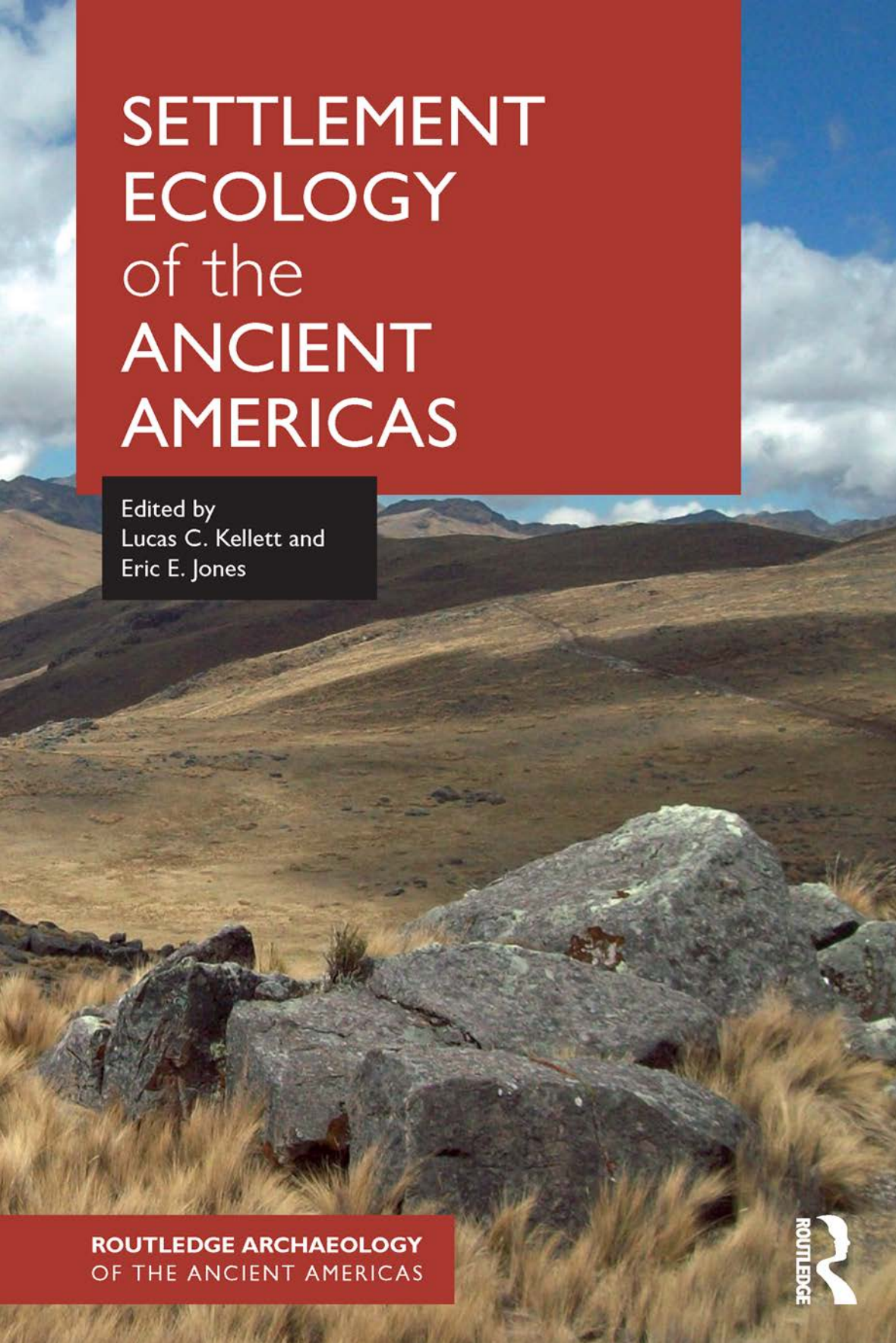
SETTLEMENT ECOLOGY of the ANCIENT AMERICAS

Edited by
Lucas C. Kellett and
Eric E. Jones



ROUTLEDGE ARCHAEOLOGY
OF THE ANCIENT AMERICAS

ROUTLEDGE

Settlement Ecology of the Ancient Americas

In this exciting new volume several leading researchers use settlement ecology, an emerging approach to the study of archaeological settlements, to examine the spatial arrangement of prehistoric settlement patterns across the Americas. Positioned at the intersection of geography, human ecology, anthropology, economics and archaeology, this diverse collection showcases successful applications of the settlement ecology approach in archaeological studies and also discusses associated techniques such as GIS, remote sensing and statistical and modeling applications. Using these methodological advancements the contributors investigate the specific social, cultural and environmental factors which mediated the placement and arrangement of different sites. Of particular relevance to scholars of landscape and settlement archaeology, *Settlement Ecology of the Ancient Americas* provides fresh insights not only into past societies, but also present and future populations in a rapidly changing world.

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Part I

Overview

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1 Settlement ecology of the ancient Americas

An introduction

Lucas C. Kellett and Eric E. Jones

Ancient settlement patterns have long fascinated archaeologists. Since its inception, settlement archaeology has played a crucial role in the comprehension of numerous complex archaeological topics, such as sociopolitical organization and development, state and imperial expansion, peer polity interaction, trade networks, demography, and economic organization, among others. The conceptual shift from a spatially limited and site-specific focus to a landscape-based regional perspective was indeed a watershed moment in archaeology (Willey 1953; see Billman 1999; Blanton et al. 2005). Through its multi-decade course of development, settlement pattern studies has matured into its own sub-field of archaeology where associated methodologies, technologies, and interpretive frameworks have continued to be refined (Kantner 2008; Kowalewski 2008).

