Native Americans, Smokey Bear and the Rise and Fall of Eastern Oak Forests

Marc Abrams*

Vegetation change is brought about by natural and anthropogenic processes, as well as an interaction of the two. Natural processes that impact vegetation include climate change, ecological disturbances (lightning fire), insect and disease outbreaks, extreme weather events, geologic phenomenon, and plant succession. Anthropogenic impacts include land-use history (e.g., fire, land clearing), and human-induced climate change. Climate change during the Holocene epoch has been attributed to natural variation as well as anthropogenic causes (e.g., fire, agriculture and greenhouse gases). 1 Studies of long-term forest dynamics have shown that oak (Quercus spp.) and pine (Pinus spp.) dominated much of the eastern United States forest biome during the Holocene epoch. 2 Their increased importance was associated with a warmer and drier climate and elevated fire frequency after glacial

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* Dr. Marc Abrams is professor of forest ecology and physiology and Endowed Steiner Professor of Agricultural Sciences at Penn State. He received his B.S. from S.U.N.Y. Binghamton and his M.S. and Ph.D. from Michigan State University. Professor Abrams’s research interests include disturbance ecology, old-growth forests, tree physiology, and vegetation classification. He has an extensive publishing history and has received numerous research grants from sources including the Nature Conservancy, the National Park Service, and the National Institute for Climate Change Research. These grants support his research on topics ranging from forest composition and structure, fire history and soils analysis, to the impacts of soil warming on ecosystem and physiological responses in contrasting tree species. The author would like to thank graduate student Ben Sands for his assistance with reviewing, editing, and formatting this article.


retreat.\footnote{3} As Native American populations increased throughout eastern North America so did their use of fire, land clearing and other agricultural activities.\footnote{4} Thus, climate change, whether natural or anthropogenic, and land-use history during the Holocene resulted in a dynamic equilibrium in forest and grassland structure and composition, which differed markedly from current conditions.

The magnitude of anthropogenic disturbances in North American forests changed dramatically following European settlement. These included extensive logging and land clearing, often associated with catastrophic fire, followed by the onset of the fire control era in the early 20th century, and the introduction of exotic insects and diseases.\footnote{5} All of these have led to unprecedented and rapid changes in forest composition and structure. This is particularly true for the eastern United States, which has seen the extirpation of the once dominant American chestnut (\textit{Castanea dentata}) from blight, loss of vast white pine (\textit{Pinus strobus}) and pitch pine (\textit{Pinus rigida}) forests to logging, followed by intense fires, a virtual cessation of regeneration of pyrogenic plants from fire suppression (Smokey Bear Policy), intensive deer browsing, and a rapid increase in native and exotic invasive plants.\footnote{6}

One of the most dramatic changes that occurred in forests of eastern North America during the 20th century is the increase in red maple (\textit{Acer rubrum}).\footnote{7} Red maple has become nearly ubiquitous across sites of greatly contrasting light, moisture and nutrient availability.\footnote{8} This is in stark contrast to the rather limited distribution of red maple reported in pre-European settlement forests, where it occurred mainly in poorly drained areas (and was commonly known as swamp maple).\footnote{9} The increase in red maple is thought to be related, at least in part, to the exclusion of fire in most forests, particularly those dominated by oak and

\footnotetext{6}{See id.; Whitney \textit{supra} note 4; see also Marc D. Abrams, \textit{Fire and the Development of Oak Forests}, 42 \textit{BiScience}, 1992, 346-353 [hereinafter Abrams, \textit{Fire and Development}].}
\footnotetext{7}{See Abrams, \textit{The Red Maple Paradox}, \textit{supra} note 5.}
\footnotetext{8}{See id.}
\footnotetext{9}{See id.}
pine, and its avoidance by loggers during the major clear-cut era from 1870-1920. In addition, differential deer browsing on oak (favored by deer) versus red maple (avoided by deer) has also acted to promote red maple. Presently, red maple dominates the understory and mid-canopy of many oak, pine, and northern hardwood forests, and it appears that it will increase in the overstory during the next century, causing widespread replacement of the historically dominant trees in the eastern United States. The increase in red maple and other shade tolerant, non-pyrogenic species has contributed to the “mesophICATION” process (a cooling, dampening and reduced flammability of the ground layer) in many eastern oak forests, reducing the likelihood of restoring the natural fire cycle in these forests. It is thought that low-to-moderate understory fire is needed for the long-term sustainability of most eastern oak forests. This type of fire was highly effective in eliminating fire sensitive, shade tolerant, oak replacement trees species, while creating the proper light and forest floor conditions for oak seedlings to regenerate.

