Incorporating Archaeological Resources in Landscape-Level Planning and Management

William H. Doelle, Pat Barker, David Cushman, Michael Heilen, Cynthia Herhahn, and Christina Rieth*

In July 2015, the Bureau of Land Management (BLM) approached the Society for American Archaeology (SAA) about developing a discipline statement regarding the efficacy of incorporating archaeological resources in regional land-use plans (see Altschul 2016). The SAA established a task force charged with assessing the kinds of landscape-scale planning tools that exist for cultural resources and advancing recommendations about when and how to use them (See Supplemental Appendix A). The BLM, like all federal land-managing agencies, is responding to increased development pressure on public and private land in the United States, while safeguarding cultural resources. The agency is shifting to landscape-scale approaches to land-use planning and to mitigation responses to impacts or threats to resources, spurred in part by the Secretary of the Interior's (Jewell 2013) department-level directive to take a landscape-level approach

ABSTRACT

The increasing importance of landscape-scale research and preservation goals within the archaeological profession coincides with expanded threats to the archaeological record through massive energy exploration and infrastructure projects and through the cumulative effects of smaller-scale development. It is further stimulated by the recognition that conservation strategies that span multiple resource classes and disciplines are best formulated at multiple and larger spatial scales. These are key drivers behind efforts to improve the ways that archaeological resources are considered in the context of development-related planning and implementation, including mitigation measures. In a prominent example, recent department-level direction from the Secretary of the Interior calls specifically for landscape-level planning as a critical component of responses to both large-scale development and climate change. This article reviews three current approaches to landscape-level planning in archaeology and calls for increased commitment to advancing their development and effectiveness.

Dentro de la arqueología, la creciente importancia de investigaciones a nivel de paisaje y objetivos de conservación coincide con nuevas amenazas al registro arqueológico creadas tanto por proyectos de exploración e infraestructura para la generación masiva de energía como por los efectos cumulativos del desarrollo en pequeña escala. Ésta se estimula más al reconocer que las estrategias de conservación que abarcan varias disciplinas y categorías de recursos se formulan mejor en escalas espaciales múltiples y más grandes. Estos son factores impulsores claves en los esfuerzos por mejorar la consideración de los recursos arqueológicos en el contexto de la planificación y ejecución de los proyectos de desarrollo, incluyendo las medidas de mitigación. En un ejemplo destacado reciente, el Secretario del Interior exigió expresamente y a nivel de departamento la planificación a nivel de paisaje como componente crítico de las respuestas tanto al desarrollo en escala grande como al cambio climático. Este artículo revisa tres enfoques actuales para la planificación a nivel de paisaje en la arqueología y pide un mayor compromiso con fomentar su desarrollo y eficacia.

*Cynthia L. Herhahn's affiliation is listed for identification purposes only. This article does not represent the views of the Bureau of Land Management.

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when developing mitigation measures to address the increasing scale and intensity of development across the nation.

Current landscape-scale planning processes tend to be driven by biological and natural resource concerns (see resulting Energy and Climate Change Task Force Report by Clement et al. 2014), while cultural resource concerns are still being addressed largely on a site-specific scale. As a consequence, archaeological resources rarely receive serious attention in the initial stages of development projects when alternatives are under consideration. When addressed later, after critical decisions have been made regarding the selected alternative and even the precise configuration of the undertaking has been determined, archaeological management options are very limited. Minor design or implementation adjustments may allow for preservation through avoidance of some sites, but generally a data recovery and monitoring plan is formulated based on the outcome of a process that involved little direct archaeological input. The landscape-scale planning processes for cultural resources that are explored here are essential tools that we must understand and further develop if we are to bring relevant information to bear within regional planning processes by government agencies and within a variety of initiatives that fall outside of the National Historic Preservation Act (NHPA).

To understand why archaeological resources are treated differently from natural resources, we need to examine the process by which cultural resources, of which archaeological resources are a subset, are managed by federal agencies. Potential damage to cultural resources from land-use authorizations on federally managed land or from federally permitted or funded activities on nonfederal land is managed under Section 106 of the NHPA. Section 106 requires that federal agencies take into account the effects of their undertakings on cultural resources and afford the president's Advisory Council on Historic Preservation (ACHP) and the state historic preservation officer (SHPO) an opportunity to comment on these undertakings before they are implemented. Since the NHPA became law in 1966, implementing Section 106 has evolved through rule-making, congressional amendment, and judicial decisions into a relatively standardized and somewhat complex process. The way in which the NHPA is usually applied has led to an overemphasis on site-by-site evaluation at the expense of more regional approaches to historic preservation such as discussed here. Recent guidance issued by the ACHP and Council on Environmental Quality for the integration of Section 106 and National Environmental Policy Act (NEPA) review offers a framework within which cultural resource management may be undertaken on a regional scale and therefore be more meaningfully incorporated into regional land-use planning efforts.

In addition, there are activities that do not fall under NHPA that are considered here. For example, oil and gas exploration and extraction that is undertaken on private land and privately owned mineral rights commonly fall outside of NHPA. The effects of energy extraction on archaeological sites on private lands are generally not given the same consideration as the effects on sites on federal lands. Yet, industry and historic preservation groups would like to find some accommodation. As the Frack-Tracker Alliance (http://www.fractracker.org/2014/03/gapp/) notes: "There is, therefore, much to be gained by all stakeholders in generating a model that will help companies manage risk effectively and protect these [195,000 cultural, historic, and archaeological] sites with consistent, thoughtful approaches."

In short, there are multiple positive reasons to move the archaeological profession toward effective ways of being a part of a trend among federal agencies to promote landscape-scale approaches to their core land-management missions.

WHAT IS A LANDSCAPE?

The definition of a landscape depends on who you ask. For a federal land manager, a landscape generally includes a relatively large area that has clear boundaries. Landscapes include not only multiple types of natural and cultural resources, but also many individual resources of each type. Landscapes often include lands managed by different federal, state, tribal, and municipal owners, as well as private property. They often are not "natural" units defined by physiography, hydrology, or vegetation, but instead are lands joined together by one or more land-use or management purposes. Rarely are cultural resources part of the decision to define a federally managed landscape.

