

UNDERSTANDING THE EVIDENCE FOR HISTORICAL FIRE ACROSS EASTERN FORESTS

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Abstract.—Evidence for historical fire across the eastern deciduous biome spans several fields, including paleoecology, fire scar analysis, witness tree studies, historical documents and ethnographic sources. In this paper I provide an overview of many of these methods as well as the limitations and examples of each. While the use of any single approach has its cautions and pitfalls, the interpretation of the considerable material available allows a view into the history and effects of fire on eastern oak forests.

INTRODUCTION

As foresters, ecologists, and land managers, each of us is charged with understanding our ecosystems and the processes that have acted to form those systems through time. Learning as much as possible about the original vegetation and structure of our systems is vital to identify and manage these natural areas for the optimal biodiversity inherent in original conditions (Loucks 1970; Ladd 1991; Kay 1995; Olson 1996). Across the East, the historical role of fire has been implicated in driving diversity and maintaining keystone species in many ecosystems and the body of literature investigating these processes continues to grow. Mutch (1991) suggested that fire regime information is “absolutely essential background data for the appropriate design and implementation of resource management projects at the ecosystem and landscape level of organization.” In southern Illinois, I work with landowners and agency managers in finding information concerning the pre- and post-European settlement conditions of their land holdings. These endeavors often focus on gaining a better understanding of the historic range of variability represented in some systems, or understanding the spatial distribution of hill prairies and barrens. No matter the objective, much of the data sources available for these studies are found across several disciplines and thus are sometimes difficult to access or, quite frankly, understand.

The objectives of this paper are to review many of the basic approaches used to interpret or infer historical

conditions for fire so that land managers can begin to assemble and interpret evidence for their respective holdings, no matter where they occur across the eastern forests. I hope that many engaged land managers will embrace the historical ecology approach in researching and managing their properties. Because so many excellent reviews have been published I reference them often so that attendees here can find those key resources and use the many citations included.

Investigating the role of fire in eastern oak forests

To a large extent, historical fire has been implicated in the wide distribution of oak forest and woodlands, prairies, savannas, and glades that are found within nearly every state in the eastern deciduous biome (see reviews by Lorimer 1985; Abrams 1992; 2002, Van Lear and Watt 1993; Whitney 1994; Dey 2002). The wide range of evidence concerning historical fire across many parts of the East ranges from paleoecology studies (see Patterson, this volume), fire histories and chronologies (Guyette, this volume), archaeological investigations (Chapman et al. 1982; Delcourt et al. 1986, 1998), native American sources (Parker 1968; Adovasio et al. 1985; Doolittle 1992; Kimmerer and Lake 2001), and witness tree analysis and surveyor records (Bourdo 1956; Hutchison 1988; Whitney 1994; Black and Abrams 2001; Abrams 2003), to historical documents such as deed descriptions and tax records (Foster 1992; Olson 1996), plat maps, travel documents and journals (Schoolcraft 1820; Burges 1965; Ladd 1991; Whitney 1994; Olson 1996; Ruffner and Arabas 1999), and stand structure analysis and dendroecological studies (Henry and Swan 1977; Dorney and Dorney 1989; Nowacki and Abrams 1992; Ruffner and Abrams 2002).

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Specific limitations and/or assumptions about many of these data formats must be considered (Forman and Russell 1983, also see review in Whitney 1994). For many of the primary documents, the historical context during its writing or surveyor bias against some landscape feature or misidentification of a species and least of all the observers' training and skill level may shade the interpretation of these historic documents. Nonetheless, as many authors note, these data sources often are the only representation of the pre-European landscape. Despite their variable training levels, many primary authors had "the unsurpassable advantage of actually having seen presettlement landscapes and aboriginal land management practices" (Ladd 1991). Thus, while many methods have their critics, when interpreted together or by applying an historical ecological approach they provide the land manager with much needed information to place her/his land parcel in its historical context and begin to model the types of vegetation structure and function appropriate for that area (Myers and Peroni 1983).