The critical question in settlement archaeology can be stated as follows: why do people settle in a given place during a specific time and in a particular arrangement? Ostensibly, this appears to be a simple question, yet the corresponding answer often remains frustratingly elusive. This is because a prehistoric settlement pattern is the result of complex decision-making in the face of innumerable social, political, and economic factors. As such, analyzing specific rationale for particular settlement decisions presents an especially challenging problem for archaeologists. In a similar vein, mutual causation or equifinality have plagued settlement pattern studies, requiring such studies to remain descriptive rather than explanatory (Stone 1996). Yet, rather than fading away in the modern era of archaeology, settlement pattern studies have done the opposite and witnessed a new renaissance in large part due to the rapid technological advances (e.g. Global Positioning Systems [GPS]; Geographic Information Systems [GIS]; remotely sensed data; and unmanned aerial vehicles [UAV]) in the past two decades.

So, a number of readers who encounter this volume may likely first ask: *do we really need another volume on ancient settlement patterns?* Our answer to this question is *yes* for several reasons. First, the rapid change in technological innovation related to the recording, analyzing, and modeling of settlement patterns demands that archaeologists periodically address and evaluate how we use and interpret ancient settlement patterns. Second, while technology has rapidly "evolved," there has been much less attention paid to reconceptualizing and the

further development of theories behind settlement pattern analysis. As discussed below, archaeologists still most often describe rather than fully understand or explain settlement patterns and changes to them. A settlement ecology approach seeks to dissect settlement patterns and identify what influencing factors underlie how and why people decide to settle on a given landscape. Finally, a basic understanding of how prehistoric people settled in a particular area over time is especially relevant in today's rapidly changing world. Decisions of where to live in the past shape the distribution of our modern settlement patterns. Across the Americas, the distribution of indigenous settlements had a significant impact on the settlement patterns of early European colonizers. Furthermore, in the face of globalization, modernization, climate change, and migration, humans today are still having to making the critical decision of where to live often in the face of complex and difficult circumstances. We hope that this volume can extend our thinking beyond the past and into the present and future to more fully comprehend settlement as an essential part of the human experience (see Moore 2012).

We presume a number of readers of this volume will also pose this question: *what is settlement ecology?* This will likely be followed by two other questions: *where did it come from and is it really a new approach in settlement archaeology or just a rehash of previous models outlined decades ago?* We argue that it is both. That is, it is both a new and more comprehensive way to think about ancient settlement patterns as well as a more sophisticated and refined synthesis of previous thinking and applications in regional studies and settlement archaeology. This volume attempts to bring together for the first time a group of scholars who are currently using a settlement ecology approach to answer complex archaeological questions across the Americas.

In this volume contributors tackle a range of questions that in some way link to ancient settlement patterning, including settlement formation, aggregation, dispersion, abandonment, relocation, fission-fusion, and many others. These broad overlapping settlement phenomena are typically a response to a wide range of physical (environmental) and non-physical (sociocultural) pressures, factors, or priorities that influence settlement decision-making and ultimately help concretize a settlement arrangement in material form. The authors in this volume seek to understand *why* particular settlement patterns are established and what caused them to change over space and time.

Defining settlement archaeology

In the simplest of terms, settlement archaeology is the study of settlement patterns. But how do we define a settlement pattern, and more importantly what does it signify to archaeologists about past cultures and their behaviors? Fish offers a useful definition of a settlement pattern:

> a settlement pattern is a set of culturally significant locations, each of which occupies a specified position within an array that makes up a

> coherent distribution … settlement patterns are spatial matrices marking the intersection of human activities and the natural environment. As such they provide a basis for examining the relationship between cultural loci and relevant geographic variables. Settlement patterns simultaneously mark the intersection of human activities and their cultural environment. They encode relationships among spatially distinct elements of societies and reflect the cumulative outcomes of spatially expressed decisions and interactions.
>
> (Fish 1999: 203)

This eloquent definition embodies the concept of a settlement pattern, by considering the significant components of space, culture, and geography. Thus, a working definition of settlement archaeology can be stated as the study of past culture through the examination of spatially defined loci of human activity.

Studies in settlement archaeology share a number of common characteristics, which set them apart from other approaches in archaeology. Marquardt and Crumley (1987: 1–9) outline several underlying components of such a settlement approach. First, settlement archaeology makes special efforts to understand the *archaeological landscape*, which is the totality of the archaeological record in a given region, reflecting the interaction between humans, their culture, and their environment. Second, it considers the *spatial orientation* among different archaeological sites and between archaeological sites and the physical environment. Third, such studies adopt a *regional perspective* that examines the totality of settlement across a large area. As we discuss below, these basic components of settlement archaeology are important in contemporary studies and approaches, including settlement ecology.

The origins of settlement ecology

Although the term settlement ecology was not coined until the mid-1990s, many of its principal tenets were in use well before. Processual archaeology in particular played an important role in how settlement patterns were originally conceived, how they were studied using archaeological methods, and how they were described through the development of middle-level theory (e.g. Chang 1972; Flannery 1976; Trigger 1967, 1968; Parsons 1971, 1972; see also Billman and Feinman 1999; see Kantner 2008 and Kowalewski 2008 for reviews). Within the processual movement, cultural ecology and systems theory approaches were most commonly used to explain settlement patterns and shifting cultural dynamics (e.g. Binford 1968; Flannery 1968; Plog 1975; Struever 1968). In this context, settlement systems were often seen as adaptive to external stimuli. The processual period also saw the widespread adoption of systematic ground survey in numerous parts of the world, which elevated the value and importance of settlement patterns in large regional archaeological studies (e.g. Adams 1965, 1981; Billman and Feinman 1999; Blanton 1978, 2005; Chang 1972; Flannery 1976; Gumerman 1971; Parsons 1971; Parsons et al.

