IN THE PINES:

A SPATIAL ANALYSIS OF ANCESTRAL INDIGENOUS LANDSCAPE USE AND BOUNDARY EFFECTS ON THE COCONINO PLATEAU IN NORTHERN ARIZONA

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ABSTRACT

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A SPATIAL ANALYSIS OF ANCESTRAL INDIGENOUS LANDSCAPE USE AND BOUNDARY EFFECTS ON THE COCONINO PLATEAU IN NORTHERN ARIZONA

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Ancestral Indigenous peoples of the Coconino Plateau in northern Arizona used a broad range of resources and environments to survive and thrive. Based on these observations, it is hypothesized that archaeological site density and clustering patterns may accordingly vary in different environments. The purpose of the present study is to examine site location patterns in two adjacent but differing biotic zones—Pinyon-Juniper Woodland and Ponderosa Pine Forest—and to determine whether archaeological sites in these zones display differing density and clustering patterns in relation to the boundary with the other zone, i.e., boundary effects. The study utilizes locational data of 3,743 prehistoric archaeological sites collected on the Williams Ranger District of the Kaibab National Forest from 1978 through 2022. The results of the study support previous research suggesting ancestral Indigenous peoples of the Coconino Plateau, including the Cohonina, utilized Pinyon-Juniper Woodland more intensively and centrally, while pushing into Ponderosa Forest only as far as necessary for seasonally- or biotically- specific purposes. A brief discussion on methodological approaches is also included, concerning spatial analysis of all prehistoric sites in an area versus sites of

specific archaeological cultural traditions. Further studies into site type and functionality patterns may further this research, lending more insight into ancestral Indigenous landscape use and aiding the Forest Service in managing its lands and prioritizing cultural resource surveys.

Acknowledgements

This thesis owes its existence to lands, materials, and histories ancestral to the Apache, Diné (Navajo), Havasu Baaja (Havasupai), Hopitutskwa (Hopi), Hualapai, Pueblo groups, Yavapai, and others. The study area is United States federal land taken from these communities, and the study subject material consists of archaeological sites ancestral to these communities. Northern Arizona University is situated on ancestral Indigenous land, and I researched and wrote my thesis on this land. I hope that by contributing to research on ancestral Indigenous land use patterns, my thesis will contribute to protecting, preserving, and compassionately managing these lands in the future.

I am thankful to the faculty and staff at Northern Arizona University for facilitating and guiding my research. This thesis would not have been possible without the thoughtful time and effort of my committee chair Dr. Kerry F. Thompson and committee members Dr. Francis E. Smiley and Dr. Melissa A. Liebert. I also extend deep thanks to professors Christopher Downum, Emery Rose Eaves, David Folch, Ruihong Huang, Mark Manone, Michelle Parsons, and Christopher Schwartz.

My research also would not have been possible without the ready cooperation and contribution of current and former archaeologist personnel on the Kabab National Forest, most notably Charles Webber and Neil Weintraub.

Ultimately, none of this would have happened without the deep appreciation for history and the past instilled in me by my parents, and their encouragement to follow my passions. I love you both and am grateful for that. Finally, thank you Farrah. And Misty, our cat.

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PREFACE

This thesis manuscript is prepared in a journal article format to facilitate future publication and hopefully aid in public access to contemporary anthropological and archaeological research. The document's formatting and layout thus differs from a traditional thesis. **Chapter 1** is a *General Introduction*, orienting the reader to the topic of the thesis, and provides context including an academic literature review of archaeological and ethnographic research, along with a discussion on theoretical underpinnings. **Chapter 2** is the *Journal Article* itself, formatted for journal submittal, including sections on background, analysis methods, and results and discussion. **Chapter 3** is an *Afterword*, consisting of final thoughts and reflections on the research and addressing any issues not previously covered. Because of the formatting choice there is some necessary redundancy in topics and content between different chapters and sections.

The journals *American Antiquity* and/or *Kiva* are both potential publication outlets for the journal article; accordingly, the manuscript follows the Society for American Archaeology (SAA) "Editorial Policy, Information for Authors, and Style Guide for American Antiquity, Latin American Antiquity, and Advances in Archaeological Practice" document, i.e., the SAA Style Guide (Society for American Archaeology 2021). These guidelines are adjusted where appropriate, such as applying continuous pagination throughout the manuscript, citing tables and figures as they appear in the journal article, and including only one comprehensive *References* section. Tables and figures are included in an appendix. This formatting will help the manuscript read more clearly and can be quickly modified for journal submittal thanks to automated figure and table crossreferencing and reference management software. Acronym abbreviations may also restart for the journal article.

CHAPTER 1: GENERAL INTRODUCTION TO THESIS

The purpose of this thesis is to investigate the relationship between ancestral Indigenous archaeological site patterning on the Coconino Plateau subdivision of the Colorado Plateau in northern Arizona and the boundaries of the native Pinyon-Juniper Woodland and Ponderosa Forest (Figure 1). The dry, high elevation regions of northern Arizona can be harsh but still contain a rich mosaic of environments and resources. This challenging yet abundant landscape presents a series of important and complex questions including: How did ancestral Indigenous peoples survive and thrive in these differing environments? Does geospatial site patterning vary from environment to environment? What does this tell us about potential movement patterns? How does the way we ask these questions influence our results and how we understand the past? To address some of these outstanding questions, the present study examines prehistoric site distribution based on biotic zone boundary effects in northern Arizona using geographic information systems (GIS) analysis. This work is important for both the academic understanding of landscape archaeology, as well as for helping land agencies manage cultural resources better.

Most previous archaeological work in the specific area of the Coconino Plateau considered here has focused on the Cohonina, a spatially and temporally distinct group that lived in the region and whose heartland is broadly centered on my study area—specifically, the Williams Ranger District on the Kaibab National Forest. Other studies have looked more broadly at prehistoric activity in the area (Phillips 2019). However, few researchers have looked broadly into all prehistoric site geospatial patterning (i.e., regional density or clustering) in my study area, nor contrasted broad prehistoric patterning with specific findings regarding the Cohonina. Since Cohonina sites are defined primarily through ceramics, aceramic sites may often not be considered, and omitting said aceramic or atemporal sites may skew Cohonina landscape level analysis. Further, no researchers have analyzed Williams Ranger District site patterns looking at the large cohort of data collected since the transition to a new spatial database implemented by the United States Forest Service (USFS) in 2004. My research intends to address both deficiencies.

My research will articulate with some of the “grand challenges” for archaeology (Kintigh et al. 2014): What are the relationships between environment, population dynamics, settlement structure, and human mobility? Human adaptation strategies to harsh environments are of critical importance today and were no less so in the past. Archaeologists are perennially interested in environment and adaptation as they relate to human movement, mobility, and migration. Archaeological research matters not just for the sake of gaining knowledge but also for how it impacts USFS land management in the future. If archaeologists on the Kaibab National Forest have a better idea of how the Cohonina and other ancestral Indigenous peoples used the landscape, then USFS personnel can plan surveys and manage archaeological sites better. Better management of cultural resources contributes to better managed forests, to the benefit of the environment and surrounding communities.

The dataset—and associated research area—consisted of prehistoric archaeological sites on the Williams Ranger District of the Kaibab National Forest. Thanks to the management practices of the USFS and the Kaibab National Forest, an exceptionally large portion of the Williams Ranger District has been surveyed, presenting a great opportunity for landscape analysis. Some existing datasets have been analyzed previously, but some have not.

Analysis of the Williams Ranger District site dataset affords the opportunity to answer the key research goal of my study: do different environmental zones predict specific site distribution patterns within zone perimeters? My analysis was approached with two specific mutually supportive objectives and hypotheses:

1. **Proximity**. The first objective was to examine sites in Pinyon-Juniper Woodland and Ponderosa Forest and to assess their mean distance to the central boundary between the two zones (Figure 5). I hypothesized that sites in Ponderosa Forest will tend to be closer to Pinyon-Juniper Woodland (i.e., show lesser mean distance). This is in part due to greater overall resource diversity and availability in Pinyon-Juniper Woodlands and the benefit of being able to access those resources more readily.
2. **Intensity**. The second objective was to examine landscape site density in Pinyon-Juniper Woodland and Ponderosa Forest and to assess whether density patterns change in relation to the central boundary between the two zones (Figure 6). I hypothesized that site distributions in Ponderosa Forest will tend to be denser toward the central boundary, while in Pinyon-Juniper Woodland distributions will tend to be denser further away from the central boundary.

Archaeological sites are reflective of past human activity on the landscape. The proximity and intensity of human activity in relation to environmental transition boundaries—i.e., boundary effects—is thus important because it tells us how past human activity differed in different environments. Supplemented by ethnographic and other archaeological data, differential land use patterns help inform our understanding of past lifeways.

Finally, a tertiary objective of my research was to compare the results of my study looking at all ancestral Indigenous sites (e.g., including Archaic and prehistoric aceramic/atemporal sites), versus more specific Cohonina-centric studies conducted previously (Bone 2002; Cureton 2014; Gibbs 2012; Schubert 2008; Sorrell 2005). This is addressed in the *Discussion* below.

Notes on Terminology

First, “prehistoric” is widely considered to be a Eurocentric term that carries implicit bias, along with terms such as pre-Hispanic and pre-Columbian (Society for American Archaeology 2021). In North American archaeology and anthropology, the term is understood broadly as referring to ancestral Indigenous peoples. More specifically, in the world of legal compliance archaeology where the data for my thesis are derived from, the term is used to categorically differentiate from “historic” archaeological sites, which are generally associated with historical European-American peoples. Because of such data classifications and usage conventions, I use the terms “prehistoric” and “ancestral Indigenous” interchangeably in my thesis.

Second, to be clear, “Cohonina” is an archaeological term referring to a set of peoples and practices in a set time and space and is not functionally equivalent to the names of real, self-defined cultural groups such as the Havasupai, even though I may use the terms comparatively.

Third, a note on place names. Much as I use the term “Cohonina” to summarize a complex set of people, practices, and things, I will generally use European-American place names—not because such names are the correct names, but because they follow a convention for understanding in my target academic community. Indigenous names for places vary from group to group and language to language, and certainly provide a linguistic anthropological angle through which to interpret landscapes, but that is unfortunately outside the scope of my project.

Finally, a distinction on spatial analysis terminology. The biotic zone boundary *effects* that are the subject of my current study are conceptually distinct from the broader boundary *problem* in spatial analysis studies. The latter refers to the problematic effects that arise from assigning artificial or arbitrary boundaries (such as municipal borders) over spatial data, potentially skewing analysis of that data due to the artificially imposed boundary parameter. While conceptually associative with the boundary problem, my analysis of boundary effects (as referred to in my title) refers to spatial data's real relation to living and tangible biotic boundaries, rather than skewing factors arising from artificially imposed boundaries.

