Fire Ecology: An annotated bibliography

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Fauna


Sites were either control, once or twice burned sites over 2 years on xeric ridgetops in southeastern Kentucky. Foliar calcium levels were slightly lower in seedlings from burned sites, but levels were similar to controls the next year. Overall, fire was not correlated with white oak phytochemistry or increased insect herbivory.


Study looked at the effects of 1-4 years of annual burning followed by 1 year of recovery on breeding bird communities. Burning temporarily reduced habitat for ground and low-shrub nesting birds, and improved habitat for ground and aerial-foraging birds. Populations were unaffected. Long-term or large-spatial scale burning may adversely affect ground and low-shrub nesting birds, but other affects may be minimal as long as the closed-canopy structure is maintained.


This article addresses the need for long-term studies to understand effects of fire on bird populations. Prescribed fire reduces habitat suitability for ground-nesting forest-interior birds, but increases suitability for woodland, savannah, and early-successional forest species. Some bird species benefit while others are negatively affected.

Biennial spring fires were conducted after 50 years of fire suppression in the Ozark Mountains of Missouri, until 2004 when study was conducted. Prescribed fire can provide an influx of dead and dying trees, increased light availability, decreased canopy and sub-canopy tree density, which is beneficial habitat for bats. The initial fire created ideal cavity-dwelling habitat, and continued burning perpetuated the ideal open sub-canopy. All 63 bat roosts were found in the burned portion of the study.


Examined forest floor and ground dwelling arthropods, and their response to prescribed burning. Arthropod abundance was negatively affected by fire, and recovery was longer slow, indicating that a fire interval of >2 years is indicated. The impacts of more intense fires could be expected to be greater, as arthropod response was closely tied to reductions in forest floor mass and depth.


Five-year study evaluating the affects of annual and biennial fires on lone-star tick abundance in the Piedmont region of Georgia. Annual and biennial burning reduced larval, nymph, and adult abundance, but did not alter their seasonal trends. Annual burning suppressed all life stages more than biennial burning. The magnitude of tick suppression increased with successive burns. On burned sites, tick abundance was equal to or greater than unburned sites, in years of fire omission.


This study assessed effects of a community restoration fire on small mammals and herpetofauna in the upper slope pitch pine stands, neighboring mid-slope oak stands and rhododendron dominated riparian areas during 1995 and 1996. Post-treatment in 1995 and 1996, showed no significant differences among most species between burned and control areas. Slope position accounted for more variation among the species of greatest abundance than did burning.


This study is part of the National Fire and Fire Surrogate study, conducted in the Southern Appalachian Mountains of North Carolina. One to two years after treatment, low-intensity fuel reduction treatments were found to have little impact on shrews. This is in contrast to high-intensity disturbance, such as prescribed fires that kill trees and reduce shade and leaf litter, which can lead to the reduction in abundance of some shrew species.

This study is part of the National Fire and Fire Surrogate study, conducted in the Southern Appalachian Mountains of North Carolina, and focused on white-footed mice, which made up >79% of captures of rodents in treated sites.


This study is part of the National Fire and Fire Surrogate study, conducted in the Southern Appalachian Mountains of North Carolina, and examined the responses of different bird species associated with different forest conditions, including open and forested habitats, and found differing responses among them.


Report on invertebrate response one year following a prescribed fire on ridges of the Cumberland Plateau in Kentucky. A 36% total reduction of soil invertebrates due to fire, 95% of which was in the forest floor, and 60% attributed to loss of beetle larvae. The number of invertebrate orders and frequency of occurrence of mesofaunal ants and macrofaunal beetles declined due to fire. Beetles were ubiquitous on the ridges and account for 38% of invertebrate dry mass. Repeated fire at short-intervals may result in significant and long-lasting declines in beetle populations. Spatial heterogeneity on multiple scales may add complexity to the system, therefore, alleviating pressures on populations due to fire.


Winter, spring and summer prescribed fires were applied to first-stage shelterwood harvested stands in the Virginia Piedmont. One year after the fire, herpetofaunal abundance was not significantly different than unburned shelterwood stands.


This article reviews the implications for songbirds after the use of the shelterwood-burn technique followed by complete or partial canopy retention, post-harvest prescribed burning or complete canopy removal. They suggest that shelterwood-burns and later management options can be viable alternatives for managing both songbird and timber resources where oak-dominated stands are the desired goal in upland southeastern sites.

This study assessed the effects of a single prescribed fire on foliar chemistry of chestnut oak, scarlet oak, and red maple, and the impact of potential changes on herbivore fitness in oak/pine forests of the Cumberland Plateau, Kentucky. Total non-structural carbohydrate concentrations in scarlet oak and red maple foliage, and calcium levels of red maple foliage, were lower in burned plots than unburned plots. Relative growth increased in chestnut oak, decreased in scarlet oak, and was unchanged in red maple due to burning. Caterpillars fed scarlet oak foliage had greater size and development than those fed red maple foliage. Burning had no significant affect on caterpillar development.

**Fuels**


This technical note describes the composition of fuels in Appalachian mixed-oak forests. Downed woody materials are comprised of roughly 50% duff and litter combined, 30% fine fuels, and 15% coarse woody materials.


The effects of a single low- to moderate-intensity burn on forest floor mass, carbon (C), and nitrogen (N); soil nutrient (NO\textsubscript{3}, NH\textsubscript{4}, PO\textsubscript{4}, Ca, Mg, and K) availability; and vegetation mortality and regeneration were evaluated in a cove-hardwood forest in western North Carolina. Forest floor mass, carbon and nitrogen in the duff layer decreased about 50% and 90% in litter after one fire. (See “Seedling Establishment”, “Soil”, “Stand Structure”)


In the Missouri Ozarks 2, 3, and 5 burns were conducted over 5 years to record changes in herbaceous and woody vegetation in response to fire. Herbaceous, 1-, 10-, 100-, and 1000-hour fuels and litter depth were sampled prior to the first burn in 1998 and again in 2003. After 5 years only herbaceous fuels decreased while 1- and 10-hr fuels increased. South slopes trended toward an increase in 1000-hr fuels.


Study in southeast Missouri Ozarks evaluated whether aspect has an affect on fuel loading in stands that received prescribed burning, thinning, burning and thinning, or no management. In the pre-treatment, post-thinning, and post burn-thinning treatments fuel loading was highest on protected slopes, followed by ridges, and the least on exposed slopes. Thinning increased total fuel loading 300%, with 100- and 1000-hr fuels becoming dominant. The prescribed burn did not reduce 100- and
1000-hr fuels. Burning and burning/thinning resulted in a 50% and 25% reduction in total fuel loading, respectively. In both treatments a majority of consumption occurred in 1-, 10- and 100-hr fuels. Litter was nearly 100% consumed on all aspects in both treatments, creating horizontal discontinuity.


This study characterized fuel loading before and after a single spring prescribed fire. Prior to burning duff comprised the largest fuel component (48%) followed by 1000-hr fuels (24%). Duff mass was greater on sub-xeric landscape positions, Litter was reduced 88% from fire, but returned to pre-burn quantities 10-months following autumn leaf-fall. Duff depth decreased 36% following fire, while changes to duff mass were not detected.


