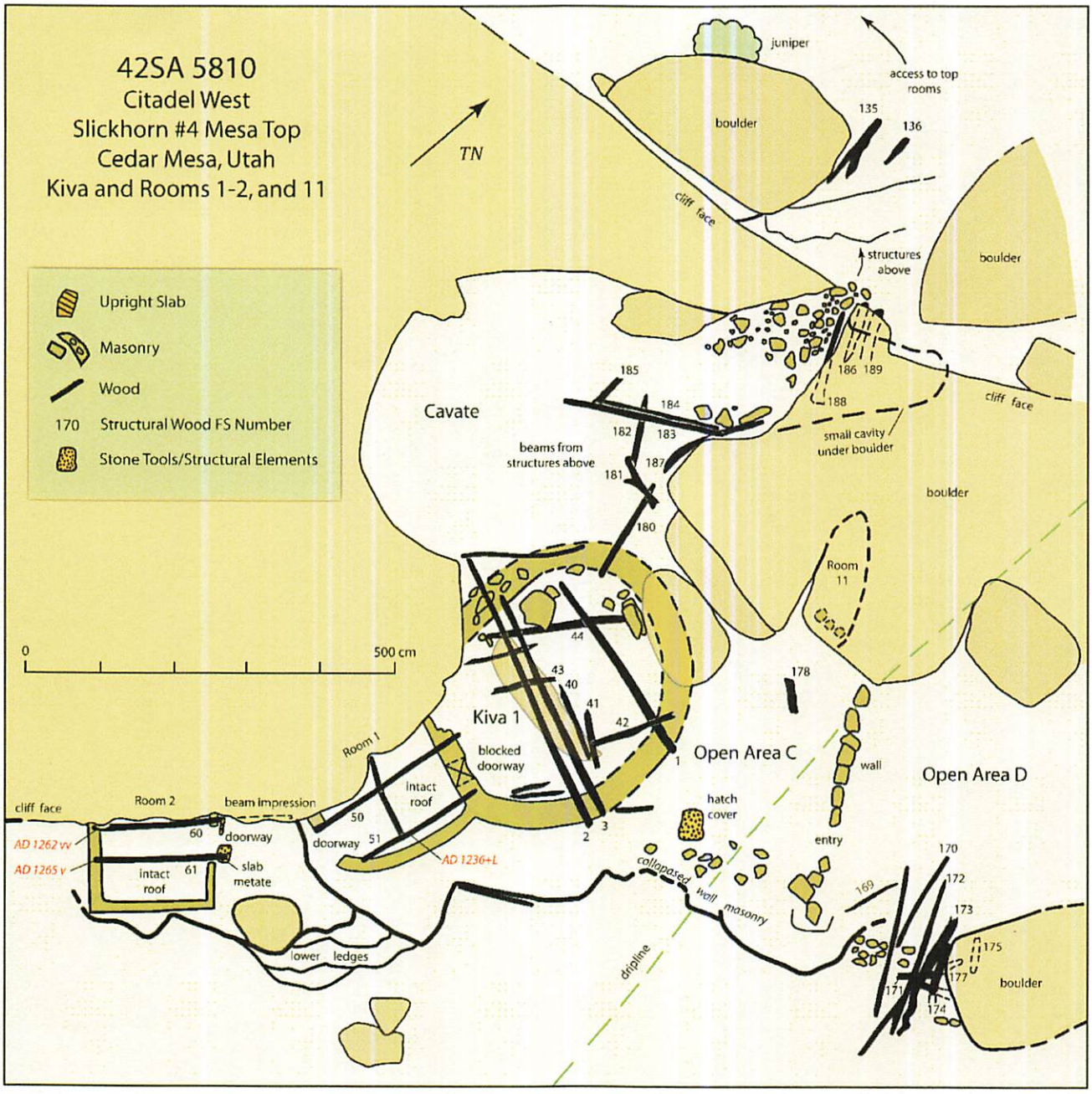

Figure 5. Citadel House-West (42SA 5810), Kiva 1 and Rooms 1-2 with tree-ring dates. Most roofing elements in Kiva 1 are not shown.

Despite the poor dating success of these structures (more have been sampled since), the dates mark these three structures as being built in the mid-AD 1200s, which is supported by the relatively robust overall site ceramic tally of 264 sherds dominated by overall indented corrugated culinary, McElmo, Mesa Verde, and McElmo/Mesa Verde black-on-white sherds, with a bare trace of earlier Mancos B/w and plain gray and narrow neckbanded sherds present (**Table 6**). The dominance of McElmo B/w supports a late AD 1100s to early AD 1200s occupation (possibly Kiva 1 and Room 1) with subsequent later construction(s), such as Room 2 built at about AD 1265. Over 200 wood structural elements were documented at the site; another 18 samples taken later may help refine the chronology of the site, but the lack of dates from the kiva bode for more poor results. Given its location and use of the pinnacle, the site can be considered built in a defensive manner.

42SA 5814 (Tadpole House, in Slickhorn Canyon #5 trail)

This is the largest site in the Slickhorn Canyon system that I know of but it is a 2-3 hour backpack trip to reach it with recording, sampling, and camping equipment. Although located high along a broad ledge above the canyon floor, the site was not specifically defensive in regards to ledge access; it also lacks defensive masonry barriers. It has numerous kivas and rooms (an estimate of 50 or so structures) and a possible large community structure located on the widest open area bordering the ledge, for which mere foundation stones now remain. We have only mapped and documented a small part of this site, but the dendrochronological results were disappointing, as is common for the Slickhorn area. The canyon bottom wash has a gushing permanent spring and a large pool of water that is generally available just below the site–the largest and most reliable water source for the entire upper fingers of the Slickhorn Canyon system.

Much of the site is sheltered along the ledge, and preservation of the structures is excellent (**Figure 6**). We started at the ledge's northeastern end, where the cliff overhang sheltered Kiva 1 and Rooms 1-4 that form a single domestic unit (**Figure 7**). Two of the rooms (2 and 3) may be considered living rooms based on their size and the use of an adjacent mealing room (Room 4, with three mealing bins). The kiva roofing was collapsed to the ground (39 elements were evident) and open to weathering but exhibited some sizeable primary beams. Only one (NBR-1924; AD 1156+vv, a non-cutting date; **Table 6**) dated of the seven samples taken and provides only limited temporal information of some construction after AD 1156. However, a date (NBR-1930; AD 1149+B) from a roof secondary in Room 3 does help support that some construction in this unit, perhaps all of it, took place in the mid AD 1100s. Generally, all of the other 13 samples, all juniper, failed to date because they suffered from the same poor growing conditions (e.g., exhibiting erratic, suppressed, and double rings) seen at many other Slickhorn sites.

South along the ledge from the above group and tucked well under the cliff overhang is a jacal-constructed Room 15 (**Figure 6**), with some 50 hefty juniper and piñon posts in its eastern front and southern side walls (the rock ceiling served as its roof). Dating success was somewhat better here, which generated three piñon dates (AD 1230vv; AD 1211++v [deadwood]; and AD 1223vv; see **Table 7**), all non-cutting dates, but establish its construction in the early AD 1200s, if not later. Seven others, all juniper, failed to date for the usual reasons.

Thus, at this point, two periods of construction appears to have taken place here; the end group of structures, possible housing 1-2 families, built in the mid AD 1100s and the large domestic Room 15 built in the early or later AD 1200s. More extensive sampling may change this interpretation, however. This site may be one of the earlier PII-III sites in the Slickhorn system, perhaps formed from several groups joining together over a period of time. But the vast reminder of the site waits for additional work to get a better handle on its occupational history, hopefully in 2018. Although a concerted effort to record ceramics and other artifacts at the site has not yet been done, artifacts seemed to be rare at the site.

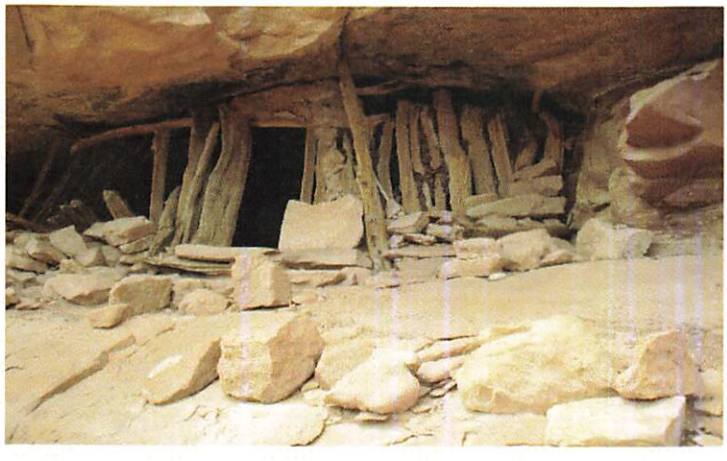

Figure 6. Tadpole House, Room 15; habitation structure.

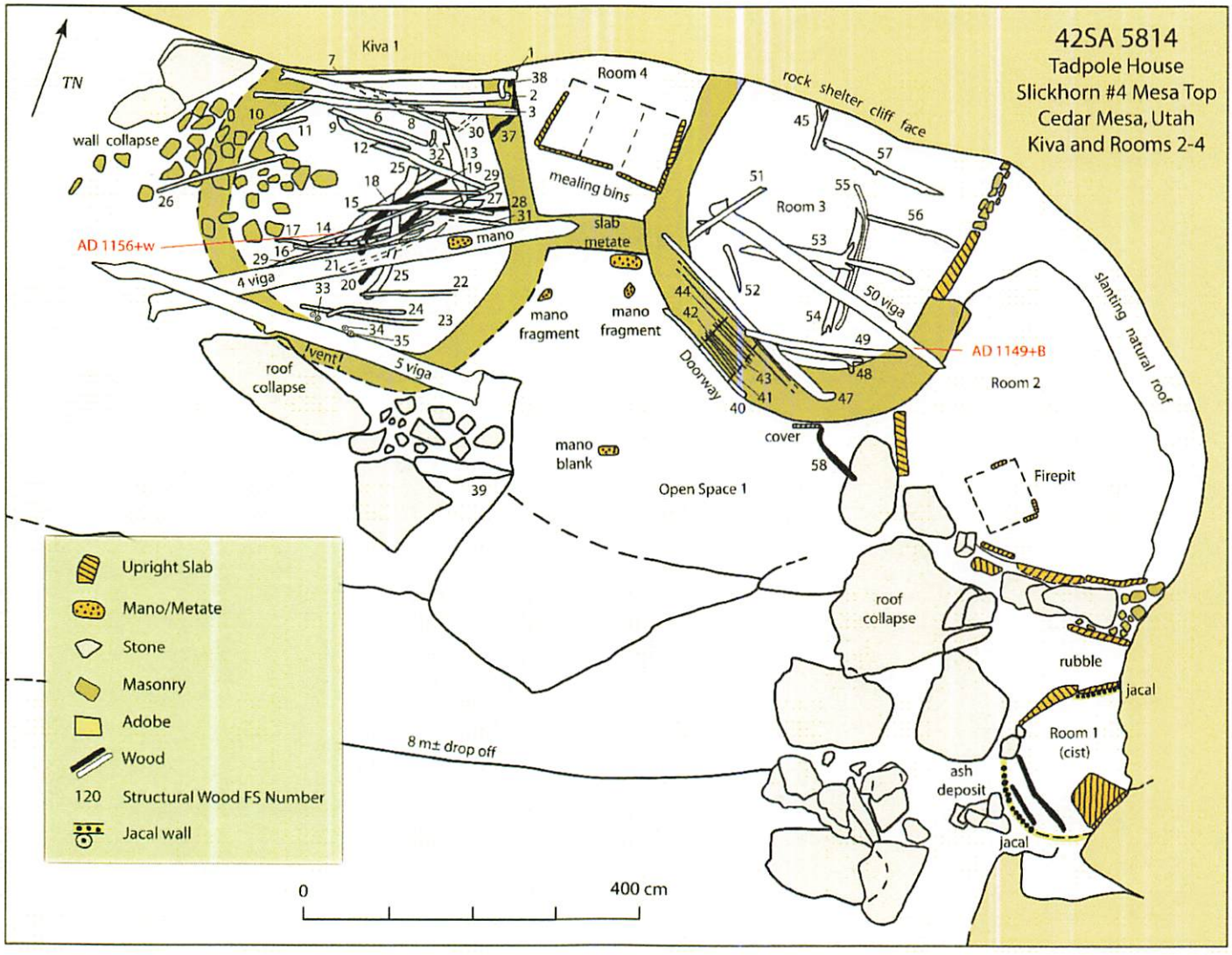

Figure 7. 42SA 5815, Tadpole House. Plan view of Kiva 1 and Rooms 1-4.