Environmental Context

Biotic communities or zones are a way of classifying the natural environment according to the dominant expression of vegetation. They are "characterized by a distinctive vegetation physiognomy… They are plant and animal community responses to integrated climatic factors, more or less regional in scope" (Brown 1994:9). Because biotic zones are primarily climate driven, they have remained mostly consistent since the end of the Pleistocene about 9000 BCE. The two most prevalent biotic zones in the present study area are Pinyon-Juniper Woodland and Ponderosa Forest (Figure 1). Brown (1994) classifies these as "Great Basin Conifer Woodland" and "Petran Montane

Conifer Forest” respectively, but the terminology is roughly interchangeable, and I use the former for clarity. While biotic communities are mapped as polygonal areas with distinct boundaries, zonal transitions tend to be gradual with broad areas of intermixed dominant vegetation.

Pinyon-Juniper Woodland is dominated by Pinyon Pine (*Pinus* sp.) and Juniper (*Juniperus* sp.), with various grasses, cacti, and shrubs (Figure 2). The community is often directly adjacent to Ponderosa Forest, but slightly warmer and lower in elevation. Pinyon Pine produce pine nuts, a relatively abundant food source and important source of protein prehistorically, although nuts are only produced every four to seven years and not always reliably (Schubert 2008). Other food resources include agave and cacti.

Ponderosa Forest is dominated by Ponderosa Pine (*Pinus ponderosa*), often in pure park-like stands (Figure 3). The community is often directly adjacent to Pinyon-Juniper Woodland, but slightly cooler and higher in elevation.

Cultural Context

The archaeological chronology of the U.S. Southwest generally begins with the Paleoindian, followed by Archaic, followed by Basketmaker, followed by Formative periods. In the present study area, the Formative period is dominated by the Cohonina cultural tradition. In this literature review pre-Cohonina periods are addressed briefly, followed by a more in-depth review of the Cohonina, followed by a brief background on Havasupai ethnography. The Havasupai are a potential descendant community of the Cohonina, and an understanding of Havasupai lifeways is relevant to my exploration of ancestral Indigenous landscape use in the present study area.

Pre-Cohonina Periods

The Paleoindian period (9500–6500 BCE) is the term used by archaeologists to refer to the timeframe beginning with the first groups of people who migrated from Asia across the Bering Strait into the Americas at the end of Pleistocene glaciation (Bonnichsen and Turnmire 2005; Feder and Park 2006). More recent theories suggest a coastal migration based on marine resources as an alternative or supplementary pattern (Davis et al. 2019; Dixon 2000). The Clovis complex is the earliest firmly established Paleoindian complex and is characterized by fluted projectile points with overshot flaking and basal grinding. Clovis points have been found in association with the remains of the Columbian mammoth (*Mammuthus columbi*), establishing a tradition of association of Paleoindians with the hunting of late Pleistocene megafauna, although some studies indicate a more diversified resource base (Stanford 1999; Waguespack and Surovell 2003). Some recent studies have suggested the presence of earlier, perhaps pre-Clovis activity in North America, including the Gault and Cooper's Ferry sites in Texas and Idaho, respectively (Davis et al. 2019; Williams et al. 2018). Firm evidence for Paleoindian activity in or near the current study area is limited to a few isolated projectile point finds (Smiley et al. 2017). This limited presence suggests that few of the aceramic/atemporal prehistoric sites in the study date to the Paleoindian.

The Archaic period (6500−500 BCE) is defined by a notable change in the material record corresponding with climatic changes and megafaunal extinctions. Regarding projectile point morphology, the period sees the appearance of corner and side notched atlatl dart points, along with smaller arrow points and other stone tools. Changes in projectile technology suggest a further diversification in animal and plant resource procurement sources in this period (Huckell 1996). Compared to the Paleoindian there is greatly increased evidence for Archaic activity in the current study region, particularly near the Grand Canyon to the north. Such evidence includes a variety of projectile points, organic materials such as sandals and baskets, thermal features, and rock art, as well as split twig figurines dating to the Late Archaic found in caves in the Grand Canyon (Smiley et al. 2017). This increased presence suggests that a significant portion of aceramic/atemporal prehistoric sites considered in the study may in fact date to the Archaic.

The Basketmaker period (500 BCE−550 CE) is subdivided into Basketmaker II and Basketmaker III, and is generally accepted as corresponding with the adoption of agriculture (Coltrain and Janetski 2019). Basketmaker II peoples did not generally use ceramic technology. Ceramics appear with Basketmaker III peoples. Due to agricultural evidence often being ephemeral and other factors, the exact chronology and nature of human activity during the Basketmaker period in the study region still leaves many questions (Smiley et al. 2017). One study places agricultural origins at the Grand Canyon quite early at around 1210 BCE based on dated corn pollen (Davis et al. 2000), however more studies are needed to support this date. If proven, an early start date also does not mean the adoption of agriculture was widespread, and leaves open the question of if and how lifeways changed from the Archaic through the adoption of ceramic technology and the Formative period.

The Cohonina

The Cohonina are an archaeologically defined cultural tradition of north-central Arizona, dating from about 550 to 1200 CE. Historically, the Cohonina have been relatively understudied compared with some neighboring traditions, including the Virgin and Kayenta Ancestral Puebloan groups to the north and east, and the Sinagua to the east and south (Cartledge and Cleeland 1986; Colton 1939, 1946; Cureton 2014; Hargrave 1938; McGregor 1951). Relatively few Cohonina sites have been excavated. Fundamental questions remain surrounding Cohonina lifeways, including built environment, subsistence, and movement. Much of the Cohonina region lies within the bounds of the USFS, which in recent years have seen extensive survey by cultural resource management (CRM) firms under the impetus of the Four Forest Restoration Initiative (4FRI).

The archaeological cultural tradition of the Cohonina was established following a series of surveys and excavations by the Museum of Northern Arizona (MNA) in the 1930s (Colton 1939; Hargrave 1932, 1938). These projects characterized the Cohonina based on two artifactual markers: the manufacture and use of San Francisco Mountain Gray Ware ceramics and a unique projectile point type, aptly named the Cohonina point. These projects also established an initial chronology. Research by the MNA continued over the years, but in the 1970s that changed with the expansion of CRM archaeology. Much of the Williams and Tusayan Ranger Districts of the Kaibab National Forest lie within the bounds of Cohonina archaeology and consequently came to be subject to large-scale survey (Cureton 2014). Increased systematic survey began to result in larger-scale and more processual syntheses of the Cohonina, using survey data to give new insight into specific Cohonina adaptation strategies and lifeways (Cartledge 1979; Cartledge and Cleeland 1986). Research has continued with analyses on Cohonina public space (Bone 2002), changes in ceramic thickness over time (Sorrell

2005), geospatial site distribution (Gibbs 2012; Schubert 2008), local area interactions with neighboring groups (Bayman and Sullivan 2008; Sullivan 1995), and others.

Since San Francisco Mountain Gray Ware is the type-ware of the Cohonina, the geographic extent of the Cohonina has been defined as, and equivalent to, the geographic extent of San Francisco Mountain Gray Ware ceramics (Colton 1939; Garcia 2004; Sorrell 2005). This extent encompasses much of the Coconino Plateau, bordered to the north by the Colorado River, to the east by the Little Colorado River, to the south by the Verde River and Mogollon Rim, and to the west by the Aubrey Cliffs (see Figure 4). It should be noted that along these borders are often large areas of overlap with other ceramic cultural signifiers, creating a relatively homogenous heartland surrounded by a suggested frontier.

The temporal extent and subdivision of the Cohonina has been interpreted in various ways over time. A Hermit focus (550 to 800 CE), Coconino focus (800 to 1025 CE), Medicine Valley focus (1025 to 1125 CE), and Hull focus (1125 to 1200 CE) chronology is currently generally accepted (Colton 1946; Cureton 2014; Schubert 2008; Schwartz 1955; Sorrell 2005). “Naylier” and “Cataract” foci were briefly employed but have since been discarded (McGregor 1951). It should be noted that early archaeologists used the term “focus” to describe blocks of Cohonina time (Colton 1939). Subsequent research in neighboring areas (such as the Sinagua) has generally replaced “focus” with “phase” or “period,” but “focus” continues to be the most generally preferred term for the Cohonina (Cureton 2014).

A discussion of Cohonina lifeways might begin with architecture. The Cohonina constructed a variety of permanent features, including pithouses, multi-room above-ground pueblos, hill-top structures termed forts, single-room fieldhouses, and oval features often termed ballcourts (Cartledge 1979; Colton 1939; Cureton 2014; McGregor 1951; Wilcox et al. 1996). It is not clear, however, exactly how the preceding sites were utilized. Some have suggested that pithouses likely functioned as habitations (as pithouses did elsewhere) while small above-ground structures might have served for storage or seasonal habitation, as some have been found to lack hearths (McGregor 1951; Samples 1992).

Regarding subsistence, it is generally assumed that the Cohonina grew corn and hunted, due to the identification of maize at some Cohonina sites (Colton 1939; Hargrave 1932, 1938; McGregor 1951), as well as general assumptions about subsistence in the U.S. Southwest during the Formative period. However, the relative paucity of maize evidence has led others to question the relative importance of corn agriculture versus hunting and gathering in the Cohonina diet (Cartledge 1979; Cartledge and Cleeland 1986). Past geospatial site analyses found that a majority of Cohonina sites fall within the Pinyon-Juniper Woodland biotic zone, where pinyon pine nuts would present a ready food source, and that a majority of sites with ground stone fall within that same biotic zone (Brown 1994; Schubert 2008). The emerging consensus is that agriculture was adopted in some parts of the southern U.S. Southwest as early as 2100 BCE during the Archaic, via hunting and gathering networks, and was then adapted in a piecemeal or as-needed basis across different regions (Roth 2016). It remains to be seen how the Cohonina fit in with this model.

Having discussed architecture and subsistence, I turn to movement. It has been suggested that the Cohonina followed a seasonal, elevation-based rotation, thereby utilizing the full range of resources available at the wide-ranging elevations of the region—this is based on analogies with Havasupai lifeways and geospatial site analyses, among other things (Gibbs 2012; McGregor 1951, 1967; Schubert 2008). Most prior analyses have relied on spatial data from prior to 2004. One goal of my project is to reexamine questions about movement incorporating data collected since 2004.

Archaeologists have debated the origins and descendant community(ies) of the Cohonina (Martin 1985; Schwartz 1955, 1959). The Havasupai live in the area in-and-around Havasu Canyon (also called Cataract Canyon) and other smaller tributary canyons to the Grand Canyon. This area is located solidly within the footprint of the Cohonina tradition (see Figure 4), and thus the Havasupai are a frequent candidate as a descendant group, as suggested by Schwartz (1959). Martin (1985), however, disputed this idea, citing a lack of compelling archaeological evidence—notably, a gap of about 200 years in the material record on some sites between the end of Cohonina artifacts and the beginning of Havasupai artifacts. More importantly though, the area of Cohonina cultural footprint encompasses areas considered ancestral to the Apache, Diné (Navajo), Havasu Baaja (Havasupai), Hopitutskwa (Hopi), Hualapai, Pueblo groups, Yavapai, and others, all of which must properly be considered descendent communities. Thus, all that can be firmly said based on current knowledge is that the specific lifeway(s) that created Cohonina-associated artifacts and features apparently ceased to create such artifacts and features around 1200 CE.