Paleoecology

Across the eastern deciduous biome, many authors have used pollen and charcoal analysis to reconstruct and interpret vegetational development at different scales (Watts 1979; Webb 1981; Whitney 1994). According to Patterson (this volume) some areas of the region have fairly well documented paleoecological reconstructions based on the work of key researchers, for example, Watts' work in the Appalachians (Watts 1979), Davis' work in the northeast and Lake States (Davis 1983), Clark's work in the Midwest and Northeast, and work in New England, primarily from Patterson and associates at the University of Massachusetts and from Foster and others at Harvard Forest.

In comparing sedimentary charcoal and archaeological site distributions in New England, Patterson and Sassaman (1988) found that fires were common on coastal sites where native populations were greatest and their land-use practices most intensive. Across the region, others have noted archaeological site distributions corresponding well with areas characterized by high oak pollen percentages and usually elevated amounts of charcoal fragments (Dincauze and Mulholland 1977;

Patterson and Sassaman 1988; Delcourt et al. 1998; Fuller et al. 1998). More recently, Clark and Royall (1995) contributed greatly to this discussion reporting a transition from northern hardwood to white pine-oak forests at Crawford Lake, Ontario, following a period of Iroquois occupation and agricultural clearing. Moreover, Ceci (1979) and Loeb (1998) discussed native corn and hickory planting episodes from the pollen record in the coastal regions of New York. Delcourt et al. (1998) reported that Archaic and Woodland period natives cleared forest gaps to cultivate native plants, and that human-caused fires increased populations of fire tolerant oaks, chestnut, and pine in upland forests of the Cumberland Plateau of central Kentucky. Still, Clark and others have provided evidence that some oak communities can be maintained in oak-chestnut with little charcoal present in their sedimentary records (Clark and Royall 1995; Foster et al. 2002). While several regional studies suggest the correlation of fire occurrence and native occupation with oak forest distribution, more research at the local level must be completed to better understand the pre-European landscape across the Northeast (Black and Abrams 2001; Parshall and Foster 2002).

Fire Scars

Another quantitative approach to understanding historical fire is using dating fire scars or tree-ring analysis to reconstruct disturbance regimes at native sites (Batek et al. 1999; Shumway et al. 2001; Ruffner and Abrams 2002). Few presettlement fire papers have been published for the Northeast; most represent fire evidence from the Midwest and Central plains (Abrams 1985; Guyette and Cutter 1991; Cutter and Guyette 1994; Batek et al. 1999). Buell et al. (1954) reported six fire scars from a single tree dating from 1641 to 1711 in Mettler's Woods, New Jersey, indicated a mean fire interval (time between fires) of 14 years. In western Maryland, Shumway et al. (2001) reported a mean fire interval (for consistency) of 7.6 years in an old-growth upland oak-hickory forest. Across the region, estimates of mean fire interval within oak forests are surprisingly similar ranging from 2 to 24 years (Shumway et al. 2001). At many sites, fire frequency increased or decreased during the initial period following European settlement depending on the stand and

region. Fire histories for the Missouri Ozarks indicate that during periods of late Native American settlement (1701 to 1820), fire return intervals were longer ($11.96 \text{ years} \pm 2.4$, mean $\pm$ SE) than those during European settlement ($3.64 \text{ years} \pm 0.35$) (adapted from Guyette and Cutter 1991). In southern Illinois, little is known of the historical fire regime because most of the needed fire scars were lost after logging of the primary forests and deterioration of cut stumps (Robertson and Heikens 1994; Olson 1996). Robertson and Heikens (1994) reported high fire ignitions during European settlement due to farmers clearing underbrush from the forest, closely following Guyette and Dey's model of frequent European ignitions immediately following settlement.