42SA 1763 (Pickett Fork House, Dry Wash Canyon)

This site complex extends nearly 2 km along the north side of Pickett Fork off Dry Wash Canyon along the northeastern area of Cedar Mesa. It was first investigated by Dee Green (Weber State University) and Ray Matheny (Brigham Young University) in 1967, who conducted survey and excavations over a large area that included all the north-side cliff-ledge, side-canyon sites canyon inventoried under a single site number, 42SA 1763. A MA thesis by student Dee Hardy (1975) produced much of the information known of this early work. BLM archaeologist Don Simonis was particularly concerned that the excavations at one of the nearly-intact ledge kivas yielded very little write-up of the work and that it suffered from increased visitation, so that a through mapping, recording, and sampling the kiva (Structure 12 in the Hardy thesis) became a priority. We collected 52 tree-ring samples from across the site, but only the intact kiva contained nearly entire set of structural wood (**Figure 8**).

Figure 8. 42SA 1763, Pickett Fork Structure 12 (kiva) showing the roof plan, and documented and numbered roofing elements. Note protection afforded by the overhanging upper cliff face (violet dashed line).

Access to the priority kiva was hampered by a 2-3 m gap in the ledge, 15-25 m deep, which was formerly bridged by 2" x 12" boards, one with a knot hole in the middle, that Winston Hurst, his wife Cathy (personal communication, July 2012), and others crawled over to access the kiva in the 1970s. A pile of long logs (FS 105–111, 113; Hardy's Component B, pg. 70–71) stacked along the ledge route into the kiva is backed with stacked stones (masonry?). The longer logs would not have come from the kiva, which was mostly intact and had all of its vigas. Instead, these may have facilitated assess across the deep crevasse where we used a planked horizontal ladder to cross the gap. Several of these elements were piñon or *Populus* sp. (probably cottonwood), both species which were little used, if at all, for the kiva construction. Five of these timbers were sampled but yielded only a single near-cutting date (AD 1243 +vv; see **Table 8**).

In addition, next to the stacked logs were several scattered wood elements (FS 100-105) that may have come from the missing roofing section at the north end of the nearby priority kiva. FS 100 was sampled and provided a near-cutting date of AD 1254, which falls into the clustered construction dates from the kiva.

Many of the kiva's (Hardy's Structure 12, Component C) roof beams were badly weathered and split (especially along the top upper surfaces exposed to weathering) and not conductive for sampling, although all were juniper. Elements used for the two south wall niches and lintels in the ventilator, as well as the two ladder poles (with a couple of rungs in the fill on the floor) were in good condition (see **Figures 9-12**). A single lintel (FS 11) in the West Niche, however, of piñon, is exposed where the corner masonry had collapsed and had been previously saw cut as if to be tree-ring sampled—the only such beam that we noted (**Figure 9**). It dated at AD 1254+B. Twenty-eight samples were collected from the kiva, and all that dated are considered cutting or near-cutting dates based on field inspection by the author despite the lab's determination of the outer ring condition (**Table 8**). Of course, the lab analyst is only seeing a tiny fraction of the sample core's outer surface compared to our examination of the entire element. Of the 14 kiva tree-ring dates, 11 clustered between AD 1254 and 1263, and these were spread throughout the construction, indicative of a selection from stockpiled timbers. The three latest dates at AD 1263 probably mark the end of tree-felling and the completion or near-completion of the kiva (**Figures 9-10**).

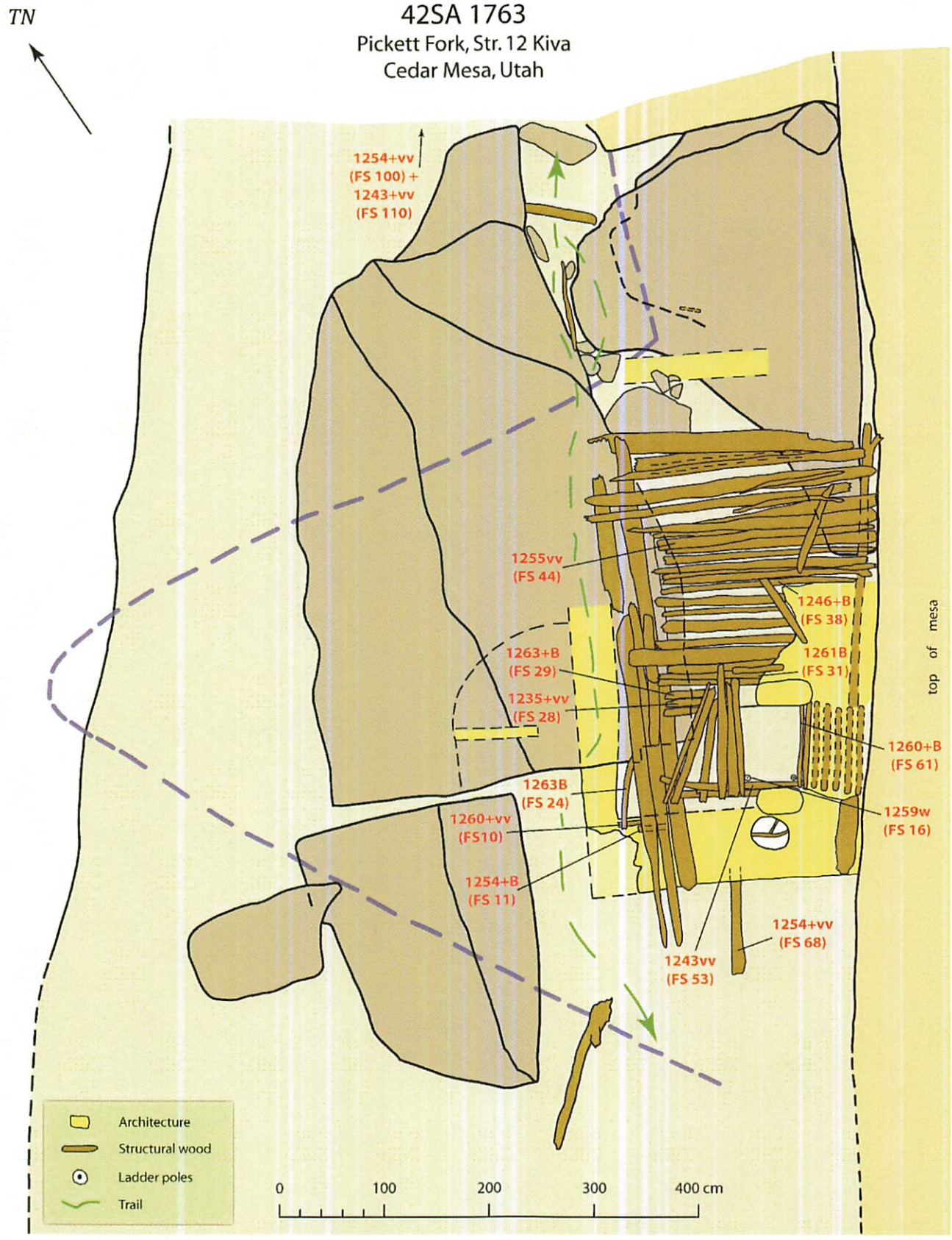

Figure 9. 42SA 1763 Structure 12 kiva plan showing tree-ring dates. All are considered cutting or near-cutting dates despite the lab's outermost date symbols to the contrary.

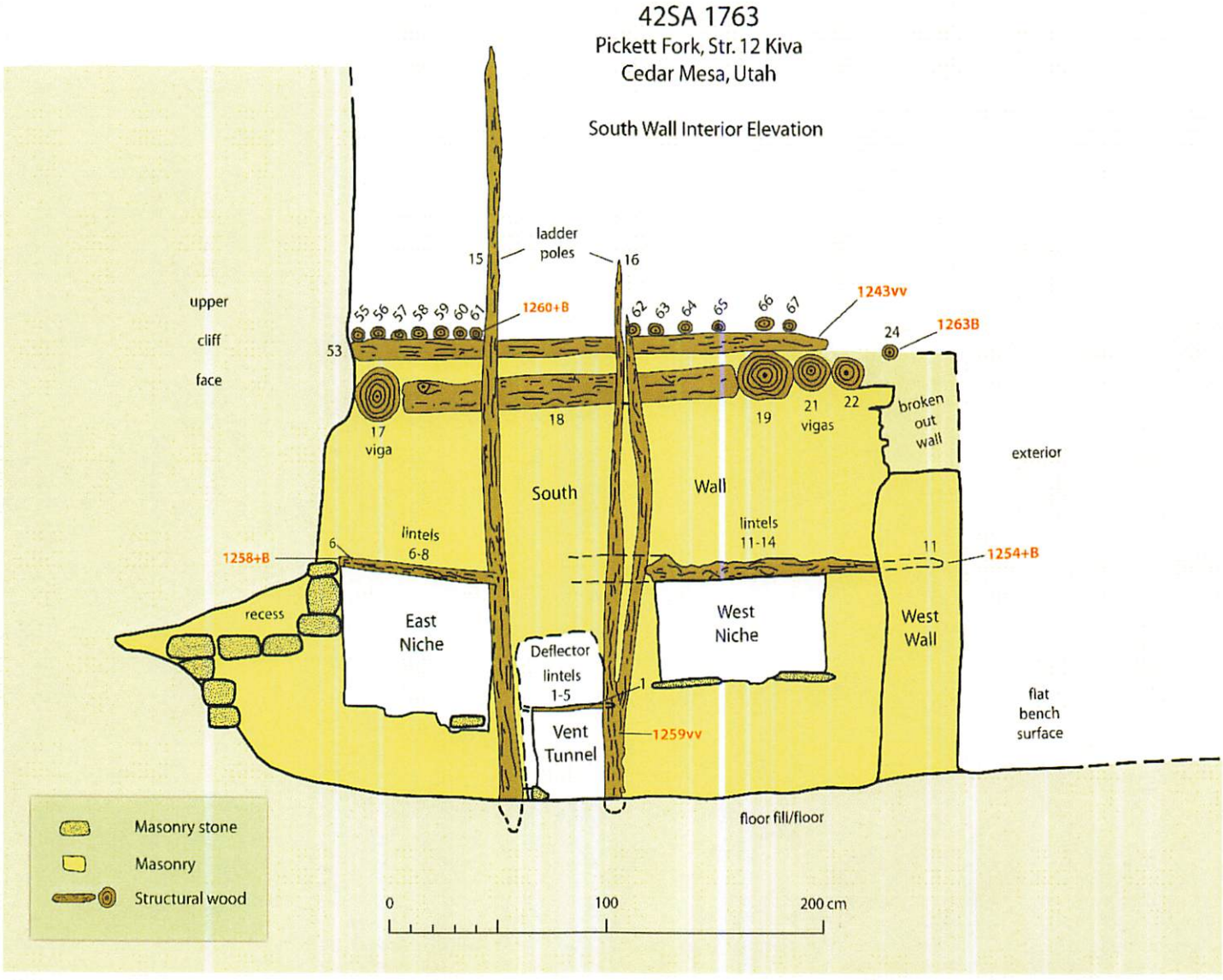

Figure 10. 42SA 1763, Pickett Fork, Structure 12 (kiva). Showing the wall elevation for the interior South Wall. Note the range of cutting dates that indicate stockpiling elements before construction commenced at about AD 1260-1263.