This paper reports changes in fuel accumulation, soil, and hardwood regeneration which have occurred since controlled burning started in 1963. Approximately 16 acres on the eastern Highland Rim of Tennessee were used for fire study. Examined effects of annual and periodic (every 5 years) surface fires on characteristics of the overstory, hardwood reproduction, herbaceous and shrub vegetation, fuel accumulation, and soil in a hardwood forest. Prescribed burns occurred in late winter. Total litter weight was highest on the control plots (3.9 tons/acre) and lowest on the annual burn plots (2.1 tons/acre). A decrease in litter weight from 3.7 tons/acre to 2.4 tons/acre was observed on the periodic burn plots 1 year after the 1969 fire.

Herbaceous Vegetation


This study reports on changes to shrub and ground layers after 17 years of annual dormant season low-intensity burning in a central Illinois oak forest. Shrubs and small saplings were reduced by 97%; stems >5 to 10 cm DBH were reduced by 38%, leading to greater canopy openness in burned sites. Burning eliminated most alien shrubs. Fire also likely had a positive effect on seedling establishment through reduction of leaf litter.


The study reports on the response of the vegetation and soils to a ground fire that burned much of the Linville Gorge Wilderness Area in North Carolina in the fall of 2000. The fire burned through an oak-pine forest that had not been burned in ~50 years. Although there was no apparent overstory mortality, most of the Kalmia latifolia stems were top-killed, leading to an increase in light penetration of 15%. Species richness in the herbaceous layer increased, as did pine seedling regeneration, as well as the exotic invasive Paulownia tomentosa. The temporary loss of the kalmia shrub layer is altering
the composition of the ground layer and the re-accumulation of surface soil carbon through reduced rates of litter decay.


Riparian-cove, mixed-oak, and pine/hardwood communities were evaluated after one fire. On the ridge, herbaceous layer diversity was significantly increased by burning. After burning, non-woody species increased from 6% to 22% in relative abundance. (See “Stand Structure”)


Using treatments of burning, litter removal, increased pH, and control applied to small plots in a central hardwood forest in Ohio, the authors examined the understory plant community response. Fires reduced emergence of red maple post-fire. Hot fire, but not cool fires, increased germination of *Vitis* spp., *Rhus glabra*, and *Phytolacca americana*. Cool burns and litter removal increased *Erechtites hieracifolia* and yellow-poplar.


This study looked at the response of the herbaceous layer to unburned, periodic and annual fires over five years in southern Ohio. Herbaceous vegetation is affected by fire on a small-scale; increased species richness of grass, summer forbs, and seed-banking species. Little difference occurred between fire frequencies or moisture indexes. (See “Seedling Establishment” and “Stand Structure”)


This study examined changes in species richness of plant after a wildfire in the Linville Gorge Wilderness Area, North Carolina. The authors found increased species richness of plants after the fire, and explores the nuances of these findings at differing spatial scales.

**Historic and Prehistoric Use of Fire**


This paper provides an overview of the role of fire in the development of oak forests in eastern North America. The article describes the paleoecology of eastern oak forests, the ecophysiological features of oak that allow it to compete on sites with drought and fire, the expansion of oak in the tallgrass prairie region, red oak expansion in the northern hardwood forest, and the mixed-oak forests of the Mid-Atlantic region, oak in the southeastern coastal plain and Piedmont forests, and how oak forests are changing today. Abrams ties the loss of oak dominance in eastern forests to fire suppression.

Prior to European settlement, much of the eastern deciduous forest was oak-dominated, and there is significant evidence that this species composition was fire-mediated. Recruitment of oak species, especially on upland forests, has declined recently on all but the most xeric sites, with increasing dominance by mixed-mesophytic and later successional species such as maples, beech, and black gum. As these mesophytic species increase in importance, the ecosystems themselves become less flammable, suggesting a limited opportunity for restoring the pre-European fire regime.


Analyzed composition, structure and radial growth patterns in mature mixed-oak forests in central Pennsylvania that were relatively undisturbed, and similar forests in areas that were extensively logged between 1936-1946. Pre-settlement forests were dominated by white oak and white pine; logging and fire between 1780-1900 led to a reduction in pine and an increase in oak. Cessation of burning between 1908-1989, as well as decreased logging, led to increased recruitment of maple and cherry into oak forest understories. Logging of forests in this condition accelerated dominance by maples and cherry.


Using witness tree distribution, Native American archaeological sites, and geological and topographic information, the authors examined relationships between Native American populations and the vegetation composition of pre-European settlement forests on the Allegheny Plateau in NW Pennsylvania. The authors conclude that Native American practices of agriculture, burning and resource extraction could have helped to maintain oak-hickory-chestnut forest composition in a landscape that would otherwise have supported beech-maple-hemlock forest.


Appalachian mixed-oak forests have experienced three very different fire regimes over the past ~4,000 years. Native American burning produced a fire regime typified by periodic, low-intensity surface fires, which helped to perpetuate oak dominance in upland forests. This was followed by a period of high-intensity burning during the Industrial Revolution which led to stand-replacing fires which left forests damaged and led to a national policy of fire suppression. This third fire regime has permitted forests to recover, but with increased dominance by mesophytic species with potential to replace oaks in the overstory. Research is currently underway to identify how fire can be returned to these ecosystems to benefit oak through improved oak regeneration.

Using fossil pollen records and charcoal-particle records preserved in peat in a bog in North Carolina, the authors examined the importance of pre-Columbian human impacts on vegetation in the southern Appalachians. They suggest that humans in the late Archaic, Woodland, and Mississippian times concentrated fire within two landscape positions, the alluvial bottoms where camps and villages were established, and along upper slopes and ridge tops where people hunted and gathered nuts, acorns and chestnuts. They conclude that fire management to maintain the landscape mosaic present during the 4,000 years prior to European settlement will require that fire be excluded from areas that do or may support old-growth mixed mesophytic forests, while using frequent ground fires to promote Appalachian oak forests and woodlands, and periodic crown fires on exposed ridges to regenerate fire-adapted endemic pines.


Fossil pollen and charcoal in peat deposits and pond sediments from three sites in the southern Appalachians yielded evidence for a direct relationship between prehistoric Native American use of fire and increases in the importance of oak-chestnut forest between about 3,000 and 1,000 years ago. At Cliff Palace Pond on the Cumberland plateau of southeastern Kentucky, Tuskegee Pond, in the Ridge and Valley of East Tennessee, and Horse Cove Bog in the Blue Ridge Mountains of western North Carolina, increases in fire frequency corresponded with the change in Native American activities from hunting and gathering in the Late Archaic cultural period toward more sedentary lifestyles and cultivation of native plants in the Woodland cultural period. Forests of oak and chestnut became dominant on upper slopes, with fire-adapted pines establishing on ridge tops and disturbance-adapted hardwoods invading abandoned Indian old fields.


Forest composition over the past 9,500 years was characterized from fossil pollen assemblages from an upland pond in eastern Kentucky. After ~3,000 BP, mixed oak-chestnut and pine forests were dominant in the pollen record. Charcoal in the fossil record provides evidence that Late Archaic and Woodland peoples used fire to clear forest gaps for cultivation of native plants. Anthropogenically-ignited fires increased populations of fire-tolerant oaks, chestnut and pines in upland forests of the northern Cumberland Plateau.


This paper examines the impact of fire and related anthropogenic disturbances on the southern Appalachian landscape before white settlement. Accounts of sixteenth, seventeenth, and eighteenth century explorers document vast amounts of cleared land held by aboriginal inhabitants, who likely populated the continent in much higher numbers than have been traditionally accepted. Fire was the principal tool used by the Indians to clear vegetation. Despite frequent historical reference to the Indian use of fire and the documentation of Indian old fields, the role of fire has been largely underplayed. Fire was implemented for forest management, driving game, and preparing land for agriculture.

