



PROJECT MUSE®

11. Viewscapes and Soundscapes

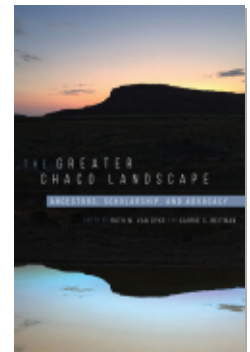
Published by

Dyke, Ruth M. Van and Carrie C. Heitman.

The Greater Chaco Landscape: Ancestors, Scholarship, and Advocacy.

University Press of Colorado, 2021.

Project MUSE. <https://dx.doi.org/10.1353/book.83549>.



➔ For additional information about this book

<https://muse.jhu.edu/book/83549>

IV

Experiencing the Landscape

Watch the video version of this chapter, recorded at Crow Canyon Archaeological Center on August 15, 2017.

<https://doi.org/10.5876/9781646421701.ch11.v000>

In Keith Basso's (1996) famous ethnography, *Wisdom Sits in Places*, he and his Apache interlocutors eloquently demonstrated the importance of a sensory, human experience of the landscape for Native inhabitants of the American Southwest. Yet, despite the presence of vibrant descendant communities and awe-inspiring topography, there has been relatively little archaeological work on the Chacoan landscape focused specifically on the senses. There are good reasons for this. The study of sensory experience is difficult and problematic on many levels (see, e.g., Day 2013; Hamilakis 2012). Phenomenological research is often (and perhaps justifiably) viewed with a healthy dose of skepticism by Southwest archaeologists trained in processual traditions. But Chacoan ceremonialism, like Pueblo and Navajo ceremonialism today, must have had vibrant sensory dimensions. We will never understand Chaco without explorations into the sensory human experience on the Chaco landscape.

In this chapter we forge a productive path forward combining systematic data collection, ArcGIS modeling, and video footage. We focus on viewscapes and soundscapes. We use the term *viewscape* rather than the more familiar *viewshed* to underscore that—although our techniques incorporate Geographic Information

Viewscapes and Soundscapes

RUTH M. VAN DYKE,
TIMOTHY DE SMET,
AND R. KYLE BOCINSKY

DOI: 10.5876/9781646421701.ch11

System (GIS) modeling—we move beyond the model to encompass lived, experiential dimensions of sight on the landscape. In the first part of the chapter, we provide background for our work, describing previous research on viewsapes and soundsapes in the Chaco world. We then turn to two case studies on the greater Chacoan landscape: the outliers of Bis sa’ani, and Pierre’s (figure 11.1). We use the two case studies to illustrate our methods and to demonstrate the impact of oil and gas extraction on sensory experience within outlier communities. Bis sa’ani is in a relatively pristine environment with little energy extraction infrastructure. Pierre’s, by contrast, is in the center of the Mancos Shale oil and gas development area. The chapter concludes with our recommendations for archaeologists and land managers to better record, study, understand, and protect the visual and auditory dimensions of the greater Chaco landscape.

CHACOAN VIEWSCAPES

Viewsapes are an important part of the Chacoan experience, past and present. The human eye can see for great distances on the Colorado Plateau, where many high places are intervisible due to the elevated topography and the clear, open skies. Although the name Chaco Canyon suggests depth, Fajada Butte and the mesas that form the canyon walls are some of the highest points in the surrounding San Juan Basin, affording spectacular visibility for over 100 km in nearly all directions. From these high places, Huerfano Mesa, the San Juan Mountains, the Nacimiento Mountains, Mount Taylor, the Dutton Plateau, Hosta Butte, the Chuska Mountains, and Shiprock punctuate Chaco’s horizons. Archaeoastronomers, GIS-based scholars, and phenomenologists are among those interested in the study of visibility—who can see whom, and what can be seen—across the Chaco landscape. We know that viewsapes are critical for understanding Chaco, because (1) descendant communities incorporate dramatic topography into their cosmographies and ideologies, (2) descendant communities value the dualistic opposition between highly visible and hidden elements of the landscape and the material world, (3) Chacoans frequently positioned great houses and other features on highly visible terrain, and (4) Chacoans marked solar and lunar phenomena.

In Pueblo and Diné worldviews, dramatic topographic features such as highly visible mountain peaks and hidden canyons mark mythic events, homelands, and sacred directions. The rugged Colorado Plateau topography contains landmarks by which to measure the movements of celestial bodies throughout the year (e.g., Parsons 1939). We know that Chacoans carefully

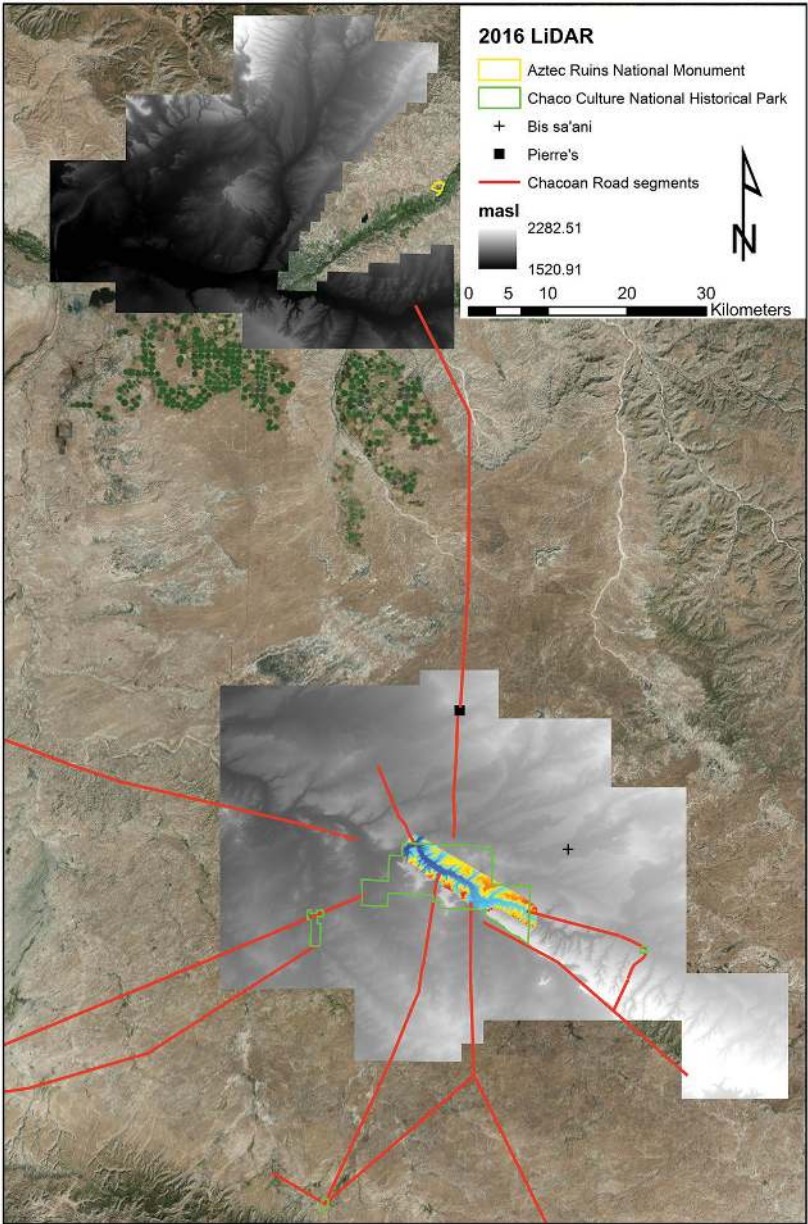


FIGURE II.1. *Composite LiDAR and satellite imagery of the central Chaco Canyon area, showing locations of Bis sa'ani and Pierre's great house communities. Graphic created by Timothy De Smet.*

marked solstices, equinoxes, and lunar standstills with great house alignments and with rock art, such as the Sun Dagger petroglyph atop Fajada Butte (Sofaer 2007) and the Chimney Rock outlier great house in southwest Colorado (Malville 2004). At Chimney Rock, during a major lunar standstill year on the full moonrise nearest the winter solstice, the full moon ascends directly between the two natural rock pinnacles that tower over the great house, moving through a narrow passage from the earth into the sky.

Chacoan great houses often are situated in visually prominent locations on elevated terrain (Van Dyke 2007:169–199; Dungan et al. 2018). Enigmatic features such as shrines, stone circles, and cairns in high places further enhance intervisible connections among Chacoan sites (Van Dyke et al. 2016; Van Dyke, chapter 6 in this volume). For example, Chacoans positioned a stone circle atop the canyon's north rim to create a line-of-sight through South Gap to Hosta Butte (Van Dyke 2007:155, figure. 6.6 in this book). There could be many reasons for this Chacoan emphasis on elevated positions, and these may have involved desires both *to see* and *to be seen* (Van Dyke et al. 2016:3). At the local level, Chacoans may have wanted to surveil or keep an eye on others in the community, and /or people on high places may have wanted to be seen by others in the community. At the regional level, Chacoans may have wanted to create visual connections beyond local communities, linking neighboring communities and/or linking themselves to Chaco Canyon. These connections could have been for communication, to foster a sense of common identity, or both (see, e.g., Bernardini et al. 2013; Bernardini and Peebles 2015). It is likely that intervisibility among high places, great houses, and communities helped weave together the fabric of the Chacoan world.