2000, 2013; Peterson and Drennan 2005; Sanders 1965; Sanders et al. 1979; Willey 1956).

The processual era ushered in a shift from just describing broad patterns of settlement to also building deterministic models to explain and predict them. In addition, these models attempted to account for the specific determinants that influenced the formation of ancient settlement patterns (Trigger 1968; Peebles 1978). Most early considerations of settlement determinants included primarily environmental factors (e.g. water, resource availability) as well as population growth in reaction to environmental conditions (e.g. Brown et al. 1978; Flannery 1976; Peebles 1978; Sanders 1981). The majority of studies during this time were also focused on prehistoric hunter-gatherers (e.g. Binford 1980; Kelly 1985; Thomas 1972) much more so than on sedentary agrarian societies. The emphasis on the former was directly related to the rise of behavioral ecology (BE) and "optimal foraging theory" (OFT) within the field of archaeology and their shared focus on "two sets of phenomena: past human behavior and its material consequences" (Bird and O'Connell 2006: 143; see Schiffer 1987; Smith and Winterhalder 1992). In particular, behavioral ecology aims at modeling past human behavior using a "fitness related landscape" in which to understand human action. While BE has faded in popularity (as originally conceived), it has impacted on approaches to settlement archaeology since the latter often adopts assumptions of economic efficiency (e.g. resource maximization, travel cost reduction) to understand settlement patterns and their changes.

Settlement archaeology in the 1970s and 1980s also saw the heavy influence of geographic models (Hagget 1965; Johnson 1977) on the analysis of ancient settlement patterns, including Central Place Theory (CPT) (e.g. Christaller 1966; Crumley 1979; Evans and Gould 1982; Steponaitis 1978, 1981), Site Catchment Analysis (SCA) (e.g. Chisolm 1968; Higgs et al. 1967; Higgs and Vita-Finzi 1972; Vita-Finzi and Higgs 1970), and models of rural land use (Chisolm 1968; Von Thünen (1966) [1826]). Nearly all of these geographic models offer a series of assumptions, which help model human settlement arrangement. First, settlements are located on the landscape intentionally, not randomly, primarily for economic or material reasons. Second, through a detailed understanding of the surrounding physical landscape, one can understand settlement locations based on the spatial correlations between site location and local available resources. Third, since the costs of subsistence production and the related transport costs of goods and people increase as one moves away from a given settlement, people will place their settlements closest to the most critical of resources (otherwise known as the proximity principle). Finally, it is assumed that under normal conditions, the spatial arrangement of settlements is ordered in a predictable and hierarchical fashion (e.g. lattice patterns) to most efficiently produce and move goods among different sites (especially among market systems). While these geographic/spatial assumptions have been critiqued on several grounds (e.g. Crumley 1979; Stone 1996: 12–27), they still form an undeniable part of the continuing development of settlement archaeology, as well as the approach embodied by settlement ecology.

The 1980s and 1990s witnessed the increasing frustration of some archaeologists with the trajectory of processual archaeology and thus spawned post-processual theory and approaches. This paradigm heralded a return to a consideration of individual actors and their lived and sensorial experiences in the past. Landscape as a term came to signify something that is or was more culturally constructed, as space had no meaning separate from human actions and thus all places were assumed to have symbolic meaning (Tilley 1994). Settlement archaeology, like other sub-fields, saw a shift in how sites were viewed, experienced, and interpreted with deliberate consideration of use of space and the construction of place (i.e. Ingold 1993; Llobera 1996, 2001; Tilley and Bennett 2001). At the same time, individual monuments, as well as entire settlement patterns, witnessed a more inclusive examination of the ideological, religious, social, and cultural phenomena, which may have helped plan and place sites on the landscape (i.e. Lekson 1999; Thomas 1991).

In addition, the increased technological power and accessibility of GIS within archaeology witnessed an explosion in three-dimensional spatial modeling. Visual analyses, such as the popular viewshed analysis, showed some promise when used in an attempt to humanize the landscape and reconstruct the social relationships among groups of people and settlements (e.g. Llobera 2003, 2007; Wheatley 1995; Wheatley and Gillings 2000, 2002). Conversely, the ability of GIS to analyze the relationships between measurable features of the landscape and settlement patterns can also be given some credit for the survival of processual ideas through the post-processual movement. Studies of the environmental influences on settlement patterns gained convincing empirical support (e.g. Allen 1996; Kvamme 1990), and survey methods like predictive modeling showed real correlations between environmental features and past human behavior (Bevan and Conolly 2002; Kohler 1988; Warren 1990a, 1990b; Wescott and Brandon 2000).

Finally, before fully describing settlement ecology we must also briefly discuss the continuing role that landscape archaeology, including historical ecology, has played on settlement archaeology. Landscape archaeology can be broadly defined as the systematic study of how cultural and environmental variables influence the way humans interacted with their landscape (Ingold 1993 Hu, 2011: 80). Landscape archaeology has attempted to move past a site-centered, processual approach to understanding settlement patterns by treating the landscape as a formation of continuous culturally defined spaces in which humans actively create, use, manipulate, and experience landscapes (e.g. Ashmore and Knapp 1999; Crumley and Marquardt 1990; Gillings et al. 1999; Marquardt and Crumley 1987; Tilley 1994; Wagstaff 1987). Landscape archaeology remains a poorly defined term that subsumes a wide array of disparate approaches to landscape studies in archaeology, including more traditional scientific approaches as well as phenomenological and performative approaches (Bruno and Thomas 2010: Hu 2011: 80–81). In addition, while landscape archaeology has embraced geospatial technology (e.g. GIS, remote sensing) with mixed results, it has offered new and creative approaches to

better comprehend how ancient peoples experienced their landscapes (Gillings and Goodrick 1996; Gillings et al. 1999; Hu 2011).