Havasupai Ethnography

Regardless of descendancy, the Havasu Baaja (colloquially, the Havasupai) are immediately apparent as an appropriate source of ethnographic analogy for the Cohonina (McGregor 1951, 1967), and Havasupai history should certainly be discussed in a literature review of the area. The Havasupai demonstrably live within the geographical extent of the Cohonina, with some Havasupai sites possessing deeper stratigraphic layers with Cohonina artifacts (though, as noted, there may be a discontinuity). Further, ethnographic documentation from the early 20th century recorded traditional Havasupai lifeways and subsistence in the post-contact era, but prior to widespread modernization. There is a question of validity surrounding the usefulness of such ethnographies. The two most pertinent ethnographies were conducted by Leslie Spier from 1918 to 1921 (Spier 1928, 1929) and by A.F. Whiting in the 1940s (Whiting 1985). Whiting's work was published posthumously. Both came from a European-American background and from an early-20th century school of anthropological thought, so it is appropriate to look critically at research questions, methods, reporting, and possible editorializing. At the very least, ethnographies must be contextualized within the anthropological culture of the time. What I glean from Spier and Whiting are largely physical observations—i.e., seasonal movement and associated material culture—and thus I would suggest that if Spier and Whiting agree on details of such things, then the details should be trustworthy. Early ethnographies also have the advantage of perhaps better capturing earlier cultural patterns, which may not be as evident—or remembered—in more recent ethnographies.

Anthropologists and archaeologists have analyzed and synthesized these ethnographies and have concluded that the Havasupai "utilized their upland territory for winter, spring and fall hunting and gathering while retiring to the canyon bottoms for summer irrigation farming" (Schwartz 1959:1061). Martin (1985) largely concurs. Such a cycle would result in agricultural sites at lower elevations, and resource procurement and processing sites at higher elevations. That such movement was practiced historically suggests that the Cohonina may have similarly utilized different elevations or associated biotic zones for different uses, and that this differential usage may be reflected in site spatial distribution and density.

A Discussion on Landscape Theory

A study on geospatial distribution of archaeological sites would not be complete without a discussion on landscape theory in archaeology, a broad body of thought that encompasses a variety of theoretical approaches (Preucel and Mrozowski 2010). Landscape theory can be applied heavily as a key determinant in anthropological and archaeological observations or lightly as a subtle influence on another theory. It can be applied narrowly to a single site or broadly to a physiographic region. Fowles (2010) described an emerging "American Southwest" school of landscape archaeology, characterized by an increasingly phenomenological approach and incorporation of Indigenous philosophies and traditional views. Such an approach is firmly situated in the post-processual tradition, eschewing positivist reduction in favor of more open-ended observations. Accordingly, perhaps we cannot seek to *know* the past but can seek to *understand* it better. This is the approach I take in my thesis, leaning on insights from Taçon (1999), Turner (1966), and Laluk (2017). Past and present Indigenous understandings of the landscape are varied, and as a person of European-American descent, I am not claiming to define, describe, or fully grasp such understandings. I do try to pull a few small observations together to provide a potential backdrop for how the Cohonina and other ancestral Indigenous peoples may have viewed and moved across the landscape.

Engaging in a "thick description" of the landscape—as Geertz (1972) advocates for cultures—is necessary to situate my discussion. The potential range of Cohonina-associated lands is vast, incorporating portions of the Colorado Plateau and Basin and Range physiographic regions. Elevations vary widely and vegetation zones vary from desert scrub to grassland to Pinyon-Juniper Woodland to Ponderosa, subalpine to alpine forest and to tundra at the top of the San Francisco Peaks (Brown 1994). Some elevation changes are long and gradual, allowing for near complete freedom of movement, while others are sharp and dramatic, restricting or directing movement. The latter features include canyons cut by the Colorado and Verde Rivers, from the Grand Canyon to numerous smaller tributary canyons; mountains, such as the San Francisco Peaks and numerous smaller peaks of the San Francisco Volcanic Field; and escarpments, such as the Coconino Rim and portions of the Mogollon Rim (U.S. Geological Survey 2019). In this landscape, the right combinations of elevation and vegetation frequently provide for very long lines of sight.

It is useful to contrast this Colorado Plateau landscape against other quite different physiographic regions. In the Appalachian Mountains, for instance, a combination of low, rolling hills, compact, cradling valleys and hollows, and dense, deciduous forest makes for a landscape of small, homogenous spaces with subtle transitions (U.S. Geological Survey 2019). By comparison the places and spaces of the Cohonina are large and varied, frequently with long distances between transitions, and with those transitions often being dramatic.

Holding on to these thoughts on physical landscape properties, I turn now to Taçon's concept of "sacred" landscapes and sites. Though he focuses on aboriginal groups in Australia, he is confident in making a broad assertion: "In areas of the world where ethnographic or historic information is available we know that certain landscape features invoke common responses in human beings—feelings of awe, power, majestic beauty, respect, enrichment among them" (Taçon 1999:79). He identifies four general categories for such spaces, which are worth relaying in detail:

> "(a) [W]here the results of great acts of natural transformation can be best seen, such as mountain ranges, volcanoes, steep valleys or gorges; (b) at junctions or points of change between geology, hydrology, and vegetation, or some combination of all three, such as sudden changes in elevation, waterfalls, the places where rainforest meets other vegetation; (c) where there is an unusual landscape feature, such as a prominent peak, cave, or hole in the ground that one comes upon suddenly; and (d) places providing panoramic views or large vistas of interesting and varied landscape features. Often these are places where concepts of an upper world, a lower world and the earth plain come together visually in a striking manner" (Taçon 1999:79).

As we have seen, the world of the Cohonina is replete with such spaces. Importantly, I am not claiming that ergo the Cohonina considered each of these such spaces "sacred" per-se, but Taçon's point that these spaces invoke certain responses rings true. (I am also not claiming that other physiographic regions, such as Appalachia, completely lack such features.)

Something these four types of spaces have in common is that they are liminal—that is, they are points of contact between one thing and another, places of transformation or change, and/or margin zones. In *The Ritual Process*, Turner (1966) draws on a variety of examples to show that shared experiences of liminality are fundamental to a sense of shared community—he uses the term *communitas* to differentiate from the physical place where people live together. He discusses *communitas* largely in terms of human practices. For instance: child-to-adult rites of passage, festivals of social hierarchy reversal, and fringe religious movements. Such experiences are vital to *communitas*; they bind people together through a shared experience of uncertainty, fear, and/or exaltation. Without the binding of *communitas*, society itself is at risk. As humans are a social species, we see that the experience of liminality is itself an existential need.

Turner does not elaborate greatly on how liminal human practices might interface with places of liminality on the landscape. A connection can be readily made, however. Laluk (2017) provides one way through the Apache word and concept *Ni*. *Ni* is both land and mind: the mental and the geographic are two sides of the same coin. It follows that when the landscape experiences liminality, the human experiences it as well; if human liminality is an existential need, so too are points of liminality on the landscape. Other commonly known examples of Indigenous human/landscape liminal intersectionality include understandings that place the Grand Canyon as a point of human emergence, or that place the San Francisco Peaks as a dwelling place of the *katsinam* or kachinas.

If places of liminality on the landscape are set apart by (relatively) great distances, and if such places are existentially necessary for society and life, I would suggest it follows that the landscape itself promotes a mobile lifeway. This is not to say that landscape theory directly supports the hypothesis that the Cohonina—nor, by extension, other local ancestral Indigenous peoples—practiced a particular seasonal movement pattern. Further, my thesis is not meant to imply that the Cohonina followed a purposeful migration route from sacred-space to sacred-space for the purpose of maintaining existence. Rather, the preceding discussion provides a solid theoretical foundation to the idea that the Cohonina *moved*, in a way that was influenced by the landscape. In turn, it is supposed that such movement of the body would have influenced mindsets and vice versa, in terms of individual physical practice, social behavior, and social capital (Bourdieu 1986; Jackson 1983; Reid et al. 1975; Sack 1997).

CHAPTER 2: JOURNAL ARTICLE

Background and Purpose of Study

The purpose of this article is to investigate the relationship between ancestral Indigenous archaeological site patterning on the Coconino Plateau subdivision of the Colorado Plateau in northern Arizona and the boundaries of native Pinyon-Juniper Woodland and Ponderosa Forest (Figure 1). The dry, high elevation regions of northern Arizona can be harsh but still contain a rich mosaic of environments and resources. This challenging yet abundant landscape present a series of important and complex questions including: How did ancestral Indigenous peoples survive and thrive in these differing environments? Does geospatial site patterning vary from environment to environment? What does this tell us about potential movement patterns? How does the way we ask these questions influence our results and how we understand the past? To address some of these outstanding questions, the present study examines prehistoric site distribution based on biotic zone boundary effects in northern Arizona using geographic information systems (GIS) analysis. This work is important for both the academic understanding of landscape archaeology, as well as for helping land agencies—such as the U.S. Forest Service—manage cultural resources better.

Biotic communities or zones are a way of classifying the natural environment according to the dominant expression of vegetation. Because biotic zones are primarily climate driven, they have remained mostly consistent since the end of the Pleistocene about 9000 BCE. The two most prevalent biotic zones in the present study area are Pinyon-Juniper Woodland and Ponderosa Forest (Figure 1). Brown (1994) classifies these as “Great Basin Conifer Woodland” and “Petran Montane Conifer Forest” respectively, but the terminology is roughly interchangeable, and I use the former for clarity. Pinyon-Juniper Woodland is dominated by Pinyon Pine (*Pinus* sp.) and Juniper (*Juniperus* sp.), with various grasses, cacti, and shrubs (Figure 2). The community is often directly adjacent to Ponderosa Forest, but slightly warmer and lower in elevation. Pinyon Pine produce pine nuts, a relatively abundant food source and important source of protein prehistorically, although nuts are only produced every four to seven years and not always reliably (Schubert 2008). Other food resources include agave and cacti. Ponderosa Forest is dominated by Ponderosa Pine (*Pinus ponderosa*), often in pure park-like stands (Figure 3). The community is often directly adjacent to Pinyon-Juniper Woodland, but slightly cooler and higher in elevation. While biotic communities are mapped as polygonal areas with distinct boundaries, zonal transitions tend to be gradual with broad areas of intermixed dominant vegetation.