Geographic Information System technology has proven to be an excellent tool for examining and modeling visible connections over large areas such as greater Chaco. GIS-based visibility studies usually focus on determining lines-of-sight, viewnets, and viewsheds (Wheatley 1995; Wheatley and Gillings 2002). Lines-of-sight involve the reciprocal ability of people at two locations to see one another. For example, GIS analysis predicts (and experiments have confirmed) that a person standing atop Pueblo Alto and a person standing atop Pierre's El Faro can signal to one another using mirrors (Chacoans probably used selenite). Viewnet analysis uses GIS modeling to identify networks of locations connected by lines-of-sight. Bocinsky (Van Dyke et al. 2016:222, fig. 7) generated viewnets to demonstrate that 74 percent of Chacoan great houses can see at least one other great house, for example. Viewshed analysis identifies the surrounding terrain and features that can be seen from a particular location. Many Chaco scholars are working with GIS line-of-sight

and viewshed analyses in attempts to look at visibility within Chacoan communities, within areas of 10–25 sq km. See, for example, John Kantner and Ronald Hobgood (2003) at Kin Ya'a, Katherine Dungan (2009) at Kin Bineola, and Katharine Ellenberger (2012) at Kin Klizhin. Bocinsky (Van Dyke et al. 2016:222) used cumulative viewshed analysis to learn that 258 Chacoan great houses can see 30 percent of all the terrain within a 160,000-sq.-mi. area of the Chacoan world. Most recently, Dungan et al. (2018) conducted a total viewshed analysis for the local environs of 430 great houses and great kivas; their study demonstrated that builders across most of the Chacoan world consistently sited great houses (but not great kivas) in highly visible locations. These kinds of analyses, involving hundreds of potential viewpoints and thousands of sq. mi. in area, can only practically be carried out using GIS.

Although GIS studies and remote aerial data are undeniably useful, GIS analyses can never tell us whether visibility was meaningful (Frieman and Gillings 2007; Hacıgüzeller 2012; Llobera 2007). Top-down modeling studies are useful at reconstructing past connections and pinpointing possible relationships, but because we are ultimately interested in the experiences of human bodies, we consider it best to combine GIS analyses with phenomenological, on-the-ground, embodied field-based investigations. Again, we here employ the term *viewscape* to move the conversation beyond viewshed or line-of-sight modeling within GIS, to encompass the lived, experiential dimension of visibility on the Chacoan landscape.

In this study we examine viewscales using GIS analyses in tandem with phenomenological methods. Early critics of phenomenology in archaeology were concerned with subjectivity and lack of replicability (Brück 2005), but good phenomenological research can be both systematic and replicable (see, e.g., Hamilton and Whitehouse 2006). Van Dyke has developed a method for documenting viewscales that incorporates still and video photography as well as paper forms, top-down maps, and digital elevation models (DEMs). She first establishes locations that are likely to have been important viewscales—these are usually pinnacles or high places such as great houses or unusual topographic features topped with ERFs (see chapter 6, this volume). For comparison, she also chooses locations with more restricted viewscales, such as a small community site at the base of a pinnacle. From each point she uses digital and video cameras to record the 360 degree panorama. A video camera offers the added benefit that she can narrate what her human eye can see as the camera turns. On paper, she sketches the visible attributes of the near, intermediate, and far horizons using a modified version of Sue Hamilton and Ruth Whitehouse's (2006) circle maps. She then juxtaposes this information

with top-down maps of archaeological features and digital elevation models of the terrain. The result is a comprehensive digital record of a viewscape from a particular location, such as a great house. The different kinds of information can be combined in programs such as iMovie to show how different recording techniques highlight different kinds of visible attributes and to make the results accessible to a reader or viewer (videos 11.1 and 11.2).

In the second half of this chapter, we illustrate these techniques at the Chaco outliers of Bis sa'ani and Pierre's. But first, we turn to a short review of the study of Chacoan soundscapes.

CHACOAN SOUNDSCAPES

Archaeologists have only recently begun to study soundscapes (e.g., Miller 2008; S. Mills 2014; Mlekuz 2004; Scarre and Lawson 2006; Schofield 2014; Scullin 2019; Till 2014; Villanueva-Rivera et al. 2011). A soundscape is defined as “any sonic environment, with particular emphasis on the way it is perceived and understood by an individual or by a society” (Truax 1999, cited in Elliot and Hughes 2014:306). In the Chacoan world, sounds created by human voices, animals, water, wind, thunderstorms, daily activities, and musical instruments would have been part of the fabric of life. Previous researchers have thought a lot about sound from the perspective of musical instruments. Pueblo peoples used a wide variety of percussion and wind instruments: drums, copper bells, kiva bells, tinklers, rasps, bullroarers, conch shell trumpets, flutes, and whistles (see Brown 2005 for a comprehensive discussion). Acoustic researchers at Chaco have been particularly interested in conch shell trumpets—an instrument likely employed in the context of ritual events at Chaco. By removing the pointed end and then blowing through the whorls of these exotic shells, it is possible to create a very loud blast. Trumpets made from the shells of Pacific ocean conch, particularly *Strombus* sp. and *Murex* sp., are found in very small numbers from contexts across the Southwest (Brown 2005:291–305; B. Mills and Ferguson 2008; Vokes and Gregory 2007). Out of forty-six known conch shells or fragments in the Southwest, seventeen were found in Chaco Canyon, and one was found with Chaco's most elaborate burial under a plank floor in Room 33 of Pueblo Bonito (Brown 2005:299–300; B. Mills and Ferguson 2008:347, table 1).

Richard Loose and his colleagues have used experiments to explore the resonance of conch shell trumpets in Chacoan settings. Loose (2012) re-created a shell trumpet using a *Strombus galeatus* shell, and he used digital software to measure the pitch and loudness when blown. His 20-cm-long experimental

shell trumpet produced a sound at at 329.84 Hz, with harmonic overtones at 650 and 974.4 Hz; he measured the sound at 96 decibels above the noise floor of his recording system. (This is approximately the decibel level produced by a motorcycle or a handheld drill.) Loose observes that pitch and loudness would vary, however, depending on each shell's bore configuration as well as the volume of air forced through the bores. Loose deployed his experimental trumpet in acoustic research carried out with John Stein, Richard Friedman, and others in front of a toric sandstone cliff face in downtown Chaco Canyon, between the great houses of Pueblo Bonito and Chetro Ketl (Loose 2008, 2010; Stein et al. 2007). In Diné oral traditions this cliff face is called Tse' Biinaholts'a Yáti (Curved Rock That Speaks), and it is where deities taught Navajo hero twins how to produce the vocal tones used in ritual chants, accompanied by shell trumpet, eagle bone whistle, and reed flute. The investigators measured the sandstone cliff at approximately 150 m long × 25 m high and dubbed the region in front of it "the amphitheatre," due to the interesting acoustic effects they observed. Over multiple occasions the researchers played amplified music, sine waves, flutes, and conch shell trumpets in the amphitheatre, acquiring five hours of experimental recordings. Reverberations in the amphitheatre last for 2 seconds (comparable to a concert hall), and there is a secondary echo with a 3.5-second delay from across the canyon to the south. The torus curve of the cliff causes unusual effects, including virtual sound image, in which sounds seemed to be emanating from within the cliff, and acousma, in which sounds produced nearby were heard as garbled or spooky, unintelligible noises. John Stein et al. (2007) conclude that the amphitheatre was intentionally used by Chacoans during ritual performance events.

Geographic Information Systems is a useful tool for acoustic studies, just as with visibility studies. It is very challenging to study archaeo-acoustics across open-air areas such as a Chacoan outlier community, but GIS modeling can help. Working toward this end, Kristy Primeau and David Witt (2018) developed a soundshed analysis tool for ArcGIS that takes into account distances, physical barriers, air temperature, relative humidity, and ambient sound pressure. After evaluating their tool in a controlled setting, they employed it to replicate and analyze the sound of a conch shell trumpet blown at dawn from outside Pueblo Bonito in downtown Chaco Canyon. Primeau and Witt discovered that certain features such as stone circles on the canyon rims might be positioned to be able to hear this kind of event. Primeau and Witt's work offers a promising way forward to evaluate speculations regarding the performative resonances of musical instruments and chants during ceremonies and processions in Chaco Canyon (Van Dyke 2013; Weiner 2015).

TABLE 11.1. Sound model variables for raised voice, conch trumpet, and pump jack sources.

<i>Model inputs</i>	<i>Raised Voice</i>	<i>Conch Trumpet</i>	<i>Pump Jack</i>
Sound source height (m)	1.524	1.8288	1.828
Frequency (Hz)	325	330	500
Source sound level (dB)	84	96	82
Source measurement distance (m)	0.9144	0.30483	15.24
Temperature (°C)	32	32	32
Relative humidity (%)	30	30	30
Receiver measurement height (m)	1.524	1.524	1.524

In our study, De Smet followed Primeau and Witt's (2018) procedures to model soundscapes in the Bis sa'ani and the Pierre's communities. De Smet specifically focused on the reach of three kinds of sounds: a male human shout, a blast from a conch shell trumpet, and the noise produced by an active drill rig. To model the spread and attenuation of sound, he input nine model parameters: a 1 m LiDAR DEM raster, sound source location points, and seven user-determined variables. He used the frequency (Hz), source sound level (dB), source sound height (m), source measurement distance (m), temperature (°C), and relative humidity (%) variables to calculate the resulting A-weighted sound pressure levels (dBA) at a specified receiver measurement height (human ear height) of 1.524 m, or about 5 feet (table 11.1). These input variables allow the model to calculate for attenuation of the sound source signal, namely, spherical spreading loss (distance), atmospheric absorption loss (temperature, humidity, elevation), and terrain effects (ground and barrier loss). These models assume no wind speed or direction. The results of De Smet's modeling exercises are striking, and we present them within the context of our two case studies below.