Historical ecology is a closely related approach to landscape archaeology. It also employs the landscape as a lens to understand the long-term interaction between peoples and their environment (Crumley 1994). More specifically, historical ecology asserts that the landscape is inherently cultural and the result of persistent and intentional human action upon the physical and cultural environment (Balée 1998, 2006; Balée and Erickson 2006). At its core, historical ecology also fervently refutes "environmental determinism" and views settlement patterns and the built environment not as the result of human adaptation to the environments but as the accretional and materialized historical record of complex human environmental interaction. This approach, as with many of those previously discussed, also features strongly in the settlement ecology approach.

What is settlement ecology?

While it is still unknown who first coined the term "settlement ecology," we know that its first thorough consideration was by anthropologist Glenn Davis Stone in his book *Settlement Ecology: The Social and Spatial Organization of Kofyar Agriculture* (1996). In this book, Stone uses a synthetic approach from anthropology, economics, geography, and ecology to meticulously chart the historical changes to the settlement dynamics of Kofyar agriculturalists of Nigeria. This groundbreaking study offers a powerful interpretive frame through which to comprehend how competing polities, along with the Kofyar, positioned and subsequently changed their settlement arrangements over time in the face of rapidly changing and interconnected historical, ethnic, environmental, and political conditions and processes.

Settlement ecology as envisioned by Stone (1996) remedies a suggested bias in settlement studies towards hunter-gatherer ecology rather than agrarian ecology. He states that, "we have a wide and growing disparity in settlement theory, with our understanding of hunter-gatherer settlement far outstripping what we know about agrarian settlement" and as such he terms settlement ecology as the explicit examination of agrarian settlements or farming communities (Stone 1996: 5). As discussed further below, we do not feel that settlement ecology needs to be agrarian in nature as Stone asserts, but should be inclusive of all types of societies, modes of production, and degrees of mobility. As one can see from the chapters in this volume, we offer a broad perspective of settlement ecology, including semi-sedentary hunter-gatherers, semi-sedentary and sedentary agriculturalists, and mixed-strategy groups that combine multiple subsistence and settlement regimes.

Settlement ecology is best understood as an outgrowth of location studies in geography, which uses an inherently spatial approach to understand the causes of particular settlement strategies. Building on work by Netting (1993), Stone creates a historically contingent agrarian settlement model of the Kofyar and more

prominently sets out to make inroads in addressing causality in the formation of settlement patterns—something he believes has been long neglected in anthropology, archaeology, and geography (Stone 1996: 227). In response, Stone proposes that in order to develop a new theory on agrarian settlement, one needs to examine cause-and-effect relationships on settlement arrangements and associated change. Stone argues new settlement studies cannot just describe patterns but must build explanations to understand "[w]hat are the factors that push and pull agrarian settlements?" (Stone 1996: 13). In this context he argues that settlement theory should include the set of rules agricultural populations followed, which in part can address the problem of equifinality in settlement pattern studies (Stone 1996: 7, 13). Since the list of influences that may "determine" settlement patterns is "as long as one cares to make it," as well as limited by the investigator's imagination, a set of robust rules or determinants is needed to understand agrarian ecology. However, he is wary about building a set of rules for settlement behavior since real world case studies always deviate and offer exceptions to rule-based models. Instead, Stone (1996: 8) prefers "to think of [settlement rules as] priorities of varying strength." As archaeologists, we, along with Stone (1996), argue than many scholars have tended to uncritically adopt settlement models often without full consideration of their assumptions and implications. For example, *a priori* assumptions concerning cost efficiency and settlement arrangements need to be deconstructed and evaluated critically.

Population and agricultural production

Since many previous settlement studies derive models from human and economic geography, such work has concentrated more on consumptive and marketing factors rather than on productive and population factors. Stone adeptly makes the following point:

> There is an important gap in our knowledge of how the productive activities of rural agricultural settlements affect the location, arrangement, size and duration of those settlements. As a result, archaeologists have come to rely on models that hold agricultural production constant even as population density rises. … Without a better understanding of the factors that actually drive agrarian settlements, it is impossible to adduce general models of agricultural settlement behavior.
>
> (Stone 1996: 27)

As the quote demonstrates, settlement studies must be wary of holding conditions constant and must consider dynamically changing variables such as population pressure and changing subsistence production (e.g. extensification, intensification) and land tenure. He begins by profiling the migration of the Kofyar within central Nigeria, during the middle of the twentieth century, from the uplands of the Jos Plateau to the broad low-lying Muri Plains almost 30km to the south. His diachronic analysis provides an exceptional understanding of linked changes

in settlement strategies and agricultural production. This first phase consisted of "Frontiering" in which low numbers of Kofyar gradually leapfrogged across the fertile piedmont to sandy plains, periodically abandoning settlements in the process. These groups practiced a shifting extensive agricultural pattern in a situation where land was abundant and productive. In the second phase, increasing numbers of Kofyar people settled on the plains causing land scarcity and intensive local agriculture. Demographic pressure co-occurred with the development of spatially defined sociopolitical and/or ethnic units called *ungwa*, and witnessed the formation of a complex system of labor exchange.

From his research on the Kofyar, Stone (1996) offers two important ethnographically based conclusions for new settlement studies. First, the rules of agrarian settlement are embedded in the ecology of agricultural production and such settlement is integrally linked to agricultural intensification (Stone 1996: 181). Second, Kofyar settlement decisions were mediated by numerous sets of priorities, of which certain priorities favored particular locational solutions and the variation in the value of following (or cost of neglecting) each priority (Stone 1996: 182).