Moving eastward, a fire history study of mixed oak forests originating after 1850 in southeastern Ohio revealed that fire return interval averaged 7.5 years (Sutherland 1997). In northwestern Pennsylvania, Ruffner and Abrams (2002) reported dendrochronological evidence at a native Seneca village site revealed a frequent, low-intensity fire regime with a return interval of 11 to 26 years during native habitation. However, following European settlement (post-1800) the fire free period is significantly longer with a disturbance-free interval of 28.5 ± 2.8 years. Where prehistoric fire scars are available, these studies have provided valuable insight into native disturbances and their localized impacts. However, they are largely restricted to the area immediately surrounding the study sites and cannot characterize native influences at the landscape level (Batek et al. 1999).

Witness Trees

During the period of early European settlement in the Eastern United States, land surveyors recorded and marked witness trees (warrant, bearing, and/or corner) to identify property corners and boundaries (Lutz 1930; Spurr 1951; Bourdo 1956). When compiled from surveyors' notes, these trees provide a landscape level snapshot of forest composition at the time of European settlement and have been used to reconstruct regional vegetation composition throughout the Eastern and Midwestern United States (Lutz 1930; Siccama 1971; Whitney 1986; 1990, Loeb 1987; Seischab 1990, 1992; Marks and Gardescu 1992; Nowacki

and Abrams 1992; Abrams and Ruffner 1995; Black and Abrams 2001). Such vegetation reconstructions are valuable in areas where most original vegetation has been destroyed or altered, making it difficult to assess natural vegetation types or disturbance regimes. In many studies, reconstructed patterns of vegetation have been attributed to edaphic conditions such as topography, soils, slope class or drainage classes (Gordon 1940; Abrams and Ruffner 1995). In more recent years studies have taken a more integrative approach and recognized that native populations also may have affected vegetation patterns. A study by Dorney and Dorney (1989) documented a native maintained oak savanna in northeastern Wisconsin using General Land Office survey information.

In documenting pre-European vegetation of central New York State, Marks and Gardescu (1992) identified old Native American clearings and reported oak-hickory-pine growing in areas previously inhabited by peoples of the Iroquois Confederacy. In western New York, on lands surveyed for the Holland Land Company, including Gordon's (1940) area, Seischab (1990) reported that most oak communities occurred in southern areas along the Allegheny River and its tributaries, dominating a landscape formerly inhabited by Seneca people of the Iroquois Confederacy. Within the Lower Susquehanna Valley of Pennsylvania, Black and Abrams (2001) reported significant differences in witness tree distributions between areas adjacent to Native American village sites and those in areas with low native activity. Whitney and Decant (2003) suggested that Iroquois habitation may be associated with oak-chestnut forests along the French Creek area in their witness tree study of northwestern Pennsylvania.

Most recently, Black et al. (unpublished) integrated witness tree distributions, Native American archaeology, and geologic and topographic variables to investigate the relationships between Native American populations and pre-European settlement forest types on the Allegheny Plateau of northwestern Pennsylvania. Logistic regression of natural and cultural variables demonstrated that Native American habitation and travelways were the most significant predictor of oak, hickory, and chestnut trees in the pre-settlement forest. Although cause and

effect cannot be tested at this time (the paleoecology data are still being analyzed), the authors suggest that long-term Native American activities such as agricultural clearing and burning, as well as possible wood and mast resource extraction selected for the disturbance, adapted oak-hickory and chestnut. Overall, an increasing number of studies suggest that Native Americans had at least some association with forest composition, though the degree of the relationship often is not quantified.