A landscape can be many things to an archaeologist. Landscapes can be defined and investigated not only along ecological and environmental dimensions, but also along social, historical, and relational dimensions (Whittlesey 2004; Zedeño 1997, 2000). From a landscape perspective, these dimensions of landscape are intricately and holistically intertwined, historically contingent, and mutually causative (Barton et al. 2004; van der Leeuw and Redman 2002). Archaeologists increasingly look to landscape not simply as the environment where activities take place and with which people interact, but as a material medium for structuring and reproducing social relations and historical interactions (Hood 1996). From an archaeological perspective, landscapes are no longer viewed as the environmental backdrop of human activities, but the historical, cumulative result of people living in, adapting to, and manipulating the natural and built environment as well as interacting with each other. While people derive sustenance through technological and ecological interactions within landscapes, they also construct meaning and social memory through the experience and conceptualization of places and landmarks (Ingold 1993; Johnson 2012; Tilley 1994). As a result, social identity and history become embedded and materialized in landscapes, reflecting how people use and interact with the landscape. In this way, landscapes are culturally and historically constructed and are dynamic and changing (Bender 1993; Gailing and Leibenath 2015; Thomas 1996). Because of the distinctive technological, economic, political, and ideological ways that individual groups may interact with each other and their environment, the same physical parcel of land could contain remains from multiple past landscapes. In this sense, landscapes are in a constant state of becoming as they are used, transformed, or abandoned in the context of environmental and cultural change.

The archaeological literature on landscapes is far too immense to review here (see Anscheutz et al. 2001; David and Thomas 2008; Fowles 2010; Wandsnider and Rossignol 1992). In this

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paper, our main concern is with landscape in terms of geographical scale and as a unit of analysis, interpretation, and management. Managing at a landscape level requires an appreciation for issues of scale and units of analysis and the consideration of resource patterns and processes from multi-scalar perspectives. The social, temporal, and spatial scales at which landscapes are investigated depends on the processes and patterns that are of interest (Crumley and Marquardt 1990; Wandsnider 1998). Emically, spatial scale is socially constructed based on how social relations are expressed geographically and structured by social networks and characteristics of the landscape, including aspects of both the natural and built environment (Head 2008; Strang 2008). From an etic perspective, the spatial scale of a landscape is measured in both grain (size of smallest observation unit) and extent. When grain size decreases, the variance and detail of a landscape increases. When the spatial extent of a landscape is increased, broad-scale patterns can be observed with greater frequency and finer-scale patterns become more variable (Heilen et al. 2008; Wu and Qi 2000). Understanding both the broad-scale and fine-scale patterns provides for the development of more robust conservation strategies.

Archaeologists often think of landscapes as being substantially larger than individual sites or clusters of sites and smaller than a region. The scales at which archaeologists have investigated landscapes vary from tens to hundreds of thousands of square kilometers. For example, one might think of landscapes as encompassing the land and resources needed to support a particular community, ethnic group, population, or technological system. Ultimately, the scale and shape of a landscape is process- and problem-oriented. The size and configuration of a hunter-gatherer landscape for a pre-agricultural time period may be of a different size and shape than a later agricultural landscape. Thus, individual regional planning efforts in archaeology will likely have to consider multiple landscapes and may also need to consider, where possible, multiple spatial scales.

To some extent, our objective is to marry the management of current land use with ancient land use. To do so, we consider three current approaches to regional planning in archaeology. The approach with the longest developmental history within the discipline is predictive modeling, and it is addressed first. Two more recent developments are significance modeling and regional priority area planning. Each approach is briefly described and their particular contributions are considered.

A discussion of when and where these different approaches may be most appropriate for land-use planning is presented. In the final section, a set of desired outcomes is identified. In most cases, there will be several ways to advance toward those outcomes. Not surprisingly, it will often be the realities of development threats, funding availability, and/or the nature and number of involved land managers that will determine which options are feasible. As an online supplement, further consideration of land-use planning issues and links to several online examples of the different types of archaeological regional studies are provided (See Supplemental Appendix B).

PREDICTIVE MODELING

Many archaeologists have expectations about where sites are likely to be located, based on behavioral inference, ethnographic analogy, regional culture history, and prior experience with archaeological survey and excavation. As such, archaeologists often have a model "in their heads" concerning the environmental settings where sites of different types are more or less likely to be located. Archaeological locational models leverage this professional insight and archaeological and environmental data in a systematic and replicable manner to predict the density and distribution of sites relative to environmental and/or cultural variables (Sebastian et al. 2005).

The theoretical underpinnings for locational models include cultural ecology (Steward 1938, 1955), site catchment analysis, and optimal-foraging theory (Bettinger 1991; Kelly 1995; Kohler 1988). Overall, such studies have shown that the range of possible group behavior in a given area was limited by local or regional environmental constraints in predictable ways and revealed statistical associations among site locations and environmental variables (Bettinger 1975, 1979, 1991; Plog and Hill 1971; Thomas 1971, 1972, 1973, 1983, 1988; Trigger 1989). Although early attempts at modeling found simple correlations among variables, they lacked a sound theoretical foundation. In the 1990s, optimal-foraging theory, landscape approaches, and other middle-range theories provided an improved theoretical basis for making and testing predictions about settlement and subsistence systems.

In recent decades, advances in geographical information systems (GIS) and relational databases allowed researchers and managers to map large numbers of sites against environmental zones in ways that facilitated regional resource planning (Kvamme 1989; Mehrer and Wescott 2006). Major improvements in statistical computing techniques and in the quality and availability of digital environmental data used in modeling have also led to substantial improvement in locational modeling. Now, it is possible to systematically model the density and distribution of archaeological sites across ecological zones in ways that can reliably quantify the likelihood of impacting significant cultural resources (Ingbar et al. 2000; Sebastian et al. 2005). Such models allow archaeological resources to be fully integrated in regional resource management planning and replicable and defensible choices among competing alternatives in environmental documentation and planning to be made.

Predictive Model Building

There are many different ways to construct locational models, including both deductive and inductive approaches (Altschul 1988; Green et al. 2012; Ingbar et. al. 2000; Kohler 1988; and Sebastian et al. 2005). The standard approach is to create a modeling dataset using a representative sample of sites and non-site locations derived from available survey data and a set of spatially explicit predictor variables representing environmental and/or cultural factors hypothesized to be associated with site location. Predictor variables are generally considered to serve as proxies for some of the major factors that influenced settlement decisions, such as the availability of arable soils or potable water. They often include soil types or attributes, plant communities, and variables related to topography and hydrol-

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ogy, but may also include cultural variables such as proximity to roads or central places. The values of predictor variables are then analyzed and compared among sites and non-site locations to test for associations and to develop a series of expectations regarding the influence of predictor variables on site location. The art in selecting or developing predictor variables lies in having enough variation to produce large homogeneous stratification zones, while not having so much variation that sampling becomes an issue. Experimentation in creating or refining variables relevant to the specific historic and environmental context of the study area is often prudent and necessary. Care also needs to be taken in accounting for correlations between predictor variables that could influence modeling results.

Sample locations and predictor variables useful in distinguishing site and non-site locations are then used to develop a model. Sometimes, this is accomplished by weighting predictor variables and combining them using Boolean logic to derive a sensitivity map. More powerful approaches involve the use of multivariate statistics, such as logistic regression or classification and regression tree (CART) analysis. Such approaches can handle interactions among variables and calculate for each land parcel in a study area the probability that a site will be present, based on the values of multiple predictor variables (Green et al. 2012).