Stone (1996: 182–184) offers several basic observations concerning agrarian settlement. He argues that land pressure does not automatically lead to intensification or site abandonment, but to a choice between the two (Stone 1996: 182). The decision is based on the effects of marginal work on total agricultural production. In general, increasing labor stimulates population aggregation, except for when inputs are divided among locations, which results in a more dispersed settlement pattern.

Stone also argues that labor scheduling has been instrumental in the shaping of Kofyar settlement patterns. Since pooled labor is necessary for success in an intensive agricultural strategy, farm location and shape is defined by proximity to one's own plots as well as those of neighbors. Stone argues that labor pooling has the effect of formatting the landscape into sociosettlement units (*ungwa*) containing similar ethnic groups that can manage localized labor exchange.

In terms of ecology, Kofyar settlement locations were heavily influenced by the availability of water, which was critical for a successful agricultural regime. The one exception to this pattern was that in some cases larger-sized plots were more important than locally available water. Finally, over time, Stone observed that with population and agricultural intensification, soil productivity was more important than water availability, especially in the context of decreasing agricultural yields.

While Stone does make important contributions to agrarian settlement strategies, he still restates the warning offered by Grossman (1971: 23) that "general laws [of settlement] are meaningless outside the specific cultural and technological context." Stone stresses the variation in responses that different cultures' (e.g. subgroups of the Kofyar) settlement systems have to specific ecological constraints and general cultural goals despite access to similar land.

In sum, a settlement ecology approach as outlined by Stone is a useful theoretical model for archaeologists. The particularly applicable components are the

examples of how settlement changes across time and space and a framework for identifying causative factors and conceptualizing how people weigh those factors in settlement decisions. Moreover, the goal of moving from primarily a descriptive to an explanatory settlement archaeology—with a focus on isolating individual factors and their importance in settlement patterning—is crucial in the development of the field. In addition, Stone (1996) generally argues that settlement ecology is most useful when considered as a system, rather than a set of rules. Furthermore, as Jones (2010: 3) elaborates on Stone's (1996) approach,

> the best method is to analyze cultures case-by-case and avoid establishing rules of settlement for any particular subsistence strategy. In each culture, there are too many factors originating from too many sources to establish any rules that incorporate all societies practicing a particular subsistence strategy.

In this context, each settlement ecology is unique given a range of contingent factors such as occupational period, local environment, local history, subsistence organization, population, etc. Within this more realistic approach to settlement analysis "the benefits and drawbacks of each factor [are] weighed in each decision and [are] affected by the circumstances at the time" (Jones 2010: 10).

Conceptualizing settlement ecology

Based on the above outline of Stone's settlement ecology, we can identify a number of useful premises. However, we also feel that a more comprehensive and inclusive schema needs defining. In this section we attempt to clearly articulate the underlying conceptual underpinnings and then we will attempt to operationalize a settlement ecology approach. First, we argue as mentioned above that settlement ecology is an inclusive approach that is not limited to agrarian societies as outlined by Stone (1996), but rather can include societies of all types (e.g. hunter-gatherer, agricultural, pastoral) and specific characteristics (e.g. degree of social complexity, mobility/sedentism). Moreover, it is not necessarily limited to prehistoric case studies, but can be useful in understanding modern settlement patterns and changes thereof in numerous areas around the world in the face of rapidly changing conditions and circumstances (e.g. globalizations, war, migration, urbanization, climate change).

Second, we are not offering an entirely new perspective on settlement archaeology, but repacking and synthesizing numerous previous approaches and the ideas of countless archaeologists who have come before us. In addition, settlement ecology is not meant to offer a universal theory or law for human settlement as was the goal of many settlement models of the processual era. Rather it is best understood as a conceptual and methodological approach, which is more comprehensive, robust, and powerful for archaeological interpretation. In addition, we believe that settlement ecology is time and space contingent, and that settlement pattern analysis requires a consideration of

primarily specific and local environmental, social, political, economic, ideological, and historical conditions. Although generalization about human settlement can certainly be constructed through cross-cultural comparisons of different settlement ecologies, one must be cautious of overgeneralizing results to create any sort of predictive model of settlement.

Third, settlement ecology includes the term "ecology," which is not accidental. Since ecology can be broadly defined as the "relationships and interactions between entities," we also believe that this concept is very applicable to a more nuanced and dynamic understanding of human settlement. In archaeology, we can clearly state that a specific settlement strategy is rarely the result of a single phenomenon, but typically and necessarily the result of a total suite of cultural and ecological conditions, needs, pressures, and relationships. It is not just the influence of individual pressures *upon* settlement decisions, but how they intersect, connect, and impact on one another. For example, a heightened level of warfare may bring people together via local settlement aggregation for communal defense, which may reverberate numerous changes including new forms of political leadership, harden local ethnic divisions, and cause scalar stress while at the same time requiring further travel to fields and other resource areas. In this way the "push and pull" dynamics are complex, coupled, and often contingent, such that the individual strings are tied not just to the settlement, but to one another, resulting in a constantly changing webbed arrangement of settlement pressures, priorities, and values. In this way settlement is usefully considered partly as an adaptation to conditions, but also as an expression of human, cultural, and environmental relationships in a given time and space.

Within an archaeological context there have already been a number of successful studies by Elliott (2005), Jones (2010, 2012) Hasenstab (1996), Kohler (1988), Maschner (1996a), Maschner and Stein (1995), and others, who all treat prehistoric settlement as an adaptation by local populations to both natural and cultural environments. For example, in his study of the Haudenosaunee, Hasenstab (1996) argues that settlements' locations were not random, but strategically placed to have access to local resources and agricultural land, as well as maintain protection from local enemies. More recently, Jones (2010) analyzed 125 Haudenosaunee settlements against a range of landscape variables and found that transportation routes, conditions favorable to agricultural production, and stands of hardwoods heavily influenced the placement of settlements. By isolating those particular settlement factors and/or pressures, one can discern the causes that contributed towards a given culture's settlement organization.