Previous Research

The archaeological chronology of the U.S. Southwest generally begins with the Paleoindian, followed by Archaic, followed by Basketmaker, followed by Formative periods. In the present study area, the Formative period is dominated by the Cohonina cultural tradition. The Cohonina are a spatially and temporally distinct group that lived in the region from around 550 to 1200 CE and whose heartland is broadly centered on the study area (Figure 4), and most previous archaeological work in the study area has focused on them. The archaeological cultural tradition of the Cohonina was established following a series of surveys and excavations by the Museum of Northern Arizona (MNA) in the 1930s (Colton 1939; Hargrave 1932, 1938). These projects focused on cultural and temporal markers, and characterized the Cohonina primarily based on the manufacture and use of San Francisco Mountain Gray Ware ceramics. These projects also established an initial Cohonina chronology from around 550 to 1200 CE, with subgroupings.

Research on the Cohonina continued by the MNA over the years; however, the expansion of cultural resource management (CRM) archaeology in the 1970s changed this area of study. The Kaibab National Forest—much of which lies within the bounds of Cohonina archaeology—came to be subject to large-scale survey (Cureton 2014). Increased systematic survey began to result in larger-scale and more processual syntheses of the Cohonina, using survey data to give new insight into specific Cohonina adaptation strategies and lifeways (Cartledge 1979; Cartledge and Cleeland 1986). Research in recent decades has continued with analyses on Cohonina public space (Bone 2002), changes in ceramic thickness over time (Sorrell 2005), geospatial site distribution (Gibbs 2012; Schubert 2008), and local area interactions with neighboring groups (Bayman and Sullivan 2008; Sullivan 1995).

Other studies have looked more broadly at resource procurement and processing in the area (Phillips 2019). However, few researchers have looked broadly into all prehistoric site geospatial patterning (i.e., regional density or clustering) in my study area, nor contrasted those with specific findings regarding the Cohonina. Since Cohonina sites are defined primarily through ceramics, aceramic sites may often not be considered—this limitation is important since omitting said aceramic or atemporal sites may skew Cohonina landscape level analysis. Further, no researchers have analyzed site patterns in the study area looking at the large cohort of data collected since the transition to a new spatial database implemented by the United States Forest Service (USFS) in 2004. My research intends to address both of those possible deficiencies.

Significance

My research will articulate with some of the “grand challenges” for archaeology (Kintigh et al. 2014): What are the relationships between environment, population dynamics, settlement structure, and human mobility? Human adaptation strategies to harsh environments are of critical importance today and were no less so in the past. Archaeologists are perennially interested in environment and adaptation as they relate to human movement, mobility, and migration. Archaeological research matters not just for the sake of gaining knowledge but also for how it impacts USFS land management in the future. If archaeologists have a better idea of how the Cohonina and other ancestral Indigenous peoples inhabited and used the landscape, then USFS personnel can plan surveys and manage archaeological sites better. Better management of cultural resources contributes to better managed forests, to the benefit of the environment and surrounding communities.

Objectives and Hypotheses

The dataset—and associated research area—consisted of prehistoric archaeological sites on the Williams Ranger District of the Kaibab National Forest. Thanks to the management practices of the USFS and the Kaibab National Forest, an exceptionally large portion of the Williams Ranger District has been surveyed, presenting a great opportunity for landscape analysis. Some existing datasets have been analyzed previously, but some have not.

Analysis of the Williams Ranger District site dataset affords the opportunity to answer the key research goal of my study: do different environmental zones predict specific site distribution patterns within zone perimeters? My analysis was approached with two specific mutually supportive objectives and hypotheses:

1. **Proximity**. The first objective was to examine sites in Pinyon-Juniper Woodland and Ponderosa Forest and to assess their mean distance to the central boundary between the two zones (Figure 5). I hypothesized that sites in Ponderosa Forest will tend to be closer to Pinyon-Juniper Woodland (i.e., show lesser mean distance). This is in part due to greater overall resource diversity and availability in Pinyon-Juniper Woodlands and the benefit of being able to access those resources more readily.
2. **Intensity**. The second objective was to examine landscape site density in Pinyon-Juniper Woodland and Ponderosa Forest and to assess whether density patterns change in relation to the central boundary between the two zones (Figure 6). I hypothesized that site distributions in Ponderosa Forest will tend to be denser toward the central boundary, while in Pinyon-Juniper Woodland distributions will tend to be denser further away from the central boundary.

Archaeological sites are reflective of past human activity on the landscape. The proximity and intensity of human activity in relation to environmental transition boundaries—i.e., boundary effects—is thus important because it tells us how past human activity differed in different environments. Supplemented by ethnographic and other archaeological data, differential land use patterns help inform our understanding of past lifeways.

Finally, a tertiary objective of my research was to compare the results of my study looking at all ancestral Indigenous sites (e.g., including Archaic and prehistoric aceramic/atemporal sites), versus more specific Cohonina-centric studies conducted previously (Bone 2002; Cureton 2014; Gibbs 2012; Schubert 2008; Sorrell 2005). This is addressed in the *Discussion* below.

Looking for Boundary Effects

Description of Dataset

For the present study, I utilize data provided by the Kaibab National Forest, i.e., a secondary data source. The raw dataset consists of a geodatabase of 5,065 archaeological sites representing all recorded archaeological sites within the Williams Ranger District on the Kaibab National Forest, an area covering about 593,586 acres (2,402 kilometers[km]^2). The Kaibab National Forest's Cultural Resource Automated Information System (CRAIS) electronic database of archaeological sites was employed to store site data from 1978 to 2004. Since then, the Four Forest Restoration Initiative (4FRI) and other management efforts have greatly increased the volume of available data, but this data has been stored in a new database and has not been substantially analyzed. Data collected from 2004-to-present are stored in a new USFS database called INFRA. INFRA also contains migrated data from CRAIS. I used the latter INFRA database, containing data collected from 1978 through 2022. The dataset was provided by the Kaibab National Forest and includes site data entered through April 2022 (United States Forest Service 2022).

The surveys that recorded the sites in the database(s) were conducted largely (though not exclusively) under compliance obligations under the National Historic

Preservation Act (NHPA) of 1966 and the National Environmental Protection Act (NEPA) of 1970 prior to undertakings such as prescribed fire treatments, timber harvesting, and others. The surveys cover about 287,719 acres (1,164 km^2) of the Williams Ranger District. Some recorded archaeological sites fall outside of areas that have been systematically surveyed. To control for survey bias, I selected only sites that intersect with surveyed areas. This resulted in a narrower data set of 4,611 sites (Figure 7).

Research Design

As my research compares site distribution data in relation to ecological data, it adopts a correlational research design. Correlational studies look at a population of entities to examine whether a change in one variable or characteristic correlates with a change in another variable or characteristic. Such an approach is in line with other similar studies conducted recently looking at environment and prehistoric site characteristics (Bayman and Sullivan 2008; Marwick et al. 2018).

It should be noted that the biotic zone boundary *effects* that are the subject of my current study are conceptually distinct from the broader boundary *problem* in spatial analysis studies. The latter refers to the problematic effects that arise from assigning artificial or arbitrary boundaries (such as municipal borders) over spatial data, potentially skewing analysis of that data due to the artificially imposed boundary parameter. While conceptually associative with the boundary problem, my analysis of boundary effects (as referred to in my title) refers to spatial data’s real relation to living and tangible biotic boundaries, rather than skewing factors arising from artificially imposed boundaries.

The practical problems surrounding my study generally stemmed from the accessibility of INFRA data. For example, many interesting attributes of sites—such as cultural/temporal affiliation and featural and artifact characteristics—could not be queried in the INFRA dataset. This is in part why I adopted a more geospatial distribution-oriented research design (i.e., looking at sites' geographical distribution as a variable).

It should be noted that the study area encompasses areas considered ancestral to many Indigenous groups, all of whom must properly be considered descendent communities. These groups include the Apache, Diné (Navajo), Havasu Baaja (Havasupai), Hopitutskwa (Hopi), Hualapai, Pueblo groups, Yavapai, and others. "Cohonina" is an archaeological term referring to a set of peoples and practices in a set time and space and is not functionally equivalent to the names of real, self-defined Indigenous groups, even though I may use the terms comparatively.

To aid in reproducibility, full models of geospatial processing parameters and statistics code will be made available upon request from the author. Archaeological site locational data is confidential and must remain protected per USFS policy and out of respect to descendant communities.

Description of Study Units and Variables

Spatial and associated attribute data were collected either by USFS archaeologists or by permitted archaeological firms under contract. Attribute data may have included information on archaeological features and artifacts at the sites as well as cultural/temporal affiliation, photographs, site maps, and other information, but this attribute data is not necessarily linked to geospatial data and may only be available in forms or reports in paper or electronic format. Regardless of who collected the data, data collection standards adhered to USFS guidelines. Pedestrian survey was conducted by archaeologists walking a series of parallel transects spaced no more than 20 meters (m) apart. Cultural resources were defined as sites per guidelines provided in the USFS Region 3 (Southwest Region) Programmatic Agreement. Site boundaries were recorded in the field with a handheld global positioning system (GPS) unit. Some older sites only have buffered points for site boundaries, and such sites are thus unsuitable for detailed shape analysis but applicable for general location information.

Variable fields provided with the raw data from the Kaibab National Forest included the following:

1. *Resource ID*. Each site has a unique USFS site number, consisting of an 11-digit numerical identifier.
2. *Cultural Resource Description*. Each site has a brief textual description, generally including key characteristics of the site.

To conduct statistical analyses to answer my research questions regarding landscape use and zonal patterning, I used geoprocessing tools to append new variables to my data, including the following:

1. *Biotic Zone*. Each site was assigned categorical biotic zone data derived from the site's dominant ecological area (Brown 1994), consisting binarily of either Pinyon-Juniper Woodland or Ponderosa Forest. While these are not the only biotic zones present on the Williams Ranger District, they are by far the most prevalent.

2. *Distance-Boundary*. Each site was assigned continuous data representing sites' distance in meters to the nearest boundary with the opposite biotic zone, either Pinyon-Juniper Woodland or Ponderosa Forest.

Data Analysis

Raw site data from the Kaibab National Forest included historic and other non-prehistoric sites, and thus needed to be trimmed down to only include data applicable to the study. Therefore, I conducted a selecting search in the *Cultural Resource Description* field for keywords such as *Prehistoric, Cohonina, Sinagua,* and others (for a complete list see Table 1). While not perfect, I reviewed a large portion of the very large dataset and determined that such a keyword search was the most efficient and effective way to skim string-format data, with the keywords selected strategically based off the data entry conventions in the dataset. Sites meeting these criteria were then overlayed with standard corresponding biotic zone maps so that appropriate zonal data could be appended to them (Brown 1994), producing two categories or groups of sites: Pinyon-Juniper Woodland sites, and Ponderosa Forest sites. Geoprocessing tools were then used on each of the two groups separately to calculate and append each sites' distance to the boundary with the opposite biotic zone (see Figure 5). No data should be missing or excluded. Sample sizes, means, and frequencies are provided below and in attached tables (see Table 2).

