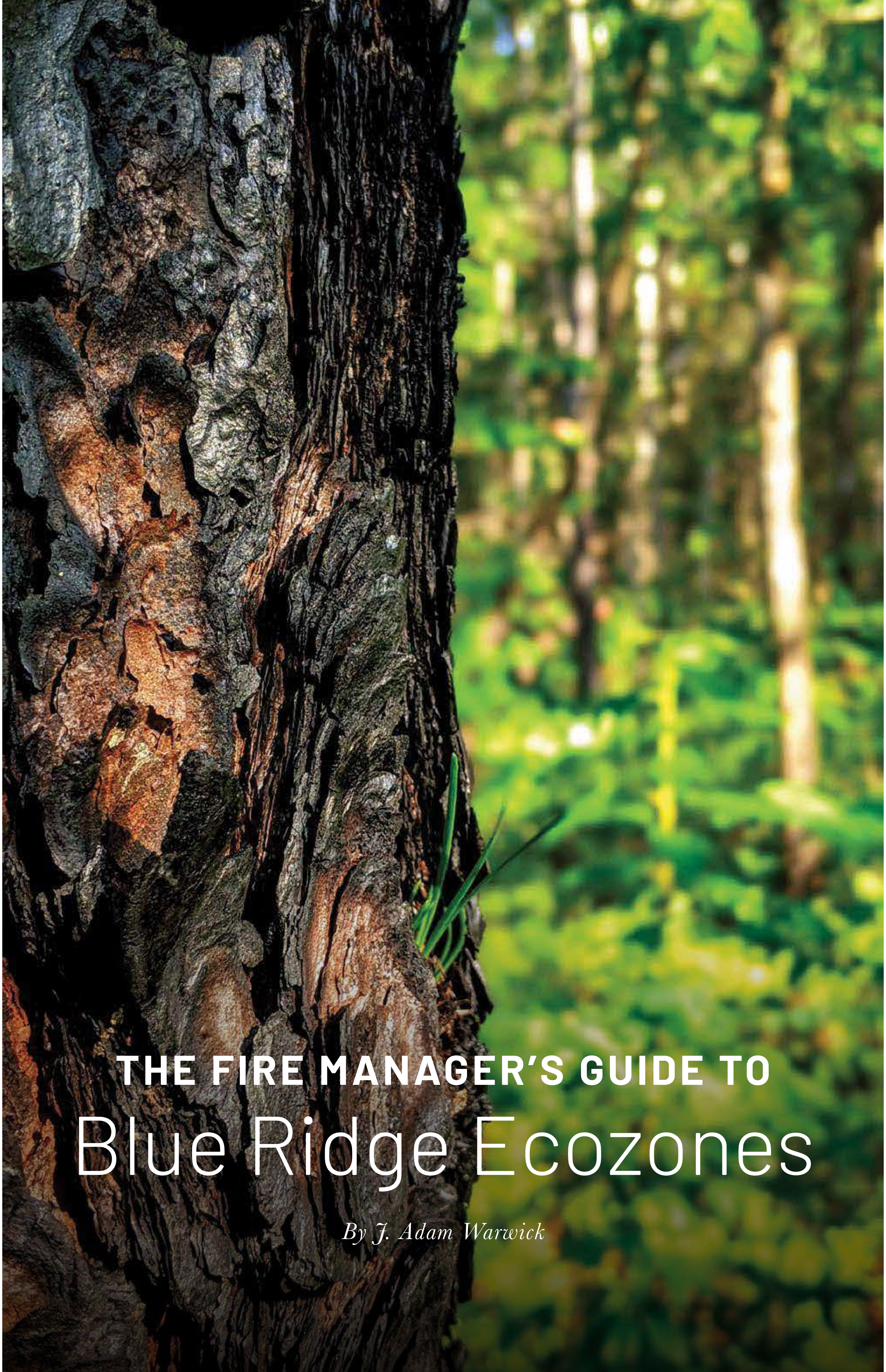

THE FIRE MANAGER'S GUIDE TO

Blue Ridge Ecozones

By J. Adam Warwick

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Written by J. Adam Warwick
Design by Chelsea Broderick
Maps by Greg Cooper

Advisory Committee:
Pete Bates, Western Carolina University and Forest Stewards
Gary Kaufmann, USDA Forest Service
Josh Kelly, MountainTrue
Ed Schwartzman, Joe Pye Ecological Services
Lesley Starke, North Carolina Department of Agriculture

Additional technical review by:
Margit Bucher, Greg Cooper, Liz Kalies, Jean Lorber, Katherine Medlock and Megan Sutton
— The Nature Conservancy
Ryan Jacobs and Dean Simon (retired)
— North Carolina Wildlife Resources Commission
Matt Keyes and Rachel Dickson
— USDA Forest Service

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The Southern Blue Ridge Mountains can provide an ensemble you won't hear at a backyard bird feeder. Pine warblers, chestnut-sided warblers, indigo buntings and yellow-breasted chats are a chorus everyone should be able to experience. As you venture off the trail, the crunchy pine needles and oak leaves are a signal for skinks and fence lizards to dash from their sunning spots. The air is a little different — crisper than you might expect in the mountains — and the pollinators; so many flowers, with bees and butterflies even the most prolific pollinator gardens can't match. Sunlight beams through an open tree canopy falling on little bluestem, asters, Joe-Pye weed and goldenrod. It's not the most hospitable environment for people, July especially, but it is the ideal home for many of our native plants and animals. Once you have visited one of these places, you won't see Blue Ridge forests the same.

Sites like this are rare in the mountains, as are many of the plants and animals that depend on them. They contribute immensely to biodiversity — the essence of the Southern Blue Ridge. From broad river valleys to the spruce fir, the infinite blend of aspect, elevation and soil support one of the world's most botanically rich places. These diverse environments beget unique natural communities subjected to continually changing processes, or disturbances, that further define the species and structure of the vegetation.

While these mountains have changed over time and woods-burning culture has waned, the potential for fire remains. It is a disturbance that will forever be a part of this environment. Fire has been a fundamental influence on the Blue Ridge landscape; it once sustained open forests, woodlands, shrublands and grasslands in some cases. Where fire occurs regularly, it governs species persistence and dominance as well as size and shape; and if, when and how a species reproduces. If humans allow it, fire-prone environments help to sustain ruffed grouse, timber rattlesnakes, shortleaf pine and white oak.

Blue Ridge Mountains © Dennis Oakley ◀

FIRE IN THE MOUNTAINS

Explorers' journals describe the ways that the native Appalachian people harnessed fire and used it to sustain food and medicinal plants, among the many purposes. Tree rings have recorded the years and even seasons when fire occurred, as far back as the 1600s. Buried charcoal and microscopic pollen help portray the evolution of pine- and oak-dominated communities over thousands of years, from which we can estimate fire frequency and relative forest openness. Traits of plants present today, such as thick bark, serotinous cones, sprouting capacity and combustible leaves indicate sites that are most receptive to fire.

The Appalachians historical fire regime was complex, but evidence suggests fire was frequent, typically low- to moderate-intensity fire in pine and oak forests. This fire regime has been altered because of land management policies adopted in the early 1900s and subsequent reforestation. Distinctive plants and animals have disappeared, and exotic plants and animals have harmed populations of economically, culturally and environmentally important species; and fire became an enemy that has been fought for more than 100 years.

We are bringing fire back to the mountains. The Southern Blue Ridge Fire Learning Network was formed in 2007; the goal is to build and maintain healthy and resilient

Low-intensity fire in Pine-Oak Heath ▲

ecosystems for the future of people and for the lands and waters in which we live. Guided by science and cultural history, fire is prescribed for ecological health. We learn from management actions and share what we observe to collectively adapt and hone fire management strategies.

Land management agencies, nongovernmental conservation organizations and private landowners are increasingly interested in restoring fire to montane pine and oak ecosystems. Where managers have implemented burning programs to restore ecologically appropriate conditions, the results are evident from sights and sounds. The difference between pine and oak-hickory forest that has been managed, compared to unmanaged sites, is quite noticeable. Decades of research from the Central Hardwood Region provides a solid framework for understanding the Appalachians' fire-dependent communities and how to conserve them. Plant and animal communities seem to come to life when sunlight can penetrate the tree canopy, and science solidly supports the value of restoring fire to fire-dependent natural communities. Fire creates diversity of light and moisture environments, productive groundcover and thus diverse life forms.

HIGH-INTENSITY CATASTROPHIC FIRE

Live and dead vegetation accumulate when fire is suppressed. Moisture evaporates from living plants and large logs during dry spells and can lead to hotter fires and tree mortality.

FORESTS OUT OF WHACK

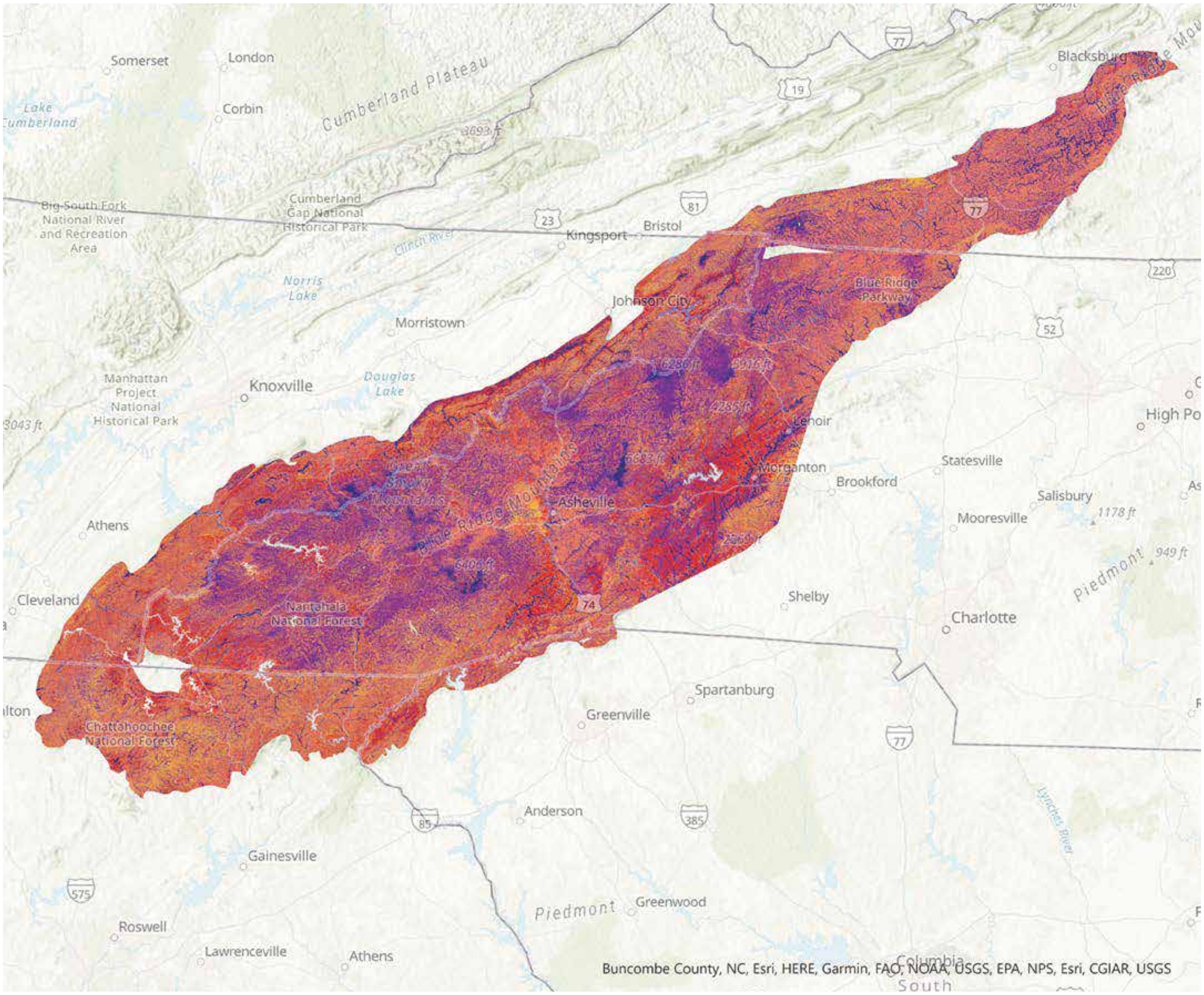
The effects of fire on vegetation is often considered in terms of **succession** — the change of a biological community over time. Almost invariably, it is defined as ecosystem development from barren ground towards a climax forest; predictable stages appear over time, each with characteristic plant assemblages — grass-forb, shrub, young forest, mature forest and climax forest. **Secondary succession** then follows a severe fire or catastrophic event that kills most of the vegetation. This does not appear to have been common or widespread in the southern U.S. over the past several thousand years, as opposed to lodgepole pine or boreal spruce forests of the West and North, respectively, where large areas of forests burn in stand-replacement fires. The South's historic fire regimes (frequency, seasonality, intensity) did not often result in vast areas of tree mortality. It occurred often enough to limit heavy fuel accumulation and woody understory, which could otherwise contribute to high fire intensity. Fire-adapted plants are fertilized via the minerals and nutrients returned to the soil as ash. Sunlight invigorates blueberries, turkeybeard and Table Mountain pine, which supports biodiversity and ecosystem services.

FREQUENT LOW-INTENSITY FIRE

Fire is generally limited to low or moderate intensity when it occurs regularly. Routine fire, whether controlled or uncontrolled, limits the accumulation of heavy brush and dead plant material and promotes small, fine fuel such as grasses and forbs.

The fire regime shapes the structure and composition of vegetation to promote stability, although a range of conditions *(Historic Range of Variation, or HRV)* could be present. Some vegetation today known as "early successional" would have historically been abundant in open forests and woodlands, along with long-lived, light-loving herbs such as legumes as well as shrubs that benefit from frequent fire. Today, fire is less frequent and tree mortality can be severe when long-accumulating fuels ignite during dry periods.

Fire suppression has also allowed for the **mesophication** of forests, wherein shade-tolerant vegetation, otherwise precluded by frequent fire, gradually replaces fire-adapted plants. Succession in the absence of fire has led to greater tree and shrub density, and overall cooler and wetter conditions in fire-adapted ecozones. The characteristically dense crowns of mesophytic trees can impede nearly all light penetration, and these trees produce less-flammable leaves that disintegrate. This can increase soil acidity, which may limit the nutrients available to trees and herbaceous plants.



PURPOSE AND NEED

The diversity of the Appalachians does not allow for an instruction book from which strategies and actions can be copied and pasted; nor should any activity be applied without considering specific site conditions. Fire science in the Blue Ridge Mountains is relatively young, so we continue to study the ways of original Appalachian people and learn by burning. Not all information can be provided definitively, but nature will not wait for science to reach complete certainty. This book integrates both science and fire managers' experience to characterize the complexity and considerations for managing montane fire-adapted environments. Fire practitioners will benefit from science translated and consolidated into usable guidance to aid planning and implementation. Those who are new to mountain woods burning will have a reference to become familiar with nuanced biophysical relationships to serve as a foundation for developing fire management programs.

The Southern Blue Ridge Fire Learning Network has identified and prioritized six fire-dependent **ecozones (ecological zones)** — areas that support plant and animal communities characteristic of the local environment. Ecozone maps reflect and model vegetation patterns and complex, interrelated physical factors that determine the vegetation we expect to be present, including: elevation, aspect and solar exposure, geology, landform, variable temperature, and soil chemistry and moisture. Some of the Appalachians distinct ecozones —

HIGH

FIRE FREQUENCY ACROSS SOUTHERN BLUE RIDGE ECOZONES

ECOLOGICAL ZONE	APPROXIMATE FIRE RETURN INTERVAL (YEARS)
PINE-OAK HEATH	3-7
SHORTLEAF PINE-OAK	3-7
DRY OAK	5-12
DRY-MESIC OAK	12-15
MESIC OAK	20-25
HIGH ELEVATION RED OAK	20-25

LOW — None of the ecozones described in this book would be represented by the lowest "blue" frequency.

Source: LANDFIRE

verdant cove forests, northern hardwoods and spruce fir — are home to unique species not adapted to frequent fire. These communities are not prioritized in efforts to restore fire.

Six ecozones need fire to sustain the flora and fauna that evolved to live in them. This book profiles the distinctly fire-adapted **Pine-Oak Heath** and **Shortleaf Pine-Oak** ecozones — situated on dry, exposed sites of south- and west-facing slopes, and dominated by pines and fire-loving plants. Chestnut oak dominates the canopy of the **Dry Oak** ecozone, but American chestnut was historically codominant. Fire once maintained an open canopy; grasses, forbs and combustible oak leaves carried fire and perpetuated oak dominance across the eastern U.S. **Dry-Mesic Oak** and **Mesic Oak** cover more of the Southern Blue Ridge than any other ecozones, generally occupying protected slopes with moderate solar exposure. Oak and a broad range of hardwoods thrive in a wide variety of soil conditions, ranging from acidic to basic in these species-rich ecozones. The physical setting and plant assemblages of **High-Elevation Red Oak** suggest less-frequent fire, but much remains to be learned about the ecology and natural history. Oak canopy dominance is indicative of fire's influence, historically. Embedded throughout these ecozones are fens, bogs, and seeps, rocky bluffs and summits, glades and barrens differentially influenced by fire.