Using dendrochronology applied to cut stumps of oaks and maples in southern Ohio, the authors examined the fire history, and the establishment of oaks and maples on the sites in relation to past fire history. They documented 26 fires between 1870 and 1933, with a mean fire occurrence of 11.6-30.7 years. Stands were initiated between 1845 and 1900. There was an absence of oak recruitment after ~1925; most maples were recruited into the stands after the last major fire. This study suggests a relationship exists between fire/fire cessation and a shift from oak to maple establishment.


This report examines the role of fire in the southern Appalachians and the Cumberland Plateau, fire history in the southern Appalachians, forest fires in the Daniel Boone National Forest (DBNF) from 1930-1989, and fire as a potential management tool in the DBNF. Martin notes that 56 - 98% of fires in the DBNF are human caused, and most fires in the DBNF occur in March and April and October and November. "Along with thunderstorms with high wind, tornados, insect and disease attacks, and landslides, fire is a disturbance factor that shaped the composition, structure, age, and growth of these predominantly deciduous forests as they moved back from southern refugia to dominate the Appalachian mountains, valleys and plateaus with global warming at the end of the Pleistocene." Fire suppression in Kentucky has resulted in (1) increased ericaceous shrubs in the understory, particularly *Rhododendron maximum* and *Kalmia latifolia*, (2) increases in overstory and understory of fire-sensitive Virginia pine and white pine, especially on drier sites, (3) increases of fire-sensitive hickories and oaks to oak, oak-pine, and upper cove forests (4) possible decline in oak reproduction in oak and oak-pine forests. The author cites Huntley and McGee (1981) as stating that red maple responds well to fire and often outcompetes oaks unless controlled. The author cites several studies in listing sprouting ability in decreasing order: red maple, white oak, chestnut oak, scarlet oak, black oak.


Using fire scar dating and dendrochronology, the authors demonstrated that fire was a frequent and widespread occurrence during the formation of mixed-oak forests on the Allegheny and Cumberland Plateaus of eastern North America. Fire return intervals ranged from 1.7 to 11.1 years from 1875-1936. Fires were rare from 1936 to present.


This paper discusses the role of fire suppression in decreased oak regeneration in the Ozark and Shawnee Hills of southern Illinois, where cultural burning and harvesting fostered consistent oak recruitment until the 1950s, when cutting declined and fires were suppressed. The authors review the evidence for fire as an ecosystem process and discuss strategies for reintegrating fire management across the Midwestern landscape.

The authors searched archival information for evidence of lightning strike ignitions of forests in Pennsylvania. They report evidence that lightning strikes and tree ignitions occur relatively frequently in Pennsylvania forests. For the recent period (1960-1997) they found evidence for areas burned by lightning ignitions during drought years.


This study examined the fire history and ecological changes in an old-growth forest in western Maryland located on side slopes of a ridge system using fire scars obtained from old trees. Trees were cut in 1986, revealing a record of 44 fires from 1615 to 1958. The Weibull modal fire interval was 7.6 years, and oaks recruited consistently from the early 1600s to the early 1900s. With fire suppression in 1930, red maple and black birch recruitment into the stand increased. The evidence from this study supports the hypothesis that periodic fire played an important role in the historical development and perpetuation of oak forests of the mid-Atlantic region before and after European settlement.


Report that numerous studies support the theory that multiple prescribed burns are necessary to promote advanced oak regeneration prior to harvest. Single prescribed fires have little effect on species composition in the understory, although yellow-poplar seed stored in the lower duff germinates rapidly following low-intensity prescribed fires. Low intensity prescribed fires in unthinned pine stands not likely to stimulate herbaceous plant production.

Residual Stems, Effects of Fire on


A study was initiated in 1994 to evaluate the degree of bole damage and crown decline residual overstory trees would experience because of prescribed burning of shelterwood stands. Three oak-dominated shelterwood stands, partially harvested 2 to 4 yr earlier, were divided into four treatments (unburned control, spring burn, summer burn, and winter burn). Fifteen permanent sampling points were systematically located in each 5 to 12 ac treatment area, and overstory trees were selected from these points with a 10 BAF prism. Before burning, each tree was evaluated for lower bole and crown condition and reevaluated two growing seasons after the fires. Hickory, oak, and yellow-poplar were largely unaffected by the winter and summer prescribed fires but displayed bole damage and crown decline following spring burning. American beech and red maple declined after all fire treatments. Fire damage to oak, hickory, and yellow-poplar was strongly associated to presence of logging slash near a tree's base. Directional felling or moving slash should minimize injury to these trees. This research will aid resource managers wishing to use prescribed fire in shelterwood stands to favor oak regeneration while minimizing damage to residual overstory oaks.

The importance of bark thickness, diameter, and growth rate in determining tree survival following low-intensity surface fires was examined in xeric pine and oak forests of western Great Smoky Mountains National Park. Bark thickness at breast and ground levels increased with dbh, and tree survival of low-intensity surface fires increased with bark thickness. Equations relating bark thickness, survival, diameter, and diameter growth rate were used to estimate the time required to grow a tree with a 50% chance of surviving a low-intensity surface fire. The mean pre-park fire return interval of 10 yr favored fast-growing, thick-barked tree species to grow into size-classes that are resistant to fire. This indicates that restoration of the pre-park fire interval alone will not restore the pre-park forest structure. It. May be very misleading to rank species on bark thickness alone unless a range of sizes is specified. For example, chestnut oak is considered to have one of thickest barks in eastern US and dogwood thinnest, yet C. florida, at a dbh of 15 cm or greater, can have bark nearly as thick or thicker than Q. prinus at the same dbh. Some thin-barked trees like Virginia pine have thick bark collars, which may allow surviving low-intensity surface fires. Both Nyssa sylvatica and Q. prinus require an interval of 14 yr for 50% survival, while A. rubrum would require 23 yr. Thus, short fire frequencies favor dominant Pinus sp., N. sylvatica, O. arboreum, and Q. prinus over A. rubrum and suppressed Pinus sp. Other thin-barked, slow-growing species such as Carya spp. and Q. coccinea would also be reduced by short fire intervals. Given the duration of fire suppression it seems unlikely that the pre-suppression forest structure and role of fire could be restored easily, even if a program to reintroduce fires was adopted in Great Smoky National Park. For example, although in 1940 only 10% stands were old enough to allow 50% survival of A. rubrum, the proportion of these stands in 1980 has increased to 100%. Thus the importance of species like A. rubrum could be reduced by reintroduction of fire, but restoration of the pre-suppression forest structure would be a very long-term process.


Some physical, thermal, and chemical properties of bark of 16 tree species native to the central hardwood region were measured to determine their potential to protect the vascular cambium from damage by fire. The relationship between DBH and bark thickness for each of 16 species was determined. For purposes of monitoring seasonal trends, two species (*Quercus macrocarpa* Michx. and *Acer saccharinum* L.) were sampled periodically during one growing season. Temperature response to bark surface heating of 11 species was monitored at the cambial layer during simulated fires conducted in the field. Bark samples were analyzed for moisture content, specific gravity, dry weight, volatile matter content, and time until ignition. Overall, during simulated fires, temperature gradients were decreased and maximum cambial temperatures were reduced as bark thickness increased. Thick-barked species had lower maximum cambial temperatures, longer times to reach peak temperatures, slower rates of heat loss, and shorter time until surface ignition. *Populus deltoides* Marsh. was the most heat resistant among species tested, while *Acer saccharinum* was the least. Higher specific gravities were associated with higher rates at which cambial temperatures rose as well as with increased time required for surface ignition.