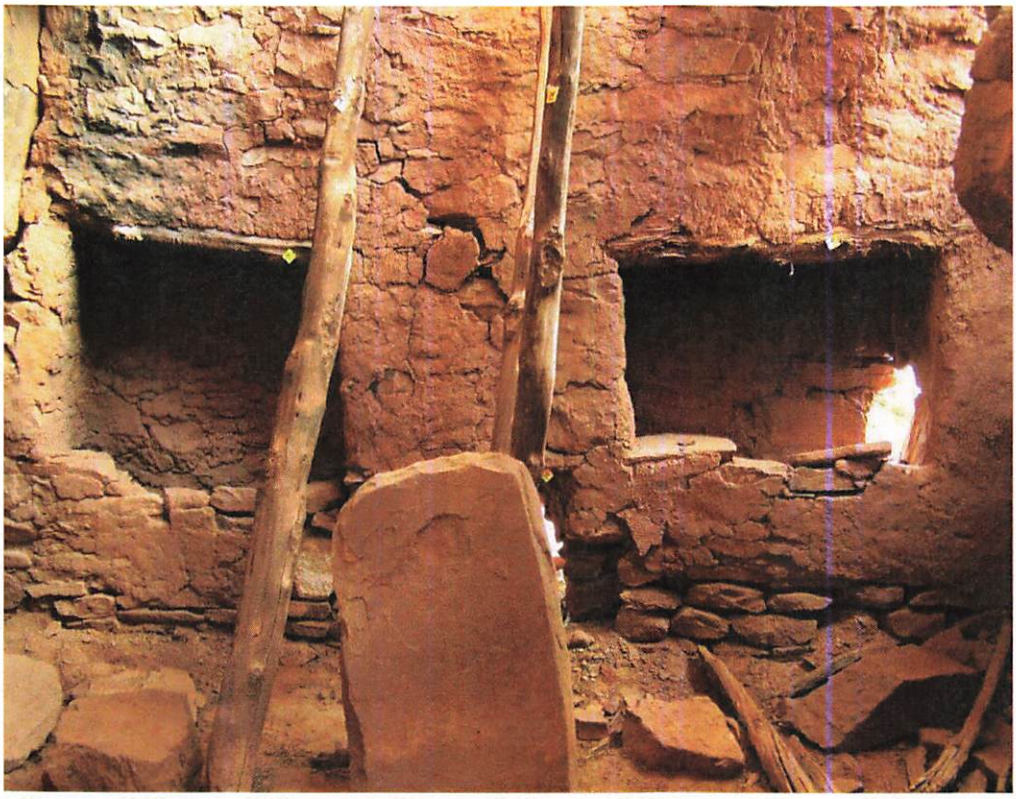

Figure 11. 42SA 1763. Pickett Fork, Str. 12. Interior South Wall. Note the ladder poles, the two niches, and the shaped deflector slab. Photo by Ben Bellorado.

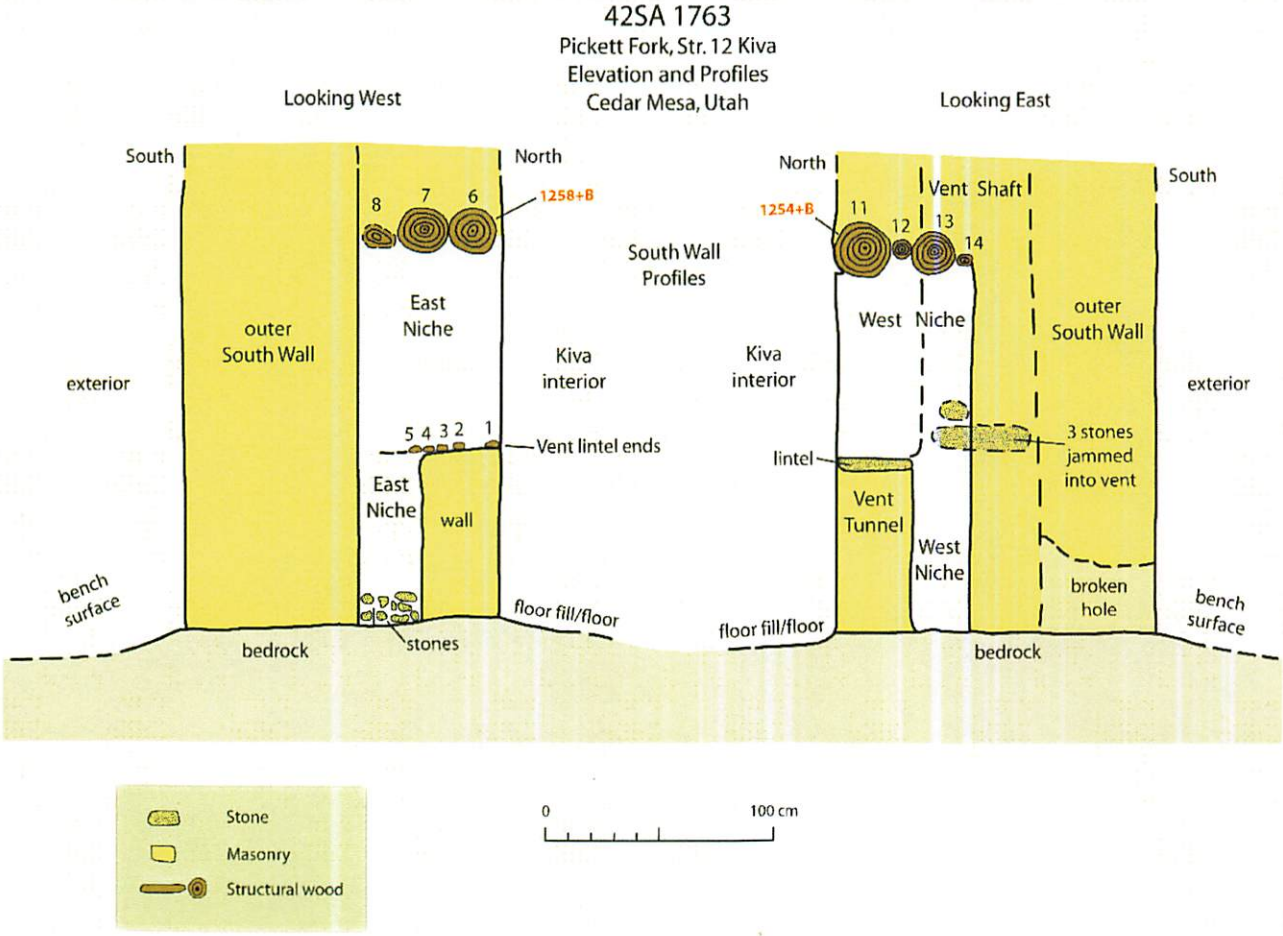

Figure 12. 42SA 1763, Str. 12 kiva, south wall profiles showing features. Dashed vent shaft is hidden behind the West Niche, showing its relative positioning.

Continuing west along the ledge and slope one must cross a large fallen tree trunk (33 cm in diameter) that is weathered into a spiral series of large cracks. We sampled this tree (FS 142) to determine its species (thought to be ponderosa pine or Douglas-fir?, but it turned out to be a piñon) and to provide an extensive ring series for the laboratory's paleo-climatic studies, but it failed to date.

Nearby, several more collapsed masonry rooms were found in a low undercut cliff face with an intact deep storage facility located behind the slumped cliff face north of Structure 6 but not noted by Hardy (1975). This structure was mapped and sampled in later years but the tree-ring analyses have not been completed as of January 2018.

Below this storage room and just south before the 90° bend in the cliff west is the collapsed Structure 6 kiva with one pilaster (south side) still standing and numerous roofing elements scattered about (FS 120–129, 141). Major structural roofing elements were present—vigas and closing splints but no long, small-diameter poles that might have served as latillas. This structural wood is in poor condition and fragmented from exposure; we sampled seven of these but only the large viga dated, with a near-cutting date of AD 1250+v.

We mapped and documented the wood resources among several collapsed rooms and some standing walls remain just west of the Structure 6 kiva but most of the wood structural elements were badly rotted from exposure to the weather and few pieces could be sampled and dated. The uneven ledge here is broad and walking is easier. Several weathered roof beams are clustered under a tamarisk bush nearby between two structures—one to the west with partial standing walls, and a collapsed roomblock east of the tamarisk that could have been four rooms. Only a single non-cutting tree-ring date could be obtained (Structure 4; AD 1232 vv) from among the many scattered structural elements and collapsed rooms in this area (**Figure 13**).

Figure 13. 42SA 1763, Str. 4, scattered roofing. Pink tags mark wood to be sampled. Photo by Tom Windes.

In summary, this concentrated area of rooms and kivas at 42SA 1763 may have been built in the mid-AD 1200s, with the two kivas constructed in the 1250s or the very early 1260s. Only the intact kiva, however, yields a robust dating of its construction, completed at about AD 1263, and strategically separated from the others to the west by the deep ledge gap and barrier walls. A small ceramic sample of 71 sherds dominated by Mancos, McElmo, and McElmo/Mesa Verde black-on-whites (**Table 9**), found downslope from the chasm and the intact kiva, and below the western Structures 4 and 6, however, may mark some earlier occupation(s) between about AD 1150 to 1260, especially for those structures in the Structures 4 to 6 area.

Target House (42SA 5303) on Butler Wash

This site, in upper Butler Wash, is named after a very large red and white bull's eye painted on the west exterior wall of Room 2 (**Figure 14**). It was first visited by the Hyde Exploring Expedition in 1894 and later recorded by David Rial, of Pittsburg's Carnegie Museum, in 1947, by Seibert in 1965 for Utah State University, and by the Butler Wash Archaeological Project in 1976. More recently Winston Hurst has greatly expanded the history and detailed information of this site (updated site form in progress).

The wood crew took extensive notes and documentation of the 57 pieces of structural wood at the site and obtained a cluster of tree-ring dates from Room 2 (**Table 10**), of which 8 of the 10 piñon roof beams dated: AD 864 (2) and 865 (6); all were cutting dates, and for a date cluster, it doesn't get much better than this. The dates are unusually early; unfortunately none of the six others taken from other rooms and features in the dwelling dated (**Figure 15**). I suspect that these should date much later, in the AD 1200s, judging from the few late sherds noted by Hurst. Except for Room 2, most of the remaining structural wood is wall pegs, splints, and doorway lintels, typically much smaller than roofing elements and more difficult to date because of shorter ring series and a preference for these of local erratic-growth juniper, undateable *Populus* sp. (cottonwood), and various shrubs. It could be that the Room 2 vigas were robbed from another structure and moved *en masse*, although this situation is rarely encountered in our work. Winston Hurst (personal communication 6 February 2018), however, believes that the dates are perfectly reasonable for Room 2:

> "My perspective on Target [House] is that it has deep history as a storage/ritual focus, that the use of the alcove for storage started in BMIII if not earlier, while the structure complex on the ledge started with a very nicely crafted one-room [Room 2-author] free standing structure (the one with the "target") in the 800s, related to Cholla Knoll site across the wash, and was added upon through time into the 1200s."

