IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

The Wilderness Society, *et al*.,	)
Plaintiffs,	) Civil Action No. 1:17-cv-02587 (TSC)
v.	)
Donald J. Trump, *et al*.,	)
Defendants.	)
Grand Staircase Escalante Partners, *et al*.,	)
Plaintiffs,	) Civil Action No. 1:17-cv-2591 (TSC)
v.	)
Donald J. Trump, *et al*.,	)
	) CONSOLIDATED CASES
Defendants.	)

ARCHAEOLOGICAL ORGANIZATIONS' BRIEF AS *AMICI CURIAE*
IN SUPPORT OF PLAINTIFFS

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The American Anthropological Association is a nonprofit, tax-exempt organization incorporated in the District of Columbia. The American Anthropological Association has no parent corporation and, as it has no stock, no publicly held company owns 10% or more of its stock.

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RULE 29(a)(4)(E) STATEMENT

No party's counsel authored this brief in whole or in part. No party or its counsel contributed money that was intended to fund preparing or submitting this brief. No person other than *amici curiae*, including their members and counsel, contributed money that was intended to fund preparing or submitting this brief.

s/ *Nicholas A. DiMascio*
NICHOLAS A. DIMASCIO

INTRODUCTION

The American Anthropological Association ("AAA"), Archaeological Institute of America ("AIA"), and the Society for American Archaeology ("SAA" and, collectively, the "Archaeological Organizations") submit this brief as *amici curiae* in support of Plaintiffs. The President's recent proclamations ("New Proclamations") do not merely modify the boundaries of Grand Staircase-Escalante National Monument ("Grand Staircase"), 82 Fed. Reg. 58,089 (Dec. 4, 2017) and Bears Ears National Monument ("Bears Ears"), 82 Fed. Reg. 58,081 (Dec. 4, 2017). Rather, to facilitate mining, off-road vehicle use, and other surface-disturbing activities, the New Proclamations entirely rescind monument protections for numerous archaeological objects identified in the original proclamations ("Original Proclamations"). Grand Staircase, 61 Fed. Reg. 50,223 (Sept. 24, 1996); Bears Ears, 82 Fed. Reg. 1139 (Jan. 5, 2017). The Antiquities Act—a statute intended to ensure the preservation of archaeological resources and their surrounding context for scientific study—provides the President with no authority to rescind the protection of those objects and lands. As explained below, this Court should declare the President's New Proclamations to be *ultra vires* and thereby ensure the preservation and discovery of the record of human history that exists only within the Monuments as originally designated.

INTERESTS OF *AMICI*

The Archaeological Organizations collectively represent over 200,000 members in educational institutions, museums, government agencies, and the private sector in the United States and abroad. As the oldest professional archaeological and anthropological organizations in the United States, *amici* were instrumental in the drafting and passage of the Antiquities Act and other federal laws to protect archaeological resources.[1] The Organizations agree with Plaintiffs that, under the Antiquities Act, archaeological objects designated for protection within a national monument cannot lose those protections absent congressional action. The Organizations further agree that other federal laws, such as the Archaeological Resources Protection Act of 1979 ("ARPA") and the National Historic Preservation Act ("NHPA"), do not ensure that archaeological resources and their surrounding context are preserved for scientific study, as does the Antiquities Act. The President's New Proclamations open up vast tracts of land that formerly were part of the Monuments to mining, off-road vehicle use, and other activities that greatly increase the risk that archaeological resources and their contexts will be forever damaged or destroyed. The Organizations therefore request that the Court grant Plaintiffs' request to declare the New Proclamations *ultra vires* and restore the protection of the Antiquities Act to all archaeological resources within the original boundaries of the Monuments.

ARCHAEOLOGICAL BACKGROUND OF THE MONUMENTS

A. Grand Staircase-Escalante National Monument

1. Effect of Original Proclamation and Monument Management Regime

Grand Staircase was "the last place in the continental United States to be mapped" and previously encompassed 1,880,461 acres of land in Southern Utah.[2] Given its unique historical,

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[1] Ronald F. Lee, *The Antiquities Act of 1906*, Chp. 6 "The Third Round" (2001 Electronic Ed.) (chronicling AAA and AIA's efforts, together with the Smithsonian Institution, to draft and obtain passage of the Antiquities Act), https://www.nps.gov/archeology/pubs/lee/Lee_FPM.htm; Robert B. Collins & Mark P. Michel, *Preserving the Past: Origins of the Archaeological Resources Protection Act of 1979*, American Archaeology, Vol. 5, No. 2, 87-89 (1985) (recounting SAA's efforts to obtain passage of the Archaeological Resources Protection Act).

[2] U.S. Bureau of Land Management, Grand Staircase-Escalante National Monument Manager's Annual Report 2, 57 (2016), https://www.blm.gov/sites/blm.gov/files/documents/files/GSENM_Annual_Managers%20Report.pdf.

geological, paleontological, and archaeological importance, Grand Staircase was the first national monument to be managed by the Bureau of Land Management ("BLM"), as opposed to the National Park Service.[3] As recounted in the Original Proclamation, ancient Native American cultures made "extensive use of places within the monument," creating a "significant opportunity for archaeological study." 61 Fed. Reg. at 50,224. It is difficult to overstate the archaeological significance of Grand Staircase. As one BLM archaeologist put it: "What is special is the *wholeness* of the archaeological record on the monument and our ability to study it in its natural setting."[4]

Most of what was known about the area before the Original Proclamation derived from research conducted between 1920 through 1960.[5] Compilations of this research indicate that ancient peoples occupied the area for over 11,000 years, consisting of archaic hunter-gatherers in the early years to the Ancestral Puebloans and Fremont people in later years.[6] Historic resources associated with the Paiute, Ute, Hopi, Zuni, and Navajo also are prevalent within Grand Staircase.[7] Certain studies date early habitation of the Grand Staircase area to as early as A.D.

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[3] U.S. BLM, *Grand Staircase-Escalante National Monument Approved Management Plan and Record of Decision* ("Monument Management Plan"), at vi (effective Feb. 2000), https://eplanning.blm.gov/epl-front-office/projects/lup/65870/79803/92581/GSENM_MP.pdf.

[4] Doug McFadden, *Grand Staircase-Escalante*, 15 Archaeology Southwest 2, 2 (Winter 2001) (emphasis in original), http://archive.li.suu.edu/docs/ms130/AR/mcfadden.pdf.

[5] David B. Madsen, *A Preliminary Assessment of Archaeological Resources Within the Grand Staircase-Escalante National Monument*, Utah Geological Survey Circular 95, at 6-7 (1997), https://ugspub.nr.utah.gov/publications/circular/C-95.pdf.

[6] William B. Fawcett & William R Latady, *Investigating Human Land Use Within the Grand Staircase-Escalante National Monument: The Roles of Archaeological Surveys*, *in* Learning from the Land: Grand Staircase-Escalante National Monument Science Symposium Proceedings, at 43-49 (1997), https://play.google.com/books/reader?id=TollFKJhVdoC&pg=GBS.PA1925.

[7] Monument Management Plan, *supra* note 3, at 66.

700,[8] and Grand Staircase holds the oldest evidence of human habitation on the Colorado Plateau.[9]

Using ceramics, sites, architecture, and other resources found within Grand Staircase, archaeologists have been able to build upon earlier research to better understand the contact and interaction between the Monument's early inhabitants, including the Fremont and Central Puebloan cultures.[10] Historic sites identified within the area, while receiving only limited study over the last century, include quarries, lithic scatters, camps, structures, rock shelters, and visually impressive masonry village sites.[11] Additionally, rock art and petroglyphs in the area are rich, extensive, and in many places undisturbed.[12]

At the time of Grand Staircase's designation as a monument, hundreds of sites, including "rock art panels, occupation sites, campsites and granaries" had been recorded. 61 Fed. Reg. at 50,224. In addition to recorded sites, the Original Proclamation expressly recognized that "[m]any more undocumented sites . . . exist within the monument [and] are of significant scientific and historic value worthy of preservation for future study." *Id.* To protect those

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[8] Joel C. Janetski & Richard K Talbot, *Learning to Preserve and Preserving to Learn, A Case Study in Grand Staircase National Monument Archaeological Research*, *in* Learning from the Land, *supra* note 6, at 72.

[9] Joel C. Janetski, et al., *Deep Human History in Escalante Valley and Southern Utah*, 79 Utah Historical Quarterly 204, 205 (2011), https://anthropology.byu.edu/SiteAssets/Pages/Faculty/joeljanetski/Janetski%20et%20al.%20NCS%20Utah%20Hist%20Quart%202011.pdf.

[10] Florence C. Lister, *Kaiparowitz Plataeu and Glen Canyon Prehistory: An Interpretation Based on Ceramics*, 71 U. Utah Anthropological Papers, Glen Canyon Series No. 23, at 1, 1-2, 76 (July 1964).

[11] Madsen, *supra* note 5, at 3-5.

[12] Phil R. Geib & Helen C. Fairly, *Archaeological Research in the New Monument: Lessons from Glen Canyon*, *in* Learning from the Land, *supra* note 6, at 62.

resources, the Original Proclamation withdrew lands within Grand Staircase from entry, sale, leasing, or other disposition (subject to valid existing rights) and instructed BLM to create a management plan that "furthers the protective purposes of the monument." *Id.* at 50,225.

BLM subsequently issued a management plan emphasizing that the Monument was "created to protect a spectacular array of historic, biological, geological, paleontological, and archaeological objects" and that "[a]ll other considerations are secondary to that edict."[13] The plan further recognized that "[s]afeguarding the remote and undeveloped frontier character of the Monument is essential to the protection of the scientific and historic resources as required by the Proclamation."[14] Consequently, under the plan, BLM stated that it would protect archaeological resources in their original context, could deny proposed development activities that threaten adverse impacts to such resources, and would permit excavation or curation of archaeological resources due to surface-disturbing activities only "*as a last resort*."[15]

According to BLM staff, Grand Staircase's designation as a monument led to "increased funding and greater research opportunities," which in turn dramatically increased the number of cultural resources surveys performed and the number of archaeological sites recorded.[16] By March 6, 2017, the number of archaeological sites within Grand Staircase officially recorded by the Utah State Historic Preservation Office had grown from 358 to 3,985.[17] BLM staff estimate

[13] Monument Management Plan, *supra* note 3, at 3.

[14] *Id.* at 5.

[15] *Id.* at 10-11, 52, 84 (emphasis added).

[16] Ex. 1, U.S. BLM, Call for Data Related to Review of National Monuments under EO 13792 at 11-12, 15 (Apr. 26, 2017).

[17] *Id.* at 7.

that there were, in fact, "more likely around 6,000 recorded archaeological sites within the [Monument], due to a records backlog. This is with only five to seven percent of the Monument surveyed."[18] More research of archaeological resources in the area likely would produce more evidence of the lives of early inhabitants, with some studies estimating that there could be over 100,000 prehistoric sites with archaeological significance located within Grand Staircase.[19]

2. Effect of New Proclamation

Despite Grand Staircase's unique importance, the President's New Proclamation revokes monument protections for numerous recorded and unrecorded archaeological resources and surrounding lands, purportedly because they are not "of any unique or distinctive scientific or historic significance" and are protected by other federal laws, such as ARPA and the NHPA. 82 Fed. Reg. at 58,090. The New Proclamation reduces the size of Grand Staircase by nearly half and reopens the excluded lands to entry, sale, or other disposition under the mineral laws. *Id.* at 58,093-94. The New Proclamation also instructs BLM to create a new management plan for Grand Staircase and permits BLM to authorize motor-vehicle use on roads that preexisted creation of the Monument. *Id.* at 58,094.

Of the approximately 4,000 recorded archaeological and historic sites previously included within Grand Staircase, the New Proclamation removes protection for 1,915, or approximately half. Ex. 2, Spangler Decl. ¶ 6. Of those removed sites, 1,286 are eligible for listing on the National Register of Historic Places. *Id.* The removed sites relate to the earliest humans in the American West at the end of the last Ice Age (3 sites), Archaic hunters and gatherers who occupied the region for 7,000 years (271 sites), the ancient farmers who

[18] *Id.*

[19] *See* Madsen, *supra* note 5, at 5.

constructed villages and granaries (534 sites), Ancestral Paiute peoples (40 sites), and historic ranchers and miners (127 sites). *Id.* ¶ 7.

Moreover, the New Proclamation excludes from protection five areas previously within Grand Staircase that are likely to contain numerous unrecorded archaeological sites:

1. The Lampstand, an area renowned for its abundance of Ancestral Puebloan villages;
2. The Hole-in-the-Rock Road, an iconic transportation route of tremendous spiritual significance to members of the Church of Latter Day Saints;
3. The Little Valley area south of the modern community of Escalante that has a high density of documented Archaic and Fremont Culture sites;
4. The area southeast of Bryce Canyon National Park where previous research has documented near-continuous human occupations over 10 millennia; and
5. The Vermilion Cliffs/Kitchen Corral Canyon area east of Kanab, which has one of the highest concentrations of Ancestral Puebloan villages, farmsteads, granaries, and rock art sites yet to be documented on the northern Colorado Plateau.

Id. ¶ 9. Existing inventory data suggest that site density in those areas could be as high as 60 to 80 sites per square mile. *Id.*

Those sites excluded from Grand Staircase, if properly protected, could help researchers understand human responses to shifting food sources and changing climates and answer unresolved questions concerning the relationship between the Fremont people and later-arriving Kayenta immigrants, as well as the reasons for the area's abandonment by Ancestral Puebloans in AD 1250. *Id.* ¶¶ 10-15. Removal of the sites from Grand Staircase greatly increases the probability that mining, transportation infrastructure, motor-vehicle use, vandalism, and looting will degrade or destroy important archaeological resources. *Id.* ¶¶ 16-20. Damage to the resources compromises a "wealth of important scientific data that, when studied in proper context, can reveal keen insights to past human behavior." *Id.* ¶ 21. Because archaeological resources are nonrenewable resources, such damage "cannot be reversed." *Id.*

B. Bears Ears National Monument

Like Grand Staircase, Bears Ears is filled with "an extraordinary archaeological and cultural record." 82 Fed. Reg. at 1,139. A proposal from the Hopi, Navajo, Uintah and Ouray Ute, Ute Mountain Ute, and Zuni Tribes spurred designation of the Monument by, among other things, urging the President to "protect historical and scientific objects . . . of ancestral land."[20] As originally designated, Bears Ears encompassed just over 1.3 million acres, and the area constitutes one of the "densest and most significant cultural landscapes in the United States." 82 Fed. Reg. at 1,139. Bears Ears is home to "abundant rock art, dwellings, ceremonial sites, granaries, and many other cultural resources reflecting its historical and cultural significance to a variety of Native American peoples."[21]

Research within Bears Ears has confirmed the archaeological importance of the area. Bear Ears contains a "mosaic of human prehistory that includes populations articulating differently with different landforms depending upon time, ecology, and climate."[22] Presently,

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[20] Bears Ears Inter-Tribal Coalition, *Proposal to President Barack Obama for the Creation of Bears Ears National Monument*, 1 (Oct. 15, 2015), http://www.bearsearscoalition.org/wp-content/uploads/2015/10/Bears-Ears-Inter-Tribal-Coalition-Proposal-10-15-15.pdf.

[21] U.S. Forest Service and U.S. BLM, *Bears Ears National Monument: Questions and Answers*, https://www.fs.fed.us/sites/default/files/bear-ears-fact-sheet.pdf (last visited Oct. 25, 2018).

[22] R.E. Burrillo, *The Archaeology of Bears Ears*, 17 SAA Archaeological Rec. 12-13 (Nov. 2017), http://www.saa.org/Portals/0/Record_Nov_2017%20SAAweb.pdf.

"there are about 9,000 recorded archaeological sites within the monument boundary," with only about 5% to 7% of the area inventoried.[23] In another report, stemming from a two-day working group of over 60 professional archaeologists with expertise in the Utah area, it was estimated that "no more than 10 percent of Bears Ears has been surveyed" and "at least 100,000 sites [within Bears Ears] is a very reasonable minimum estimate for the entire monument."[24] Those identified and potential sites consist not only of important archaeological artifacts and resources like potsherds, petroglyphs, textiles, human remains, and grinding stones, but also include cliff dwellings, kivas, great houses, room blocks, and ancient roads.[25]

One area that the New Proclamation has stripped away from the Bears Ears landscape is the Greater Cedar Mesa area, known to archaeologists as having "one of the most significant concentrations of archaeological sites in the nation."[26] In a comprehensive analysis of the Cedar Mesa area, three preeminent archaeologists outlined damage to some of the archaeological resources in the area from looting, vandalism, road construction, a proliferation of off-road vehicle use, and generations of livestock grazing.[27] The report concludes that the "scientific value of archaeology here . . . is contingent upon the preservation of cultural deposits in

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[23] *Id.* at 9, 16, 17.

[24] William H. Doelle, *Bears Ears: Archaeological Experts Gathering Report*, 3, 4 (2017), https://www.archaeologysouthwest.org/pdf/Bears_Ears_Report.pdf.

[25] Hannah Nordhaus, *What Trump's Shrinking of National Monuments Actually Means*, Nat. Geo. (Feb. 2, 2018), https://news.nationalgeographic.com/2017/12/trump-shrinks-bears-ears-grand-staircase-escalante-national-monuments/.

[26] Jerry D. Spangler, Andrew T. Yentsch, & Rachelle Green, *Farming and Foraging on the Southwest Frontier: An Overview of Previous Research of the Archaeological and Historical Resources of the Greater Cedar Mesa Area*, Vol. IX Antiquities Section Selected Papers No: 18, at 200 (Feb. 2010).

[27] *Id.* at 189-90.

relatively undisturbed condition."[28] The inclusion of this area within the Monument's original boundaries accomplished that goal. The President's New Proclamation strips away this protection, opening the area to the very activities that threaten the remaining intact resources. Cedar Mesa is just one example of the many areas within the Monument's original boundaries that is at risk of destruction and degradation without monument protections. *See* Pls.' Compl. ¶¶ 168, 174-75, *Utah Diné Bikéyah, et al. v. Trump, et al.*, No. 1:17-cv-02605 (D.D.C. Dec. 6, 2017), ECF No. 1 (detailing areas that the President's New Proclamation has removed from Bears Ears).

Like Grand Staircase, the designation of Bears Ears as a national monument had the potential to increase archaeological research and discovery throughout all portions of the Monument's original boundaries. Despite that important potential for scientific exploration and discovery, the President's New Proclamation has reduced Bears Ears to just 16% of its original size and has reopened the excluded lands to mining, off-road vehicle use, and other activities that threaten the integrity of archaeological objects and their surrounding context. 82 Fed. Reg. at 58,085-86. The President's New Proclamation has removed monument protections for numerous recorded and unrecorded archaeological resources identified in the Original Proclamation, thereby increasing the risk that those objects will be forever damaged or destroyed. Pls.' Compl. ¶¶ 168, 174-76, *Utah Diné Bikéyah, et al. v. Trump, et al.*, No. 1:17-cv-02605, (D.D.C. Dec. 6, 2017), ECF No. 1.

The Archaeological Organizations agree with Plaintiffs that approximately 73% of the documented archaeological sites found within the original boundaries of Bears Ears are removed by the President's New Proclamation. *Id.* ¶ 175. As Plaintiffs explain, opening up these

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[28] *Id.* at 200.

previously protected areas will lead to reduced legal protection and increased surface-disturbing activities like mining, oil and gas development, off-road vehicle use, and road building that will destroy archaeological resources. *Id.* ¶¶ 177-183. Furthermore, the areas excluded from Bears Ears will no longer be subject to BLM policies requiring cultural-resource surveys, despite the fact that only 10 percent of the area has been surveyed. *Id.* ¶ 188. Ultimately, these "incompatible uses will result in the destruction and degradation of irreplaceable" archaeological resources that the Original Proclamation aimed to protect. *Id.* ¶ 176.

ARGUMENT

I. The President lacks the authority to excise previously protected objects and their surrounding context from the Monuments.

The Archaeological Organizations agree with Plaintiffs that the text, structure, purpose, and history of the Antiquities Act all indicate that the President lacks the authority to rescind the prior designation of the Monuments. The overriding purpose of the Antiquities Act is to "identify and protect important scientific and historic objects and to set aside the necessary surrounding land to insure their continued protection." *Utah Ass'n of Ctys. v. Bush*, 316 F. Supp. 2d 1172, 1192 (D. Utah 2004); *see also Cameron v. United States*, 252 U.S. 450, 455-56 (1920) (upholding original designation of the Grand Canyon as a national monument because it is an "object of unusual scientific interest" that "affords an unexampled field for geologic study"). Revoking monument protections from previously designated archaeological objects is antithetical to that preservationist purpose and the specific goal of protecting archaeological sites for scientific research. Because the Antiquities Act gives the President the authority only to declare—not to rescind—a monument, the New Proclamations are beyond the President's power.

The key motivation for enacting the Antiquities Act was the preservation of archaeological sites.[29] In fact, the Antiquities Act has been described as "the nation's first archaeological preservation law."[30] Growing public interest in the history and archaeology of the Southwest in the late nineteenth and early twentieth centuries led to an avid demand for authentic artifacts.[31] As a result, the AIA, which had initiated explorations in the American Southwest in 1880, became concerned about vandalism of archaeological sites and historic structures. The AIA and the American Association for the Advancement of Science therefore formed a committee in 1899 to draft a bill to protect archaeological and historical objects.[32]

In advocating for the Act's passage, however, archaeologists were not merely concerned with the preservation of isolated structures or objects. Archaeologists were greatly concerned about the impacts that "indiscriminate digging" and vandalism were having on the integrity of archaeological sites in the Southwest.[33] "Pot-hunting" and other forms of amateur excavation were damaging site context and consequently causing an irretrievable loss of scientific knowledge concerning ancient cultures and history.[34] As preeminent archaeologist T. Mitchell Prudden summarized in an article published shortly before the Act's passage:

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[29] Mark Squillace, The Monumental Legacy of the Antiquities Act of 1906, 37 Ga. L. Rev. 473, 478-81 (2003).

[30] Raymond Harris Thompson, "An Old and Reliable Authority": Introduction, 42 J. of the Southwest 191, 191 (2000).

[31] Lee, *supra* note 1, Chp. 4 "Vandalism and Commercialism of Antiquities, 1890-1906."

[32] *Id.*, Chp. 6 "The Antiquities Act 1900-1906."

[33] *Id.*, Chp. 4 "Vandalism and Commercialism of Antiquities, 1890-1906."

[34] *Id.*; *see also* Brian I. Daniels, "A History of Antiquities Ownership in the United States, 1870-1934," (Ph.D. diss., University of Pennsylvania, 2012), 84-91 (summarizing the role of AIA and other professional archaeologists in raising public awareness about "pot hunting" and archaeological site destruction).

> In the early days, before the problems connected with these ruins had become clear and definite, the simple collection of pottery and other utensils was natural and not without justification. But it is now evident that to gather or exhume specimens—even though these be destined to grace a World's Fair or a noted museum—without at the same time carefully, systematically, and completely studying the ruins from which they are derived, with full records, measurements, and photographs, is to risk the permanent loss of much valuable data and to sacrifice science for the sake of plunder.[35]

Prudden's hope, which the larger archaeological community shared and ultimately pursued, was that Congress would enact legislation to "protect these relics of a most instructive phase" of prehistory and create a system for "authorized and intelligent research" of archaeological resources situated on the public lands.[36] The Antiquities Act's subsequent passage fulfilled that hope by providing the President with the authority to declare as national monuments "objects of historic or scientific interest" *and* to reserve "parcels of land as part of the national monuments." 54 U.S.C. § 320301(a)-(b). Thus, under the plain text of the Act, the objects and the surrounding reserved land *together* comprise a monument.

Preservation of objects and their associated context together is essential to scientific study of the archaeological record. "Context is extremely important to the archaeologist; . . . artifacts are only of scientific value when their context is known."[37] The archaeological significance of an object "depends on many associations, including the stratigraphic layers in which the artifact

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[35] T. Mitchell Prudden, *The Prehistoric Ruins of the San Juan Watershed in Utah, Arizona, Colorado, and New Mexico*, American Anthropologist, Vol. 5, No. 2 at 288 (1903), https://www.jstor.org/stable/pdf/659054.pdf?refreqid=excelsior%3A896b41eb1250bb8f8e26e798e3f6b3bf.

[36] *Id.*

[37] Catherine Sease, *Conservation and the Antiquities Trade: The Importance of Archaeological Context*, 37 J. American Inst. For Conservation 49, 53 (1997), http://cool.conservation-us.org/jaic/articles/jaic36-01-004.html; *see also Colin Renfrew & Paul Bahn, Archaeology Essentials: Theories, Methods, Practice* 42, 63 (3d. ed. 2015) ("In order to reconstruct past human activity at a site it is crucially important to understand the context of a find.").

was found, its position in the ground, its relationship to other artifacts, and traces of material found with it."[38] Through careful study of site context, an archaeologist may learn "not only about [particular objects'] function within a past society, including how and why they were made and used, but about broader issues, such as ancient economy, trade, or religion."[39]

"Artistic and utilitarian objects, faunal and floral remains, architectural features, human remains, and their original contextual relationship to each other are all equally essential in achieving an optimal understanding of the past. This full body of contextualized information is a destructible, nonrenewable cultural resource. Once it is destroyed, it cannot be regained."[40] Thus, archaeologists aim to secure "the most complete record possible, not only of those details which are of interest to the collector, but of the entire geographic and human environment."[41] An archaeologist's central axiom is that "it is not what you find, but how you find it."[42]

Archaeologists and anthropologists do not focus on individual sites in isolation, but rather study groups of sites within their cultural landscapes. Since the nineteenth century, archaeologists working in tandem with indigenous communities have recognized the value of cultural landscapes—"networks of natural and constructed places perceived and made

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[38] Sease, *supra* note 37, at 53; *see also* Barbara J. Mills & Rafael Vega-Centeno, *Sequence and Stratigraphy*, *in* Handbook of Archaeological Methods 176-215 (Herbert D.G. Maschner & Christopher Chippindale eds., 2005).

[39] Sease, *supra* note 37, at 53.

[40] Patty Gerstenblith, Controlling the International Market in Antiquities: Reducing the Harm, Preserving the Past, 8 Chicago J. Int'l L. 169, 170-72 (2007).

[41] Walter W. Taylor, *A Study of Archaeology*, 50 American Anthropologist No. 3, Pt. 2 at 154 (July 1948) (No. 69 of the Titles in the Memoir Series of the American Anthropological Association).

[42] *Id.*; *see also id.* at 90-91 (explaining that an "analysis of the culture-environment relationship . . . is an imperative requirement for every archaeological report").

meaningful by particular human communities"—in defining personal and social identities.[43] These landscapes, preserved by the designation of a broadly defined monument, are as critical to archaeological meaning as singular built structures.

The Original Proclamations appropriately recognized the scientific, historical, and cultural values of the landscapes originally included within the Monuments. The very first sentence of the Original Proclamation for Grand Staircase explains that the Monument's "vast and austere landscape embraces a spectacular array of scientific and historic resources." 61 Fed. Reg. at 50,233. The term "landscape" appears a dozen times in the Original Proclamation for Bears Ears. 82 Fed. Reg. at 1139-43. Those landscapes *are* the "landmarks" or "objects of historic or scientific interest" to be protected under the Antiquities Act. 54 U.S.C. § 320301(a).