Given current conditions of the ecology and management of eastern forests, the loss of oak and pine domination in eastern U.S. forests will be one of the primary consequences of the continued expansion of later successional tree species. Periodic burning of oak, hickory (Carya spp.) and pine types prior to European settlement was arguably a key factor limiting red maple domination in the original forests. In contrast, fire suppression policy during the Smokey Bear era appears to be leading to the demise of many historically dominant trees in the eastern United States. Suppressing fire in most oak forests allows later successional, oak replacement species (e.g., red maple) to flourish, while reducing the ability of oak to regenerate and/or recruit into the forest canopy.

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11. See Abrams, The Red Maple Paradox, supra note 5.
12. Id.
15. See id.
16. See id; Abrams & Nowacki, supra note 2, at 1124.
17. Id.
HUMAN IMPACTS ON VEGETATION PRIOR TO THE INDUSTRIAL REVOLUTION

The long-term stability of oak existed during the last 7000-9000 years in the eastern United States.\(^\text{18}\) This period included major climatic shifts such as the Holocene Optimum centered around 3000 years ago, the Medieval Warm period around 1000 years ago and the Little Ice Age 150-500 years ago.\(^\text{19}\) The rise in oak populations prior to the Holocene Optimum, its relative stability in the intervening cooling period (up until the Medieval Warming) and through the Little Ice Age, suggests that oaks were promoted by Native American activity.\(^\text{20}\) For example, on the eastern Highland Rim and adjacent Cumberland Plateau of Tennessee, Delcourt reported that mixed mesophytic forest taxa (e.g., oak, ash (Fraxinus spp.), ironwood (Ostrya virginiana), hickory, birch (Betula spp.), walnut (Juglans nigra), elm (Ulmus spp.), beech (Fagus grandifolia), sugar maple (Acer saccharum), basswood (Tilia americana), and hemlock (Tsuga canadensis) were most abundant during the early Holocene.\(^\text{21}\) A warming trend in the region from 8000-5000 years BP was reflected in higher pollen influx values for oak, ash, and hickory, and lower pollen influx for the mixed-mesophytic species.\(^\text{22}\) Domination by oak continued for the remainder of the Holocene.\(^\text{23}\)

Another important indication of humans’ role in the ecology of eastern North America is the long-term persistence of disturbance-dependent vegetation types where natural disturbances are not particularly inherent to the system. In my opinion, the vast expanses of tallgrass prairie, oak savannas, oak-hickory-chestnut forests, and southern and northern pine that cover much of the eastern United States fall into this category. Tallgrass prairie once covered approximately 240 million acres in the central United States.\(^\text{24}\) An additional 30 million acres of oak savanna covered portions of Minnesota, Iowa, Missouri,
Illinois, Wisconsin, Michigan, Native Americana and Ohio. Tallgrass prairie and oak savannas have persisted for most of the Holocene epoch in regions that receive 30-36 inches of rain per year, more than enough to support most central hardwood species. Ironically, occurrence of lightning is relatively low in the central, Lake State, and Midwest regions of the United States, as is their importance as an ignition source for large-scale fire. This has led most researchers to conclude that grasslands and oak savannas were maintained by human-caused fire rather than climate. Native Americans of the Central Plains used fire management to promote prairie as a grazing habitat for large herbivores, such as bison, as well as a dietary resource for themselves. Kay concluded that Aboriginal burning in the United States was the dominant ecological force and that lightning-caused fires were largely irrelevant; this is particularly true for most of the eastern United States. The widespread conversion to shrubs and trees following European fire suppression is highly convincing evidence of the fire dependency of tallgrass prairies and oak savannas. Very early on, Gleason recognized that the suppression of Native American fires led to the conversion of tallgrass prairie to oak forests in the Midwest.