Fourth, we argue that settlement ecology can offer the valuable perspective of a settlement pattern as the result of human decision-making. We emphasize that it is not individual factors that "determine" a settlement arrangement (cf. Stone 1996), but it is the conscious decisions made by people in the face of these factors that ultimately *create* a pattern of settlements. This point is important as it maintains the importance of human agency and cultural context in a previously reductionist, anonymous, and often acultural tradition in settlement archaeology. Thus, settlement ecology encapsulates the totality of diverse needs,

concerns, and resulting innumerable complex decisions of a society, which together define the size, type, location, and duration of portions or all individual sites of a given settlement pattern. In this way, a settlement pattern is the materialized record of human decision-making over time, which serves as a rich dataset with which to understand the lived experiences of particular cultures over time and space.

Finally, we argue that settlement ecology requires a spatial consideration of the settlements in relation to one another. The site/settlement concept and its employment have been critiqued on a number of grounds (and alternatives for a "siteless" archaeology have been proposed: e.g. Ebert 1992; Rossignol and Wandsnider 1992). We contend that despite certain weaknesses, the site concept is still a meaningful analytical unit that can help us understand past human activities. In addition, we do not feel that site/settlement vs. landscape epistemological debate is necessary when aspects of both approaches are valuable in a settlement ecology approach. In large part this is because spatial analysis within GIS can accommodate both bounded entities like defensive forts and springs (e.g. nearest neighbor analysis) as well as continuous entities like elevation and slope (e.g. least cost path analysis). As such, GIS is not only a powerful spatial analytical tool but also a tool that allows for comprehensive examinations of both natural environments and cultural landscapes. This highlights the importance that a spatial analytical framework has in understanding the relative importance (e.g. spatial correlation, regression) that certain influences had on prehistoric settlement decision-making. While the use of GIS or other spatial technologies is not absolutely necessary for a settlement ecology approach, it does offer the best methodological approach through which to unravel the complex nature of prehistoric settlement patterns and the conditions and decision-making which underlie them (e.g. Wheatley and Gillings 2002; Maschner 1996a).

Operationalizing settlement ecology

Our focus to this point has been theoretical, so it is critical at this juncture to discuss the ways in which archaeologists have executed settlement ecology studies. Just as it is difficult to pinpoint the origin of the term settlement ecology, it is difficult to identify the first settlement ecology study. A full treatment of the methodology of the approach requires a summary of the history of the analytical methods used (e.g. spatial analysis, GIS) and the steps in the research process necessary to establish an explanation of past settlement behaviors. We will start with the latter.

As with all settlement archaeology studies, the results of a settlement ecology study will only be as good as the data collected. Most data for settlement ecology studies come from regional surveys, both past and present. Although smaller-scale analyses of intrasite patterning and even household patterns are starting to fluoresce (e.g. Berman 1994; Creese 2009, 2012), settlement ecology remains largely a regional or subregional venture. With the abundance of

regional settlement data and environmental data available in digital formats today, it is easier to access the required information for building explanations of past settlement behaviors. Settlement pattern data are generally more straightforward, assuming that the locational data are accurate and at the proper level of precision for the scale of analysis, and that the function of a site as a settlement can be established. The more difficult task for any settlement ecology study is the reconstruction of past environments

Many studies of the recent past (i.e. focusing on the past 1000 years) rely on modern environmental and landscape data, and assume continuity in basic environmental and landscape features (e.g. Allen 1996; Hasenstab 1996; Maschner 1996a; Jones 2006, 2010; Jones et al. 2012; Jones and Ellis 2016). Although not perfect, the assumption of similarity in most locations without drastic human impacts is not overly problematic for recent cases. In addition, large-scale changes, such as sea-level change or dammed rivers, can easily be accounted for. More problematic are the attempts to characterize or describe environments and landscapes in the deep past, such as during the Pleistocene or Early Holocene. Where paleo-environmental data are not available—with cases of poor preservation or lack of research—this task can be extremely difficult and may require extensive modeling or simulation embedded with many assumptions. Where they are available, reconstructing total environments can still be difficult. For example, knowing the percentages of particular tree species that existed in an area does not tell you exactly where those trees were on the landscape. Brouwer Burg (2013) presents one of the best examples of creating "total" landscapes, or those landscapes reconstructed using a suite of paleo-environmental data and GIS-based spatial simulation software. She uses this method to approximate the location of major bodies of water and their impact on sediments and plant and animal life for the Post-Glacial Netherlands. Other exciting technologies, such as those that can estimate water-table levels using paleo-climatological data (French et al. 2012) or estimate vegetation composition using sediment types (Sipkins 2000), have yet to be applied widely in settlement ecology research but hold enormous potential given the difficulties of reconstructing past surface-water distribution as a result of the modification of wetlands, rivers, and lakes around the world over the past 200 years.

As mentioned, the as a result of identification of research as settlement ecology followed about a decade after the establishment of GIS as a productive tool in archaeological research (Maschner 1996b; Maschner and Aldenderfer 1996). However, we must trace the methodological and theoretical roots of settlement ecology back much further to pioneering research that searched for associations between settlements and environmental features. Serious applications of spatial archaeology began 40 years ago, and were solidified by Hodder and Orton's (1976) work. Included within were methods for determining spatial associations of archaeological remains with particular features of the environment. Similar work continued throughout the 1970s (e.g. Plog and Hill 1971; Thomas and Bettinger 1976), and was made considerably easier with the introduction of GIS technologies.