Despite the high density of identifiable sites in the original Monuments, the New Proclamations instead focus on individual sites, obscuring the significance of the broader landscape within each Monument as a site in its own right. The New Proclamations reduce the Monuments from complete cultural landscapes to a series of separate and disconnected objects. In fact, the New Proclamations go so far as to physically divide the Monuments into "non-contiguous parcels of land." 82 Fed. Reg. at 58,083; *see* also Spangler Decl. Attach. C. Those acts fundamentally altered the nature of the Monuments. Maintaining some sites within the new Monuments does not compensate for excluding other sites and fragmenting their associated cultural landscapes, which are now at much greater risk of damage or destruction.

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[43] Severin Fowles, The Southwest School of Landscape Archaeology, 39 Annual Review of Anthropology 453, 455 (2010). Fowles reviews the development of landscape archaeology in the American southwest, arguing that a "rigorous investigation of past landscapes must also seek to understand the way in which they were perceived and experienced on the ground by culturally situated individuals." *Id.* at 458-59. The major landmark studies on southwest landscapes remain Alfonso Ortiz, The Tewa World (1969), and Keith Basso, Wisdom Sites in Places: Landscape and Language among the Western Apache (1996).

Thus, seen through an archaeological lens, the New Proclamations do not merely "modify" the boundaries of the Monuments. 82 Fed. Reg. at 58,093; 82 Fed. Reg. 58,085. The New Proclamations remove vast tracts of land from the Monuments and excise numerous recorded and unrecorded archaeological objects that the Original Proclamations expressly designated for protection and study. 61 Fed. Reg. at 50,224; 82 Fed. Reg. at 1139-40. Those objects and the surrounding land were integral to the identities of the Monuments. Excising the objects and reopening the surrounding land to development effectively rescinds the original Monuments and replaces them with different Monuments. The Antiquities Act provides the President no such power. If the President could withdraw protection from previously designated objects and their surrounding context, the goal of the Antiquities Act to facilitate scientific exploration and discovery through preservation of objects and land would be entirely defeated.

II. The President also lacks the authority to diminish the protection of archaeological resources in order to facilitate surface-disturbing activities.

The President also exceeded his authority under the Antiquities Act by issuing New Proclamations that subordinate archaeological resources to mining, off-road vehicle use, and other surface-disturbing activities. The New Proclamations seek to obfuscate their effects by asserting that the objects excised from the Monuments are "otherwise protected by Federal law." 82 Fed. Reg. at 58,090, 58,093; 82 Fed. Reg. at 58,082, 58,085. But the statutes invoked by the New Proclamations—primarily ARPA and the NHPA—do not ensure that archaeological resources and their surrounding context are preserved for scientific study. Unlike the Antiquities Act, neither ARPA nor the NHPA authorizes or requires BLM, when making land-management decisions, to prioritize preservation of archaeological resources over other conflicting uses of the land.

Typically, under the Federal Land Policy and Management Act ("FLPMA"), BLM must manage the public lands according to principles of "multiple use and sustained yield unless otherwise specified by law." 43 U.S.C. § 1701(a)(7). Those principles require BLM to balance the protection of "scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values" with the "Nation's need for domestic sources of minerals, food, timber, and fiber from the public lands." *Id.* § 1701(a)(8), (12). Although FLPMA mandates that BLM prevent any "unnecessary or undue degradation of the lands," *id.* § 1732(b), BLM has broad discretion in implementing that standard, and courts often uphold actions that degrade public lands and resources when such degradation is "necessary to allow significant recovery" of natural resources. *Theodore Roosevelt Conservation P'ship v. Salazar*, 661 F.3d 66, 76-77 (D.C. Cir. 2011) ("FLPMA prohibits only unnecessary or undue degradation, not *all* degradation."); *see also Moapa Band of Paiutes v. U.S. BLM*, No. 2:10-CV-02021-KJD-LRL, 2011 U.S. Dist. LEXIS 116046, at *11-12 (D. Nev. Oct. 6, 2011); *S. Fork Band Council of W. Shoshone of Nev. v. U.S. Dep't of Interior*, No. 3:08-CV-00616-LRH-WGC, 2012 U.S. Dist. LEXIS 988, at *22 (D. Nev. Jan. 3, 2012).

FLPMA further provides, however, that "where a tract of such public land has been dedicated to specific uses according to any other provisions of law it shall be managed in accordance with such law." 43 U.S.C. § 1732(a). The Antiquities Act is one such law that enables the President to dedicate land to "specific uses" and thereby alter BLM's typical management regime. *Id.*; *see also* 16 U.S.C. § 7202(b)(1)(A) (incorporating national monuments into the National Landscape Conservation System). BLM must manage a monument "in a manner that protects the values for which" it was created. 16 U.S.C. § 7202(c)(1). Consequently, when a presidential proclamation designating a monument "conflicts with

FLPMA's multiple use mandate, the designating language will apply." BLM Manual 6220 § 1.6(B)(1). BLM must prohibit other, discretionary uses of land within such a monument when necessary to protect the objects identified in the proclamation. *Id.* § 1.6(A)(2); *see also Nat'l Tr. for Historic Pres. v. Suazo*, No. CV-13-01973-PHX-DGC, 2015 U.S. Dist. LEXIS 39380, at *17-21 (D. Ariz. Mar. 27, 2015) (invalidating monument management plan when administrative record contradicted BLM's determination that recreational target shooting would not harm ecological or archaeological objects designated for protection).

Here, BLM's Monument Management Plan for Grand Staircase has long recognized that the Monument was "created to protect a spectacular array of historic, biological, geological, paleontological, and archaeological objects" and that "[a]ll other considerations are secondary to that edict."[44] BLM's Plan consequently prioritized "[s]afeguarding the remote and undeveloped frontier character of the Monument" and committed to preserving archaeological and historical resources in their original context.[45] Although BLM never issued it, the Original Proclamation for Bears Ears similarly mandated that BLM prepare a management plan for the "purposes of protecting and restoring the objects identified." 82 Fed. Reg. at 1,143-44. The Antiquities Act therefore not only authorized BLM to prioritize the protection and restoration of archaeological resources in Grand Staircase and Bears Ears, the Act *required* BLM to do so given the values established in the Original Proclamations. *See* 16 U.S.C. § 7202(c)(1).

Neither ARPA nor the NHPA similarly ensures that BLM's management decisions will preserve archaeological resources for scientific study. Congress passed ARPA in 1979 to address shortcomings in the criminal-enforcement provision of Section 1 of the Antiquities Act,

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[44] Monument Management Plan, *supra* note 3, at 3.

[45] *Id.* at 5, 10-11, 52, 84.

which imposed maximum penalties of a $500 fine and 90-days imprisonment upon a person's conviction for excavating or destroying an "object of antiquity" without a permit. Antiquities Act of 1906, ch. 3060, 34 Stat. 225, § 1 (codified as amended at 18 U.S.C. § 1866). Those penalties had proven ineffective in stemming vandalism and looting of archaeological sites,[46] and one federal court had held the provision to be unconstitutionally vague because it did not define "object of antiquity" with sufficient specificity, *United States v. Diaz*, 499 F.2d 113, 14-15 (9th Cir. 1974). ARPA rectified those and other enforcement problems and clarified the process for obtaining excavation permits. *See* 16 U.S.C. § 470bb(1) (defining "archaeological resource" with specificity); *id.* § 470cc (creating new permitting provisions); *id.* (increasing criminal penalties).

ARPA did not, however, repeal or in any way amend the Antiquities Act.[47] ARPA's provisions therefore exist alongside and function in conjunction with—not as a replacement for—the Antiquities Act. Moreover, unlike the land-withdrawal provision of the Antiquities Act, nothing in ARPA has any effect on the multiple-use and sustained-yield regime under FLPMA. ARPA expressly provides that "nothing in this chapter shall be construed to repeal, modify, or impose additional restrictions on the activities permitted under existing laws and authorities relating to mining, mineral leasing, reclamation, and other multiple uses of the public lands." 16 U.S.C. § 470kk.

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[46] *See generally* Collins & Michel, *supra* note 1, at 84-89; Don D. Fowler & Barbara Malinky, *The Origins of ARPA: Crafting the Archaeological Resources Protection Act of 1979, in* Presenting Archaeology in Court: Legal Strategies for Protecting Cultural Resources 1, 2-4 (Sherry Hutt et al. eds., 2006).

[47] *See* Collins & Michel, *supra* note 1, at 88 (recounting Congressman Morris Udall's insistence that all references to the Antiquities Act be removed from ARPA to ensure the continued effectiveness of the "land-withdrawal section of the Antiquities Act")

Thus, contrary to the proclamation's suggestion, ARPA does not protect archaeological resources from being incidentally damaged or destroyed by conflicting uses of the public lands. Indeed, BLM's regulations provide that no ARPA permit is required for "any person conducting activities on the public lands under other permits, leases, licenses, or entitlements for use, when those activities are exclusively for purposes other than the excavation and/or removal of archaeological resources, even though those activities might incidentally result in the disturbance of archaeological resources." 43 C.F.R. § 7.5(b)(1); *see also Franco v. United States Dep't of Interior*, No. CIV S-09-1072 KJM-KJN, 2012 U.S. Dist. LEXIS 105316, at *35-40 (E.D. Cal. July 26, 2012) (dismissing ARPA claims when plaintiffs alleged no "intentional disturbance of archaeological resources," but rather alleged "a degradation of archaeological resources as an incidental effect, or externality from some other activity").

By revoking monument protections for numerous archaeological resources and their surrounding lands, the New Proclamations return those objects and lands to FLPMA's multiple-use and sustained-yield regime. BLM therefore no longer can prioritize the protection of those resources over other uses of the public lands, such as mining, off-road vehicle use, and other surface-disturbing activities. The President exceeded his authority by using the Antiquities Act—a statute dedicated to preserving scientific and historic objects and their surrounding context—to diminish the protection of archaeological resources in favor of developmental interests. Nothing in ARPA in any way alters or mitigates that *ultra vires* effect of the New Proclamations.

The NHPA similarly does not require BLM to prioritize the preservation of archaeological resources and their surrounding context over development of the public lands. Under the NHPA, an agency with jurisdiction over a proposed federal "undertaking" must "take into account the effect of the undertaking on any district, site, building, structure, or object that is included or eligible for inclusion in the National Register." 54 U.S.C. § 306108. It is well understood, however, that the NHPA is an "essentially … procedural statute" that imposes "no substantive standards on agencies." *Nat'l Mining Ass'n v. Fowler,* 324 F.3d 752, 755 (D.C. Cir. 2003) (quoting *City of Alexandria v. Slater*, 198 F.3d 862, 871 (D.C. Cir. 1999)). Unlike the Antiquities Act, the NHPA simply does not "compel particular preservation-oriented outcomes." *Wilderness Watch v. Iwamoto,* 853 F. Supp. 2d 1063, 1070-71 (W.D. Wash. 2012).

Thus, although the NHPA regulations require agencies to take steps to identify adverse effects to cultural resources and evaluate alternatives that could avoid or mitigate those effects, 36 C.F.R. § 800.6(a), the NHPA ultimately imposes no "substantive mandate on the agency to protect the resources." *San Juan Citizens All. v. Norton*, 586 F. Supp. 2d 1270, 1294 (D.N.M. 2008) (citing *Valley Cmty. Pres. v. Mineta*, 373 F.3d 1078, 1085 (10th Cir. 2004)). So long as the agency follows the required consultation and decision-making procedures, mining or other surface-disturbing activities that may damage or destroy archaeological resources and their surrounding context can and frequently do proceed.[48] As a practical matter, sensitive archaeological resources often are excavated and the surrounding contexts disturbed, leading to a loss of valuable scientific information.[49]

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[48] *See* Renfrew & Bahn, *supra* note 37, at 320 ("In rare cases, the value of a site is so great that it will be preserved and a project canceled or re-routed. In the vast majority of cases, though, sites are excavated, recorded, and destroyed: a compromise between development and heritage needs.")

[49] *See* Secretary of Interior's Standards and Guidelines for Federal Agency Historic Preservation Programs Pursuant to the NHPA, 63 Fed. Reg. 20,496, 20,505 (Apr. 24, 1998) (explaining that when surface disturbance is unavoidable, the agency should excavate, recover, and deposit the resources in "repositories capable of proving [sic] long-term curatorial services"); Ruthann Knudson, *Cultural Resource Management in Context*, in *Science and Technology in Historic*

Without the extra protection afforded by monument designation under the Antiquities Act, BLM's commitment to permit the displacement of archaeological resources only "as a last resort" is history.[50] Mining companies interested in developing resources within the Monument's former boundaries already have begun staking claims and developing plans.[51] And BLM recently leased over 50,000 acres of public land near Bears Ears National Monument that contain high densities of archaeological sites. BLM had previously deferred leasing on many of those parcels when nominated for a lease sale because they would have an "adverse effect" on archaeological resources eligible for listing on the National Register, but BLM found no adverse effect this time.[52]

The NHPA requires BLM to consider impacts to archaeological resources within FLPMA's multiple-use and sustained-yield framework, but the NHPA does not ensure that those resources and their surrounding context will remain intact for scientific study. Thus, just like ARPA, the NHPA does not alter or mitigate the central effect and purpose of the President's proclamation, which is to diminish the protection of archaeological resources in favor of development and other surface-disturbing activities. The President cannot use a statute dedicated to the preservation of scientific and historic objects to achieve that anti-preservationist end. This Court therefore should hold that the President's New Proclamations are beyond his power under

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Preservation 267, 283-84 (Williamson & Nickens eds., 2000) (criticizing the tendency in "public archaeological resource treatment . . . to dig it up . . . [and] let the highway construction stay on schedule").

[50] Monument Management Plan, *supra* note 3, at 84.

[51] Chris D'Angelo, *A Canadian Firm Prepares to Mine Land Trump Cut from Monument Protection*, HuffingtonPost (June 19, 2018), https://www.huffingtonpost.com/entry/grand-staircase-copper-cobalt-mine-trump-monument_us_5b2948d4e4b0f0b9e9a6074a.

[52] Brian Maffly, *Feds sell leases on archaeologically rich southern Utah lands for oil and gas*, Salt Lake Tribune (Mar. 20, 2018), https://www.sltrib.com/news/environment/2018/03/20/feds-hold-another-auction-of-archaeologically-rich-southern-utah-lands-for-oil-and-gas.

the Antiquities Act and restore the monument status of all archaeological resources and lands designated for protection under the Original Proclamations.

CONCLUSION

The Antiquities Act aims to facilitate scientific exploration and discovery through permanent preservation of archaeological objects and their surrounding lands. The Act provides the President no power to elevate developmental interests over scientific discovery and historic preservation. Once a monument is designated, only Congress can decide that protected objects and lands no longer deserve that protection. This Court therefore should rule in favor of the Plaintiffs and declare the President's New Proclamations to be *ultra vires*.

Respectfully submitted,

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NOV. 19, 2018

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[53] Richard J. Peterson-Cremer and Zachary L. Lass substantially contributed to the research and drafting of this *amicus* brief while employed as law clerks at Kaplan Kirsch & Rockwell.

Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Exhibit 1

U.S. BLM, Call for Data Related to Review of National Monuments Under EO 13792

Boshell, Brandon <bboshell@blm.gov>

Monument Data Call

1 message

Boshell, Brandon <bboshell@blm.gov> Mon, May 22, 2017 at 4:44 PM
To: Krissy Sherman <ksherman@blm.gov>, "Jasper, Jonathan" <jjasper@blm.gov>
Cc: Amanda Harrington <asharrin@blm.gov>

Krissy and Jon

I need you both to tag team this data call and need it done asap. I understand it is last minute but it is due by COB Friday and we have RMP evaluations scheduled this week as well.

Attached is GSENM's responses to this same data call. They submitted their info. last week as they were on a different schedule. It may be of some assistance. Please let me know how I can help.

--
Brandon E. Boshell
Assistant Field Manager / Vermilion Cliffs National Monument Manager
BLM - Arizona Strip Field Office
(435) 688-3241

3 attachments

Additional Information Requested Template_5_22_2017.docx
22K

Initial Data Request Related to Review of National Monuments (2).docx
20K

IDRR_NIM_GSENM.docx
34K

New Information Requested on Executive Order on the Review of Designations Under the Antiquities Act

BLM Responses to Additional Questions for [Name] National Monument

a) Any legislative language, including legislation in appropriations bills

[Identify if there is any related legislation regarding your monument]

b) Alternative options available for protection of resources applicable at each monument, such as Native American Graves Protection and Repatriation Act, Paleontological Resources Preservation Act, Archaeological Resources Protection Act, Historic Preservation Act and agency-specific laws and regulations.

The following could provide some options to protect specific resources found in [Name] National Monument. Protection would likely occur on a site-by-site or resource-by-resource basis and also would take a significant amount of time to accomplish under these various laws. These laws may not provide a mechanism to protect all cultural or tribal resources in [Name] National Monument. [Provide any specific information or examples for your monument.]

National Historic Preservation Act, (NHPA)

Native American Graves Protection and Repatriation Act, (NAGPRA)

Paleontological Resources Preservation Act, (PRPA)

Archaeological Resources Protection Act, (ARPA)

American Indian Religious Freedom Act (AIRFA)

c) Designated wilderness areas (name, acreage), Wilderness Study Areas (name if there is one, acreage, type), and/or areas managed to preserve wilderness or roadless characteristics that are not WSAs.

[Insert monument specific response]

d) Outstanding R.S. 2477 claims within a monument – type of road claimed and history

[Insert monument specific response]

e) Maps
[Insert monument specific response]

f) Cultural or historical resources, particularly Tribal, located near a monument but not within the boundary that might benefit from inclusion in the monument

[Insert monument specific response]

g) Other – general questions or comments

[Insert monument specific response regarding any other information that should be considered in the review of your monument]

Call for Data Related to Review of National Monuments under EO 13792 (April 26, 2017)

Please help us gather information about each of the items listed below, for each of the National Monuments listed below in Table 1.

1. Documents Requested
    a. Resource Management Plans/Land Use Plans
    b. Record of Decision
    c. Public Scoping Documents
    d. Presidential Proclamation
2. Information on activities permitted at the Monument, including annual levels of activity from the **date of designation to the present**
    a. Recreation - annual visits to site
    b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)
    c. Minerals - annual mineral production on site
    d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
    e. Grazing - annual grazing on site (AUMs permitted and sold)
    f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
    g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
3. Information on activities occurring during the **5 years prior to designation**
    a. Recreation - annual visits to site
    b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)
    c. Minerals - annual mineral production on site
    d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
    e. Grazing - annual grazing on site (AUMs permitted and sold)
    f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
    g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
4. Information on activities that likely would have occurred annually from the date of designation to the present **if the Monument had not been designated**
    a. Recreation - annual visits to site
    b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)
    c. Minerals - annual mineral production on site
    d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
    e. Grazing - annual grazing on site (AUMs permitted and sold)

   f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
   g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
5. Changes to boundaries - dates and changes in size
6. Public Outreach prior to Designation - outreach activities conducted and opportunities for public comment
7. Terms of Designation

Table 1. List of National Monuments Included in Review (per DoI Press Release dated May 5, 2017)

National Monument	Location	Managing Agency
Basin and Range	Nevada	BLM
Bears Ears	Utah	BLM, USFS
Berryessa Snow Mountain	California	USFS, BLM
Canyons of the Ancients	Colorado	BLM
Carrizo Plain	California	BLM
Cascade Siskiyou	Oregon	#N/A
Craters of the Moon	Idaho	NPS, BLM
Giant Sequoia	California	USFS
Gold Butte	Nevada	BLM
Grand Canyon-Parashant	Arizona	BLM, NPS
Grand Staircase-Escalante	Utah	BLM
Hanford Reach	Washington	FWS, DOE
Ironwood Forest	Arizona	BLM
Mojave Trails	California	BLM
Organ Mountains-Desert Peaks	New Mexico	BLM
Río Grande del Norte	New Mexico	BLM
Sand to Snow	California	BLM, USFS
San Gabriel Mountains	California	USFS
Sonoran Desert	Arizona	BLM
Upper Missouri River Breaks	Montana	BLM
Vermilion Cliffs	Arizona	BLM
Katahdin Woods and Waters	Maine	NPS
Marianas Trench	CNMI/Pacific Ocean	FWS
Northeast Canyons and Seamounts	Atlantic Ocean	NOAA, FWS
Pacific Remote Islands	Pacific Ocean	FWS
Papahānaumokuākea	Hawai'i/Pacific Ocean	NOAA, FWS
Rose Atoll	American Sāmoa/Pacific Ocean	FWS

Call for Data Related to Review of National Monuments under EO 13792 (April 26, 2017)

1. Documents Requested
   a. Resource Management Plans/Land Use Plans
      i. The Monument Management Plan (MMP) and Record of Decision (ROD) is located within this Drive folder (1.GSENM_mgmt_plan.pdf).
      ii. The entire GSENM RMP (DEIS/FEIS/ROD) can be accessed here: https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=94418
      iii. The Livestock Grazing EIS/Plan Amendment has been initiated. The DEIS has been reviewed by the BLM Utah State Office and BLM Washington Office and is nearing public release: https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=100826
      iv. The MMP has also been amended for Greater Sage Grouse habitat conservation (2015), for an electrical transmission line Right-of-Way to support local communities (2011), and for an update to fire management (2005).
   b. Record of Decision
      i. The 1999 MMP and ROD is located within this Drive folder (1.GSENM_mgmt_plan.pdf).
   c. Public Scoping Documents
      i. Grand Staircase-Escalante National Monument's (GSENM) Management Plan included substantial outreach, public scoping and comment periods according to land use planning regulations and policies. See Federal Register Notices in Drive folder (1.c.Federal Register, Volume 64 Issue 145 (Thursday, July 29, 1999).pdf).
      ii. Public Comments and Responses for the MMP FEIS are located within this Drive folder (1.c.GSENM_FEIS_Comments.pdf).
      iii. See also Scoping Report for Livestock Grazing EIS (1.c.GSENM_GrazingEISScopingRpt_Final.pdf) and at: https://eplanning.blm.gov/epl-front-office/projects/lup/69026/89803/107384/2014.05.21_GSENM_ScopingRpt_Final_508.pdf.
      iv. GSENM worked with multiple agencies, tribes and communities and individuals

and responded to more than 6,800 letters commenting on the 2000 MMP. Nearly all site-specific NEPA analyses include public comment periods. Additionally, GSENM has offered multiple opportunities for public engagement in the Livestock Grazing Plan Amendment/EIS including:

- Development of a Situation Assessment by National Riparian Service Team
- Hosted 12 public scoping meetings and/or workshops
- Hosted 3 Socio-economic workshops
- Five newsletters developed along with a "Fact Sheet Series"
- Press releases published in five Utah newspapers
- Maintained Project website with project updates
- Hosted a Biological Soil Crust Forum
- Public Release of Draft Alternatives
- The inclusion of two Action Alternatives in the PDEIS that were derived from external sources
- Hosted 27 Cooperating Agency Meetings; 12 Forage Team Meetings
- Outreach to local tribes
- Monument Advisory Committee Input
- Joint BLM/NPS Programmatic Agreement for Cultural Resources
- Broad Consulting Party Process
- Other meetings: County Coordination, State of Utah, Earthfest

GSENM demonstrates a commitment to continued public engagement in land use planning processes.

d. Presidential Proclamation

i. Proclamation 6920 of September 18, 1996 is in this folder (1.d.Presidential_Proclamation_6920.pdf).

