APPLIED HISTORICAL ECOLOGY: BRINGING PERSPECTIVE AND QUESTIONS ABOUT OAK WOODLAND ECOLOGY AND MANAGEMENT

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Extended abstract—Prior to and during Euro-American settlement (EAS), the structure and composition of many forest communities throughout the United States were mediated by frequent and recurring fires. A major ecological consequence of 19th- to 20th-century era of fire suppression has been the alteration of these fire regimes, often resulting in increased woody vegetation density (Nowacki and Abrams 2008). Another major consequence has been that little cultural or experiential knowledge about the ecology and management of these fire-mediated communities was preserved or passed down to future generations. Thus, reliable and long-term information is needed to understand the past to better manage natural resources into the future.

A model for how to address these information needs lies within the discipline of applied historical ecology. Applied historical ecology is the use of long-term information in natural resource management (Allen and others 1998, Swetnam and others 1999). Applied historical ecology draws on multiple information sources such as natural archives, forest inventories, and remote sensing. Long records from natural archives provide a unique contribution to ecological understanding because they significantly lengthen temporal scales of observations, thus enhancing the ability to identify features such as slow changing processes (e.g., decadal variability in moisture regimes) and infrequent, yet ecologically important events (e.g., a high severity fire).

Applied historical ecology is often erroneously simplified as aiming to identify and promote restoring some past condition. Rather, the discipline aims to identify the range of past conditions and, from this, improve the ability to set achievable and sustainable management goals. Interest in applied historical ecology has increased in recent decades, especially as a result of forest restoration and ecosystem management directives. Although an alternative to applied historical ecology could be conducting long-term experiments, in many cases, decision-making related to managing natural resources cannot afford the time lag or replication investment required to obtain results.

Management of oak woodlands in the Central United States is an excellent subject for discussing the value of applied historical ecology. Oak woodlands were historically a fire-mediated forest structure that existed throughout North America. Oak woodlands are characterized as highly variable forest communities with a canopy of trees ranging from 30 to 100 percent closure with a sparse understory (or midstory) and a dense ground flora rich in forbs, grasses, and sedges (Nelson 2005). The historical ecology of oak woodlands in the Eastern United States is poorly understood. Further, scientists and managers have begun to recognize complex ecological and social challenges to managing woodlands with fire as they have commercial (e.g., harvesting) and non-commercial (e.g., decreased fire risk, biodiversity) values that can be conflicting.

In the Eastern United States, current understanding of the applied historical ecology of oak woodlands fits well within the current historical narrative and modern day conditions. It has been recognized that transition of closed-canopy forests to more open structured, fire-mediated woodlands has the potential to affect many taxa (Guyette and Kabrick 2002). From an ecological standpoint, these transitions in taxa are often considered positive since woodland management practices (e.g., prescribed burning, harvesting) often increase abundance of native disturbance-dependent, early-successional species, including many oaks. In the Eastern United States, restoration treatments applied to closed-canopy forests on sites of historical oak woodlands often result in significant increases in native plant diversity (e.g., from suppressed plants, seedbanks, and dormant rhizomes), including species of conservation concern.

Many different questions related to managing for woodlands in the Central United States are well-suited for an applied historical ecology approach. Some questions require a general understanding of the deep past while others benefit from also having a detailed understanding of present conditions and ecological relationships. For

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the past, many questions remain as to the spatial extent of woodlands, how they changed in structure, and to what extent they were of anthropogenic construct. For example, in the Missouri Ozarks, most forested areas increased in tree density from mid-19th-century land surveys to present (Hanberry and others 2014). Although the greater historical extent of woodland conditions across the Eastern United States is not well known, many other regions were observed and/or given place names that emphasized woodland or savanna conditions such as the Cross Timbers ecoregion, The Big Barrens of Kentucky, and The Barrens of Tennessee. Even the current abundance of some tree species, including oaks (e.g., *Quercus stellata, Q. marilandica, Q. macrocarpa*), implies that more open canopy conditions must have occurred to perpetuate their historical existence considering that they largely fail to regenerate as more closed-canopy conditions advance.

Long-term forest and fire history data have improved knowledge of woodland ecology and will likely continue to influence interpretation of other data sources by putting them in greater temporal context. For example, in many locations, the timing of the General Land Office (GLO) surveys corresponded with the beginning of EAS. In many eastern U.S. forests, the historical ecology information from fire scar history records shows that the period during EAS corresponded to increased fire frequency and decreased fire severity from previous times. In some cases, fires during EAS were more frequent than any other time in the last 400 years. This culmination of data sources begs the question: What were the effects of this altered EAS period fire regime, and how does this timing correspond with the timing of GLO information?

Many modern day questions directly related to management practices can also be addressed by applied historical ecology. For example, a region-wide concern for oak forests is the apparent lack of oak regeneration and recruitment in locations currently dominated by an oak overstory. Outstanding, yet seemingly basic questions related to the ecology and management of oak woodlands include: In the past, did oak woodlands always exist in open-canopy conditions, or did they begin as forests that then underwent tree density reductions? Were oak woodlands predominantly even-aged, uneven-aged, or mixed? Is the disturbance regime that favors oak regeneration the same that is needed to favor its successful recruitment and survival?

In the future, as more and new demands are placed on natural resources, it will be important to revisit the relevance of historical conditions to future management. In the future, likely questions addressed by applied historical ecology include: Is there any evidence that what is desired today has existed in the past? If so: What disturbance regimes and ecological processes made this possible, and will this be feasible through management given modern day constraints? An example of this scenario is that, although frequent fire may have been important in the past, future smoke emission standards could be exceeded with the level of burning required to manage for woodland conditions. In this way, applied historical ecology may be extremely valuable to setting achievable and sustainable management goals.

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