A method is presented here, applicable to the oak-hickory forest, for immediately predicting tree mortality and estimating basal wound size for surviving trees. This method can be used at any time of year; it requires only observations or measurements of (1) tree species, (2) tree DBH, (3) height of bark blackening at 1 foot above ground (stump height). It is best applied to trees from 1 to 16 inches DBH. However, with caution it can be used for larger trees.


In addition to addressing the effects of a single fire on fuel loading (cited as Loucks et al. 2008), this Master’s research described the effects of prescribed fire on bark scorch heights. Tree species, DBH, and landscape position were found to influence maximum bark scorch height on trees >2cm DBH.


Fire scars result from the death of the vascular cambium resulting from excessive heating, which exposes sapwood to infection and initiates the wood decay process. In southeastern Ohio, prescribed fires in April 1995 and 1997 scarred Quercus prinus L. and Q. velutina Lam. Low-intensity fires scorched bark and produced scars, primarily on the downslope side of the stem. Eighteen scorched trees (4-23 cm at DBH) were dissected in November 1997, 14 of which had fire scars. The vascular cambium beneath natural bark fissures was most vulnerable to injury. No charred or scorched wood was associated with scars of trees exposed to single fires; wood exposed by scars from the 1995 fire was charred by the 1997 fire. Consistent with the compartmentalization process, discoloration and white rot occurred within compartment boundaries of wood present at the time of wounding. Scars from the prescribed fires were consistent in size and shape with scars in nearby oak trees previously hypothesized to have been burned prior to 1950.


This poster abstract describes the first-year effects of a fall groundfire which passed through a sapling-sized (mean dbh = 7.8 cm) stand dominated by Acer rubrum and Quercus prinus trees (n=344). The stand was on an upland site at Robinson Experimental Forest on the Cumberland Plateau in eastern Kentucky. One year prior to the burn, trees in one-half of the stand were released using a crown-touching technique. Post fire inventory included individual tree measures of dbh, minimum and maximum scorch height, percent circumference scorched, and percent bole surface area scorched. Mortality data was collected at the end of the growing season. Data was collected for all trees in the stand and trees were classed into 2.5 cm dbh classes, providing 5 dbh classes ranging from <2.5 cm to 10-12.5 cm. Correlations between fire indicators and species mortality were made within dbh classes to provide information which could be used to predict species mortality for oak-maple stands of varying mean diameters. Overall mortality averaged 62% for A. rubrum and 26% for Q. prinus.

Five years after a single prescribed fire in a second-growth central Appalachian oak-hickory stand, many overstory trees died or declined in vigor. A major reduction in butt-log quality on the residual trees was observed. Fire scars were prevalent on a large number of trees and scars showed various stages of decay. Advanced seedling and sprout reproduction increased for red maple, northern red oak, and hickory. Overall stocking of advance reproduction of red maple, black locust, and hickory increased during the 5 years; red and chestnut oak were poorly distributed and accounted for only 3 percent of the stocking. Striped maple was the most abundant and widespread noncommercial species before and after burning. The large amount of damage to the overstory stand and failure to control the large number of noncommercial understory stems with a single prescribed fire indicate that more research is needed before fire can be recommended for use as a regeneration tool in central Appalachian hardwood stands. Red maple was the most common sprout and changed little in number during the 5 years after burning.

Seedling Establishment and Advance Regeneration


Study in southern Ohio looked at effects of four treatments on tree recruitment: control, prescribed burn, mechanical thinning, and mechanical thinning followed by prescribed fire. Treatments were applied in dormant season. After one prescribed fire red maple seedlings and sapling densities were reduced, but recovered to pre-burn conditions within four seasons. Mechanical thinning increased recruitment of shade-intolerant yellow-poplar and sassafras. In all treatments, white and chestnut oaks seedlings declined over the four years following treatment, while black oak seedlings increased. In mechanically thinned or burned forests oak seedlings were not released from growth suppression. Prescribed fire multiple years after mechanically thinning could reduce competitive red maple sprouting.


In this study, conducted in the Daniel Boone National Forest on the Cumberland Plateau in eastern Kentucky, the authors followed ~3,000 seedlings of oaks and oak-competitors (sassafras and red maple) for 5 years, recording survival as well as height and diameter. Treatments were fire-excluded sites, sites burned 1x and sites burned 3x. Red maple seedlings had low survival (40%) after burning and fire did not enhance seedling growth. Sassafras survival was unaffected by burning, by seedlings on burned sites had 2x greater height and diameter than seedlings on unburned sites. Survival of red oaks was reduced by burning and growth was similar to seedlings on unburned sites. Survival of white oaks was reduced by burning and growth was similar to seedlings on unburned sites.


Fire treatments were initiated in 1990 to evaluate effects of low-intensity prescribed fires on composition and structure of the advanced regeneration pool under mixed-hardwood stands on upland sites in the Piedmont of South Carolina. One spring burn was as effective as three winter burns in
reducing midstory density, considered a prerequisite for subsequent development of oak (Quercus spp.) advanced regeneration. Burning increased the number of oak rootstocks, reduced the relative position of competing species, and increased root-to-shoot ratios of oak stems in the regeneration layer. These favorable effects of fire on oak regeneration outweigh the removal of small, poorly formed oak stems from the midstory/understory strata during burning. Prescribed burning in hardwood forests may solve some of the current oak regeneration problems, especially on better upland sites in the South.


This study evaluated the effects of a single late-winter prescribed fire on oak/pine forest ridgetops of the Cumberland Plateau in Kentucky. Pre-burn overstory (>10cm DBH) was dominated by oaks, and the midstory (2-10cm DBH) was dominated by white pine and red maple. Two seasons after fire nearly all white pine <2 cm dbh were killed, 50-80% of stems 2-6 cm were killed, and post-burn regeneration was abundant. White pine age-structure, but not long-term regeneration was affected by prescribed fire. (See “Stand Structure”)


This abstract discusses the predictive power of 0.5” basal diameter, 4.5’ stem height and root collar diameter of oaks to determine early height growth of regeneration after spring, summer and winter prescribed fires in oak shelterwood stands. Root collar diameter explained seedling height growth more so than pre-burn height or basal diameter.


The study examined the effects of for treatments (spring burn, summer burn, winter burn and unburned control) on productive upland sites that were previously cut using a shelterwood technique. Nearly all hardwood regeneration was top-killed, and despite resprouting of rootstocks, fire treatments reduced densities of all hardwood species compared to not burning. Spring and summer fires caused a greater reduction in density of hardwood regeneration than winter burning. Oaks and hickories were more resilient sprouters than yellow-poplar and red maple, especially as fire intensity increased. All prescribed fires improved oak stem form and stimulated height growth of hickory and oak. Overall, prescribed fires improved oak advance regeneration with spring burning providing the most benefit, leading to the conclusion that this method of using prescribed fire after shelterwood cutting may be a viable approach to regenerating oak-dominated stands on productive upland sites.


Spring, summer, and winter burns were conducted in a Virginia mixed-oak forest 10 years following a shelterwood harvest. Advance regeneration of oak, maple and yellow-poplar was present. Greater root
collar diameter and location is critical in rootstock survival, and advanced regeneration of oaks exposed to fire. Species is not as important as root collar diameter and depth, though the silvics of oak gives it the necessary advantage over maple and yellow-poplar.