2. Information on activities permitted at the Monument, including annual levels of activity from the **date of designation to the present**

Designation date for GSENM is September 18, 1996.

a. Recreation - annual visits to site

i. To protect Monument resources and objects and to provide economic opportunities in the local communities, major facilities including the four visitor centers are located in the gateway towns of Kanab, Cannonville, Escalante, and Bigwater.
ii. GSENM provides a large variety of multiple-use recreation opportunities including traditional hiking and camping, hunting, fishing, horseback riding, mountain biking, as well as motorized activities for off-highway vehicles.
iii. Commercial recreation activities (Outfitter and Guides) have risen since Monument designation (2.a._GSENM Commercial_SRP.pdf).
iv. In 2016, 926,235 million visitors came to GSENM.
GSENM uses the Recreation Management Information System (RMIS) to report visitor use, which is calculated using data from multiple traffic counters, permits and visitor counts in the four Visitor Centers. BLM's Recreation Management Information System (RMIS) is generally accepted as the agency's official record, however, RMIS was not available until 1999. Prior to 1999, GSENM aggregated data from the Kanab and Escalante offices. (See: 2.a.GSENM_RecreationData_Excel.xls and 3.a.GSENM_Recreation_MMP_DEIS_Tables.pdf)

b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)
i. All Valid Existing Rights for leasable minerals including coal, and oil and gas are continued.
ii. No new leases have been issued since designation. GSENM has no commercial renewable energy.
iii. The annual production of oil and gas in the GSENM is currently limited to lands in or adjacent to the Upper Valley Unit (UVU) in the north-central area of the GSENM (Attachments: 2.b.Upper Valley Unit Map.pdf; 2.b.Upper Valley GSE Production.pdf; 2.b.Upper Valley Wells in GSENM.xls; and 2.b.UDOGM_O&Gprod_data_Upper Valley.pdf). GSENM shares the Upper Valley Oil Field with the Dixie National Forest; this field accounts for all oil and gas production in GSENM. Attached documents disclose production for the Upper Valley Field. Four wells within the GSENM are currently producing oil and a small amount of gas. The UVU was approved in 1962 and production from the wells peaked in 1972 at 183,133 barrels. In the last 20 years (1997-2016) production

has slowly declined from about 65,828 barrels of oil and no gas annually to 45,538 barrels of oil and 2,357 thousand cubic feet (mcf) of gas. There is no other oil and gas production in GSENM, or Kane and Garfield Counties.

iv. No coal lands have been explored or coal produced within the GSENM since the September 18, 1996 designation. Existing coal leases were voluntarily exchanged for Federal payments totaling $19.5 million (not adjusted for inflation) (2.b.GSENM Coal Lease Cancellation Payments.pdf)

v. 34 oil and gas leases (45,894 acres) are in suspension while a Combined Hydrocarbon Lease (CHL) conversion application is processed.

vi. Information related to energy transmission infrastructure and lands and realty actions is included in the table below:

Grand Staircase-Escalante National Monument Existing Rights-of-Way/Permits/Authorized 09/25/1996 – 05/15/2017	
Existing Withdrawals: PSR, PWR, Bureau of Reclamation, Forest Service Wilderness, Power Site, National Park Service, In Trust for Indians	17
Road ROWs	19
Misc. Roads and Associated Uses - Sec 107 Federal Aid Hwy, Revised Statute 2477, Mineral Material Sites	0
Power Transmission Lines and Power Facilities	20
Communication Sites – Telephone, Telegraph, Radio Transmission, Global Positioning Systems	15
Water ROWs, Irrigation Facilities	14
Oil and Gas Pipelines, Oil and Gas Facilities	5

Other FLPMA ROWs, Perpetual Easements, Federal Facilities	2
Airport	0
Permit - 302 FLPMA – Misc.	0
Permits Film - 302 FLPMA (popular location (closed))	54

c. Minerals - annual mineral production on site

i. Mineral materials

- No new Free Use, commercial, or over-the-counter permits have been issued since Monument designation.
- Valid existing permits, including those in Title 23 (3 Federal Highway Rights of Way), continue to be recognized until permit expiration.
- Significant quantities of gravel and riprap from existing pits continue to be provided for Federal Highways projects, primarily to Utah Department of Transportation.
- According to UGS Circular 93, January 1997, "A Preliminary Assessment of Energy and Mineral Resources within the Grand Staircase-Escalante National Monument" (2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf) there were five small mining operations on unpatented mining claims, four of which were active alabaster quarries and one, a suspended operation for petrified wood. Annual production of the alabaster was about 300 tons worth $500 per ton ($150,000/yr). These claimants failed to pay the required annual filings and therefore, the claims were terminated. The BLM's decision to close the claims was upheld by IBLA in March 2008. Since that time, there have been no mining law operations within the monument.

ii. Locatable Minerals

- No new mining claims were issued after Monument designation, however existing claims and active mines were allowed to continue. (List of active mines in MMP DEIS located within this Drive folder 2.c. MMP_DEIS Table 3.10_Locatables.pdf).

d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
   i. No commercial timber production pre/post Monument designation.
   ii. GSENM does allow continued firewood cutting in two forestry product areas.
e. Grazing - annual grazing on site (AUMs active and billed)
   i. Grazing on the Monument Fact Sheet (2.e_GSENM Grazing EIS Fact Sheet 05-08-2017.pdf).
   ii. Grazing AUMs/ Active and billed (2.e._GSENM Grazing AUMs).
   iii. When the Monument was designated, there were 106,645 total AUMs, with 77,400 of these active. Today, there are 106,202 total AUMs and 76,957 are active. In 1999, an adjustment in AUM levels was made to resolve riparian resources issues and address recreation conflicts. In the current Livestock Grazing EIS/Plan Amendment process the current prefered alternative will have a slight reduction with 105,765 AUM but an increase of total acres for grazing within the monument.

f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
   i. **Subsistence activities** are those that provide the bare essentials for living: food, water, and shelter. The Federal Subsistence Management Program provides opportunities for subsistence way of life in Alaska on federal public lands and waters. There are no formal subsistence programs outside of Alaska. There are no known true subsistence activities occurring on GSENM or prior to its designation. GSENM does provide for the collection of certain natural materials by Native American Indians, under BLM permit. RMIS data provides the number of permitted/guided and recreational hunting activities, fishing activities and gathering activities (See: 2.a.GSENM_RecreationData_Excel.xls). These numbers do not reflect the actual number of licensed hunters/fishermen. That data is available from the State of Utah Division of Wildlife Resources. Outside of developed recreation sites, the entire GSENM is open for hunting and fishing, which is regulated by the State of Utah Division of Wildlife Resources.
g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
   i. Archeological/cultural data is provided in the following Utah Division of State History Maps in the google drive (2.g.1_GSENM_SiteDensity,

2.g.2_GSENM_Inventories, 2.g.3_GSENM_ArchSites, 2.g.4_GSENM_ArchNumofSites).

ii. Archaeological surveys carried out to date, show extensive use of places within the monument by ancient Native American cultures and a contact point for Anasazi and Fremont cultures. The cultural resources discovered so far in the monument are outstanding in their variety of cultural affiliation, type and distribution. Hundreds of recorded sites include rock art panels, occupation sites, campsites and granaries. Cultural sites include historic and prehistoric sites, Traditional Cultural Properties, Native American Sacred Sites and cultural landscapes.

iii. According to the Utah State Historic Preservation Office (SHPO), as of March 6, 2017, there are 3,985 recorded archaeological sites within the Grand Staircase-Escalante National Monument (GSENM)(2.g.4_GSENM_ArchNumofSites). However, the GSENM staff estimates that there are more likely around 6,000 recorded archaeological sites within the GSENM, due to a records backlog. This is with only five to seven percent of the Monument surveyed.

iv. Cultural Values (Tribal): Prehistoric archaeological sites in the GSENM include pottery and stone tool (lithic) scatters, the remains of cooking features (hearths), storage features such as adobe granaries and subsurface stone lined granaries, prehistoric roads, petroglyphs, pictographs and cliff dwellings. Historic sites include historic debris scatters, roads, trails, fences, inscriptions, and structures. Following the designation of GSENM, consultations were initiated with the Native American tribes associated with the GSENM area, including the Hopi, the Kaibab Paiute, the San Juan Paiute, the Paiute Indian Tribes of Utah, the Zuni, and the Ute, and the Navajo. Over the past 20 years, the Hopi and the Kaibab Paiute have been most closely associated with the Monument and most responsive to continued consultations, as the GSENM area is central to the historic and prehistoric territories of these two tribes. All tribes considered the Monument area to be culturally important; the Hopi (as the modern descendants of the Ancestral Puebloans), for example, can trace the migrations of at least twelve clans through what is today GSENM (Bernardini 2005). The tribal connections to this land are probably best described by an example from the Kaibab Paiute, as related to ethnographers from the University of Arizona, as follows (Stoffle et al 2001): “*The Southern Paiute people continue to maintain a* *strong attachment to the holy lands of their ethnic group as well as to their own local territory. These attachments continued even though Paiute sovereignty has been lost over portions of these lands due to Navajo ethnic group expansion, encroachment by Euro Americans, and Federal government legislation. Despite the loss of Paiute sovereignty over most traditional lands, Southern Paiute people continue to affiliate themselves with these places as symbols of their common ethnic identity. Additionally, all Southern Paiute people continue to perform traditional ceremonies along with the menarche and first childbirth rites of passage rituals. The locations at which these ceremonies and rituals have been or are currently performed become transformed from secular "sites" to highly sacred locations or places. By virtue of the transformation of locations into sacred places, Southern Paiute people reaffirm their ties to traditional lands because they have carried out their sacred responsibilities as given to them by the Creator."*

v. **Cultural values (Ranching)** Local ranching began in the 1860s, and became a major focus of area livelihood and increased settlement in the 1870s. Ranching was initially small scale and for local subsistence, but the herds quickly grew so that by the late 1800s the raising of cattle, sheep, and goats was of major economic importance. Ranching and subsistence farming was historically the backbone of the local economies, and this is still reflected in the views of the modern communities surrounding GSENM. In modern times the economic importance of ranching has somewhat diminished, but the culture of, and past history of, livestock grazing and ranching is one of the important "glues" that binds local communities and families in the GSENM area.

3. Information on activities occurring during the **five years prior to designation**
   a. Recreation - annual visits to site
      i. The BLM transitioned to RMIS in 1999. Data prior to 1999 is not available in the same reporting mechanism as from 1999-Present. GSENM did report visitor use beginning in FY97. (See: 2.a.GSENM_RecreationData_Excel.xls and 3.a.GSENM_Recreation_MMP_DEIS_Tables.pdf).

         Overall visitation increased prior to designation and the projecting trends based on the historical information would see a continued rise of visitors seeking recreational opportunities. Just prior to designation Escalante Canyon received

373,200 visitors in 1994, 384,800 visitors in 1995 and 456,400 in 1996.

b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)

i. The Upper Valley Oil Field was in production prior to designation; no other oil and gas production existed in Kane and Garfield Counties. From 1992 until 1996, 336,313 barrels of oil were produced in the GSENM. No natural gas was produced during that time. (2.b.Upper Valley GSE Production.pdf).

ii. No coal was produced from the GSENM in the five years preceding designation. A regional analysis/FEIS for mining was completed in 1979 (3.b.FINAL EIS - Dev of Coal Resources in Southern Utah Title Pages.pdf). Exploration activities and planning for mining operations continued from the 1980's until the monument designation.

- 64 coal leases (~168,000 acres) were committed and a plan was submitted for Andalex Resources' Smoky Hollow Mine. The plan proposed mining on 23,799 acres of the area leased in GSENM. In the mid-1990's an EIS was initiated (3.b.4.b.Warm Springs Smoky Hollow PDEIS December 1995_Coveronly.pdf).
- 600+ exploration drill holes were completed prior to GSENM designation to defined the coal geology to plan for underground mines (See 3.b.BLM 1996-1997 Kaiparowits Coal Report - DRAFT.pdf and https://pubs.usgs.gov/of/1996/OF96-539)

iii. Information related to energy transmission infrastructure and lands and realty actions is included in the table below:

Grand Staircase-Escalante National Monument Existing Rights-of-Way/Permits/All Dispositions Authorized/Closed/Relinquished/Withdrawn/Expired/Terminated/Cancelled/Pending/Rejected/Void 01/01/1991 – 09/24/1996 *(In March 1999, BLM added Case Recordation components to the LR2000 Database System; therefore, some of the pre-LR2000 data may remain in the Status Database*)

Existing Withdrawals: PSR, PWR, Bureau of Reclamation, Forest Service Wilderness, Power Site, National Park Service, In Trust for Indians	1
Roads ROWs	8
Misc. Roads - Sec 107 Federal Aid Hwy, RS2477, Mineral Material Sites	1
Power Transmission Lines & Power Facilities	1
Communication Sites – Telephone, Telegraph, Radio Transmission, Global Positioning Systems	1
Water ROWs, Irrigation Facilities	0
Oil & Gas Pipelines, Oil & Gas Facilities	2
Other FLPMA ROWs, Perpetual Easements, Federal Facilities	6
Airport	0
Permit - 302 FLPMA – Misc.	25
Permits Film - 302 FLPMA (popular location (closed))	0

c. Minerals - annual mineral production on site
    i. The alabaster quarries were the only authorized locatable minerals operation (dating to 06/30/1986) in the area prior to designation.
    ii. Mineral materials, primarily sand and gravel and riprap, were extracted from developed pits by counties and commercial entities for local use. There were eight Mineral Material Cases in the monument at designation, and most were Free Use Permits granted to the county.
d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
    i. No commercial timber production pre/post Monument designation.
    ii. Prior to designation, the Kanab and Escalante Resource Areas were open to firewood cutting.
e. Grazing - annual grazing on site (AUMs active and billed)
    i. Grazing on the Monument Fact Sheet (2.e_GSENM Grazing EIS Fact Sheet 05-08-2017.pdf).
    ii. Grazing AUMs/ Active and billed (2.e._GSENM Grazing AUMs)
    iii. When the Monument was designated, there were 106,645 total AUMs, with 77,400 of these active. Today, there are 106,202 total AUMs and 76,957 are active. In 1999, an adjustment in AUM levels was made to resolve riparian resources issues and address recreation conflicts. The current Livestock Grazing EIS/Plan Amendment process the current prefered alternative will have a slight reduction with 105,765 AUM but an increase of total acres for grazing within the monument.
f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
    i. There are no known true subsistence activities occurring on GSENM or prior to its designation. Recreational fishing, hunting and gathering data from RMIS is not available prior to designation.
g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
    i. In the five year period prior to designation of GSENM, a total of approximately 358 cultural resource sites were documented in what was to become GSENM, or about 72 sites/year. Following designation, approximately 3,219 sites were documented, or about 161 sites/year. This increase reflects the increased

funding and greater research opportunities following GSENM designation.

ii. In the five year period prior to designation of GSENM, a total of approximately 3991 acres of new cultural resource surveys were conducted in what was to become GSENM, or about 798 acres/year. Following designation, approximately 41, 024 acres of new cultural resource surveys were conducted, or about 2051 acres/year. This increase reflects the increased funding and greater research opportunities following GSENM designation, as well as substantial habitat improvement projects.

4. Information on activities that likely would have occurred annually from the date of designation to the present **if the Monument had not been designated**

The answers to this question are speculative. The question is best answered with qualitative (rather than quantitative) data. As GSENM was designated 20 years ago, the factors affecting such projections are subject to a wide range of variables (many of which are outside of BLM's purview, such as market prices).

a. Recreation - annual visits to site

i. Research by external parties (e.g., Headwaters Economics and Pew Trust reports) indicate that protected landscapes are a draw for visitors and do result in increased visitation to a region. Thus, it is reasonable to conclude that visitation would be less if the lands had not been designated as a monument.

b. Energy - annual production of coal, oil, gas and renewables (if any) on site; amount of energy transmission infrastructure on site (if any)

Commercial speculation depends on the price of commodities.

i. Except for the Upper Valley Field, there have been no oil and gas discoveries within the GSENM. Forty-seven exploratory wells have been drilled; exploration activities were relatively sparse and cover an average of 57 square miles per well (2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf, page iv).

ii. An Application for a Permit to Drill (APD) was submitted for valid existing leases within the Circle Cliffs Unit. The APD was neither approved nor rejected and the lessee allowed the leases to terminate.

iii. Four wildcat oil and gas wells have been drilled on GSENM since designation (1997-1999); none went into production.

iv. Since there have been no discoveries upon which to base production numbers, estimates of the value of production vary widely. The Utah Geological Survey (UGS) projected 2.6 to 10.5 trillion cubic feet (2.6 to 10.5 billion mcf) of coal-bed methane may be contained in the GSENM. The UGS also projected "…550 million barrels of oil might be contained within tar sands of the monument." In January 1997, it was speculated that total value of coalbed natural gas and petroleum within the GSENM ranged between $2.02 and $18.6 billion (2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf).

v. It is reasonable to conclude absent a national monument designation, the opportunities for additional oil and gas exploration, discovery and development would be based on the viability of development and the economic value and access to distribution.

vi. The Kaiparowits plateau, located within the monument, contains one of the largest coal deposits in the United States. The USGS projected "an original resource" of 62 billion tons of coal with a geologic and mining technology adjusted resource of 30 billion tons (https://pubs.usgs.gov/of/1996/OF96-539). The DEIS for the Smoky Hollow Mine (3.b.4.b.Warm Springs Smoky Hollow PDEIS December 1995_Coveronly.pdf) and the Alton coal mine producing from adjacent private lands provide an example of the development potential.

vii. Andalex coal leases were voluntary sold to the Land and Water Conservation Fund (LWCF) at market value. At the time of designation, the Warm Springs Smoky Hollow DEIS was in progress to analyze the proposed mine. Andalex Resources may or may not have actually decided to develop the coal resources based on varying economic projections for the project, particularly the cost of transporting the coal.

viii. The Utah Geological Service projected 11.36 billion tons are "technologically recoverable" (including 870 million tons in what was previously State of Utah School and Institutional Trust lands (SITLA)(2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf). Recent advances in underground coal mining techniques would likely result in the development of additional large areas of Kaiparowits coal resources not considered minable in the 1990's.

ix. The School Institutional Trust Lands Administration (SITLA) lands were exchanged for cash payments and federal coal and oil and gas properties outside the monument. Absent a monument designation, the federal/SITLA land exchange would likely not have occurred.

x. Applications for rights of way and other energy transmission infrastructure may have continue to occur within the current monument boundaries including opportunities for mineral development.

c. Minerals - annual mineral production on site
   i. Absent monument designation, it is likely relinquished alabaster claims may have been relocated and additional alabaster mining claims may have been filed. For the alabaster quarries, "Over a 30-year period, the quarries should generate $4.5 million in production." (2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf)
   ii. The Utah Geological Survey mineral report stated, "Various types of metallic-mineral deposits are known to be present in the monument (figure 14). Most of these are small and low-grade with uncertain likelihood of significant development." The report addressed specific minerals with known or potential deposits within the monument, but they determined at that time they were probably not commercial quality due to low, often subeconomic grades and limited tonnage. Thus, it is unlikely that metallic mining would have occurred. (2.c.UGS Circular 93 GS Energy and Mineral Resources.pdf)
   iii. There would most likely be additional mineral material sites for sand and gravel and the existing Free Use Permits granted to Kane County most likely still be in use.

d. Timber - annual timber production on site (in board-feet, CCF, or similar measure)
   i. There is little harvestable lumber on the Monument (a little more than 1,000 acres of ponderosa). The mill harvested trees from the surrounding Dixie National Forest. The closure of the mill in Escalante was not connected to timber harvest on BLM lands.

e. Grazing - annual grazing on site (AUMs Active and billed)
   i. Grazing/ AUMs active and billed would likely have remained the same.
   ii. Grazing is and was managed by applicable laws and regulations. As stated in the Proclamation; "Nothing in this proclamation shall be deemed to affect existing permits or leases for, or levels of, livestock grazing on Federal lands within the monument; existing grazing uses shall continue to be governed by applicable laws and regulations other than this proclamation."
   iii. Although grazing use levels have varied considerably from year to year due to factors like drought, no reductions in permitted livestock grazing use have been made as a result of the Monument designation.

f. Subsistence - participation rates for subsistence activities occurring on site (fishing, hunting, gathering); quantities harvested; other quantifiable information where available
    i. No likely changes or statistically significant differences from the reported RMIS data.
g. Cultural - list of cultural uses/values for site; number of sites; other quantifiable information where available
    i. Less inventory would have likely occurred without the Monument designation. The Resource Areas averaged about 72 sites/year inventoried. After designation, the average was about 161 sites/year.
    ii. More vandalism would have likely occurred without Monument designation. After designation, research, inventory and educational and interpretive outreach programs increased. Between 1996 and 2006, GSENM presented more than 500 talks, classroom visits, field trips and other educational events relating to cultural resources and archeology. Education, increased presence of staff and researchers and improved management likely led to the reduction in numbers of sites looted and rock art panels defaced.
    iii. Less archeological research would have occurred without the Monument Designation. Early GSENM efforts included initiating large, landscape surveys which recorded and documented hundreds of sites.

5. Changes to boundaries - dates and changes in size
    i. Monument Designation September 18, 1996 (1,878,465 acres).
    ii. H.R.3910, Automobile National Heritage Area Act, Public Law 105-355, Nov. 6, 1998, 112 Stat. 3253. 1,884,011 acres, net gain of approximately 5,546 acres (See 5.a.H.R.3910_Automobile National Heritage Area Act Synopsis)
    iii. H.R.377, Public Law 111-11, 2009, Boundary change and purchase for Turnabout Ranch, approximately 25 acres removed from GSENM (See 5.c.GSENM_Boundary_SaleHR3777_PL111-11_Turnabout.pdf)
    iv. Utah Schools and Land Exchange Act 1998: State of Utah School and Institutional Trust Lands Administration lands within the boundaries of GSENM were exchanged. The Federal government received all State inholdings in GSENM (176,699 acres) while the State Received $50 million plus $13 million in unleased coal and approx 139,000 acres including mineral resources. The Federal Government received additional State holdings within other National

Park Service and US Forest Service units. (See 5.1998_Utah school Land Exchange_PL105-335.pdf)

v. Small acquisitions of inholdings, private land located within the Monument boundary, have occurred since designation. The acquisitions have not resulted in boundary adjustments, but have increased total Federal land ownership. More information is available upon request.

6. Public Outreach prior to Designation - outreach activities conducted and opportunities for public comment

i. No public outreach documents specifically related to the designation of Grand Staircase-Escalante National Monument are available. However, the area in southern Utah had long been considered, discussed and evaluated for the possibility of providing greater recognition of and legal protection for its resources. As early as 1936, the National Park Service (NPS) considered making a recommendation to President Roosevelt to designate a 6,968 square mile "Escalante National Monument."

7. Terms of Designation

i. Refer to Proclamation for the terms of designation.

ii. GSENM has additional data describing terms of the designation

- Presidential remarks announcing the designation of GSENM (7.1_Remarks Announcing GSENM_pg1782-2).
- Secretary of the Interior Memo to the President describing the objects and providing a listing of Monument Objects and a bibliography of Monument object data (7.2_8-15-96 Secretarial_Memo).
- Secretary of the Interior Memo to the BLM Director describing Interim Management Direction for GSENM (7.3_11-6-96 Secretarial_Memo).

Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Exhibit 2

Declaration of Jerry Spangler in Support of Archaeological Organizations' *Amicus Curiae* Brief

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

The Wilderness Society, *et al.*,	)	
Plaintiffs,	)	
v.	)	Civil Action No. 1:17-cv-2587-TSC
Donald J. Trump, *et al.*,	)	
Defendants.	)	
Grand Staircase Escalante Partners, *et al.*	)	
Plaintiffs,	)	Civil Action No. 1:17-cv-2591-TSC
v.	)	
Donald J. Trump, *et al.*,	)	
Defendants.	)	CONSOLIDATED CASES

DECLARATION OF JERRY SPANGLER IN SUPPORT OF ARCHAEOLOGICAL ORGANIZATIONS' AMICUS CURIAE BRIEF

I, Jerry D. Spangler, being competent to make this statement, do swear and affirm the following:

1. I am the Executive Director of the Colorado Plateau Archaeological Alliance, a 501(c)(3) non-profit organization based in Ogden, Utah, dedicated to the preservation of archaeological and historical resources on public lands in the West. I am a member of the Society for American Archaeology (SAA) and I am a Registered Professional Archaeologist (RPA).

2. I have worked as a professional archaeologist in Utah, Colorado, and Arizona since 1993, first through the private firm Uinta Research and then through the Colorado Plateau Archaeological Alliance beginning in 2005. I am a recognized expert on the prehistory of the northern Colorado Plateau, and I have authored scores of technical reports and peer-reviewed monographs, research papers, and award-winning books on the archaeology and history of the American West (see Attachment A). Since 2005, my research has focused on anthropogenic (human-caused) impacts to cultural resources on public lands and the potential strategies federal land managers can implement to minimize degradation to archaeological and historic sites.

3. I began my archaeological research in Grand Staircase-Escalante National Monument in 2000, and my research has continued to the present day, funded largely by research grants from the Bureau of Land Management (BLM). My research in the Monument has included a comprehensive synthesis of the regional prehistory (Spangler 2001); the first archaeological inventory of the middle Paria River corridor, an area rich in previously undocumented sites related to Archaic and Ancestral Puebloan occupations, as well as historic Mormon pioneer inscriptions (Spangler and Zweifel 2012); groundbreaking inventory on the Kaiparowits Plateau that demonstrated high-elevation maize farming where agriculture is not possible today (Spangler and Zweifel 2016); an interdisciplinary study in the Meadow Canyon area in the Grand Staircase that examined the relationship between archaeological site distribution and prehistoric climate change (Spangler and Zweifel 2017; see also D'Andrea 2015), and a comprehensive history of grazing practices in the region (Spangler and Holland 2017). I am currently working in partnership with the University of Utah to develop a predictive model for the Monument whereby land managers can better understand where sites are likely to be located.

4. My archaeological expertise in Grand Staircase-Escalante National Monument led to my 2007 appointment to the BLM's Resource Advisory Council for the state of Utah, and my 2011 appointment to the Grand Staircase-Escalante National Monument Advisory Committee.

Exclusion of Known Archaeological Resources from Monument Boundaries

5. All documented archaeological and historic sites within Grand Staircase-Escalante National Monument are, according to federal law and protocol, cataloged in confidential databases maintained by the Bureau of Land Management and the Utah State Historic Preservation Office (SHPO). These site data were retrieved from both sources by University of Utah researchers Kenneth Blake Vernon and Peter Yaworsky as part of our collaborative predictive modeling efforts, and each individual site record was examined in detail to determine exact site locations, site types, site complexity, the age of each site, associated artifacts and features, and a multitude of environmental variables associated with each site. A total of 4,225 documented archaeological and historic sites are located within the original boundaries of the Monument.

6. In December 2017, after the monument was reduced in size by executive order and split into three separate monuments, we obtained GIS shape files of the new monument(s) boundaries. We then examined the locations of documented sites within the original boundary compared to the revised 2017 boundaries. The revised boundaries excluded a total of 1,915 documented archaeological and historic sites that were previously included within the original monument boundary (see Attachments B and C). Of these excluded sites, 1,286 sites were determined eligible for listing on the National Register of Historic Places by the Utah SHPO under the National Historic Preservation Act.

7. The 1,915 sites now excluded from the Monument represent a detailed catalog of 10,000 years of human history in the region. These include sites related to the earliest humans in the American West at the end of the last Ice Age (3 sites), Archaic hunters and gatherers who occupied the region for 7,000 years (271 sites), the ancient farmers who constructed villages and granaries (534 sites), Ancestral Paiute peoples (40 sites), and historic ranchers and miners (127 sites). The cultural affiliation of the remainder of the sites cannot yet be determined without excavation and additional research. Most of the excluded sites (478 sites) can be attributed to the Fremont Culture or to Ancestral Puebloan peoples popularly referred to as the Anasazi.

Exclusion of Unknown Archaeological Resources from Monument Boundaries

8. Only about 10 percent of the land within the original Monument boundaries has been systematically inventoried for archaeological resources. Using individual environmental characteristic data related to resource distribution, environmental productivity, climatic, landscape attributes, and soil qualities, we are able to predict areas of high to low probability for archaeological sites (see Attachment D). The precision of the model allows us to predict with high confidence not only specific site types, such as hunting and gathering versus agricultural sites, but the different types of sites attributable to different cultures throughout prehistory (see Attachment E).

9. Using the predictive model, I have identified five areas now removed from the Monument that have the very highest probability of containing archaeological sites and where existing inventory data suggest site density could be as high as 60 to 80 sites per square mile. From east to west, these excluded areas include:

a. the Lampstand, an area renowned for its abundance of Ancestral Puebloan villages;

b. the Hole-in-the-Rock Road, an iconic transportation route of tremendous spiritual significance to Mormon faithful;

c. the Little Valley area south of the modern community of Escalante that has a high density of documented Archaic and Fremont Culture sites;

d. the area southeast of Bryce Canyon National Park where previous research has documented near-continuous human occupations over 10 millennia; and

e. the Vermilion Cliffs/Kitchen Corral Canyon area east of Kanab, which has one of the highest concentrations of Ancestral Puebloan villages, farmsteads, granaries, and rock art sites yet to be documented on the northern Colorado Plateau.

Importance of Archaeological Resources Removed from the Monument

10. Archaeological sites represent important datasets that can shed insights to human behavior over time, and the pristine nature of the dataset in the Monument affords a unique opportunity wherein hypotheses can be tested, modified, and tested again during a rigorous scientific process. Documented archaeological sites in the Monument area are commonly organized according to topographic location (open or sheltered), relative permanence (architectural or non-architectural), and suspected function (residential, storage, and rock art) (see site type definitions articulated in Spangler 2001 and 2016, and in Attachment E hereafter).

11. In those areas now excluded from the Monument, archaeological resources reflect site types attributed to all of these overarching site types. A total of 649 sites are indicative of longer-term residential activities, mostly attributed to agricultural adaptations between ca. AD 200 and 1250; 91 sites are storage locations where surplus food crops were stored in granaries and cists, mostly attributed to these same agriculturalists; 1,113 sites are representative of shorter-term

occupations, mostly indicative of hunting and gathering from about 10,000 years ago through the ethnographic present; and 40 sites have clusters of rock art images believed to date from about 1500 BC to the ethnographic present.

12. Most documented sites in areas excluded from Monument protection are non-architectural sites (1,621) that are indicative of shorter-term hunting and gathering activities (1,113). Taken individually, these sites might appear to be of minimal importance, but taken in aggregate these sites help to explain human responses to shifting food resources through time and in response to changing climates. For example, researchers have postulated a region-wide drought of unprecedented proportions from about 5500 BC to about 2500 BC when entire areas were abandoned (Ambler 1996; Berry and Berry 1986; Geib 1996; Grayson 1993; Jennings 1978). In the Grand Staircase-Escalante National Monument, however, the number of sites attributed to this period of time increases over earlier occupations, suggesting that human populations responded to drought conditions by moving to higher elevations with greater biodiversity and greater effective moisture (Spangler et al. 2018).