Prior to analysis, I assessed the site distance data for normality via descriptive data and histograms, and although some skewness and kurtosis levels were elevated, all were within standard acceptable ranges for parametric testing (±1.00; Field 2018). The large sample size of the data also served to mitigate any potential normality concerns (Field 2018). Because I compared site distance data, a continuous variable, to biotic zone data, a categorical variable, and then compared results between groups, I used a *t*-test statistical analysis. A *t*-test is a statistical analysis used to compare the means of a continuous variable of two groups within a population, often two groups with a differing categorical variable reflecting different characteristics of the population. The analysis produced results appropriate to a correlational research study to determine if differences in means were significant. Results were assessed with equal variances not assumed.

Site density was visually assessed using kernel density geospatial analysis tools. Kernel density mapping takes site point feature information as input and generates a smooth heat map based on neighborhood density (see Figure 6, Figure 10). This transforms spatial vector data, in which geographical information is represented by points, lines, and/or polygons, into raster data, in which geographical information is represented by pixels in a flat image. The resulting raster heat map was visualized with eight equal intervals, with yellow and red representing more dense "hot" areas and purple and blue representing less dense "cool" areas. The heat map was not conducive to quantitative analysis and so was analyzed visually, looking for areas of high density versus low density and comparing them from one biotic zone to the other and in relation to the central zonal boundary.

Geospatial analysis was conducted using ESRI ArcGIS Pro Version 3.0, and statistical analysis was conducted using IBM SPSS Statistics Version 27. Results were regarded as significant at $p = \leq .01$ to achieve a high level of significance.

Effects of Biotic Boundaries on Archaeology

Objective 1 Results: Proximity

The initial analysis of the sites to filter for only prehistoric sites yielded a total of 3,879 archaeological sites (Figure 7). Of these, the great majority were in either Pinyon-Juniper Woodland (n = 1,950) or Ponderosa Forest (n = 1,793). A lesser portion were in other biotic zones including Plains and Great Basin Grassland (n = 98) and Interior Chaparral (n = 38). These were eliminated from the study, leaving a total of 3,743 sites considered in my analysis (Figure 8; Table 2).

For sites located within Pinyon-Juniper Woodland zones, distances to the nearest Ponderosa Forest boundary ranged from one meter to 26,812 meters. For sites located within Ponderosa Forest zones, distances to the nearest Pinyon-Juniper Woodland boundary ranged from one meter to 13,366 meters.

It was hypothesized that within Ponderosa Forest zones, sites would tend to be closer to Pinyon-Juniper Woodland zonal boundaries, i.e., show lesser mean distance, due to greater overall resource diversity and availability in Pinyon-Juniper Woodlands and the benefit of being able to access those resources more readily. Results showed that on average, sites located in Ponderosa Forest zones showed lesser distances from zonal boundaries (M = 4,732.65, SE = 82.97) than sites located in Pinyon-Juniper Woodland zones (M = 7,510.75, SE = 139.48; Figure 9). A t-test conducted with this distance data showed that the difference in average zonal boundary distances between the two zones was statistically significant, at $t(3{,}144.178) = 17.118$, $p = \leq .001$, with equal variances not assumed and with a medium size effect, $r = 0.26$, $d = 0.59$. This finding aligns with the hypothesis, showing that sites in Ponderosa Forest tend to be closer to Pinyon-Juniper Woodland, while sites in Pinyon-Juniper tend to be further away from Ponderosa Forest to a degree that is statistically significant.

Objective 2 Results: Intensity

It was hypothesized that within Ponderosa Forest zones site density would tend to be higher toward zonal boundaries, while within Pinyon-Juniper Woodland site density would tend to be higher further away from zonal boundaries, for the same reasons stated above. Kernel density analysis of prehistoric site points from all biotic zones yielded a site density heat map (Figure 10). The map shows several areas of distinct site density, including an outlier area of very high density just northwest of Sitgreaves Mountain. There is an area of notably light density toward the interior of the Ponderosa Forest zone, and within the Pinyon-Juniper Woodland zone there are a few areas of distinct density further away from the zonal boundaries. These findings somewhat align with the hypothesis, showing that in many instances site densities in Ponderosa Forest are higher toward the central zonal boundary, but raise questions to be discussed further below.

Discussion

The results of the first analysis show that broadly, ancestral Indigenous sites in Ponderosa Forest tend to be closer to boundaries with Pinyon-Juniper Woodland than vice versa. The results support the first hypothesis of my study and may suggest that peoples tended to utilize Ponderosa Forest lands closer to boundaries with Pinyon-Juniper Woodland to more easily utilize the resources present in the latter.

The second analysis, looking at site density, roughly supports my hypothesis but also lends nuance and raises additional questions. First, an outlier area of particularly high site density just to the northwest of Sitgreaves Mountain may be somewhat skewing the distance data. However, the area of high site density straddles the zonal boundary, with the densest part being in Pinyon-Juniper Woodland but much of the rest being in Ponderosa Forest, so the skewness may balance itself out. This “Sitgreaves settlement system” is anchored by 17 examples of Cohonina public architecture, including the Walavudu plaza site (Cureton 2014:138), so it is unsurprising that the settlement system dominates the heat map. What is notable is that my analysis, looking at all prehistoric sites, continues to support the Cohonina-specific Sitgreaves settlement pattern.

Another pocket of high site density in Ponderosa Forest is at the far southern edge of the study area. If anything, the concentration pulls away sites’ average distance to Pinyon-Juniper Woodland zonal boundaries as considered in my study. However, the concentration borders the Mogollon Rim as the plateau drops off into Sycamore Canyon and the Verde River valley (see Figure 4). Biotically, this cluster of sites borders an Interior Chapparal zone, and thus still suggests a boundary effect of Ponderosa Forest sites clustering toward an outer boundary.

With these two potential skewing factors aside, the density analysis generally supports the distance analysis. Sites in Pinyon-Juniper Woodland tend to be further away from Ponderosa Forest and show greater clustering further away from that boundary. Conversely, sites within Ponderosa Forest tend to be closer to Pinyon-Juniper Woodland (and other zonal boundaries), and to be generally more dispersed toward the interior of the biotic zone, with any clustering toward zonal borders. This patterning supports the idea that while Ponderosa Forest presents some unique resource benefits, it is preferable for human activity to stay near the biotic zone boundary, and not proceed too far into the zone's interior. Conversely, Pinyon-Juniper Woodland environments appear to present sufficient resource availability for sites to cluster well away from Ponderosa Forest.

Both my descriptive statistics and density analysis suggest generally more sites present in Pinyon-Juniper Woodland versus Ponderosa Forest. This aligns with past geospatial site analyses, that have found a majority of Cohonina sites fall within the Pinyon-Juniper Woodland zone, where Pinyon pine nuts would present a ready food source—a majority of sites with ground stone are there as well (Brown 1994; Schubert 2008).

Other studies, based on analogies with Havasupai lifeways and geospatial analyses among other things, have suggested that the Cohonina followed a seasonal, elevation-based rotation, thereby utilizing the full range of resources available at different elevations and environments (Gibbs 2012; McGregor 1951, 1967; Schubert 2008). My analyses support these previous studies, suggesting greater activity within the lower-elevation Pinyon-Juniper Woodlands, with perhaps seasonal forays upslope just far enough to reach Ponderosa Forest, without need to proceed much further.

What is notable is that these previous large-scale studies utilized site spatial data from prior to 2004 and examined only sites with Cohonina-specific identifiers. Not only does the present study include new site spatial information collected from 2004 to 2022, but it also includes non-Cohonina-specific sites. This means I look at Archaic through Formative sites, but also aceramic/atemporal prehistoric sites that may not have been factored into culturally specific studies. This implies at least two things. First, previous studies into the Cohonina were robust. Robust enough, that Cohonina-specific trends hold true across all prehistoric sites within the study area. Second, human strategies for surviving and thriving in the study area may be surprisingly consistent from the Archaic through the Formative Periods.

The second point above has potentially significant implications for how archaeologists chronologically structure the past. The Pecos classification and other such chronologies tend to be structured around certain technologies or material practices—i.e., projectile point types, agriculture, ceramics, building types (Plog and Grey 2011). Brackets of chronology may be defined by the emergence, dispersion, prevalence, decline, and extinction (i.e., the "battleship curve") of these things. However, in certain areas, despite the adoption or prevalence of certain technologies or practices, basic lifeway patterns—such as seasonal migration—may persist. Alternatively (or additionally), groups of people may temporarily alter fundamental behavior after adopting a new technology or practice, but if things do not go desirably, return to a more established and sustainable behavioral pattern. Rushforth and Upham (1992) term this "adaptive diversity." Such an interpretation is not to suggest that chronologies are irrelevant, nor that prehistory be viewed as a static block. Rather, it is to suggest that the way archaeologists chronologize the past may have far more significance for archaeologists than for past peoples, and that landscapes and environments may be far more significant behavioral factors than the coming and going of technologies and peripheral practices.

Conclusion

Ancestral Indigenous peoples of the Coconino Plateau generally—and in the current study area specifically—would have had to utilize a broad range of resources to survive and thrive. Different biotic zones in the study area present quite different profiles regarding availability and diversity of resources. It follows that peoples would have utilized these landscapes differently, and that these varied activity patterns would result in differing archaeological footprints.

My study supports previous research suggesting the Cohonina utilized Pinyon-Juniper Woodland more intensively and centrally, while pushing into Ponderosa Forest only as far as necessary for seasonally- or biotically- specific purposes. Further, my study may promote a similar lifeway for pre-Cohonina peoples living in the study area as well. The relationship of site patterning to environmental transition zones—i.e., boundary effects—thus can be shown to support or subvert ideas on prehistoric behavior and lifeways. Such an approach is supported by previous studies (Marwick et al. 2018). It is not enough alone, however, and must be supported by other lines of argument. In my study, analogies to Havasupai ethnography play a key role, along with past studies looking at more specific Cohonina site attributes. Future research will hopefully look more closely at the artifactual and functional makeup of Cohonina and other prehistoric sites in the study area, lending more insight into ancestral Indigenous landscape use and boundary effects on the Coconino Plateau.

CHAPTER 3: AFTERWORD

This thesis manuscript was extremely rewarding to research and prepare. It builds on years of survey and other archaeological work that I have done on the Kaibab National Forest and nearby areas. It was a privilege to have the opportunity to synthesize the work myself and so many others have put in.

There are two principal shortcomings or limitations to my study. One is that the study area is a socially defined ranger district on a national forest, happening to be shaped somewhat like a "U" or "J" (see Figure 4). This presents clear issues for large scale geospatial analyses. What site locations are left out? Would that information have influenced the statistical results of my study? I believe it is still beneficial to use large-scale datasets when they are available. It makes use of data that are available, and there are tracts of land (e.g., privately held) that will simply never yield equivalent spatial archaeological information—we should not let the perfect get in the way of the good.