Locational models are typically depicted as a series of sensitivity zones indicating within a region of interest where sites are more or less likely to be located (e.g., low, moderate, and high sensitivity zones). Such maps allow researchers and managers to comprehend regional variation in archaeological sensitivity "at a glance" and can be readily used within a GIS to organize planning and research efforts according to sensitivity zone and other spatial parameters. In many cases, models are created to predict archaeological sensitivity for sites of any type, but some of the most effective models are those created for individual site types, such as those defined according to site function, period, and/or cultural affiliation (e.g., Heilen et al. 2013). For some contexts, it may also be important to predict the location of especially significant sites and/or sites that would likely require special consideration to mitigate (Altschul 1990). To do this, models are developed using site types that may be especially important or sensitive, such as large residential sites or sites with burials. Alternatively, models may be created using sites that fulfill particular NHPA significance criteria, such as modeling separately the location of sites that fulfill criterion D versus those that fulfill criteria A, B, or C. Since many models are based on data from surface or near-surface survey, it can be useful to combine a statistically derived locational model with a buried sites model. Such models use geoarchaeological information and an understanding of landscape-formation processes to identify where within a study area cultural deposits are likely to be buried. When operationalized in a GIS, individual site type models and buried site models can be readily integrated into a single planning model indicating where sites of different types are located as well as where sites are likely to be buried but may lack a surface component (Green et al. 2012).

Predictive Model Performance

To gain stakeholder confidence, the performance of a locational model should be tested using data that are independent of those used to build the model. Often, testing data consist of an environmentally stratified random sample of available survey data not used to build the model, but may also include new field data developed for test purposes. For example, a model can be refined with targeted field inventory, until there is a good fit among the expectations and available data and a planning model can be derived from the results.

A variety of statistics have been developed to test model performance, including several designed specifically for assessing archaeological locational models: Gain, Gain Over Random, and Sensitivity Score (Altschul et al. 2004; Green et al. 2012; Kvamme 1988). Essentially, these statistics are used to quantify the proportion of sites or the site area that falls within each sensitivity zone, relative to the amount of area covered by the sensitivity zone. Overall, the goal in using such statistics is to maximize the proportion of sites found within moderate and high sensitivity zones while minimizing the area covered by those zones. For example, to implement a locational model developed for the state of Minnesota, stakeholders agreed that an acceptable level of performance would be achieved when 85 percent of sites were found within moderate and high sensitivity zones comprising no more than 33 percent of the study area (Hudak et al. 2002). While models with high prediction success are clearly the goal, useful information for planning purposes can be gained from models that still require additional refinement.

Predictive Models in Action

A predictive model developed for Railroad Valley in east central Nevada (Ingbar et al. 2000) illustrates a combined payoff in terms of resource management practices by the BLM and compliance processes with small-scale oil and gas developers with federal leases. The model applies to roughly 2137 km^2 (825 mi^2). It incorporates anthropological theory, a diversity of mapped environmental variables, and archaeological data from roughly 254 km^2 (98 mi^2) of the study area that was previously surveyed. The predictive model process defined six management zones that have explicit archaeological compliance requirements prior to land development activities, primarily oil and gas development at present. These mapped zones in some cases have moderate to dramatic cost implications for archaeological compliance (Figure 1). One zone requires no inventory whatsoever, and two zones require reduced intensity of survey coverage. Together, these three zones of lower sensitivity comprise 65 percent of the area covered by the model. The other advantage to potential developers, even if the land they are interested in lies in the higher sensitivity zones, is that they have this information from the outset. They don't have to await the outcome of a project-specific intensive survey to find out that they have leased themselves a major archaeological problem that will affect both their development costs and their schedule. BLM can use resource significance as a reliable variable in defining parcels for lease, and developers can balance costs and potential benefits as they evaluate whether to place a bid on a particular parcel. Ingbar et al. (2000:9) note:

> The goal of the entire approach is to minimize the impacts to cultural resources through sound planning and management tools; this in turn lessens the collateral impact of cultural resources on fossil energy extraction. We think this is wise use of resources: cultural resources, natural resources, manpower, and capital.

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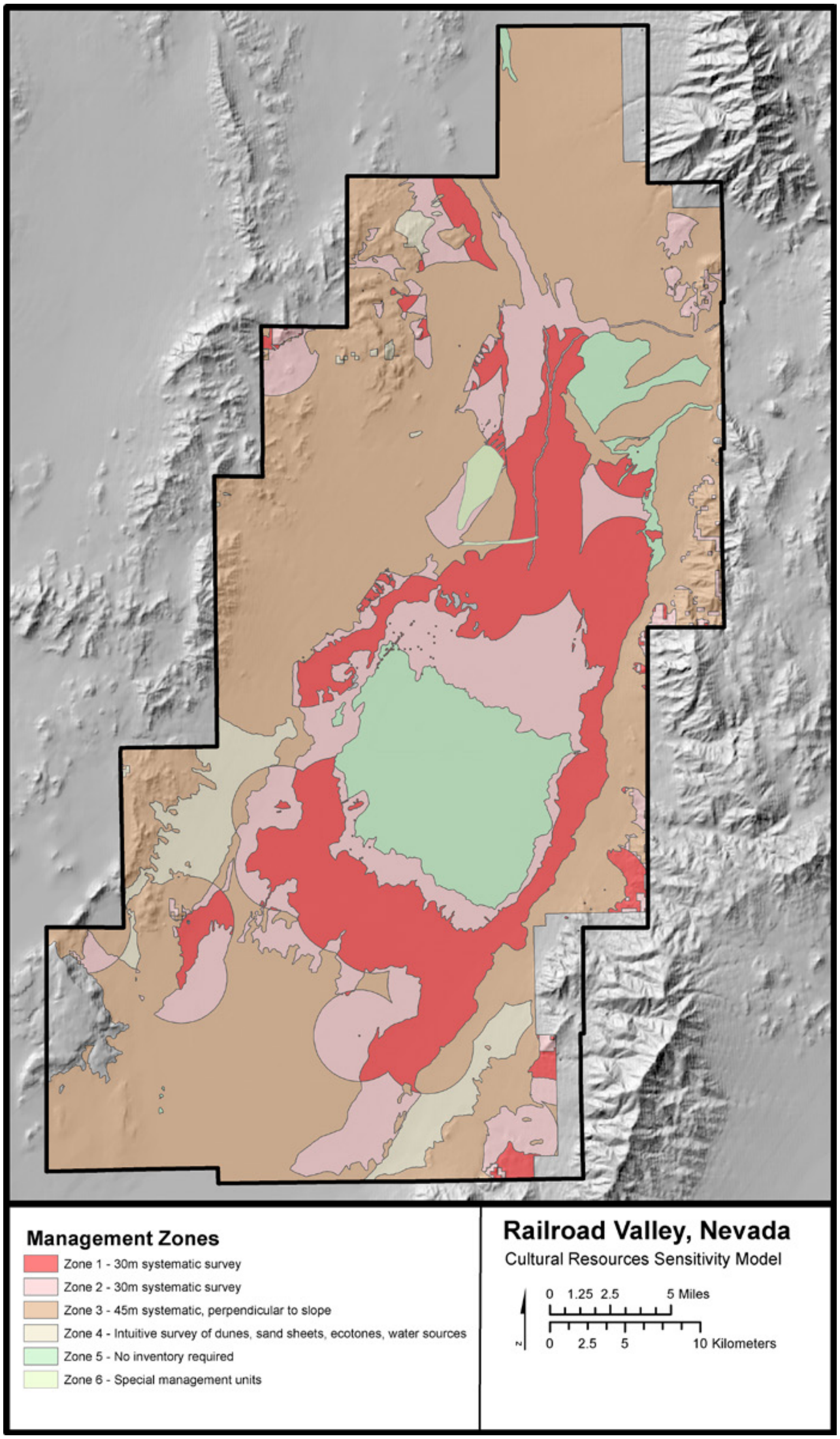