13. In agricultural times (AD 1 to 1250), the Monument region was a transition zone wherein three different cultures interacted and competed for limited resources (see Altschul and Fairley 1989; Geib 1996; McFadden 2016; and Spangler 2001 for detailed syntheses of these data and relevant citations). The Fremont Culture occupied the Escalante River Basin on the east side of the Monument where they engaged in a flexible subsistence involving both farming and foraging. The Virgin Branch of Ancestral Puebloans (Virgin Anasazi) occupied the well-watered drainages in the Grand Staircase region, becoming full-time farmers by about 200 AD in what archaeologists commonly refer to as a Basketmaker II adaptation. At approximately AD 1050,

waves of Ancestral Puebloan immigrants from the Kayenta, Arizona, area (Kayenta Anasazi) swept into both areas, perhaps disrupting the social and economic balance that had persisted for eight centuries. By AD 1250, the region had been abandoned. The factors leading up to this abandonment – populations exceeding the carrying capacity of a marginal desert environment, deteriorating climates, and potentially violent competition for limited resources – are poorly understood. Archaeological sites removed from the Monument boundaries could help researchers develop answers to these questions.

14. The Escalante River Basin represents the northernmost expansion of Kayenta peoples onto the northern Colorado Plateau, and the archaeological evidence suggests the immigration involved large numbers of people with new architectural and technological traditions that might have displaced Fremont farmer-foragers who lived there for centuries (Altschul and Fairley 1989; McFadden 2016; Spangler 2001). Although the occupation was short-lived, the Kayenta presence on the northern Colorado Plateau resulted in large pueblos throughout the basin, especially in the Boulder and Lampstand areas where the ancient villages remain standing some 750 years after their abandonment. The relationship between the Kayenta immigrants and long-time Fremont residents remains unknown. For example, archaeologists have not yet determined whether Fremont groups simply left, or whether they were assimilated into the new Kayenta lifeway. Again, archaeologists can discover answers to these questions only by studying these sites, many of which now fall outside the Monument's boundaries.

15. The Vermilion Cliffs area of the Grand Staircase represents a remarkable and unspoiled outdoor laboratory for the study of upland Virgin Branch peoples. Sites here demonstrate (1) a robust agricultural adaptation with large and small pueblos, (2) a complex

strategy of remote farmsteads associated with larger population centers, and (3) intricate trade networks linking the region to the St. George Basin to the west and the San Juan River country to the east. Site densities in the Vermilion Cliffs are among the highest in southern Utah, ranging from 60 to 80 sites per square mile. And sites have largely escaped the ravages of looters, making them ideal for careful scientific analysis with the potential to explain human adaptations to desert environments.

16. The original 1996 Monument boundary assured that all archaeological sites within those parameters would be protected and managed for their scientific qualities. The removal of lands from the original boundary greatly increases the probability that archaeological sites will be degraded and their eligibility for listing on the National Register of Historic Places will be diminished.

17. Management of the lands for oil, natural gas, and coal extraction requires construction of transportation infrastructure to accommodate development. Section 106 of the National Historic Preservation Act and its implementing regulations require archaeological inventory prior to development to identify cultural resources that might be adversely effected by the undertaking, but this Section 106 process does not ensure those resources will be protected for their future scientific, education, or aesthetic values. In effect, the process amounts to identification of cultural resources that might be subsequently damaged or destroyed during the course of the undertaking. This stands in decided contrast to Monument management practices that protected cultural resources for their future scientific potential. (Monument investigations are largely conducted under provisions of Section 110 of the National Historic Preservation Act).

18. The increased accessibility of areas previously protected by their isolation greatly increases the likelihood that archaeological sites will suffer degradation. Studies throughout the Colorado Plateau have repeatedly demonstrated that archaeological sites in close proximity to existing travel routes and/or sites that are visible from travel routes are more vulnerable to vandalism, looting, improper Off-Highway Vehicle travel outside designated trails, camping, and improper removal of artifacts (Ahlstrom et al. 1992; Hedquist et al. 2014; Nickens et al. 1981; Simms 1986; Spangler and Yentsch 2009, 2010; Spangler et al. 2006). In effect, development of natural resources results in an infrastructure that is subsequently used to damage and destroy archaeological sites. This is especially evident in the Wygaret Terrace area adjacent to the Monument wherein a legal OHV trail resulted in numerous secondary trails leading to vandalism of Ancestral Puebloan villages (Spangler and Yentsch 2010).

19. Based on my considerable field experience and research on archaeological sites in Utah, motor vehicle use, including OHV use, may constitute the greatest threat to the long-term preservation of cultural resources on public lands, including those in the Monument and on lands subsequently removed from Monument protection. Travel over cultural sites can result in permanent damage, primarily in the form of disturbed context. Artifacts can contribute important information regarding prehistoric human behavior when studied within the context of their relationship to one another and to other features such as fire hearths and residences (Binford 1980; Metcalfe and Heath 1990; Mills and Vega-Centeno 2005; O’Connell 1987).

20. Vehicle travel over sites can and often does crush objects and artifacts, rendering them unusable for research. The most significant problem is the accelerated erosion that occurs along the route itself, which displaces the objects from their original context, erodes important cultural deposits such as charcoal that can be radiocarbon dated, and mixes older and younger cultural deposits, rendering them largely useless for meaningful interpretation. Since many prehistoric cultures in this region led a nomadic or semi-nomadic existence, the context and layout of cultural sites is frequently one of the most important clues for deciphering the human behavior behind the artifacts themselves.

21. Archaeological sites serve as the pages of books of our Nation's prehistory, with each site and artifact holding clues as to how the ancient societies rose and fell through time in response to changing climates and social pressures. Each site contains a wealth of important scientific data that, when studied in proper context, can reveal keen insights to past human behavior. These sites are easily damaged by the dislocation or removal of surface artifacts by visitors, by pedestrian and vehicle trails that accelerate erosion, compromising the spatial context of the artifacts to one another, and by vehicle traffic that breaks and displaces artifacts rendering them of minimal value for scientific study. This damage cannot be reversed.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 14 day of November, 2018, at Ogden, Utah.

Jerry D. Spangler, MA RPA

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2009 *Baseline Site Condition and Vandalism Assessments of Archaeological Sites in Tenmile Canyon, Grand County, Utah: Final Report.* Colorado Plateau Archaeological Alliance, Ogden, Utah.

2010 *Cultural Resource Inventories Along OHV Routes in Kane, Wayne, and San Juan Counties, Southern Utah*. Colorado Plateau Archaeological Alliance, Ogden. Utah

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Spangler Declaration Attachment A

Spangler Vitae

Vitae (2018)
Jerry D. Spangler, M.A., RPA

Jerry D. Spangler is a registered professional archaeologist (RPA) and executive director of the Colorado Plateau Archaeological Alliance, a Utah-based nonprofit company that works collaboratively with governments, private entities and conservation organizations to develop strategies that will further the protection and preservation of historic and archaeological sites on public lands to ensure their scientific and aesthetic values are retained for future generations. He is also the owner of and principle investigator for Uinta Research LLC, a for-profit entity that has worked in Utah since 1995. Spangler has devoted the past 30 years to archaeological research and public outreach with the expressed purpose of furthering the protection and preservation of cultural resources in the western United States. He is a recognized expert on prehistoric peoples of the northern Colorado Plateau, and has published widely in peer-reviewed journals, monographs and books.

Education

1993 Master' Degree, Anthropology. Brigham Young University, Provo, Utah

Professional Experience

Spangler has been principle investigator on scores of field research projects throughout the northern Colorado Plateau, including BLM-funded statewide research into vandalism of cultural sites and the development of public land management strategies to better protect cultural resources for future generations. In 2007, he was appointed by the Secretary of the Interior as a member of the Bureau of Land Management Resource Advisory Council for the state of Utah to a term ended in 2009, and in 2011 he was appointed the Grand Staircase-Escalante National Monument Advisory Committee (GSENM), a term that expired in 2014. He is currently involved in collaborative partnerships with GSENM and the Arizona Strip BLM.

Major Ongoing Research Projects

- 2016-2018 – Entered into a long-term research project with the Arizona Strip BLM to conduct baseline inventories in northern Arizona, including the Parashants National Monument and the Vermilion Cliffs National Monument.
- 2011-2018 – Entered into a long-term research project with the Grand Staircase-Escalante National Monument to conduct baseline inventories and assessments of adverse anthropogenic impacts in the Paria River corridor, the Kaiparowits Plateau and Johnson Canyon areas, as well as assisting with the ongoing grazing EIS and preparation of a new Class I and predictive model.
- 2006-2016 – Initiated and directed a large-scale reconnaissance of Desolation Canyon and an analysis of cultural resources impacted by recreational visitation, in cooperation with Utah Division of State History, National Park Service and the BLM.
- 2007-2018 – Initiated and directed an effort in Nine Mile Canyon to relocate and document previous recorded sites to determine the nature of adverse impacts since they were initially recorded. This effort, designed to augment the National Register database for the canyon.
- 2006-2018 – Initiated and directed an effort to utilize historic photographs (1928-1932) to identify legacy sites throughout the state and to determine the nature and extent of adverse impacts on archaeological sites over the past eight decades. This effort, which is part of larger research into vandalism, is being conducted collaboratively with the Peabody Museum at Harvard University, among other private and public entities.

Teaching Experience:

- 2008-2012 – Associate instructor, The Archaeology of Utah, Osher Institute, University of Utah.

- 2002-2006 – Project coordinator for the Range Creek Archaeological Project, a cost-sharing endeavor with the Utah Museum of Natural History, the University of Utah, College of Eastern Utah, Salt Lake Community College and others.
- 1994-2007 – Adjunct instructor, College of Eastern Utah, Price, Utah. "The Archaeology of the Northern Colorado Plateau" and "Introduction to Archaeological Survey."
- 1990 to present – Volunteer instructor/lecturer to various chapters of the Utah Statewide Archaeological Society, the Utah Rock Art Research Association, the Colorado Historical Society, the University of Utah Law School, the Colorado Archaeological Society and other community and school groups.

Major Publications and Monographs

- 2018 – *The Crimson Cowboys: The Remarkable Odyssey of the 1931 Claflin Emerson Expedition to Eastern Utah*. University of Utah Press, Salt Lake City.
- 2017 – *Short Creek Serenade: Class III Inventories on Lost Spring Mountain near Colorado City, Arizona*. Colorado Plateau Archaeological Alliance, Ogden, Utah. Report on file, Arizona Strip Field Office, Bureau of Land Management, St. George, Utah.
- 2017 – *Snap Shot: Class III Inventory in Lower Snap Draw, Grand Canyon-Parashant National Monument*. Colorado Plateau Archaeological alliance, Ogden, Utah. Report on file, Arizona Strip Field Office, Bureau of Land Management, St. George, Utah.
- 2016 – *Last Chance Byway: A History of Nine Mile Canyon*. University of Utah Press, Salt Lake City.
- 2016 – *Fire on the Mountain: Class III Inventories in the Lake Canyon Area, Kaiparowits Plateau, Kane County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2016 – *From Meadow to Mesa: Class III Inventories in the Meadow Canyon Area in the Grand Staircase, Kane County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2014 – *The Flat Canyon Archaeological Project: Report of 2013 Investigations in Desolation Canyon, Carbon County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- *2014 -- The Devil's Due: Class III Cultural Resources Inventory in the Devils Canyon area of Nine Mile Canyon, Carbon County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- *2013 – Devil's Playground: Site Documentation and Comparative Analysis of 42Cb3162 With Complete 1931 Claflin Emerson Expedition Field Notes.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2013 – *Two Block Surveys in the Rock House Bottom and Long Bottom Areas, Green River Corridor, Desolation Canyon National Historic Landmark*. Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2013 – *Dart Points, Dugways, and Life on the Northern Fringe of the St. George Basin: A Class III Cultural Resource Inventory in the T Bone Hill and Black Gulch Areas of the Red Cliffs National Conservation Area, Washington County, Utah*. Colorado Plateau Archaeological Alliance, Ogden, Utah
- 2013 – *Nine Mile Canyon: The Archaeological History of an American Treasure*. University of Utah Press, Salt Lake City.
- 2012 – The Archaeology of Desolation Canyon, Utah. In *An Archaeological Legacy: Essays in Honor of Ray T. Matheny*, edited by Deanne G. Matheny, Joel C. Janetski and Glenna Nielsen, pp. 99-124. Occasional Paper No. 13, Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.
- 2012 – *Risky Business: Farming and Travel in the Upper Paria River Corridor* (lead author). Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2012 – *Fremont, Freighters and Flagpoles: An Archaeological Inventory of the North Side of Nine Mile Canyon Between Gate Canyon and Pete's Canyon*. Ogden: Colorado Plateau Archaeological Alliance, 2012.
- 2012 – *The Upper Fringe: Archaeological Inventory in Upper Nine Mile Canyon, Carbon County, Utah*. Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2012 – *Preliminary Report on Two Block Surveys in the Steer Ridge Canyon and Lower Range Creek Areas,*

Desolation-Gray Canyon Corridor, Eastern Utah. Colorado Plateau Archaeological Alliance, Ogden, Utah.

- 2011 -- *Formal Site Documentation and Analysis of Visitor Impacts at Warrior Ridge (42Dc1), Duchesne County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2011 -- *Of Owls and Cranes: A Cultural Resource Inventory of Section 35, Township 11 South, Range 14 East, Middle Nine Mile Canyon, Duchesne County, Utah.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2011 -- *The Pete's Canyon Complex: Formal site Documentation and Analysis of Visitor Impacts in Nine Mile Canyon, Duchesne County, Utah*. Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2011 -- *2009 Test Excavations at Fish Creek Cove (42Wn503): Revisiting the Legacy of Noel Morss and the Peabody Museum Investigations of 1928.* Colorado Plateau Archaeological Alliance, Ogden, Utah.
- 2011 -- *The Nutter Ranch Project: Investigations in the Gate Canyon Area of Nine Mile Canyon, Duchesne County, Utah. Colorado Plateau Archaeological Alliance, Ogden, Utah* (in prep.)
- 2010 – *Cultural Resource Inventories Along OHV Routes in Kane, Wayne, and San Juan Counties, Southern Utah*. Colorado Plateau Archaeological Alliance, Ogden. Utah (lead author).
- 2009 -- *Land of Wildest Desolation: Final Report. The Desolation Canyon Intuitive Surveys and Baseline Site Condition Assessments of 2006 to 2008* (lead author). CPAA Manuscript on file, Price Field Office, Price, Utah.
- 2009 – *The Nutter Ranch Project: Preliminary Report of the 2008 Intuitive Surveys*. CPAA manuscript on file, Price Field Office, Price, Utah.
- *2009 -- Foraging and Farming on the Southwestern Frontier: A Class I Analysis of Cultural Resources in the Greater Cedar Mesa, Southeastern Utah*. CPAA manuscript on file, Monticello Field Office, Monticello, Utah (lead author).
- 2008 – *The Desolation Canyon Baseline Site Condition and Vandalism Assessments: October 2007.* CPAA manuscript on file, Price Field Office, Price, Utah (lead author).
- 2007 – *Baseline Site Condition Assessment of Historic Properties Near the Bureau of Land Management Sand Wash Ranger Station, Uintah County*. CPAA manuscript on file, Price Field Office, Bureau of Land Management (lead author).
- 2007 – *Baseline Site Condition and Vandalism Assessments of Archaeological Sites in Tenmile Canyon, Grand County, Utah.* CPAA manuscript on file, Moab Field Office, Bureau of Land Management (lead author).
- *2007 – The Desolation Canyon Baseline Site Condition and Vandalism Assessments: May 2007.* CPAA manuscript on file, Price Field Office, Bureau of Land Management (lead author).
- *2007 – An Intuitive Survey and Site Condition Assessment in the Desolation Canyon National Historic Landmark, Carbon County, Utah (September 2006).* CPAA manuscript on file, Price Field Office, Bureau of Land Management (lead author).
- *2007 – Desolation Canyon Baseline Site Condition and Vandalism Assessment: October 2007.* CPAA manuscript on file, Price Field Office (lead author).
- *2007 – Treasures of the Tavaputs: The Archaeology of Desolation Canyon, Nine Mile Canyon and Range Creek (co-author).* CPAA publication on file, Ogden, Utah.
- 2007 – *Vermillion Dreamers, Sagebrush Schemers: An Overview of Human Occupation in House Rock Valley and the Eastern Arizona Strip*. CPAA publication prepared for the Grand Canyon Trust, Flagstaff, Arizona.
- 2006 – Chasing Ghosts: An Analysis of Vandalism and Site Degradation in Range Creek Canyon, Utah. *Utah Museum of Natural History Occasional Papers* 2006:1. Salt Lake City. (lead author)
- 2006 – *Site Condition and Vandalism Assessment of Archaeological Sites, Lower and Middle Arch Canyon, San Juan County, Utah.* CPAA manuscript on file, Monticello Field Office, Bureau of Land Management.
- 2006 -- *Data Recovery at Two High Elevation Archaic Residential Base Camps (42Cb2178 and 42Cb2186)*

and a Historic Homestead (432Cb2185), on the West Tavaputs Plateau, Carbon County, Utah. CPAA manuscript on file, Utah Division of State History (lead author).

- 2006 – Migrations of Western Native Americans and the Fall of Cahokia: Responses to Early-Eleventh, Middle Twelfth and Late-Thirteenth Century Droughts. *Quaternary Science Reviews* 26:336-350. (Co-author)
- 2004 – Categories and Conundrums: The Rock Art of Lower Nine Mile Canyon. In New dimensions in Rock Art Studies, edited by Ray T. Matheny. *Museum of Peoples and Cultures Occasional Papers Series* No. 9. Provo, Utah.
- 2004 – A Summary of the 2002-2003 Intuitive Surveys of the Wilcox Acquisition and Surroundings Lands, Range Creek Canyon, Utah. *Occasional Papers of the Museum of Natural History*, Salt Lake City.
- 2003 – *Horned Snakes and Axle Grease: A Roadside Guide to the Archaeology, History and Rock Art of Nine Mile Canyon*. Uinta Publishing, Salt Lake City.
- 2002 – *Paradigms and Perspectives Revisited: An Updated Class I Overview of Cultural Resources in the Uinta Basin*. Bureau of Land Management Cultural Resource Series (in press).
- 2001 – *Human Landscapes and Prehistoric Paradigms: A Class I Overview of Cultural Resources in the Grand Staircase-Escalante National Monument*. Utah Museum of Natural History Reports of Investigations No. 01-2, Salt Lake City.
- 2000 – Old Paradigms and New Perspectives: A Reinterpretation of Cultural Chronology in the Uinta Basin, in *Intermountain Archaeology*, edited by David B. Madsen and Michael D. Metcalf. University of Utah Anthropological Papers No. 122, Salt Lake City.
- 2000 – One Pot Pithouses and Fremont Paradoxes: A Case for Itinerant Aceramic Fremont Horticultural in Northeastern Utah, in *Intermountain Archaeology*, edited by David B. Madsen and Michael D. Metcalf. University of Utah Anthropological Papers No. 122, Salt Lake City.

Other Experience

- 2006 – Technical consultant to the Utah Museum of Natural History, Range Creek Canyon Exhibit.
- 2004-2006 – Assisted non-profit organizations in the development of National Register nominations for two large archaeological districts (Nine Mile Canyon and Range Creek Canyon), under provisions of the National Historic Preservation Act of 1966.
- 1994-2002 – Technical consultant to the College of Eastern Utah Prehistoric Museum in connection with the procurement of National Endowment for the Humanities, National Science Foundation and State of Utah grants.
- Research curator, Utah Museum of Natural History, 2010-2018.

Honors

- *2018* – Don and Catherine Fowler Award for *The Crimson Cowboys: The Remarkable Odyssey of the Claflin-Emerson Expedition.*
- 2016 – Clarence Dixon Taylor Award from the Charles Redd Center for *Last Chance Byway: A History of Nine Mile Canyon.*
- 2013 – Recipient of Choice Outstanding Academic Title Award for *Nine Mile Canyon: The Archaeological History of an American Treasure*.
- 2009 – Preservation efforts in Nine Mile Canyon honored with the highest award from the American Rock Art Research Association
- 2007 – "Treasures of the Tavaputs" honored with the President's Award, Utah Professional Archaeological Council.

- 2004 – The Utah State Historical Society awarded "Horned Snakes and Axle Grease" its annual book award, commending it for message of preservation and respect for prehistoric and historic resources.

Professional Affiliations

Society for American Archaeology, Washington D.C.
Utah Professional Archaeological Council, Salt Lake City.
Register of Professional Archaeologists, Baltimore.

Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Spangler Declaration Attachment B

Society for American Archaeology Sites Removed Final Worksheet

Before Dec. 2017	Sites After Dec. 2017	Sites Removed from Monument Protection	Summary
42GA1000	42GA1000	42GA1572	
42GA1001	42GA1001	42GA1573	**Garfield County Before: 1260**
42GA1002	42GA1002	42GA1580	**Garfield County After: 715**
42GA1003	42GA1003	42GA1581	**Garfield Sites Removed: 545**
42GA1004	42GA1004	42GA1582	
42GA1006	42GA1006	42GA1585	
42GA101	42GA101	42GA1586	
42GA1099	42GA1099	42GA1587	
42GA1101	42GA1101	42GA1588	
42GA115	42GA115	42GA1592	
42GA1423	42GA1423	42GA1593	
42GA1424	42GA1424	42GA1594	
42GA1425	42GA1425	42GA1595	
42GA1426	42GA1426	42GA1596	
42GA1427	42GA1427	42GA1597	
42GA1428	42GA1428	42GA1615	
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42GA1430	42GA1430	42GA1617	
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42GA1437	42GA1437	42GA1655	
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Before Dec. 2017	Sites After Dec. 2017	Sites Removed from Monument Protection	Summary
42KA100	42KA1361	42KA100	
42KA101	42KA1362	42KA101	Kane County Before: 2995
42KA102	42KA1363	42KA102	Kane County After: 1625
42KA103	42KA1364	42KA103	Kane Sites Removed: 1370
42KA104	42KA1365	42KA104	
42KA105	42KA1366	42KA105	
42KA1056	42KA1367	42KA1056	
42KA1058	42KA1368	42KA1058	
42KA1059	42KA1369	42KA1059	
42KA106	42KA1370	42KA106	
42KA107	42KA1371	42KA107	
42KA108	42KA1372	42KA108	
42KA110	42KA1373	42KA110	
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Before Dec. 2017	Sites After Dec. 2017	Sites Removed from Monument Protection	Summary
42GA1000	42GA1000	42GA1572	
42GA1001	42GA1001	42GA1573	**Total Sites Before: 4225**
42GA1002	42GA1002	42GA1580	**Total Sites After: 2340**
42GA1003	42GA1003	42GA1581	**Total Sites Removed: 1915**
42GA1004	42GA1004	42GA1582	
42GA1006	42GA1006	42GA1585	
42GA101	42GA101	42GA1586	
42GA1099	42GA1099	42GA1587	
42GA1101	42GA1101	42GA1588	
42GA115	42GA115	42GA1592	
42GA1423	42GA1423	42GA1593	
42GA1424	42GA1424	42GA1594	
42GA1425	42GA1425	42GA1595	
42GA1426	42GA1426	42GA1596	
42GA1427	42GA1427	42GA1597	
42GA1428	42GA1428	42GA1615	
42GA1429	42GA1429	42GA1616	
42GA1430	42GA1430	42GA1617	
42GA1431	42GA1431	42GA1618	
42GA1432	42GA1432	42GA1619	
42GA1433	42GA1433	42GA1620	
42GA1434	42GA1434	42GA1650	
42GA1435	42GA1435	42GA1651	
42GA1436	42GA1436	42GA1654	
42GA1437	42GA1437	42GA1655	
42GA1438	42GA1438	42GA1656	
42GA1439	42GA1439	42GA1807	
42GA1440	42GA1440	42GA1808	
42GA1441	42GA1441	42GA1809	
42GA1442	42GA1442	42GA2059	
42GA148	42GA148	42GA2060	
42GA1536	42GA1536	42GA2061	
42GA1537	42GA1537	42GA2062	
42GA1538	42GA1538	42GA2063	
42GA1539	42GA1539	42GA2064	
42GA1541	42GA1541	42GA2065	
42GA1542	42GA1542	42GA2066	
42GA1543	42GA1543	42GA2067	
42GA1544	42GA1544	42GA2068	
42GA1545	42GA1545	42GA2069	
42GA1546	42GA1546	42GA2070	
42GA1548	42GA1548	42GA2071	
42GA1549	42GA1549	42GA2072	
42GA1572	42GA1598	42GA2073	
42GA1573	42GA1599	42GA2074	

42GA1580	42GA1600	42GA2075
42GA1581	42GA1601	42GA2076
42GA1582	42GA1602	42GA2077
42GA1585	42GA1603	42GA2078
42GA1586	42GA1604	42GA2079
42GA1587	42GA1605	42GA2080
42GA1588	42GA1606	42GA2081
42GA1592	42GA1607	42GA2082
42GA1593	42GA1608	42GA2087
42GA1594	42GA1609	42GA2088
42GA1595	42GA1610	42GA2129
42GA1596	42GA1611	42GA2238
42GA1597	42GA1612	42GA2239
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42GA1599	42GA1614	42GA2241
42GA1600	42GA1621	42GA2242
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42GA1602	42GA1623	42GA2244
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42GA1628	42GA1669	42GA2275
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42GA1636	42GA1675	42GA2287
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42GA1669	42GA1695	42GA2527
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42GA1682	42GA2094	42GA2540
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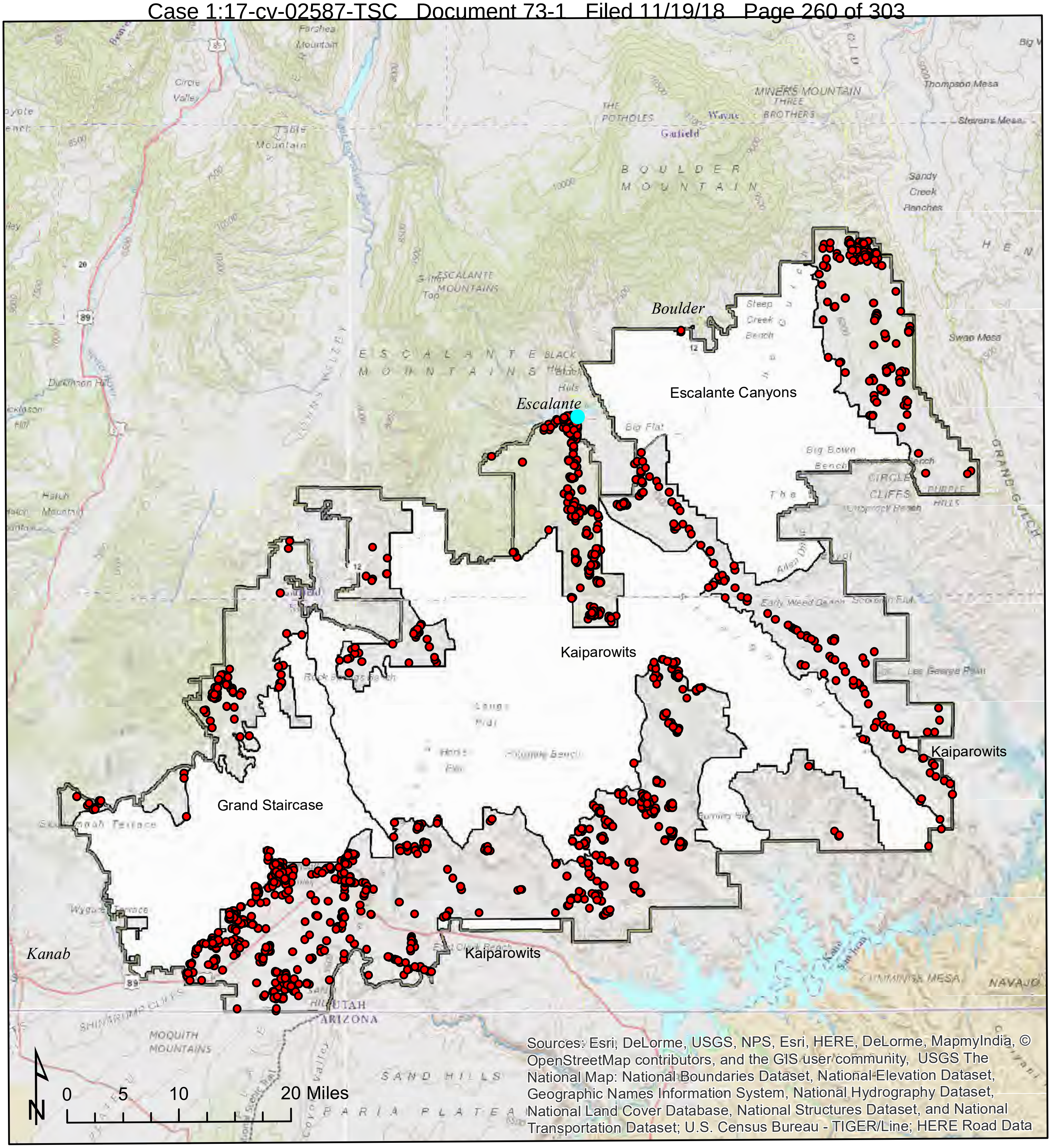
Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Spangler Declaration Attachment C

Grand Staircase-Escalante National Monument Excluded Sites Map



The original boundary of the Grand Staircase-Escalante National Monument has a total of 4,225 documented cultural resources within it.