By the late 1980s, GIS facilitated the study of settlement–environment feature associations by making datasets easier to compile, visualize, manipulate, and analyze and by making environmental variables easier to quantify (Kvamme 1999). In particular, GIS made it easier to determine whether observed associations were legitimate spatial correlations or autocorrelations. The latter occur when the observed pattern is a reflection of the background data not an actual pattern. For example, if 70 percent of settlements exist on loamy sediments, it is not a significant percentage if loamy sediments cover 70 percent of the study area. In fact, that percentage would be expected in a random distribution of settlements with regard to sediment type. Analyses of autocorrelation occurred before the implementation of GIS (see Plog and Hill 1971), but GIS allowed researchers to use computing technology to summarize and measure the features of large geographic areas and to produce site distribution statistics in a fraction of the time it took with orthographic maps (Kvamme 1999). Thus, while the settlement ecologist's methods existed prior to GIS, the technology expanded the scope of research. GIS allowed for the analysis of larger archaeological spatial datasets and for building easier and more manipulable maps of environments and landscapes. This, in turn, led to expansions in the number of people—because of the ease of obtaining and sharing data as well as the reduced need to understand complex spatial statistics—studying the relationships between settlements and environments and landscapes and in the amount of data that could be analyzed.

Several studies throughout the 1990s used a variety of methods to identify significant correlations and explain them. Kvamme (1990) characterized the entire background landscape, comparing his archaeological sample with the sample universe. Allen (1996) and Hasenstab (1996) opted for comparing archaeological samples with random samples (i.e. control groups) across the settled landscape to approximate random settlement behavior. They employed this method to narrow the study area to those places occupied on the landscape. In a similar approach, Kvamme (1996) used Monte Carlo methods to compare archaeological samples with random locations of regular sizes (i.e. 99 or 999) to examine where the samples fall in an arbitrary distribution of points on a landscape. If they fall at the extremes, they represent a tendency away from random patterning. Again, GIS was not doing anything new in these studies; it simply made existing methods more powerful and efficient by making it easier to examine larger samples and larger control groups.

With methods for estimating past landscapes and for establishing spatial correlations between archaeological and environmental and landscape data, the stage was set for explaining those patterns. As mentioned, many of the early settlement ecology studies focused on environmental features because the data are easy to obtain and measure. Data concerning past cultural landscapes and perceptions of the landscape are harder to acquire. In addition, the postmodern critique brought along with it questions of the static and utilitarian way in which landscapes were being studied and even inherent biases within GIS methods (Wheatley 1993; Harris and Lock 1995; Gillings and Goodrick 1996;

Llobera 1996). Like many other areas of archaeological study that found scientific ways of examining both adaptational and ideational components of past behavior after the postmodern critique, many modern settlement ecology studies integrate environmental and cultural landscape data into traditional settlement location studies (Brannan and Birch, this volume; Jones, this volume; Lemmonier, this volume). Several studies (e.g. Arkush 2011; Borgstede and Mathieu 2007; Haas and Creamer 1993; Maschner 1996a; Jones 2006; Kellett 2010; Sakaguchi et al. 2010) have attempted to understand how settlement behaviors were influenced by intergroup violence and how communities would attempt to increase the defensibility of particular locations in a tumultuous sociopolitical landscape. Others (e.g. Bell and Lockbauer 2000; Llobera 2000; Carballo and Pluckhahn 2007) have examined how mobility and transportation influenced decisions of where to live. Studies of perceptions of the landscape and ideological components of space and place (e.g. Tilley and Bennett 2001; Llobera 2001) with interesting applications to understanding social inequality (Kosiba and Bauer 2013; Wernke 2013) have also been successfully undertaken.

In addition, the range of settlement behaviors studies has begun to expand, using a myriad of other statistical and visualization methods. Examples include studies of settlement duration using hazards models (Jones and Wood 2012), studies of mobility and movement using least cost surfaces and incorporating ethnographic data on landscape (Howey 2007, 2011). Furthermore, the use of agent-based modeling is another innovation with enormous potential for helping us learn more about the spatial components of past human behavior and decision-making (Kohler and Gumerman 2000; Wurzer et al. 2015).

We make the argument here that specialized studies of how particular factors influenced settlement location decisions are important, but more comprehensive studies, which try to approximate the settlement location decision and a range of natural and cultural landscape features that were considered, are even more important. There is no doubt that such studies are much more difficult, but they are necessary. Those that have been completed have produced valuable information from combined examinations of subsistence, sociopolitical, economic, and ideological data and how they made up the "mental balance sheet" of past decision-makers (e.g. Arkush 2011; Bauer and Kellett 2010; Elliott 2005; Hasenstab 1996; Jones 2010; Jones and Ellis 2016). In the long run, these attempts to understand decision-making with regard to settlement behaviors will be the meaningful contribution of settlement ecology to the study of the past. Theories concerning human-settlement patterning and human ecology are critical, but so is the ability to understand how these behaviors were experienced by past people.