I concur with this more detailed explanation of the dating for Room 2, for which Winston Hurst has far more knowledge of the surrounding cultural landscape than my limited work at the site. It is unfortunate that none of the more recent structural materials dated so that the later use of the site could be more closely determined.

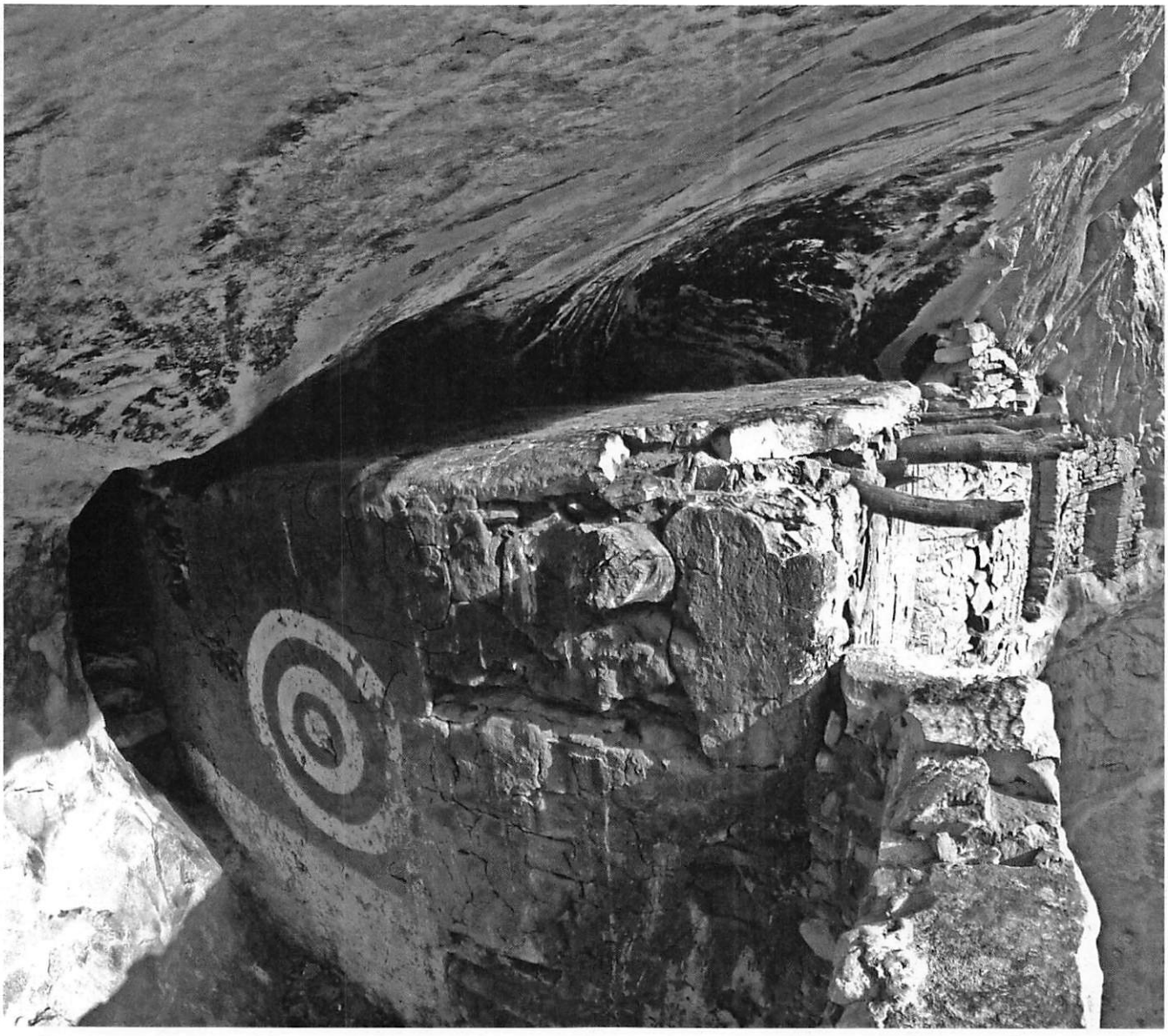

Figure 14. 29SA 5303, Target House. Note roof beam ends extending out from Room 2, most of which tree-ring dated. Photo by Ben Bellorado, December 2014, using a pole camera.

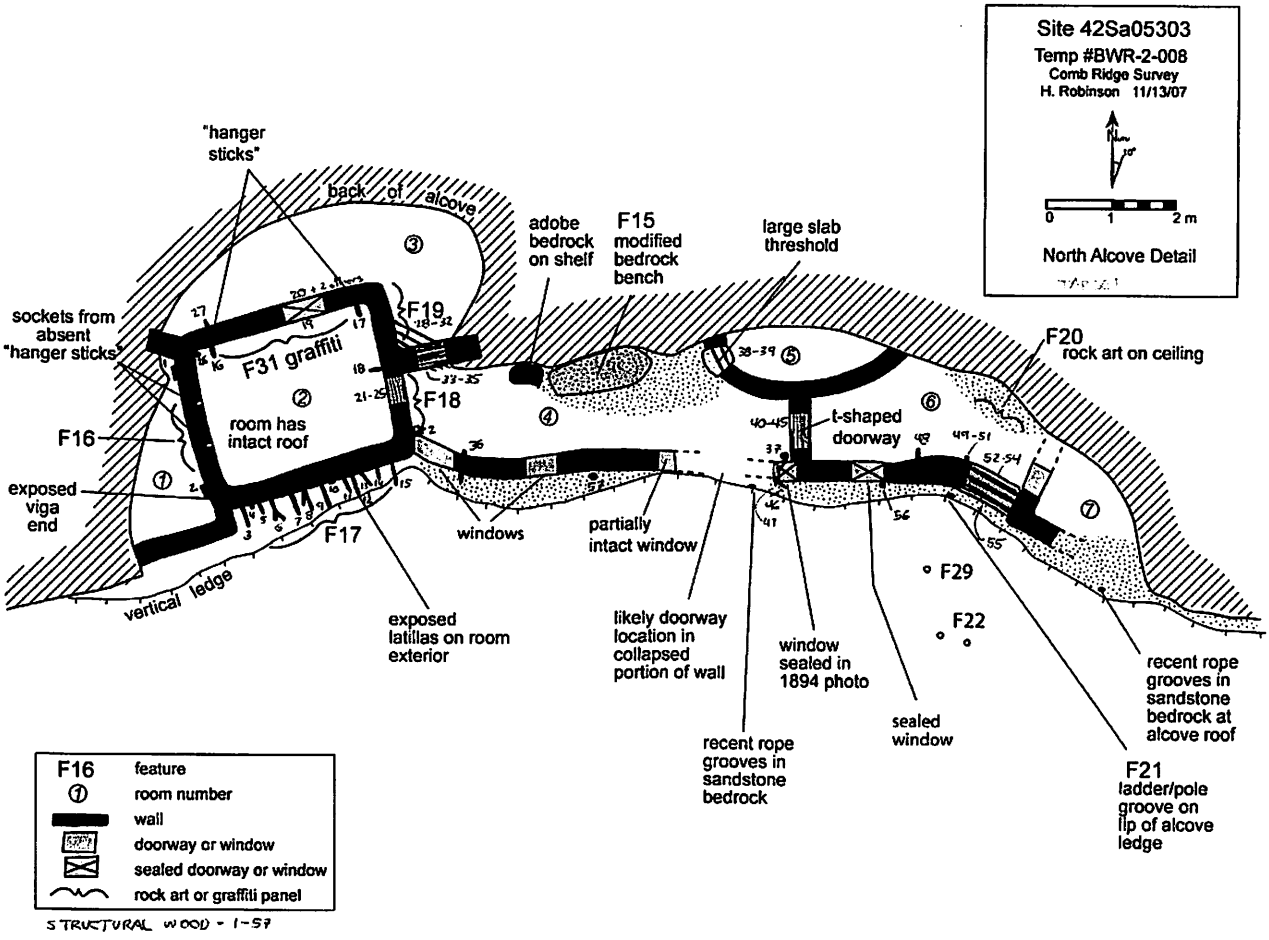

Figure 15. 29SA 5303, Target House plan by H. Robinson, 2007. Hand-written numbers mark documented structural wood elements. Rectangular room at far left is the tree-ring-dated Room 2.

Navajo site (42SA 28243), Butler Wash

Maps of this site and its features were done during the Comb Ridge Survey, conducted by Winston Hurst in 2006 (see Hurst and Willian 2011). Photographs of the hogan and sweat lodge are illustrated in Hurst and Willian (2011:51–52) as well as here (**Figure 16**).

According to Hurst, the site had been vandalized for wood for a camp firepit in the fall of 2011. Much of the forked stick hogan had been scattered, particularly upslope to the west (where we found 1 partially burned piece and collected it for sampling on 3 June [FS 1, but failed to date]), although the storage room under the cliff face, the surrounding corral remains, and the conical-shaped sweat lodge across the dirt road to the south remained relatively untouched. We took piñon and juniper samples, but the juniper offers a poor chance for dating success in this marginal tree area. At the scattered forked stick hogan (Feature 1) remains, we took cores or cut sections from several side poles and the two large-diameter probable forked-entry poles (FS 2–9). We took just two samples from the corral (FS 10–11), probably comprised mostly of scavenged dead wood and from a single good piece of wood (FS 12) lying across the mouth of the cliff face storage unit (Feature 4: 110 cm deep with a rock and log wall pile across the 153 cm front). We also took several piñon and juniper cores from the small sweat lodge (FS 13–17) across the 2-track road just the south of the hogan.

Despite this work, only a single beam from the forked-stick hogan dated (**Figure 16 right**; **Table 10**), a piñon side pole that dated at 1868+vv. Generally, a date with these outer ring observations from the core end (+vv) are considered a non-cutting date because the outermost ring is too worn to tell how many outer rings may have eroded from the element. I believe that this sample, however, is a near-cutting date based on my field observations taken of the entire element during sampling. It is imprudent, however, to rely heavily on dating the structure's construction based on a single date, especially given the typical Navajo construction behavior to use local deadwood for much of their construction needs.

The small Navajo sweat lodge located nearby and considered within the general site boundaries presents a different tree-ring dated picture (**Figure 16 left**, **Table 10**). We obtained two juniper dates from a side pole and one of the two entry jambs that indicates construction of this took place at or after 1950. Overall, there are exceeding few tree-ring dates from Ute and Navajo structures in the area so that these will help add to the limited historic dendrochronological dating record, which greatly needs expanded for the region.