The other practical shortcoming or limitation surrounding my study generally stems from the accessibility of INFRA data as discussed above. Many interesting attributes of sites—such as cultural/temporal affiliation and featural and artifact characteristics—could not be queried in the INFRA dataset. This is in part why a more geospatial distribution-oriented research design was adopted. If site characteristics could be assessed more granularly, then the potential for analysis expands exponentially. This lack of analysis potential comes down to how INFRA data are entered and stored. The ability of the database to be queried is currently more oriented toward cultural resource significance regarding the National Register of Historic Places and toward fire sensitivity and necessary protective measures. These are good priorities. But investment in time and resources toward being able to query for featural and artifact characteristics, site function, and cultural/temporal affiliation would greatly advance our understanding of these cultural resources and of the past.

As a final note, I would like to advocate for these types of spatial archaeological studies going forward, versus intrusive excavation techniques. While there is always much to be gained by exploring vertically, it necessarily results in destruction of the resource—unless ground penetrating techniques are used, which are often cost prohibitive. Compare excavation to the surficial, nondestructive archaeological data being collected at massive levels by federal agencies thanks to CRM compliance laws and policies. Taken together, there is a huge potential for reduced intrusive harm to Indigenous ancestral sites, while simultaneously exploring a massive volume of nonintrusive data that may help us understand the past, to better protect it and to better manage our future.

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Appendix: Tables and Figures

Table 1. Raw data from the INFRA database included unsorted prehistoric and historic archaeological sites. The following keyword search list was used to select out prehistoric sites from the dataset. Multiple capitalization forms were searched.

Keyword	Definition
COHO	Standard coding abbreviation for "Cohonina"
Cohonina	Archaeologically defined cultural tradition present in the study area
Fort	Cohonina site type present in the study area
Preh	Standard coding abbreviation for "Prehistoric"
Prehistoric	Relating to ancestral Indigenous peoples; used to categorically differentiate from "historic" archaeology, which is generally associated with historical European-American peoples
Sinagua	Archaeologically defined cultural tradition present in the study area

Table 2. Group statistical results for analysis of archaeological site distance to central zonal boundary.

	Biotic Zone	*n*	*Mean (SD)*	*SE*	*Min*	*Max*
Distance to Boundary (in meters)	Pinyon-Juniper Woodland	1,950	7,510.75 (6,159.24)	139.48	1	26,812
	Ponderosa Forest	1,793	4,732.65 (3,513.27)	82.97	1	13,366

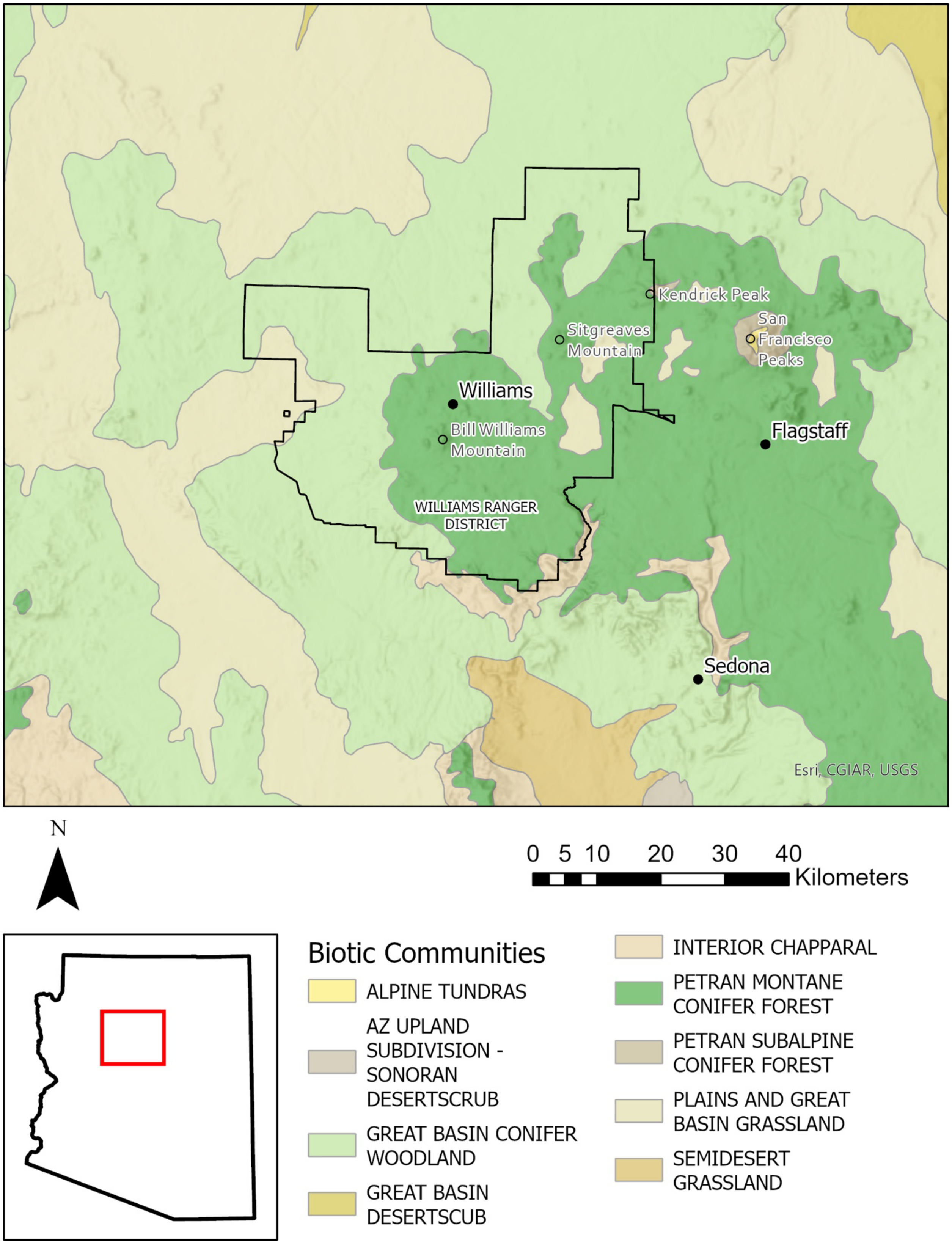

Figure 1. Biotic communities (zones) in the study region from Brown (1994), and including the current study area, the Williams Ranger District. Map by author.

Figure 2. Example of Pinyon-Juniper Woodland biotic zone, west of Williams, Arizona. These communities are dominated by Pinyon Pine and Juniper species, interspersed with various grasses, shrubs, and cacti. Photograph by author.

Figure 3. Example of Ponderosa Forest biotic zone, south of Flagstaff, Arizona. These communities are dominated by Ponderosa Pine, often in pure park-like stands, with a grassy understory. Photograph by author.

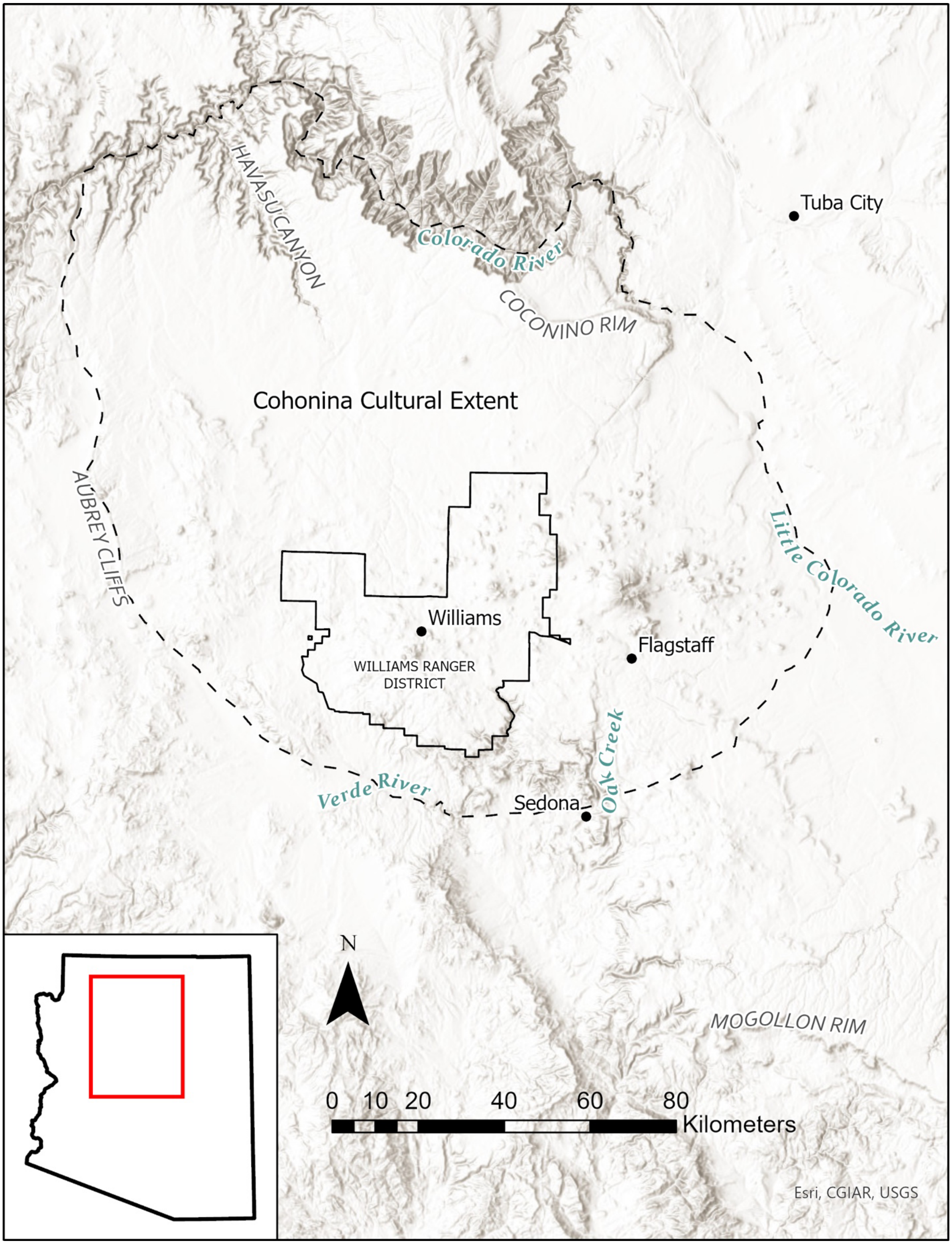

Figure 4. Geographic extent of the Cohonina cultural tradition, including the current study area, the Williams Ranger District. Map by author.