Historical documents

Much of the literature surrounding Native American effects on vegetation have been developed from some type of historical document. By the middle of the 20th century, several key historical geographers had laid the framework for investigating native land uses e.g., Maxwell (1910), Bromley (1935), Day (1953), Stewart (1963), and Sauer (1975). These authors reviewed numerous primary and secondary sources to build their cases that native groups had influenced vegetation to varying degrees across the continent (Whitney 1994). While some authors suggested the widespread use of fire by natives, others cautioned against the idea of natives wantonly burning the landscape. Still, the preponderance of early forests described as “open and park like” led Bromley (1935) to conclude that it was “due to the universal factor of fire, fostered by the original inhabitants to facilitate travel and hunting” (Nowacki 2002). Indeed, natives affected ecosystem development in a variety of ways: hunting, fishing, agricultural clearing, and associated activities (including the introduction and dissemination of new cultigens), wood gathering, village and trail construction, and habitat manipulation (Maxwell 1910; Day 1953; Mellars 1976; Nowacki 2002). It is widely accepted that natives intentionally used fire for more than 70 reasons (Lewis 1993), particularly in the alteration and maintenance of surrounding environments for their benefit (Day 1953; Cronon 1983; Mellars 1976; Doolittle 2004).

Examples from early travel documents include William Strachey’s (1620) description of the Hampton, Virginia, area as “the seat sometime of a thowsand Indians and three hundred houses...which is the reason that so much ground is there cliered and opened, enough already prepared to receive corne and make viniards of two or

three thowsand acres.” Another published in 1672, The Discoveries of John Lederer: In three several marches from Virginia to the west of Carolina, relates open valleys and active burning of pine forests near Indian settlements throughout the Piedmont and Ridge and Valley provinces. In 1794, William Bartram traveled through the Cherokee, Creek, and Choctaw nations, characterizing their farms, orchards, and woodlands. In 1810, Francois Michaux published memoirs of his and his father’s travels through the southern Appalachians with their astute depictions of native village life and culture. Farther west, Henry Schoolcraft’s 1821 Ozark Journals documents his travels through the Ozark region where his training allowed him to accurately identify plant assemblages and report on the character and conditions of many unique ecological sites and phenomenon encountered on his trips through Indian territory. Most authors recorded an anthropogenic landscape heavily influenced by native activities and populations.

Researchers using surveyor accounts, treaties, deeds, wills, sheriff sales, tax records, and other collected papers and manuscripts have characterized and explained vegetation change from pre-European settlement to the present (Raup 1966; Cronon 1983; Foster 1992; Orwig and Abrams 1994; Ruffner and Abrams 1998; Foster 2002). While native effects differ across these studies, there are general patterns. For instance, many early documents reflect a managed landscape with tended agricultural fields interspersed through open woodlands and numerous abandoned habitation areas. This clearly suggests a cultural landscape. In a search of historical documents of Cape Cod, one of the earliest places written about by Europeans, Patterson and Ruffner found evidence for large “open fields” and “upland meadows” surrounding native settlements (Plymouth Colony records, vol. 3, p. 85). A 1648 deed records “the fields over the pond have been cleared and improved by the Indians as long as the oldest can remember” (Massachusetts Archives. 33: 245-247). As in other places across the East, these “planting fields” were the most commonly sought after real estate by Freeman during the ensuing years of European expansion (Williams 1989, Whitney 1994).

Another common observation is the usefulness and purposeful nature of many native burning regimes, which usually were adopted by incoming European settlers (Whitney 1994). Whether the reason was reducing rattlesnake and insect populations, improving browse or fruit production, or easing travel through the forest, authors have reported the widespread adoption of the native practices. Plymouth Colony records revealed evidence for early prescribed burning of pine lands by selected officials because they recognized the need to reduce potential fire hazards around settlements and improvements (Lovell 1984).

CONCLUSION

The use of historical evidence to reconstruct past vegetation distribution and fire regimes spans paleoecological, ethnobotanical, and archaeological fields. While the field of historical ecology has grown over the last 50 years to include many disciplines and journal outlets, I hope that this introduction contains sufficient examples of outstanding research and review articles to allow newcomers to find new sources of information. It is testament to the usefulness of these historical analyses that so many authors rely on them to corroborate other sources of evidence pertaining to past landscapes and events.

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