The proposed boundary (Dec 4th, 2017) has a total of 2,340 documented cultural resources.

In addition, the small amount of inventory conducted on the GSENM means that there are still many unknown and undocumented archaeological sites of great cultural and scientific importance.

Legend

- Cultural Resource
- Original GSENM Boundary
- Revised Monument Boundary (12/4/17)

Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Spangler Declaration Attachment D

Archaeological Potential of the Grand Staircase-Escalante National Monument

Archaeological Potential of the Grand Staircase-Escalante National Monument

Peter M. Yaworsky, Kenneth Blake Vernon, Brian F. Codding

THE UNIVERSITY OF UTAH
ARCHAEOLOGICAL CENTER

Background

Executive proclamation 9682 reduces the size of the Grand Staircase-Escalante National Monument (GSENM), removing protections for at least 2,000 known archaeological sites and an unknown number of undiscovered cultural properties. Because only 10% of the GSENM's 1.9 million acres has been inventoried by archaeologists, fully evaluating the potential consequences of these boundary reductions in the remaining 90%, or 1.71 million acres, requires the use of predictive modeling. Here we report the major findings of a comprehensive predictive modeling program undertaken by the University of Utah Archaeological Center. Methodological and analytical details are available from the authors or in a report issued to the Bureau of Land Management.

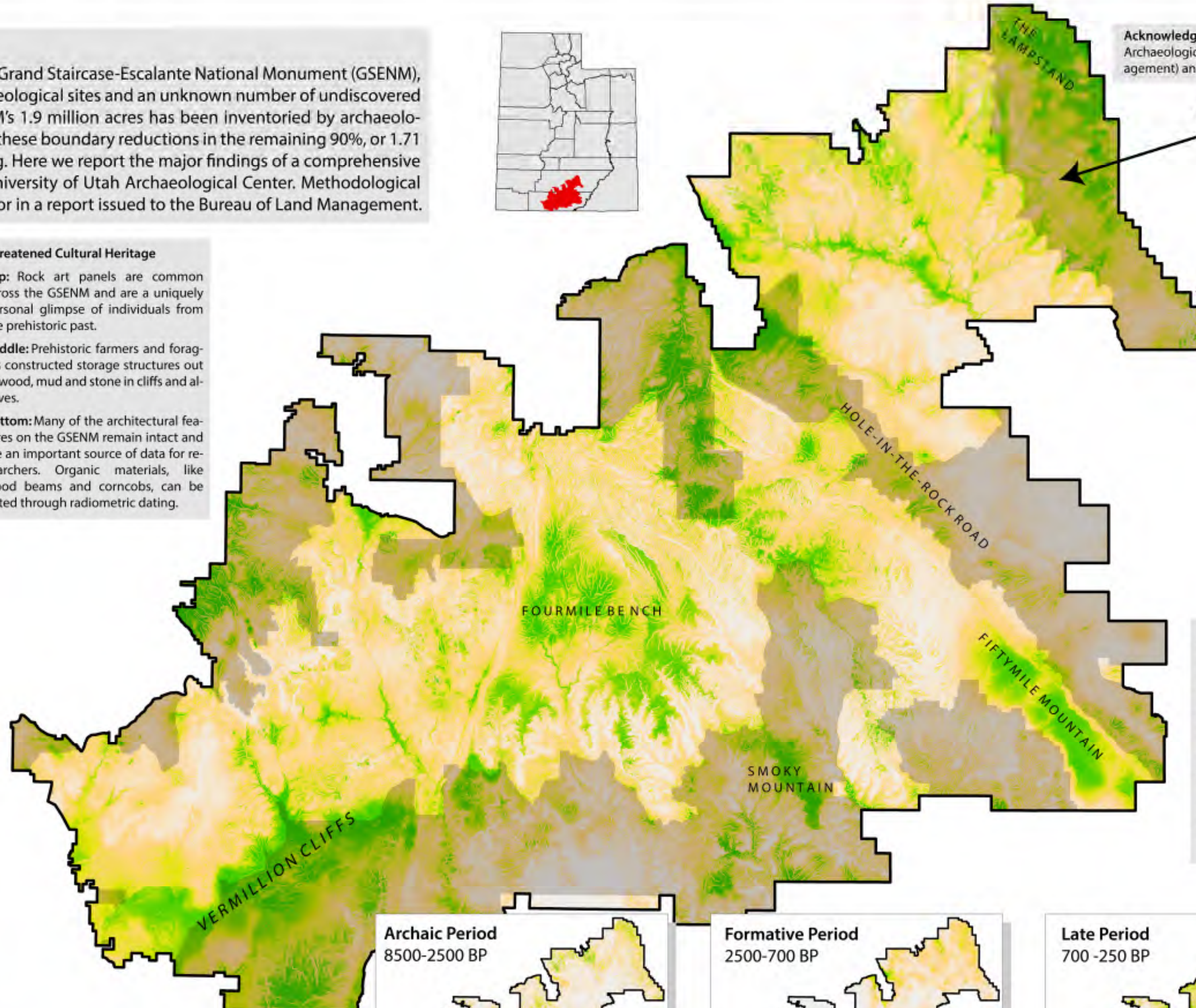


Threatened Cultural Heritage

Top: Rock art panels are common across the GSENM and are a uniquely personal glimpse of individuals from the prehistoric past.

Middle: Prehistoric farmers and foragers constructed storage structures out of wood, mud and stone in cliffs and alcoves.

Bottom: Many of the architectural features on the GSENM remain intact and are an important source of data for researchers. Organic materials, like wood beams and corncobs, can be dated through radiometric dating.



Acknowledgment: Thanks to Jerry Spangler (Colorado Plateau Archaeological Alliance), Matt Zwiefel (Bureau of Land Management) and the UU Center for High Performance Computing.

Excised from Monument on December 4, 2017 (shaded in grey)

Original Monument Boundary (black line)

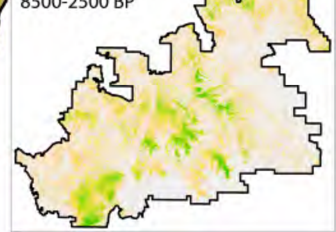
Probability Area Contains Cultural Resources

- Very High
- High
- Moderate
- Low
- Very Low

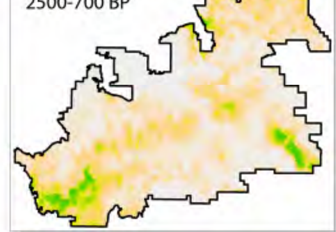
Conclusion

The new monument boundary excludes areas with some of the highest potential for cultural resources, leaving an estimated 20,000 or more undiscovered archaeological sites at risk. Protecting these resources is critical for future scientific inquiry and for preserving cultural heritage.

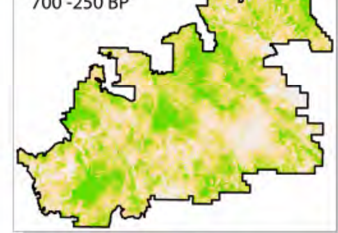
Archaic Period
8500-2500 BP



Formative Period
2500-700 BP



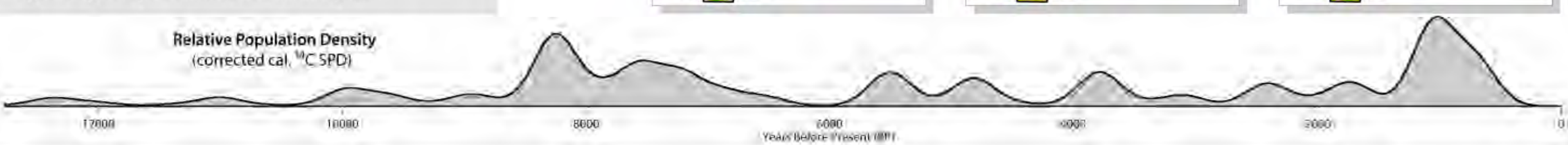
Late Period
700 -250 BP



Snapshots Through Time

Our analysis reveals changes in prehistoric land use through time, including the 6000 year record of Archaic hunter-gatherers, the nearly 2000 year Formative Period dominated by maize agriculturalists, and the Late Period return to hunting and gathering in response to multidecadal droughts.

Relative Population Density
(corrected cal. ^{14}C SPD)



Details on data, methods, analysis and results are available from the authors.

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Wilderness Society *et al.* v. Trump, *et al.*, Civil Action No. 1:17-cv-02587 (TSC), 1:17-cv-2591 (TSC) (Consolidated Cases)

Spangler Declaration Attachment E

The Grand Staircase-Escalante National Monument Cultural Resources Predictive Model

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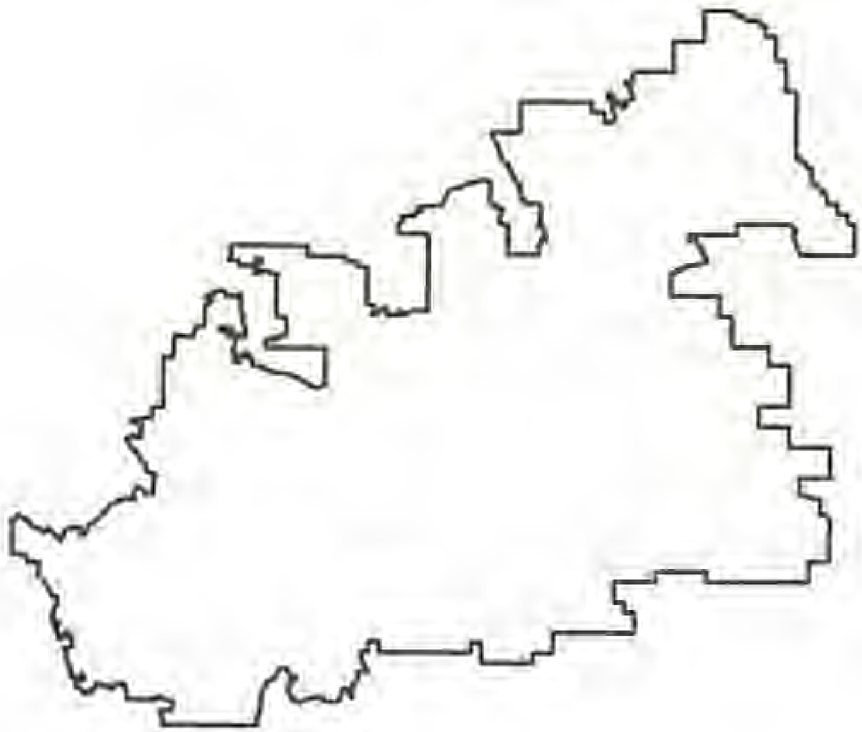
ARCHAEOLOGICAL CENTER



The Grand Staircase-Escalante National Monument Cultural Resource Predictive Model

Peter M. Yaworsky, Kenneth B. Vernon, Brian F. Codding

January 23, 2018

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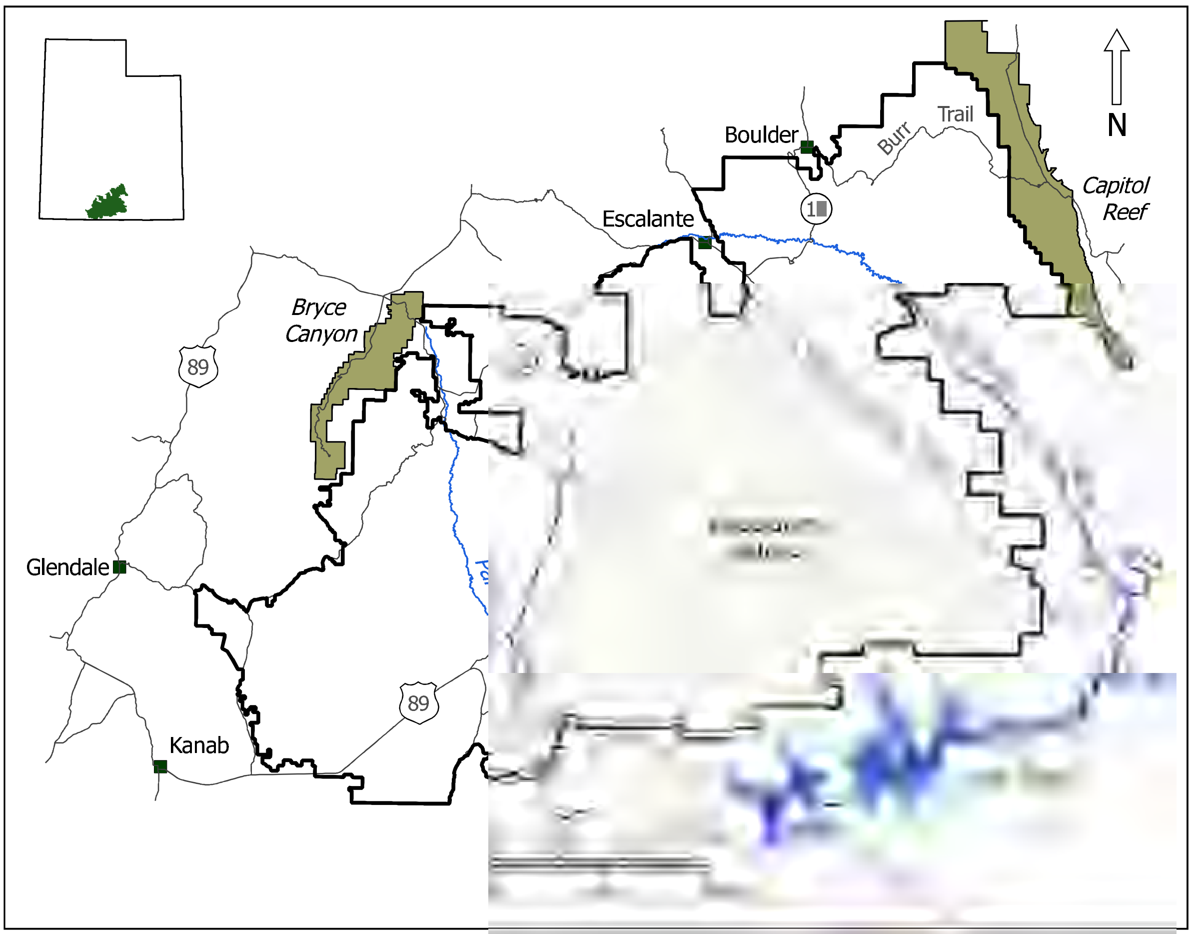


Figure 1: Reference Map for the Grand Staircase-Escalante National Monument.

1 INTRODUCTION

While predictive modeling in archaeology has improved significantly, current implementations still suffer many of the same deficits that have plagued predictive site modeling for decades: small and opportunistic training data sets, coarse, discrete and naïve environmental data, underpowered computing and statistical tests, and only implicit expectations about human land-use patterns. These deficits render most archaeological predictive models insufficient to accomplish their stated goals. Fortunately, recent advances in the behavioral and environmental sciences offer solutions to these issues, signaling a new era for predictive site modeling. This progress comes in two areas. First, recent anthropological research has coupled theoretical insights into human behavior with high resolution, remotely sensed, environmental data to accurately predict human land-use patterns in both prehistoric (Codding and Jones, 2016; Jazwa et al., 2017) and historic (Yaworsky and Codding, 2017) contexts (Codding and Bird, 2015). Second, new advances in species distribution models (SDMs) are revolutionizing ecology, allowing researchers to predict the distribution of rare and endangered species with greater certainty (Elith et al., 2011; Guisan et al., 2013; Phillips and Dudík, 2008; Wilson et al., 2011; Bradie and Leung, 2017).

The University of Utah Archaeological Center (UUAC) has drawn on both advances to develop a predictive model of cultural resource occurrences in the Grand Staircase-Escalante National Monument (GSENM). Referred to as the GSENM Cultural Resource Predictive Model (or GSENM-CRPM), the model serves to support a Class I Existing Information Inventory of the monument undertaken by the Colorado Plateau Archaeological Alliance (CPAA) as part of a cooperative agreement with the Bureau of Land Management (BLM).

Table 1: Project Deliverables

Deliverable	Quantity
GSENM-CRPM	1
Environmental Predictor Rasters	132
Site Component Database	1
Data Models v1	38
Data Models v2	5
Predictive Rasters	6

GSENM-CRPM relies on a specific statistical approach known as Maximum Entropy (MaxEnt) (Jaynes, 1957; Phillips et al., 2006) to evaluate associations between environmental variables and known site component occurrences. It then uses that evaluation to predict locations where site components are likely to occur. To develop the GSENM-CRPM, we (1) compile locations of known occurrences using the BLM and SHPO archaeological site databases, (2) select environmental variables expected to characterize land-use, (3) train the model with occurrence and absence data to estimate similarity between locations of occurrence and absence, and (5) use the model to predict occurrences throughout the GSENM.

Our use of MaxEnt for cultural resource management is the first of its kind in the state of Utah. Incipient anthropological applications of SDMs elsewhere have yielded promising results (Sesink Clee et al., 2015). For example, anthropologists have used a MaxEnt model to identify the locations of un-contacted tribes in the Amazon (Kesler and Walker, 2015), demonstrating the ability of these models to predict human land-use patterns. Initial archaeological applications have also demonstrated the effectiveness of the approach in northeastern California (Oyarzun, 2016).

An important strength of our modeling effort involves the classification of site components into culturally-delimited time periods. The transitions between these time periods, broadly construed, correspond to familiar subsistence transitions: from narrow to broad spectrum foraging, from broad spectrum foraging to low scale corn agriculture, and vice versa. Since subsistence effort plays a significant role in shaping land-use patterning, and land-use patterning shapes the distribution of site components, structuring our response variables by time period gives our model more predictive power, as is shown below by the comparison of MaxEnt's performance for a general time period category to its performance for each specific time period cateogry.

2 DATA METHODS

The data used in the GSENM-CRPM are broken into two components, predictor variables (specifically, geospatial rasters representing various environmental features of the GSENM) and response variables (or known site components, including their spatial location and other attributes).

2.1 Predictor Variables: GSENM Environmental Data

The predictor data consist of 132 geospatial rasters (Appendix 7). Only 110 are used in the model due to an abundance of missing values in 22 of the geospatial rasters. The predictor data are vital to the model and need to reflect socioenvironmental influences of land-use patterns. Because of the time expanse and changes in subsistence that likely resulted in different land-use patterns through time, we select data that pertain to specific time periods and subsistence strategies that likely influenced land-use throughout time. Predictor variables fall into five categories: resource distribution, climate, environmental productivity, landscape, and soil attributes. Here we outline our general reasoning for including each.

Resource Distribution

All else being equal, we expect that people should distribute themselves close to profitable resource patches in order to reduce travel time between resource acquisition locations and central places (Orians and Pearson, 1979; Zeanah, 2004). The raster data representing resource distribution in the GSENM focus primarily on distance to water, both as a necessary resource in itself and as a proxy for other profitable resources in an arid environment like that characteristic of the Colorado Plateau.

The resource distribution data are cost-distance rasters. A cost-distance raster is the distance from a resource to any cell in the raster. To account for the topographic landscape, our cost-distance rasters are measured in time. They are calculated using Tobers Hiking function (Tobler, 1993) to account for the effect of slope on walking speed. The default walking speed used in our cost-distance raster is 4 kilometers per hour. By using time instead of linear distance as our measure, we are better able to understand the actual cost of accessing these resources from anywhere on the GSENM.

Cost-distance rasters are created at extents much larger than the GSENM boundary in order to avoid an edge-effect. These include:

- Cost-distance to lakes
- Cost-distance to springs
- Cost-distance to streams
- Cost-distance to wetlands

Climate

Local climate likely influenced both prehistoric hunter-gatherers and agriculturalists. To account for this we use a range of fine-grained climate data that has both monthly and annual 30-year averages. While we do not account for fluctuations in past climate, we assume that variations in regional climate across the GSENM fluctuated together. That is, if climate became hotter and dryer by an order of magnitude in one area, it also became hotter and dryer by a similar magnitude in other areas, with relative temperature and moisture remaining constant. These include:

- Frost-free days
- Growing-degree days (GDD)
- Heating-degree days
- Average monthly precipitation (30 year normal)

- Average annual precipitation (30 year normal)
- Average monthly temperature (30 year normal)
- Average annual temperature (30 year normal)
- Average monthly minimum temperature (30 year normal)
- Average annual minimum temperature (30 year normal)
- Average monthly maximum temperature (30 year normal)
- Average annual maximum temperature (30 year normal)
- Average monthly mean dewpoint temperature (30 year normal)
- Average annual mean dewpoint temperature (30 year normal)
- Average monthly minimum vapor pressure deficit (30 year normal)
- Average annual minimum vapor pressure deficit (30 year normal)
- Average monthly maximum vapor pressure deficit (30 year normal)
- Average annual maximum vapor pressure deficit (30 year normal)

Environmental Productivity

The overall productivity of an environment determines the abundance of profitable resources and resource patches. Assuming that individuals seek to maximize their rate of energetic return (see Charnov 1976a,b), they should prefer to occupy locations of higher environmental productivity. While most often applied to hunting and gathering populations (Codding and Jones, 2013), this logic also holds for agriculturalists. Given that their broad diets (Barlow, 2002) consisted of less profitable resources requiring significant investment in handling rather than search, they should be less mobile and, therefore, more sensitive to variation in environmental productivity. As such, environmental productivity will be relevant for all time periods, but particularly important for agricultural. These include:

- Average Annual Actual Evapotranspiration
- f1 (Growing Degree Days, GDD)
- f2 (Moisture Index)
- Moisture Index (MI)
- Crop productivity
- Net Primary Productivity (NPP)
- Average Annual Potential Evapotranspiration
- Probability of Cultivation (S)

Soil Attributes

As with environmental productivity, soil attributes are likely more salient to the land-use decisions of agricultural populations. However, some soil attributes may also constrain specific vegetation that affect hunter-gatherer land-use patterns. Additionally, archaeological sites may be more common in specific depositional and erosional contexts. Unfortunately the soil data are largely incomplete and could not be used effectively in any models. These include:

- Depth to restrictive layer
- Drainage class

- Soil texture
- Soil health
- Soil classiffication
- Taxonomic class
- Surface texture
- T-factor
- Water depth

Landscape Attributes

Landscape attributes impose physiological constraints on land-use. These data are commonly documented in Intermountain Antiquities Computer System (IMACS) site forms and are recognized as potential contributors to land-use patterns. These include:

- Aspect
- Elevation
- Slope
- Dominant vegetation
- Watershed Size

Final Predictors

From the 132 geospatial rasters, we use 110 in the initial run of the model. The 22 geospatial rasters that are not included in the model primarily derive from the USDA SSURGO data (Soil Survey Staff). The USDA SSURGO is largely incomplete. Additionally, a few others were dropped due to high correlation with other geospatial rasters and a lack of variation in values across the project area.

2.1.1 Data Preparation

Since the data come from a number of sources, the coordinate reference systems, extents, and resolutions differ. This necessitates manipulation of the predictor data before use. To do this, we use R (R Development Core Team, 2017) and the R package raster (Hijmans et al., 2017b) to 1) specify coordinate reference systems using ESPG codes, 2) crop each raster to an extent slightly larger than the GSENM, 3) transform the raster coordinate reference system to a standard coordinate reference system (in our case it is ESPG: 26912 NAD83 Zone 12N), 4) resample cell values at a standard resolution (in our case we resample to the resolution of the elevation DEM data at 5 meters squared), 5) and crop each raster to the GSENM extent.

The process of preparing the predictor data is done using for-loops in R that are specific to subsets of the data. The subsets of data are broken into original coordinate reference systems and whether the data is categorical or continuous. For categorical data, a nearest-neighbor approach is used to resample raster cells. For continuous data, a bilinear approach is used. Once all predictor data are standardized to a common extent, resolution, and coordinate reference system, using R we create a raster stack which stacks all the rasters into one object.

2.2 Response Variables: GSENM Site Database

The Grand Staircase Escalante National Monument Site Database, version 1 (here labelled GSENM-SiteDB-01), provides important information regarding Descriptive, Interpretive, and Temporal site types found in the national monument. Its primary purpose is to organize those site response variables for use in the GSENM-CRPM. The data derive from site records curated by the BLM GSENM Field Office. Digital copies of the site records provided by the BLM are entered into the database.

2.2.1 Database Design

GSENM-SiteDB-01 is a non-relational database, whose structure is shown in Table 2. **The basic unit of analysis is the site component, rather than the whole site, as components provide a more precise indication of settlement patterning by time period**. Therefore, the database consists of a number of rows equal to the number of site components in the GSENM, plus one additional row (the first row) for column headers. Each site is assigned a unique key. The key is identical to its Smithsonian Trinomial Number, which is provided by the UT State Historic Preservation Office (UT-SHPO). Each component of a site takes the same site key but occupies its own row in the database.