FIGURE 1. Management zones defined for the Bureau of Land Management's Railroad Valley cultural resource management plan in east-central Nevada. The valley has a large central playa, and habitat zones relate to elevation, water resources, and special conditions such as dunes. A predictive modeling study by Ingbar et al. (2000) combined environmental data with both anthropological models and existing data from previous archaeological surveys that covered 254 km^2 (98 mi^2) of the 2551 km^2 (985 mi^2) study area. They defined the six management zones shown here, and each zone has specific cultural resources inventory requirements prior to development activities. Zones 1 and 2 have standard systematic survey requirements, but Zones 3, 4, and 5 have a reduced level of effort for inventory. [Courtesy of Gnomon, Inc.]

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Discussion: Predictive Planning Models

Current methods for inventory and evaluation often treat all areas as having an equal potential for containing archaeological sites, as if no knowledge exists regarding where sites tend to be located. Modeling leverages information about cultural resources that was collected at considerable cost to the American public and can be an important tool for considering the potential effects on cultural resources across broad planning areas, in addition to predicting the kinds of resources likely to occur where survey is absent or incomplete. Because models focus on prediction in ecological zones, data from all jurisdictions willing to share data (federal, tribal, state, local, and private) can be used to build the model. Models can also be used to measure the knowledge gained through additional survey efforts, helping managers decide how to best use scarce resources to identify and protect significant resources. In addition, such models provide a valuable tool for analyzing in a NEPA document the environmental consequences of different alternatives considered in a land-use plan, something that is nearly impossible without regional data.

Prior to predictive modeling, federal land-use plans usually included a discussion of the Section 106 process, a list of special management areas, if any, and possibly a list of known significant resources. Other than stating that archaeological resources will be managed according to the Section 106 process, plans may have included management prescriptions usually intended for interpretation of the most significant places. Land-use plans represent decisions about where and how land uses will be managed. If these basic decisions are made without appropriate consideration of archaeological resources, such as can be attained through the use of modeling, then managers are forced to rely exclusively on project-specific compliance processes, with all their inherent inefficiencies and uncertainty (Barker 2009).

Planning models provide empirically sound and legally defensible ways to justify cultural resource land-use restrictions in general land-use plans. By providing spatially explicit expectations regarding the nature and distribution of cultural resources according to transparent and replicable methods, decisions can be made consistently and reliably according to a programmatic approach (McManamon 2016). As such, compliance processes can move away from a reactive single site/single undertaking management and towards defensible and proactive adaptive management (Green et al. 2012). Ways in which predictive models can be translated into planning models are well described by Ebert (2001), Sullivan (2001, 2008), and Zeanah et al. (2004). With predictive planning models, individual undertakings in areas open to other land uses can still be subject to standard compliance processes; in limited areas, undertakings can be managed with predefined best management practices that are factored into undertaking budgets and timelines. There would be a basis for prescriptive land-use policies if the agency desired to exclude certain classes of activities in areas of known highly sensitive cultural resources, or at a minimum the cost implications of proposed development in such areas would be highlighted. Such decisions are best made within a consultative framework that makes the best use of available data, professional insight, and the limited resources available for research and management.

The acceptance and implementation of planning models is a social process that needs to take into account stakeholder concerns and perceptions regarding modeling. In the past, many researchers and managers have been cautious about applying models in their work, with some harboring a long-standing mistrust of models. As noted above, the data available for use in modeling are often far from perfect, leading to the concern that available data are inadequate to produce a reliable model. Predictions can be faulty, sometimes resulting in unforeseen impacts or project delays when too much reliance is placed on a model. There is also a common concern that modeling will be used as a substitute for inventory or that rare site types in anomalous locations will be missed. These concerns can be allayed by clearly explaining how a model was built and why; demonstrating the ways in a which a model works well or does not; calculating the potential for error and communicating that potential clearly to stakeholders; developing agreements that stipulate periodic evaluation of model performance; updating models where appropriate with new data and professional insight; and working with stakeholders to decide on how a planning model can be used in making management decisions.

SIGNIFICANCE MODELING

Issues related to the formal process of determining the significance of archaeological resources by applying National Register eligibility criteria are discussed elsewhere (McManamon et al. 2016; NRHP 1991; Sebastian et al. 2005). Significance modeling as discussed here refers to a suite of techniques for predicting the information potential and/or cultural sensitivity of sites using their recorded attributes. Common site attributes, such as site size, types and counts of artifacts, presence or absence of features, etc. can be used as proxies for inferring information potential and potential traditional cultural sensitivity. Using recorded characteristics, sites can be grouped into categories by period, type, and attribute or other characteristics to reflect different kinds of information potential and management implications. Sebastian (2009:100) suggests that these categories can include: sites whose information potential is so limited that the act of recording them exhausts their information potential; sites whose information potential cannot be captured with current research approaches and methods; sites that have information potential but whose current research potential has largely been exhausted by previous excavation of similar sites; sites likely to contribute significantly to current research questions and theoretical issues; and sites with high traditional cultural values as identified by descendant communities and other sources.