Structure of this volume

The broad goals of this volume are to usher in the next wave of settlement ecology research in archaeology and to establish it as a viable and stand-alone area of study. In the first 15–20 years of settlement ecology research, archaeologists

focused primarily on synchronic regional settlement pattern analyses to produce results on settlement location choice and human interactions with resources and landscapes. This type of research has produced information that has helped us better understand several past behavioral patterns, including semi-sedentary swidden farmers (Allen 1996; Hasenstab 1996; Jones 2010) and the role of visibility in defense (Haas and Creamer 1993; Jones 2006; Maschner 1996a; Sakaguchi et al. 2010). These projects created the base of knowledge on human–landscape interactions and should continue to be an important part of settlement ecology. However, settlement ecology, as we defined it above, is about more than location choice. This volume embodies both the growth of settlement location choice studies as well as explorations into new topics concerning human settlement behavior, including migration patterns, subsistence–settlement dynamics, and the development of sociopolitical complexity. In addition, the research described in the following chapters shows a mix of theoretical orientations, case studies from a variety of geographic areas and time periods, and diverse methods. As such, we believe this volume can be the starting point for a proliferation of settlement ecology research within anthropology and the point of recognition that this area of research is broadly applicable across a wide variety of research questions and theoretical orientations.

The variability in settlement ecology research is on display in the first section of the book, which covers projects conducted in North America. In Chapter 2, Jones examines the environmental and sociopolitical factors that influenced a significant shift in settlement size and geographic range among Piedmont Village Tradition communities in the Southeast during AD 800–1600. This is a blending of the old and new strategies described above because it produces regional settlement location results from sites in the western Piedmont of North Carolina but uses them to examine changes in those preferences over time. In addition, this work incorporates political and economic landscape data that suggest that the formation of Mississippian hierarchical polities, and their participation in political and economic networks in adjacent areas, may have had a significant impact on the observed changes. In Chapter 3, Brannan and Birch examine the spatiotemporal characteristics of demographic change at the Singer-Moye site, a Mississippian center in the Southeast dating to AD 1100–1500. They use ceramic data from survey work and demographic modeling from similar Mississippian centers to reconstruct population sizes and use of space at the site. Using existing archaeological data, landscape characteristics, and an explicit historical ecological approach, they provide an explanation for the growth, decline, and shifts in geographic patterning and monumental construction seen over the life of this settlement. In Chapter 4, Ingram offers an intriguing view by focusing on patterns of settlement abandonment rather than settlement formation. He considers how drought affected the cessation of settlement activities at sites in the Southwest by examining the relationship between population size, proximity to rivers, and drought episodes in central Arizona during AD 1200–1450, a period of notable climatic instability. Using a quantitative approach, he establishes a connection between population density

and drought but, interestingly, not one between proximity to rivers and drought. Perhaps more than any other chapter in this work, Ingram clearly displays the utility of archaeological settlement ecology research for modern people and societies as we think about solutions to our own problems with population density, access to water, and unstable climatic conditions.

The second section of the book contains studies from Mesoamerica that include detailed examinations of both natural and cultural landscapes. In Chapter 5, Loughlin examines the role a major communication route played in the rise and fall of the Olmec center of El Mesón. Survey results establish the timeline of the site and its connections to other Olmec centers, like La Venta and Tres Zapotes, and an analysis of the stylistic properties of recovered artifacts and the chronology of monumental architecture helps him establish the complex relationship between control over exchange and political power. In Chapter 6, Elliott examines data and results from the Northern Frontier Region of Mesoamerica, particularly as they relate to the formation and collapse of the site of La Quemada, to begin forming an explanation for the observed settlement patterns and processes. This work challenges many of our current notions of how people expand into arid and "harsh" environments. She completes her work by outlining an innovative approach to completing the explanation, which incorporates multiple scales of analysis and several diverse lines of paleo-ecological and archaeological data. In Chapter 7, Lemonnier constructs a new model for Maya agricultural-architectural complexes. She employs settlement data from the La Joyanca and Río Bec sites and estimated agricultural production values, and uses the results to characterize human–environment and human–landscape interactions. Her model has implications for social organization, as it pertains to the development of elite households in these two communities and how urban areas and monumental landscapes were created and used in different ways over time. In Chapter 8, Herrera describes and explains patterns of sedentism as well as sociopolitical and socioeconomic organization in southern Costa Rica from 300 BC to AD 1550. He summarizes a broad set of current information, ranging from environmental reconstruction to mortuary data to perceptions of landscape, and incorporates new information from the site of El Cholo. In an area assumed to have been occupied by hierarchically organized and sedentary communities, he provides compelling evidence for a settlement system involving semi-sedentary communities collectively contributing to monumental landscapes.

The final section of the book includes research projects from South America that are pushing our studies of settlement location choice into increasing levels of detail and complexity. In Chapter 9, Kellett takes a novel approach to settlement ecology by using it as a means to explore the impact of risk on past human behaviors among the Chanka of Peru during the twelfth and thirteenth centuries. Using Maslow's hierarchy of needs as a hypothesis, he tests whether Chanka communities chose settlement locations based on basic needs before sociopolitical needs. The preference for locations meeting the latter encourages

all of us to incorporate social, political, economic, and ideological factors into our settlement ecology models. In Chapter 10, Van Gijseghem re-examines current models of rainfall patterns and water use, and their impact on settlement patterns in the Ica-Nasca region of Peru. He attempts to break down a common assumption that farming and settlement practices, both modern and recent, provide a window into the deep past. In removing his work from this framework, and by incorporating new survey data and recent paleo-climatic and environmental data, he constructs a new model for the spatial organization of agriculture and settlement in the region. His model has broader implications for persisting population-pressure models for sociopolitical development in the region and interesting results pertaining to the politics of water distribution and use. Finally, in Chapter 11, Almeida describes the variability in settlement forms and settlement location choices on several scales, from the household to the micro-regional, in several areas of the Amazon basin. By using a combination of ethnographic, ethnohistoric, and archaeological data, he is able to provide ample evidence for a variety of factors that influenced where people chose to live and in what types of households or communities. These factors range from agricultural to political to ideological. The result is a rich description of the settlement pattern and behavior variability in this region that is a thoughtful complement to many of the quantitative and ecologically based chapters in this volume.

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