Table 2: Structure of GSENM-SiteDB-01

SITE_NO	A_N	O_S	RE	SO	ST	RA	TIME	NRHP	GPS	INITIAL	DATE	NOTE
42GAxxx1	A	O	1	0	0	0	PA	1	1	PY	081017	*note*
42GAxxx2	N	S	0	0	1	0	AR	0	0	BV	081017	*note*
42GAxxx3	U	U	0	0	0	0	FO	1	0	A	081017	*note*
42KAxxx4	A	O	1	0	1	1	LP	1	1	BV	081017	*note*
42KAxxx5	N	S	0	1	0	0	HI	0	1	BV	161117	*note*
42KAxxx6	N	O	0	1	0	0	LP	0	1	BV	161117	*note*
42KAxxx6	N	O	0	1	0	0	HI	0	0	PY	161117	*note*
42KAxxxx	U	U	0	0	0	0	U	0	0	A	241117	*note*
...	U	U	0	0	0	0	U	0	0	PY	281117	*note*

KEY:

	Descriptive		*Interpretive*		*Time Period*		*Numerals*
A	Architectural	RE	Residential	PA	Paleo-Archaic		
N	Non-Architectural	SO	Short Occupation	AR	Archaic	1	TRUE
O	Open Air	ST	Storage	FO	Formative	0	FALSE
S	Sheltered	RA	Rock Art	BM	Basketmaker II		
U	Unknown	U	Unknown	FR	Fremont		
				PB	Pueblo		
				LP	Late Prehistoric		
				HI	Historic		
				U	Unknown		

The database consists of twelve columns specifying a number of potential site attributes. Headers for those columns include the following: SITE_NO, A_N, 0_S, RE, SO, ST, RA, TIME, NRHP, GPS, INITIAL, DATE, and NOTE. SITE_NO identifies the column whose values are each site's unique Smithsonian Trinomial. A_N and O_S are columns for attributing to sites membership in various Descriptive categories: Architectural and Non-Architectural in the case of A_N and Open Air and Sheltered in the case of O_S. Their potential values are i) A, N, and U and ii) O, S, and U, respectively. RE, SO, ST, and RA are columns for attributing to sites membership in different Interpretive categories: Residential (RE), Short Occupation (SO), Storage (ST), and Rock Art (RA). Their potential values are 1 and 0. *If the site is a member of that category, then it receives a 1. If the site is NOT a member of that category, then it receives a 0.* TIME, as its name suggests, is a column for associating a site with a specific time period: Prearchaic (PA), Archaic (AR), Basketmaker (BM), Fremont (FR), Pueblo (PB), Late Prehistoric (LP), Historic (H), and Unknown (U).

In Appendix 8.2, Descriptive, Interpretive, and Temporal categories are given definitions, including explicit identification rules for data entry purposes. Where possible, rules are based on criteria developed for the original

(IMACS) site forms and the recently developed Utah Archaeology Site Forms (UASF). Here, NRHP refers to field evaluations of site significance and eligibility for inclusion in the National Register of Historic Places (NRHP). Its potential values are 1 and 0. *If the site is eligible, then it receives a 1. If NOT, then it receives a 0.* GPS refers to the method of collecting UTM coordinates for the site datum. Its potential values are also 1 and 0. *If UTM coordinates were collected using a GPS receiver, then it receives a 1. If NOT, then it receives a 0.* INITIAL and DATE are administrative columns, providing a means of keeping track of who added the entry and when they added it. Finally, the NOTE column allows us to track any question or concern that cannot be answered using one of the rules outlined in the appendix.

Table 3: Quantitative Summary of GSENM-SiteDB-01

TIME			PA	AR	FR	BM	PB	FO	FO_TOT	LP	HI	U	NA	TOTAL
		TOTAL	3	514	274	7	1089	264	1634	70	230	1824	253	4528
DESCRIPTIVE	A_N	A	0	0	91	3	532	210	836	1	80	45	0	962
		N	3	514	182	3	552	50	787	68	150	1760	0	3282
		U	0	0	1	1	5	4	11	1	0	18	0	30
		NA	0	0	0	0	0	0	0	0	0	1	253	254
		TOTAL	3	514	274	7	1089	264	1634	70	230	1824	253	4528
	O_S	S	0	21	74	1	100	111	286	8	69	116	0	500
		O	3	493	200	5	985	141	1331	62	161	1696	0	3746
		U	0	0	0	1	4	12	17	0	0	12	0	29
		NA	0	0	0	0	0	0	0	0	0	0	253	253
		TOTAL	3	514	274	7	1089	264	1634	70	230	1824	253	4528
INTERPRETIVE	RE	1	0	209	178	5	631	126	940	28	29	504	0	1710
		0	3	305	96	2	458	138	694	42	201	1320	0	2565
		NA	0	0	0	0	0	0	0	0	0	0	253	253
	SO	1	2	287	69	0	299	19	387	40	129	1207	0	2052
		0	1	227	205	7	790	245	1247	30	101	617	0	2223
		NA	0	0	0	0	0	0	0	0	0	0	253	253
	ST	1	0	1	36	3	197	107	343	1	2	9	0	356
		0	3	513	238	4	892	157	1291	69	228	1814	0	3918
		NA	0	0	0	0	0	0	0	0	0	0	253	253
	RA	1	0	26	40	1	32	19	92	3	44	64	0	229
		0	3	488	234	6	1057	245	1542	67	186	1759	0	4045
		NA	0	0	0	0	0	0	0	0	0	0	253	253
ADDITIONAL	NRHP	1	2	440	246	6	819	140	1211	57	145	1026	0	2881
		0	1	65	18	1	74	11	104	12	76	637	0	895
		NA	0	9	10	0	196	113	319	1	9	160	253	751
	GIS	1	3	275	80	4	339	48	471	26	124	585	0	1484
		0	0	238	193	3	747	215	1158	44	106	1235	0	2781
		NA	0	1	1	0	1	0	2	0	0	0	253	256

2.2.2 Quantitative Summary of GSENM-SiteDB-01

The complete GSENM-SiteDB-01 is included as a separate comma-separated values (.csv) file. For our purposes, we briefly discuss some general patterns revealed by the database. For an exhaustive summary, see Table 3. The GSENM contains roughly 4,245 known archaeological sites. The number of components exceeds this number by 283, totaling 4,528. Of these site components, 2704 are affiliated with a time period, with 3 Paleoarchaic (PA), 534

Archaic (AR), 274 Fremont (FR), 7 Basketmaker II (BM), 1,089 Puebloan (PB), 264 generic Formative (FO), 70 Late Prehistoric (LP), 230 Historic (HI), and 1824 Unknown (U). The total for all Formative sites (FOTOT) is 1,634. **It is worth emphasizing how many site components have received field designations of NRHP quality (n = 2881), roughly 64% of all components within the GSENM.**

Several site records are either missing (n = 138) or illegible (n = 23), and several sites have evidently been merged, a fact not necessarily reflected in GSENM-SiteDB-01. To correct for the latter problem, we enter "NA" values for merged sites. Some of these may have been missed, however, so the exact number of such cases remains unknown. There are also a number of sites that appear to have been assigned multiple Smithsonian Trinomials. Again, the exact number of such cases is unknown. We are also aware that a number of site records have not yet been digitized and are not a part of GSENM-SiteDB-01. Additional data management effort would be required to address these issues.

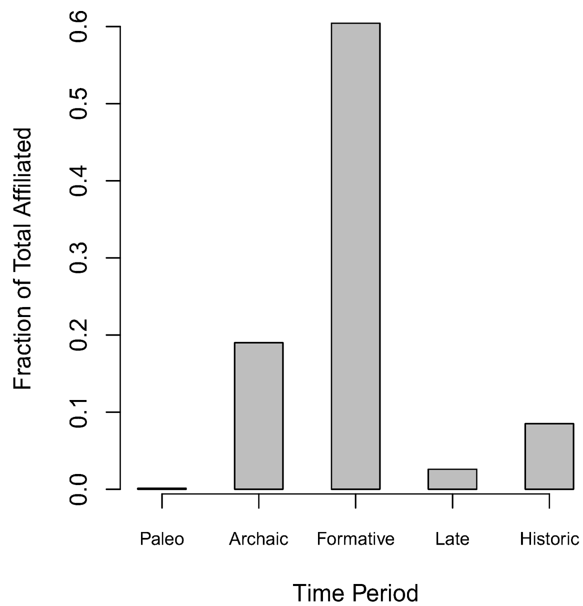


Figure 2: Distribution of Site Components by Time Period

Time Period Categories

If component density adequately reflects population trends through time, then demographic patterning in the GSENM reflects larger demographic patterns seen elsewhere, specifically those concerning interactions between density and diet (Bettinger and Baumhoff, 1982; Bettinger, 2015; Kennett et al., 2006). The minimal number of Paleoarchaic individuals who first colonized the region encountered a rich and productive environment and were thus encouraged to narrow the breadth of their diet. Subsequent population infilling by Archaic hunter-gatherers, as well as general climate trends, led to a broadening diet, which in turn gave way to even more intensification in the form of low scale food production during the Formative period, specifically corn agriculture. This change in subsistence strategy increased the sustainable population size of the GSENM, a fact reflected in the proportion of FO components (see 2). With the collapse of these agricultural economies and their replacement by broad spectrum foraging, population levels naturally declined, only rebounding with the arrival of European pioneers.

Descriptive Categories

Although the vast majority of components within the GSENM are non-architectural (n = 3282) and/or open air (n = 3746), a spike in architectural features, both residential and storage, is discernable within the Formative period. This fact also reflects changes in subsistence strategies. As diets broaden, individuals invest more time in handling more abundant, low ranked resources (like nuts and seeds), rather than searching for less abundant, high ranked resources (like large game) (Hawkes and O'Connell, 1992). A broadening diet would, therefore, favor increasing capital investments that reduce handling time (and/or risk). Architectural features, especially storage related features, are probably capital investments of this sort.

Interpretive Categories

Subsistence transitions likely alter levels of mobility and sedentism. Because low ranked resources require more handling time, individuals relying on a broad spectrum diet are better served spending more time in a resource patch rather than moving between them. This is observable within GSENM-SiteDB-01, specifically in the ratios of residential to short occupation sites, at least through the prehistoric period. As diets expanded and intensified to the point of low scale food production, individuals apparently became more sedentary, giving up short occupation sites for more residential ones.

What function rock art may have served, and its relation to other behaviors, is a notoriously tricky problem of interpretation, which we will not speculate on here. So far as the records suggest, there are a total of 229 archaeological components with rock art in the GSENM. The database shows a trend toward more rock art during the Formative period, though this may be solely a function of population density.

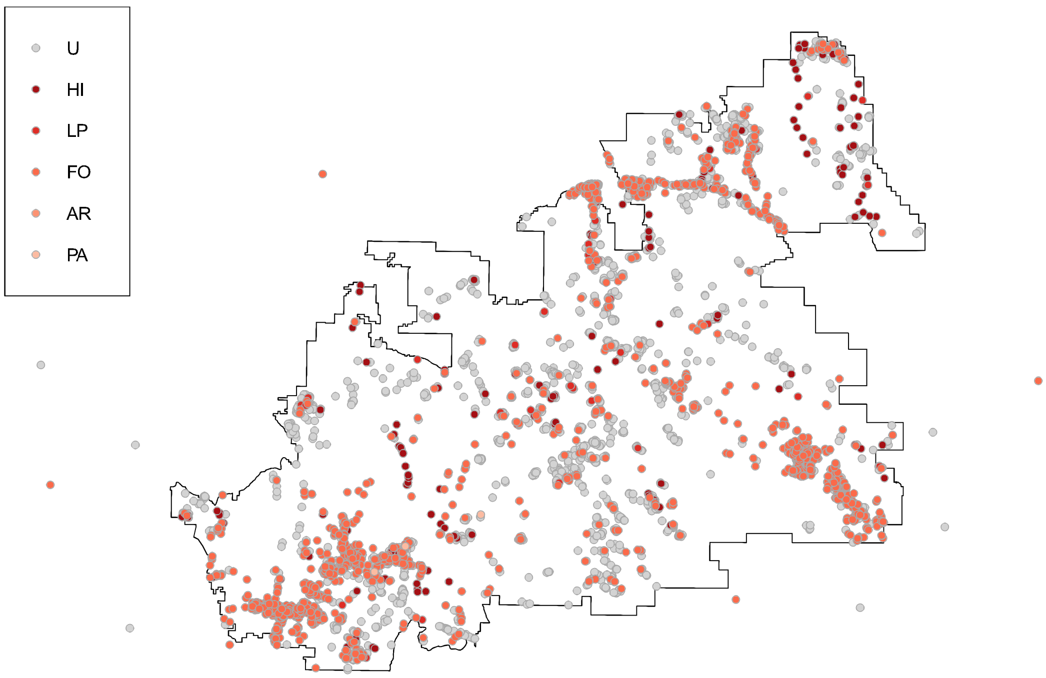


Figure 3: Known Site Component Occurrences in the GSENM

2.3 Combining Spatial and Attribute Data for Site Components

The statistical modeling method (Maximum Entropy) evaluates the strength of correlation between locations of known site component occurrences and environmental features at those locations to assess the probability that site components will occur at other locations. Building the data model, in turn, requires that we combine the GSENM-SiteDB-01 with spatial data for each site component (see Fig. 3), specifically their Universal Transverse Mercator (UTM) coordinates.

Spatial data is from a June 2017 data cut of the CURES database from the GSENM. The GSENM CURES data represents archaeological sites in three data types: points, lines, and polygons. Because line data are generally linear features (historical roads, rail road grades, canals, etc.), we do not use the CURES line data. The polygon data are transformed into points, with a single point at the center of the polygon representing each site. The point data are already in a point format. We then combine both data into one dataset removing all repeated Smithsonian Trinomials. Next, we merge the attributes with the spatial points. For sites with multiple components, each component is given its own row in the data with the same coordinate location of the other components (i.e., they overlap). All data manipulation is done using R.

3 ANALYTICAL METHODS

For our modeling effort, we use two different versions of each data model (i.e., a set of predictor and response variables). Version 1 (v1) data models include all 110 of the predictor rasters (the "kitchen sink" or KS predictor set) combined with (i) a general time period category with rock art, (ii) four of the five specific time periods (Archaic, Formative, Late Prehistoric, and Historic) without rock art, and (iii) all other combinations of Descriptive and Interpretive site types and time periods that had a sample size greater than 20. After the first model run, we create new Version 2 (v2) data models by including only a subset of the original predictor rasters (the "specialized" or SP predictor set). Rasters are included only if they have high percent contribution and permutation importance scores, and low correlations with other variables (detailed in the Results section). V2 data models include only one general time period and four specific time period categories.

3.1 Maximum Entropy

Maximum Entropy, or MaxEnt, is a relatively novel machine learning method commonly used to predict endangered species distributions, where predictions take the form of a probability of species presence (or absence), so the model not only predicts whether a species is likely to occur, but *how* likely it is to occur at a given location compared to others. The particular strengths of the MaxEnt approach are two-fold. First, MaxEnt allows us to evaluate the relative contribution individual predictor variables or environmental features make to predictions (or the assignment of probabilities). Second, MaxEnt minimizes as far as possible the number of extraneous assumptions that might bias its assignment of probabilities.

For each data model, MaxEnt provides an overall evaluation of its performance as well as a measure of how significant each predictor variable is to its performance (detailed in the Results section). With the results of MaxEnt, we can also produce predictive rasters or heat maps showing the spatial distribution of probabilities of site component occurrence. For the v1 models, we generated only performance evaluations. After refining the data models for v2, we generate both performance evaluations and predictive rasters.

MaxEnt is a part of the dismo package in R (Hijmans et al., 2017a).

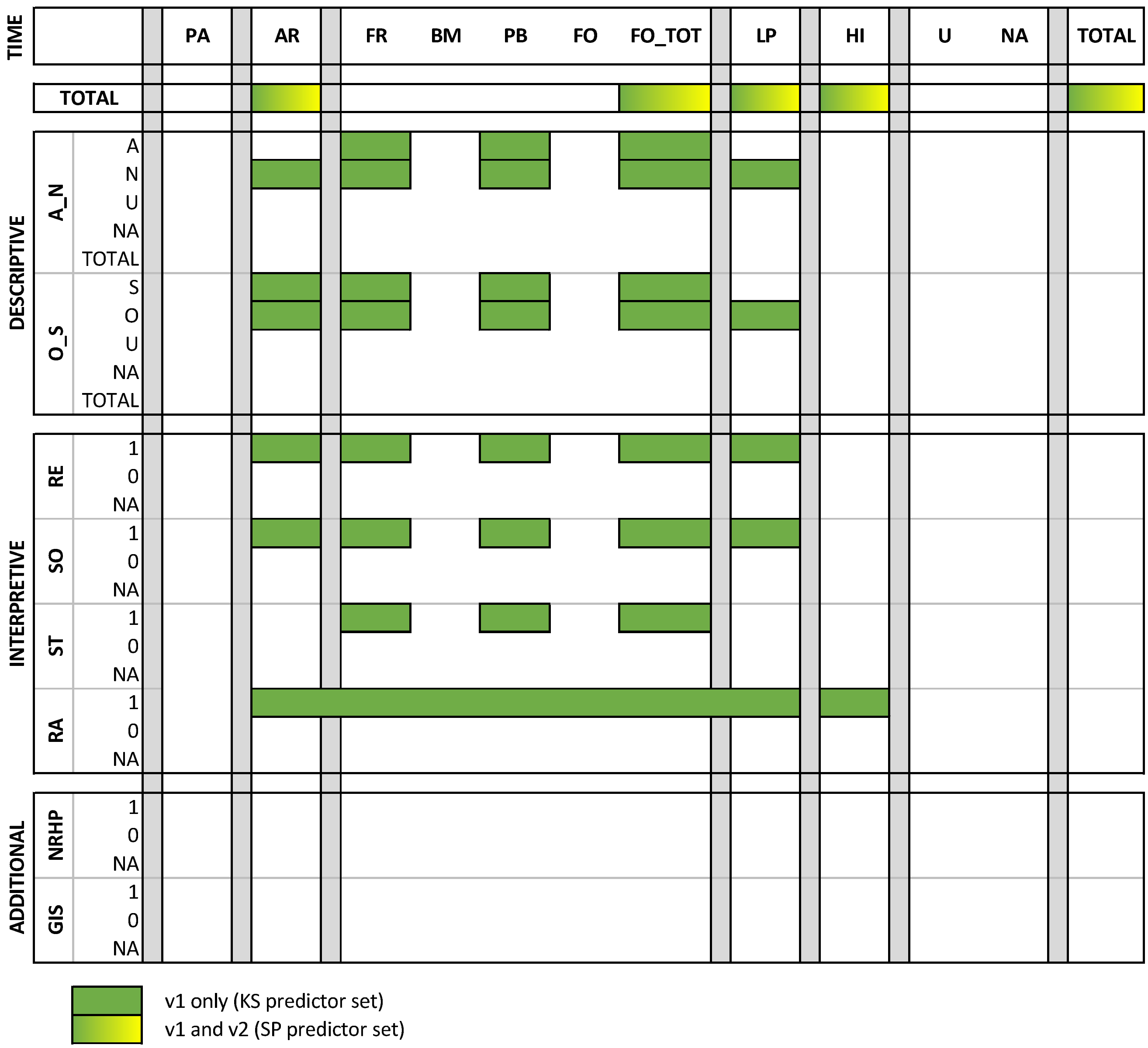
3.2 Data Models Version 1

V1 data models include all 110 of the predictor rasters for (i) a general time period category including rock art, (ii) each specific time period category (Archaic, Formative, Late Prehistoric, and Historic) excluding rock art, and (iii) every combination of Descriptive and Interpretive site types and time periods that had a sample size greater than 20. These include a general prehistoric rock art data model and a historic rock art data model. Each model in v1 uses archaeological site components within the GSENM boundaries and a set of random points outside any raster cells containing archaeological site components within the GSENM (>10,000 for each run). A total of 37 v1 data models are created (see Table 4).

3.3 Data Models Version 2

Using performance evaluations for v1 data models, we refine the analysis for one general (including rock art), four specific time period (excluding rock art) models, and one combined time period model to develop our Version 2 (v2) data models, paying particular attention to the analysis of predictor variable contributions. Selection of variables for v2 occurs in three steps. First, we select all predictor variables that have a percent contribution equal to or greater than one. Next, we rank the predictor variables with a percent contribution greater than 1 by their permutation importance. Last, we check for correlation among the predictor variables. Any predictor variables with a correlation greater than or equal to 0.9 are removed, giving preference to retaining higher ranked variables. In addition, we remove the predictor raster for elevation. It strongly correlates with many other variables that likely give a better representation of what prehistoric people sought for land-use. V2 models are created for the Archaic, Formative, Late Prehistoric, Historic, all sites, and combined time periods, resulting in six v2 data models (see Table 4).

Table 4: Summary of GSENM Data Models



3.4 Evaluating model results: The ROC/AUC score

The performance of the v1 and v2 data models is assessed using a receiver operating curve and area under the curve (ROC/AUC) score. The ROC/AUC score allows us to evaluate how well each data model predicts compared to random. In addition, it provides a uniform measure for comparing its performance for each data model. Plotting an ROC curve requires that we know the sensitivity and specificity of the model run. Sensitivity may be defined as the proportion of presence points a model correctly identifies as such, i.e., as locations likely to contain archaeological components. Since a number of those presence points will be mistakenly classified as absence points, the value 1 - sensitivity can, therefore, be interpreted as the rate of false negatives. Conversely, specificity may be defined as the proportion of absence points correctly identified as such, i.e., as locations likely not to contain archaeological components, and the value 1 - specificity can be interpreted as the rate of false positives, or absence points mistakenly classified as occurrence points.

Based on these concepts, the ROC curve is defined as the ratio of a statistical model's sensitivity to its rate of false positives, or 1 - specificity, for each model run. The area under the ROC, the AUC score, can then be interpreted as the probability that a point has been correctly classified as either a presence or an absence point. At this point, we emphasize that our general hypothesis is that specific time period data models should result in a higher AUC scores than that achieved by a general time period data model.

To obtain actual measures of sensitivity and specificity, MaxEnt apportions the sample of occurrence data into two populations: a training sample and a test sample. When only presence data is available, as is the case with our study, only sensitivity can be measured, which makes plotting an ROC curve inapplicable. To accommodate this deficiency in our data models, we follow a method suggested by (Phillips et al., 2006) by introducing randomly distributed background points into our sample. As they note, this requires re-interpeting model specificity in terms of randomness, rather than absence.

MaxEnt runs several hundred iterations, with each iteration involving a unique apportionment of site components into the training and test samples. It then produces a final ROC curve once training completes.

3.5 Evaluating predictor import: Percent Contribution and Permutation Importance

When modeling the distribution of a species, it is natural to ask which environmental features matter most. To answer this question, MaxEnt provides two scores for each predictor variable: percent contribution (%C) and permutation importance (PI). In effect, percent contribution tells us how important each environmental feature is to each data model. For each run of the model, MaxEnt weights each environmental feature differently to increase the model's overall AUC score. MaxEnt then attributes the change in AUC score to the environmental feature itself, tracking its contribution through each of the several hundred training runs mentioned above. It then averages those contributions and converts them into a percentage, the percent contribution.

As Phillips (2006) notes, "These percent contribution values are only heuristically defined: they depend on the particular path that the Maxent code uses to get to the optimal solution, and a different algorithm could get to the same solution via a different path, resulting in different percent contribution values. In addition, when there are highly correlated environmental variables, the percent contributions should be interpreted with caution."

Unlike percent contribution, permutation importance depends only on the end result of a model. Permutation importance tells us what effect excluding a feature would have on the model's performance (its AUC score). To assign this score, MaxEnt takes the final training run, randomly changes the value of each environmental feature among training points, and measures the resulting decrease in AUC score. If the AUC score decreases substantially, this suggests that the model depends heavily on that variable. If the AUC score decreases only a little, this suggests the model depends minimally on that variable. Values for permutation importance are also nromalized to give percentages.

4 RESULTS

4.1 Model Performance

4.1.1 *Version 1 Models*

AUC scores for all v1 models are reported in Table 5. Further details regarding v1 model results may be found in the supplementary material (see Appendix 8.4).

The v1 General Time Period or All Sites Model (GEN_ALL_v1) utilizes 3981 observed site components, 14,212 absence points, and 110 predictor rasters. The model performs well, achieving an AUC of 0.749. The most predictive predictor variables pertain to slope, precipitation, temperature differences, and distance to water.

The v1 Archaic Model (AR_ALL_v1) utilizes 487 observed Archaic site components (excluding rock art), 10,561 absence points, and 110 predictor rasters. The model performs well achieving an AUC of 0.909. The most predictive predictor variables pertain to slope, precipitation, temperature differences, and distance to water.

Table 5: Performance Evaluations for v1 Data Models

v1 Model	AUC	#Samples	Background Points
General Time Period (all sites)	0.749	3981	14212
Archaic	0.909	0487	10561
Archaic Non-architectural	0.908	0511	10737
Archaic Sheltered	0.994	0020	10301
Archaic Open Air	0.904	0491	10766
Archaic Residential	0.927	0207	10611
Archaic Short Occupation	0.925	0287	10441
Formative (excluding Rock Art)	0.869	1495	11726
Formative Architecture	0.921	0820	11093
Formative Non-architectural	0.884	0752	11063
Formative Sheltered	0.945	0271	10433
Formative Open Air	0.887	1291	11437
Formative Residential	0.896	0892	11097
Formative Short Occupation	0.914	0379	10644
Formative Storage	0.932	0336	10484
Fremont Architecture	0.990	0089	10295
Fremont Non-architectural	0.958	0181	10365
Fremont Sheltered	0.984	0073	10200
Fremont Open Air	0.961	0181	10392
Fremont Residential	0.966	0175	10379
Fremont Short Occupation	0.944	0069	10451
Fremont Storage	0.992	0034	10287
Puebloan Architecture	0.949	0531	10734
Puebloan Non-architectural	0.906	0551	10744
Puebloan Sheltered	0.962	0100	10532
Puebloan Open Air	0.913	0983	11230
Puebloan Residential	0.919	0629	10849
Puebloan Short Occupation	0.930	0299	10545
Puebloan Storage	0.963	0196	10493
Late Prehistoric	0.883	0067	10187
Late Prehistoric Non-architectural	0.885	0068	10263
Late Prehistoric Open Air	0.896	0062	10220
Late Prehistoric Residential	0.932	0028	10341
Late Prehistoric Short Occupation	0.874	0040	10251
Historic (excluding Rock Art)	0.906	0186	10497
Historic Rock Art	0.974	0044	10230
Prehistoric Rock Art	0.952	0162	10356

The v1 Archaic Non-Architectural Model (AR_N_v1) utilizes 511 observed Archaic site components, 10,737 absence points, and 110 predictor rasters. The model achieves an AUC of 0.908. The most predictive predictor variables pertain to slope, precipitation, temperature differences, and distance to water.

The v1 Archaic Sheltered Model (AR_S_v1) utilizes 20 observed Archaic site components, 10,301 absence points, and 110 predictor rasters. The model achieves an AUC of 0.994. The high AUC is most likely a product of the small sample size and should be interpreted with caution. The most predictive predictor variables pertain to slope, precipitation, temperature differences, and distance to water.

The v1 Archaic Open Air Model (AR_O_v1) utilizes 491 observed Archaic sites, 10,766 absence points, and 110 predictor rasters. The model achieves an AUC of 0.904. The most predictive predictor variables pertain to slope, precipitation, temperature differences, aspect and distance to water.

The v1 Archaic Residential Model (AR_RE_v1) utilizes 207 observed Archaic site components, 10,611 absence points, and 110 predictor rasters. The model achieves an AUC of 0.927. The most predictive predictor variables pertain to slope, temperature differences, and distance to water. These preliminary results of residential locations may be indicative of seasonal sedentism.