TOP: Shortleaf Pine-Oak woodland three- to five-year burn interval. Pine Mountain, Sumter National Forest, South Carolina. ▶

BOTTOM: Fire-excluded Shortleaf Pine-Oak forest. ▶

ECOLOGICAL CONCEPTS

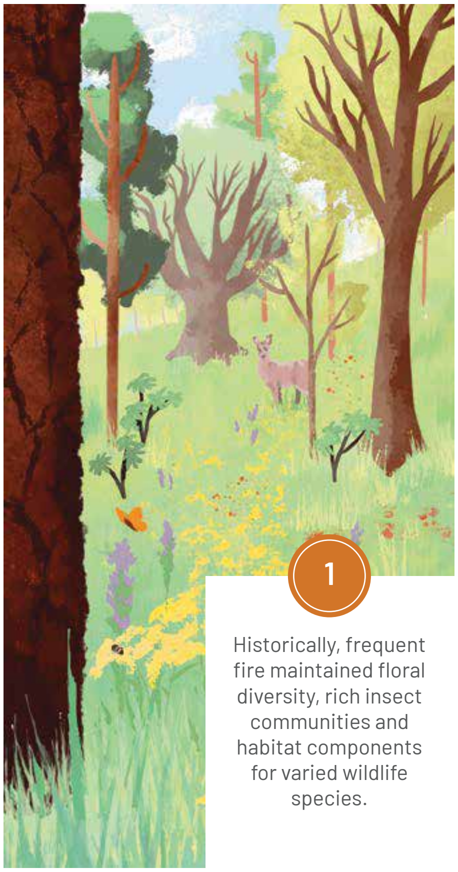
The historical extent of Blue Ridge forest and woodland is not well understood. It was undoubtedly variable over time, with varying climatic and human influence. Precise definitions are less important in defining woodland conditions than is the maintenance of a light regime that meets the photosynthetic demands of many native plants. Nevertheless, the terms are useful in helping define management goals. For purposes of this book, **forest** is defined as an area dominated by trees with greater than 90% canopy closure — generally with multiple layers of shade-tolerant trees in the subcanopy and a variable blend of shrubs, vines, ferns and forbs, depending on soil chemistry and drainage.

An **open woodland** could be expected in the Dry Oak, Shortleaf Pine-Oak, and Pine-Oak Heath ecozones where fire occurs regularly. Such areas are defined by an open canopy ranging from 40% to 80% coverage. Historically, frequent low- to moderate-intensity fire contributed to the maintenance of open woodland conditions where the fire-adapted trees persist, with some damaged and succumbing to injury over time. The midstory, if present, is sparse, so light-dependent grasses and forbs thrive. Soil chemistry is often overlooked, but it is important to consider when interpreting a vegetation response to fire, or whether fire exclusion is a basis for an observed proportion of herbs to shrubs, for example. Fire exclusion has made open woodlands rare in the Blue Ridge. The reality is that many such sites are forest or **closed woodland**, which is naturally characteristic of Dry-Mesic Oak and High Elevation Red Oak sites. Longer time is required for the leaf litter and other fine fuels of this ecozone to dry out enough to burn, and thus, they burn less often. Depending on soil nutrient availability and fire frequency, one could expect to find canopy cover around 80% to 90% in such sites, with more mature trees per acre than open woodland, and an understory with variable proportion of shrubs to herbs.

Within the broad spectrum of conditions in fire-prone environments exists variable plant assemblages, including both **fire-tolerant** and **fire-adapted** species. The bark of mature fire-tolerant trees is sufficient to resist injury from low-intensity fire. Fire-tolerant forbs, grasses and deciduous shrubs endure by sprouting after aboveground portions are topkilled. However, fire confers a competitive advantage for fire-adapted trees such as oaks and yellow pines. Dormant buds are situated below ground just deep enough to be insulated from heat, yet close enough to sprout soon after fire. Fire melts the resin that seals pine cones closed, and the seeds are released about two minutes after fire has passed, so that they fall on bare, but fertilized, ground that has cooled. Bluestems and other grasses seed prolifically, and basal meristems allow rapid regeneration, and growth after fire. Dense leaf litter inhibits regeneration and fire is needed to reduce litter depth. These plants need fire and have adapted to thrive in fire-prone environments, and the vast majority require abundant sunlight that fire maintains.

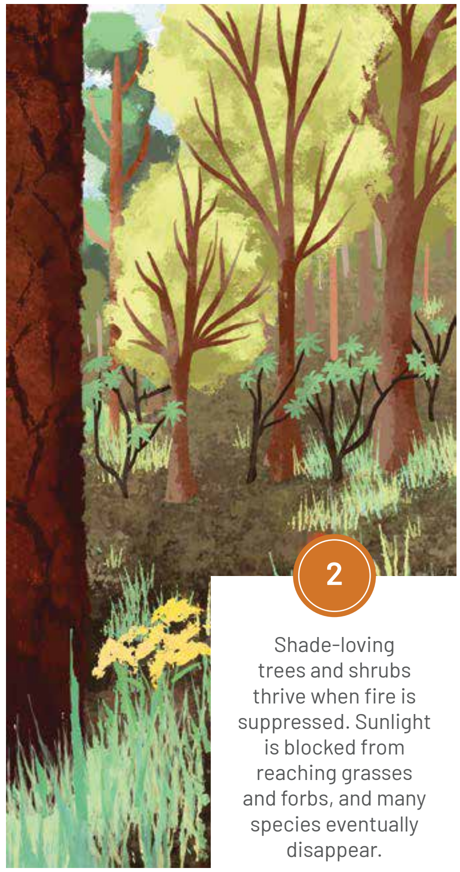
Although manager experience and literature have been synthesized for this book, using fire to restore ecologically appropriate vegetation is both art and science, and nascent relative to what we understand about fire in southern ecosystems. Research, monitoring and learning by burning will continue to inform and refine management.

Among the important considerations when reviewing and applying fire management guidance to Blue Ridge ecozones is **variability.** Defined boundaries between ecozones do not exist. It is unrealistic to capture the full extent of Appalachian diversity in a book, so consideration should be given to site-specific conditions when forecasting management outcomes. The dynamic equilibrium of each ecozone can create a range of possible outcomes. What do the soil, elevation and aspect indicate about the plant community we can expect to be present? How does the current appearance, composition and structure differ from what science and modeling suggest? How has land-use history influenced conditions? Which plants increase or decrease in the years following a burn? A partial list of plants that can be found in fire-adapted ecozones is provided to help with this, but there is no substitute for the insight that is gained from knowledge of a site and learning by burning.



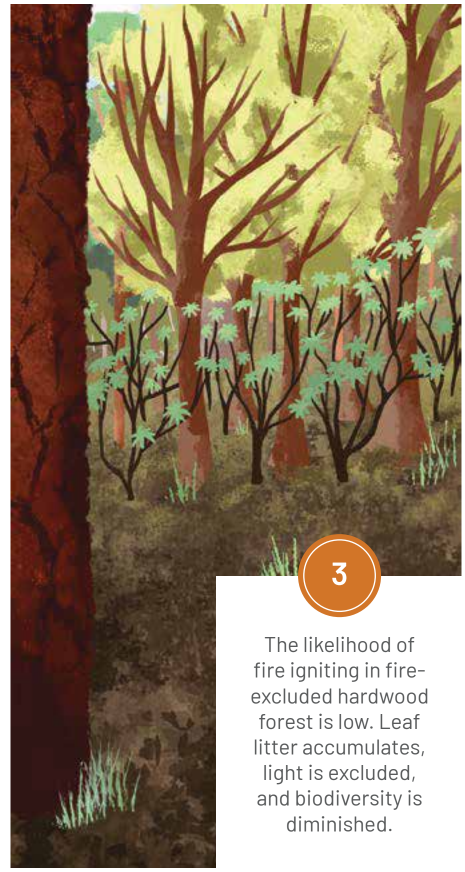
1

Historically, frequent fire maintained floral diversity, rich insect communities and habitat components for varied wildlife species.



2

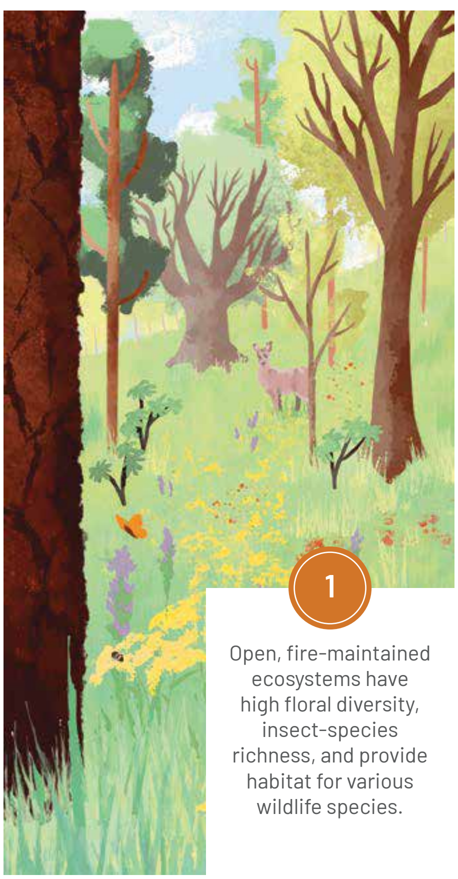
Shade-loving trees and shrubs thrive when fire is suppressed. Sunlight is blocked from reaching grasses and forbs, and many species eventually disappear.



3

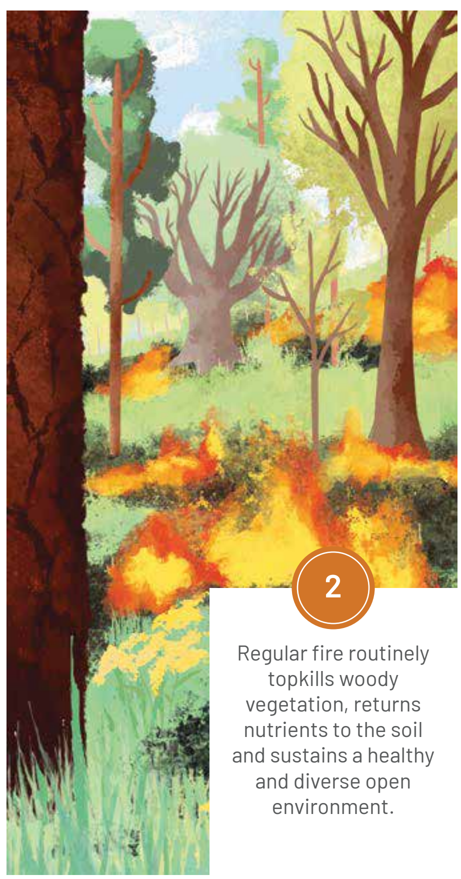
The likelihood of fire igniting in fire-excluded hardwood forest is low. Leaf litter accumulates, light is excluded, and biodiversity is diminished.

MESOPHICATION VS. REGULAR FIRE



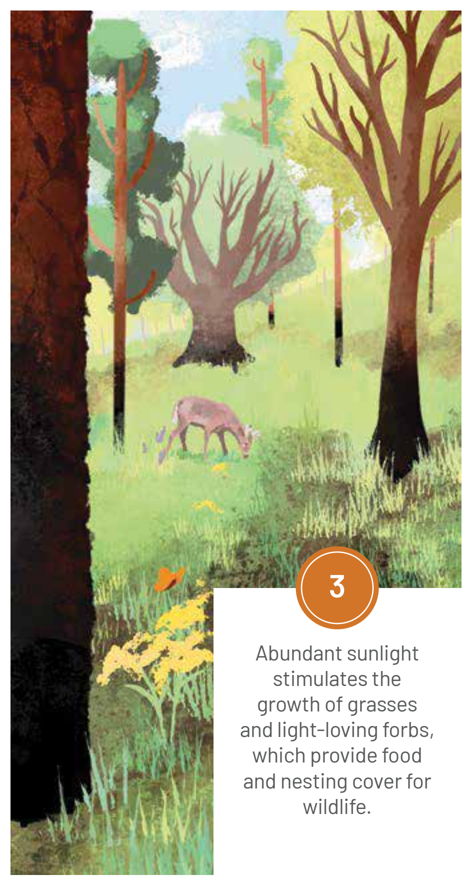
1

Open, fire-maintained ecosystems have high floral diversity, insect-species richness, and provide habitat for various wildlife species.



2

Regular fire routinely topkills woody vegetation, returns nutrients to the soil and sustains a healthy and diverse open environment.



3

Abundant sunlight stimulates the growth of grasses and light-loving forbs, which provide food and nesting cover for wildlife.

WHAT DOES RESTORATION LOOK LIKE?

Resilience is nature's ability to maintain species diversity, stability, and function as changes occur. Most southern ecosystems that have developed with frequent disturbance, such as fire, are resilient and recover quickly; some have become dependent on disturbance to remain stable and maintain biodiversity. A resilient ecosystem endures pest and disease outbreaks, drought and wildfire that threaten catastrophic effects for ecologically important landscapes. Fire is a disturbance process in the Appalachian ecosystem, with an important ecological restorative function: Unnaturally dense forest that develops in its absence increases competition for resources, which stresses trees. Plants have various strategies for compensating to endure stress, but additional stressors can be lethal to weakened trees.

Is it feasible to restore the conditions we believe to have existed 300 years ago? Rarely. However, reestablishing a range of diverse structure and composition (HRV) is achievable with fire. Managing ecozones toward a range of conditions is an appropriate strategy to regain resilience; and restoration will result from the gradual adjustment of the vegetation to the characteristic fire regime.

Reestablishing open conditions in fire-excluded sites may begin with burning as often as once per year. Frequent initial burning can jump-start the **restoration phase** and begin to reduce accumulated live and dead vegetation. A good restoration that topkills a majority of the undesirable shrubs and saplings can fertilize soil and provide some filtered sunlight to stimulate growth of suppressed plants. Well-established mesophytic trees are able to withstand low-intensity fire. In various instances, a second burn in less than two years, and mechanical or chemical vegetation management, have expedited achievement the **maintenance phase.**

Undesired or off-site species will continue to sprout, but appropriate burning regimes will gradually reduce their abundance, while fire-tolerant species should increase over time. Time, patience and even outplanting may be required for desired species to be reestablish. Upon reaching objectives for fuel reduction, light levels or vegetation structure, the subsequent burning should not require frequent fire to maintain open forests, though some treeless, herb-dominated areas may require such frequent fire. Objectives, site-specific conditions and vegetation response inform the ideal intervals for which fire should be repeated.

Low-intensity fire. ▲

Moderate-intensity fire. ▲

FIRE INTENSITY AND SEVERITY

Fire can affect species in different ways, and each species response can vary based on intensity and severity — terms that label observed fire behavior and measure its effect on vegetation and soil, respectively. Interchangeable use of these terms can be problematic because these measurements can be imprecise and interpreted differently among managers and scientists.

Fire intensity is the combustion or energy release from the burning of leaves, sticks and plants. The measurement is heat output per unit of time and related to flame height and duration of heating. These are readily observable features that allow a fire practitioner to assess potential **fire severity,** or the degree to which plants will be damaged or killed by fire and adjust firing accordingly. Severity measurements reveal information about above and below-ground organic matter consumption, or the relative change in vegetation as a result of fire.

Elevation, landform position, steepness of a slope, ambient air temperature, humidity, wind speed, fuel load and fuel moisture interact to determine the intensity of fire, which is relative to specific ecozones. *The Photo Guide for Estimating Fuel Loading in the Southern Appalachian Mountains* has been developed specifically to help fire managers estimate fuel loads in the Southern Appalachians' fire-excluded forests. A firefighter burning in Dry-Mesic Oak may judge 8-foot flame lengths to be moderate- to high-intensity, which may predict damage to white oak. Such fire behavior may be considered low- to moderate-intensity in Pine-Oak Heath where Table Mountain pines emerge unscathed. Subtle nuances among the ecozones challenge the forecasting of fire effects.

Low-intensity fire in Blue Ridge oak forests is generally characterized by flame length of less than 2 feet and typically results in low-severity effects. Very few canopy

High-intensity fire. © Dean Simon ▲

trees are killed or damaged, and leaf litter may not be completely consumed, with variable shrub and sapling topkill. However, severity is also influenced by flame duration. Short flame lengths with long residence time can often cause more severe fire effects than long flame lengths with a short duration of exposure to flames.

Three- to 6-foot flame lengths in oak forest are indicative of moderate-intensity fire. Midstory mortality is higher, and up to 20% of the canopy trees may be killed or damaged.

More severe effects such as soil organic matter consumption, altered soil structure and/or substantial tree mortality may result from high-intensity fire, which can occur during drought. But high-intensity fire does not always result in high-severity fire effects. Tree roots in duff exposed to high temperatures for long duration may be killed. Some management objectives may necessitate severe fire effects, but it is generally limited to areas where tree mortality is of less concern.

The complex relationships among topography, fuels, and weather, and fire intensity and severity does not limit Blue Ridge burning, but it can confound the achievement of specific objectives.

ECOLOGICAL ZONE

Oak Forest

DRY, DRY-MESIC AND MESIC OAK

ECOZONE	RESTORATION-FIRE FREQUENCY	MAINTENANCE-FIRE FREQUENCY
DRY OAK	2-4 YEARS	5-12 YEARS
DRY-MESIC OAK	2-7 YEARS	12-15 YEARS
MESIC OAK	2-7 YEARS	15-25 YEARS

Dry-Mesic Oak woodland burned every three to five years. Catoosa Wildlife Management Area, Tennessee ▲

EXTENT

Dry Oak 617,000 acres
Dry-Mesic Oak 2,142,000 acres
Mesic Oak 2,017,000 acres

ELEVATION

Dry Oak 1,200 – 4,000 feet
Dry-Mesic & Mesic Oak 1,200 – 4,500 feet

LANDFORM

Dry Oak Partially exposed sites, ridges, plateaus and steep, convex upper slopes.
Dry-Mesic & Mesic Oak Sheltered ridges, concave upper slopes and narrow coves.