CASE STUDIES: BIS SA'ANI AND PIERRE'S

The Chaco outliers of Bis sa'ani and Pierre's are ideal cases upon which to demonstrate our viewscape and soundscape study methods. Both communities are well studied, with accurate and detailed community site information. Both are relatively close to Chaco, on terrain with dramatic topographic features, and both were most intensively occupied during the early AD 1100s. However, there is one important difference between the two communities. The terrain surrounding Bis sa'ani has not been subjected to intensive oil and gas infrastructure development, while the terrain surrounding Pierre's is at the



FIGURE 11.2. *Bis sa'ani* great house, looking north. Photo by Ruth Van Dyke.

center of Mancos Shale energy development. Thus, the two communities form an ideal pair within which to contrast the impacts of energy development on viewsapes and soundsapes.

Bis sa'ani

The *Bis sa'ani* outlier is situated approximately 12 km northeast of Chaco Canyon. East Great House and West Great House structures perch atop a prominent shale ridge on the south side of Escavada Wash (figure 11.2). Sixteen small habitations and field houses form an associated community in the aeolian dunes to the south (figure 11.3). Robert Powers et al. (1983:21–54) intensively surveyed a 3.2-km (2 mi.) diameter area around the great houses and mapped the great houses and community. Cory Breternitz et al. (1982) conducted extensive excavations at the great houses and some of the small sites. No known road segments connect *Bis sa'ani* to Chaco Canyon, although to reach Chaco Canyon, one can merely follow Escavada Wash.

The two south-facing great houses are “rather precariously situated” atop an isolated 750-m-long shale ridge; the narrow ridge measures at least 20 m high but only 20–50 m wide (Powers et al. 1983:21). The West House contains twelve rooms and a kiva. A little over 100 m to the east, the East House contains at least twenty-five rooms and four kivas with a total floor area of at least 1040 sq. m. Breternitz et al. organized the East House into four substructures: Rabbit House (to the east), Casa Quemada (in the center), South House (to the south), and Casa Hormiga (to the west) (figure 11.4). Builders erected Casa Hormiga, South House, and Rabbit House using sandstone core-and-veneer,

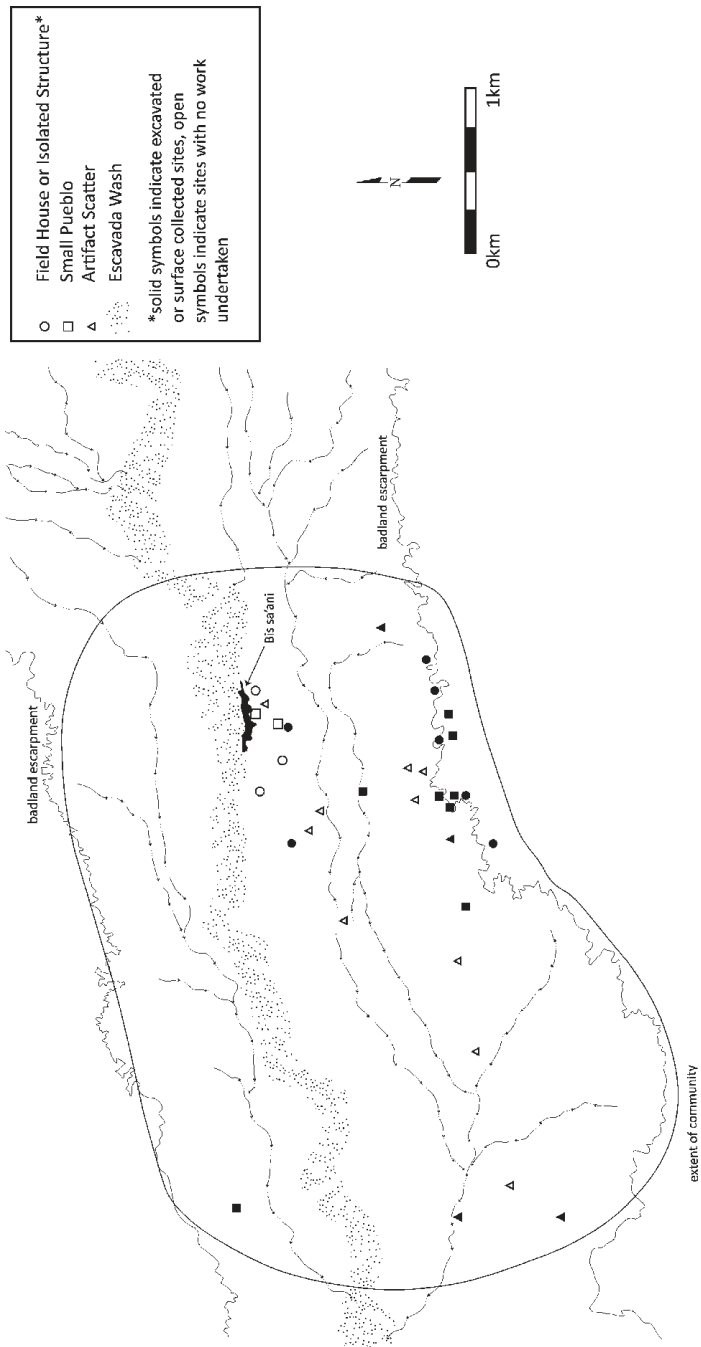


FIGURE II.3. Map of the Bis sa'ani Community. From Breternitz et al. (1982).

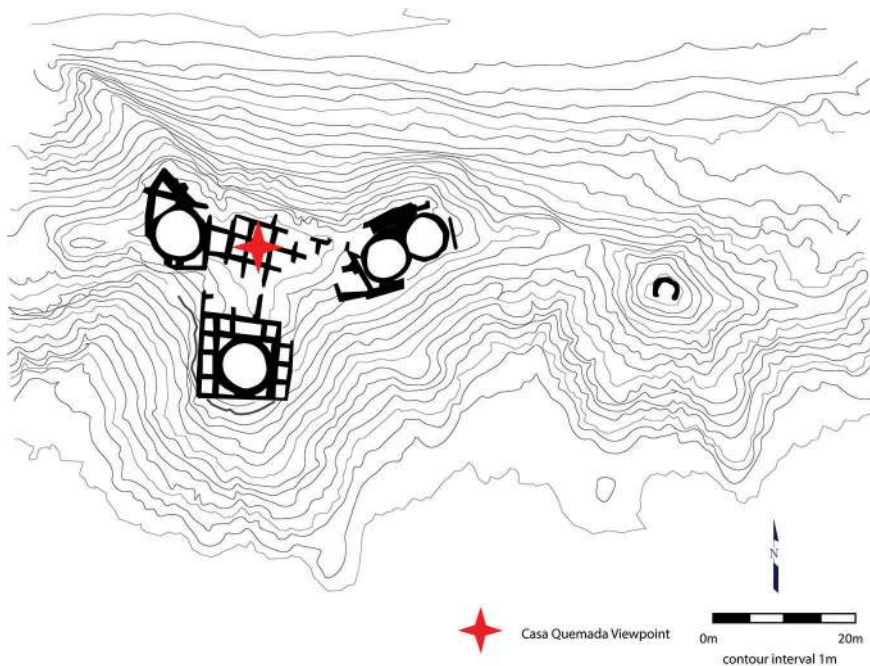


FIGURE II.4. Eastern component of Bis sa'ani great house, with Casa Quemada denoted by red star. Modified from Breternitz et al. (1982).

but they used adobe—a highly unusual Chacoan construction technique—to construct the aptly named Casa Quemada, or “burned house.”

Van Dyke visited Bis sa'ani on a clear summer morning in June 2017. She chose Casa Quemada—the highest and most central area—as the representative viewpoint for the East House at Bis sa'ani. Van Dyke recorded the 360° panoramic viewscape from Casa Quemada atop the East House at Bis sa'ani using three techniques: circle drawings, still photography, and digital video. She confirmed the coordinates of her location using a handheld GPS, and she established cardinal directions using a Silva Ranger compass calibrated to true north. First, she used a graphic method of field recording developed by Hamilton and Whitehouse (2006) to create 360° circular drawings of the prominent visible elements from each location (figure II.5).

These drawings include three sight horizons (near distance, middle distance, and final horizon). Within each horizon, and using the compass for accuracy, she noted major topographic and architectural features. Second, from the same location, she used a Pentax K200D 10.2 mega-pixel digital

Viewscape Circle Map

Site: Bis sa'ani, Casa Quemada
Date: 12 June 2017
UTM: Z 13 E 248771 N 3997265
Weather conditions: clear, sunny, light breeze

Recorder: R. Van Dyke Height: 5'2"
Time: 9 AM
Position of sun: 50°
Light conditions: clear Temp: 80° F

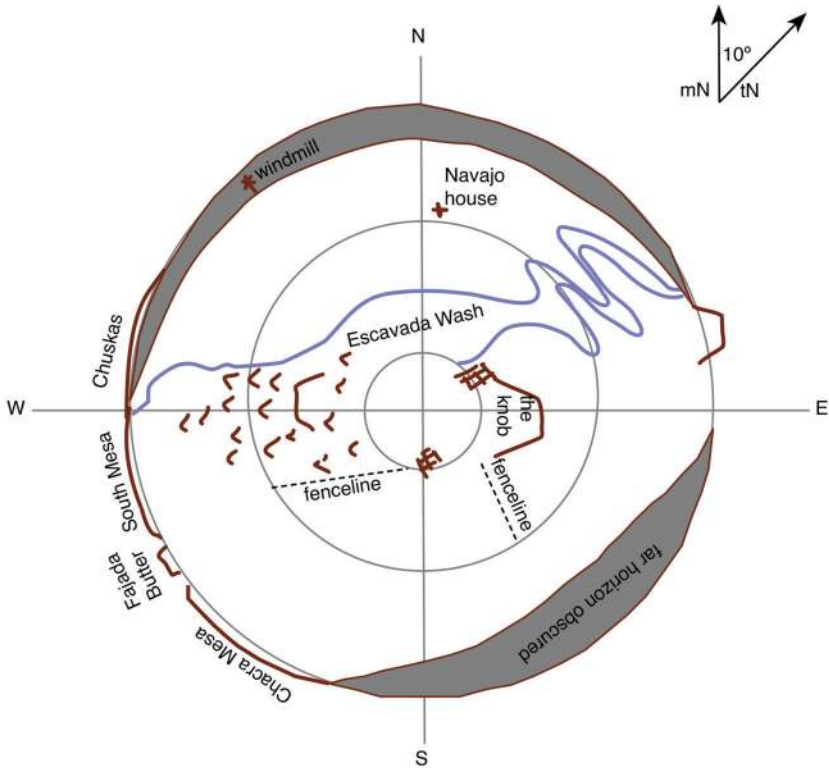


FIGURE 11.5. Example of a circle map: viewscape from Casa Quemada, Bis sa'ani. Graphic by Ruth Van Dyke.