The v1 Archaic Short Occupation Model (AR_SO_v1) utilizes 287 observed Archaic site components, 10,441 absence points, and 110 predictor rasters. The model achieves an AUC of 0.925. The most predictive predictor variables pertain to slope, precipitation, temperature differences, and distance to water.

The v1 Formative Model (FOTOT_ALL_v1) utilizes 1,495 observed Formative site components (excluding rock art), 11,726 absence points, and 110 predictor rasters. The model achieves an AUC of 0.869. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Formative Architectural Model (FOTOT_A_v1) utilizes 820 observed Formative site components, 11,093 absence points, and 110 predictor rasters. The model achieves an AUC of 0.921. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Formative Non-Architectural Model (FOTOT_N_v1) utilizes 752 observed Formative site components, 11,063 absence points, and 110 predictor rasters. The model achieves an AUC of 0.884. The most predictive predictor variables pertain to precipitation, temperature, slope, environmental productivity, and distance to water.

The v1 Formative Sheltered Model (FOTOT_S_v1) utilizes 271 observed Formative site components, 10,433 absence points, and 110 predictor rasters. The model achieves an AUC of 0.945. The most predictive predictor variables pertain to precipitation, slope, environmental productivity, and distance to water.

The v1 Formative Open Air Model (FOTOT_O_v1) utilizes 1291 observed Formative sitecomponents, 11,437 absence points, and 110 predictor rasters. The model achieves an AUC of 0.887. The most predictive predictor variables pertain to precipitation, temperature, slope, environmental productivity, and distance to water.

The v1 Formative Residential Model (FOTOT_RE_v1) utilizes 892 observed Formative site components, 11,097 absence points, and 110 predictor rasters. The model achieves an AUC of 0.896. The most predictive predictor variables pertain to precipitation, temperature, slope, environmental productivity, and distance to water.

The v1 Formative Short Occupation Model (FOTOT_SO_v1) utilizes 379 observed Formative site components, 10,644 absence points, and 110 predictor rasters. The model achieves an AUC of 0.914. The most predictive predictor variables pertain to precipitation, temperature, slope, and distance to water.

The v1 Formative Storage Model (FOTOT_SO_v1) utilizes 336 observed Formative site components, 10,484 absence points, and 110 predictor rasters. The model achieves an AUC of 0.932. The most predictive predictor variables pertain to precipitation, temperature, slope, environmental productivity, and distance to water.

The v1 Fremont Architectural Model (FR_A_v1) utilizes 89 observed Fremont site components, 10,295 absence points, and 110 predictor rasters. The model achieves an AUC of 0.99. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Non-Architectural Model (FR_A_v1) utilizes 181 observed Fremont site components, 10,365 absence points, and 110 predictor rasters. The model achieves an AUC of 0.958. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Sheltered Model (FR_S_v1) utilizes 73 observed Fremont site components, 10,200 absence points, and 110 predictor rasters. The model achieves an AUC of 0.984. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Open Air Model (FR_O_v1) utilizes 181 observed Fremont site components, 10,392 absence points, and 110 predictor rasters. The model achieves an AUC of 0.961. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Residential Model (FR_RE_v1) utilizes 175 observed Fremont sites, 10,379 absence points, and 110 predictor rasters. The model achieves an AUC of 0.966. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Short Occupation Model (FR_SO_v1) utilizes 69 observed Fremont site components, 10,451 absence points, and 110 predictor rasters. The model achieves an AUC of 0.944. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Fremont Storage Model (FR_ST_v1) utilizes 34 observed Fremont site components, 10,287 absence points, and 110 predictor rasters. The model achieves an AUC of 0.992. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Pueblo Architectural Model (PB_A_v1) utilizes 531 observed Pueblo site components, 10,734 absence points, and 110 predictor rasters. The model achieves an AUC of 0.949. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Pueblo Non-Architectural Model (PB_N_v1) utilizes 551 observed Pueblo site components, 10,744 absence points, and 110 predictor rasters. The model achieves an AUC of 0.906. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Pueblo Sheltered Model (PB_RE_v1) utilizes 100 observed Pueblo site components, 10,532 absence points, and 110 predictor rasters. The model achieves an AUC of 0.962. The most predictive predictor variables pertain to precipitation, slope, aspect, environmental productivity, and distance to water.

The v1 Pueblo Open Air Model (PB_O_v1) utilizes 983 observed Pueblo site components, 11,230 absence points, and 110 predictor rasters. The model achieves an AUC of 0.913. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Pueblo Residential Model (PB_RE_v1) utilizes 629 observed Pueblo site components, 10,849 absence points, and 110 predictor rasters. The model achieves an AUC of 0.919. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v1 Pueblo Short Occupation Model (PB_RE_v1) utilizes 299 observed Pueblo site components, 10,545 absence points, and 110 predictor rasters. The model achieves an AUC of 0.930. The most predictive predictor variables pertain to precipitation, slope, environmental productivity, and distance to water.

4.1.2 *Version 2 Models*

Time period specific v2 models perform significantly better than the general time period v2 model, as evidenced by their AUC scores (Table 6). The fact that environmental features have different percent contribution and permutation importance scores would suggest that individuals from different time periods rely more heavily on different envirnomental features when evaluating the suitability of a habitat. This is likely due to differences in their subsistence. These points together would suggest that our predictive modeling strategy is a good one. Further details regarding v2 model results may be found in the supplementary material (see Appendix 8.5).

The v2 All Sites Model (GEN_ALL_v2) utilizes 3981 observed site components, 14,310 absence points, and 15 predictor rasters. The model performs well achieving an AUC of 0.729. The AUC of the v2 Model is slightly lower than the v1 Model. The difference is a result of v2 being more selective in the predictor rasters used. Predictor rasters that correlate artificially inflate the AUC score. By excluding predictor rasters that significantly correlate, the AUC score is lowered, but the model is refined to better represent the reality of Archaic site distribution.

The v2 Archaic Model (AR_ALL_v2) utilizes 487 observed Archaic site components (excluding rock art), 10,677 absence points, and 13 predictor rasters. The model performs well achieving an AUC of 0.887. The AUC of the v2 Archaic Model is slightly lower than the v1 Archaic Model. The difference is a result of v2 being more selective in the predictor rasters used. Predictor rasters that correlate artificially inflate the AUC score. By excluding predictor rasters that significantly correlate, the AUC score is lowered, but the model is refined to better represent the reality of Archaic site distribution.

The v2 Formative Model (FOTOT_ALL_v2) utilizes 1495 observed Formative site components (excluding rock art), 11,674 absence points, and 10 predictor rasters. The model achieves an AUC of 0.842. The difference is a result of v2 being more selective in the predictor rasters used. Predictor rasters that correlate artificially inflate the AUC score. By excluding predictor rasters that significantly correlate, the AUC score is lowered, but the model is refined

Table 6: Performance Evaluations for v2 Data Models

	GENERAL		ARCHAIC		FORMATIVE		LATE PREHISTORIC	
#Samples	3981		487		1495		67	
AUC	**0.7294**		**0.8871**		**0.8422**		**0.869**	
#Background points	14310		10561		11674		10431	
	%C	PI	%C	PI	%C	PI	%C	PI
GDD_doubletriangle_2005	2.9525	4.0767	2.9654	2.1316				
Heating_dds_2005	13.13	9.4851			31.462	9.3726		
Moisture_Index1	3.1665	9.8817	1.087	4.2777	6.6114	2.1719	11.0799	14.6122
NPP_mean_00_15					5.9203	10.4044		
PET_mean_00_13	7.6984	13.368	4.938	4.6961			6.9296	11.5521
PRISM_ppt_30yr_normal_800mM2_01_asc	8.9719	0.8621						
PRISM_ppt_30yr_normal_800mM2_04_asc					18.7285	5.8989	6.2319	5.556
PRISM_ppt_30yr_normal_800mM2_05_asc			11.2423	7.6462				
PRISM_ppt_30yr_normal_800mM2_06_asc	10.1709	8.5009					1.3306	0.6987
PRISM_ppt_30yr_normal_800mM2_11_asc			7.5037	5.2821				
PRISM_tdmean_30yr_normal_800mM2_04_asc	0.6869	3.419						
PRISM_tdmean_30yr_normal_800mM2_05_asc							4.5989	14.7789
PRISM_tdmean_30yr_normal_800mM2_06_asc	2.4398	2.736	6.6761	3.4505				
PRISM_tmin_30yr_normal_800mM2_06_asc					13.7028	40.5616		
PRISM_tmin_30yr_normal_800mM2_09_asc	6.0459	16.8472						
PRISM_tmax_30yr_normal_800mM2_01_asc					1.8685	5.8557		
PRISM_vpdmin_30yr_normal_800mM2_11_asc							4.9953	1.2077
PRISM_vpdmax_30yr_normal_800mM2_01_asc			3.4745	2.2131				
PRISM_vpdmax_30yr_normal_800mM2_07_asc			1.9685	7.6982				
aspect	1.8498	1.3861	1.8875	1.2564			7.0131	4.4119
slope	27.1804	17.9959	47.8679	50.426	1.4411	2.9734	4.2721	3.3352
springs_cd	2.8616	3.7298			10.4823	8.0335	4.8286	11.7878
streams_cd	1.9509	1.831	5.5515	6.9813			20.3425	24.805
wetlands_cd	9.9555	4.7806	1.9464	2.4541	7.4614	9.4837	28.3776	7.2544
wtrshd_size	0.939	1.0999	2.891	1.4867	2.3216	5.2443		

to better represent the reality of Archaic site distribution.

The v2 Late Prehistoric Model (LP_ALL_v2) utilizes 67 observed Late Prehistoric site components (rock art excluded), 10,431absence points, and 11 predictor rasters. The model achieves an AUC of 0.869. The model should be interpreted with caution due to its small sample size.

The v2 Historical Model (HI_noRA_v2) utilizes 186 observed Historical site components (historic inscriptions excluded), 10,437 absence points, and 13 predictor rasters. The model achieves an AUC of 0.872. The most predictive predictor variables pertain to precipitation, temperature, environmental productivity, and distance to water.

The v2 Combination Model is a combination of the v2 time period specific models (Archaic, Formative, Late Prehistoric, and Historic). Each time period specific v2 model allows us to account for differences in land-use patterns through prehistory. By combining these, we are better able to predict the occurrence of an archaeological site, rather than just using a general model that uses all archaeological sites. The Combination Model achieves an AUC of 0.805.

4.2 Model Output: Predictive Rasters

Model predictions are indicative of changing prehistoric land-use patterns through time (see Fig 4). Looking at the General Time Period predictive raster (Fig 4a) and the Combined Time Period predictive raster (Fig 4b), we see that the archaeological record of the GSENM reflects the full range of human land-use strategies. Note that where the General Time Period raster averages probabilities across time periods, the Combined Time Period raster overlays each time period, taking the highest probability of occurrence at any location.

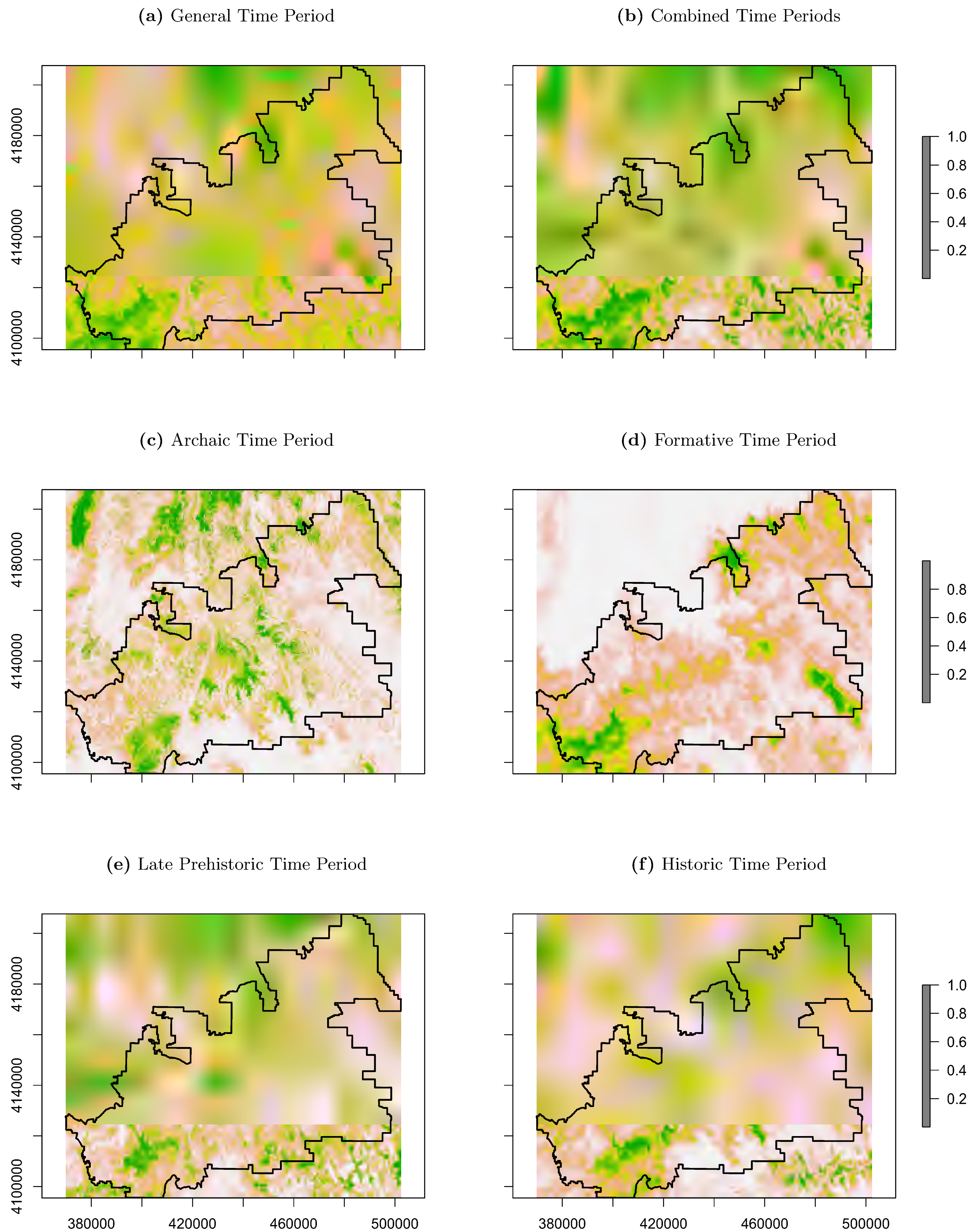


Figure 4: GSENM-CRPM Predictive Rasters

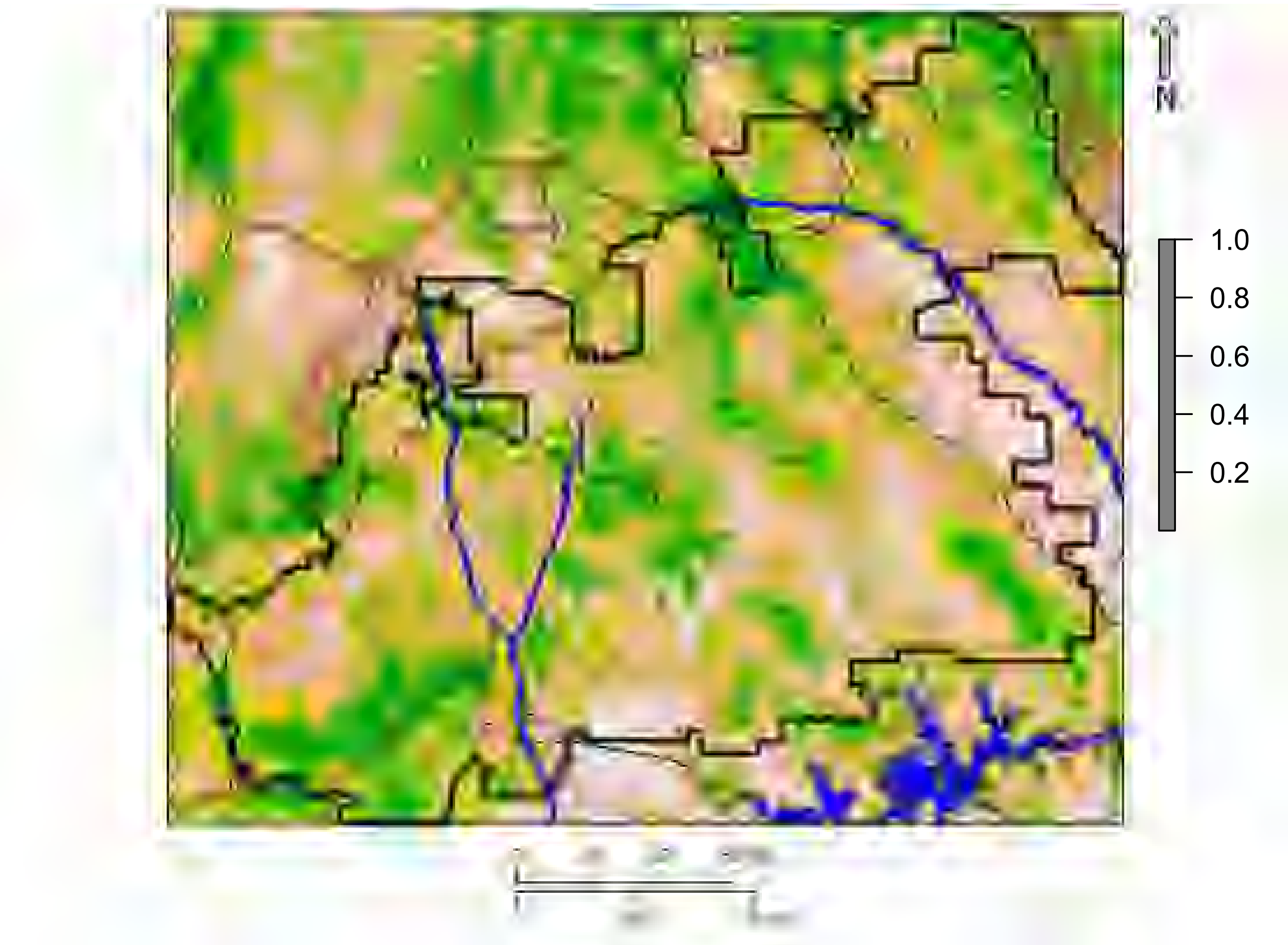


Figure 5: Combined Time Periods Predictive Raster with Map References

The Archaic distribution (Fig 4c) seems fairly constant across the GSENM, with high probability areas to the southwest near the Paria River, Mollies Nipple, Kitchen Corrall Canyon, and Eastern Nephi Pasture. In addition, we see high probability areas south of Cannonville on Four Mile Bench and extending down along Wahweap Wash.

Many of the high probability areas of the Archaic are mirrored by the Formative (Fig 4d). Formative Period land-use appears to be much more constrained in its suitable habitats when compared to the Archaic or Late Prehistoric. This is likely a function of Formative reliance on agricultural subsistence limiting the extent of suitable habitats. Johnson Canyon and many of the tributary canyons are high probability for Formative Period sites. The high probability extends east from here below the White Cliffs across Nephi Pastures out to Mollies Nipple. In contrast to the Archaic, we see that areas around Escalante now have a much higher probability of Formative sites. In addition, we see that Formative people began using Fifty-Mile Mountain, with high probability on the southern section. Greater probability for Formative sites are scattered across the GSENM.

During the Late Prehistoric (Fig 4e), we see a return to Archaic land-use patterns, but with more broadly distributed site components. The change from the Formative is likely a result of a return to broad-spectrum foraging after the collapse of agriculture in the region. Historic land-use (Fig 4f) is dispersed across the GSENM with high probability areas concentrated around permanent water resources and travel corridors.

4.3 Recommended Precautions When Interpreting Results

Certain precautions are called for when interpreting these results. First, because of known correlations in predictor rasters used in v1 data models, their AUC scores are artificially inflated. The is seen by comparing v1 and v2 models. For example, while the v1 ALL Sites Model has an AUC score of 0.749, the v2 model has an AUC of 0.729. The same is true for the Archaic v1 (0.909) and v2 (0.887), the Formative v1 (0.869) and v2 (0.842), the Late Prehistoric v1 (0.883) and v2 (0.869), and the Historic v1 (0.906) and v2 (0.872). In all cases, because of correlation issues, results of v2 models are to be preferred over those for v1 models.

Second, the probabilities are short of absolute as they are not strictly independent of one another, so the results should be interpreted as specifying the relative probability that a site will be located within a cell. The probabilities are relative in the sense that if the probability in one area increases, then the probability in another area will decrease. This is a necessary consequence of MaxEnt assuming unity (i.e., $\sum p(x_i) = 1$). **It cannot, therefore, be assumed that areas assigned low probabilities by the GSENM-CRPM are free of cultural material. Furthermore, while the model is meant to help land managers make informed decisions, standard resource inventory is still the only way to ascertain the significance of individual cultural resources.**

5 THE PREDICTIVE RASTERS: A BRIEF ARC-MAP TUTORIAL

The five v2 models are used to create six predictive rasters (Archaic, Formative, Late Prehistoric, Historic, General, and Combined). The predictive rasters are composed of 5 m^2 cells with a value between 0 and 1. The value of each cell is the likelihood that an archaeological site fitting the description of the predictive layer (e.g. Archaic, Formative, Late Prehistoric, Historic, or any site) is found within that cell.

In addition to creating a model for all sites, we also created an additional predictive raster using the time period specific predictive rasters (see (b) in Figure 4 and Figure 5). We did this by overlaying the time period predictive rasters and taking the highest value for each cell. This results in a predictive raster superior (AUC = 0.81) to the all site model (AUC = 0.73) as a result of preserving changes in land-use rather than smoothing likelihood values across time.

1. *Raster Format and Size*

   Each predictive raster contains roughly 2.5 gigabytes of information and covers the extent of the GSENM (the smallest rectangle that encompasses the whole monument). All predictive rasters are in a GEOtiff (.tif) format.

2. *Checking and Setting CRS*

   The Coordinate Reference System (CRS) for the predictive rasters is NAD83_UTM_Zone_12N and the datum is D_North_American_1983. The ESPG code for this CRS is 26912. To check that the CRS is correct before loading the predictive rasters to ArcMap, open ArcCatalog and navigate to the predictive raster. Right click on the predictive raster and look under the Spatial Reference tab. The XY Coordinate System should have NAD_1983_UTM_Zone_12N and the Datum should be D_North_American_1983. If these fields are incorrect, select Edit and specify the correct XY Coordinate System and Datum.

   If your Coordinate System for your data frame differs from that of the predictive rasters, ArcMap will open a window titled Geographic Coordinate Systems Warning. Click on Transformations to transform the CRS of the predictive raster to that of your dataframe for a proper and accurate projection. Visually inspect the projected raster to ensure the CRS transformation has been successful. This can be done by looking at satellite imagery, topographic maps, or GSENM boundaries and matching the predictive layers with prominent landforms.

3. *Suggested Color Scheme*

   Once loaded into ArcMap, ArcMap will default to a black-and-white color scheme. To change the symbology of the predictive rasters, right click on the predictive raster and select Properties. You can then change the color scheme under the Symbology tab to fit your preference. Under the Display tab you can adjust the transparency as well to better see underlying base maps (e.g. topographic maps, satellite imagery).

4. *Interpreting Raster Values*

   Using the ArcMap Identify cursor, you can select specific cells within the predictive rasters. When you use the Identify cursor to select a cell, a window will open giving you the vell value. The cell value is the probability that an archaeological site is present within that cell. For example, a cell value of 0.83 can be interpreted as an 83% chance that an archaeological site is present within that cell. This can be interpreted as a high-likelihood location for an archaeological site. The presence of contiguous cells with high cell values would further substantiate that the area is predicted to have a high site density.

6 DATA AVAILABILITY

1. *What data is available?*

   Archaeological site data is protected and cannot be disclosed. The predictive rasters are meant for archaeological professionals only. A more thorough description of the methods used in this project can be found in (Yaworsky et al., 2018).

2. *Where is it?*

   All data presented in this manual, the predictive rasters, and the R Scripts used to create the models are housed at the University of Utah Archaeological Center.

3. *Who to contact?*

   To access digitally archived data pertaining to this manual, please contact Mattnew Zweifel (mzweifel@blm.gov) or the current GSENM archaeologists for permission. Model data can be acquired by contacting the University of Utah Archaeological Center director, Brian F. Codding (brian.codding@anthro.utah.edu). For questions about using the predictive rasters, please contact Peter M. Yaworsky (p.yaworsky@utah.edu).

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8 APPENDIX

8.1 PREDICTOR RASTERS

This appendix lists in table format all rasters initially gathered for our modeling effort, including both used and unused rasters, as well as source information and time periods covered by each raster.