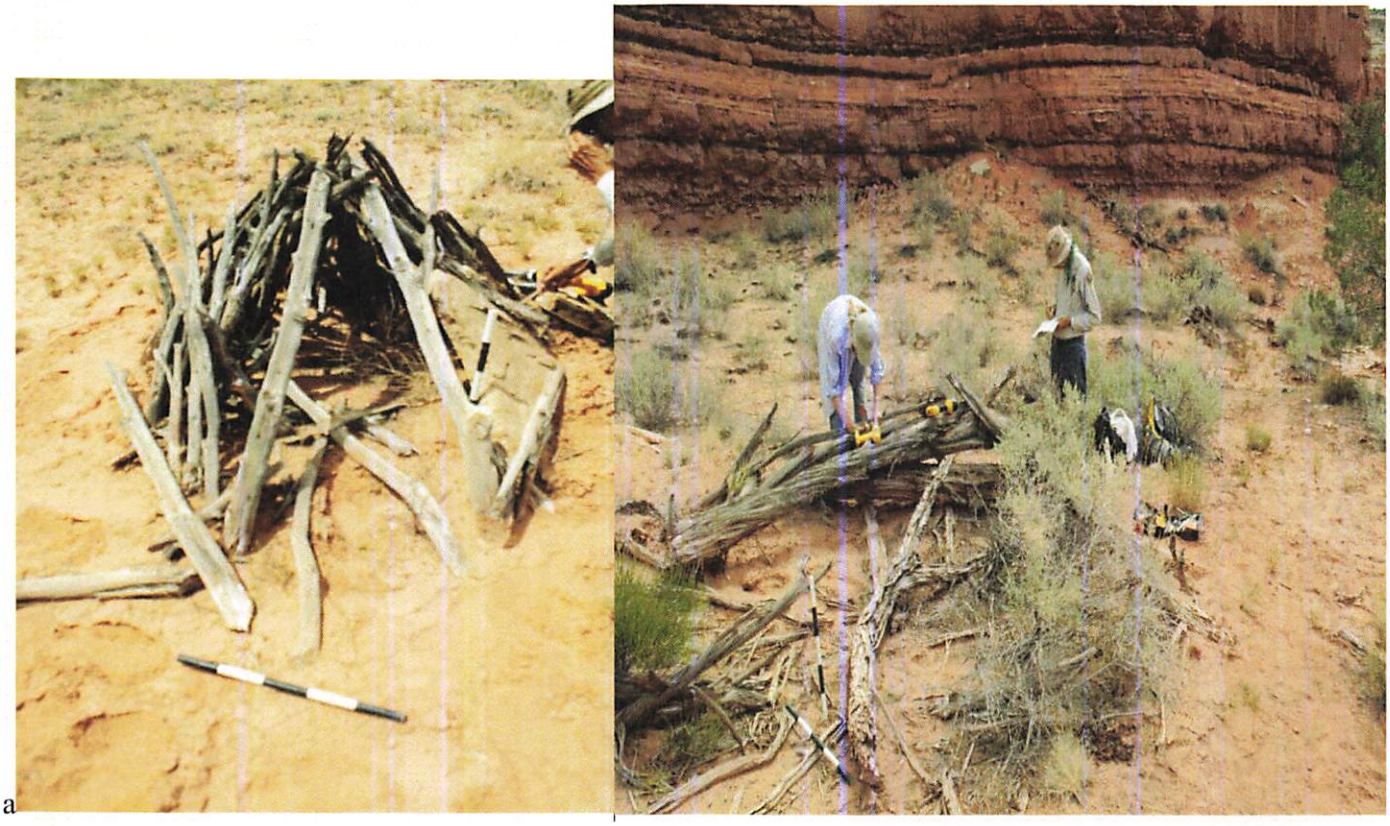

Figure 16. 42SA 28243. Left: Navajo sweat lodge constructed in about 1950. Note the two larger vertical side pole jambs of the entry, one of which dated. Right: Forked stick hogan remains after looting. C. Gilbertson & T. Windes preparing to sample the wood elements. Photo by Cliff Evans.

Summary and Conclusions

Our sample of dated sites, although thus far small, provide a clustering of late construction in the canyons in the the AD 1250-1265 period, primarily for sites showing defensive attributes in the choice of difficult-to-access locations along cliff ledges and around and on top of pinnacle outcrops. These sites also exhibit various architectural barriers inhibiting direct access to parts of the site. Some of these also suggest an earlier late AD 1100s/early 1200s initial occupation. A notable defensive regional example site took place at Castle Rock (site 5MT1825), in McElmo Canyon, southwestern Colorado, where the AD 1200 Puebloan inhabitants were besieged by "Utes" (perhaps Paiutes?), massacred, and parts of the village burned, according to Hopi oral traditions (Kuckelman 2000, 2002; Lightfoot and Kuckelman 2001). Castle Rock was founded in about AD 1256 with major additions into the 1260s, but attacked in the 1270s (Kuckelman 2000, 2010:193). A similar site history took place at nearby San Canyon Pueblo (Kluckelman 2007). Defensive site location behavior is common in nearby Beef Basin and is also seen in the Chaco region, where late AD 1200s sites in Chaco Canyon and throughout the southern San Juan Basin are located on top of difficult-to-access pinnacle rock formations. In Chaco, these same locations were later reoccupied by Navajos in the AD 1500s for escape from Spanish, Ute, and Comanche raiders (McKenna and Windes 2011), raiding behavior that we also believe conditioned the site location choices made by the earlier 1200s Puebloan inhabitants.

While our sites reveal nothing so dramatic as events at Castle Rock, those with tree-ring dates in the AD 1250-1265 period from our studies are highly defensible, and 4-Shield House (42SA 5619), at least, does reveal secondary defensive measures taking place at the kiva, which was eventually burned:

Defensive Site	Location	Name	Latest tree-ring cutting dates AD (no. of dates)	Total site dates of sample
42SA 1763	Dry Wash Canyon	Pickett Fork	1254+B – 1263B (13)	18 of 51
42SA 5619	Pt. Lookout Canyon	4-Shield House	1252+B -1259+B (2) [a]	5 of 33
42SA 5810	Slickhorn Canyon	Citadel West House	1265v (1)	3 of 22
42SA 6654 [b]	White Canyon	Ledge Runner House	1257+B – 1267B (9)	14 of 67
42SA 6965 [b]	White Canyon	Bare Ladder, Upper Level?	No samples yet	--
42SA 29514	Slickhorn Canyon	Blue Man/Square Kiva	1257v (1)	1 of 9

[a] Does not include a deadwood date of 1260++vv, which context and field inspection support a near-cutting date.
[b] Natural Bridges National Monument sites not part of this particular study but within the overall wood project.

We know that the AD 1200s was a period of great change for Puebloan occupations across the Four Corners region with much warfare, out-migration to the east and south, and final cessation of habitation over much of the region by AD 1300 (e.g., Ahlstrom et al. 1995; Dean 1988; Dean et al. 1994; Duff and Wilshusen 2000; Glowacki 2006; Lightfoot and Kuckelman 2001). But there is also an influx of population into the canyons and plateaus along the east peripheries of the Colorado River that are part of this study. Much of this area is marginal for farming, particularly as one shifts away from the nearby mountain uplands—this appears to be particularly true of southern Cedar Mesa, where the Slickhorn–Point Lookout canyon system is located.

Climate change

Although the Great Drought (Douglass 1929) in the late AD 1200s is often cited as a primary factor in the final depopulation of the Northern San Juan region—and it should be noted that the Great Drought was "more pronounced in the western Mesa Verde Region than in the central area" (Wright 2010:93)—the relationship of precipitation and temperature are critical environmental factors for agrarian subsistence success (Lipe 1995; Salzer 2000; Van West 1994), among many other factors. Closer to the Bears Ears, there is more moisture but shorter growing seasons, while conversely, further away, it is drier with longer growing seasons, except within the canyons affected by cold-air drainage.

Reconstructed paleo-temperature indices (Salzer and Kipfmueller 2005) now provide yearly estimates along with precipitation for the past 2,000 years for the Colorado Plateau (**Figure 16**) that help to provide a better picture of changing environmental conditions. Note that the periods in the AD 1200s are particularly cold, despite some above-average precipitation years. According to Salzer and Kipfmueller (2005:478), temperature and precipitation are usually out-of-phase in the American Southwest (correlation of -0.41, $p < 0.001$); when it is dry, it is usually warm, and when it is wet, it is usually cool, a dispiriting situation for farmers who would instead favor warm and wet seasons for their best crop success—weather that occurs rarely in the marginal regions of prehistoric Puebloan settlement. Wright (2010:97) argues that if a stable and predictable precipitation regime elsewhere was a significant factor for the out-migration of the Central Northern San Juan (i.e., Central Mesa Verde) during troubled times, than there would be an expected population increase in these outer areas after about AD 1250. While this does not exactly predicate the reasons for a shift to more defensive sites in the western region, it does temporally correlate with the overall population movement out from the Central Northern San Juan Region, and groups undergoing some level of fear.

One of the principal dramatic factors in climate change is the impact of large, explosive volcano activity, of which within the period in question (AD 1250-1265), is rift with eruptions: in 1257 and 1260s of the Samalas volcano in Indonesia; in Orizaba, Mexico (1260±50); Pelee in the West Indies (1260±20); Katla in Iceland (1262); and a large eruption of Oshima, Japan, in 1267 (see Langway et al. 1995; Salzer 2000). But the most explosive of these is Samalas, which had one of the greatest eruptions of the entire Holocene (Lavigne et al. 2013), causing the English food crises in 1258 with widespread starvation (e.g., Campbell 2018). This eruption surpassed in magnitude even the famed 1815 Indonesian Tambora eruption, which caused the devastating 'year without summer'.

Large eruptions can affect climate on the decadal level. Although the effect of the Samalas eruptions has not been studied for the Southwest, it had marked effects on the world's northern and southern hemispheres, darkening them for two years in 1258 and 1259 (Guillet et al. 2017: Figure 4), leading to shortened or no growing season and untimely killing frosts (see also Van West et al. 2013). Salzer (2000:305, 307, Figure 3), using the nearby San Francisco Peak (SFP) paleoclimate record, notes particularly cold periods for 1195-1219 (a particularly bad period of more than 2 s.d. below normal), 1225-1245, and 1258-1271 that would have negatively affected crop productivity in the region (note the severity of these periods in the southern Colorado Plateau record in **Figure 16**). While climate change due to volcanic activity is not the only factor involved in the stressful AD 1200s, it has received little note since Salzer's (2000) initial attention, although we now know much more about the severity of the Samalas eruptions. Although unrelated(?) to volcanic activity, the 1912-1932 cold period in **Figure 16** spelled the ultimate doom for the Hispanic farming villages in the Middle Rio Puerco (Windes and Van West 2018), an agrarian culture little changed from prehistoric farming.

The demarcation between better growing conditions, and thus tree-ring date success, and the poorer areas, might be made between Grand Gulch and the Slickhorn Canyons. Poorer tree and corn growing conditions in Slickhorn should also equate to poorer crop growing conditions, creating resource stress that could have precipitated conflict between Slickhorn and Grand Gulch inhabitants. Grand Gulch has larger sites, with a larger population, and enjoys more reliable moisture than Slickhorn, given its more northern, higher elevation, and proximity to the Bears Ears mountainous terrain of the Abajos. It also has deeper soils, which would be more attractive to horticulturalists (Lipe et al. 1977) and greater wood resources both locally and in the nearby Bears Ears plateau. Thus, any downturn in environmental conditions, as might have been caused specifically by the Samalas eruptions, could have severely exasperated conditions in the southern canyon regions of Cedar Mesa, if not all over.

That habitation in the southern area was stressful may be marked by the increased defensive measures taken in the AD 1250-1265 period as people sought homes in more remote topographic areas in Slickhorn and perhaps other nearby southern canyons. Our sample is intriguing but limited to mostly a single canyon system with limited dating thus far, although further work will help to build on this study for the AD 1200s.