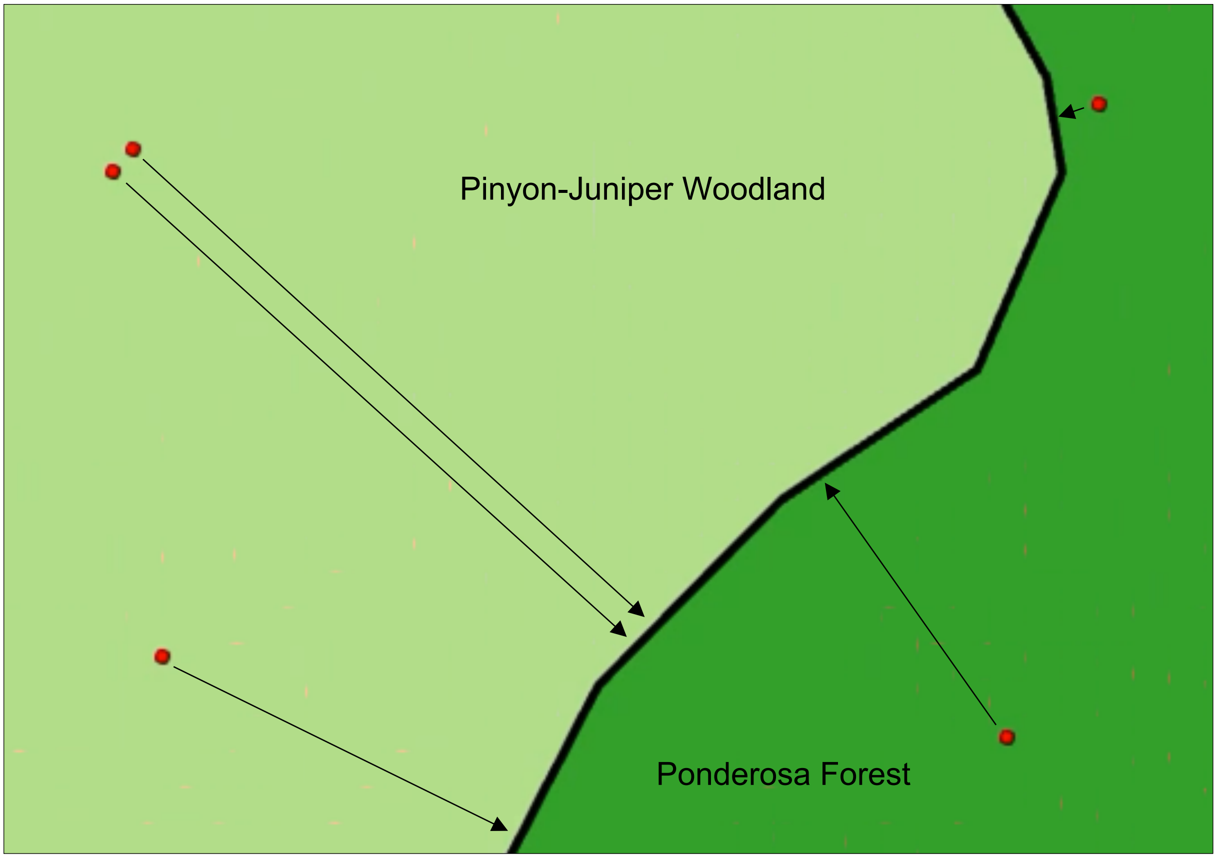

Figure 5. Illustration of analysis of proximity, showing sites' distance to the nearest central zonal boundary between Pinyon-Juniper Woodland and Ponderosa Forest.

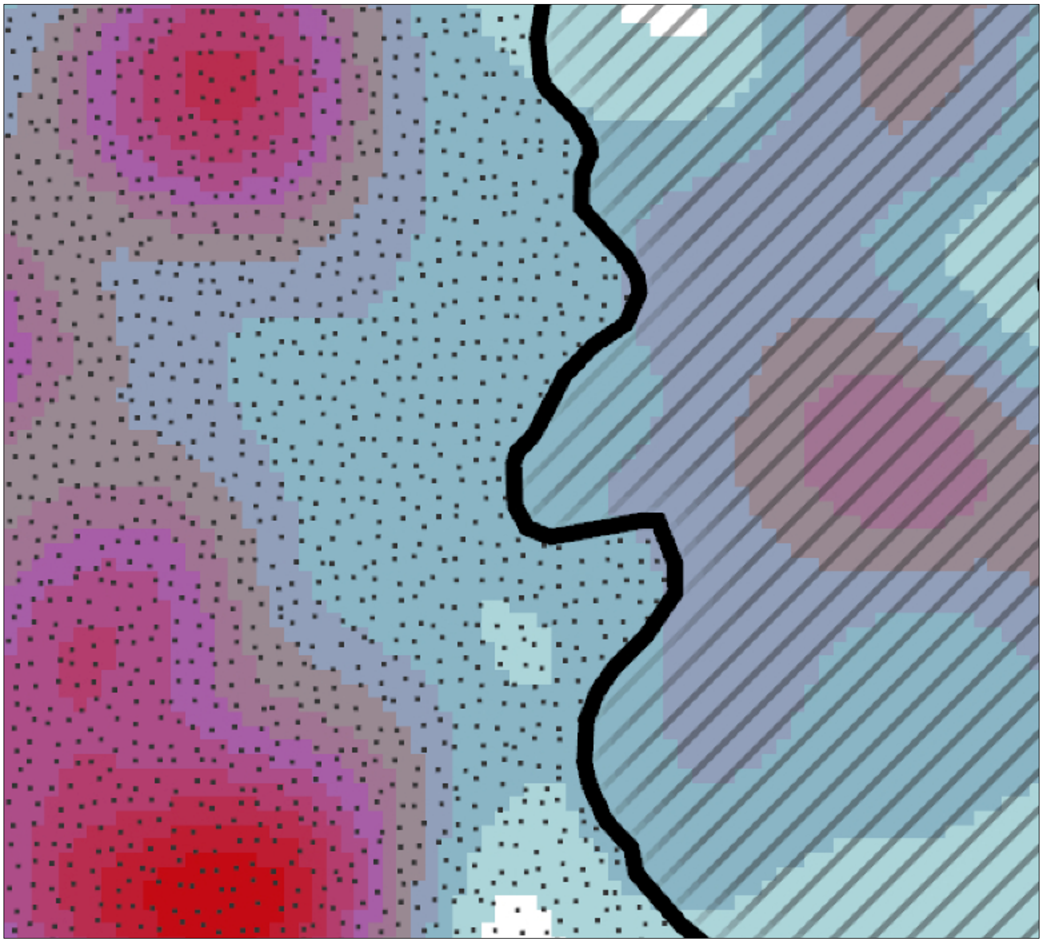

Figure 6. Illustration of analysis of intensity, showing site density in relation to the central zonal boundary between Pinyon-Juniper Woodland and Ponderosa Forest.

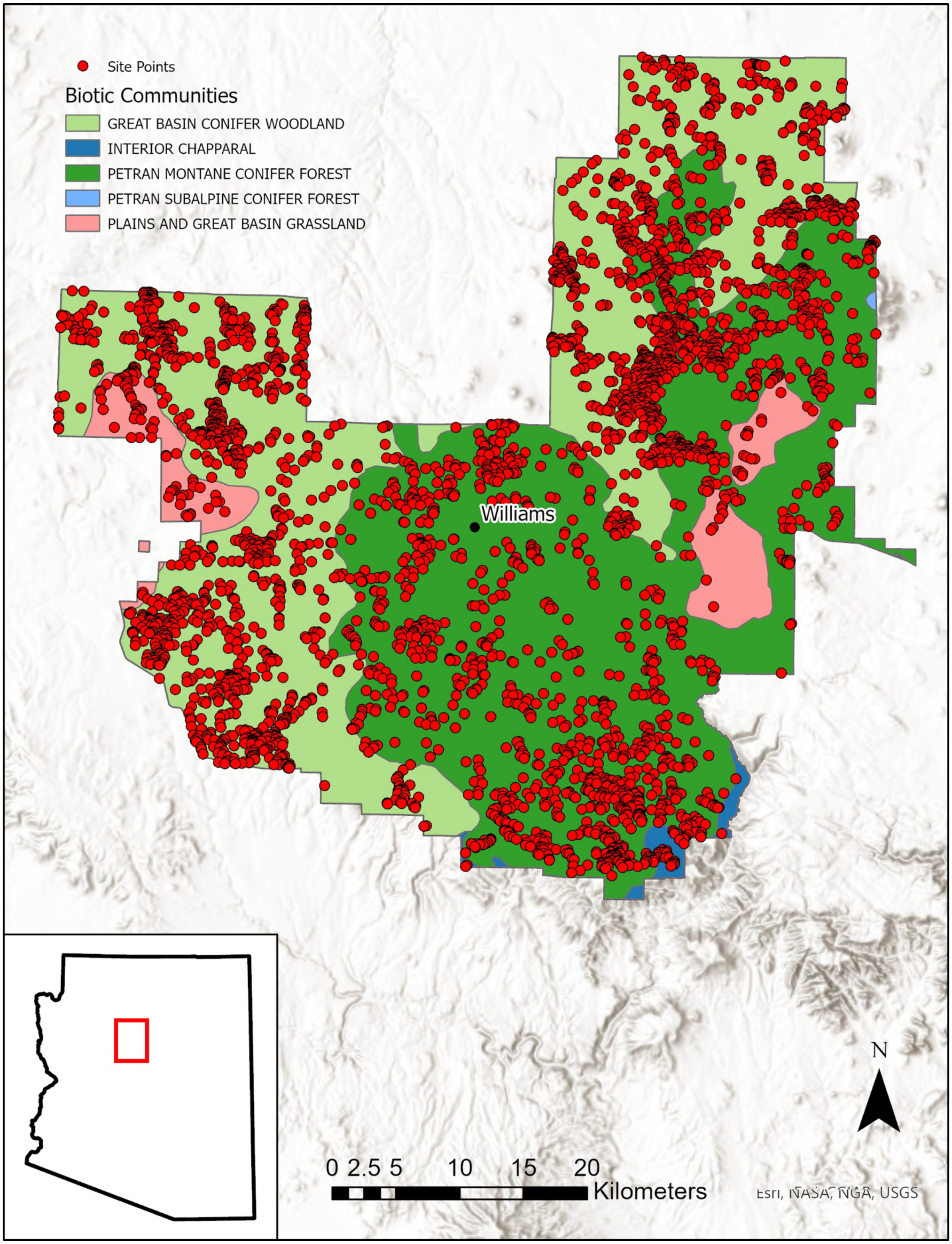

Figure 7. The study area and all prehistoric site points, with biotic communities included. Map by author.