Table 7: Predictor Rasters

Raster	Source	Data Time Frame	Used
Climate Rasters			
Actual Evapotranspiration	NTSG	mean from 2000 - 2013	Yes
Potential Evapotranspiration	NTSG	mean from 2000 - 2013	No
Forecast zones	Utah AGRC	NA	No
30 year average annual precipitation	PRISM	1981 to 2010 average	Yes
30 year average April precipitation	PRISM	1981 to 2010 average	Yes
30 year average August precipitation	PRISM	1981 to 2010 average	Yes
30 year average December precipitation	PRISM	1981 to 2010 average	Yes
30 year average February precipitation	PRISM	1981 to 2010 average	Yes
30 year average January precipitation	PRISM	1981 to 2010 average	Yes
30 year average July precipitation	PRISM	1981 to 2010 average	Yes
30 year average June precipitation	PRISM	1981 to 2010 average	Yes
30 year average March precipitation	PRISM	1981 to 2010 average	Yes
30 year average May precipitation	PRISM	1981 to 2010 average	Yes
30 year average November precipitation	PRISM	1981 to 2010 average	Yes
30 year average October precipitation	PRISM	1981 to 2010 average	Yes
30 year average September precipitation	PRISM	1981 to 2010 average	Yes
30 year average annual dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average April dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Aug dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average December dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Feb dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Jan dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average July dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average June dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average March dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average May dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Nov dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Oct dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average Sept dewpoint temp	PRISM	1981 to 2010 average	Yes
30 year average annual max temperature	PRISM	1981 to 2010 average	Yes
30 year average April max temperature	PRISM	1981 to 2010 average	Yes
30 year average August max temperature	PRISM	1981 to 2010 average	Yes
30 year average December max temperature	PRISM	1981 to 2010 average	Yes
30 year average February max temperature	PRISM	1981 to 2010 average	Yes
30 year average January max temperature	PRISM	1981 to 2010 average	Yes
30 year average July max temperature	PRISM	1981 to 2010 average	Yes
30 year average June max temperature	PRISM	1981 to 2010 average	Yes
30 year average March max temperature	PRISM	1981 to 2010 average	Yes
30 year average May max temperature	PRISM	1981 to 2010 average	Yes
30 year average November max temperature	PRISM	1981 to 2010 average	Yes
30 year average October max temperature	PRISM	1981 to 2010 average	Yes
30 year average September max temperature	PRISM	1981 to 2010 average	Yes
30 year average annual mean temperature	PRISM	1981 to 2010 average	Yes

Raster	Source	Data Time Frame	Used
30 year average April mean temperature	PRISM	1981 to 2010 average	Yes
30 year average August mean temperature	PRISM	1981 to 2010 average	Yes
30 year average December mean temperature	PRISM	1981 to 2010 average	Yes
30 year average February mean temperature	PRISM	1981 to 2010 average	Yes
30 year average January mean temperature	PRISM	1981 to 2010 average	Yes
30 year average July mean temperature	PRISM	1981 to 2010 average	Yes
30 year average June mean temperature	PRISM	1981 to 2010 average	Yes
30 year average March mean temperature	PRISM	1981 to 2010 average	Yes
30 year average May mean temperature	PRISM	1981 to 2010 average	Yes
30 year average November mean temperature	PRISM	1981 to 2010 average	Yes
30 year average October mean temperature	PRISM	1981 to 2010 average	Yes
30 year average September mean temperature	PRISM	1981 to 2010 average	Yes
30 year average annual min temperature	PRISM	1981 to 2010 average	Yes
30 year average April min temperature	PRISM	1981 to 2010 average	Yes
30 year average August min temperature	PRISM	1981 to 2010 average	Yes
30 year average December min temperature	PRISM	1981 to 2010 average	Yes
30 year average February min temperature	PRISM	1981 to 2010 average	Yes
30 year average January min temperature	PRISM	1981 to 2010 average	Yes
30 year average July min temperature	PRISM	1981 to 2010 average	Yes
30 year average June min temperature	PRISM	1981 to 2010 average	Yes
30 year average March min temperature	PRISM	1981 to 2010 average	Yes
30 year average May min temperature	PRISM	1981 to 2010 average	Yes
30 year average November min temperature	PRISM	1981 to 2010 average	Yes
30 year average October min temperature	PRISM	1981 to 2010 average	Yes
30 year average September min temperature	PRISM	1981 to 2010 average	Yes
30 year average annual vap press max	PRISM	1981 to 2010 average	Yes
30 year average April vap press max	PRISM	1981 to 2010 average	Yes
30 year average Aug vap press max	PRISM	1981 to 2010 average	Yes
30 year average December vap press max	PRISM	1981 to 2010 average	Yes
30 year average Feb vap press max	PRISM	1981 to 2010 average	Yes
30 year average Jan vap press max	PRISM	1981 to 2010 average	Yes
30 year average July vap press max	PRISM	1981 to 2010 average	Yes
30 year average June vap press max	PRISM	1981 to 2010 average	Yes
30 year average March vap press max	PRISM	1981 to 2010 average	Yes
30 year average May vap press max	PRISM	1981 to 2010 average	Yes
30 year average Nov vap press max	PRISM	1981 to 2010 average	Yes
30 year average Oct vap press max	PRISM	1981 to 2010 average	Yes
30 year average Sept vap press max	PRISM	1981 to 2010 average	Yes
30 year average annual vap press min	PRISM	1981 to 2010 average	Yes
30 year average April vap press min	PRISM	1981 to 2010 average	Yes
30 year average Aug vap press min	PRISM	1981 to 2010 average	Yes
30 year average December vap press min	PRISM	1981 to 2010 average	Yes
30 year average Feb vap press min	PRISM	1981 to 2010 average	Yes
30 year average Jan vap press min	PRISM	1981 to 2010 average	Yes
30 year average July vap press min	PRISM	1981 to 2010 average	Yes
30 year average June vap press min	PRISM	1981 to 2010 average	Yes
30 year average March vap press min	PRISM	1981 to 2010 average	Yes
30 year average May vap press min	PRISM	1981 to 2010 average	Yes
30 year average Nov vap press min	PRISM	1981 to 2010 average	Yes
30 year average Oct vap press min	PRISM	1981 to 2010 average	Yes
30 year average Sept vap press min	PRISM	1981 to 2010 average	Yes

Raster	Source	Data Time Frame	Used
Environmental Productivity Rasters			
Net Primary Productivity (NPP)	NTSG	mean from 2000 - 2015	Yes
Agricultural Suitability (S)	Yaworsky (2016a)	NA	No
Moisture Index (MI)	Yaworsky (2016b)	mean from 2000 -2013	Yes
f1	Ramankutty et al. (2002)	2005	Yes
f2	Ramankutty et al. (2002)	NA	No
GDD - growing dds (50F - 86)	IPPC	2005	Yes
GDD - double sine (50F -86)	IPPC	2005	Yes
GDD - double triangle (50F -86)	IPPC	2005	Yes
GDD - simple average (50F - 86)	IPPC	2005	Yes
GDD - single sine (50F -86)	IPPC	2005	Yes
GDD - single triangle (50F -86)	IPPC	2005	Yes
Heating dds (32F -130)	IPPC	2005	Yes
Landscape Attribute Rasters			
Slope	From elevation	NA	Yes
Aspect	From elevation and slope	NA	Yes
Elevation	Utah AGRC	NA	Yes
Watershed Size	Utah AGRC	NA	Yes
Resource Distribution Rasters			
Cost Distance to Lakes	From Utah Lakes	NA	Yes
Cost Distance to Springs	From Utah Springs	NA	Yes
Cost Distance to Streams	From Utah Streams	NA	Yes
Mule Deer Habitat	Utah DWR 2017	NA	No
Cost Distance to wetlands	From Wetlands	NA	Yes
Soil Attributes Rasters			
Dominant Vegetation	Utah AGRC	NA	No
Soil Series	SSURGO	NA	No
Frost free days	SSURGO	NA	No
Depth to restrictive layer	SSURGO	NA	No
Drainage class	SSURGO	NA	No
Vegetation Code	SSURGO	NA	No
Soil Texture	SSURGO	NA	No
Soil Health	SSURGO	NA	No
Soil Classification	SSURGO	NA	No
Taxonomic Class	SSURGO	NA	No
Surface Texture	SSURGO	NA	No
T-factor	SSURGO	NA	No
Water (0-50 cm)	SSURGO	NA	No
Water (0-150 cm)	SSURGO	NA	No
Water (0-25 cm)	SSURGO	NA	No
Non-irrigated crop subclass	SSURGO	NA	No
Non-irrigated crop class	SSURGO	NA	No
Crop production norm	SSURGO	NA	No
Used to create cost-distance rasters			
Utah Lakes	Utah AGRC	NA	Yes
Utah Springs	Utah AGRC	NA	Yes
Utah Streams	Utah AGRC	NA	Yes
Utah Rivers	Utah AGRC	NA	Yes
Wetlands	Utah AGRC	NA	Yes

8.2 CLASSIFICATION RULES FOR GSENM-SITEDB-01

This appendix details the explicit rules and other theoretical assumptions used to enter data into the GSENM-SiteDB-01. Where possible, we have relied on the most general site categories, choosing to lump rather than split. We have chosen this strategy because (i) it minimizes both computation and data management costs and (ii) it ensures an intra-category sample size sufficient for the model to work.

8.2.1 DESCRIPTIVE SITE CATEGORIES

KEY:

A Architectural
N Non-Architectural
O Open Air
S Sheltered
U Unknown

Descriptive site categories imply only the most minimal of functions, where 'function' refers to the reason for which a site was used. In IMACS, relevant information may be found in Part A, under Site Description; Part B, under Architectural Features; and Part C, under Architectural Features. Similar categories are found in the same parts of the UASF.

Architectural

Def: A site including architectural features constructed on or below the surface. These may involve substantial features requiring considerable investment of time and energy, or ephemeral and expedient features requiring little if any investment of time and energy. Examples of prehistoric architectural features include pithouses, granaries, and rock alignments. Examples of historic architectural features include cabins, corrals, building foundations, and mines. Note that the Descriptive Architectural category crosscuts the Interpretive categories Residential and Storage.

Form: (IMACS) Part B and C, Architectural and Non-Architectural Features

ID Rule: If the site includes an architectural feature, then the site is Architectural.

(*Enter 'A' in column A_N.*)

Non-Architectural

Def: A site including *no* architectural features.

Form: (IMACS) Part B and C, Architectural and Non-Architectural Features

ID Rule: If the site does *not* include an architectural feature, then the site is Non-Architectural.

(*Enter 'N' in column A_N.*)

Open Air

Def: A site *not* located in a cave, under an overhang, or in or under any non-constructed, geologic structure that provides shelter from the elements.

Form: (IMACS) Part A, Site Description

ID Rule: If the site is *not* Sheltered, then the site is Open Air. (*Enter 'O' in column O_S.*)

Sheltered

Def: A site located in a cave, under an overhang, or in or under a non-constructed, geologic structure that provides shelter from the elements. The boundary between a Sheltered and Open Air site is a vague one. Does 0.5 m of site cover count as an overhang? Does 0.4 m or 0.3 m? To deal with this vagueness, we assume that a Sheltered site is one occurring in a cave or other geologic structure that provides *any degree* of cover for the site. Sheltered Non-Architectural sites are sites that often consist at least minimally of (i) lithic tools and debitage, (ii) smoke staining on an overhang surface, and (iii) ash staining on the soil surface. Granaries and storage features built under overhangs and other natural shelters will also count as Sheltered Architectural sites.

Form: (IMACS) Part A, Site Description

ID Rule: If any part of a site is located under an overhang or in a cave or any other non-constructed structure, then the site is Sheltered. (*Enter 'S' in column O_S.*)

Unknown

Def: *Not Applicable*

ID Rule: If a site form lacks sufficient information to infer a site's descriptive status, then Descriptive site type is Unknown. (*Enter 'U' in column A_N and/or O_S.*)

8.2.2 INTERPRETIVE SITE CATEGORIES

KEY:

RE Residential

SO Short Occupation

ST Storage

RA Rock Art

1 TRUE

0 FALSE

Interpretive site categories have a strong implication of function. In the IMACS form, this information is found in Part B, under Site Type; Part C, under Site Type; and any information found in Part D entails that the site is a member of the Rock Art category. Similar categories are found in the same parts of the UASF. Because interpretive site categories strongly imply function, classifying sites according to these categories is fraught with difficulty. On the one hand, sites having different functions may, nevertheless, share the same form (debitage, formal tools, structures, etc.), so form is not by itself *sufficient* for membership in an interpretive category. On the other hand, two sites having very different forms may, nevertheless, share the same function, so form is not by itself *necessary* for membership in an interpretive category. These difficulties are unavoidable, but the GSENM-SiteDB-01 accomodates them as far as possible by adopting a lumping strategy, utilizing only very general interpretive categories.

Residential

Def: Sites involving long term occupation, whether seasonal or year-round. These are typically composed of a number of different artifacts and features one would intuitively associate with residential or domestic activities performed repeatedly over time. In the prehistoric context, relevant artifacts include ground stone tools. In a historic context, relevant artifacts include wood burning stoves, beds, and other familiar accoutrements. In either context, relevant architectural features will typically be habitation structures, whether pithouses, cliff dwellings, or cabins.

Form: (IMACS) Part B and C, Architectural and Non-Architectural Features.

Note: A list of Architectural Features in Section 320 of the IMACS User's Guide (2001) includes both residential and non-residential (mostly storage) features. Non-residential features include Granary, Cist, Cairn, Storage Bin, and War Lodge (Yes, it includes War Lodge). In order for a site to be Residential, it must include Architectural Features other than those. This we are doing to distinguish Residential Non-Storage (sites where people lived but did not store food) from Residential Storage (sites where people lived and stored food) and Non-Residential Storage (places where people did not live but did store food).

ID Rule: If (i) non-storage architectural features are present; OR

(ii) the site contains a diversity of tools including groundstone; AND

(iii) the site is NOT Short Occupation, then the site is Residential.

(*Enter '1' in column RE.*)

Short Occupation

Def: Sites involving short occupation, from a few weeks to a single night. These typically reflect activities associated with either food procurement or tool manufacture and maintenance, or some combination of the two. In prehistoric contexts, short term occupation sites would include those involved with more mobile hunter-gatherers or those involved with hunting activities away from a residential base camp. In historic contexts, short term occupation sites will typically involve activities associated with herding sheep and cattle.

Form: (IMACS) Part B and C, Architectural and Non-Architectural Features

ID Rule: If (i) the site consists of *only* lithic debitage or lithic stone tools (or both), *and* no ground stone is present; OR

(ii) the site consists of *only* assorted cans, bottles, or other historic artifacts typically not associated with historic residential activities; AND

(iii) the site is NOT Residential, then the site is Short Occupation.

(*Enter '1' in column SO.*)

Storage

Def: Sites where individuals stored food. Features commonly associated with storage sites include granaries (typically above ground storage structures) and cists (typically below ground storage structures). A Storage site may also be a Residential site.

Form: (IMACS) Part B and C, Architectural Features

ID Rule: If a granary, cist, or storage bin is present, then the site is Storage.

(*Enter '1' in column ST.*)

Rock Art

Def: Sites consisting of petroglyphs (art carved or etched into a rock surface) and pictographs (art painted on a rock surface). A Rock Art site may also be either Residential or Short Occupation.

ID Rule: If either petroglyphs or pictographs are present, then the site is Rock Art.

(*Enter '1' in column RA.*)

Unknown

Def: *Not Applicable*

Form: *Not Applicable*

ID Rule: If a site form lacks sufficient information to infer a site's interpretive (or functional) status, then Interpretive site type is Unknown. (*Leave all interpretive categories at value '0.'*)

It is important to stress that some of these interpretive categories are mutually exclusive, others not. **The same site can NOT be both a Residential and a Short Occupation site**, but it can be both Residential and Storage or Short Occupation and Rock Art.

8.2.3 TIME PERIOD CATEGORIES

<u>KEY</u>:

PA	Paleo-Archaic
AR	Archaic
FO	Formative
BM	Basketmaker II
FR	Fremont
PB	Pueblo
LP	Late Prehistoric
HI	Historic
U	Unknown

Nominally, Time Period specific site categories refer either to (a) the time at which the site was initially formed or (b) the time at which the site was modified by subsequent occupations. In the older IMACS form, this information is found in Part A, under Class; Part B, under Cultural Affiliation; and Part C, under Cultural Affiliation. Similar categories are found in the same parts of the UASF.

As with the other categories outlined above, certain challenges naturally arise when trying to assign a site to one or more of its temporal affiliations. These arise almost exclusively from the fact that Time Period categories are not strictly temporal in nature, specifying instead a cultural affiliation, hence the use of that nomenclature in the IMACS and UASF. So, rather than saying, for example, that site 42KAxxx3 was established around 1500 BP, IMACS (and/or UASF) tells us that it was formed by individuals affiliated with, say, the Puebloan culture. This introduces taxonomic difficulties similar to those that arise for interpretive categories. Sites affiliated with different cultures may, nevertheless, exhibit the same form (debitage, formal tools, structures, etc.), so a site's form is not by itself *sufficient* for membership in a time period category. Conversely, sites affiliated with the same culture may exhibit different forms, so a site's form is not by itself *necessary* for membership in a time period category. Unlike with the other categories enumerated above, the GSENM-SiteDB-01 addresses these taxonomic difficulties by adopting both a lumping and a splitting strategy with respect to Time Period categories.

In a standard IMACS form (and in the UASF), an archaeologist may categorize a site as Prehistoric, Protohistoric, or Historic (in Part A, under Site Class).[1] Prehistoric sites are those sites formed by individuals who are members of societies *without* a system of written language. Historic sites are those formed by individuals who are members of societies *with* a system of written language. Finally, protohistoric sites are those sites that do not fit easily into one or the other category because they involve occupations that occur either i) at or around the introduction of writing or ii) at or around contact between historic and prehistoric cultures. *GSENM-SiteDB-01 drops the Protohistoric component on the assumption that few if any protohistoric sites occur within the GSENM. The general category, Prehistoric, is also dropped in favor of a splitting strategy, using instead the sub-categories Prearchaic, Archaic, Basketmaker, Fremont, Pueblo, Late Prehistoric, and Historic.* In some ways this is a novelty of GSENM-SiteDB-01. The historic category is left intact, so if that affiliation is specified in Part A, then the site takes that value in the TIME column.

Including all the specific temporal categories within the braces faces two important difficulties. First, intra-category sample size might be insufficient to run the GSENM-MaxEnt model. Second, it would pass the modeling effort well over the inflection point of a diminishing marginal utility curve, requiring significant time investment to database sites using these categories and introducing combinatorial explosion into the total number of model iterations required for the larger Class I inventory. To avoid these difficulties, GSENM-SiteDB-01 lumps the original IMACS cultural affiliations (those within the braces) into the general categories Prearchaic, Archaic, Formative, Late Prehistoric, and Historic (those outside the braces).

Because one of the aims of the GSENM MaxEnt model is to estimate the distribution of sites by time period, the GSENM-SiteDB-01 will not use the multi-component Time Period category (or the category involving multiple occupations by individuals having different cultural affiliations). Instead, multi-component sites are assigned multiple rows, one for its prehistoric component (or more depending on how many time-period specific, prehistoric occupations are represented) and one for its historic component. An example of this is shown in Table 2, specifically site 42KAxxx6.

[1] The IMACS also includes an ethnographic component, but that category is not used here.

Section 320 of the IMACS User's Guide (2001) includes a list of all of the following prehistoric cultural affiliations:

Table 8: Generalized Culture Taxonomy for GSENM

Paleo-Archaic		Pre-Paleoindian
		Paleoindian
Archaic		Archaic (general)
		Early Archaic
		Middle Archaic
		Late Archaic
Formative	**BM**	Basketmaker (general)
		Basketmaker I
		Basketmaker II
	FR	Fremont
	PB	Basketmaker III
		Anasazi/Pueblo (general)
		Pueblo (general)
		Pueblo I
		Pueblo II
		Pueblo III
		Pueblo IV
		Pueblo V

Late Prehistoric (general)	**Late Prehistoric**
Protohistoric/Contact (general)	
Numic (general)	
Ute/Paiute	
Shoshoni	
Hopi	
Washoe	
Algonquian (general)	
Cheyenne	
Arapaho	
Nez Perce	
Navajo	
Sioux (general)	
Dakota	
Lakota	
Crow	
Yuman	
Pima	
Western Pluvial Lake Tradition	
Post-European Contact	**Historic**

Table 9: Diagnostic Artifacts for the GSENM[a,b,c]

		Lithics	Ceramics	Features
[illegible]	[illegible]	[illegible]		
	Archaic	[illegible]		
[redacted]				
	Basketmaker II	[illegible]	[illegible]	[illegible]
	Fremont		[illegible]	[illegible]
Formative	Pueblo	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]
[illegible]				
	Late Prehistoric	[illegible]	[illegible]	

[illegible]

[d] PP = Projectile Point.

[e] Diagnostic only of Formative. Does not differentiate Formative sub-categories.

[f] Either Basketmaker II or Fremont.

Paleo-Archaic

Def: Sites consisting of components showing signs of prehistoric hunter-gatherer activities that were deposited during a period beginning with the initial colonization of the region and ending with the onset of the Archaic period. Diagnostic artifacts include fluted and Western Stem Tradtion (WST) points and/or crescents.

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation is Pre-Paleoindian, Paleoindian, or Prearchaic; OR

(ii) the site contains fluted points, WSTs, or crescents, then the site is Paleo-Archaic.

(*Enter 'PA' in column TIME.*)

Archaic

Def: Sites consisting of components showing signs of prehistoric hunter-gatherer activities. Diagnostic artifacts include several projectile point types (Gypsum, San Rafael Side-Notched, McKean Lanceolate, Rocker Side-Notched, Sudden Side-Notched, Hawken Side-Notched, Pinto, and Northern Side-Notched)

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation is Early, Middle, or Late Archaic; OR

(ii) the site contains Gypsum, San Rafael Side-Notched, McKean Lanceolate, Rocker Side-Notched, Sudden Side-Notched, Hawken Side-Notched, Pinto, or Northern Side-Notched projectile points, then the site is Archaic.

(*Enter 'AR' in column TIME.*)

Basketmaker II

Def: Sites consisting of components that show evidence of prehistoric agricultural activities, specifically maize agriculture, including storage features and residential structures, *but lacking ceramic artifacts or sherds*.

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation is Basketmaker (general), Basketmaker I[2], or Basketmaker II; OR

(ii) the site includes pithouses or storage features; AND

(iii) the site includes NO ceramics, then the site is Basketmaker II.

(*Enter 'BM' in column TIME.*)

Fremont

Def: Sites consisting of components that show evidence of prehistoric agricultural activities, specifically maize agriculture, including storage features (granaries, cists), pit houses, and plain ceramic artifacts or sherds (specifically Emery Gray Ware).

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation is Fremont; OR

(ii) the site includes pithouses (with few if any above ground residential structures) or storage features (granaries, cists); AND

(iii) the site includes Emery Gray Ware ceramics, then the site is Fremont.

(*Enter 'FR' in column TIME.*)

Pueblo

Def: Sites consisting of components that show evidence of prehistoric agricultural activities, specifically maize agriculture, including storage features and residential structures, and various decorated ceramic types (except Emery Gray Ware or Plain Brown Ware).

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation is Basketmaker III, Anasazi, or Pueblo I-V; OR

(ii) the site includes above ground room blocks, kivas, cliff dwellings, granaries, or cists; OR

(iii) the site contains Parowan Basal-Notched or Bull Creek PPs; OR

(iv) the site contains any complex or decorated ceramic type (basically any ceramic type that is not Brown, Utility, or Emery Gray Ware), then the site is Pueblo.

(*Enter 'PB' in column TIME.*)

Formative

Def: Sites consisting of components that show evidence of prehistoric agricultural activities, specifically corn agriculture, including storage features and residential structures, and various ceramic types.

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If cultural affiliation is Fremont, Anasazi, Basketmaker I-III, or Pueblo I-V, then the site is Formative.

(*Enter 'FO' in column TIME.*)

Note: Defer to BM, FR, or PB where possible.

[2] Basketmaker I is an obsolete synonym for the Late Archaic that is no longer in use (Utah State History), but it is included here because archaeologists may have assigned sites to that category in the past, in which case it will show up on IMACS forms.

Late Prehistoric

Def: Sites consisting of components that post-date the Formative period and pre-date the Historic period. Late Prehistoric societies were non-agricultural, so Late Prehistoric sites should NOT include evidence of agriculture, and Late Prehistoric ceramics in the GSENM were primarily *brown ware* with simple or no decorations.

Form: (IMACS) Part B, under Cultural Affiliation; see also Lithic and Ceramic descriptions

ID Rule: If (i) cultural affiliation includes any culture group labeled Late Prehistoric in the taxonomic table above; OR (ii) the site includes brown ware ceramics; OR (iii) the site contains Desert Side-Notched PPs, then the site is Late Prehistoric.

(*Enter 'LP' in column TIME.*)

Historic

Def: Sites consisting of components that reflect European settlement.

Form: (IMACS) Part A, under Class, and Part C, under Cultural Affiliation

ID Rule: If the site includes any historic component, then the site is Historic.

(*Enter 'HI' in column TIME.*)

Unknown

Def: *Not Applicable*

Form: *Not Applicable*

ID Rule: If a site form lacks sufficient information to infer a site's temporal status or cultural affiliation, then site type is Unknown. (*Enter 'U' in column TIME.*)

8.2.4 ADDITIONAL RULES

National Register of Historic Places

Def: "The National Register of Historic Places is the official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources." –NRHP

Form: (IMACS) Part A, under National Register Status

ID Rule: If the site is deemed eligible, then the site is Eligible. (*Enter '1' in column NRHP.*)

GPS

Def: The Global Positioning System. We want to know how reliable UTM coordinates are for each site, so we are including a column that specifies whether the site recorder used a GPS receiver to locate the site. We are assuming that individuals who estimated UTMs without the support of a GPS receiver would not have attempted to specify coordinates to one meter (34689**3** mE), choosing instead to round at most to the nearest ten meters (34689**9**0 mE).

Form: (IMACS) Part A, under UTM Grid, specificaly the numbers preceding 'mE' and 'mN.'

ID Rule: If both UTM coordinates end in a zero, then GPS is 0. (*Enter '0' in column GPS.*)

Missing IMACS Forms

Def: Some IMACS forms were lost and/or never scanned as a pdf. These were also noted in the administrative NOTE column.

Form: *Not Applicable*

ID Rule: If unable to locate IMACS form, then *Enter 'NA' for each column.*

8.3 GSENM-SITEDB-01

The site database is provided as a separate Comma-separated values (.csv) file that can be opened in Microsoft Excel (File name: GSENM_SiteDB_01_RAW.csv). The summary table is also included as an Excel document (.xlsx) (File name: GSENM_SiteDB_01_SUMMARY.xlsx).

8.4 v1 OUTPUTS

All performance evaluations for v1 models are included as separate portable document format (PDF) files that can be opened in Adobe Acrobat. A list of file extensions is found in Table 10.

Table 10: File Extensions for v1 Performance Evaluations

v1 Model	File Name
General Time Period (all sites)	GEN_ALL_v1.pdf
Archaic	AR_ALL_v1.pdf
Archaic Non-architectural	AR_N_v1.pdf
Archaic Sheltered	AR_S_v1.pdf
Archaic Open Air	AR_O_v1.pdf
Archaic Residential	AR_RE_v1.pdf
Archaic Short Occupation	AR_SO_v1.pdf
Formative (excluding Rock Art)	FOTOT_ALL_v1.pdf
Formative Architecture	FO_A_v1.pdf
Formative Non-architectural	FO_N_v1.pdf
Formative Sheltered	FO_S_v1.pdf
Formative Open Air	FO_O_v1.pdf
Formative Residential	FO_RE_v1.pdf
Formative Short Occupation	FO_SO_v1.pdf
Formative Storage	FO_ST_v1.pdf
Fremont Architecture	FR_A_v1.pdf
Fremont Non-architectural	FR_N_v1.pdf
Fremont Sheltered	FR_S_v1.pdf
Fremont Open Air	FR_O_v1.pdf
Fremont Residential	FR_RE_v1.pdf
Fremont Short Occupation	FR_SO_v1.pdf
Fremont Storage	FR_ST_v1.pdf
Puebloan Architecture	PB_A_v1.pdf
Puebloan Non-architectural	PB_N_v1.pdf
Puebloan Sheltered	PB_S_v1.pdf
Puebloan Open Air	PB_O_v1.pdf
Puebloan Residential	PB_RE_v1.pdf
Puebloan Short Occupation	PB_SO_v1.pdf
Puebloan Storage	PB_ST_v1.pdf
Late Prehistoric	LP_ALL_v1.pdf
Late Prehistoric Non-architectural	LP_N_v1.pdf
Late Prehistoric Open Air	LP_O_v1.pdf
Late Prehistoric Residential	LP_RE_v1.pdf
Late Prehistoric Short Occupation	LP_SO_v1.pdf
Historic (excluding Rock Art)	HI_noRA_v1.pdf
Historic Rock Art	HI_RA_v1.pdf
Prehistoric Rock Art	PH_RA_v1.pdf

8.5 v2 OUTPUTS

All performance evaluations for v2 models are included as separate portable document format (PDF) files that can be opened in Adobe Acrobat. A list of file extensions is found in Table 11.

Table 11: File Extensions for v2 Performance Evaluations

v2 Model	File Name
General Time Period	GEN_ALL_v2.pdf
Archaic	AR_ALL_v2.pdf
Formative	FOTOT_ALL_v2.pdf
Late Prehistoric	LP_ALL_v2.pdf
Historic without Rock Art	HI_noRA_v2.pdf

Note: No supplementary material is provided for the v2 Combination model as the analysis for it was conducted separately.