CONTEXT

Dry Oak Southerly slopes generally upslope of Dry-Mesic Oak, often blending with Pine-Oak Heath and Shortleaf Pine-Oak.
Dry-Mesic Oak Intermixed with, or upslope of, Cove and Mesic Oak forest, and downslope of Dry Oak and/or Pine-Oak Heath.
Mesic Oak Intermixes with High-Elevation Red Oak from 3,500-4,500-foot elevation with subtle differences between them.

SOIL

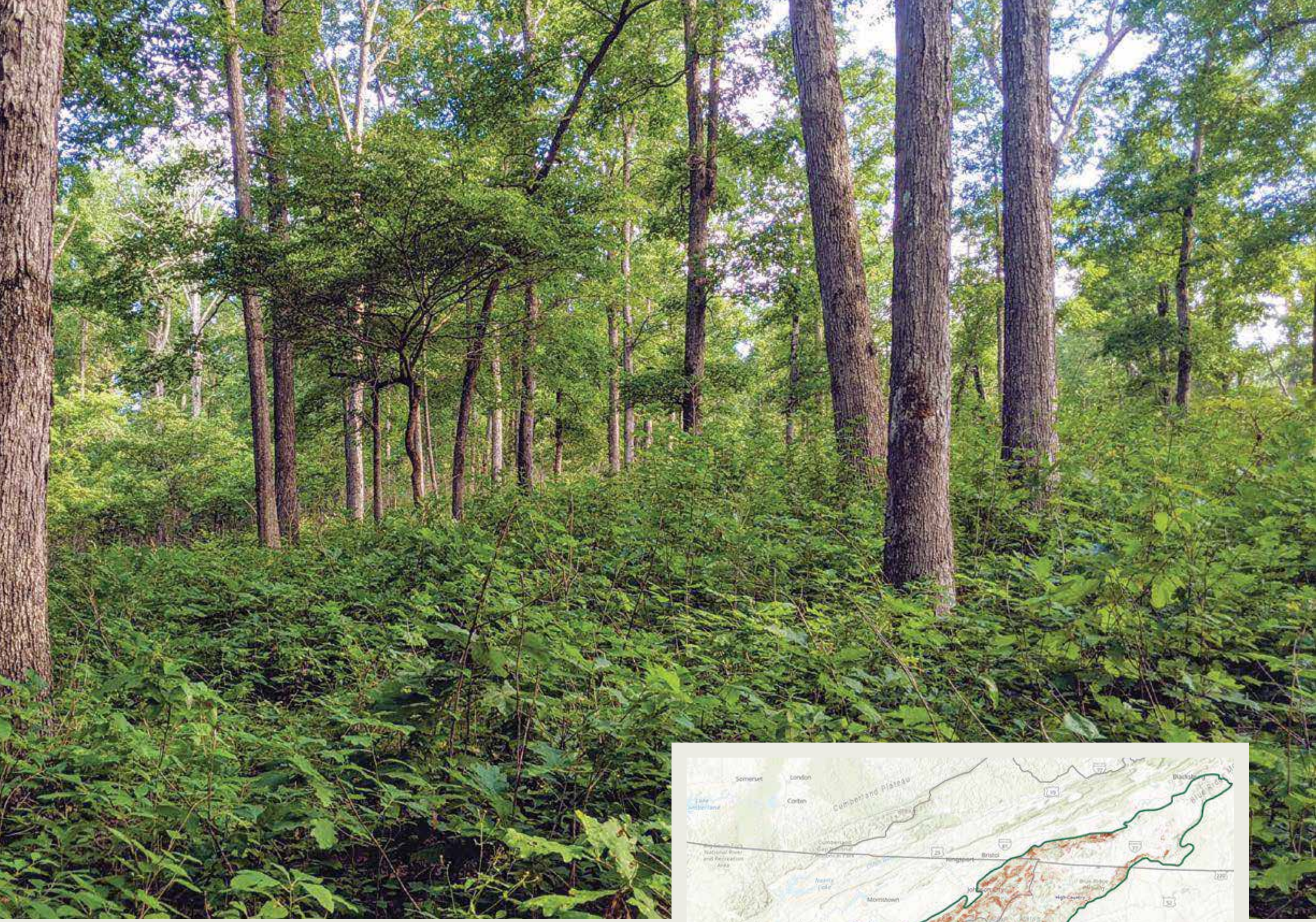
Dry Oak Rocky, generally acidic, well-drained with low fertility.
Dry-Mesic & Mesic Oak Broad pH range; well-drained, and moderate fertility.

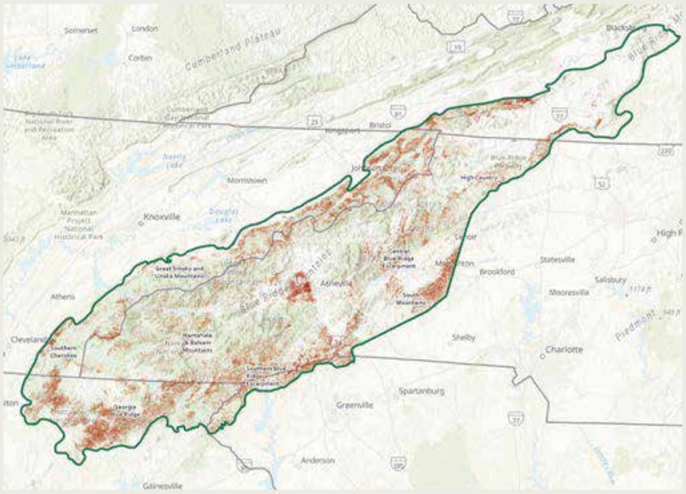
NATURAL DISTURBANCES

Fire, ice, wind, tree-fall, pests and disease.

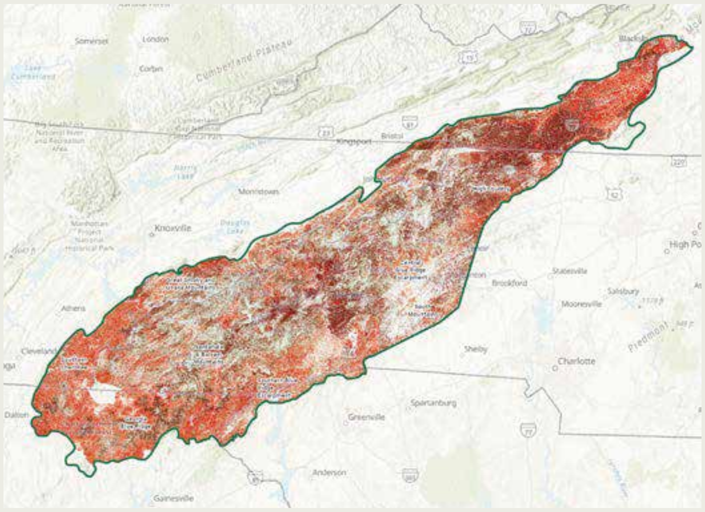
EMBEDDED COMMUNITIES

Cliffs, granitic domes, glades and barrens, Carolina hemlock bluffs, rocky summits.





DRY OAK ▶
The Southern Blue Ridge periphery: southwestern Georgia Blue Ridge and Southern Blue Ridge Escarpment landscapes; South Mountains and western flank of the Great Smoky and Unaka Mountains landscapes.

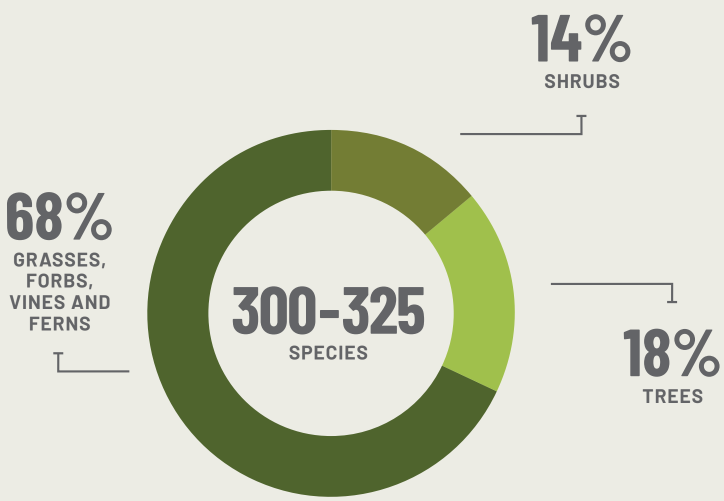


DRY-MESIC OAK (light red) & MESIC OAK (dark red) ◀
Throughout the Southern Blue Ridge but concentrated in the Georgia Blue Ridge Escarpment, Southern Blue Ridge Escarpment and the western Nantahala Balsam landscapes.

ECOLOGY

Dry Oak

Forest canopy is generally open and dominated by chestnut oak and scarlet oak, with variable blends of hickory species and white oak, shortleaf pine, red maple, blackgum, and Virginia and pitch pine. American chestnut may have occupied at least 25% of the canopy before blight. Understory structure and composition vary based on fire frequency, land-use history and biophysical setting.



DRY OAK COMPOSITION

Oak ecosystems have dominated the Blue Ridge since the earth began warming, and the periglacial spruce fir forests retreated around 10,000 years ago. Chestnut codominated throughout most Appalachian forest and woodland. Oak woodlands once burned frequently; a broken canopy allowed sunlight to support diverse herb ground cover that facilitated fire. Explorers described savannas and woodlands with abundant forbs and grasses and expansive lowland canebrakes that attracted deer, bison and elk.

Contemporary Dry Oak sites have a closed canopy, and evergreen shrub cover often exceed 50%. Herbaceous plants are a greater component in rich sites and frequently burned sites with canopy cover less than 70%. Mature oaks are present, but an increasingly dense variety of shade-loving, fire-intolerant trees and shrubs suppress herbaceous cover and plant diversity.

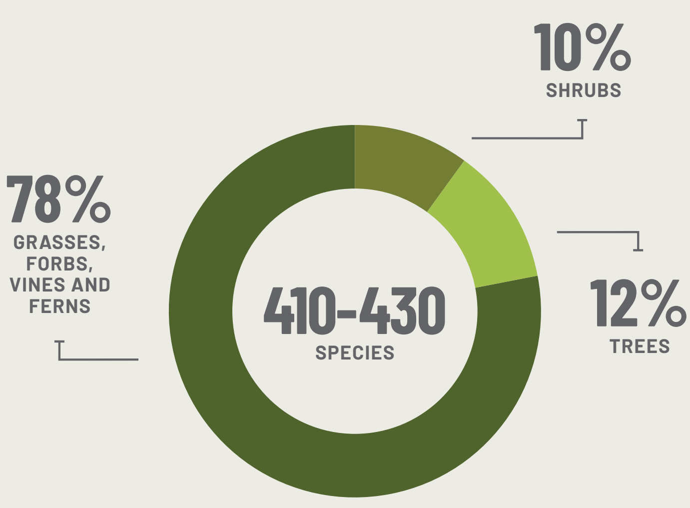
Oak woodlands and open forests provide copious ecosystem services: biodiversity that bolsters ecological resilience; habitat components for numerous plants and animals; and abundant, clean water that endures drought. Lower fuel loads in burned woodlands reduce the risk of wildfire.

Canopy following shelterwood and burn. © Chris Neggers ◀

Dry-Mesic Oak & Mesic Oak

These ecozones cover nearly half of the 9-million-acre Southern Blue Ridge. Mesic Oak is less fire-dependent, relatively — similar to that of High-Elevation Red Oak. White oak is a dominant canopy tree in Mesic Oak, whereas the dominant trees of Dry-Mesic Oak are often northern red oak, or one of scarlet oak, white oak, and black oak. Tree diversity is high in both ecozones, including several hickory species, red maple and numerous mesic hardwoods. White pine comprises a greater proportion of the forest canopy in the Southern Blue Ridge escarpment. Lower elevations generally have a greater proportion of shortleaf pine, southern red oak and post oak.

The herb diversity of Mesic Oak is very high with relatively fewer shrubs. However, if managed with regular fire, Dry-Mesic Oak may have similarly high understory diversity and structure; otherwise rhododendron and deciduous shrubs can dominate. Forb diversity is usually very high. Species composition varies considerably depending on soils, landform position, elevation, aspect, precipitation and land-use history. Typical herb species within Mesic Oak include: whorled loosestrife, summer bluet, speckled wood lily, stone-root, Curtis's goldenrod, squawroot, wild yam and Solomon's plume. Deciduous shrubs such as blueberry species and bear huckleberry are common soft-mast producers.



DRY-MESIC AND MESIC OAK COMPOSITION

Deep litter and duff inhibit acorn germination and seedling growth. ▶

Grasses and forbs following late-winter burn. Catoosa Wildlife Management Area, Tennessee. ▶

OAKS & WILDLIFE

Over 100 vertebrate species regularly consume acorns, a critical hard mast in the southern Appalachian Mountains. Acorn crops influence black bear reproduction and survival. The insulating properties of soil protect acorns that are cached by birds and rodents. Those that go unretrieved are buffered from fire, freezing and desiccation, and thus have a greater chance of germination and establishment, compared with uncached acorns.

Oaks are important for butterflies and moths; the larvae of many priority species consume the leaves and they serve as prey for birds and other insects. Flower and pollinator diversity increases when sunlight can reach the ground. Herb forage is more nutritious to deer and elk than hardwood browse.

Oak ecozones support a rich bird assemblage through all seasons. The loss of oak woodlands and herb plant cover has contributed to a 70% decline in disturbance-dependent birds. Grasses and forbs of fire-maintained woodlands are critical for nesting and provide diverse forage options. Oaks also have a high crown-to-stem ratio, which allows for greater canopy cover at lower stem density — optimal structure for songbirds like the cerulean warbler.

Dry-Mesic and Mesic Oak ecozones are home to a rich woodland salamander community. The biomass of salamanders reportedly outweighs the collective biomass of all other vertebrates in suitable Appalachian forests. Fire can adversely impact salamanders, but communities rebound to pre-burn levels in a few years. Drought-induced wildfire threatens isolated populations because it often burns deep into the duff and consumes most leaves and logs — refugia for salamanders, small mammals and invertebrates during fires. Heavy tree mortality can change the light and moisture environment over large areas and create unsuitable habitat conditions for salamanders.

Deeply shaded forests offer few basking areas where snakes and lizards can regulate body temperature. Lack of sunny patches makes areas unsuitable for most reptiles. In part, for this reason it is unclear if northern pine snakes still inhabit the Appalachians, and many reptile species are declining in the region.

Floral diversity improved through burning promotes diverse insect forage for bats. Larger, less-agile bats need a relatively uncluttered midstory for echolocation and efficient foraging. Roosting habitat is provided by trees with exfoliating bark and hollowed snags. Roosts near open foraging areas are ideal.

CULTURAL IMPORTANCE

Indigenous Appalachian people harvested trees for various purposes and burned oak forests and woodlands to promote the health and productivity of important plants. Fire was used to manage a dense shrub understory, which would have otherwise impeded hunting and provided areas from which enemies could set an ambush.

Fresh herbaceous growth after fire is highly palatable for large game and rich in protein and essential nutrients. Fire is used to improve livestock forage. Abundant high-quality forage promotes animal health and size, and improves hunting opportunity and success.

Open oak ecosystems once provided important foods such as nuts and berries, materials for medicine, tools and weapons, structures and fuelwood. Fall burning facilitated acorn and chestnut harvest, and returned minerals and nutrients to the soil to sustain agricultural productivity. Spring and summer burning promoted forbs, as well as soft mast such as blueberries and woodland strawberries.

Today, oak woodlands attract game animals and provide diverse, high-quality hunting experiences. Oak lumber is sought after for its strength and durability; veneer and bourbon barrels are economically important uses.

Few herbaceous plants and absence of oak regeneration characterize fire-excluded, closed-canopy Dry-Mesic Oak site. Foster Creek, Pisgah National Forest, North Carolina. ▲

CONSERVATION CHALLENGES

THE RARE WOODLAND

High-quality Appalachian oak woodlands are very rare; open forest is uncommon. Land has been converted for various purposes, and fire has now been suppressed for nearly 100 years. An evergreen, shrub-dominated understory has developed in most areas, and forests are characterized by a less diverse, closed-canopy forest with a dense midstory of red maple and mesic hardwoods.

BRITTLE LEAVES – LESS FIRE

Receptivity of oak woodlands to fire is moderate to high but declines with time following fire. The rapidly decomposing, paper-like leaves of shade-tolerant trees replace combustible oak leaves that facilitate ignition and fire spread. Mesophytic leaves absorb more moisture, dry slowly, contain less energy for combustion, and, in effect, protect areas that are not fire-adapted. However, because the litter requires more time to dry and become burnable, good burn days in oak systems are limited to dry periods.

LOW LIGHT – LOW DIVERSITY

The high biodiversity of Mesic Oak and Dry-Mesic Oak is due, in part, to periodic fire; diversity is diminished where the light-dependent grasses and forbs have disappeared. Further, senesced herbaceous vegetation is a crucial feedback that facilitates fire ignition and spread.

YOUNG OAKS ARE MISSING

Present-day oaks that sprouted from the trees logged in the early 1900s are mature but generally stressed from the competition of dense forests. Increasingly vulnerable to pests and disease, oaks are a declining component of the Appalachian forest. Very few sites have enough sunlight to provide oak sprouts or seedlings vigor to reach the canopy when gaps are created by lightning, ice or wind.