SLR camera to capture a series of still photographs in 360° circumference. Third, she used an iPhone 6 with a 29-mm lens and 8-megapixel resolution to shoot high-definition (1080-pixel) video in 360° at 60 frames/second. She mounted the iPhone on a tripod for stability and rotated it by hand, while narrating a description of the views. The background narration provides notes useful in pulling together the final viewscape. Back from the field, Van Dyke used iMovie to create a short video illustrating the Casa Quemada

Bis sa'ani Viewscape

Ruth Van Dyke

12 June 2017



VIDEO 11.1. *Bis sa'ani viewscape* (<https://doi.org/10.5876/9781646421701.c011.v001>).

viewscape. The video (video 11.1: <https://doi.org/10.5876/9781646421701.c011.v001>) combines Van Dyke's field data with Breternitz et al.'s (1982) top-down maps and Bocinsky's GIS-modeled viewsheds and line-of-sight analyses to present a short, seamless illustration of what a human observer standing atop Casa Quemada can see.

The viewscape at Bis sa'ani links the community with the greater Chacoan landscape. Upon initial entry, Bis sa'ani seems its own self-enclosed world on the banks of the Escavada. From the valley floor within Bis sa'ani, the shale ridge with the great houses is a prominent location, but a viewer can see neither Chaco Canyon nor any of its familiar landmarks (e.g., Fajada Butte, Huerfano Mesa). Furthermore, not all of the community sites are intervisible with the great houses. However, the viewscape afforded by the great houses on the ridge tells a different story. From this vantage point, someone walking to Bis sa'ani from Chaco along the Escavada Wash would see the great house silhouetted against the sky long before they arrived in the community. And someone standing atop any of the Bis sa'ani great houses could see Fajada Butte, central Chaco Canyon, and ERF locations atop Chacra Mesa and South Mesa. The viewscape also links Bis sa'ani to communities far beyond Chaco Canyon. Not only could a viewer standing atop Casa Quemada see 90 km west to the Chuska Mountains, but (perhaps more important) this viewer could see White Rock, a landform 40 km to the west. Van Dyke et al. (2016) identified White Rock as a major node in the Chacoan great house

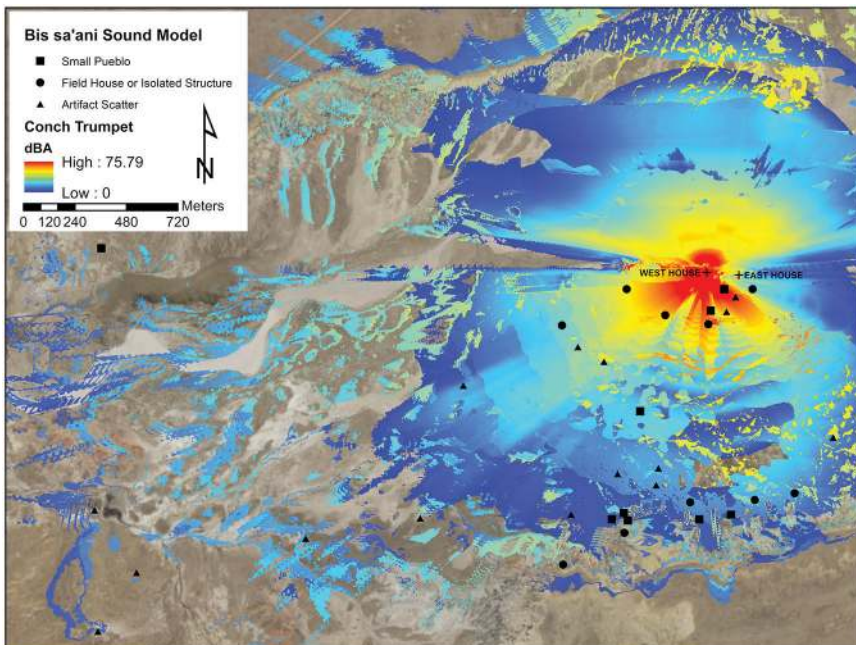
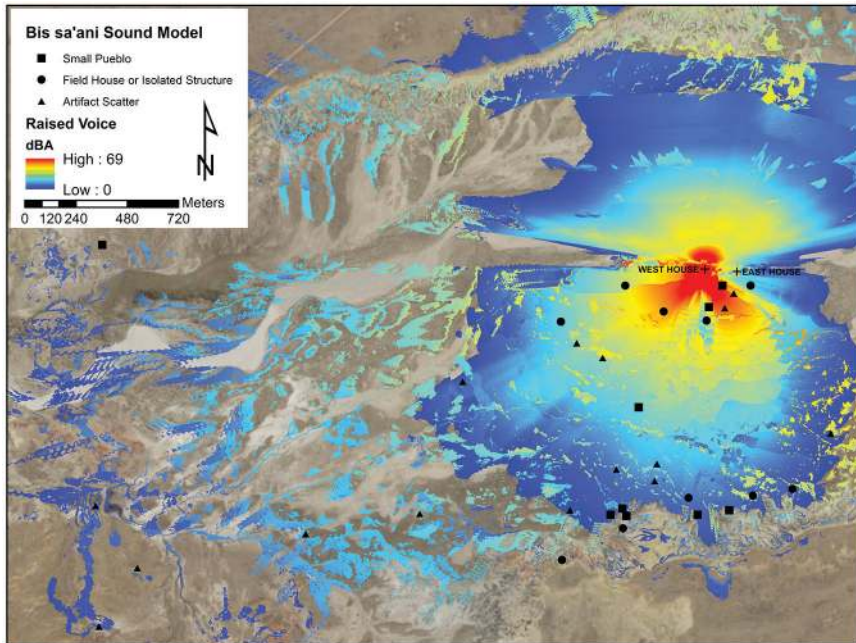
viewnet—in other words, the great houses at Bis sa’ani were linked to scores of Chacoan outliers in the western San Juan Basin and beyond, through intervisibility with White Rock. So, although early twelfth-century Bis sa’ani residents may have moved east up the Escavada Wash and out of Chaco Canyon’s direct purview, they were not by any means visually separated from doings in Chaco Canyon or more distant outliers. The builders of Bis sa’ani appear to have intentionally situated their great houses atop the “precarious” shale ridge, not for intervisibility with the immediate community of small sites, but to maintain connections with the greater Chacoan world.

The soundscape at Bis sa’ani tells a different, but equally compelling story. As with the viewscape, we were interested in exploring how the position of the great houses atop the shale ridge might, or might not, affect acoustics across the community. Using the procedures outlined previously in this chapter and the variables presented in table 11.1, De Smet created a GIS model for the reach of a human shout (figure 11.6) and the blast of a conch shell trumpet (figure 11.7) emanating from atop the West Great House. We found that both sounds traveled outward for distances up to 3 km. The shout extended across most of the community, but it failed to reach two small pueblos, two field houses, and an artifact scatter situated on the outskirts. The conch shell trumpet blast, however, reached every one of the thirty-four sites in the community. In fact, the extent of the conch shell trumpet blast mapped surprisingly well onto the boundaries of the Bis sa’ani community as previously defined by archaeological survey.

To date, most Chaco researchers interested in the sensory dimensions of outlier communities have focused exclusively on the intervisibility of great houses with community sites. Our experimental soundscape results suggest that the acoustic reach of a conch shell blast may be even more important. If leaders atop great houses needed to quickly communicate with all community residents, a conch shell blast would have been a much more effective method than relying upon community residents to look in the right direction at the right time. It is possible that community boundaries map onto the extent of the conch shell blast because community members did not wish to live, or were not permitted to live, where they could not be reached.

FIGURE 11.6 (FACING PAGE, TOP). *Reach of a human shout emanating from the West Great House at Bis sa’ani. Model and graphic by Tim De Smet.*

FIGURE 11.7 (FACING PAGE, BOTTOM). *Reach of a conch shell blast emanating from the West Great House at Bis sa’ani. Model and graphic by Tim De Smet.*



We were able to examine viewsapes and soundsapes at Bis sa'ani with little interference from modern landscape intrusions. The Bis sa'ani area is remote and sparsely populated, and there has been little to no impact from energy development in the area. Although we are aware that the ancient visual and acoustic landscapes would have differed from the contemporary landscape, there was no need for us to attempt to remove or counterbalance modern intrusions such as those created by gas wells. For counterpoint, we turn now to the Pierre's community, situated in the midst of Mancos Shale energy development.