Significance Models in Action

There is a variety of ways that significance models can be built. What is important is that the methods applied appropriately match how the archaeological record is conceptualized, interpreted, and managed and that the approach followed is transparent, objective, and replicable. For example, there may be particularly rare or important site types or periods, such as Paleoindian sites, that warrant their own category by virtue of their high research value. Alternatively, sites that are likely to be of high importance to Native Americans, such as sites with petroglyphs, could be categorized for special management purposes. Rule-based sorting algorithms are developed to

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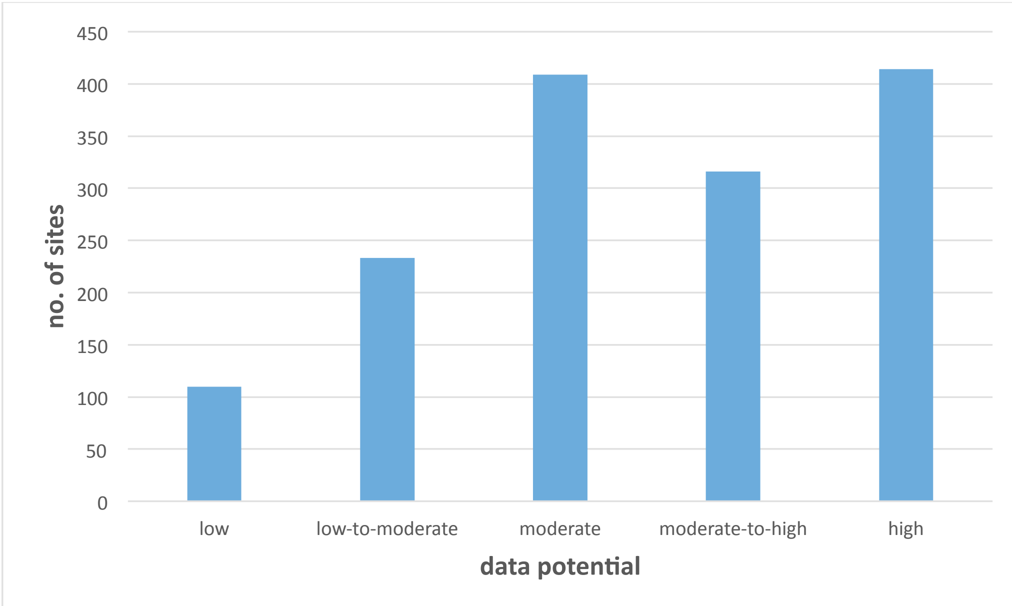

FIGURE 2. Significance modeling was applied to a sample of 1,500 of the several thousand sites on San Clemente Island, administered by the U.S. Navy. Sites were ranked according to data potential using algorithms that sorted sites into significance categories based on recorded site attributes.

assign sites into their respective categories and are based on the nature of the archaeological record of the region. These rules take the form of if/then statements, as in "if site has less than 100 artifacts and no features, then assign to category 1," where category 1 is for sites with low information potential. For a site significance model developed for the White Sands Missile Base in New Mexico, physical data on over 3,400 archaeological sites representing 10,000 years of prehistory were sorted through three separate sorting stages, each with its own sorting rules, to create multiple categories reflecting different kinds of information potential for individual site components (Heilen et al. 2012). Since a majority of sites used in the study had not been evaluated for National Register eligibility, the installation can now make better and more informed decisions regarding the management of its archaeological resources.

Another significance model was recently developed for Navy Auxiliary Landing Field San Clemente Island (SCI), California, following an approach that replicates how the archaeological record is conceptualized and managed on the island, using multiple research proxies. At SCI, site density is very high, and thousands of sites have been recorded. The vast majority of sites consist primarily of a shell midden, many of which have similar characteristics when viewed from the surface. The research potential of these sites and their eligibility for listing on the NRHP under criterion D has for the past 25 years been evaluated based on four research proxies that correspond to specific kinds of information identified in SCI's research design as being integral to answering research questions and addressing data gaps: debitage potential, formed artifact (tool) potential, marine shell potential, vertebrate faunal potential (Raab and Yatsko 1990, 2001). To evaluate a site's eligibility, standardized testing procedures are used to estimate artifact and ecofact densities according to the above four proxies for research potential. If a tested site exceeds a critical density threshold for one or more of the four research proxies, then the site is considered eligible. Based on this method, some 83 percent of tested sites at SCI are considered eligible under criterion D.

The significance model for SCI uses multiple categories of information derived from survey and site-recording efforts to individually predict debitage, formed artifact, marine shell, and vertebrate potential, using a series of sorting algorithms that place sites into categories of low, low-to-moderate, moderate, moderate-to-high, and high research potential (Heilen et al. 2015). Comparison of model predictions with the results of eligibility testing efforts suggests that the algorithms perform well in predicting research potential according to each of the four proxies. Individual research potential predictions were also combined to develop an overall data potential score that ranges from 1 to 5, with 1 being very low overall information potential and 5 being very high overall information potential (Figure 2). For the first time, the model allows managers to view research potential along a graded continuum and to predict the kinds and degree of research potential for thousands of sites with broadly similar characteristics. Importantly, the model shows that, while relatively small percentages of sites have either very low or very high research potential, most sites fall between these extremes. Moreover, spatial analysis of model results shows that sites tend to cluster spatially according to research potential. These clusters could be used to select samples of sites for testing, identify priority areas, create archaeological reserves and preserves, and develop creative mitigation approaches. The Navy is currently considering how to best use the model predictions as part of a programmatic agreement that specifies how the model should be used to make planning and management decisions.

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Discussion: Significance Models

There are a number of advantages to significance modeling. Significance models:

- leverage available data to provide a proactive, transparent approach to evaluating information potential and cultural sensitivity;
- can be tailored to meet a variety of research and management objectives
- can be refined over time to reflect changing management priorities and research agendas
- promote attention to properties of high cultural significance to tribes and descendant communities, rather than focusing primarily on the information potential of a property.

A criticism of the National Register evaluation process is that it forces the user to consider only our current understandings about the past. With a significance modeling approach, land managing agencies can set aside a sample of sites that may yield important information in the future when new questions arise and new investigative technologies are available (Sebastian 2009). Special consideration can be given to sites of high traditional cultural significance, such as the establishment of preserves. Sites can also be formally evaluated, as necessary, according to a sampling approach that focuses on site types and significance categories and also contributes to model refinement.

Modeling site significance has its limits. It requires enough information of sufficient detail to allow categorization and the data must be available in a computerized database. The modeling is best achieved in places where the archaeological record is well-known and well-described. An understanding of the relationship between surface and subsurface contexts is also important, as is an appropriate sample of tested or excavated sites that can be used to test model predictions. The significance categories may require field verification through archaeological testing to establish the relationship between surface and subsurface context, where that relationship is unclear. Lastly, site significance modeling requires a proactive approach to managing archaeological sites and may be more suitable to land managing agencies that have control over and responsibility for their resources.

EXPERT-INFORMED PRIORITY AREA PLANNING

A third approach to regional modeling involves expert-informed planning. Archaeologists and other cultural resource professionals represent a high-value source of information about the archaeological record. These are the people who know the sites and can assist planners and resource managers to organize site data, assign value, and identify management priorities.