DEEP DUFF

Fire smoldering during drought often burns deep into duff that has accumulated over many years. Tree roots that anchor in the duff are susceptible to heat-induced mortality, and seedlings are vulnerable to drought.

Shelterwood harvest followed by three burns resulted in abundant oak regeneration and diverse ground cover in a Dry Oak woodland. Leonard Farm, South Mountains Game Land, North Carolina. ▲

White oak seedlings grow slowly and are overtopped by competition in the absence of fire. ▲

RED MAPLE

Oaks are less able to adapt to a low-light environment, relative to red maple, and are generally outcompeted in all but the driest nutrient-limited sites. Complete fire exclusion further reduces any chance of curtailing rapid growth of maples in favor of young oaks.

NO LIGHT FOR GROWTH

Light is the limiting factor for seedling survival, and oak photosynthesis requires more sunlight than that provided under a closed canopy, so most seedlings eventually lose vigor and die. Most Appalachians conservation lands lack the light conditions that will ensure future oak ecosystems. Good acorn crops often result in copious seedlings that grow to a few feet under a closed canopy. However, conventional timber management has largely ignored differing life histories of oak species — specifically, the requirement for repeated disturbance. Burning or other management that mimics natural disturbance is required to sustain oak woodlands and open forests; otherwise, mesophytic trees will continue to supplant oaks in eastern hardwood forests.

FIRE MANAGEMENT

REGULAR BURNING

Trees and shrubs that compete with the growth of young oaks can be managed with fire; routine fire is fundamental to restoring open forest or woodland from closed-canopy forest. A long-term, regular burn cycle with mixed seasonality and intensity is ideal to build ecosystem resilience. Site-specific prescriptions vary. However, programs that have achieved open forest conditions have burned repeatedly and often augmented fire with mechanical tree thinning, chemical treatment of undesirable sprouts, shrub management and deer herd management.

SUNLIGHT AND GAPS

Although variability exists among oak species, seedlings and saplings thrive with 30% to 50% full sunlight. Vigorous young trees are more likely to reach the canopy if they are growing in a gap. Such light levels also promote herbaceous ground cover and diverse food and cover for wildlife. Openings within oak ecozones can be maintained to benefit shrubland (three-year interval) or grassland birds (two-year interval).

GOOD SEEDBED

Conditions that support oak seedling establishment can be improved with fire if it consumes most of the accumulated leaf litter. Acorns that fall upon a deep bed of leaves are vulnerable to drying out or freezing before germination.

VARIABLE RESULTS

The likelihood of topkilling a shade-tolerant shrub or sapling with fire depends on fire intensity, and the plant's stem diameter and moisture content. Weather conditions vary during a burn and throughout a burn unit. Diverse topography produces a variety of fire effects.

BURNING FOR SPECIES

Fire is an imprecise tool for establishing or maintaining tree species composition. The fire intensity threshold wherein oak and hickory are preserved and undesirable trees are killed is very small. Fire tolerance differs considerably among oak species. So, it is difficult to use fire to selectively kill undesirable species.

COMPETITION ON FERTILE SITES

The ability of young oaks to compete declines with increasing site quality (i.e., more available water and nutrients). Mesophytic trees grow rapidly in rich environments, which also burn less often and usually with an intensity insufficient to topkill larger saplings. Fire is more frequent, and the effects on woody competition are usually greater, on xeric sites, where mesic hardwoods lack vigor and grow more slowly.

OAK SPECIES VARIABILITY

Some oak species can endure more frequent and/or higher-intensity fire. Chestnut oak bark is thicker than northern red oak, so it is more fire resistant. The size, timing and frequency of acorn crops vary among species; even among individual trees of a species. Some oaks grow best in poor, dry soils. White oak is arguably the most shade-tolerant oak. The species-specific traits of oak species should be considered, whether burning for specific objectives or to promote focal species.

FIRE AND TIMBER MANAGEMENT

Regular burning favors oaks by topkilling fast-growing, fire-intolerant competitors; it can be beneficial both before and after timber harvest. Without fire or prior treatment, even small harvest gaps will favor mesophytic trees. Leaving shelter trees and/or removing only the midstory can provide light for oaks without stimulating a vigorous hardwood response. Although a complete midstory removal enhances light conditions, the result is around 10% to 15% full sunlight — short of photosysnthetic requirements for oak growth. Partial overstory harvests can help achieve 30% full sunlight.

BURN AND LEARN

Plant responses to a given burning regime (frequency, intensity, seasonality) vary because the soil and physical environment of each site differs; even the response of individual trees or forbs of the same species can vary among sites. The ideal way to learn how species and sites respond is to burn and monitor the vegetation response.

LEFT: Good fuel consumption provides a suitable seedbed for acorns. Lake James State Park, North Carolina. ◀

RIGHT: Mixed grass, forb and white oak response two months after fire. Catoosa Wildlife Management Area, Tennessee. ▲

FREQUENCY

The benefits of fire to oaks become increasingly noticeable the more it is repeated. However, if fire intensity is low, more burns will be required to achieve optimum sunlight for growth of oaks and sun-loving forbs and grasses.

Burning about once every three to five years promotes herbaceous ground cover; variability in the vegetation response depends on site fertility and moisture (how rapidly vegetation re-grows), disturbance history, fire intensity and the amount of light available. Better shrub and small hardwood mortality can be achieved by increasing frequency to one burn every two years.

Periodic fire-free intervals may be required if an objective is to improve oak reproduction. Eight or more years without fire can allow vigorous seedlings to develop; more than 20 years may be necessary to allow saplings to grow into the canopy.

Curled oak litter dries rapidly, ignites easily and facilitates fire spread. ▲

INTENSITY

Fire intensity, flame duration, tree diameter and bark thickness influence hardwood mortality, which can roughly be determined by the char height on trees. Greater fire intensity and/or longer flame duration is required to topkill larger stems and penetrate thick bark. Prolific sprouting of the targeted undesirable species usually ensues.

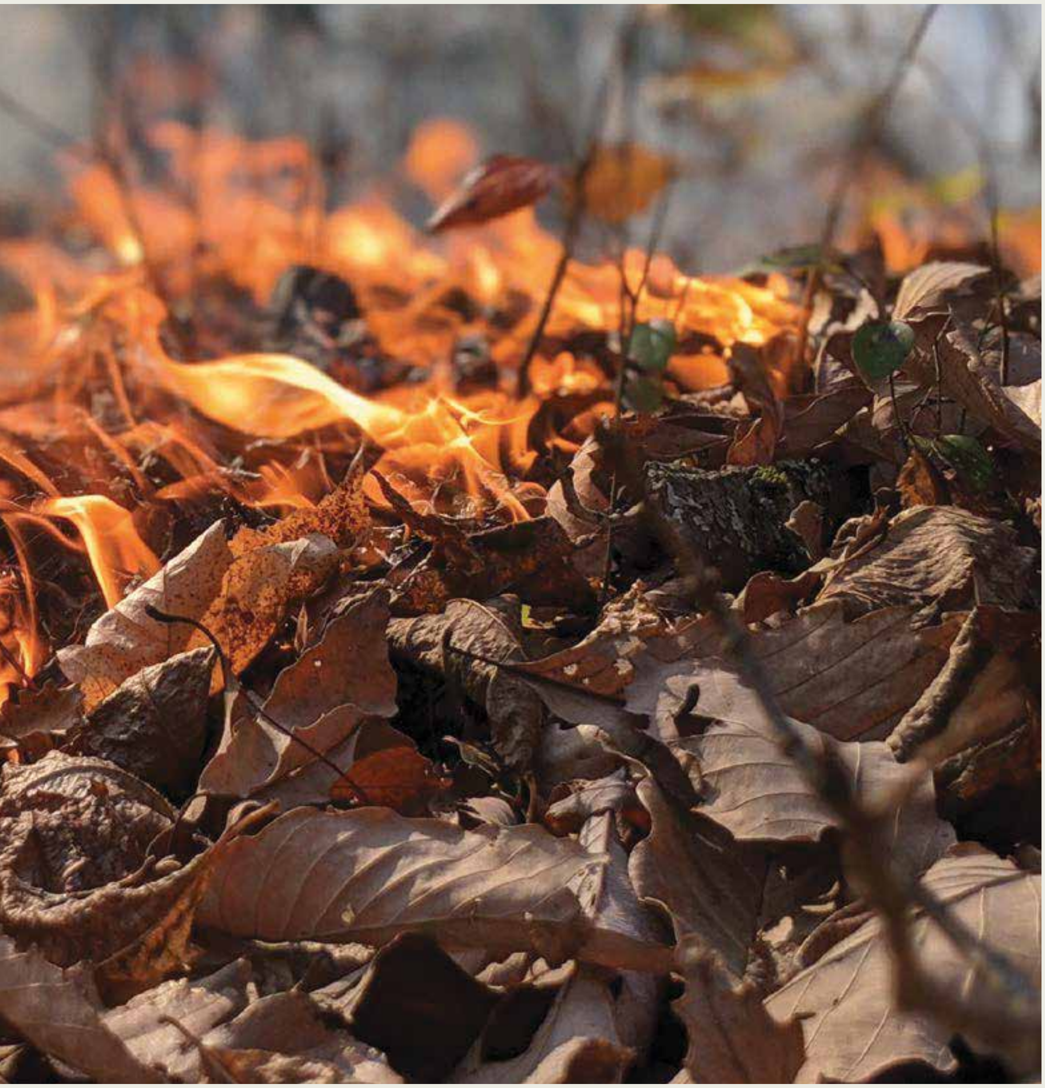
A single, low-intensity fire is largely ineffective for improving sunlight penetration, but frequent low- to moderate-intensity fire topkills fast-growing mesophytic saplings, such as poplar and red maple, repeatedly. Oaks and a blend of annual and perennial herb ground cover are favored over time; the vigor of competitor sprouting declines and open conditions and light levels improve.

Backing fire prolongs the woody stems' exposure to heat and generally results in good litter consumption. However, fire intensity will be increasingly subdued as mesophytic litter replaces oak litter because the leaves release less energy.

Flames less than a foot in length can be effective for managing the abundance and density of small evergreen shrubs over the long term. However, the proportion of mesophytic hardwoods over 6 inches in diameter that are topkilled by low-intensity fire is generally small; thus, many burns are often required to thin the midstory and understory.

High-intensity, stand-replacing fire is thought to have been infrequent historically. Mortality events were likely patchy and may have occurred only once or twice over the average lifespan of an oak.

An entire forest stand can be regenerated by burning at high intensity, but it is infeasible to selectively topkill large, mesophytic trees while leaving oak and hickory unscathed. Undesirable hardwoods sprout regardless of intensity, and most species thrive in abundant sunlight that follows heavy tree mortality. Hardwood thickets often develop within a few years and the absence of oak litter may limit the receptivity, and intensity of future burns. However, a



regular burning regime that follows catastrophic wildfire can manage hardwoods and sustain diverse ground cover over the life of a stand. Such conditions are not often achievable under prescribed-burning conditions, and sites can be prioritized for burning to maintain the open conditions.

SEASONALITY

Indigenous burning is believed to have occurred primarily in fall and spring, but open oak woods can burn at any time of year. Optimal burn timing is that which provides the greatest opportunity to meet objectives. Timing of burning, although important, appears to be generally less influential than fire frequency and intensity, in terms of changing plant composition and structure. Repeated burning, regardless of season, maintains an open environment and suitable conditions for light-loving plants.

Winter can provide conditions for cooler burning and gradual reduction of heavy fuel loads, which may be preferable for first-entry burns. However, initial low-intensity burns result in little, if any, change in plant species composition. Winter burning requires several burns over many years to restore herbaceous diversity.

Spring burns are effective for managing woody stem sprouting and restoring ground cover, but oak seedlings may be vulnerable if root reserves have not developed.

Lethargic reptiles emerging from winter dens are vulnerable and should be considered when planning early growing-season burns. Ground-nesting birds may be impacted, but spring burns do not appear to affect bird populations more than winter burns.

Good litter consumption can result from late summer or early fall burning. The exposure of bare soil with light leaf cover provides a suitable seedbed for acorns and pine seeds that drop in autumn. Drought and the potential for smoldering and duff fire can be a concern during this time.

Woody stems sprout after fire, regardless of season. Density and coverage often increase following initial winter burns. In general, greater control over woody sprouting can be achieved by burning when plants are growing (May – September) because carbohydrate root reserves are low.

Oak stumps cut level to or below ground level promotes sprouts that anchor roots independently of the stump. Burning after harvest kills high buds on stumps to discourage multiple, high-origin sprouts and which enhances growth for a single low-origin sprout, supports tree health, growth form and timber quality.

Dry-Mesic Oak forest burned once every five years. Chestnut Mountain, Chattahoochee National Forest, Georgia. ▶

PLANTS OF
Oak Forest

Without action, we could see our white oak forests disappear in a generation with significant impacts on wildlife, forest ecosystems and timber supplies. To protect and enhance American white oak, we need to work together — thinking, planning and acting — to prevent a crisis. Starting today, we must help landowners and forest managers actively manage our oak forests to restore the health by removing competing tree species, preventing diseases and invasives, and improving conditions for this majestic and ecologically invaluable tree to flourish.

— White Oak Initiative

White Oak

CHEROKEE NAME: *Tă'lû'*
SCIENTIFIC NAME: *Quercus alba*

GROWTH FORM
Tree

FIRE TOLERANCE
Medium

FIRE ADAPTEDNESS
High

LOCATION
Sea level up to 5,000-foot elevation on all upland aspects and slope positions, from ridges to fertile coves; abundant on dry to mesic south- and west-facing slopes.

SOIL
Deep and well-drained but widely tolerant.

ECOLOGY & LIFE HISTORY

White oak is a large strong tree with complex wood structure that is dominant in dry-mesic sites and codominant in mesic areas and within Dry Oak and Shortleaf Pine-Oak ecozones. Canopy gaps and a mixed-severity fire regime have sustained white oak for thousands of years.

A very slow-growing oak that can live nearly 500 years, usually to around 80 feet in height and 3 feet in diameter, white oak has the largest range of the eastern oaks and is arguably the Blue Ridge's most valuable wildlife tree. It is shade-tolerant, and second only to northern red oak as the most mesophytic montane oak.

Good white oak acorn crops occur about once every four to seven years, depending on tree size and vigor, drought, competition, spring freezes and genetics. Some individuals may consistently produce abundant acorn crops; others may produce very few. Traditionally, sprouting is a more dependable source for reproduction.

White oak acorns germinate quickly, but longevity is less than one year and viability can drop from 90% to 7% after six months. White oak acorns are more palatable than tannin-rich red oak acorns: Wildlife shift to red oak acorns during a poor white oak

Cultural Uses

Tă'lû' sapwood was used with rivercane and hickory bark to make baskets; it was taken apart by the grain to make splints, scraped with a knife, cut and dyed with bloodroot. Eight- to 10-inch saplings were preferred.

Acorns (gule) were traditionally an important food and tă'lû' acorns were used to make bread (gulé gátŭ) and ground up as a type of coffee (kawi). Oils derived from acorns were used to alleviate joint pain.

LEFT: Oak leaf shape facilitates light penetration through the canopy. © Katja Schulz, iNaturalist ◀

RIGHT: White oak acorns are a highly desirable food in the fall. @ Raul H. Perez, iNaturalist ◀

crop or later in winter and early spring after tannins have leached. Animals may consume 70% of a white oak acorn crop.

White oak cavities are preferred dens for bears, and acorns are a preferred food. In the fall, bears require more than 15,000 calories per day (1 pound = 1,300 calories), and crop size influences the number of offspring.

White oak wood is heavy, durable and impervious to liquid. The structure and porosity of the wood is ideal for alcohol storage. For wine, the wood allows enough exchange of oxygen and water through the barrel to soften the wine and increase the wine's concentration. The reaction of fruit with the complex chemistry of white oak wood imparts unique flavors and tastes through the aging process. White oak is highly valued for construction, flooring, cabinets and bourbon barrels. Significant concern exists for supply to meet growing demand because of steady decline, slow growth and inadequate conditions for regeneration.

FIRE MANAGEMENT CONSIDERATIONS

FIRE TOLERANT

Mature white oaks are seldom killed by low- to moderate-intensity fire. Damage is mitigated by reallocating functions if parts of the tree are killed. Little change in growth has been observed in trees subjected to frequent fires. The heartwood of white and chestnut oaks is highly decay-resistant.

SUSCEPTIBLE ROOTS

Fire exclusion has resulted in deep duff into which trees have rooted. Long-duration drought-induced smoldering exposes roots to lethal temperatures.

SEEDLING SURVIVAL

Seedlings are able to withstand fire better than most hardwoods. The main root forms an S-shaped curve to insulate dormant buds. Lack of vigor in shade-suppressed seedlings increases the chances of fire-induced mortality. White oak seedling establishment is favored with about 40% sunlight.

SEEDLING SPROUTING

Large root reserves allow seedlings to sprout vigorously. A topkilled white oak seedling less than 5 inches in diameter has about an 80% chance of sprouting.

TREE AGE AND SPROUTING

Root stools contain callus tissue filled with dormant buds. These develop below ground after repeated fire and produce vigorous sprouts. Fire can induce sprouting from older root systems, but it generally declines with age. The sprouting capacity of a 12- to 16-inch tree is about 15%. White oak is among the most difficult to regenerate silviculturally. The vast majority of white oak in the Blue Ridge has exceeded the age where sprouting can be considered a dependable source of regeneration.

CARE AFTER HARVEST

White oaks are prone to epicormic sprouting following heavy timber harvest and can suffer delayed mortality. Such effects are exacerbated by drought, dry soil and intense fire after harvest. Trees can be protected by burning at low intensity.