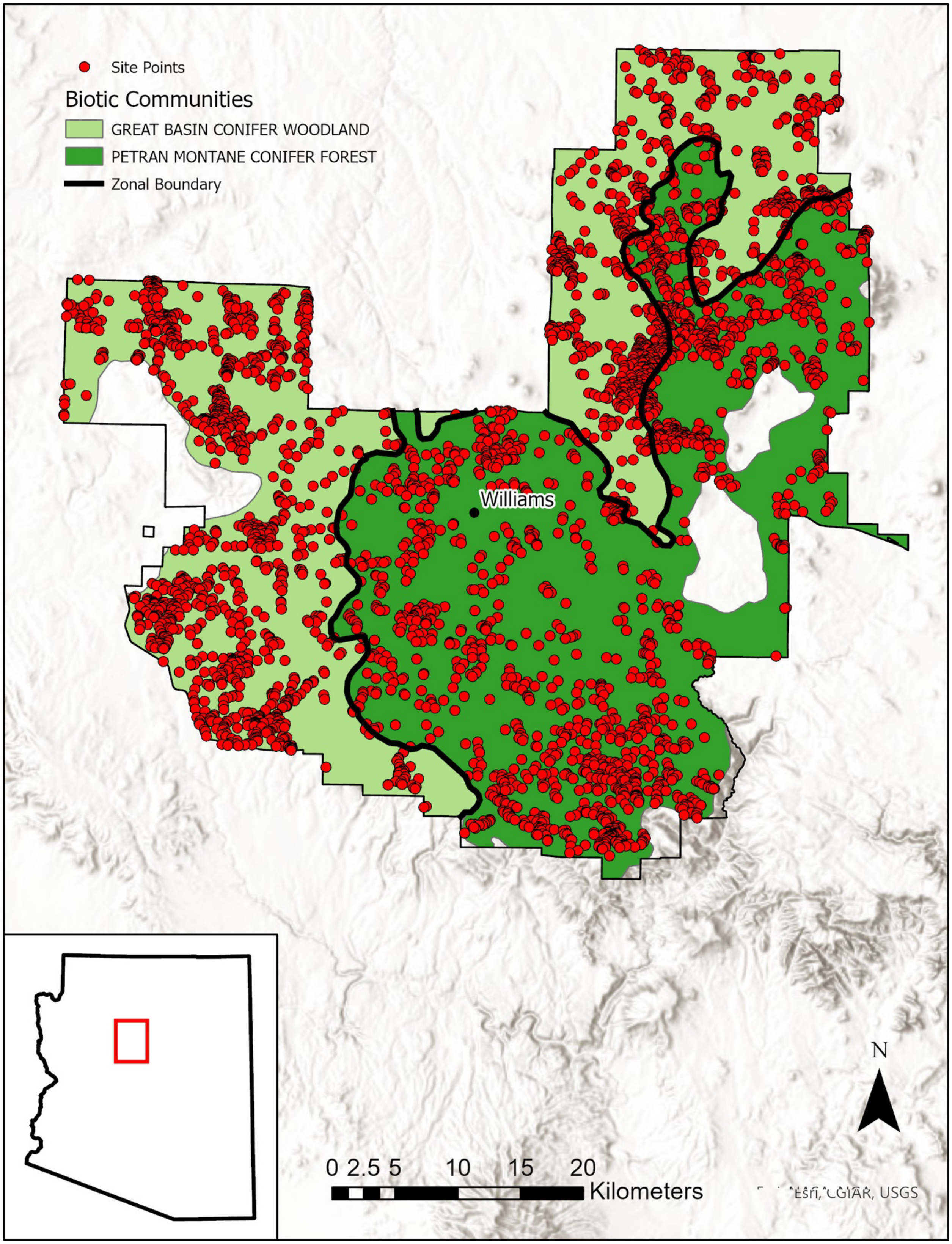

Figure 8. The study area with biotic zones and archaeological site points considered in this study. Map by author.

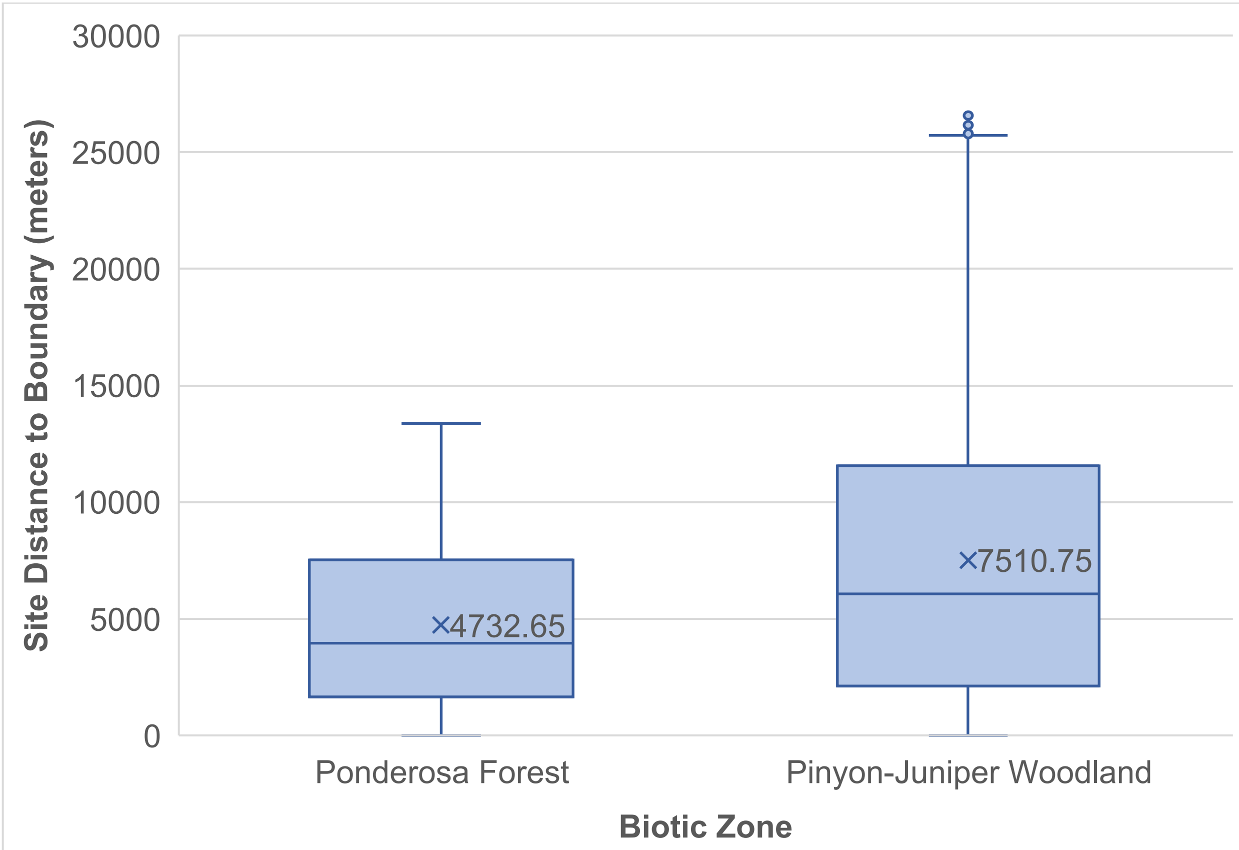

Figure 9. Boxplot showing results of proximity analysis, including mean values. Note several outlying sites in Pinyon-Juniper Woodland.

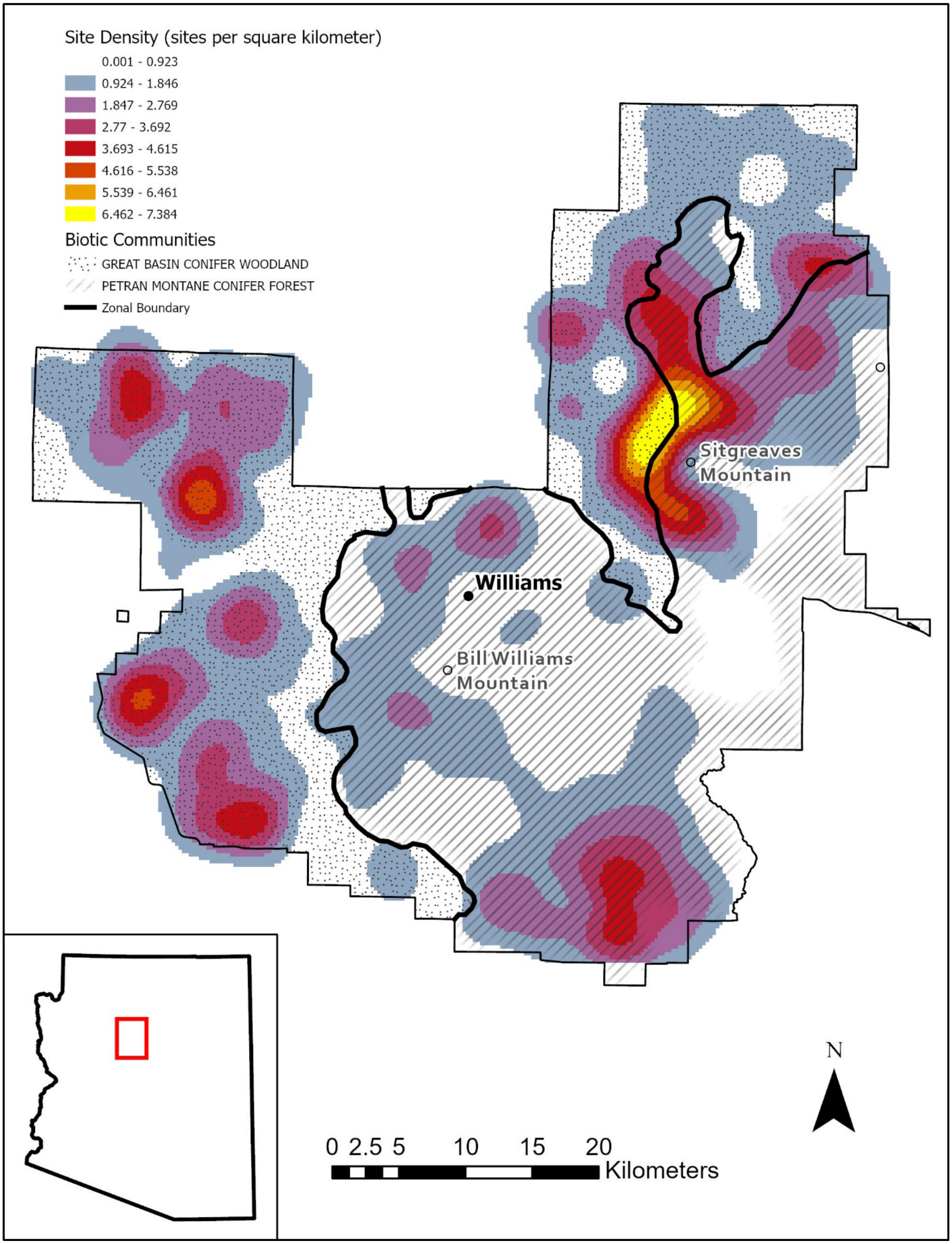

Figure 10. Study area with biotic zones showing kernel density of sites, with red-to-yellow areas being more site dense. Map by author.