The Elements of Priority Area Planning

Recent efforts in Arizona and New Mexico have convened groups of cultural resource experts with local knowledge in order to identify specific high-priority areas for consideration in long-term preservation plans (Cushman 2002; Laurenzi 2012; Laurenzi et al. 2013). The methods include five basic elements described by Laurenzi et al. (2013:63): "geospatial data organization within a defined area (typically watersheds), expert opinion, field assessments, more detailed site survey information (when available), and land ownership records review." Each of these elements is briefly discussed.

Geospatial Data Organization. Many states have digital databases that are the official or primary inventories for the archaeological resources of the entire state. Other databases also exist for lands administered by other government agencies. Many of these databases began as or were transitioned to geodatabases. Experience in the Southwest has shown that these administrative databases, even if their data are georeferenced, contain large numbers of sites with "low information content," sometimes due to insufficient data recording in the distant past, sometimes because they represent marginal resources, and sometimes both (see Wilshusen et al. 2016). Thus, a significant initial effort in assembling geospatial data within a study area involves informal discussion with experts to identify types of sites and features they see as important. This discussion leads to the development of an explicit set of criteria to winnow large databases into greatly reduced geospatial datasets comprised of "focal sites" that are the basis for subsequent planning. For example, site types such as "habitation, cave/rockshelter, petroglyph, or pictograph" were deemed of interest. The category "habitation" was further sorted according to presence of 10 or more pithouses or 12 or more adobe or masonry rooms. Further, Laurenzi et al. (2013) suggest that leveraging research databases compiled for other studies (e.g., regional compilations of large sites or sites of certain categories) can prove useful in such priority-setting exercises. Indeed, in an ideal world, such priority setting efforts can both inform and be responsive to ongoing programs of regional scale research (Peeples et al. 2016).

Expert Opinion. An essential element of this process is to solicit the direct input of as many experts as possible in a workshop framework. Experts generally include professional archaeologists, tribal representatives, and other heritage management specialists. Displaying the focal sites and their distribution on a base map projected on a large screen allows the entire group of experts to engage in direct discussion of what is known about focal sites, their relationships in time and space to other sites, and their significance, integrity, representativeness, and uniqueness. In the workshop context, polygons are drawn around areas that experts consider to be priority areas. Specific statements by the experts are also attached to individual priority areas as part of the documentation process in the workshop. For identified experts who were not able to participate directly in the workshop, arrangements were made for follow-up interviews, sometimes by phone but preferably in person. The outcome of the solicitation of expert opinion is a map of priority areas that is ready for further refinement through three more steps.

Additional Site Survey Information. Because focal sites are a subset of the total site universe currently known, there often is additional information on sites in the vicinity of expert-defined priority areas. This information is reviewed and helps to refine the boundaries of many areas. In addition, information on site condition is sometimes available.

Field Assessment. Where feasible, field visits are made to evaluate the location and current condition of sites within priority

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areas. If direct access is not possible, then recent development or land modifications are assessed by examining the latest imagery available via Google Earth or other landscape imaging sources.

Land Ownership Records. The final factor considered in creating priority area boundaries is land ownership. Rather than the irregular polygons established in the workshops, the goal is to create polygons that conform to the half-section (half-mile) land subdivisions, so that the sensitive areas are generalized and can be shared with public audiences. In addition, as Laurenzi et al. (2014:66) note: "In general, we sought to minimize the inclusion of private property where preservation targets were not located on private holdings. Private property rights are a sensitive issue and merit careful consideration in the priority setting process."

Priority Area Planning in Action

Eight examples of completed planning projects illustrate the flexible nature of defining study areas. One employed a hydrologically defined river valley, two were defined as major portions of an Arizona county, four were portions of watersheds and comprised culture-historical units of relevance to archaeologists, and one focused on a particular past cultural unit and limited time period. The upper limit to the size of such a planning area is constrained by general factors, such as the effort required to assemble geospatial data, the number of available experts and the spatial extent of their knowledge, available time and funding, and specific goals of a particular planning effort. Figure 3 shows the spatial coverage of the eight such projects undertaken to date, and they cover roughly half of the spatial extent of the U.S. Southwest.

Pima County, in south-central Arizona, developed the first such priority area plan (Cushman 2002), and it has guided the county's selection of archaeological sites for purchases using voter-approved bond funds. To date, they have purchased major portions of four Hohokam ball court villages for long-term preservation and interpretation. This cultural resources effort is part of a larger Sonoran Desert Conservation Plan developed by Pima County that includes open-space acquisition and ranch conservation elements that provide additional protections for archaeological resources. Archaeology Southwest, a private nonprofit organization, led the development of the other seven plans. The priorities identified serve to guide the organization's efforts to establish conservation easements or to gain fee ownership of priority archaeological properties in private ownership. Archaeology Southwest has become a formal "Consulting Party" on several major federal undertakings. In such cases, the formally prepared plan provided a basis for communicating a professional consensus regarding cultural resource priority areas and provided planning information of relevance to the agency at the initial stages of their large-scale land modification project.

Discussion: Expert-Informed Priority Area Planning

Expert-informed priority area planning identifies spatially explicit areas that complement assessments of individual site eligibility for purposes of listing on the National Register by providing an added layer of regionally contextualized information at larger geographic scales. While users of the information should acknowledge that boundaries are abstractions based on current knowledge and, in some instances, land ownership, they nonetheless provide a means of organizing site information to allow for consideration of cultural resources at landscape scales. The identification of areas where high-value cultural resources are clustered provides the land management agency with a mechanism to better contextualize cultural resources for purposes of "planning across landscapes and at multiple scales," as called for in BLM Planning 2.0 (www.blm.gov/plan2). This is similar to the concept of "biodiversity hotspots" often employed in natural resource planning efforts. Priority area identification can also inform special management area designations, both administrative and legislative. This information enables better coordination between agencies to define and achieve shared planning priorities, thus maximizing the use of limited time and financial resources. Principles of adaptive planning can be employed, resulting in better preservation outcomes over time. By focusing on site clusters and areas with substantial time depth of past use, the priority planning process often identifies areas with other resource values. For example, springs, perennial streams, and mountain settings often have high value for recreation and wildlife. Thus, protection priorities for multiple resources often come together.

Similarly, this approach allows for earlier and more substantive consideration of cultural resources in project planning efforts that occur at larger scales where Class III survey information is unlikely to occur until project location and, in some instances, design are fixed. A case in point is a recent BLM transmission line planning effort in Arizona and New Mexico that, at early stages, examined multiple alignments and sub-alignments. Avoidance of priority areas becomes one consideration in the alignment selection process and allows for robust comparison of alignments as they pertain to cultural resource impacts. At present, such projects invest less effort to avoid cultural resources relative to ecological resource values (and even less to avoid indirect effects) and address them as a mitigation cost.