Regenerating oak stands on productive upland sites in the Piedmont region is a major problem because of intense competition from yellow-poplar. As a potential solution to this problem, we tested the hypothesis that a shelterwood harvest of an oak-dominated stand, followed several years later by a prescribed fire, would adequately regenerate the stand. Three oak-dominated stands, in which shelterwood harvests had been conducted several years earlier, were each divided into spring burn, summer burn, winter burn, and control treatments. Three years after the prescribed fires, oak had higher density and stocking in burned as compared to unburned areas while yellow-poplar had its highest density and stocking in the controls. Season-of-burn interacted with fire intensity to create several probable outcomes of stand development. Areas treated with high-intensity fire during the spring will develop into oak-dominated stands after just one burn. Controls and areas treated with low-intensity fire will become dominated by yellow-poplar. Other combinations of fire intensity and season-of-burn will produce mixed hardwood stands with varying proportions of oak. Combining shelterwood harvesting with prescribed fire appears to be a viable method for regenerating oak stands on productive upland sites in the Piedmont region and may be applicable elsewhere.


Southern red oak acorns were placed at three depths in a reconstructed forest floor (L layer; at the interface of the upper and lower F layer, and at the lower F/mineral soil interface) and subjected to simulated fire. As depth increased, germination capacity increased.


These burns were dormant season with a frequency of one, three, or four fires. Seedling and sapling survival of all species after one fire was 90%. After additional burns, survival increased with increasing initial stem height and diameter, and decreased with additional burns. Black and post oaks had highest probability of survival after 3+ burns, followed by white oak and scarlet oak. Dogwood and blackgum had low survival probability. Sassafras had 90% survival. Fire frequency had less of an effect on stems greater than 7.6 cm diameter, than smaller stems. Though one fire concentrated oak stem height at <1m due to stem-kill and resprouting, repeated burns favored advanced oak regeneration. Height growth was slowed after burning due to suppression of regeneration by the overstory canopy that averaged 18 m2/ha. Repeated burning in the dormant season favored oak advance regeneration.

The effects of a single low- to moderate-intensity burn on forest floor mass, carbon (C), and nitrogen (N); soil nutrient (NO$_3^-$, NH$_4^+$, PO$_4^{3-}$, Ca, Mg, and K) availability; and vegetation mortality and regeneration were evaluated in a cove-hardwood forest in western North Carolina. In the understory (<2.5 cm dbh) all stems were killed, and 50% resprouted the next growing season. Some sprouts didn’t survive to the next growing season. Total understory density increased 6 times after burning while the basal area stayed the same. (See “Fuels, “Soil”, and “Stand Structure”)


A single dormant season fire did not prepare the seedbed for Pinus echinata one and two years following treatment. No Pinus seedlings were found. (See “Soil”, “Stand Structure” and “Water”)


This study examined the physiological responses of red maple, chestnut oak, and scarlet oak following a single prescribed fire in an oak/pine forest. Immediately following fire, seedlings in the burned area had higher foliar N, P, K, and Mg than seedlings in unburned sites. Two and three growing seasons after fire seedlings in burned sites had higher photosynthetic potential and relative diameter and height growth rates than seedlings in unburned sites. Concentration of foliar nutrients was greatest in chestnut oak, intermediate in red maple, and lowest in scarlet oak. Oaks had greater maximum photosynthesis than red maple. In burned sites red maples were taller than oaks, whereas no difference existed in unburned sites.


This thesis reports on a study of >700 oak and red maple seedlings subjected to repeated fire or fire excluded. After five years of periodic prescribed fire, red maple seedlings suffered higher mortality than oak seedlings. However, those seedlings that did survive were generally larger and showed greater growth.


Controlled ground fires had a significant effect on survival and growth of 1- to 2-year-old seedlings of Acer rubrum, Quercus rubra and Quercus alba. In addition, although not statistically significant, seedling survival of fire was higher at lower than at higher fuel loading levels. Seedlings of Q. rubra survived fire better than those of A. rubrum. This superior survival was associated with a greater rate of resprouting in Quercus after fire in the spring, but not after an autumn fire. Starch concentrations in roots fluctuated seasonally in all species, reaching minimum levels in May. Seedlings of both Quercus species maintained higher root starch levels and greater seasonal stability in starch levels than A. rubrum seedlings: results that may have contributed to the superior resprouting capacity of Quercus seedlings after spring fire. However, starch reserves could not account for differences in autumn fire
survival, as starch concentrations in this season were high and roughly equivalent in all species, and there was little subsequent resprouting observed in surviving seedlings of any species. The lower rate of resprouting in *A. rubrum* seedlings may be attributable to some combination of morphological constraints and lack of starch reserves. Carbon allocation patterns of *Quercus* seedlings apparently favored maintenance of high root starch levels while carbon allocation of *A. rubrum* seedlings apparently favored rapid growth.


Three spring prescribed fire treatments from 1995 to 2002: control, 2x- and 4x-burned, on sites classified as xeric, intermediate, and mesic moisture classes. Initial seedling decreases in red maple, and increases of yellow-poplar from fire did not persist. Fire did not affect the density of oak and hickory seedlings and their shade-tolerant competitors, or the abundance of seedlings >30cm. Canopy openness remained <6% after burning. Fire alone failed to improve oak regeneration consistently, but repeated fire reduced stand density and may be effective if applied periodically over the long-term. (See “Herbaceous Vegetation” and “Stand Structure”)


Light, soil moisture, herbs, shrubs, woody reproduction, and overstory structure were measured to quantify effects from shelterwood cutting, wildlife thinning using herbicide, wildlife thinning using herbicide combined with prescribed burning, and prescribed burning with no overstory treatment on oak regeneration and competitors. A single prescribed fire significantly increased the density of oak seedlings and sprouts <10 cm tall and reduced the density of red maple regeneration. It also significantly increased the density of sassafras and yellow-poplar regeneration.


This study examines the relationship between the size of the root system and diameter/height of small white oak seedlings on unburned and single-burned sites on the South Carolina Piedmont. 11-13 years following the burns, seedlings were excavated and diameters at the top of litter and humus layers, and at the root collar were measured. On burned sites, diameter measurements were good predictors of root biomass. On unburned sites, only root collar diameter was a good predictor of root biomass.


This study evaluated the effects of a single late-winter prescribed fire on oak/pine forest ridgetops of the Cumberland Plateau in Kentucky. Oak, yellow poplar and red maple seedling densities were higher two growing seasons after fire, as well as red maple and flowering dogwood sprouts. Prescribed fire promoted regeneration of both fire-tolerant and fire-intolerant species.

This shelterwood method provides stand conditions which enhance the growth of established red oak advance reproduction, thereby furthering oak dominance in the next stand. A mature, fully stocked stand is reduced to 60%, 65%, and 70% of initial stand basal area where oak site index is 70, 80, and 90 ft, respectively. Basal area is reduced from below using herbicides, leaving the main canopy essentially intact. Yellow-poplar, a primary competitor of red oak, is prevented from becoming established, and it reduces sprout competition from shade-tolerant sub-canopy species after the final removal cut. The final removal cut is made approximately 10 years after the initial treatment.


The authors examined the competitive response of oak and mountain laurel to prescribed fire on two sites in NE Connecticut. On moderately burned sites, the competitive position of oak was about the same as on unburned controls. On sites where fire burned much of the overstory, oak regrowth was vigorous and dense thickets of mountain laurel were not present. Results suggest the need for harvesting in conjunction with burning. Ecologically, the results point to the importance of severe disturbance for maintaining the structure of oak ecosystems.