FIRE AND GAPS

Benefit to white oak regeneration derived from burning under a closed canopy are often minor. Half-acre gaps created mechanically or with fire improve light conditions for regeneration — more so if 30% to 40% sunlight is provided prior to burning. Competition on fertile sites responds vigorously to large openings.

FREQUENCY

Burning at least once every five years can curb the growth of woody competition and promote suitable conditions for white oak regeneration.

For maximum woody stem reduction, a two-year interval stresses stems before carbohydrate reserves can be fully replenished from the previous burn.

Frequent burning can damage young white oak, though the extent to which varies depending on season and severity as well as the age, size and vigor of an individual tree. Less-frequent fire may be preferred if seedling survival and/or overstory recruitment is an objective.

INTENSITY

Large white oaks are more resilient to intense fire than smaller trees. High-intensity fire generally results in higher mortality and fewer trees

White oak healing and sprouting after wounding by fire. ▶

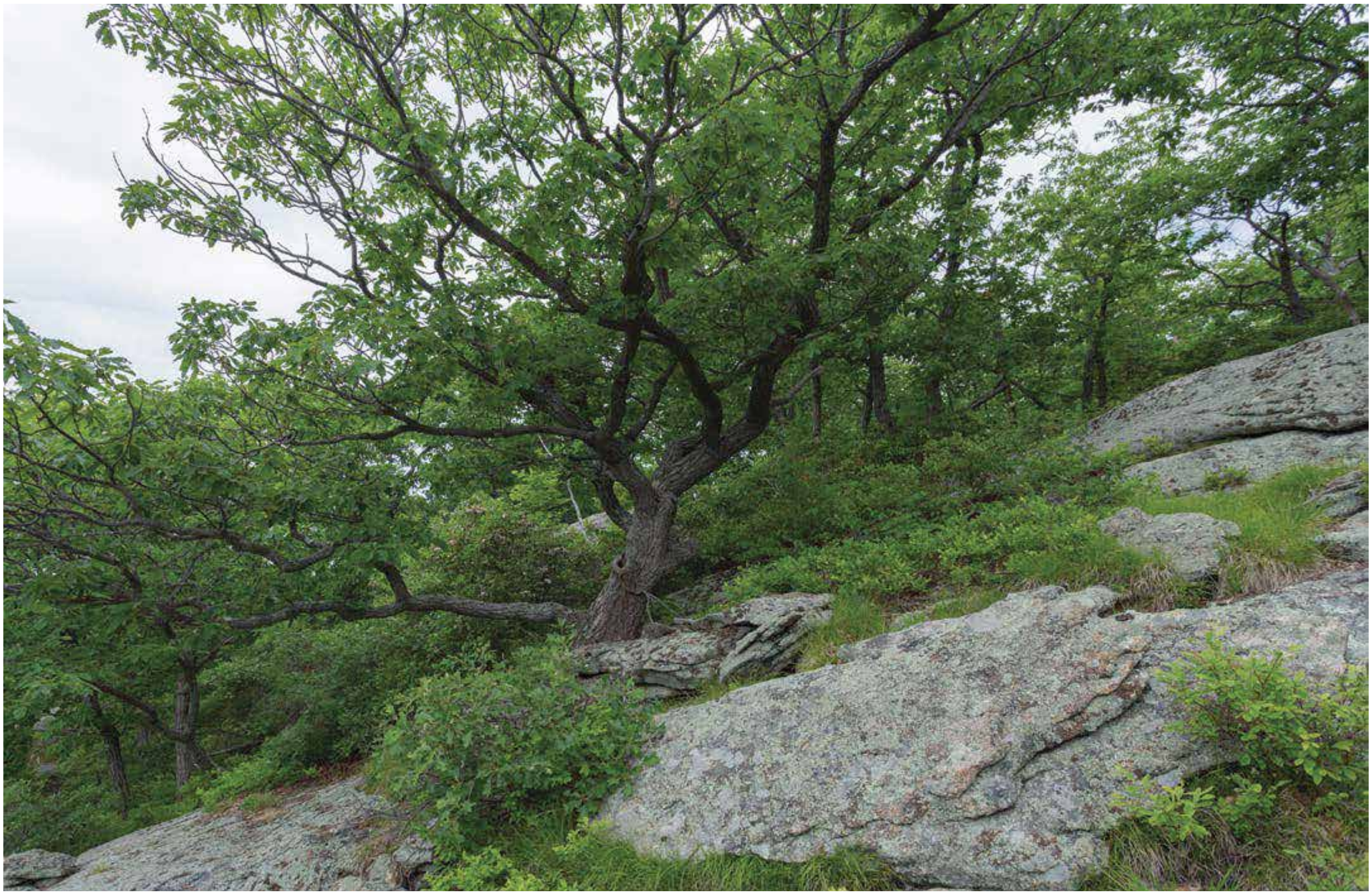
over time. Poor regeneration can result from stand replacement fire, especially if mature trees are older and advanced oak regeneration is absent or of low vigor.

Low- to moderate-intensity preceding timber harvest can help promote advanced oak regeneration while limiting timber damage. However, thinning before burning will avoid uncertainty if maximum financial return is an objective.

SEASONALITY

Winter burning is often preferred in order to limit damage to mature trees. Deep duff and vegetation that have accumulated in fire-excluded sites can burn intensely under dry conditions.

White oak mortality is generally lower following winter and early spring burns because trees are not actively growing; ambient temperature is lower, and it is the preferred timing following a timber harvest.



Chesnut oak grows in rocky, nutrient-poor soils often in exposed, fire-prone sites.
© Ulrich Lorimer, Flickr ▲

Chestnut Oak

CHEROKEE NAME: *Tsisátugwûléga*
SCIENTIFIC NAME: *Quercus montana*

GROWTH FORM
Tree

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION
500- to 5,300-foot elevation; common on dry ridges, south- to west-facing slopes and rocky outcrops.

SOIL
Dry, rocky and infertile; grows best in well-drained loams.

ECOLOGY & LIFE HISTORY

Chestnut oak is a deciduous canopy tree widespread and dominant in dry sites and increasingly common in xeric sites. It can grow up to 70 feet tall and 3 feet in diameter over 300 years.

Bristleless leaves, acorns that mature over one growing season, and clogged pores in the wood are traits chestnut oak shares with others in the white oak group.

Flowers and leaves develop in spring with bud break. Weather determines when pollen will disperse. Although acorn production is erratic, an early warm period followed by a cooler April can portend a large crop.

The one-and-a-half-inch-long acorns fall and germinate in autumn. Heavy crops occur about every four to five years, but chestnut oak produces fewer acorns relative to upland oaks.

Chestnut oak germination is around 90%. It is the most drought-tolerant of the Blue Ridge oaks and germinates well in dry soil.

As trees mature, smooth bark furrows into deeply divided ridges that become more prominent with age, serving as refugia for insects.

In North America, the caterpillars of over 700 butterfly species feed on oak. The decline of either would be catastrophic for biodiversity. Cascading effects could include the loss of a food source for birds, bats and small mammals; detrimental impacts to plant pollination; and less detritus and nutrients that support arthropod and microbial communities.

The non-native gypsy moth prefers white oak; the caterpillar eats tender leaves that flush in spring. Tree mortality can occur if defoliation occurs in successive years or if a tree is under additional stress.

FIRE MANAGEMENT CONSIDERATIONS

HIGH AND DRY

The steepest and driest sites suitable for chestnut oak are often prone to intense fire. It often co-occurs with pitch and Table Mountain pine and will increasingly dominate pine sites with less frequent fire.

STAYS STANDING

Chestnut and black oak are the most fire-tolerant oaks, and mature trees can survive high intensity fire; thick bark protects the cambium and tyloses compartmentalize wounds. One growing season should elapse before actual damage can determined.

PROLIFIC SPROUTER

Saplings are generally topkilled, even by low intensity fire; 100 percent sprouting of saplings is not uncommon.

DECLINE AFTER 60

Until about 60 years of age, chestnut oak sprouts vigorously from the root crown after topkill but begins to decline once its diameter reaches 18 inches.

DORMANT CUTS

Greater frequency of sprouting and individual vigor emerge from stumps of trees cut during the dormant season, relative to growing-season harvest.

SEEDLING ESTABLISHMENT

Seedling abundance declines as leaf litter depth exceeds 1 inch. Fire consumes accumulated litter to facilitate seedling establishment and root development. Chestnut oak seedlings can grow reasonably well from 15% to 40% sunlight.

MORE TO LEARN

The effects of fire frequency, seasonality and intensity on chestnut oak have not been well studied.

Cultural Uses

The bark of *tsisátugwûléga* ("large acorns") was once used by the Cherokees for tanning leather, while the inner portion of the bark is pounded into mush with a variety of plants used in treating fevers, bronchitis, coughs and many such ailments.

Rhododendron size and density is limited by poor soil and/or areas that burn frequently. ▲

Great Rhododendron

CHEROKEE NAME: *Dusúǵa tsúntana*
SCIENTIFIC NAME: *Rhododendron maximum*

GROWTH FORM
Shrub

FIRE TOLERANCE
Low

FIRE ADAPTEDNESS
Low

LOCATION

All aspects from sea level up to 5,000-foot elevation. Stream bottoms and cove forests providing moderate shade beneath a high canopy are ideal.

SOIL

From well-drained to saturated bogs, best growth is on mesic, acidic soil with a thick, peat-like organic layer.

ECOLOGY & LIFE HISTORY

This species is a shade-tolerant, evergreen shrub that can reach 40 feet tall and 25 feet wide with a stem 1 foot in diameter. Multiple stems grow from a root crown, and individuals can exceed 100 years old.

Rhododendron covers the midstory of nearly three million acres of the Southern Blue Ridge, primarily in cove forests, riparian zones and mesic areas. Canopy openings created by chestnut loss combined with decades of fire exclusion have made it more common in oak forests.

Thick, leathery leaves can be retained up to eight years. Leaves can acidify soil through decomposition and limit minerals and nutrients available to other plants. A mutually beneficial relationship with fungi (ectomycorrhizal association) allows rhododendron to tie up soil nitrogen and phosphorus as thickets expand.

Rhododendron can govern both midstory and understory species richness as dense thickets exclude nearly all other plants. Oak and pine seedling survival is often minimal due to insufficient sunlight.

Rhododendron is browsed by white-tailed deer in fall and winter, while grouse and turkeys eat the buds and leaves. Beavers browse twigs, and the thickets provides winter and escape cover for white-tailed deer, eastern cottontail and some songbirds. Thickets can serve as bear den sites and escape cover.

Rhododendron twigs grow longer and leaves are larger on mesic sites. Limited available water and nutrients on dry sites limit growth; mountain laurel is often the predominant shrub on xeric sites.

Cultural Uses

The Cherokee name for rhododendron is dusúga tsúntana. Indigenous people were reported to have found refuge in rhododendron thickets when in danger. The seasoned wood was said to make the finest cooking spoon. Today, it is chosen as an ornamental plant because of its evergreen foliage and attractive flowers.

Rhododendron flower. © Christian Schwarz, iNaturalist ◀

FIRE MANAGEMENT

LESS FIRE, MORE RHODO
Fire exclusion is in part cause for the proliferation of rhododendron thickets and associated decline in biodiversity in Appalachian oak ecosystems. Fire was frequent enough within oak woodlands to routinely topkill rhododendron and keep it confined to the cooler aspects and narrow coves.

FINDS THE GAPS
Rhododendron expands into disturbed areas and sprouts prolifically in canopy gaps. Branches that touch the ground form a root system from which new stems sprout (layering).

STRONG SPROUTING
Cutting a single stem often results in five or more sprouts. Stumps and roots persist, but allowing rhododendron to resprout before burning can increase fire's effectiveness.

CURED STEMS BURN HOT
Stems cured for more than six months will contribute to greater fire intensity. Cut stems piled around undesirable trees can generate high heat, thus girdling trees to create small canopy gaps as well as snags for insects, bats and cavity-nesting birds.

FIERY THICKETS
Drought-induced wildfires can result in the ignition of entire rhododendron thickets. Observed fire behavior has included flame lengths over 100 feet, and extensive tree mortality is often a result.

Rhododendron encroachment into fire-excluded pine and oak forest prevents regeneration and ground cover restoration. ▶

MANAGEMENT COSTS

PRESCRIBED FIRE	**$35** /ACRE
CHEMICAL TREATMENT + PRESCRIBED FIRE	**$330-$430** /ACRE
CHEMICAL TREATMENT	**$250-$450** /ACRE GARLON 4 CUT-STUMP
MASTICATION	**$350-$1,400** /ACRE
MECHANICAL	**$325** /ACRE
PRESCRIBED HERBIVORY	**N/A** PLANT TOXICITY

FREQUENCY

One burn is largely ineffective for curtailing rhododendron growth and spread, regardless of intensity or season.

Effective rhododendron control is possible by burning at least once every four to six years. Frequent burning over many years is often necessary to eventually kill evergreen shrubs.

INTENSITY

Low-intensity fire will often top-kill smaller rhododendron, but this becomes less likely as it grows larger and its bark thickens with age. Minimal light and air flow maintain damp conditions, and dry conditions are often required to topkill a thicket.

Fire-induced topkill can generate prolific sprouting from vigorous, well-established root systems, largely regardless of intensity. However, it can take several years for shrubs to become as large and thickets to regain their original density.

SEASONALITY

Fires in summer and fall with sufficient intensity and flame duration have completely killed individual plants and entire thickets. Duff fire and smoldering that can occur during drought-induced wildfire increase mortality.

Winter burning can topkill most rhododendron stems less than 2 inches in diameter, but nearly all sprout within two years.

Rhododendron prefers cool, moist mesic forest and stream banks. © Annkatrin Rose, iNaturalist ◀

The leaf area of red maple blocks sunlight and restricts air flow within forest.
© Katja Schulz, iNaturalist ▲

Red Maple

CHEROKEE NAME: *Tsûnwagi gigage adsilû'skĭ*
SCIENTIFIC NAME: *Acer rubrum*

GROWTH FORM
Tree

FIRE TOLERANCE
Moderate

FIRE ADAPTEDNESS
Low

LOCATION
Below 6,000-foot elevation in a wide variety of environments.

SOIL
Wide variety with best growth in moist, fertile loams.

ECOLOGY & LIFE HISTORY

Red maple is a deciduous, dominant or codominant tree that grows up to 90 feet tall and 4 feet in diameter. Bark is smooth when young but darkens, furrows and thickens with age. It has stout twigs with small, clustered flowers and three-lobed leaves.

Ubiquitous and arguably the Appalachians' most resilient, adaptable and genetically diverse tree species, red maple persists through inundation in bogs and floodplain forests, thrives in acidic, infertile soil and can endure fire on the driest ridges. It grows well in dense shade, flourishes in full sunlight and demonstrates multiple fire-response strategies.

Red maple can bear seed as early as 4 years old. Wind can carry nearly 1 million seeds from a single 12-inch-diameter tree. It is one of the first trees to emerge from winter dormancy and flower in early spring, which is important for pollinators.

With prolific sprouting and the ability to thrive under variable light levels, red maple is favored by canopy disturbance. Conditions following conventional timber management practices are often ideal, and red maple readily establishes in most disturbed areas.

Maple saplings are nutritious browse for deer and elk from late fall through winter. Woodpeckers nest in their cavities.

Few trees provide a more spectacular contribution to fall leaf colors. Leaves can turn golden yellow to orange to vibrant scarlet red before they detach (abscission).

Cultural Uses

Tsûnwagi gigage adsilû'skĭ was used medicinally, combined with persimmon, ada'yeski ("eating itself") along with du'alagosa ("inflammation of the palate"). It was combined with black oak for wounds caused by arrows, bullets and ax cuts.

Red maple is a very important species for furniture, veneer, pallets, cabinetry, plywood, barrels, crates, flooring and railroad ties.

A small red maple can produce 11,000 seeds per acre. © Wayne Longbottom, iNaturalist ▲

FIRE MANAGEMENT CONSIDERATIONS

RED MAPLE PROLIFERATION
The exclusion of fire has contributed to more red maple in forests. Fire suppression has created a shaded understory, diminished biodiversity and altered fundamental ecological relationships in fire-dependent ecozones.

MESOPHICATION
Red maple is fire-sensitive but is increasingly protected the longer fire is excluded. The typical dense crowns of mesophytic trees create a cool, dark understory. The fallen leaves rapidly decompose and are less combustible and slower to ignite. The low surface area, high bulk density, and lack of oils and resin suppress fire intensity.

FIRE AND THE MATURE TREE
Relative to the oaks, maples in all size classes are more easily topkilled by fire, regardless of intensity. While aboveground parts are vulnerable, mortality decreases as the tree grows and bark thickens with age. So with growth comes a proportional decrease in peak cambium temperature and the longer heating duration required for fire to kill cambium. Monitoring suggests that delayed mortality of mature individuals may be greater than previously thought, but this needs further study.

FIRE "MAKES IT MAD"
Following topkill by fire or cutting, red maple sprouts vigorously from the stump, root crown and root suckers. Three generations of sprouts can survive on the same root system.

CLOSED CANOPY BURNING
A single-winter burn under closed canopy often promotes maple's dominance, largely regardless of intensity. Low-intensity fire that ends up increasing ephemeral light favors maple over oak because of the rapid aboveground-growth response.

REDUCE OR ELIMINATE?
Removal of red maple from fire-adapted ecozones is largely unrealistic, given the species adaptability. Routine management is imperative if maintaining open forest or woodland condition is an objective, especially on rich, mesic sites.