Experts play a strong role in this process, which has several positive aspects. Application of this process to date has shown that it has been relatively quick and easy for experts to come to agreement on which known resources should be considered high-priority resources for preservation planning. Because the amount of time that each expert needs to contribute to the overall process is rarely more than a single day and often less, the process is relatively inexpensive to implement. Data coverage is frequently uneven and, in some instances, expert perspective can account for data shortcomings. It has been noted that the information that guides the opinions of the experts is often unique to them and many times is not adequately recorded. Thus, this process helps to preserve the knowledge of our experts.

However, for the most part, expert opinion is well-grounded in the geospatial data. While tribal experts have attended multiple priority area planning sessions, efforts to date have not attempted to map tribal concerns such as traditional cultural properties (where they do not intersect with archaeological resources). Given that tribal participants could bring the relevant expertise to this process, there is no reason to doubt that such resources could be incorporated into the priority area planning process.

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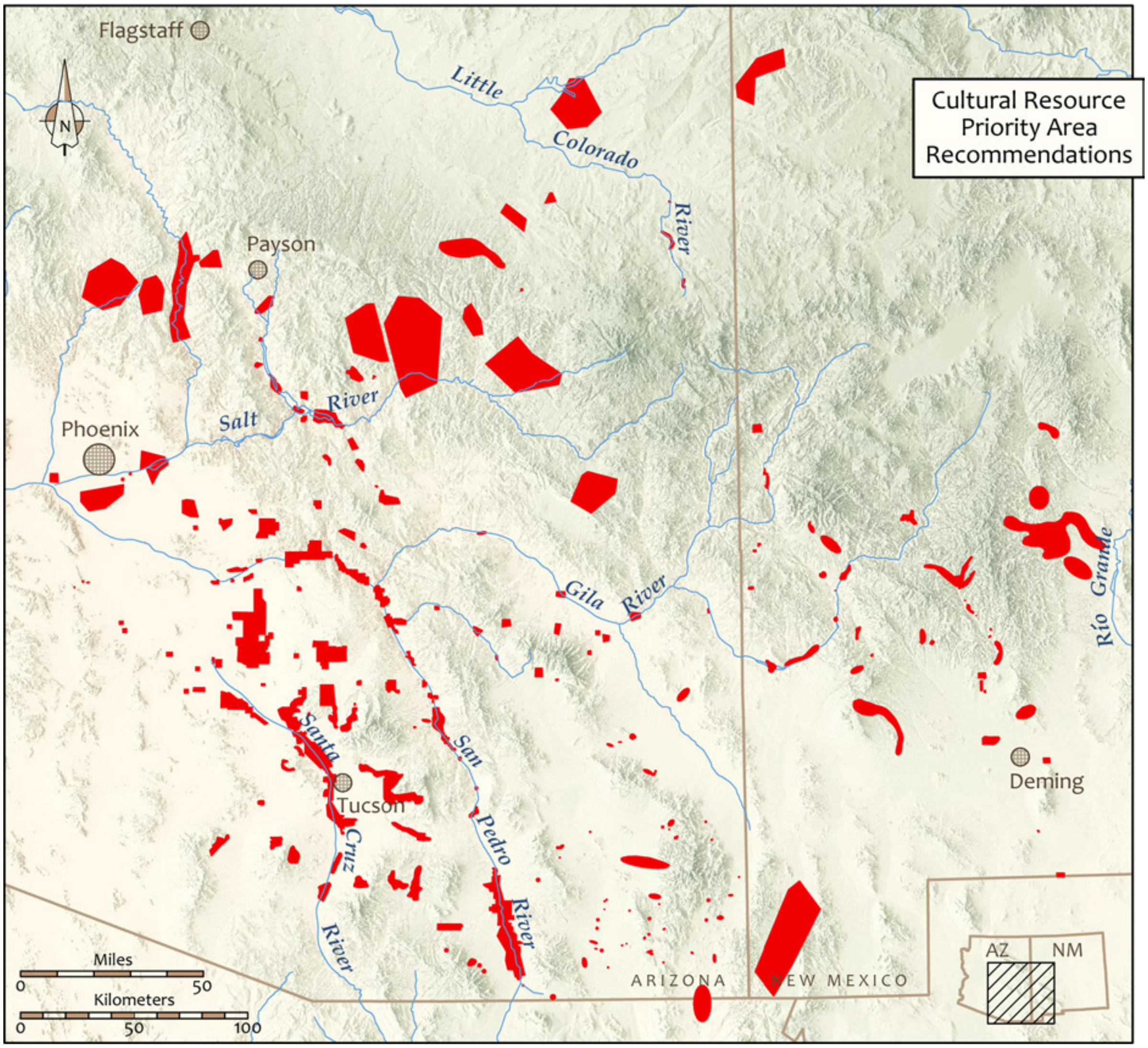

FIGURE 3. Cultural Resource Priority Areas defined for seven completed planning units within Arizona and New Mexico based on meetings with experts and site data from the Heritage Southwest database maintained by Archaeology Southwest. Criteria varied slightly by planning unit, but the kinds of focal sites considered in the initial meetings were habitation sites (especially with special attributes such as ball courts, platform mounds, kivas, or reservoirs), larger petroglyph or pictograph sites, and caves or rock shelters with cultural deposits.

DISCUSSION OF PLANNING ISSUES

This paper has identified current practices in use by cultural resource professionals for regional-scale planning. The nature of the methods has been considered, and some common impediments to implementation and some common strengths were noted. An important principle employed by the authors and that we underscore here is that an invaluable resource in the regional planning effort is the knowledge of existing archaeological experts. The growth of the discipline has greatly expanded the numbers of individuals with practical field experience and with specialized skills in regional analysis. The systematic tapping of that knowledge in group settings can elicit and document substantial amounts of regional information on priority resource areas. In addition, specialization within the larger pool of professional archaeologists has led to the development of experts' skills in ever more powerful geospatial and statistical tools. This is another invaluable form of professional expertise.

Brief consideration is given to some core issues that affect how regional assessment of archaeological resources is accomplished under the three approaches reviewed above.

Data

Each of the approaches we highlight here have elements in common that are key to their success, or could cause them to fall short. The most obvious and important is the quality of the existing archaeological site inventory. For many land-managing agencies, only a small proportion of land area has been

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surveyed for archaeological resources. Moreover, vast areas of private land potentially affected by development projects have been subject to limited or no survey. The better the quality and the currency of the archaeological survey information, the greater the potential for success—for all approaches. When the data are in a well-designed and well-maintained geodatabase, potential for success is further increased. There is broad agreement that the initial cost of developing a high-quality geodatabase is often a challenge. However, once such a geodatabase is established, the value of maintaining it and using it to improve the quality of archaeological management and planning is obvious and hopefully will be effectively implemented in most, if not all, cases. Further, it can often be useful to take advantage of existing research database resources compiled for other purposes.