Pierre's

The Chacoan outlier of Pierre's is situated 19 km north of Chaco Culture National Historical Park, on the southern edge of the break between the Chaco Slope and the mesas and badlands of the Denazin and Ah-shi-sle-pah Washes, on the USGS 7.5' Pueblo Bonito NW quadrangle. The outlier is clearly articulated with the Great North Road, which leaves the vicinity of Pueblo Alto and, in a series of stages, heads north to Kutz Canyon, 50.5 km distant (figure 11.8). Powers et al. (1983:94–122) and Randy Harper et al. (1988) both conducted intensive survey and recording in the Pierre's community during the 1980s. The community was also investigated by the Chaco Roads Project (Stein 1983) and the Solstice Project (Marshall and Sofaer 1988). The Pierre's community is spatially distributed over an area of approximately 1.6 sq. km. Powers et al. documented seventeen Ancient Pueblo sites in the surrounding community, and Harper et al. added an additional nine. All but one small Basketmaker III–Pueblo I artifact scatter date from the Late Pueblo II or Early Pueblo III period.

There are several Bonito-style structures in the community (figure 11.9). The “Acropolis” cluster consists of two core-and-veneer structures (LA 16509, House A and LA 16508, House B) atop a large butte near the center of the community. House A contains an estimated fifteen ground-floor rooms and three enclosed kivas over an area of 255 sq m. House B is located 30 m to the north/northeast of LA 16509. House B contains an estimated thirteen ground-floor rooms and a single enclosed kiva and covers 315 sq m. An additional structure, House C (LA 35423), is an isolated room located approximately 5 m northwest of LA 16509; although the room was given a separate site number by the Chaco Roads Project, Harper et al. (1988:119) contend that House C should be considered part of LA 16508.

“El Faro,” or “The Lighthouse,” consists of a pinnacle on the valley floor that is topped by a small, three-room structure including an exposed hearth (LA 16514, Powers et al.'s 1983 P-5). At the base of this pinnacle, there is another

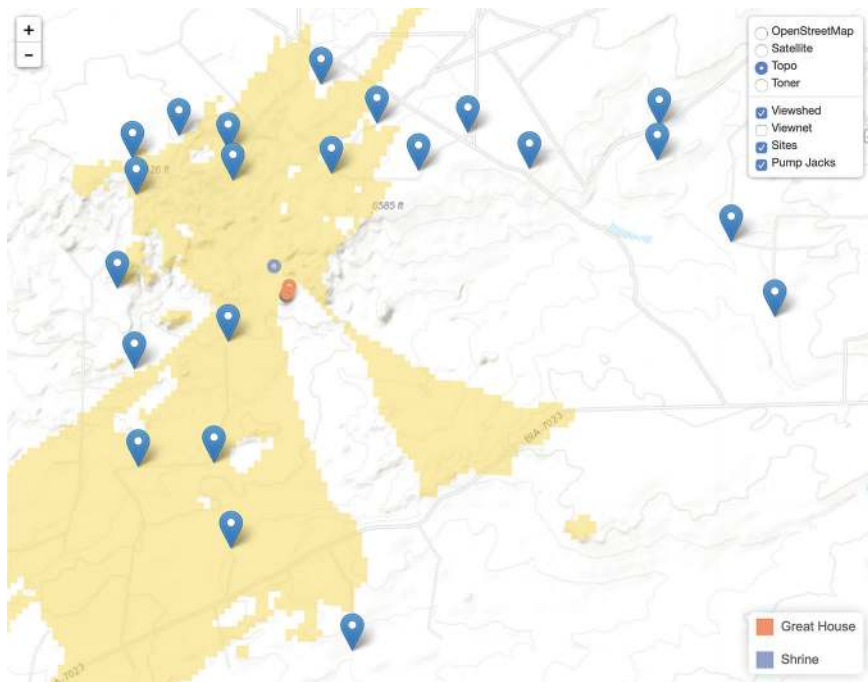


FIGURE 11.8. *The Pierre's landscape, with numbered viewpoints and drill rigs corresponding to Van Dyke's viewscape videos. Model and graphic by R. Kyle Bocinsky.*

massive core-and-veneer building covering 505 sq m, estimated to contain eighteen rooms and one enclosed kiva (LA 16515, Powers et al.'s 1983 P-6). A neighboring pinnacle 80 m ESE of El Faro hosts at least two small room blocks, LA 16518 (P-9) and LA 16519 (P-10). LA 16519 is situated directly on top of this second pinnacle and might be considered to represent an *atalaya*, or watchtower, following Marshall and Sofaer (1988).

There is little doubt that Chacoans located Pierre's in this place because of the Great North Road and because of specific visible attributes of the local topography. The Great North Road originates at Pueblo Alto. Ancient engineers could have used a simple gnomon device to derive the road's northern bearing (Lekson 2015), but as road surveyors moved north, they likely engineered road segments using backsights. Road construction would have required a clear line-of-sight, and Pierre's is located on the first major topographic break in the landscape moving north from Chaco Canyon. The pinnacles and butte of Pierre's are visible from Pueblo Alto, and vice versa. Gwinn Vivian and Doug Palmer have conducted experiments with mirrors flashed



FIGURE II.9. *Carrie Heitman and Julian Thomas sit atop Pierre's Great House B (LA 16508) as seen from Great House A (LA 16509) in September 2015, looking north, with drill rig #s 8, 9, and 1 on the horizon. Photo by Ruth Van Dyke.*

in the sunlight to establish line-of-sight connections between Pierre's and Pueblo Alto; Van Dyke participated in one of these experiments in September 2015. Hearths atop high places at Pierre's (El Faro, LA 16514, and LA 16519) suggest that the Chacoans were, indeed, interested in signaling between these locations. Looking north along the Great North Road past Pierre's, the next topographic break is Carson Divide (Marshall and Sofaer 1988), also topped by a potential signaling feature. Thus, visibility between Pierre's and Pueblo Alto in Chaco Canyon was a key part of the construction of the Great North Road and likely continued to be important for signaling between the two areas.

For extended discussions of the possible functions of Chacoan roads and associated features, see chapters 3, 5, and 10 (this volume). It seems likely that ritual processions or other movements of people took place along Chacoan road segments, particularly when those segments are in the vicinity of outlier great houses. Michael Marshall (1997) suggests that Chacoans processed north along the Great North Road to deposit vessels (and perhaps, symbolically, the dead) in Kutz Canyon. Such possibilities are understudied and could benefit from experimental reconstruction.

The Pierre's community, with its clear and strong relationship to the Great North Road, is protected as part of the Chaco Protection Sites group and was included as part of Chaco's entry on UNESCO's World Heritage List. However, despite the obvious importance of viewsapes at Pierre's, the sensory aspects of this landscape have been little studied. And, although the Pierre's Chacoan outlier is itself protected from development as part of the Chaco Protection Sites federal legislation, existing laws do little to counter the indirect cumulative adverse sensory impacts of ongoing oil and gas production in the surrounding area.

On a cold, sunny autumn day in November 2016, Van Dyke visited Pierre's to assess these sensory impacts. Following the same procedures as at Bis sa'ani, Van Dyke used digital still photography and video, as well as a variation of Hamilton and Whitehouse's (2006) circle maps, to record 360° panoramas from five Chacoan structures in the community. She observed that twelve pumpjacks and five drilling containers are visible from the high places in the community. The nearest pumpjack, Dugan Production Corp Hoss Com #95, is located just outside the Pierre's community only 650 m southwest of the great house butte (figure 11.10). Because the Pierre's sites—particularly LA 16509 (House A), LA 16508 (House B), LA 16514 (El Faro), and LA 16519 (the atalaya)—are significant in terms of visibility along the Chacoan road, Van Dyke chose these four locations for 360° viewscape investigation. She also included LA 16515, the large Bonito-style structure at the base of El Faro on



FIGURE 11.10. *Hoss Com #95 (pumpjack #6), 650 m southwest of the Pierre's community, with Great Houses A and B on butte in background. Photo by Ruth Van Dyke.*

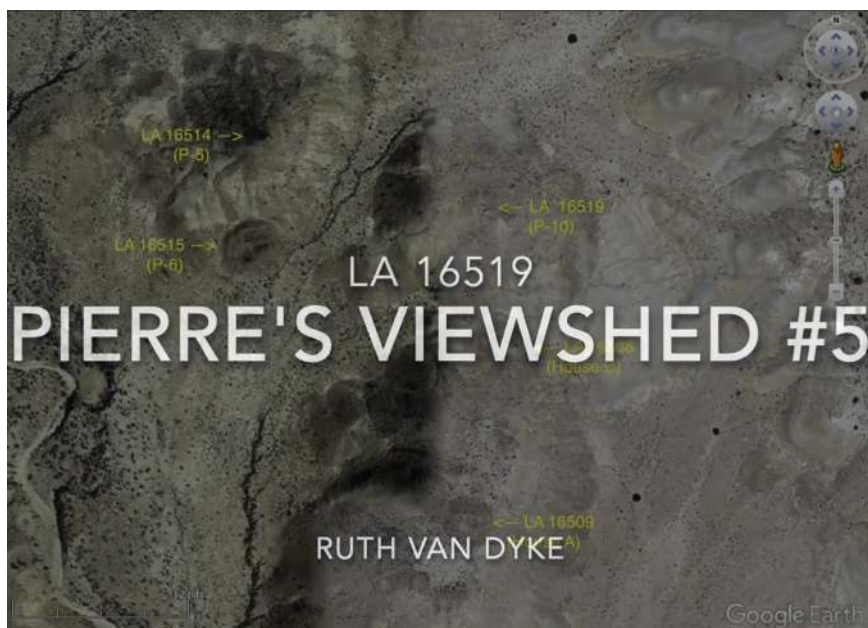
the basin floor. As at Bis sa'ani, Van Dyke determined cardinal directions using a Silva Ranger compass oriented to magnetic north. She then recorded the 360° viewsapes at each of these locations using circle drawings, still photography, and digital video. She numbered the pumpjacks within the viewsapes from #1 to #12. Back from the field, Van Dyke used the collected data to create five short videos in iMovie 10.1.4. We include one of these here as video 11.2.