This thesis presents two studies, one that examined recruitment of new seedlings on fire-excluded sites and sites burned once or three times, the other investigating the survival and growth white and chestnut oak seedlings developing from seed after a mast crop in 2005, on the same burned and fire-excluded sites. The recruitment study focused on recruitment of yellow-poplar, maples, and sassafras, as these species represented the majority of tree seedling recruitment over six years. In the oak seedling study, litter depth and percent open sky were found to be significant predictors of oak seedling mortality for the first two growing seasons after germination. Increased litter depth led to increased seedling mortality; greater percent open sky led to higher seedling survival. Overall, height growth rate and basal diameter of new oak seedlings were higher in burned sites than in fire-excluded.


These authors measured vegetation in rocky and non-rocky plots in recently burned and unburned stands. They found that with a sustained fire regime, rocky patches created sites for dominance by Quercus, with fire-sensitive species in pockets of lower fire severity. In the absence of fire, more shade-tolerant species replaced Quercus and other early-mid successional species.

This study compared stands at the National Guard Training Center in Pennsylvania that had been burned at 3-5 times since the 1980’s with unburned stands. Oak saplings had a significantly greater density in the frequently burned stands. There were no red maple saplings in three of the four burned stands. Oak saplings were most abundant when overstory density was less than 400 trees/ha, and understory was less than 200 trees/ha; excess of these values resulted in absence of oak regeneration. (See “Stand Structure”)


Oak forests throughout the southern Appalachians have been historically maintained in a regime of frequent fire. Frequent fire over an indefinite time period favors oak establishment by reducing understory and midstory competition from fire-intolerant species and by creating preferred conditions for acorn caching by squirrels and bluejays. Fire also reduces populations of insects which prey on acorns and young oak seedlings. Once established in the understory, oaks have a tenacious ability to resprout when tops have been killed repeatedly by fire. The ability to continually resprout when numbers of other sprouting hardwoods have been reduced by fire allows oak to accumulate in the advance regeneration pool and dominate the next stand when suitable conditions prevail. Intense fires in logging debris also favor establishment and development of high quality oak-dominated stands. Tentative guidelines for the silvicultural use of fire to regenerate oak are discussed.


Fire has played a dominant role in sustaining oak forests. Oak species have biological adaptations, such as thick bark, ability to resprout repeatedly following top-kill, and resistance to rot, which enable them, better than their competitors, to withstand a regime of frequent fire. Fire functions to encourage establishment of oak regeneration by: (1) creating favorable conditions for acorn caching by squirrels and bluejays, (2) reducing populations of insects which prey on acorns and young oak seedlings, (3) xerifying mesic sites through consumption of surface organic materials and exposure of the soil to greater solar radiation, and (4) reducing understory and midstory competition from fire-intolerant species. The ability of oaks to continually resprout when numbers of other sprouting hardwoods have been reduced by fire may allow oak to accumulate in the advance regeneration pool. Improved root/shoot ratios resulting from frequent top-kill should enhance response of oak seedling/sprouts to release and enable them to dominate when stand-level disturbances create conditions favorable for rapid growth.

Literature suggests that periodic summer fires may favor oaks more. Suggests that a regime of frequent understory burns, both growing-season and winter burns during a period of 5 to 20 years prior to harvest should promote a favorable root/shoot ratio during oak seedling establishment. Fire would be withheld once an adequate number of oak seedling-sprouts are present and competing species have been reduced. Wildfire is a major cause of butt rot in hardwoods, but little info on relationship between stem damage and prescribed fires.

Two prescribed fires in the two years prior to a white oak acorn mast year prepared the seed bed and increased acorn establishment. Acorn establishment and biomass was positively correlated with light and negatively correlated with duff. Increased light and decreased duff were achieved by prescribed fire.


Prescribed fire was introduced after final overstory removal of a mixed hardwood forest in Connecticut. Oak seedling survival was about 90% for pre-burn seedlings under 6 ft., but red maple survival was only 45% for seedlings <3ft, 25% for seedlings 3-6 ft, and 0% for both oak and red maple over 6 ft.

Social Dynamics


Objective was to probe in depth the attitudes and beliefs relating to a "fire culture" in an area with high forest fire rates before a program of change was implemented. Specific aims were threefold: 1) to determine the attitudes and beliefs of persons in an area of high forest incendiarism toward forest conservation. 2) To determine the attitudes and beliefs of same persons toward forest agencies and their personnel. 3) To determine whether or not incendiarism represented a definite subculture within the local community. Study area in western Louisiana where a large percentage of the 60,000 acres was converted into pine plantation. Fifty percent owned by large companies; 33% of remainder by absentee landowners. About half of residents own cattle (7500 acres in local ownership). Each household head was interviewed.


This report looks at the social dynamics of arson-caused wildfires, or “woodsburning”. Of the 60,000 southern wildfires, 40% are started by woods-burners. Woods-burners are usually young white men, and their activities are often supported by peers and older men. Fire-prevention efforts need to address the fact that woods-burning is often supported in rural communities.

Soil

On the Cumberland Plateau, periodic fire may be necessary to maintain oak-dominated stands on xeric ridgetops. However, thin organic horizons and nutrient poor soils may limit the beneficial effects of fire by further reducing nutrient pools. The USDA Forest Service has reintroduced fire to oak-pine ridgetops in the Daniel Boone National Forest in the form of single, late winter prescribed burns. Objectives of this study were to document effects of single prescribed fires conducted in March 1995 and March 1996 on soil nutrients and microbial biomass. In 1996, forest floor mass was determined before and after fire. In 1995 and 1996, total and available nitrogen, total carbon, pH, extractable cations, and microbial biomass were measured pre-burn and throughout the year after burning on burned and unburned sites. Thirty-two percent of the litter layer (Oi) was combusted in 1996, while no loss of the Oe and Oa horizons was found. A transitory increase in available nitrogen was detected in burned mineral soils. Increases in pH by 0.2-0.3 units were measured in the burned organic horizons. Lower concentrations of extractable cations were measured in burned soils than in unburned soils. Fire had a positive effect on active bacterial biomass, but no effect on fungal biomass. Our study suggests that single, late winter prescribed fire had minimal effects on belowground resources in these ridgetop ecosystems. Since repeated burning might be necessary to promote oak regeneration, future research must address the effects of repeated burning on soil resources.


The effects of a single, dormant season prescribed fire on soil enzyme activity in oak-hickory (*Quercus-Carya*) forests in southern Ohio, USA, were assessed. Single, dormant season fires may consume a large proportion of the forest floor and change the apparent character of the surface organic matter complex without having major effects on soil enzyme activity.


This study examined the effects of annual and periodic fire on soil organic C and activity rates of soil enzymes over a 5-year period in southern Ohio. Fire increased acid phosphate and beta glucosidase, decreased phenol oxidase, and had little effect on chitinase activity. These conditions indicate a shift to relatively slow nutrient recycling, low microbial activity and recalcitrant organic matter, much like what is believed to have existed prior to a century of atmospheric deposition and fire suppression. These results suggest that prescribed fire can be a significant aid in restoring mixed oak forests to pre-settlement soil conditions.