TIMBER MANAGEMENT
Reducing maple from the midstory and canopy lessens the sources of seed and allows diffuse light infiltration, which can favor oak regeneration. Prescriptions vary, but multiple burns in mixed seasons and herbicide application are often requisite to managing maple and mesic hardwoods.

BURN SEASON AND FREQUENCY
The long-term effectiveness of managing red maple with spring, summer and fall burning is not well understood. Sprouting has been curtailed, and some plants have been

Red maple regeneration from root suckers can be the dominant ground cover in some situations. ▶

killed with just one burn every two years or less. One study indicated that five dormant-season burns in five years had no effect on sprouting maple. Effectiveness of winter burning is limited in part because the tree is not actively growing. Winter burns also create an ideal seedbed for maples in spring.

MORE TO LEARN

The effects of fire season, frequency and intensity on red maple growth and reproduction is not well understood, and more research is needed to adapt fire management.

Deep, dense crowns and mesophytic trees can block 95% of sunlight from reaching the ground. ▶

Favorable oatgrass response to fire once every five years. Huckleberry Mountain, South Mountains Game Land, North Carolina. ▲

Poverty Oatgrass

CHEROKEE NAME: *Kanéska (grasses)*
SCIENTIFIC NAME: *Danthonia spicata*

GROWTH FORM
Grass

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION

Old fields, pastures, rock outcrops and dry, open forest where it is widespread at low density.

SOIL

Sandy or rocky, well-drained and infertile.

ECOLOGY & LIFE HISTORY

Poverty oatgrass is a cool-season perennial bunchgrass with fibrous roots but lacking rhizomes or stolons. Most of the foliage occurs as a crowed basal clump of leaves four to six inches long.

It begins growing in early spring, and blooms from late spring to early summer, and then lies dormant from mid to late growing season.

Reproduction is by seed, side shoots and multiple stems (tillers) that form dense clumps. Although seeds may lie dormant for decades awaiting disturbance, they germinate readily with adequate light and bare ground.

Poverty oatgrass can become dominant in favorable growing conditions.

Oatgrass thrives in poor soil.
© Rob Routledge, Sault College ▲

FIRE MANAGEMENT CONSIDERATIONS

FREQUENT FIRE

Poverty oatgrass is strongly associated with frequent fire and is often among the first plants to respond.

FAST RESPONSE

Fire usually topkills oatgrass, but the first growing season following fire often demonstrates a marked increase in vigor. With adequate sunlight, more than four times the flowering culms may be produced.

LIGHT LOVER

Population maintenance in open forest and woodland depends on fire. While small, scattered clumps may survive in the absence of fire, populations decline over time with diminishing light availability.

SEASONALITY

Little information exists regarding optimal season and fire frequency specific to poverty oatgrass. However, winter burns generally reduce cool-season species while growing-season fire favors them.

Long-horned bees, long-tongued bees and leaf-cutting bees are important pollinators for legumes like the ticktrefoils, or "beggar ticks."
© Matthew Beziat, Flickr ▲

Naked Ticktrefoil

CHEROKEE NAME: *Únistilû'istĭ-yu*
SCIENTIFIC NAME: *Hylodesmum nudiflorum*

GROWTH FORM
Forb

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
Moderate

LOCATION
Sandy, rocky oak woodlands in partial sun, often where ground cover is undisturbed.

SOIL
Rich, mesic, loamy or clay-loam soil with rock and decaying organic matter.

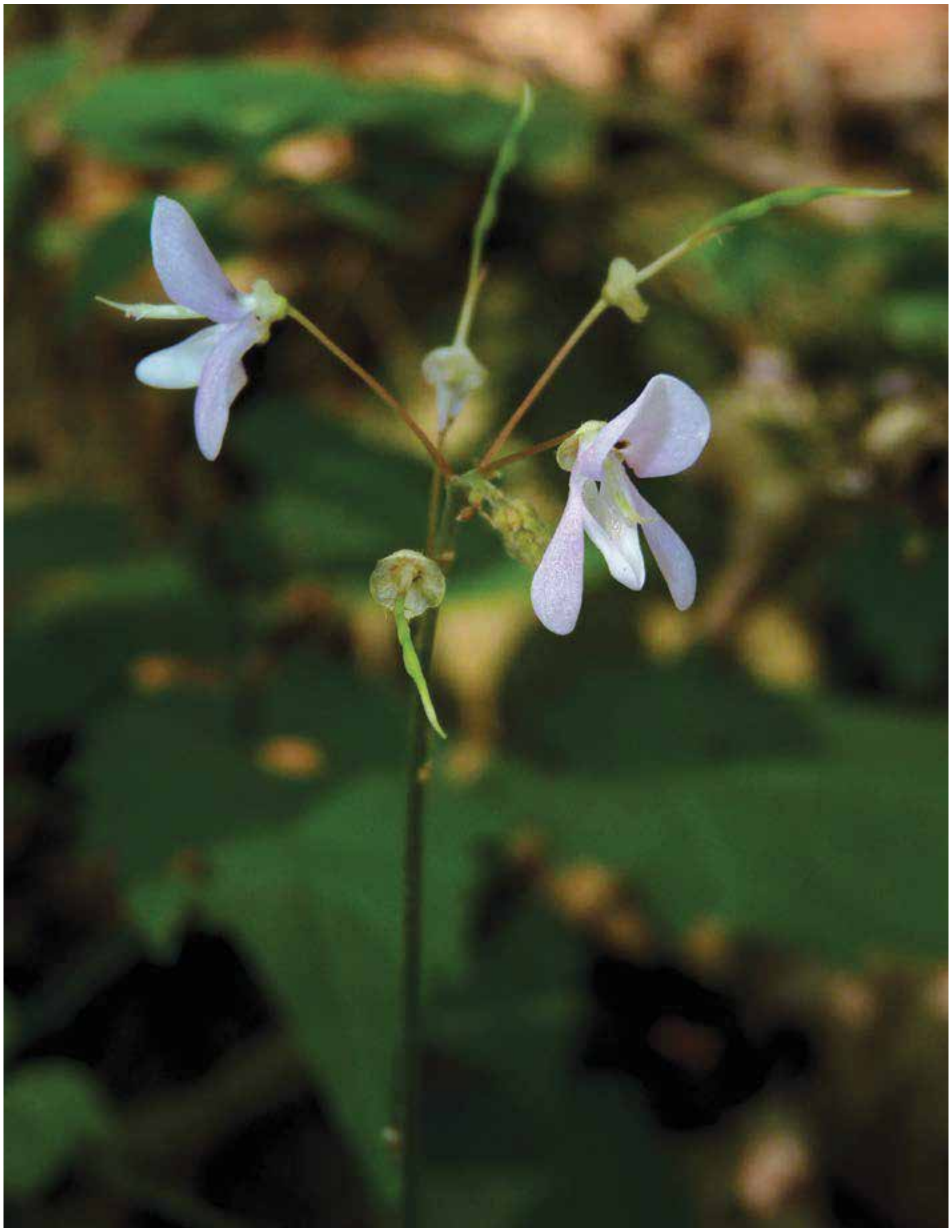
ECOLOGY & LIFE HISTORY

This species prefers mature, open woodlands, forest edges and other areas with dappled sunlight; rich soils often have high organic content.

Compound leaves bunched toward the center of the 18- to 36-inch stem. It flowers from July to September, but the flower stem emerges from the ground near the stem that bears the leaves.

Long-tongued bumblebees are important pollinators for ticktrefoil and other legumes. Eastern tailed-blue butterfly caterpillars feed on the foliage, as do white-tailed deer and cottontail rabbits. Ruffed grouse, wild turkeys and northern bobwhite eat the seeds.

Legumes convert nitrogen from the air into soil nitrogen compounds via "nitrogen-fixing" bacteria. This supplies the soil and plants with an element that is critical for growth.



Naked ticktrefoil flower stalk. © John Beetham, iNaturalist ▲

FIRE MANAGEMENT CONSIDERATIONS

FIRE REDUCES COMPETITION

Early growing-season burning reduces understory woody stem density and enhances light available for photosynthesis.

FIXED VS. MIXED

Peak productivity in some legumes has been observed with annual burning; other legumes flourish with less frequent fire. A dynamic landscape with diverse species assemblages and life histories benefits from a variable fire regime. Changing the burn's timing, intensity and frequency promotes biodiversity.

BURN THE BEANS

Legumes exhibit a variety of responses to fire season and frequency. Fire stimulates growth, and the overall response of patches is to expand coverage and increase in diversity and abundance.

BURN AND LEARN

In the Blue Ridge, the science of effects of burning on native legumes and other forbs is not well understood.

The purple rays are female flowers. The yellow disk in the center is a collection of several male flowers.
© Ulrich Lorimer, Flickr ▲

Spreading Aster

CHEROKEE NAME: *A ta' at yu stí*
SCIENTIFIC NAME: *Symphyotrichum patens*

GROWTH FORM
Forb

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
Moderate

LOCATION
Open forest and edges, rock outcrops, glades and in partial shade to full sun.

SOIL
Sandy and rocky, medium- to well-drained soils of low fertility.

ECOLOGY & LIFE HISTORY

Spreading aster is an upright perennial that grows to two and a half feet on a slender, hairy, brittle stem; a 1 inch daisy-like flower appears in late summer as an autumn harbinger.

It is often found around rock outcrops and roadsides in oak forests, especially those associated with mafic rock.

Cross-pollination is required to set seed in most asters. The rays of most species may close around the flowers at night as protection from cold temperatures.

Of the world's 20,000 bee species, 20% occur in the U.S. The estimated economic contribution of native bees to crop production is around $3 billion per year. Native bee species often specialize on certain plants; fall-emerging mining bees are often pollinator specialists for the late-blooming asters and are also primary pollinators for apples and blueberries. Diverse flowers and often those considered weeds provide nectar and pollen throughout the growing season; good pollinator nesting habitat improves fruit and vegetable production.

FIRE MANAGEMENT CONSIDERATIONS

FIRE ADAPTED

Although little information exists regarding fire effects specific to spreading aster, the perennial appears well adapted to fire and responds to increased light availability.

FORBS WILL SPROUT

Perennial forbs of oak ecozones are largely dormant during winter burns. Few sun-loving forbs fail to sprout from rhizomes after fire consumes aboveground parts. Mineral-rich ash can stimulate prolific sprouting.

ANY BURN > NO BURN

Forbs appear no more negatively affected by burning one season versus another, according to studies in prairie ecosystems. Relative to the Blue Ridge, any such negative effects should be ephemeral and relatively minor compared to the result of not burning.

VARIABLE PLANT RESPONSES

Asters and some forbs can be more negatively affected by fires that occur during dry spells. Soil moisture before and after burning influences plant recovery, and response times may be delayed under stressful conditions.

MIX UP THE TIMING

Altering burn timing fosters diversity because fire affects plant species differently, depending on the life stage when fire occurs. Repeated burning at the same time of year will favor some organisms over others. Thus, the magnitude of this effect may become pronounced the longer this is repeated and some populations may decline as a result.

YOU GET WHAT YOU GOT

The majority of native forbs in the Blue Ridge lack the ability to disperse long distances, so plant community composition is largely stable. In general, plants that have potential to emerge following fire were likely present before. Propagules of plant with intermediate shade tolerance can sometimes persist longer in a shaded environment.

Aster blooms signal the end of summer and the approach of winter. © Dwayne Estes, iNaturalist ▲

ECOLOGICAL ZONE

Pine-Oak Heath

ECOZONE	RESTORATION-FIRE FREQUENCY	MAINTENANCE-FIRE FREQUENCY
PINE-OAK HEATH	2-3 YEARS	3-7 YEARS

EXTENT
490,000 acres

ELEVATION
900 – 5,000 feet

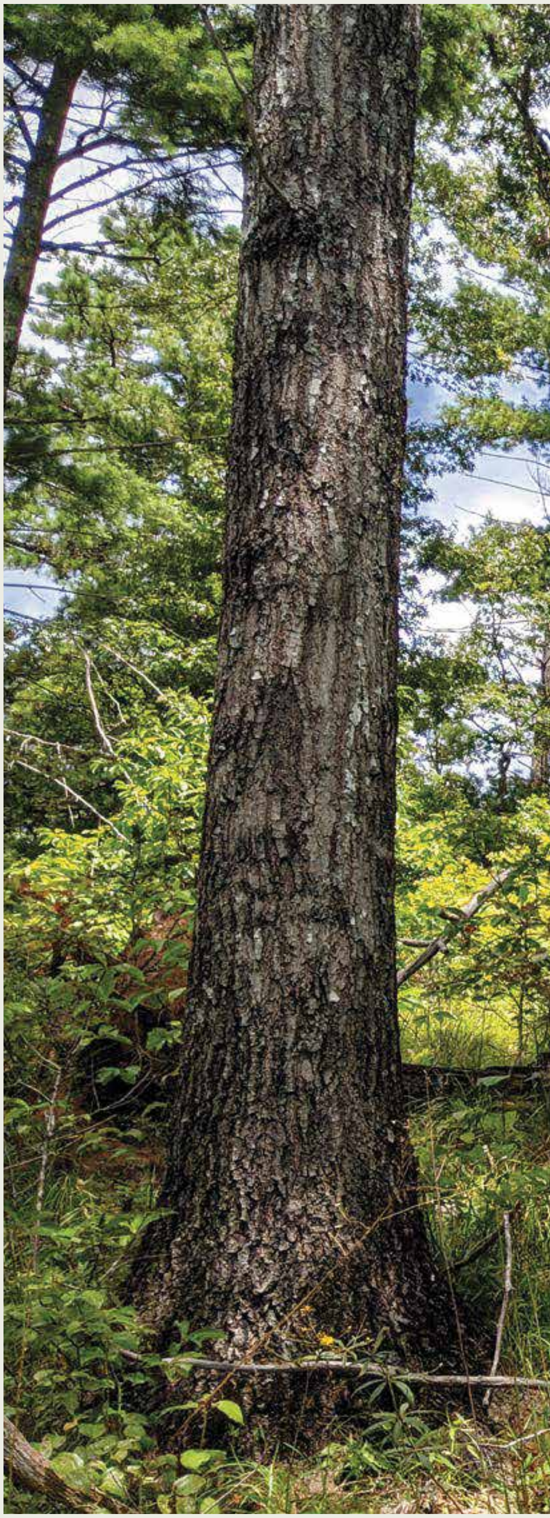
LANDFORM
Sharp, exposed spur ridges; cliff tops and convex dry slopes on generally south and west aspects; lower elevations on broader, gentler slopes and ridges.

CONTEXT
Intermixed with dry and dry-mesic oak or at slightly higher elevation; often blending with shortleaf pine-oak at lower elevations.

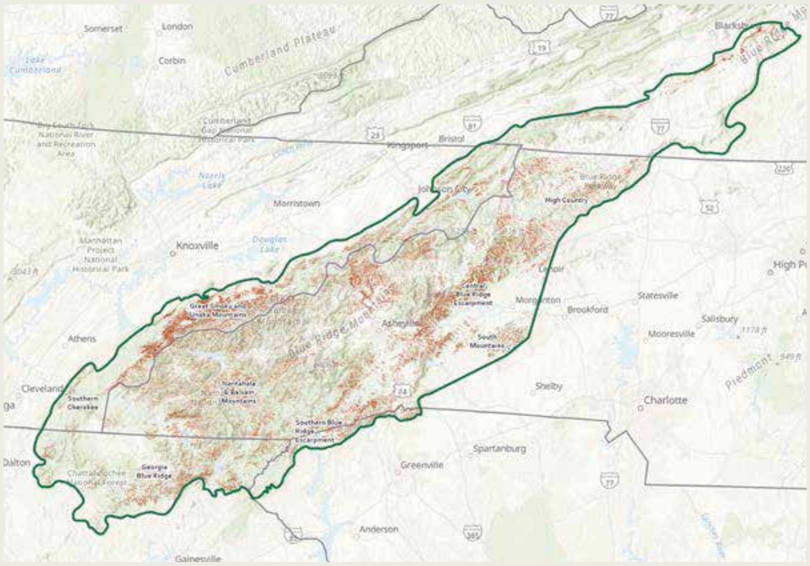
SOIL
Shallow often rocky, highly acidic, nutrient-poor and droughty.

NATURAL DISTURBANCE
Mixed-severity fire, pest outbreaks, ice and wind.

EMBEDDED COMMUNITIES
Carolina hemlock bluffs, granitic domes, rocky summits, barrens and glades.



Pine-Oak Heath structure and composition can vary greatly. Back Creek, Pisgah National Forest, North Carolina. ▲



Pine-Oak Heath has patchy distribution throughout the Blue Ridge Mountains but is concentrated largely in the Central and Southern Blue Ridge Escarpments, High Country, and the southwestern portion of the Great Smoky and Unaka Mountains. ▶

ECOLOGY

Pine-Oak Heath is naturally dominated by an open canopy of Table Mountain and pitch pine. This composition is uncommon today beyond scattered, remnant patches. Chestnut oak and scarlet oak are becoming increasingly common, along with white pine, Virginia pine and various hardwoods. Sourwood and black gum are ubiquitous. Lower-elevation sites may have more shortleaf pine.

PINE-OAK HEATH COMPOSITION

Heath refers to areas where the dominant plants are ericaceous shrubs less than 3 feet tall. Over 200 species of forbs, grasses, ferns and shrubs of variable composition and density are possible. Mountain laurel and ferns often predominate contemporary Pine-Oak Heath with patches of suppressed forbs and grasses, some rare.