Viewscape 1 records the 360° view from the highest point on LA 16508, Pierre's Great House B, and Viewscape 2 records the 360° view from the highest point on LA 16509, Pierre's Great House A. The two viewsapes are similar. There are a total of twelve pumpjacks visible. To the north, there are two pumpjacks on the horizon (#1 and #2); the closest of these is approximately 900 m away. There are also three drilling tanks. To the northwest, pumpjack #9, which is painted camouflage colors, is visible on the horizon next to a drill tank. Pumpjack #7, which is dark red, stands out against yellow caprock and is visibly moving—it is also accompanied by a tank on the horizon. To the southwest a viewer can see the knob on the other side of the Pierre's community with the Chuska Mountains on the far horizon, and White Rock visible in the foreground. There are two pumpjacks labeled #10 and #12 visible on the valley floor just south of the knob. On the valley floor 650 m to the southwest is pumpjack #6, or Hoss Com #95. Looking across the landscape

toward Chaco Canyon, there is a string of pumpjacks in view positioned along rig roads: # 5, 12, 11, 4, and 3. Behind them, the major topographic landmarks of Chaco Canyon are visible to the south: West Mesa, Hosta Butte, South Gap, South Mesa, Fajada Butte, and Chacra Mesa. To the east on the far horizon, there are a few tanks as well as a Navajo settlement.

Viewscape 3 records the 360° panorama from LA 16515, the large masonry house on the valley floor at the base of the El Faro pinnacle. Because LA 16515 is on the valley floor, there are only three pumpjacks visible from this spot (#3, 4, and 8), but all three can be seen bobbing up and down on the horizon. Viewscapes 4 and 5 record the 360° views from the sites at the tops of two pinnacles—El Faro (LA 16514) and the atalaya (LA 16519), respectively. Nine pumpjacks are visible from these locations. To the east, the badlands topography blocks the long-distance horizon, although in the far distance buildings and a vehicle on the horizon represent a Navajo settlement. To the east-southeast is the large butte crowned by the two great houses. To the south is the landscape of Chaco Canyon, with Mount Taylor, South Mesa, South Gap, Hosta Butte, West Mesa, and Little Hosta Butte. As one looks southwest down the valley toward the Chaco River, there are three pumpjacks (#3, 4, and 5) flashing in the sun as their arms pump up and down. Pumpjack #6 is located 750 m to the southwest. This rig, labeled Hoss Com #95, was reportedly placed perpendicular to Houses A and B so that it would be less visible from the Pierre's community; however, the pumpjack is not perpendicular to either of the two pinnacle sites. To the south-southwest there is another pinnacle in the middle distance, and the Chuska Mountains and Narbona Pass on the horizon. Pumpjack #7 bobs up and down on the valley rim that blocks the far western horizon. To the north-northwest, the dark red pumpjack #8 is below the yellow sandstone caprock. Pumpjack #9 is on the horizon but less visible since it is painted in camouflage colors; both are accompanied by storage tanks.

Viewscape 5 (video 11.2) may be viewed at <https://doi.org/10.5876/9781646421701.011.v002>. These viewscapes illustrate several important observations. First, the Pierre's sites on high places are situated to maximize visibility with the major topographic features of Chaco Canyon. Elsewhere, Van Dyke (2007) has argued that major landforms such as Mount Taylor and Hosta Butte were storied places for ancient Chacoans, just as they are for today's descendant communities. An individual standing atop Pierre's great houses, atalaya, or El Faro, looks south towards the striking landscape of South Mesa, South Gap, and West Mesa—downtown Chaco Canyon. And, on the horizon behind Chaco Canyon, an ancient viewer would have seen Mount Taylor, Hosta Butte, and Little Hosta Butte. If, as Marshall (1997) and Van Dyke



VIDEO II.2. *Pierre's Pinnacle Viewshed 5* (<https://doi.org/10.5876/9781646421701.ch11.v002>).

(2007:148–151) have argued, the Great North Road and the South Road are meant as a dualistic pair that counterbalance one another, then the visibility of Hosta Butte from Pierre's could have been particularly important for ancient Chacoans. As noted earlier, it is possible for viewers at Pueblo Alto and Pierre's to pinpoint one another's locations using bright light created by mirrors or flames. Van Dyke et al. (2016) and many others have argued that these connections may have been important for signaling, tying together the greater Chacoan world.

Unfortunately, the flashes seen during our November 2016 visit to Pierre's represented the sunlight glinting off a series of pumpjacks, with arms moving up and down. And, while pumpjacks do not actually impede a modern viewer's ability to see distant peaks such as Hosta Butte, they are certainly distracting. Pumpjacks silhouetted against the near horizon—numbers 1, 2, 7, and 9 in our study—make modern viewers feel as if they have stumbled into an industrial park. The National Environmental Policy Act (NEPA) states that environmental assessments must consider the “cumulative effects” of developments. While oil and gas rigs did not erase or disturb the ground at archaeological sites in or around the Pierre's community, we argue that the positioning of twelve rigs

within the great house viewscape falls into the “cumulative effects” category, as these wells clearly constitute “a pattern of actions whose effects are significant,” as stipulated in NEPA. The general viewscape of the Pierre’s community has been irreparably damaged by failure to consider these wells’ obtrusive visibility.

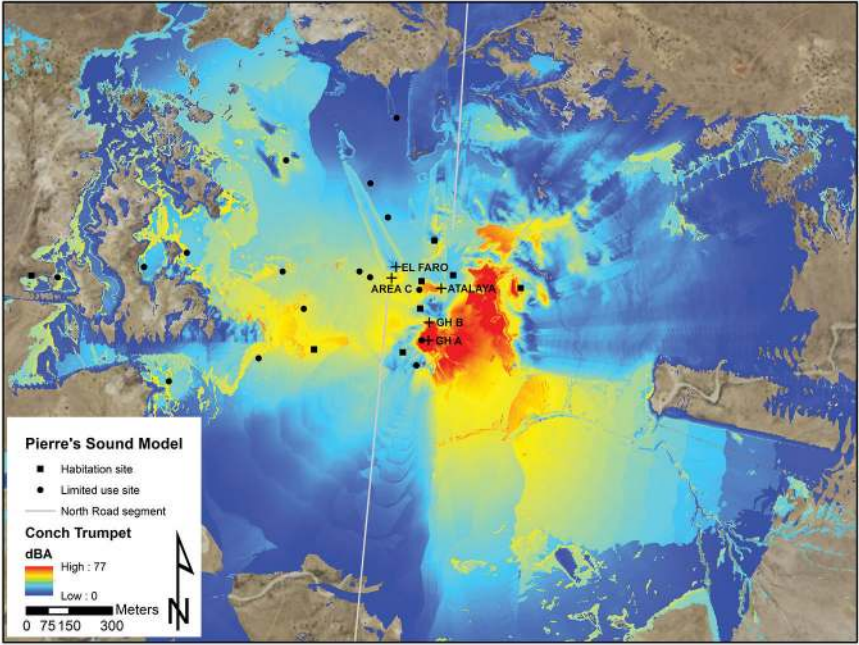
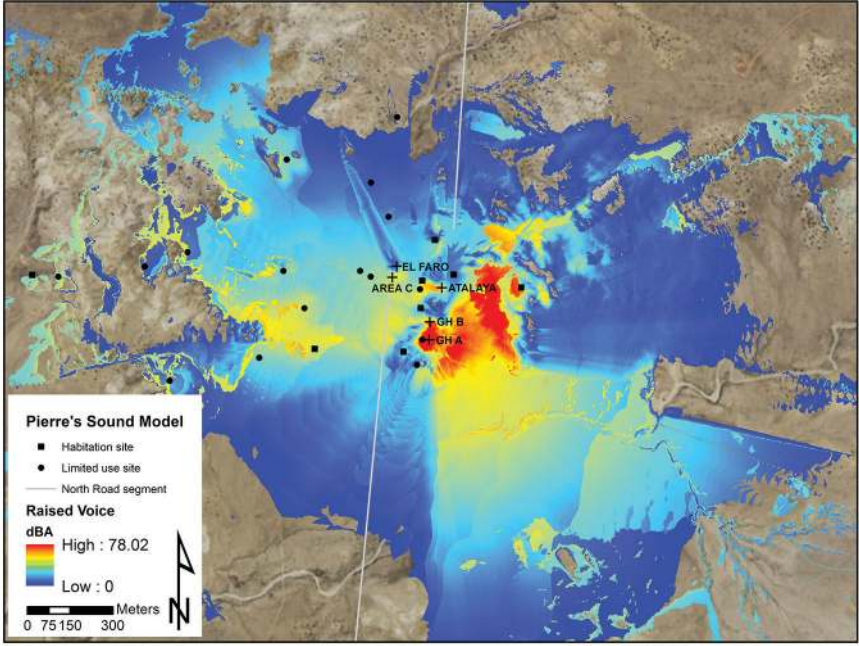
In our study we were keen to also investigate the Pierre’s soundscape, particularly because noise from nearby mineral extraction is audible within the Pierre’s community. During Van Dyke’s site visit in November 2016, she could hear the clanking and periodic backfire of the engine driving Hoss Com #95. Van Dyke used a Roland Edirol digital recorder to capture periodic bursts of sound from Hoss Com #95 that measured up to 60 decibels higher than the ambient background. When the Bureau of Land Management (BLM) was subsequently notified of this noise disturbance, they required the drilling company to outfit the rig with a new muffler.

We investigated the Pierre’s soundscape using the same acoustic modeling experiments that we had employed at Bis sa’ani. De Smet again followed the detailed procedures set out in the first part of this chapter. De Smet modeled a human shout and a conch shell trumpet blast emanating from Great House A (LA 16509). In both experiments the sounds reached distances nearly 2 km. As at Bis sa’ani, in our model, the conch shell trumpet was more effective than a human shout at reaching the entire Pierre’s community. A human shout traveled to all but one limited use site in the Pierre’s community (figure 11.11). The conch shell trumpet blast—as at Bis sa’ani—reached all twenty-eight habitations and limited use sites in the Pierre’s community (figure 11.12). Both sounds would have been heard by travelers up to 1 km away along the North Road.