The stability of oak in the eastern forests over most of the Holocene is intriguing based on the fact that most sub-xeric oak forests are successional to more shade tolerant trees in the absence of burning. Most authors report that recurring surface fire was integral to the historical development and long-term persistence of oak forests. In
New England, for example, paleocharcoal levels dating to 2500 years ago were lowest in northern hardwood forests, intermediate in oak and pine forests, and highest in pitch pine and oak forests. In the Hudson Highlands of southeastern New York, oak forests were maintained throughout most of the Holocene epoch as a result of Native American fires. A dramatic increase of oak, hickory, chestnut and pine in eastern Kentucky after 3000 yrs BP corresponded to increased fire and anthropogenic activity. Hickory, oak and walnut were the most frequent native mast tree nutshell remains, indicating that these species were an important food source of the Native Americans during the Holocene. In the southern Blue Ridge Mountains of North Carolina, oak, chestnut, pine and birch were the dominant tree taxa during the last 4000 years. There was a constant influx of charcoal during that period, including charcoal produced from regional, watershed, and local fires, as well as small, medium and large charcoal particles, respectively.

The long-term domination of pine along the northern and southern tiers of the eastern United States suggests recurring disturbance in much of the same way as in oak forests. Pines are light-demanding, early successional and fire adapted. In the absence of fire they will be replaced by more shade tolerant hardwoods in one generation. In the northern hardwood-conifer forest at Mirror Lake, New Hampshire, peak domination of white pine and oak occurred in the early Holocene epoch (9000-7000 yr BP) when the climate was warmer and drier than at present; charcoal was most abundant 8000-7000 years BP. Between 10,000 to 6,000 years BP, an expansion of pine and increase in paleocharcoal occurred in central Appalachia and the New Jersey Coastal Plain. In eastern Kentucky, where lightning-caused fires are rare, a

39. See id. at 263, 266.
40. See Delcourt & Delcourt, supra note 3, at 1010, 1012.
41. See id. at 1012-1013.
42. See id. at 1010-1013.
43. See id at 1010-1014.
44. See AN ECOSYSTEM APPROACH TO AQUATIC ECOLOGY: MIRROR LAKE AND ITS ENVIRONMENT (Gene E. Likens ed., Springer-Verlag 1985).
45. See generally William A. Watts, Late Quaternary Vegetation of Central Appalachia and the New Jersey Coastal Plain, 49 ECOLOGICAL MONOGRAPHS 427(1979).
large increase of pine, oak, hickory and chestnut after 3000 yrs BP was associated with frequent fire attributed to anthropogenic activity.\textsuperscript{46} In southern New York, the Medieval Warm Period was characterized by a large increase in charcoal and oak and pine dominance from \textasciitilde 800-1300 A.D.\textsuperscript{47} The region experienced an increase in spruce (\textit{Picea} spp.) and hemlock during the Little Ice Age between 1500 and 1850.\textsuperscript{48} At Crawford Lake in southern Ontario, Canada, Clark and Royall reported on the transformation of northern hardwood (beech-maple) forests to white pine-oak forests in response to Iroquois cultivation and burning during the 1400s.\textsuperscript{49} Northern hardwood-conifer forests across a longitudinal gradient in the northeast and north-central United States and southern Ontario reveal patterns of pine and oak abundance, and fire frequency over the last 200 years.\textsuperscript{50} The most western forests in Minnesota and Wisconsin were dominated by pine, oak, and birch and contained the most evidence of past fires relative to forests further east.\textsuperscript{51}

Oak, pine, and chestnut dominated forests in northwest Florida have dated as far back as 40,000 years, with oak dominating after 12000 year BP.\textsuperscript{52} During the early Holocene epoch in southern Alabama, sandy upland forests were first dominated by oak and hickory, followed by southern pines after 5000 years BP.\textsuperscript{53} In a review of fire history in the south, Fowler and Konopik concluded that anthropogenic fires were the key form of disturbance in southern ecosystems for more than 10000 years.\textsuperscript{54} Quarterman and Keever concluded that forest fires were set by Native Americans, European settlers, and lightning between 1600 and 1800 on the southern Coastal Plain.\textsuperscript{55} Native Americans cleared land for agriculture by girdling and burning trees.\textsuperscript{56} Longleaf pine (\textit{Pinus}

\textsuperscript{46} See Delcourt et al., supra note 38, at 263-78.
\textsuperscript{47} See Pederson et al., supra note 19, at 238-49.
\textsuperscript{48} Id.
\textsuperscript{51} Id.
\textsuperscript{56} Id.
northern and southern pines, and vegetation types do not persist. I have argued that the impact of Native American land-use practices.