Pine-Oak Heath is highly fire-adapted relative to Blue Ridge ecozones. A propensity for lightning strikes, rapid water drainage and wind contribute to a fire-prone environment and overall moderate to high fire intensity. Today, besides rock-dominated communities, regeneration of Table Mountain pine is unlikely for lack of regular fire and sunlight.

The modern pine ecozones originated the early 1900s from near-complete logging and subsequent slash fires. The previous extent of Pine-Oak Heath is uncertain, but the presence of yellow pines and pyrophytic plants, soil charcoal and tree-ring research suggests several thousand-year intervals of more or less drought and fire.

Frequently burned Pine-Oak Heath is a critical part of the region's biodiversity. Embedded rock outcrops provide refugia for fire-sensitive species such as Carolina hemlock,

Forbs and oak regeneration under open-canopy Pine-Oak Heath. Osborne Ridge, Green River Game Land, North Carolina. ▲

but these communities have not been well studied. Grass-dominated ground cover of once-open forests and woodlands was receptive to fire; ignition was more likely and frequent, and fires grew large and steeper slopes exposed to mid-day sun are apt to burn intensely.

Pine-Oak Heath stand structure is variable in part because this ecozone is subject to both high- and low-intensity disturbance. High-intensity fire can follow small-scale beetle outbreaks, which may kill most trees. Ice storms create gaps, and frequent, moderate-intensity fires topkill competing vegetation and maintain patches of bare soil for grass, forb and pine seed germination.

Wildlife adapted to fire-maintained Pine-Oak Heath

include the prairie warbler, red-headed woodpecker, brown-headed nuthatch, whip-poor-will, northern fence lizard, coal skink, timber rattlesnakes and the extremely rare northern pine snake.

Bunchgrasses, forbs and scattered shrubs provide both food and protection for young quail and turkeys. Many native forb species are good deer and rabbit forage. The seeds and berries of light-demanding shrubs are food for birds and small mammals in mid to late summer.

CULTURAL IMPORTANCE

Some native Appalachians have attributed the fertility of the valleys to soil deposited from eroded upper slopes "deforested by fire."

An abrupt increase in fire frequency occurred in the early 19th century. Scots-Irish herdsmen introduced their traditions of burning to enhance livestock forage and facilitate hunting, which blended with Indigenous burning and defined Appalachian woods burning culture.

Modern timber demand from Pine-Oak Heath is low because of poor soils, undesirable species, and a tendency to produce crooked trees. But places like Linville Gorge and Table Rock State Park are popular outdoor recreation destinations.

CONSERVATION CHALLENGES

ABSENCE OF FIRE

The most significant threat to the ecological integrity of Pine-Oak Heath is lack of regular fire.

DECLINING BIODIVERSITY

An increasing proportion of shade-loving trees and shrubs suppresses diverse herbaceous ground cover. Yellow pines have steadily declined, and sun-loving forbs and grasses are relegated to trails and rights of way.

DIMINISHED RESILIENCE

Estimates of the proportion of pre-European settlement, closed-canopy Pine-Oak Heath are around 8%, yet today more than 90% is closed. Heavy competition suppresses resin flow in pines and compromises natural beetle defense. Predicted future drought frequency is expected to increase susceptibility to both new and existing pests and disease.

FIRE REGIME THEN & NOW

Flammable fuels of Pine-Oak Heath generally have a high probability of ignition. Fire was once frequent and sometimes intense, but today a closed canopy, increasingly dense woody understory and high fuel moisture inhibit fire establishment and spread in all but the driest periods.

WILDLIFE

Open forests support greater abundance and richness of bees, relative to closed-canopy forest. Blueberry and huckleberry mast crops decline under greater canopy closure. Forbs and grasses that provide forage for small mammals decline, and thus does prey for raptors. With an increasingly dense woody understory, basking habitat for reptiles becomes scarce and sites become unsuitable.

Woodland restoration project, with mixed-season burning once every three to five years (left). Unburned (right). ◀

RARE PLANTS

The relatively harsh environment of Pine-Oak Heath is ideal for some rare plants, including Heller's blazing star, Peter's Mountain mallow, white irisette, running buffalo clover, rounded-leaf serviceberry, branched whitlow grass and witch alder.

RISKS TO PEOPLE

Few human developments are at greater risk for wildfire than those established within or near Pine-Oak Heath. Droughty soil, exposed position and heavy fuel loads result in high-intensity fire and fast rate of spread. Circuitous roads challenge evacuation and emergency response. Potential smoke impacts to communities greatly limit use of controlled burning to reduce hazardous fuels.

HEAVY FUELS AND SEVERE FIRE

Fire exclusion has resulted in substantial fuel loads. The current environment of deep, poorly decomposed duff, dead wood, dense flammable shrubs and periodic late-summer droughts can result in severe wildfires such as those that have recently impacted Linville Gorge.

NON-NATIVE SPECIES

Heavy tree mortality and soil exposure following catastrophic fire help provide the ideal conditions for the invasion of non-native plants such as princess tree.

FIRE MANAGEMENT

REGULAR FIRE

Yellow pine regeneration is consistently found where fire has repeatedly topkilled shrubs and hardwoods, or high-intensity fire has resulted in large treeless areas. Mountain laurel, sourwood, black gum, Virginia pine and white pine compete aggressively in the absence of fire. Routine fire is required to maintain adequate light to sustain yellow pines. Fire spreading over variable topography variation can create a mosaic of shrubs and herbaceous ground cover, and diverse plant structure begets a diverse animal community.

REBUILDING RESILIENCE

Pine-Oak Heath restoration requires a regime of very frequent, mixed-season burning of variable intensity, as well as a broad concept of what "restored" looks like. The result is an open woodland with site-specific blends of blueberry, huckleberry, forbs, grasses, bare soil, and abundant oak and pine regeneration. Strategic mechanical and/or chemical vegetation management can augment restoration.

OPPORTUNITY

High-severity wildfires create challenges, but a diverse plant community can be maintained throughout revegetation and the life of a stand by using frequent fire.

WOODLAND RESTORATION

Pine-Oak Heath offers excellent potential for restoring open structure using fire alone. Timber management is often infeasible, but the characteristic fire-adapted tree canopy can be sustained with frequent moderate- to high-intensity fire.

SHRUBS ARE THE NORM

Herbaceous plant coverage tends to be greater on less xeric sites, but ericaceous plants such as mountain laurel and black huckleberry are apt to dominate drier sites, even with routine burning. Soil moisture and chemistry can exert greater influence on plant distribution, relative to fire.

FREQUENCY

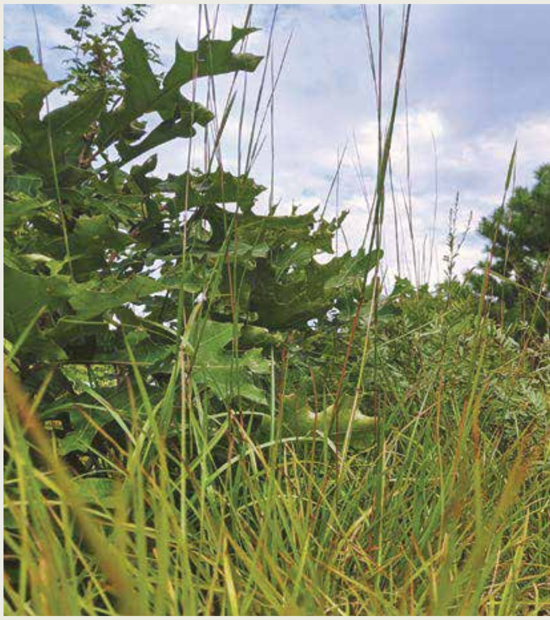
If canopy tree preservation is an objective, fire-excluded sites may need two or more moderate-intensity burns over the first two to three years to gradually reduce the fuel load.

Vegetation diversity can be maintained with a fire-return interval of about once every three to seven years, with variable timing and intensity.

Three or more burns may be required to elicit a positive response from characteristic plants: Allegheny chinkapin, little bluestem, panic grasses, coreopsis and sweet fern are among the species that begin to flourish after multiple, frequent burns.

Annual burning has resulted in open canopy and grass-

Pine-Oak Heath woodland burned by prescription and arson once every one to three years since 1998. Gravelstand Top, Cherokee National Forest, Tennessee. ▲



Diverse ground cover with pine and oak regeneration exposed to full sun. Gravelstand Top, Cherokee National Forest, Tennessee. ▲

dominated understory. A diverse forb component benefits from burning once every three years. Less-frequent fire tends to favor a greater proportion of understory shrubs and hardwoods.

A pause in burning for eight to 15 years may be warranted if an objective is to promote pine and oak survival and/or recruitment into the canopy. Historically, intervals such as this occurred episodically, perhaps once every 50 to 200 years.

INTENSITY

Fire burns with greater intensity and can lead to more severe effects, such as tree mortality, on dry, exposed ridges and upper south- and west-facing slopes.

Wind- and slope-aligned ignition (headfire) may be preferred if resetting to young forest or early succession is an objective.

Although fuels, aspect and exposed landform position make Pine-Oak Heath prone to high-intensity fire, severe effects are not required to restore characteristic open conditions.

Moderate-intensity fire is effective for maintaining an open understory and suppressing shrub and mesophytic trees. Sites tend to develop with trees of different ages because some trees are killed. Even-aged stands develop following catastrophic fire.

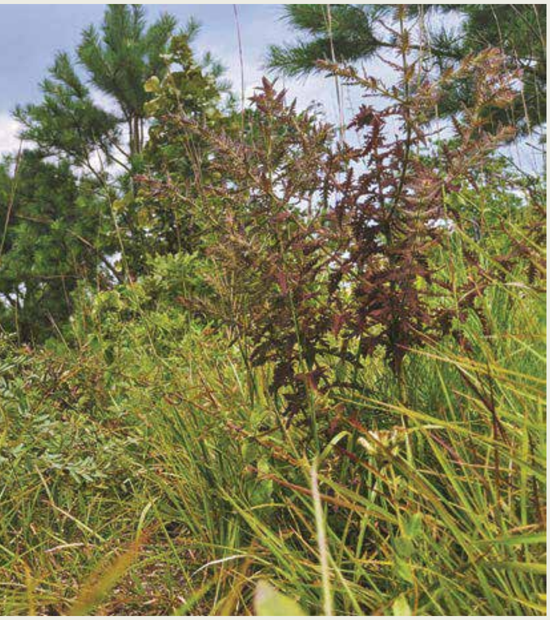
SEASONALITY

Most wildfire in the Blue Ridge is caused by humans. Fire activity peaks in April, October and November, coinciding with lower humidity and higher winds. Fewer ignitions and smaller fires result from lightning, the majority of which occurs in June.

Early to middle growing season can provide suitable burning conditions; however, closed canopy, heavy shrub cover and high fuel moisture limit the burn days that offer conditions suitable for sustaining moderate-intensity fire.

Dormant-season burning is effective for reducing accumulated fuel loads while minimizing tree mortality. Hardwoods over 4 inches in diameter are often not topkilled to the desired extent.

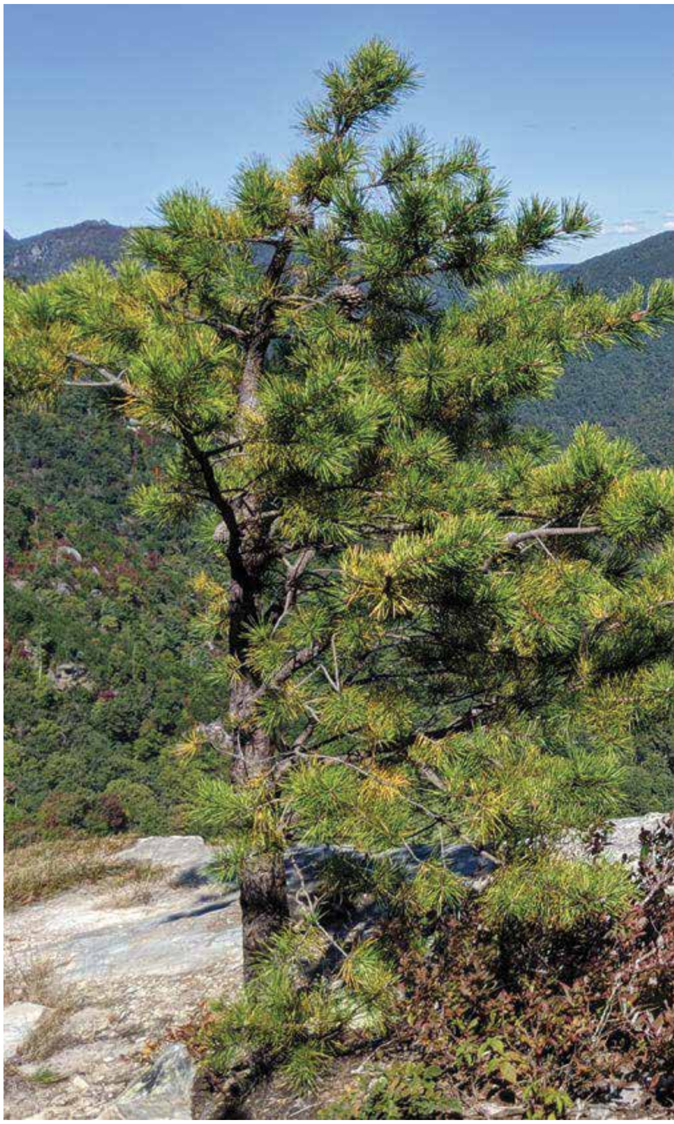
Transition to frequent, growing-season fire is ideal for long-term maintenance of Pine-Oak Heath. Perennial forbs and grass development, as well as a sparse midstory and open mixed woodland structure, are favored.



Fuels accumulate in the absence of fire and contribute to extreme fire behavior. ▲

LEFT: **Table Mountain pine may grow in shrub form. Linville Gorge Wilderness, Pisgah National Forest, North Carolina.** ▶

RIGHT: Pitch pine tends to grow straight. Chestnut Mountain, Chattahoochee National Forest, Georgia. ▶



PLANTS OF
Pine-Oak Heath

Much is left to be learned in the Table Mountain pine and oak heath system, but one fact is readily apparent. It is well adapted to fire and requires it to continue to exist. In a perfect world with unlimited resources and predictable weather, low-intensity burning every summer would best control competition with a periodic high-intensity winter fire that reaches the lower limbs of the crown; this would topkill some overstory trees and open cones just before the growing season. To my knowledge, this prescription has not been attempted.

— Tom Waldrop, USDA Forest Service (retired)

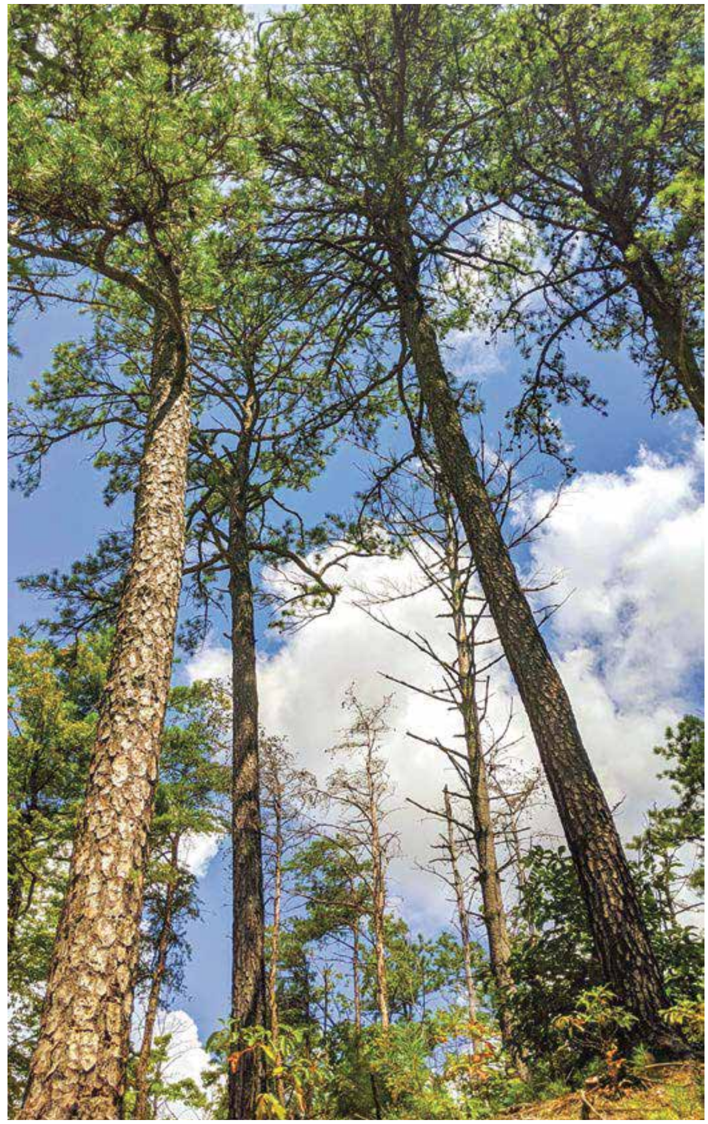


Table Mountain Pine & Pitch Pine

CHEROKEE NAME: *Natsĭ'*
SCIENTIFIC NAME: *Pinus pungens*

CHEROKEE NAME: *Natsĭ'*
SCIENTIFIC NAME: *Pinus rigida*

GROWTH FORM
Tree

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION

1,500- to 4,500-foot elevation; ridges and steep south- and west-facing slopes. Table Mountain pine is becoming increasingly restricted to the rock-dominated sites above 3,500 feet.

SOIL

Shallow, acidic, infertile and excessively drained with exposed rock.