As at Bis sa’ani, the Pierre’s community boundaries map rather neatly onto the reach of the sound of a conch shell trumpet, suggesting that it may have been important for residents to live and work within hearing distance of the Pierre’s great houses. People at Pierre’s could have seen Chacoan landmarks and could have signaled with Pueblo Alto, suggesting that viewscape is most important for long-distance interactions; by contrast, soundscape seems most important for local, community interactions. Although we need to replicate these experiments at additional outliers with good community data, our work suggests that soundscape modeling may prove useful to land

FIGURE 11.11 (OVERLEAF, TOP). *Reach of a human shout emanating from Pierre’s great house A (LA 16509). Model and graphic by Tim De Smet.*

FIGURE 11.12 (OVERLEAF, BOTTOM). *Reach of a conch shell blast emanating from Pierre’s Great House A (LA 16509). Model and graphic by Tim De Smet.*



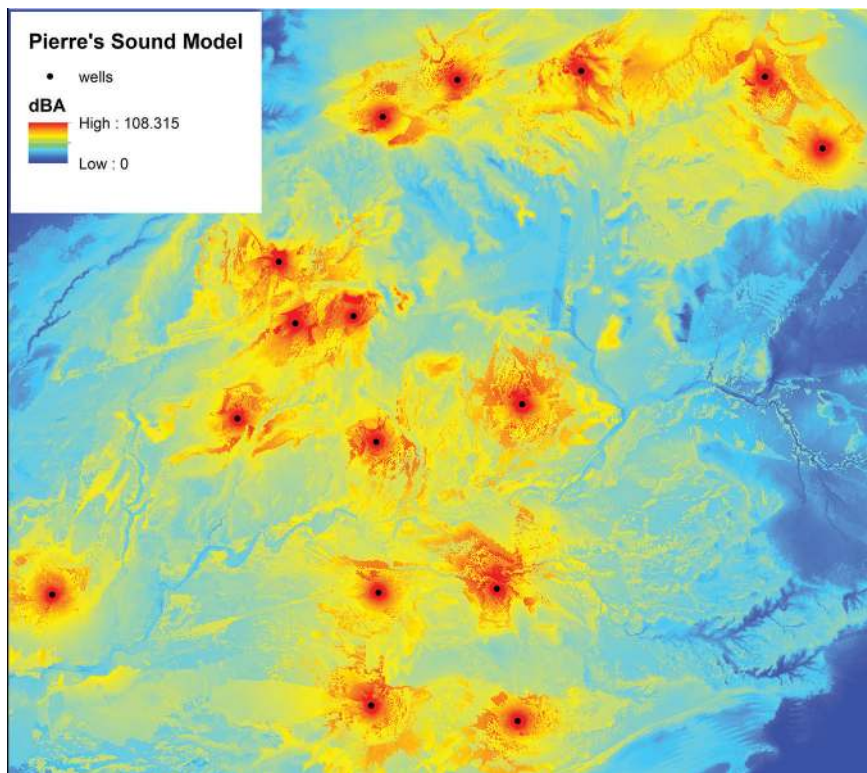


FIGURE 11.13. *Cumulative soundscape showing reach of noise from sixteen drill rigs in the Pierre's vicinity. Model and graphic by Tim De Smet.*

managers and archaeologists as a means with which to predict Chacoan community boundaries.

Noise from the surrounding drill rigs did not impact our ability to model the Pierre's soundscape, but it is always present at a low level, and it is affecting visitors' sensory experiences of this community. To measure this impact, De Smet obtained pumpjack sound decibel data from the BLM (2000). Following Primeau and Witt's (2018) procedures, De Smet modeled the extent of the noise emanating from sixteen pumpjacks located in the immediate area of the Pierre's community. This model demonstrates that between 40 dBA and 60 dBA reach most of the archaeological sites in the community (figure 11.13). For reference, 40 dBA is the ambient noise of a suburban area at night, and 60 dBA is normal conversational speech (Yale University 2018). By contrast, a natural area with no wind has an ambient decibel level of 20 dBA.

Clearly the pumpjacks are producing low-level background noise pollution that constitutes “cumulative effects” under NEPA and adds to visitor’s sense of walking through an industrial area.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Sense of place is a difficult concept to quantify. It will be different for different people. A sense of place incorporates aspects that archaeologists cannot study easily, such as meaning and memory. But in this study we hope to have shown that sensory experiences—what can be seen and what can be heard on an archaeological landscape—*can* be approached by archaeologists. Our comparison of viewscapes and soundscapes in the Bis sa’ani and Pierre’s communities has given us tantalizing ideas about interactions across the Chacoan world. Intervisibility was important for reaching beyond community boundaries and making connections to Chaco Canyon and other outliers, and the acoustic reach of a conch shell trumpet was one way that outlier communities were held together. Colleagues (e.g., B. Mills et al. 2018) are studying the “social networks” represented by moving objects, but connections also were made through sight and sound. We have the ability to study these connections, but only if we do not destroy the visual and acoustic landscapes in which they are embedded. While today’s landscape is not synonymous with the Chacoan past, neither is today’s potsherd synonymous with a Chacoan vessel. Like artifact analysts, phenomenological archaeologists take the fragments we can get, and we ask questions that we can answer. Phenomenological methods such as those we have demonstrated here, working in tandem with powerful GIS mapping and modeling programs, have tremendous untapped potential for Chacoan scholarship.

However, because these kinds of studies are relatively new in archaeology, we lack robust legislation to help landowners and agencies figure out how to evaluate, study, and mitigate potentially damaging effects from oil and gas drilling or other types of destructive development. The Pierre’s community is a poster child for what can go wrong when land managers do not assess the potential for indirect and cumulative adverse impacts to viewscapes and soundscapes. Despite efforts made by the Bureau of Land Management and the National Park Service to minimize the effects of mineral extraction on the Pierre’s community, the Pierre’s community today has the feeling of an industrial park.

We offer the following recommendations that would help prevent adverse effects across other areas of the greater Chaco landscape:

1. We cannot protect archaeological sites where we do not know about them. Site data availability and recording across the greater Chaco world are piecemeal at best. Thus, land managers should require comprehensive Class III survey across areas intended for leasing, and this survey should take place at a regional, not a local or piecemeal, scale. In other words, large-scale landscape archaeology is needed as part of a Master Leasing Plan in the greater San Juan Basin. Discrete site protection is not enough.
2. Archaeological surveys should include assessment of viewsapes and soundscapes. We have laid out here some simple and effective techniques for recording viewsapes and soundscapes in the field. These methods or similar should become part of every survey archaeologist's toolkit.
3. Land managers should use the available technology to create predictive models of potential adverse impacts. They could use ArcGIS modeling to delineate the extents of great house viewsapes. Similar, they could use our methods to predict the potential impacts of drill rigs on soundscapes. Land managers could then require mining companies to locate their machinery outside the potentially impacted areas. The areas covered by a drilling moratorium thus would vary based on the local situation at each great house—a blanket protection of 1–2 km, for example, is not sufficient, because every great house's topography and community configuration are different.
4. Where avoidance is not possible, land managers should require mineral extraction companies to camouflage equipment and to provide sound-dampening equipment to mitigate the noise.

In an era of rapidly advancing economic development on the Colorado Plateau, it is imperative for archaeologists to help government personnel and legislators develop good management strategies for the fragile and understudied aspects of the ancient sensory world.

Viewsapes and soundscapes are important dimensions of the ancient Chacoan landscape. If we are ever to understand a Chacoan sense of place, archaeologists need to continue to devise creative (yet rigorous and systematic!) methods for studying sensory experiences. And, we need to ensure that the visual and acoustic dimensions of Chacoan communities are protected, not only for our current study but to ensure that future generations of scholars and visitors will be able to experience the greater Chaco landscape.

ACKNOWLEDGMENTS

Our thanks to Paul Reed and Archaeology Southwest for the inspiration and the funding to carry out the digital viewscape studies in the Bis sa'ani and Pierre's communities. We thank Cory Breternitz for a site tour and for the accurate Bis sa'ani community site locations. We appreciate Carrie Heitman's feedback on an early draft of this paper. Jo Day's work in sensory archaeology has been an inspiration. De Smet carried out the sound modeling work in the Binghamton University Geospatial Remote Sensing/Environmental Visualization laboratory.

REFERENCES

- Basso, Keith H. 1996. *Wisdom Sits in Places: Landscape and Language among the Western Apache*. University of New Mexico Press, Albuquerque.
- Bernardini, Wesley, Alicia Barnash, Mark Kumler, and Martin Wong. 2013. "Quantifying Visual Prominence in Social Landscapes." *Journal of Archaeological Science* 40(2013):3946-3954.
- Bernardini, Wesley, and Matthew A. Peeples. 2015. "Sight Communities: The Social Significance of Shared Visual Landmarks." *American Antiquity* 80(2):215-235.
- Breternitz, Cory Dale, David E. Doyel, and Michael P. Marshall, eds. 1982. *Bis sa'ani: A Late Bonito Phase Community on Escavada Wash, Northwest New Mexico*. Navajo Nation Papers in Anthropology No. 14. 3 vols. Window Rock, AZ.
- Brown, Emily J. 2005. "Instruments of Power: Musical Performance in Rituals of the Ancestral Puebloans of the American Southwest." PhD dissertation, Graduate School of Arts and Sciences, Columbia University. ProQuest, Ann Arbor.
- Brück, Joanna. 2005. "Experiencing the Past? The Development of a Phenomenological Archaeology in British Prehistory." *Archaeological Dialogues* 12(1):45-72.
- Day, Jo, ed. 2013. *Making Senses of the Past: Toward a Sensory Archaeology*. Center for Archaeological Investigations, Southern Illinois University, Carbondale.
- Dungan, Katherine. 2009. "Visibility, Monumentality, and Community in the Chacoan Community at Kin Bineola, New Mexico." Unpublished MA thesis, Department of Anthropology, University of Arizona, Tucson.
- Dungan, Katherine A., Devin White, Sylvaine Déderix, Barbara J. Mills, and Kristin Safi. 2018. "A Total Viewshed Approach to Local Visibility in the Chaco World." *Antiquity* 92(364):905-921.
- Ellenberger, Katharine. 2012. "Scales of Visibility at a Chacoan Outlier: The Visual World of People at Kin Klizhin." Unpublished MA thesis, Department of Anthropology, Binghamton University, Binghamton, NY.