For much of the Holocene epoch, climate has been cyclic. During cooler periods (e.g., the Little Ice Age), oak, pine and prairie persisted albeit at somewhat lower levels than the intervening warm periods (e.g., Holocene Optimum and Medieval Warm periods), presumably due to a decline in the number, extent and intensity of Native American fires. Their dominance rose in warmer periods when the influence of fire was that much greater. Species’ abundances waxed and waned in relation to climate change, as reported in many palynological studies. When European settlers first arrived to the American continent, they described it as a great wilderness. That, however, is not my interpretation. I view the pre-Columbian eastern United States as a network of actively and passively managed forest and prairie used by Native Americans to promote mast, other edible plants, and grazing areas for the wildlife they hunted. The vast majority of the eastern United States was not a climax forest dominated by late successional sugar maple, beech basswood or hemlock. Nor was it an edaphic climax of mostly xeric and nutrient poor sites unsuitable for climax tree species. The majority of the eastern United States at the time of European settlement was mixed-oak, hickory and chestnut forest, northern and southern pines, and tallgrass prairie maintained as such by Native American management to meet their dietary needs. In the absence of such management, these vegetation types do not persist. I have argued that the impact of Native

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57. See id.
58. See Kay, supra note 27.
59. See Quarterman & Keever, supra note 55.
61. See Abrams and Nowacki, supra note 2.
62. See id.
63. See id. at 1127.
64. See id. at 1123-37.
65. See id. at 1129-32.
66. See Abrams and Nowacki, supra note 2.
67. See id. at 1129-33.
68. See id. at 1133.
American land-use practices in the eastern forest and tallgrass prairie were ubiquitous, not merely localized.\footnote{69}{See id. at 1133-34.}

**HUMAN IMPACTS ON VEGETATION FOLLOWING THE INDUSTRIAL REVOLUTION**

Over many millenia, oak and pine forests and tallgrass prairie vegetation persisted through changes in climax and low-to-moderate intensity human impacts (e.g., periodic surface fire).\footnote{70}{See id.} However, this dynamic went into disequilibrium following the Industrial Revolution starting around 1800 (Fig.1). The first major land-use event that followed European settlement was land-clearing and the cutting of the forests for building material and firewood.\footnote{71}{See Michael Williams, \textit{Clearing the United States forests: pivotal years 1810–1860}, 8 J. Hist. Geography 12, 12-28 (1982).} As momentum increased with a rising population and the demand for wood by the charcoal iron industry, this escalated into the “Great Cutover” during the 19th century.\footnote{72}{Id.} The forests were used for industrialization, agriculture, and the basis of material progress.\footnote{73}{See id.} Although iron furnaces in the United States date back to the early 1700s, their peak activity was in the middle 19th century.\footnote{74}{See id.} By 1856, there were 560 iron producing furnaces and 78\% used wood charcoal (as opposed to coal).\footnote{75}{See id.} Each furnace required the wood from approximately 150 acres of forest per year over a 50 year period. Areas near furnaces were often cut at a 25-30 year cycle, creating coppice (sprout) forests.\footnote{76}{See Williams, supra note 71.} Other industrial uses of wood included railroads, mines (props), ship building, and manufacturing, although the largest consumption remained for domestic uses.\footnote{77}{See id.} Most of New England, New York, the eastern seaboard, and the Ohio Valley were already logged at least once by the mid-nineteenth century.\footnote{78}{William B. Greeley, \textit{The Relation of Geography to Timber Supply}, 1 Econ. Geography 1, 1-11 (1925).} Approximately 99\% of the original forest was gone by 1920.\footnote{79}{See id.}

Much of the forested area in the eastern United States was converted by land-clearing for agriculture and the expansion of towns and cities during the nation’s building period. Williams estimates that
164 million acres of forest were cleared for agriculture by 1860. The loss of forested land to agricultural clearing ranged from 22-76% (averaging 50%) in 12 eastern states. By 1920, old-growth forests totaled less than 0.5%, while the native tallgrass prairie was reduced in area by 99%. The second-growth forests that formed in the cut-over areas were subsequently grazed by livestock (pigs, sheep and cattle), resulting in great losses of acorns and nuts, tree seedlings, other understory plants, and soil compaction. Prior to 1850, commercial forestry in the eastern United States was typically limited to small sawmills in most towns. The subsequent increasing demands for timber lead to the large-scale commercialization of the forest industry by the second half of the 19th century, including steam-powered saws and railroad logging. Logging escalated, leading to the height of the clearcut era from 1870-1920. This “Great Cutover” logged billions of board feet of timber in the east and produced vast areas covered in “slash” (logging debris). As the slash dried, huge wildfires followed, with an intensity rarely experienced in the original forest.