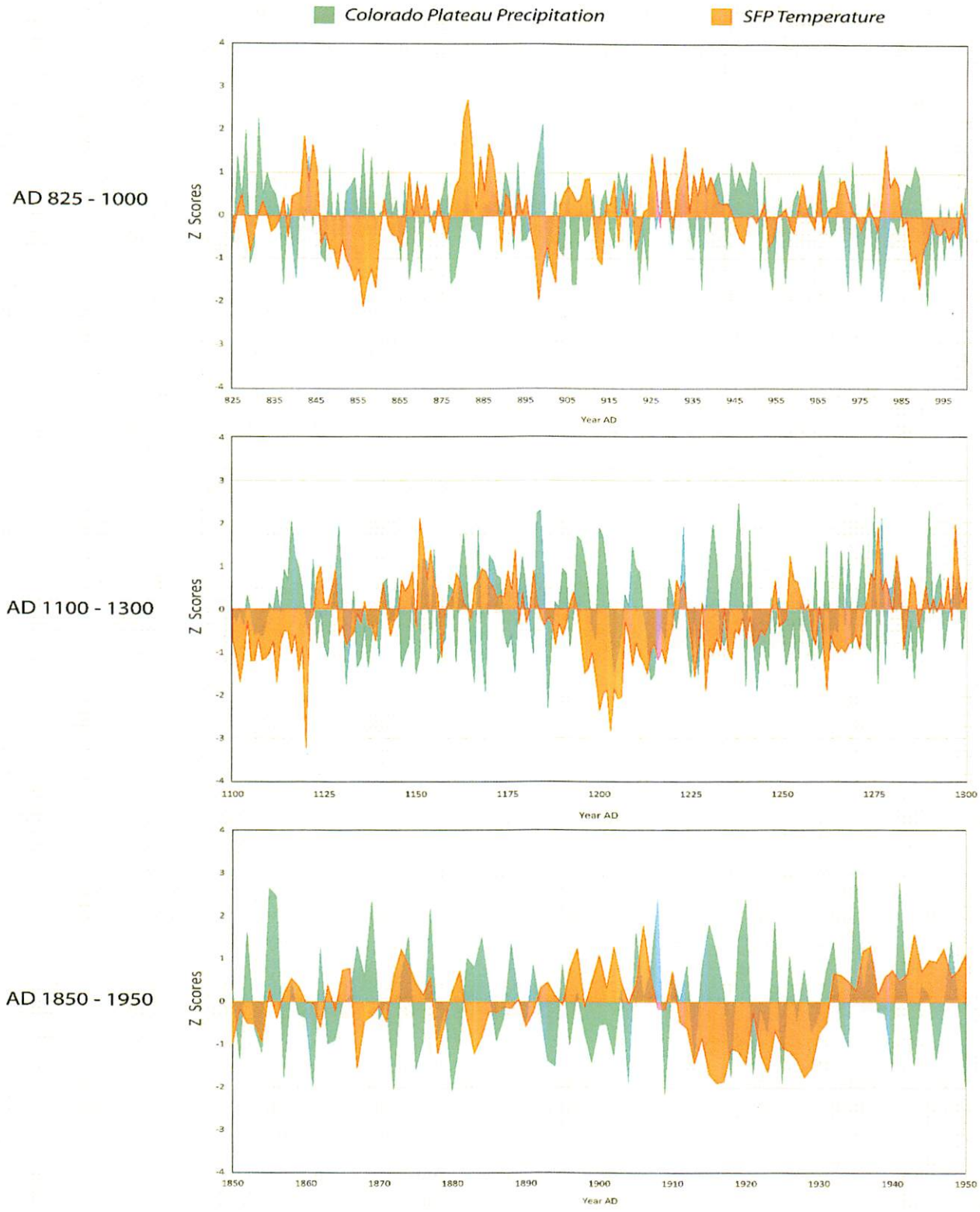

Figure 16. Reconstructed annual total precipitation for the Colorado Plateau (see Dean and Funkhouser 2002 for a tree-ring based reconstruction spanning AD 661 to AD 1990) and reconstructed annual mean-maximum temperature from the San Francisco Peaks (SFP), northern Arizona (see Salzer and Kipfmueller 2005 for a full chronology spanning 663 BC to AD 1996). Graphs by Carla Van West (Windes and Van West 2018: Figure 27).

Future Research Needs

It is imperative to continue this research before greater loss of materials and structures take place in this wonderfully natural and cultural area. The general lack of dendrochronological success, thus far, does not negate the importance of such studies and what we have learned. Even with the re-establishment of the original Bear Ears National Monument boundaries, the publicity already given the new monument will greatly increase visitation along with its drawbacks of wear and tear on the cultural and natural resources (such as increased tourist trials and wood use) along with increased vandalism. But also it is important to reserve these areas for recognition of their value to Native American groups, who have long established their important heritage ties to the area. It will also bring more eyes to bare on the surroundings from those who revere the natural landscape and provide a level of protection of its resources that law enforcement can't begin to accomplish without locking up the monument. The problem with the wood project's continuation (along with related and overlapping projects by Ben Bellorado, Laurie Webster, Winston Hurst, and, formerly, Sally Cole), however, that almost no one conducts this kind of long-term, in-depth individual-driven research and preservation unless it is provided by funding from mitigation projects. The detailed document survey, architectural, and cultural material forms along with the itemization of all he structural wood and systematic gathering of costly tree-ring and other samples, particularly within entirely separate topographic canyon areas, is invaluable for a land that is constantly under threat for its varied resources. If a program at Blanding's Utah State University Eastern could be started for continuation of like projects, it would be enormously helpful, especially to educate and to involve local communities in site preservation via detailed inventory, mapping, and documentation of site resources.

Acknowledgments

I deeply appreciate the support of the Canyonlands Natural History Association for funding the tree-ring samples of this project and the Bureau of Land Management for permission to work on Federal lands and their timely logistical support in the form of ladders, water, and outhouses. I am also indebted to those individuals that helped haul the long ladders into some sites to provide access and to the time, efforts, and expenses spent by the many volunteers on the project over the years.

References

Ahlstrom, Richard V. N., Carla R. Van West, and Jeffrey S. Dean
1995 Environmental and Chronological Factors in the Mesa Verde–Northern Rio Grande Migration. *Journal of Anthropological Archaeology* 14:125-142

Bennington, Frederick, Carl Melton, and Patty Jo Watson
1962 Carbon Dating Prehistoric Soot from Salts Cave, Kentucky. *American Antiquity* 28(2):238-241).

Bliss, Wesley
1940a A Chronological Problem Presented by Sandia Cave, New Mexico. *American Antiquity* 5(3): 200-201.
1940b Sandia Cave. *American Antiquity* 6(1):77-78.

Bullen, Ripley P. and Adelaide K. Bullen
1942 A Pueblo Cave Site at Tres Piedras, New Mexico. *American Antiquity* 1:57-64.

Campbell, Bruce
2018 Global Climates, the 1257 Mega-eruption of Samalas Volcano, Indonesia, and the 1258 English Food Crises. Talk presented at the Gustave Tuck Lecture Theatre, London. Royal Historical Society, London. On line at https://royalhistsoc.org/calendar/global-climates-1257-mega-eruption-samalas-volcano-indonesia-1258-english-food-crisis/. Last accessed, 13 February 2018.

Cressman, L. S.
1956 Additional Radiocarbon Dates, Lovelock Cave, Nevada. *American Antiquity* 21(3):311-312.

Dean, Jeffrey S.
1988 Dendrochronology and Paleoenvironmental Reconstruction on the Colorado Plateaus." In *The Anasazi in a Changing Environment*, ed. George J. Gumerman, 119–167. Cambridge: Cambridge University Press.

Dean, Jeffrey S., and Gary Funkhouser
2002 Dendroclimatology and Fluvial Chronology in Chaco Canyon. In Relation of "Bonito" Paleo-channels and Base-level Variations to Anasazi Occupation, Chaco Canyon, New Mexico, by Eric R. Force, R. Gwinn Vivian, Thomas C. Windes and Jeffrey S. Dean, pp.39-41. Arizona State Museum, The University of Arizona, Tucson.

Dean, Jeffrey S., William H. Doelle, and Janet D. Orcutt
1994 Adaptive Stress, Environment, and Demography. In *Themes in Southwest Prehistory*, edited by George J. Gumerman, pp. 53-86. School of American Research Press, Santa Fe.

Douglass, Andrew E.
1929 The Secret of the Southwest Solved by Talkative Tree-Rings. *National Geographic* 54:737-770.

Duff, Andrew I., and Richard H. Wilshusen
2000 Prehistoric population dynamics in the northern San Juan region, A.D. 950-1300. *Kiva* 66(1):167-90.

Fewkes, Jesse Walter
1909 *Antiquities of the Mesa Verde National Park: Spruce-Tree House*. Bureau of Ethnology, Bulletin 41. Washington, D.C.
1911 *Antiquities of the Mesa Verde National park: Cliff Palace*. Bureau of Ethnology, Bulletin 51. Washington, D.C.
1919 *Prehistoric Villages, Castles, and Towers of Southwestern Colorado*. Bureau of Ethnology, Bulletin 70. Washington, D.C.

Frison, George C.
1965 Spring Creek Cave, Wyoming. *American Antiquity* 31(1):81-94.

Glowacki, Donna M.
2006 *The Social Landscape of Depopulation: The Northern San Juan, A.D.1150-1300. Unpublished* Ph.D. dissertation, Arizona State University.

Guillet, Sébastien, Christophe Corona, Markus Stoell, Myriam Khodri, Franck Lavigne, Pablo Ortega, Nicolas Eckert, Pascal Dkengne Sielenou, Valérie Daux, Olga V. Churakova (Sidorova), Nicole Davil, Jean-Louis Edouard, Yong Zhang, Brian H. Luckman, Vladimir S. Myglan, Joël Guiot, Martin Beniston, Valérie Masson-Delmotte, and Clive Oppenheimer
2017 "Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records." *Nature Geoscience* 10: 123–128. Accessed November 3, 2017. doi:10.1038/ngeo2875.

Hardy, Dee
1976 *A Description and Analysis of the Architecture and Artifacts of the Pickett Fork Sites, Cedar Mesa, San Juan County, Utah.* Unpublished M.A. thesis, Department of Anthropology and Archaeology, Brigham Young University, Provo, Utah.

Hibben, Frank
1941 Evidence of Early Occupation in Sandia Cave, New Mexico, and other Sites in the Sandia–Manzano Region. Smithsonian Miscellaneous Collections, Vol. 99, No. 23. Washington, DC.

Hurst, Winston, and Jay Willian
2011 Ute and Navajo Archaeology in Butler Wash. *Blue Mountain Shadows: The Magazine of San Juan County History* 44/Fall:49–57. Deep History II: The San Juan County's Archaeological Record. Blanding, Utah.

Judd, Neil M.
1926 *Archaeological Observations North of the Rio Colorado.* Bureau of Ethnology, Bulletin 82. Washington, D.C.

Kohler, Timonty A. Kohler, Mark D, Varien, and Aaron M. Wright (ediotrs)
2010 *Leaving Mesa Verde: Peril and Change in the Thirteenth-Century Southwest.* The University of Arizona Press, Tucson.

Kuckelman, Kristin A. (editor)
2000 *The Archaeology of Castle Rock Pueblo: A Thirteenth-Century Village in Southwestern Colorado.* [HTML Title]. Site Reports and Databases. Crow Canyon Archaeological Center, Cortez, CO. Available at https://www.crowcanyon.org/ResearchReports/CastleRock. Last accessed 10 February 2018.
2007 *The Archaeology of Sand Canyon Pueblo: Intensive Excavations at a Late-Thirteenth-Century Village in Southwestern Colorado.* Site Reports and Databases. Crow Canyon Archaeological Center, Cortez, CO. Available at https://www.crowcanyon.org/ResearchReports/Sand Canyon. Last accessed 10 February 2018.

Kuckelman, Kristin A.
2002 Thirteenth-Century Warfare in the Central Mesa Verde Region. In *Seeking the Center Place: Archaeology and Ancient Communities in Mesa Verde Region*, edited by Mark D. Varien and Richard H. Wilshusen, pp. 233-253. The University of Utah Press, Salt Lake City.
2010 Catalysts of the Thirteenth-Century Depopulation of Sand Canyon Pueblo and the Central Mesa Verde Region. In *Leaving Mesa Verde: Peril and Change in the Thirteenth-Century Southwest*, edited by Timothy A. Kohler, Mark D. Varien, and Aaron M. Wright, pp. 180-199. The University of Arizona Press, Tucson.

Langway, Chester C., K. Osada, H. B. Clausen, and C. U. Hammer
1995 A 10th-Century Comparison of Prominent BiPolar Volcanic Events in Ice Cores. *Journal of Geophysical Research* 100:16,241-16,247.