- Elliot, Ben, and Jon Hughes. 2014. "Sonic Horizons of the Mesolithic: Using Sound to Engage Wider Audiences with Early Holocene Research." *World Archaeology* 46(3):305–318.
- Frieman, Catherine, and Mark Gillings. 2007. "Seeing Is Perceiving?" *World Archaeology* 39(1):4–16.
- Hacıgüzeller, Piraye. 2012. "GIS: Critique, Representation, and Beyond." *Journal of Social Archaeology* 12(2):245–263.
- Hamilakis, Yannis. 2012. "Archaeologies of the Senses." *The Oxford Handbook of the Archaeology of Religion and Ritual*, edited by Timothy Insoll, 208–225. Oxford, Oxford.
- Hamilton, Sue, and Ruth Whitehouse. 2006. "Phenomenology in Practice: Towards a Methodology for a 'Subjective' Approach." *European Journal of Archaeology* 9(1):31–71.
- Harper, Randy, and Marilyn K. Swift, Barbara J. Mills, James Brandi, and Joseph C. Winter. 1988. *The Casamero and Pierre's Outliers Survey: An Archaeological Class III Inventory of the BLM Lands Surrounding the Outliers*. Office of Contract Archeology, University of New Mexico, Albuquerque.
- Kantner, John, and Ronald Hobgood. 2003. "Digital Technologies and Prehistoric Landscapes in the American Southwest." In *The Reconstruction of Archaeological Landscapes through Digital Technologies*, edited by Maurizio Forte, P. Ryan Williams, and James Wiseman, 117–123. Archaeopress, Oxford.
- Lekson, Stephen H. 2015. *The Chaco Meridian: One Thousand Years of Political and Religious Power in the Ancient Southwest*. 2nd ed. Rowan and Littlefield, New York.
- Llobera, Marcos. 2007. "Reconstructing Visual Landscapes." *World Archaeology* 39(1):51–69.
- Loose, Richard W. 2008. "Tse' Biinaholts'a Yalti (Curved Rock That Speaks)." *Time and Mind: Journal of Archaeology, Consciousness, and Culture* 1(1):31–50.
- Loose, Richard W. 2010. "Archaeoacoustics: Adding a Soundtrack to Site Descriptions." In *Threads, Tints, and Edification, Papers in Honor of Glenna Dean*, edited by E. J. Brown, K. Armstrong, D. M. Brugge and C. J. Condie, 127–136. Papers of the Archaeological Society of New Mexico 36, Albuquerque.
- Loose, Richard W. 2012. "That Old Music: Reproduction of a Shell Trumpet from Pueblo Bonito." In *Glen Canyon, Legislative Struggles, and Contract Archaeology: Papers in Honor of Carol J. Condie*, edited by E. J. Brown, C. J. Condie, and H. K. Crotty, 127–133. Papers of the Archaeological Society of New Mexico 38, Albuquerque.
- Malville, J. McKim, ed. 2004. *Chimney Rock: The Ultimate Outlier*. Lexington Books, Lanham, MD.

- Marshall, Michael P. 1997. "The Chacoan Roads: A Cosmological Interpretation." In *Anasazi Architecture and American Design*, edited by B. H. Morrow and V. B. Price, 62–74. University of New Mexico Press, Albuquerque.
- Marshall, Michael P., and Anna Sofaer. 1988. "Solstice Project Investigations in the Chaco District 1984 and 1985: The Technical Report." Manuscript on file, Laboratory of Anthropology, Santa Fe, NM.
- Miller, Nicholas P. 2008. "U.S. National Parks and Management of Park Soundscapes: A Review." *Applied Acoustics* 69(2):77–92.
- Mills, Barbara J., and T. J. Ferguson. 2008. "Animate Objects: Shell Trumpets and Ritual Networks in the Greater Southwest." *Journal of Archaeological Method and Theory* 15(4):338–361.
- Mills, Barbara J., Matthew A. Peeples, Leslie D. Aragon, Benjamin A. Bellorado, Jeffery J. Clark, Evan Giomi, and Thomas C. Windes. 2018. "Evaluating Chacoan Migration Scenarios Using Dynamic Social Network Analysis." *Antiquity* 92(364):922–939.
- Mills, Steve. 2014. *Auditory Archaeology: Understanding Sound and Hearing in the Past*. Left Coast Press, Walnut Creek, CA.
- Mlekuz, Dmitrij. 2004. "Listening to Landscapes: Modelling Past Soundscapes in GIS." *Internet Archaeology* 16. <http://dx.doi.org/10.11141/ia.16.6>.
- Parsons, Elsie Clewes. 1939. *Pueblo Indian Religion*. University of Chicago Press, Chicago.
- Powers, Robert P., William B. Gillespie, and Stephen H. Lekson. 1983. *The Outlier Survey: A Regional View of Settlement in the San Juan Basin*. Reports of the Chaco Center 3. US Department of the Interior, National Park Service, Albuquerque.
- Primeau, Kristy E., and David E. Witt. 2018. "Soundscapes in the Past: Investigating Sound at the Landscape Level." *Journal of Archaeological Science: Reports* 19 (October): 875–885.
- Scarre, Chris, and Graeme Lawson, eds. 2006. *Archaeoacoustics*. McDonald Institute for Archaeological Research, University of Cambridge, Cambridge, UK.
- Schofield, John. 2014. "The Archaeology of Sound and Music." *World Archaeology* 46(3):289–291.
- Scullin, Dianne. 2019. "Mapping Sound: Creating a Static Soundscape." In *Re-Mapping Archaeology: Critical Perspectives, Alternative Mappings*, edited by Mark Gillings, Piraye Hacıgüzeller, and Gary Lock. Routledge, London and New York.
- Sofaer, Anna. 2007. *Chaco Astronomy: An Ancient American Cosmology*. Ocean Tree Books, Santa Fe.
- Stein, John R. 1983. "Road Corridor Descriptions." Chapter 8 in *Chaco Roads Project, Phase I: A Reappraisal of Prehistoric Roads in the San Juan Basin*, edited by Chris Kincaid, 8-1–8-15. Bureau of Land Management, Albuquerque.

- Stein, John R., Richard Friedman, Taft Blackhorse, and Richard Loose. 2007. "Revisiting Downtown Chaco." In *The Architecture of Chaco Canyon, New Mexico*, edited by Stephen H. Lekson, 199–224. University of Utah Press, Salt Lake City.
- Till, Rupert. 2014. "Sound Archaeology: Terminology, Paleolithic Cave Art and the Soundscape." *World Archaeology* 46(3):292–304.
- Truax, Barry. 1999. *Handbook of Acoustic Ecology*. Street Publishing, Cambridge.
- Van Dyke, Ruth M. 2007. *The Chaco Experience: Landscape and Ideology at the Center Place*. School of Advanced Research Press, Santa Fe, NM.
- Van Dyke, Ruth M. 2013. "Ritual, Timelessness, and Experience in the Pueblo World." In *Big Histories, Human Lives: Tackling Problems of Scale in Archaeology*, edited by John Robb and Timothy Pauketat, 193–206. School of Advanced Research Press, Santa Fe, NM.
- Van Dyke, Ruth M., R. Kyle Bocinsky, Thomas C. Windes, and Tucker J. Robinson. 2016. "Great Houses, Shrines, and High Places: A GIS Viewshed Analysis of the Chacoan World." *American Antiquity* 81(2):205–230.
- Villanueva-Rivera, Luis J., Bryan C. Pijanowski, Jarrod Doucette, and Burak Pekin. 2011. "A Primer of Acoustic Analysis for Landscape Ecologists." *Landscape Ecology* 26(9):1233–1246.
- Vokes, Arthur W., and David A. Gregory. 2007. "Exchange Networks for Exotic Goods in the Southwest and Zuni's Place in Them." In *Zuni Origins: Toward a New Synthesis of Southwestern Archaeology*, edited by David A. Gregory and David R. Wilcox, 318–357. University of Arizona Press, Tucson.
- Weiner, Robert S. 2015. "A Sensory Approach to Exotica, Ritual Practice, and Cosmology at Chaco Canyon." *Kiva* 81(3–4):220–246.
- Wheatley, David. 1995. "Cumulative Viewshed Analysis: A GIS-Based Method for Investigating Intervisibility, and Its Archaeological Application." In *Archaeology and Geographic Information Systems: A European Perspective*, edited by Gary R. Lock and Zoran Stančić, 171–186. Taylor and Francis, London.
- Wheatley, David, and Mark Gillings. 2002. *Spatial Technology and Archaeology: The Archaeological Applications of GIS*. Taylor and Francis, London.
- Yale University. 2018. "Decibel Level Comparison Chart." *Environmental Health and Safety*. <https://ehs.yale.edu/sites/default/files/files/decibel-level-chart.pdf>.