Significance

For planning studies, which must consider both present and future conditions, it is useful to adopt a more flexible view of significance than the binary view of the National Register eligibility criteria. Sebastian (2009) argues that all archaeological resources have information potential on a sliding scale from low to high. All three approaches, alone or in combination, provide information regarding resource significance that is useful in making planning decisions. In general, predictive modeling can generate zones of high, moderate, or low sensitivity that reflect multiple factors related to the significance of the resources expected within those zones. Significance modeling employs explicit algorithms to assess significance for large numbers of resources within a study area. Priority area planning employs expert opinion to identify consensus areas of high information value or other values such as cultural values. In these ways, all three approaches can provide relevant information for land-use planning on regional scales.

Study Area Size

There is no single factor determining study area size for any of these regional approaches. In fact, flexibility of study area size is notable for the different approaches. Areas do need to be sufficiently homogeneous environmentally and culturally to allow reliable and meaningful predictions to be made. Considerations of archaeological theory are often part of the process. For example, hunter-gatherer adaptations and settled agriculturalist adaptations imply different decision-making processes, and modeling their past behaviors is best considered separately. It may be necessary to consider multiple landscapes for a study area when time is factored in. Finally, all approaches can incorporate information about where in a study area information is insufficient for making reliable predictions.

Land Management Status

Areas with a single or very few land managers provide better conditions for planning studies. Agencies that manage larger land areas are likely to undertake integrated planning studies and to develop land-use management plans and protocols. The reality, however, is that much of the nation is highly fragmented in terms of land ownership and land management. As a result, partnerships between federal agencies (e.g., BLM and Forest Service) or regional (e.g., Metropolitan Planning Organizations) or state-level agencies (e.g., SHPOs or state departments of transportation) are likely to be logical coordinators of larger-scale planning studies. Private conservation organizations or industry-focused groups such as the Leaders in Energy and Preservation partnership, known as LEAP (www.gasandpreservation.org), can also be factors in overcoming fragmented land-management impediments to regional planning.

Potential to Combine Methods

As these different approaches were being described and discussed, the potential to combine the methods, or at least aspects of them became increasingly apparent. For example, the significance modeling approach could be applied as a more rigorous and explicit way of defining the focal sites employed in the priority area planning process. Similarly, predictive models could help to identify potential priority areas within zones where only limited previous survey had been conducted. Alternatively, if sufficient numbers of focal sites exist, then a focal site sensitivity map could be created, which in turn could then be a point of departure for discussion. It is clear that there is significant potential for cross-fertilization between these approaches.

CONCLUSIONS AND RECOMMENDATIONS

In this final section, we briefly address the issue of how to move these archaeological planning tools into an active presence in the regional land-use planning process. The focus is on identifying a pragmatic and flexible set of options that provide high-quality cultural resource data on a regional scale to affirmatively guide planning efforts for development projects, as well as general land-use plans. This goal places a premium on timely assessment of current data so that the data are available in a form that is relevant to planners. The following principles and practices will provide information of direct value to regional planning efforts:

- Priority resource areas, high-sensitivity resource zones, or a combination of the two must be identified and should be clearly identified as areas to avoid or as areas for which special considerations need to be made in permitting specific land uses. Ideally, this would be done at the land-use planning stage (e.g., BLM's Resource Management Plans, U.S. Forest Service Forest Plans, NPS General Management Plans), but would also be useful in travel management plans (e.g., BLM or Forest Service plans that designate roads and trails and specify authorized uses), and large-scale project-specific plans.
- It is highly desirable that low-sensitivity resource zones be defined with a clear statement that such zones are preferred for any land use because the impact on cultural resources would be far less than in other sensitivity zones.
- Information about priority planning areas and sensitivity zones must be publicly available for planners. The information will be conveyed as spatially aggregated priority areas or sensitivity zones, which are not the boundaries of single archaeological resources.
- Modeling should be viewed as a process. Models and priority planning areas should be periodically evaluated

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and updated to incorporate new methods and information about the distribution of significant resources or changes in land use that may have altered the condition of significant resources, rendering them no longer significant.

- Wherever possible, regional planning efforts for heritage resources should take advantage of existing regional planning efforts that address natural and biological resources or partner with teams undertaking such planning. Working with the state departments of transportation and Metropolitan Planning Organizations through their transportation planning processes is an example.
- Continued involvement of the SAA in this process is essential. Engagement in advocacy is an essential function of the nation's primary professional organization for archaeologists.

The most effective way to achieve these goals will vary geographically, based on the state of current knowledge, the availability and quality of cultural resource databases, the varying patterns of land ownership and land management across the nation, and the level of development threats to the cultural resources of the region. Perhaps most challenging is the issue of securing the funding to advance the above goals. Partnerships with large land-managing agencies or with state-level agencies (e.g. SHPOs or State Archaeologists) who maintain state-level cultural resource databases are likely one promising avenue. In some cases, large land managers will contract for regional plans, but, for much of the nation's land base, a single large land manager is not a reality.

To close, archaeologists have an opportunity to be "at the table" as the nation's land managers transform the ways in which they implement their obligations to manage cultural resources on federal lands and to address the compliance requirements of major (as well as numerous lesser) land modification undertakings. Archaeological modeling approaches have been under development for several decades. It is notable that the modeled environments, significance assessments, and priority areas considered here are based on large regional samples of sites, rather than on viewing each archaeological site independently. That is a critical conceptual step in transforming the ways that land managers shift to landscape-scale thinking. It is time for the archaeological profession to focus on sharing its current approaches with federal planners and land managers and for archaeologists to engage both with each other and with the diverse agencies to further advance the utility of these tools for landscape-scale planning and management.

Data Availability Statement

No data were used in preparing this manuscript. References are to other previously published examples.

Supplemental Materials

Supplemental materials are accessible via the SAA member login at www.saa.org/members-login:

Supplemental Appendix A: Task Force on Incorporating Archaeological Resources in Regional Land-Use Plans

Supplemental Appendix B: Example Applications of Archaeological Planning Tools

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AUTHOR INFORMATION

William H. Doelle ■ Archaeology Southwest (wdoelle@archaeologysouthwest.org)

Pat Barker ■ University of Nevada, Reno (barkerj@unr.edu)

David Cushman ■ SRI Foundation (dcushman@srifoundation.org)

Michael Heilen ■ Statistical Research, Inc. (mheilen@sricrm.com)

Cynthia Herhahn ■ Bureau of Land Management, New Mexico State Office (cherhahn@gmail.com)

Christina Rieth ■ New York State Museum (Christina.Rieth@nysed.gov)

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