Lavigne, Franck, Jean-Philippe Degeai, Jean-Christophe Komorowski, Sébastien Guillet, Vincent Robert, Pierre Lahitte, Clive Oppenheimer, Markus Stoffel, Céline M. Vidal, Surono, Indyo Pratomo, Patrick Wassmer, Irka Hajdas, Danang Sri Hadmoko, and Edouard de Belizal
2013 Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia. *PNAS*; Accessed 5 February 2018); www.pnas.org/cgi/doi/10.1073/pnas.1307520110.

Lipe, William D.
1995 The Depopulation of the Northern San Juan: Conditions in the Turbulent 1200s. *Journal of Anthropological Archaeology* 14:99-103.

Lightfoot, Ricky R., and Kuckelman, Kristin A.
2001 A Case of Warfare in the Mesa Verde Region. In *Deadly Landscapes: Case Studies in Prehistoric Southwestern Warfare,* edited by G. E. Rice and S. A. LeBlanc, pp. 51-64. University of Utah Press, Salt Lake City.

Loud, Llewellyn L., and M. R. Harrington
1929 *Lovelock Cave.* University of California Publications in Archaeology and Ethnology 25(1): vii-183. University of California Press, Berkeley (1931).

Matson, R. G., W. D. Lipe, and W. R. Haase IV
1988 Adaptational Continuities and Occupational Discontinuities: The Cedar Mesa Anasazi. *Journal of Field Archaeology* 15:245-264.

McKenna, Peter J., and Thomas C. Windes
2011 Early Navajo Occupations in Chaco Canyon and Western Chacra Mesa, Northwestern New Mexico. *Papers in Honor of Jeffrey Dean?*, edited by Ronald Towner. University of Utah Press, Salt Lake City (in preparation).

Over, W. H.
1936 The Archaeology of Ludlow Cave and Its Significance. *American Antiquity* 2(2):126-129.

Rowe, M. W., E. Blinman, L. Wacker, and T. Windes
2017 Plasma Micro-Excavation of Soot for $_{14}$C Chronology. Office of Archaeology Studies. In preparation.

Sagstetter, Elizabeth M. and William E.
2008 *Unraveling the Mysteries of the Telluride Blanket.* Stewards of the Blanket, Telluride Historical Museum, Telluride, CO.

Salzer, Matthew W.
2000 Temperature Variability and the Northern Anasazi: Possible Implications for Regional Abandonment. *Kiva* 65(4):295-318.

Salzer, Matthew W., and Kurt F. Kipfmueller
2005 Reconstructed Temperature and Precipitation on a Millennial Timescale from Tree-Rings in the Southern Colorado Plateau, U.S.A. *Climatic Change* 70:465–487.

Thompson, Jessica C., and C. Vance Haynes, Jr.
2012 Radiocarbon Dating the Human Occupation of Sandia Cave, New Mexico. *American Antiquity* 77(2):303-314).

Van West, Carla R.
1994 *Modeling Prehistoric Climatic and Agricultural Productivity in Southwestern Colorado: A G.I.S. Approach.* Reports of Investigations No. 67, Department of Anthropology, Washington State University, Pullman.

Van West, Carla R., and Jeffrey S. Dean
2000 Environmental Characteristics of the A.D. 900–1300 Period in the Central Mesa Verde Region. *Kiva* 66(1):19-44.

Van West, Carla R., Thomas C. Windes, Frances Levine, Henri D. Grissino-Mayer, and Matthew W. Salzer
2013 The Role of Climate in Early Spanish-Native American Interactions in the U.S. Southwest.In *Native and Spanish New Worlds: Sixteenth-Century Entradas in the American Southwest and Southeast*, edited by Clay Mathers, Jeffrey M. Mitchem, and Charles M. Haecker, pp. 81–98. Amerind Studies in Anthropology. The University of Arizona Press, Tucson, AZ.

Windes, Thomas C.
2012 Report on BLM Field Work in SE Utah 2012. Report submitted to the BLM, Monticello District Office, Monticello, Utah. (revised 2015).
2013 Report on BLM Field Work in SE Utah 2013. BLM Wood Project 2013 - U-13-BL-0707b. Report submitted to the BLM, Monticello Office, Monticello, Utah.
2014 Structural Wood Documentation and Dendrochronology in SE Utah: Report on the 2011 field work on Cedar Mesa in Slickhorn Canyon and in Natural Bridges National Monument. 2011 Discovery Grant (11-5-BLM/NPS) Final Report submitted to the Canyonlands Natural History Association, Moab, Utah.
2015 Report on BLM Structural Wood Projects in SE Utah 2014: Cedar Mesa, Fable Valley, Beef Basin, and Whiskers Draw. BLM Wood Project #2014-U-14-BL-1362. Report submitted to the BLM, Monticello Office, Monticello, Utah.
2018 Report of 2016 and 2017 Field Activities on BLM Lands, Monticello District, SE Utah. BLM Permits # 16UT85121 and 17UT86121. Report submitted to the BLM, Monticello Office, Monticello, Utah.

Windes, Thomas C., and Carla R. Van West
2018 Landscapes, Horticulture, and the Early Chacoan Bonito Phase. In *New Perspectives on the Greater Chaco Landscape*, edited by Ruth Van Dyke and Carrie Heitman. University of Colorado Press, Boulder. In preparation.

Wright, Aaron M.
2010 The Climate of the Depopulation of the Northern Southwest. In *Leaving Mesa Verde: Peril and Change in the Thirteenth-Century Southwest*, edited by T. A. Kohler, M. D. Varien, and A. M. Wright, pp. 75–101. The University of Arizona Press, Tucson.

Zielinski, Gregory A., P. A. Mayewski, L. D. Meeker, S. Whitlow, M. S. Twickler, M. Morriosn, D. A. Meese, A. J. Gow, and R. B. Alley
1994 Record of Volcanism since 7000 B.C. from the GISP2 Greenland Ice Core and Implications for the Volcano-Climate System. *Science* 264:948-952.

List of Tables

Table 1. New Tree-ring dates (n=5) from Perfect Kiva (42SA 5795) and Blue Man/Square Kiva (42SA 29514).

Location	FS #	TRL# NBR-	Species	Age (yrs)	Max. dia. – length[a] (cm)	Outer ring condition[b]	Inside date[c]	Outside date[c,d]
Perfect Kiva Ladder (2 sampled; 2 dated; 100% of sample dated)								
Ladder pole	230	1895	Jun	143	11.2 - 269	Complete	1100 ±p	**1242 B**
Ladder pole	231	1896	Jun	106	9.2 - 252	Complete	1137 ± $_{p}$	**1242 B**
Blue Man/Square Kiva Ladder poles (2 sampled, 1 dated; 50% of sample dated)								
Ladder pole	23	None	Populus	unk	6.7 - 180+	N/A	--	No date
Ladder pole	24	None	Populus	unk	5.2 - 164+	N/A	--	No date
Ladder pole	25	1950	Jun	54	7.7 - 142	Unknown	1204 $_{np}$	**1257 +v $_{r}$**

[a] Only complete lengths are listed.

[b] **Outer ring condition = Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season tree death (i.e., late spring-summer-early fall). Growing seasons vary by species.

[c] **Date subscripts** are author's inner and outer ring field observations ***if*** they differ from the laboratory analysis.

[d] **Outside dates** in **bold** are tree death date or near-death date.

Table 2. Ceramics from 42SA 29514 (Blue Man/Square Kiva House). Entire site.

Ceramic Type	Bowls	Jars	Ladles	No.	%[a]
MESA VERDE CULINARY WARE					*[50.6]*
Chapin Gray		2		**2**	*2.5*
Plain gray		11		**11**	*13.9*
Unclassified indented corrugated		24		**24**	*30.4*
Mancos Corrugated rim		2		**2**	*2.5*
Dolores Corrugated rim		1		**1**	*1.3*
MESA VERDE WHITEWARE					*[36.7]*
Cortez B/w	3			**3**	*3.8*
Mancos B/w	1			**1**	*1.3*
McElmo B/w	3			**3**	*3.8*
McElmo/Mesa Verde B/w	2			**2**	*2.5*
Unclassified San Juan (PII) Whiteware	2			**2**	2.5
Unclassified Mesa Verde (PIII) Whiteware	8	8		**16**	20.3
Unclassified PII/PIII Whiteware		2		**2**	2.5
SMUDGED WARE	1			**1**	[1.3]
SAN JUAN REDWARE					[2.5]
Deadmans B/r		1		**1**	1.3
Unclassified San Juan Redware		1		**1**	1.3
TSEGI ORANGEWARE					[8.9]
Citadel Polychrome	1			**1**	1.3
Unclassified Tesgi Orangeware	4	-	-	**4**	7.6
					[100.0]
TOTALS	25	54		**79**	*100.1*
%	31.6	68.4		***100.0***	

Note: Most ceramics are clustered just south of the kiva and in Rooms 1-2. Three of the plain gray sherds are located on upper ledge but no others. Ceramics tallied by Jerry Fetterman, 12 July 2011. Two of the Cortez B/w looked very much like Red Mesa B/w to T. Windes.

[a] Ware percentages = [ ].

Table 3. Tree-ring dates (n=5) from 4-Shield House (42SA 5819).

Location	FS #	TRL# NBR-	Species[a]	Age (yrs)	Max. dia. – length[b] (cm)	Outer ring condition[c]	Inside date[d]	Outside date[d,e]
East Ledge, isolated cross wall with doorway (7 lintels, 5 sampled; 1 dated; 14% of sample dated)								
Door lintel	55	1581	Jun*	213	11.0 - 63+	N/A	1048	**1260 ++vv $_{v/r}$**
Retaining wall across East Cavate mouth (52 elements, 14 sampled, 3 dated; 21% of sample dated)								
Tie log	84	1594	Pnn*	153	11.4 - 45+	N/A	0817	**0969 ++vv $_{rB}$**
Tie log	74	1591	Pnn*	209	6.3 - 70+	N/A	0999 p	**1207 ++vv $_{v}$**
Jacal post	61	1585	Jun	88	7.3 - 170+	Incomplete	1165 ±p	**1252 +B**
Storage Room 10 at west end of site (11 elements, 2 sampled; 1 dated = 50% of sample dated)								
Door lintel	120	1946	Jun	72	5.4 - 96+	Complete	1188 $_{p}$	**1259 +B**

Notes: Overall, 136 documented elements without West Cavate 2017 inventory. 21 were sampled (15% of total) with 24% dating success.

[a] **Species*** = deadwood (++ symbol).

[b] Incomplete (broken or hidden) lengths are given a +.

[c] **Outer ring condition** = **Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season tree death (i.e., late spring-summer-early fall). Growing seasons vary by species.

[d] **Date subscripts** are author's inner and outer ring field observations ***if*** they differ from the laboratory analysis.

[e] **Outside dates** in **bold** are tree death date or near-death date.

Table 4. Ceramic frequencies from 42SA 5819, 4-Shield House, Point Lookout Canyon, Cedar Mesa: entire site.

Ceramic Type	Bowls	Jars	Ladles	No.	*%* [a]
MESA VERDE CULINARY WARE					*[48.6]*
Plain gray	1			**1**	*1.4*
Unclassified indented corrugated		32		**32**	*45.7*
Mesa Verde Corrugated rim		1		**1**	*1.4*
MESA VERDE WHITEWARE					*[48.6]*
Mancos B/w	5	1		**6**	*8.6*
McElmo B/w		1		**1**	*1.4*
McElmo/Mesa Verde B/w	9	3		**12**	*17.1*
Mesa Verde B/w	5			**5**	*7.1*
Unclassified PII-PIII whiteware	1	9		**10**	*14.3*
TSEGI ORANGEWARE					*[2.9]*
Unclassified orangeware	1[b]		1	2	2.9
					[100.1]
TOTALS	22	47	1	**70**	*99.9*
%	31.4	67.1	1.4	***99.9***	

[a] Ware percentages = [ ].
[b] Pendant.