The resilience of eastern forest to the vast clearcutting and intensive fires is a reflection of the disturbance tolerance attributes for most of its species. Indeed, the eastern forest initially came back much the same as it was before. Whitney compared the composition of presettlement versus more recent (1960-1982) forests in four northeastern locations and found that most major species changed very little. Exceptions to this include an increase in sugar maple and red maple in some areas, a decline in beech and hemlock, and an increase in red oak (Quercus rubra) and chestnut oak (Quercus prinus). Most of these changes were less than 10%, although the beech decline was larger. White pine also declined significantly, which was attributed to it being selectively logged.

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80. See Williams, supra note 71.
81. See id.
82. See Whitney, supra note 4.
83. See id.
84. See id.
85. See id.
86. See id.
87. See Whitney, supra note 4.
88. See id.
90. See Whitney, supra note 4, at 196.
91. See id.
92. See id.
93. See id.
during the early clearcut era and its inability to sprout like most hardwoods.\textsuperscript{94} White pine increased in some areas of New England as an old-field invader in the first half of the 20\textsuperscript{th} century as farms were abandoned for more productive land in the Midwest.\textsuperscript{95} The Lake States experienced a large increase in aspen-birch as a direct result of clearcutting and burning the original pine and hardwood forests.\textsuperscript{96} Another casualty of the clearcut era was white oak (\textit{Quercus alba}), one of the east’s most dominant tree species, which declined in many eastern forests between the presettlement and present-day.\textsuperscript{97} Northern red oak and chestnut oak increased in the wake of white oak’s decline.\textsuperscript{98}

One of the most profound impacts on the eastern forest during the early 20\textsuperscript{th} century was a result of exotic diseases such as, the chestnut blight fungus (\textit{Cryphonectria parasitica}), introduced to America in the early 1900s.\textsuperscript{99} Chestnut was once a dominant along the Appalachian Mountains from Maine to Georgia, where it typically represented 10-20\%, and as high as 50-90\%, of the forest composition along with oaks and hickories.\textsuperscript{100} As a result of the blight, nearly 100\% of mature chestnut trees were extirpated, relegating the species to understory sprouts (the blight does not kill the root system).\textsuperscript{101} As the chestnut was killed off, neighboring trees such as oak and hickory filled the chestnut gaps, thereby maintaining productive forests.\textsuperscript{102} Red maple also started its rise in the eastern forest at this time in response to the chestnut blight and clearcut era logging.\textsuperscript{103}

All the factors discussed above may pale in comparison with the suppression of forests fire since the 1930s, known as the Smokey Bear era. Indeed, this topic has received a huge amount of attention in the