Changes in aboveground and forest floor mass, carbon (C), and nitrogen (N) pools were quantified on three sites in the southern Appalachians 2 yr after felling and burning. Before felling and burning, stands were characterized by sparse overstories and dense *Kalmia latifolia* L. understories. Two years after burning, foliar C and N pools had reached 25% and 29% of pretreatment levels, respectively. Foliar N concentrations were not different from pretreatment values. Standing wood C and N pools
were 1% and 2%, respectively, of pretreatment values. Wood N concentrations were significantly higher on two sites, likely related to differences in fire intensity. Forest floor N content 2 yr after burning was 90% of pretreatment levels, most contained in unconsumed large woody material. Forest floor mass was significantly lower in the Oi layer and unchanged in the Oe + Oa layers. Forest floor N concentrations were generally lower after treatment. The site with the least intense fire and the lowest mass loss from the forest floor had the highest forest floor, foliage, and wood N concentrations 2 yr after burning. Site recovery after felling and burning was a function of fire severity and the capacity for site-nutrient retention through plant uptake.


The effects of a single low- to moderate-intensity burn on forest floor mass, carbon (C), and nitrogen (N); soil nutrient (NO\textsubscript{3}, NH\textsubscript{4}, PO\textsubscript{4}, Ca, Mg, and K) availability; and vegetation mortality and regeneration were evaluated in a cove-hardwood forest in western North Carolina. Burning resulted in increased exchangeable K, Ca, mg, NH4, PO4, and NO3 availability compared to the control. There were no significant differences after one year. (See “Fuel”, “Seedling Establishment” and “Stand Structure”)


Burns were intended to restore shortleaf mixed-oak forests with more diverse understories in southeastern Tennessee and northern Georgia. Two burn and two control sites evaluated effects of burning on water quality weekly for 10 months following a prescribed fire. Low-severity and low-intensity fires had no significant impact on soil solution, including PO\textsubscript{4}, SO\textsubscript{4},Ca\textsuperscript{2+}, Mg\textsuperscript{2+}, K\textsuperscript{+} and pH. (See “Stand Structure”, “Soil” and “Water”)


Three paired watersheds treated with fell and burn prescriptions were studied to determine the effects on soil, soil water, and stream water. Soil nitrification and mineralization were measured by in situ closed-core incubation. Soil water was collected with porous cup lysimeters placed at 30 and 60 cm depths, and water samples were collected from streams draining control and burned areas on one of the three sites. All data were collected for 6 months prior to and 12 months after treatment. Soil ammonium (NH4) content increased significantly in all three sites after burning, but the magnitude differed greatly among sites. However, there was no change in soil nitrate (NO3) content. In situ measurements of net mineralization showed increased rates with increasing burn severity. Net nitrification displayed no treatment response. Slight and non-significant increases in soil water NO3 concentration occurred after burning in two of the three sites. Stream water NO3 concentrations increased in the one stream sampled. Thus, while prescribed burning increased available soil N, there was little change in N transformation rates or movement of dissolved inorganic N off site during the first year after burning.

This paper reports changes in fuel accumulation, soil, and hardwood regeneration which have occurred since controlled burning started in 1963. Approximately 16 acres on the eastern Highland Rim of Tennessee were used for fire study. Examined effects of annual and periodic (every 5 years) surface fires on characteristics of the overstory, hardwood reproduction, herbaceous and shrub vegetation, fuel accumulation, and soil in a hardwood forest. Prescribed burns occurred in late winter. No significant differences were found among treatments with regard to soil pH or available phosphorus. Available potassium appeared to increase on the control plots. A comparison between samples taken before and after the 1971 burn, of the upper 1 inch of soil on annual burn plots showed no change in soil pH or available phosphorus, but available potassium was considerably lower following this burn. Differences in bulk density among treatments were not significant.


Seasonal levels of extractable ammonium and nitrate in the surface soil of oak-hickory (Quercus spp. and Carya spp.) forest plots subjected to 30 yr of annual and periodic (4-yr) prescribed burning were studied. Laboratory incubations were also carried out for 4-, 14- and 28-d periods at each of six dates to determine the effect of the burning treatments on mineralizable N. Ammonium was the predominant N form regardless of treatment. Burning significantly (p=0.05) reduced quantities of extractable NH4+ over all sampling dates, with annual burning resulting in lower amounts than burning every 4 yr. Burning also significantly reduced the quantity of N mineralized during incubation. Since previous studies have not shown decreases in total N on the burned plots, the lower extractable N concentrations appear to be the result of an adverse effect of long-term burning on substrate quality that reduced rates of mineralization. The treatment influence on mineralizable N was more apparent during the latter 24 d of laboratory incubation, whereas the initial 4 d reflected the influence of sampling date to a greater degree. From this pattern, it is hypothesized that the initial 4 d of incubation are more indicative of field environmental conditions, whereas the latter 24 d reflect the quantity of mineralizable substrate present. Although treatment differences in extractable and mineralizable N were statistically significant overall, the lack of statistical differences at some dates indicates the importance of seasonal sampling.

Stand Structure and Effects of Fire Exclusion


Pre-settlement, red maple was minor component of most eastern US forests. During the 20th century red maple has dramatically increased in numbers and size. Red maple exhibits characteristics of both early and late successional species. Fire suppression may be the cause for much of the increase in upland oak and pine forests. Also increase of white-tailed deer populations have increased herbivory of oak foliage and acorns. Deer may also browse red maple, but impact on oaks appears to be more severe. Gypsy moth prefer oak to red maple. Red maple seeds germinate soon after dissemination in the spring and early summer. seeds that fall under a dense overstory canopy may not germinate until the second year. Red maple becomes sexually mature at 4-10 years, are prolific seed producers and are
highly shade tolerant. Red maple seems to do many things reasonably well in a wide variety of habitats and ecological conditions.


This study evaluates the affects of two 1x-burned and one 2x-burned prescribed fires on herb, shrub, and tree strata in the oak/pine ridges in the Cumberland Plateau of Kentucky. Prior to burning, the overstory was oak dominated and the midstory was dominated by red maple and black gum. Stems 2-10cm were reduced 60% and 80% by single and repeated fire, respectively. Stump sprouting was promoted by fire, though sprout density was less on the 2x-burned than the 1-x burned site. Species richness in all strata increased from 19 in the control to 35 in the 2x-burned sites. Periodic prescribed fire may reduce regeneration of red maple and other non-oak competitors, enough to promote chestnut oak regeneration.


Single prescribed fires were conducted on three different ridgetops in Oak/pine forests on the Cumberland Plateau, Kentucky. The diameter and crown of white pine were evaluated prior to burning, two-growing seasons and three growing seasons post-burn. Nearly all white pine <2cm DBH were killed by a single fire, and significant mortality was measured in size classes up to 6cm DBH. Post-burn white pine recruitment was high, resulting in a shift in age structure, but not affecting long-term species composition.


This research studied the affect of fire over nine years on fire-excluded, 2x and 3x burned stands. Overall mid-story density and basal area were reduced 91% and 86%, respectively, compared to 28% and 24% on fire-excluded sites. Burning reduced overstory stem density by 30%, whereas fire-excluded sites had a 10% decrease in basal area. Burning reduced mid-story red maple density 94% and oak 82%. Multiple prescribed fires successfully reduced midstory densities of fire-sensitive species such as red maple, but also negatively affected oaks.


This study examined the effect of prescribed burning of shelterwood stands on bole damage and crown decline. There were four treatments, all applied in stands that were partially harvested 2 to 4 years earlier: unburned control, spring burn, summer burn and winter burn. Hickories, oaks and yellow-poplar were relatively unaffected by winter and summer burns. Bole damage and crown decline occurred after spring burning, and was closely associated with logging slash around the tree base; thus, removal of slash from around the tree base should minimize injury to these tree species. American beech and red maple declined after all fire treatments, regardless of season.