Table 5. Tree-ring dates (n=3) from Citadel House-West (42SA 5810).

Location & Function	FS #	TRL# NBR-	Species	Age (yrs)	Size (max. dia. – length[a]) cm	Outer ring condition[b]	Inside date[c]	Outside date[c,d]
Storage Room 1, attached to intact kiva (n= 8 total elements, 2 sampled, 1 dated; 50% of sample dated)								
Roof primary East side	51	1916	Jun	123	9.3 – 167+	Incomplete	1114	**1236 +L r**
Storage Room 2, next to Room 1 (n=4 total elements, 2 sampled, 2 dated; 100% of sample dated)								
Roof primary West	60	1917	Jun	67	8.3 - 197±	N/A	1196	1262 vv
Roof primary East	61	1918	Jun	79	9.0 - 205±	N/A	1187	**1265 v v/r**

Notes: Total documented elements from site = 193; 22 samples taken thus far (21% of overall total sampled). Overall dating success = 14%. More samples (18) are still at lab.

[a] Incomplete (broken or hidden) lengths are given a +.

[b] **Outer ring condition** = **Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season (i.e., late spring-summer-early fall). Growing seasons vary by species.

[c] **Date subscripts** are author's inner and outer ring field observations ***if*** they differ from the laboratory analysis and provide a better outer ring determination code.

[d] **Outside dates** in **bold** are tree death date or near death date.

Table 6. Ceramic frequencies from 42SA 5810, Citadel West House: entire site.

Ceramic Type	Bowls	Jars	Ladles	No.	%[a]
MESA VERDE CULINARY WARE					*[36.5]*
Plain gray		1		**1**	*0.4*
Narrow neckbanded?		1		**1**	*0.4*
Unclassified indented corrugated		94		**94**	*35.7*
MESA VERDE WHITEWARE					*[62.0]*
Mancos B/w	1			**1**	*0.4*
McElmo B/w	48	7		**55**	*20.9*
McElmo/Mesa Verde B/w	10			**10**	*3.8*
Mesa Verde B/w	4	1		**5**	*1.9*
Unclass. Mesa Verde Whiteware carbon-on-white	38	23		**61**	23.2
Unclassified Mesa Verde Whiteware without paint	21	10		**31**	11.8
TSEGI ORANGEWARE					*[1.5]*
Unclassified Tsegi Orangeware	4	-	-	**4**	*1.5*
					[100.0]
					100.0
TOTALS	126	137		**263**	
%	47.9	52.1		***100.0***	

Note: Majority of sherds found below and northwest of Kiva 2.

[a] Ware percentages = [ ].

Table 7. Tree-ring dates (n= 5) from Tadpole House (42SA 5814).

Location & Function	FS #	TRL# NBR-	Species[a]	Age (yrs)	Size (max. dia. - length[b]) (cm)	Outer ring condition[c]	Inside date[d]	Outside date[d,e]
(n= total elements, 7 sampled, 1 dated; % of sample dated)								
Kiva 1 Roof secondary	14	1924	Jun	84+	7.8 – 159	N/A	1073	**1156 +vv** $_{r}$
(n= total elements, 8 sampled, 1 dated; % of sample dated)								
Room 3 primary $_{Loose}$	50	1930	Jun	255±	26 - 330	Incomplete	895±	**1149 +B**
Room 15 SE wall post	153	1934	Pnn	122	11.6 – 378+	N/A	1109 p	**1230 vv** $_{v/r}$
Room 15 doorway jamb $_{NE}$	167	1937	Pnn*	159	8.5 – 182+	N/A	1053 ± $_{p}$	**1211 ++v** $_{r}$
Room 15 door jamb $_{SW}$ & lintel	168	1938	Jun	350	26 – 158+	N/A	874 ±	1223 vv $_{vv/v}$

Notes: Total documented elements from site thus far = 99; 27 samples taken thus far (27% of overall total sampled). Overall dating success = 19%.

[a] **Species*** = deadwood (++ symbol). FS 153, and 167-168 appraised as deadwood in field by author (i.e., riddled with bug holes and galleries or badly weathered, despite being sheltered).

[b] Incomplete (broken or hidden) lengths are given a +.

[c] **Outer ring condition** = **Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season (i.e., late spring-summer-early fall). Growing seasons vary by species.

[d] **Date subscripts** are author's inner and outer ring field observations ***if*** they differ from the laboratory analysis and provide a better outer ring determination code.

[e] **Outside dates** in **bold** are tree death date or near death date.

Table 8. Tree-ring dates (n=18) from Pickett Fork (42SA 1763) in Dry Wash Canyon, Cedar Mesa.

Location	FS #	TRL# NBR-	Species	Age (yrs)	Max. dia. – length[a] (cm)	Outer ring condition[b]	Inside date[c]	Outside date[c,d]
Intact kiva (Structure 12) (90 elements documented, 26 sampled, 14 dated; 54% of sample dated)								
Roof secondary	28	1838	Jun	88	10.5 – 182+	Unknown	1148	**1235 +v**
Roof secondary & hatch liner	53	1848A	Jun	127	7.5 - 195	N/A	1117 ±	**1243 vv** v/r
Roof secondary	38	1843	Jun	54	9.6 - 209	Complete	1193 ± p	**1246 +B**
So. Wall exterior, elevated hanging pole	68	1850	Jun	71	14.8 – 193+	N/A	1184 ± p?	**1254 +vv** vB
W. Niche lintel North	11	1829	Jun	63	12.8 - 194	Complete	1192	**1254 +B**
Roof secondary	44	1847	Jun	64	13.2 - 201	Unknown	1192 ± np	**1255 v**
E. Niche lintel North	6	1826	Jun	69	10.4 – 102+	Incomplete	1190 ±p	**1258 +B**
Ladder west pole	16	1832	Jun	38	12.0 - 226	N/A	1222	**1259 vv** v
Roof closing splint loose	10	1828	Jun	55	4.5 - 37	N/A	1206	**1260 +vv** r
Roof hatch liner West	61	1849	Jun	53	6.7 – 110+	Complete	1208 p	**1260 +B**
Roof secondary	31	1840	Jun	70	9.3 – 207+	Incomplete	1192 p	**1261 B**
Roof secondary	29	1839	Jun	79	7.5 – 194+	Complete	1185 p	**1263 +B**
Roof Closing splint loose	9	1827	Jun	59	4.0 - 41	Complete	1205 p	**1263 +B**
Roof filler log	24	1835	Jun	39	7.6 - 118	Incomplete	1225 p	**1263 B**
"Bridging logs" stacked along ledge between intact kiva and chasm (13 documented, 8 sampled, 2 dated; 25%)								
Layer above bottom	110	1859	Jun	60	20± - 257	N/A	1184 np	**1243 +vv** v
Bottom of stack	100	1853	Jun	62	19.0 - 167	N/A	1193 ±	**1254 +vv** v
Kiva remains (Structure 6) west of chasm (12 elements documented, 8 sampled, 1 dated; 13%)								
Roofing primary	121	1861	Jun	59	11.5 – 241	Unknown	1192 p	**1250 +v**
Room remains (Structure 4) west of Structure 6 (10 elements documented, 6 sampled; 1 dated (17%)								
Roof primary	135	1871	Jun	98	11.3 - 235	N/A	1135	1232 vv vv/v

Notes: Overall, 166 documented elements. 60 sampled (36% of total) with 33% dating success thus far (5 are still at the lab).

[a] Incomplete (broken or hidden) lengths are given a +.

[b] **Outer ring condition** = **Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season (i.e., in early summer-summer-early fall). Growing seasons vary by species.

[c] **Date subscripts** are author's inner and outer ring field observations *if* they differ from the laboratory analysis and provide a better assessment of the outer ring coding.

[d] **Outside dates** in **bold** are tree death date or near death date.

Table 9. Ceramic frequencies from 42SA 1763, Pickett Fork: entire site.

Ceramic Type	Bowls	Jars	Ladles	No.	%[a]
MESA VERDE CULINARY WARE					*[57.7]*
Chapin Gray		1		**1**	*1.4*
Plain gray		1		**1**	*1.4*
Unclassified indented corrugated		36		**36**	*50.7*
Mancos Corrugated rim		1		**1**	*1.4*
Dolores Corrugated rim		2		**2**	*2.8*
MESA VERDE WHITEWARE					*[42.3]*
Mancos B/w	1	3		**4**	*5.6*
McElmo B/w	5	3	1	**9**	*12.7*
McElmo/Mesa Verde B/w	5			**5**	*7.2*
Mesa Verde B/w			1	**1**	*1.4*
Unclassified Mesa Verde Whiteware	4	7	--	**11**	*15.5*
					[100.0]
TOTALS	15	54	2	**71**	*100.1*
%	21.1	76.1	2.8	***100.0***	

Note: Almost all ceramics tallied on slopes below Structures 4 through 6 and Structure 12.

[a] Ware percentages = [ ].

Table 10. Tree-ring dates (n=8) from Target House (42SA 5303) and (n=3) a Navajo site (42SA 28243), Butler Wash, Utah.

Location & Function	FS #	TRL# NBR-	Species	Age (yrs)	Size (max. dia. – length[a]) cm	Outer ring condition[b]	Inside date[c]	Outside date[c,d]
Target House (42SA 5303) (n= 57 total elements, 18 sampled, 8 dated; 44% of sample dated)[f]								
Roof secondary	4	1877	Pnn	136	9.8 - 284±	Incomplete	729 np	**864 +B**
Roof secondary	12	1885	Pnn	134	10.3 - 302±	Complete	731 p	**864 +B**
Roof secondary	6	1879	Pnn	110	9.6 - 280±	Complete	756 ±p	**865 +B**
Roof secondary	8	1881	Pnn	100	11.0 - 290±	Complete	766	**865 +B**
Roof secondary	10	1883	Pnn	85	9.5 - 247±	Complete	781	**865 +B**
Roof secondary	5	1878	Pnn	79	11.4 - 264±	Incomplete	787	**865 +B**
Roof secondary	15	1888	Pnn	77	9.9 - 281±	Complete	789 p	**865 +B**
Roof secondary	14	1887	Pnn	67	11.4 - 274±	Complete	799 p	**865 +B**
Navajo site (42SA 28243) (n= 17 total elements, 13 sampled, 3 dated; 23% of sample dated)[f]								
Forked stick hogan, side pole fragment	7	1955	Pnn	104	5.2 - 37	N/A	1765 ±p	**1868 +vv** v
Jacal sweat lodge, side pole	16	1960	Jun	59	6.3 – 100+	N/A	1891 ±p	**1949 vv** v/r
Jacal sweat lodge, north entry liner pole	15	1959	Jun	65	6.7 – 141+	N/A	1886 ±p	**1950 vv** v/r

[a] **Size:** Incomplete lengths (post-occupation broken or partially hidden) are given a +.

[b] **Outer ring condition = Complete** ring indicates tree death during non-growing season (late fall-winter-early spring). **Incomplete** ring = indicates tree death during growing season (i.e., late spring-summer-early fall). Growing seasons vary by species.

[c] **Date subscripts** are author's inner and outer ring field observations *if* they differ from the laboratory analysis and provide a better outer-ring condition determination code.

[d] **Outside dates** in **bold** are tree death date or near death date.

[e] None of the 5 juniper roofing secondaries dated. Nor did any other samples from within the house. The 3 undated roof primaries were *Populus* sp. (cottonwood).

[f] Not all structural elements were documented for the hogan nor the sweat lodge.