\begin{footnotes}
\textsuperscript{95} See id.
\textsuperscript{96} See Brian J. Palik & Kurt S. Pregitzer, \textit{A Comparison of Presettlement and Present-Day Forests on Two Bigtooth Aspen-Dominated Landscapes in Northern Lower Michigan}, 127 AM. MIDLAND NATURALIST 327, 327-38 (1992); see also Nowacki & Abrams, supra note 4.
\textsuperscript{97} See Marc D. Abrams, \textit{Where has all the white oak gone?} 53 BIOSCIENCE 927, 927-39 [hereinafter Abrams, \textit{White Oak}].
\textsuperscript{98} See id.
\textsuperscript{100} See Abrams, \textit{White Oak}, supra note 97, at 929.
\textsuperscript{102} See id.
\textsuperscript{103} See Abrams, \textit{The Red Maple Paradox}, supra note 5.
\end{footnotes}
ecological literature. It is now well-recognized that periodic burning was and is an ecological requirement for the long-term perpetuation and health of tallgrass prairie and most oak, hickory, the former chestnut forests, and northern and southern pine.\footnote{See Abrams, Fire and Development, supra note 6; see also Nowacki & Abrams, supra note 4.} As a result of post-1930s fire suppression, most eastern oak-hickory-pine forests and savannas and tallgrass prairie on sub-xeric sites have undergone dramatic changes in composition and structure, resulting in the successional replacement by more shade tolerant species.\footnote{See id.} Fire suppression in tallgrass prairie and savannas leads to a rapid increase in shrubs and tree invasion moving these systems to shrublands or closed canopy forests where oaks can no longer regenerate.\footnote{See Cottam, supra note 32; Nuzzo, supra note 25; Abrams, Fire and Development, supra note 6.} The oak-hickory and pine forests further east, which lack shade tolerance, are also undergoing successional replacement in the absence of periodic burning, mainly by the shade tolerant red maple.\footnote{See Abrams, The Red Maple Paradox, supra note 5.} Other later successional or gap opportunistic species increasing in eastern oak and pine forests include sugar maple, beech, hemlock, blackgum (\textit{Nyssa sylvatica}), white ash (\textit{Fraxinus americana}), black birch, (\textit{Betula lenta}) tulip poplar (\textit{Liriodendron tulipifera}) and black cherry (\textit{Prunus serotina}).\footnote{See Abrams, Fire and Development, supra note 6; see also Marc D. Abrams, Tales from the Blackgum: a Consummate Subordinate Tree, 57 BIOSCIENCE 347, 347-59 (2007).} It is interesting to note that nearly all late successional trees, with the exception of blackgum, are sensitive to fire and are readily killed by repeated burning.\footnote{See U.S. DEP’T OF AGRIC., AGRICULTURAL HANDBOOK 654, SILVICS OF NORTH AMERICA, 2 HARDWOODS 325-26 (Russell M. Burns & Barbara H. Honkala, tech. eds. 1990) available at http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm.} The range of beech and blackgum, like red maple, includes nearly the entire eastern forest.\footnote{See U.S. DEP’T OF AGRIC., AGRICULTURAL HANDBOOK 654, SILVICS OF NORTH AMERICA, 1 CONIFERS 604-05 (Russell M. Burns & Barbara H. Honkala, tech. eds. 1990) available at http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm.} The scarcity of late successional tree species in the pre-European forest (outside of the northern hardwoods) is best explained by their subjugation from periodic fire (not from climate or soils). Nowacki and Abrams further analyzed
this phenomenon and reported that taxa showing the largest decrease from presettlement to present day are the fire-dependent oak, chestnut, hickory and pine.\textsuperscript{112} Beech has also declined in many areas as a result of cutting the original forest, coupled with more recent beech bark disease (\textit{Nectria ditissima}).\textsuperscript{113} The increased oak in certain forests in the early 20\textsuperscript{th} century appears to be temporary as they are presently being replaced by the non-oak tree species mentioned above and have had very little oak recruitment in the last half-century.

In conclusion, the extensive logging and land clearing, wildfires, the introduction of exotic insects, diseases and invasive plants, increasing deer browsing and the Smokey Bear era had led to unprecedented and rapid changes in forest composition and structure. The eastern United States has seen a near extirpation of the once-dominant chestnut, elm and butternut species from blight, a loss of many white pine forests, a decline in the super-abundant white oak, and a conversion of about 50\% of its forests and 99\% of its tallgrass prairie to agriculture. There has been a virtual cessation of oak, hickory and pine regeneration, and the rise of red maple \textit{et al.} in the remaining forests.\textsuperscript{114} The replacement of fire adapted trees by later successional species has resulted in a “mesophication” (cooling, dampening, and shading) of the forest understory, rendering these ecosystems less prone to prescribed or natural fire.\textsuperscript{115} Indeed, the eastern landscape has undergone a near complete transformation over the last 350 years.\textsuperscript{116} Anthropogenic impacts during the late 19th and 20th centuries have been continuous and significant in terms of their impacts on forests in the eastern United States (Fig. 1).\textsuperscript{117} Unfortunately, the dynamic equilibrium that perpetuated vast upland oak and pine, savannas and tallgrass prairie during the most of the Holocene was destroyed in the few centuries following European settlement, threatening the long-term sustainability of these major vegetation types.

\begin{thebibliography}{99}
\bibitem{112} See Nowacki & Abrams, \textit{supra} note 4, at 132.
\bibitem{113} See id.
\bibitem{114} See Abrams, \textit{Fire and Development}, supra note 6; Abrams, \textit{The Red Maple Paradox}, supra note 5; Whitney, \textit{supra} note 4; Nowacki & Abrams, \textit{supra} note 4.
\bibitem{115} See Nowacki & Abrams, \textit{supra} note 4.
\bibitem{116} See Whitney, \textit{supra} note 4; D.R. Foster et al., \textit{Land-Use History as Long-Term Broad-Scale Disturbance: Regional Forest Dynamics in Central New England}, 1 \textit{ECOSYSTEMS} 96, 96-119 (1998); Abrams & Nowacki, \textit{supra} note 2.
\bibitem{117} See generally Abrams, \textit{Postglacial History}, \textit{supra} note 2.
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Fig. 1. Major land-use history events following European settlement in the eastern United States.