In the Piedmont region three years following a shelterwood cut, prescribed fire was applied as a winter, spring, or summer burn. Three years following the fires, oak density and stocking were higher in burned than control, while yellow poplar was higher in the control. Areas treated with spring high-intensity burns will develop into oak-dominated stands after just one burn. Areas with low-intensity or no fire become dominated by yellow-poplar. Other combinations of fire intensity and season-of-burn produced mixed hardwood stands with varying proportions of oak.


This study examined the effect of single and multiple prescribed fires on forest stand structure and the subsequent impacts on gap fraction and oak regeneration. Overall midstory density was correlated with fire frequency; each additional fire reduced stem density about 550 stems/ha. In the first growing season after fire, understory gap fraction increased 3.8%, but was reduced the next year due. The gap fraction decrease coincided with an increase in shrub stem density 2000 stems/ha/yr.


Riparian-cove (low-slope), mixed-oak (mid-slope), and pine/hardwood (ridge) communities were evaluated after one fire. Overstory mortality was 31% and understory shrub mortality was 90% at the ridges. Overall mortality at mid-slope was only 3%, and was not significant at low-slope. On the ridges diversity of understory shrubs increased while overstory diversity decreased. On the mid-slope understory diversity decreased, and no other changes were evident. (See “Herbaceous Vegetation”)


The effects of a single low- to moderate-intensity burn on forest floor mass, carbon (C), and nitrogen (N); soil nutrient (NO$_3$-N, NH$_4$-N, PO$_4$-P, Ca, Mg, and K) availability and vegetation mortality and regeneration were evaluated in a cove-hardwood forest in western North Carolina. Total overstory mortality was 55%, however most of this mortality was found in trees <10cm DBH; overstory basal area was only reduced 18%. All understory stems were killed, though 50% sprouted the following growing season. 40% of red maple stem regeneration was from understory sprouting, and 49% from overstory sprouting. (See “Fuel”, “Seedling Establishment” and “Soil”)

After a single dormant season fire overstory basal area of Pinus strobus was reduced 50% and its density reduced 20%. Overstory mortality of hardwoods occurred in small size classes, but most mortality was in Pinus echinata and Pinus virginiana Miller due to bark beetle infestations. (See “Seedling Establishment”, “Soil” and “Water”)


Examines the effects of prescribed burning (1x and 2x), herbicide application and thinning treatments in upland oak stands. Two site types examined in the study were sites with oak overstory and understory, and sites with oak overstory and sugar maple understory. Structural changes were more pronounced than compositional changes, and thinning of the canopy was generally necessary for the understory to respond to burning. Burning did not affect stems >3.8 cm DBH. Density of most woody species <3.8 cm DBH decreased with burning, but density was increased with burning and thinning, suggesting that burning prior to thinning may be an effective method for controlling sugar maple invasion into upland oak stands. Species diversity of all strata were unaffected by the treatments. These authors conclude that despite the major role played by fire in upland forest dynamics prior to European settlement, forest structure and composition can not now be controlled by fire.


The composition and structure of two black oak woodlands in northwestern Indiana are examined. Current conditions are compared with those existing in the early 1800s, based on public land survey records of the two areas. Fire histories during the past 50 yr are reconstructed from fire scars, age-class distributions, and fire-control records. On the basis of this information, we concluded that frequency and intensity of fire strongly influence stand structure and succession in these black oak woodlands. The stand with frequent, low-intensity fires (about every 5.2 yr) had only oaks >5 cm dbh. The stand with infrequent, higher intensity fire (every 11.1 yr) had red maple, sassafras, and Nyssa additionally in the overstory.


Three spring prescribed fire treatments from 1995 to 2002: control, 2x- and 4x-burned, on sites classified as xeric, intermediate, and mesic moisture classes. Prior to burning red maple was abundant in mid-story and dominated the sapling layer, oak and hickory were dominant in the overstory. Density and basal area of trees >25 cm DBH was not affected by fire. Density of trees 10-25 cm DBH was reduced 31% on 2x-burned, and 19% on 4x-burned sites. Fire reduced small diameter red maple 33%, white oak 17%, hickory 13%, black gum 10%, and sugar maple 4%, though, canopy openness remained <6%. Fire alone failed to improve oak regeneration consistently, but repeated fire reduced stand density and may be effective if applied periodically over the long-term. (See “Seedling Establishment”)

This study investigated the ecology of a dry talus slope in southeastern Pennsylvania dominated by old-growth chestnut oak. Red maple was the only canopy species significantly present as a sapling. Chestnut oak was recruited from 1625-1920. Peak recruitment was associated with disturbance. The decline of disturbance and American chestnut facilitated the establishment of birch and red maple in the understory. This study indicates the possibility of oak replacement by more tolerant species on climax sites.


The authors describe the changing fire regime over the past 60 years, and demonstrate the significant and large-scale changes to vegetation composition across the US as a result of the decreased frequency of burning during that period. They make the point that as the process of shade-tolerant mesophytic species continue to expand site-dominance, the effort and cost of restoring fire-adapted ecosystems will increase dramatically and quickly.


This study compared stands at the National Guard Training Center in Pennsylvania that had been burned since the 1980’s with unburned stands. Burned sites had lower tree density and a higher proportion of overstory oak (64-92% importance value) than unburned stands (47-49% importance value). Red maple had an overstory importance of only 7% in burned stands compared to 24% in unburned. (See “Seedling Establishment”)


This paper reports changes in fuel accumulation, soil, and hardwood regeneration which have occurred since controlled burning started in 1963. Approximately 16 acres on the eastern Highland Rim of Tennessee were used for fire study. Examined effects of annual and periodic (every 5 years) surface fires on characteristics of the overstory, hardwood reproduction, herbaceous and shrub vegetation, fuel accumulation, and soil in a hardwood forest. Prescribed burns occurred in late winter. Results from annual and periodic (every 5 years) burn plots located on the eastern Highland Rim of Tennessee showed a significantly greater number of understory hardwood stems per acre on the annual (13,051) and periodic (12,540) burn plots than on the control plots (8,070). Southern red oak, post, and scarlet oak comprised over 50 percent of the stems in 1970. Number of stems per clump and clumps per acre increased on the burned plots. Both burn treatments had significantly higher number of stems of understory hardwood species than the control, most stems were of sprout origin, southern red oak and post oak had almost twice as many stems/acre on burned plots, sassafras was exceptionally higher on periodic burn treatment,

**Water**

Compared stream nitrate-nitrogen response to a stand-replacement fire, fell-and-burn prescription and an old-growth forest wildfire. Stream nitrate-nitrogen concentration increased and stayed elevated for 8 weeks after a fell-and-burn prescription fire. Stream NO increased 2 weeks after an old-growth wildfire, and remained elevated 6 weeks. The stand replacement fire exhibited no significant differences due to maintenance of a riparian buffer. The magnitude of stream N response in the old-growth stand suggests a release of unavailable recalcitrant forms of N, and an inefficiency of old-growth forests at sequestration of mobilized nutrients. In all cases, hydrologic losses NO$_3$-N were insignificant with respect to effects on water quality and site depletion on N.


Burns were intended to restore shortleaf mixed-oak forests with more diverse understories in southeastern Tennessee and northern Georgia. Two burn and two control sites evaluated effects of burning on water quality weekly for 10 months following a prescribed fire. Low-severity and low-intensity fires had no impact on streamwater nutrient concentrations and streamwater sediment concentrations. (See “Seedling Establishment”, “Soil” and “Stand Structure”)

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