Two stout, twisted needles and 3 inch cone characterize Table Mountain pine. ▲

ECOLOGY & LIFE HISTORY

These are two species that have long composed portions of the hardwood-dominated Appalachians. Conifer-dominated communities continue to decline in health and extent throughout the region.

Pitch is the dominant yellow pine in elevations from around 2,200 to 3,200 feet. Table Mountain pine is generally more prevalent above that level and shortleaf below.

Table Mountain pine is the rarest of the Blue Ridge yellow pines; it can be found only in the Appalachian Mountains. Pitch pine ranges east to the coast and north to Maine.

Conditions for these long-lived, light-loving pioneer species have been promoted by fire for thousands of years. The ideal establishment environment was created by early 20th century industrial logging and subsequent catastrophic fires.

Pitch pine grows up to 80 feet and has an average life span of 80 years. A mature Table Mountain pine generally tops out at 50 feet in height with many branches and stubs. It has a crooked form and irregular, sagging branches often in shrub form in fire-excluded sites. One individual that evaded the logging era exceeds 230 years old.

Pitch pine needles are twisted in threes. Cones mature in the fall. © Tab Tannery, Flickr ▲

Cultural Uses

Natsĭ (pine) branches were used for smudging a dwelling, also known as the Sacred Smoke Bowl Blessing. This could remove negativity such that as following the burial of a deceased family member. Smoke would attach to negative energy and remove it.

The evergreen foliage of pines symbolized long life.

The Cherokee used pitch pine for canoe construction as well as decorative carvings. The wood of pitch pine is rich in resin and short pieces were used as torches.

Presence of Table Mountain pine is directly correlated with slope aspect, which determines solar exposure, air and soil temperature, and evaporation rate. Yellow pines can germinate, establish and grow relatively quickly in a high-light environment.

Fire, beetles, drought, periodic ice events and land management drive the population dynamics of these species.

Fire confers an advantage to the fire-adapted pine. The absence of fire has resulted in few scattered stands where these species dominate the canopy.

Fire exclusion threatens the genetic diversity of Table Mountain pine; fire-intolerant species will come to dominate many pine sites.

The taproots and lateral roots of Table Mountain pine can grow through rock crevices with very little soil; mychorrizal fungi on root tips allow it to locate nutrients. Beyond these sites, pine seedling establishment and growth cannot compete with hardwoods in the absence of fire or other disturbance.

Pines can thrive in sandy soil, sometimes on broken rock where other trees cannot grow. Following fire, pines can provide soil stabilization services in an otherwise-erosive environment.

Fire in Carolina hemlock bluff within Pine-Oak Heath. © Gary Kauffman ▲

FIRE MANAGEMENT CONSIDERATIONS

HOT, FREQUENT FIRE

Moderate- to high-intensity fire is conjectured to have occurred historically about once every three to seven years. Pitch and Table Mountain pines depend on fire because it is the only disturbance that maintains a suitable seedbed and suppresses hardwoods. Table Mountain pine can persist for decades in the absence of fire, especially on dry, rocky sites. Periodic fire-free intervals allowed fuel to accumulate, often resulting in stand-replacement fire.

HIGH INTENSITY REQUIRED?

In fire-excluded sites or where mechanical thinning is infeasible, intense fire can help maintain a less-hospitable environment for shrubs and hardwoods. Mature pines can tolerate moderate- and high-intensity fire, but neither severe effects nor canopy removal is required for reproduction.

TIMING FOR REGENERATION

Spring and summer burning is ideal for these pines. If a goal is to improve seedling establishment, burning dry fuels in late summer or early autumn can expose mineral soil before pitch pine seeds fall.

SEEDS DIE ON DEEP LITTER

Pine seeds will dry out if the radicle cannot penetrate a deep litter layer. Survival is greatest with moderate shade and 3 inches of duff.

High-elevation pitch pine stand after burning.
© Ryan Jacobs ▲

How do we know these species need fire?

Insulation
Bark widens and trees become more fire tolerant with age. It protects critical tissues from temperatures that are lethal to most trees.

Serotiny
Table Mountain pine cones are the only species in the Blue Ridge that requires heat to release seed. Heat as low as 90 F melts the resin that keeps cones closed so seeds fall about two minutes after fire passes, which provides the advantage of falling on nearly bare ground. Serotiny varies among individual trees depending on aspect, tree density, shading of cones and fire frequency. Few pitch pines in the Blue Ridge exhibit serotiny, and seed is generally dispersed in fall.

Seeds
Table Mountain seeds become viable about every two to three years, suggesting a frequent fire regime. The seeds are the heaviest of the Blue Ridge pines, which allows for rapid establishment following fire. The size of both cones and seeds decreases with higher elevation.

Rooting and Sprouting
Tap roots bury deep in soil and are buffered from heat. Most pitch pines curve just above or slightly below the ground surface (basal crook) to allow rapid sprouting after topkill by fire. Pitch pine also sprouts from dormant buds along the trunk.

Resin Heals
Antibacterial properties of sap protect wounded pines from infection. Resin is antiseptic and anti-inflammatory, and the stickiness helps close wounds. People have used it to treat wounds for thousands of years.

Warm-season grasses require at least 50% sunlight.
© Tom Potterfield, Flickr ▲

Indiangrass

CHEROKEE NAME: *Selagwû'tsĭ usdí-ga*
SCIENTIFIC NAME: *Sorghastrum nutans*

GROWTH FORM
Grass

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION
Open woodlands and fields in exposed areas.

SOIL
Wide variety from rocky to clay; moderate to well-drained.

ECOLOGY & LIFE HISTORY

Indiangrass is a native, perennial, warm-season bunchgrass with short rhizomes, characterized by robust and upright growth over 6 feet. It features golden inflorescence and flat leaves up to 2 feet narrowing at the base.

Mineral soil contact is important for seed germination. Mature plants begin growing from rhizomes in the early growing season, peak mid-summer and mature by late growing season. Woody competition limits the production of side shoots (tillering).

Native grasslands are among the most threatened ecosystems in the southern U.S. The roots of native grasses are resilient to drought, with root systems that can reach 16 feet below the surface.

Soil organic matter from root biomass promotes soil stability, filters toxic compounds, facilitates water infiltration and can reduce runoff volume by 75%, compared with turfgrasses.

Many species of grasshoppers and caterpillars eat the foliage. Grassland birds and small mammals consume seeds in autumn. Indiangrass is nesting material and cover for wild turkey, grasshopper sparrow, indigo bunting and prairie warbler.

Bunchgrass structure allows for mobility for small wildlife such as quail and young turkeys. Dense woody vegetation limits movement and the ability to find seeds and invertebrates; contributing to population decline. Fresh growth of indiangrass is highly palatable and a source of protein for herbivores until mid-summer.

Native grasses with similar attributes that often co-occur with indiangrass include: big bluestem, little bluestem, broomsedge bluestem, switchgrass, eastern gamagrass and sideoats grama. (See appendix for additional species.)

Indiangrass in flower. © Joshua Mayer, Flickr ▼

FIRE MANAGEMENT CONSIDERATIONS

FIRE AND REPRODUCTION

Mature plants sprout from rhizomes soon after fire. Indiangrass should establish on pine and oak sites if just a few individuals exist and conditions are open. Grass stem density declines as woody cover increases after about three to five years without fire; at least 50% sunlight is optimal for the growth of warm-season grasses.

GROWING SEASON

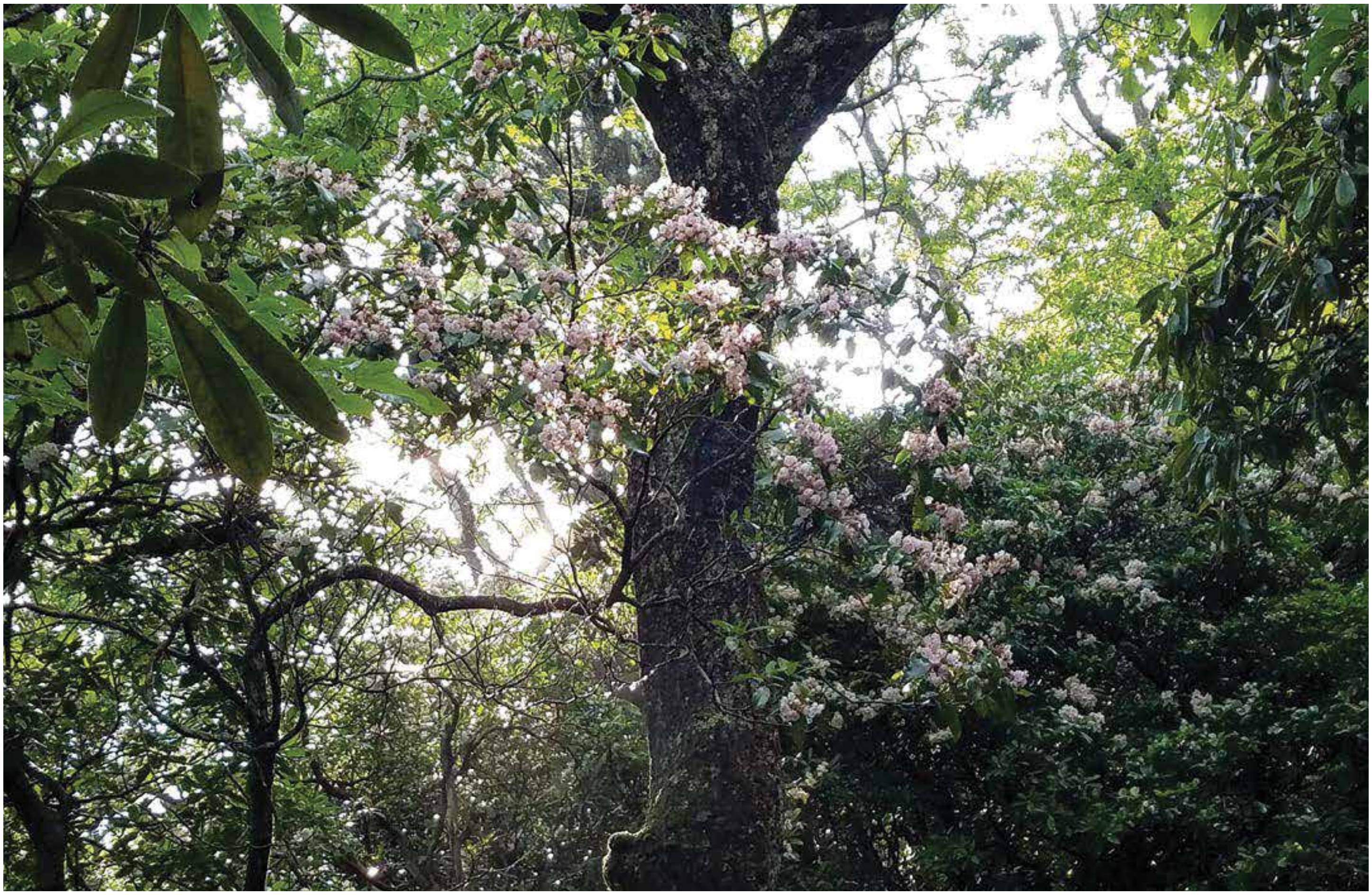
Cover and density increase after early-growing season burns; vigor and flowering improve. Fire in the late summer can stimulate forbs and thin grasses. Fire may be high intensity during this time and can reduce tiller density, but grasses fully recover by the following year.

WOODY STEMS WINTER BURNS

Topkilling woody vegetation with fire during bud break (spring) slows the rate of regrowth. Root carbohydrate reserves are highest for woody plants in winter, so growth rate is greatest following winter burns, compared with spring and early summer. Fire-free intervals beyond two to three years allow full restoration of root reserves.

FREQUENT AND HOT

Large senesced grasses contribute to fire behavior and facilitate spread at moderate intensity. Maximum indiangrass flowering and production occurs with annual burning.



Thickets limit light available to understory plants.
© Matthew Vaughan ▲

Mountain Laurel

CHEROKEE NAME: *Dusúga tsundí-ga*
SCIENTIFIC NAME: *Kalmia latifolia*

GROWTH FORM
Shrub

FIRE TOLERANCE
Moderate

FIRE ADAPTEDNESS
Moderate

LOCATION
South-facing upper slopes ridges and hillsides with sparse tree canopy.

SOIL
Acidic, dry and well-drained.

ECOLOGY & LIFE HISTORY

This species is a native, perennial, ericaceous shrub that can reach 14 feet tall and is found in varied environments throughout eastern North America.

Laurel is moderately shade tolerant and optimal growth occurs under full sunlight. However, it grows only from April through June with each stem adding only 5 inches in height and 3.5 inches in width each year. It has high water use, is efficiently drought tolerant, and dense stands compete for water on dry, exposed sites.

Primary reproduction is vegetative through basal sprouting, layering and suckering. Rhizomes can extend close to 3 feet below ground, insulated from fire.

A thicket is multiple individuals in close proximity with intersecting branches, sometimes with thousands of stems per acre.

Fire exclusion, as well as pest and disease-related tree mortality, have contributed to laurel abundance today. One study revealed that some of the oldest individuals were established soon after the fire suppression era began; five to ten foot tall plants can be up to 75 years old.

The tannic, low-nutrient leaves acidify soil as they accumulate and slowly decompose. Litter quality is reduced and the nitrogen and phosphorous is decreasingly available to other plants.

Bears den in laurel thickets. Deer may browse leaves only when food is scarce. Bumblebees are the primary means of insect pollination.

Showy pink and white flowers in mid-summer. © Matthew Vaughan ▲

Cultural Uses

Indigenous Appalachian people would not burn any part of dusúǵa tsundí-ga because it would destroy the species' medicinal qualities and bring an early winter.

An elixir extract from mountain laurel, rhododendron and doghobble was applied to skin for rheumatism of the knee. Laurel was also known as "spoonwood" and was used to make eating utensils.

Laurel is a popular landscape plant today, with more than 100 varieties. John Bartram sent plants back to England in 1740 for ornamental use.

FIRE MANAGEMENT CONSIDERATIONS

HISTORIC FIRE

Historically, periodic surface fires would have routinely consumed low-branch layering and topkilled shrubs; dense, expansive thickets would have been a more limited occurrence.

BURN, REPEAT

Fire limits the establishment and spread of laurel; coverage can be reduced if it is burned about once every three years.

OAK AND PINE REGENERATION

Reducing laurel cover to less than 30% may be necessary for oak and pine regeneration. No technique (chemical, mechanical, fire) has proven effective for controlling laurel if done less frequently than once every three to four years. Thickets can redevelop within five years after fire.

ALTERNATIVES TO FIRE?

Slopes greater than 40% and exposed rock can make mastication challenging. August has been an optimal time for chemical treatment. Imazapyr can completely kill laurel within a few years, whereas sprouts emerge two years after tri-clopyr is applied. Andromedotoxin in leaves is poisonous to livestock, so prescribed herbivory is infeasible.

SPROUTS FOLLOWING FIRE

The vigor of mature root systems is a challenge to managers. Laurel sprouts prolifically from basal burls and rhizomes, seemingly regardless of fire season or severity. However, shoots are slow to develop, allowing oaks and pines the chance to compete.

FLAMMABLE LEAVES

Laurel leaves have relatively low moisture content. Older leaves are driest in early summer, whereas new leaves in spring have more moisture; but overall the leaves of plants on dry sites have less moisture. Dead twigs and leaves can remain attached for some time, and terpene content contributes to flammability. Thickets can produce flames up to 100 feet tall.

BURN AND LEARN

The effectiveness of broadcast herbicides that both kill laurel and prevent redevelopment of thickets is unclear. It is unknown whether intense fire can kill laurel completely, nor which season of burning is most effective. The extent to which laurel's allelopathic compounds can inhibit hardwood seed germination and establishment requires further study.

Laurel thicket burned at high intensity and basal sprouting. © Matthew Vaughan ▶

Legumes often flower prolifically following fire, which attracts pollinators.
© M.C. Barnhart, Missouri State University ▲

Goat's Rue

CHEROKEE NAME: *Distaíyĭ -or- su ah s gi*
SCIENTIFIC NAME: *Tephrosia virginiana*

GROWTH FORM
Forb

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
Moderate

LOCATION
Abundant sunlight in open woods and steep terrain including glades and barrens.

SOIL
Sandy, rocky, well-drained and acidic.

ECOLOGY & LIFE HISTORY

Goat's rue is a herbaceous, long-lived perennial legume up to 2 feet tall and characteristic of pine-oak woodlands.

Dissected leaves on a hairy stem with bi-colored, irregularly shaped flowers (yellow base and pink wings) in summer. The flowers depend on bees for successful pollination.

The long, thin, and tough roots help resist drought. "Devil's shoestring" is derived from the nitrogen-fixing roots.

Germination occurs from March to June, and fruiting occurs from July to October. Seeds can remain viable for several years.

Northern bobwhites, wild turkeys, brown thrashers and field mice all depend on seeds of wild legumes like goat's rue and partridge pea as fall and winter food.

Cultural Uses

During the late-summer and early fall dry periods, mountain stream flows are generally low and concentrate fish in pools. Indigenous people ground up goat's rue, or the "fishing plant," and buckeye nuts on posts. The poison extracts, rotenone and aesculin, respectively, would disperse in the water and paralyze fish, which would float to the surface. Goat's rue leaves were used in decoctions to wash.

Slivers of hickory or oak were tipped with rotenone and used as blowgun darts. Rotenone was used in World War II to kill lice in trenches. Today it is used as an insecticide in homes and gardens, and applied topically to pets for flea and tick control.

The legume of goat's rue contains multiple seeds, which is food for birds and small mammals. © Randy Shonkwiler, iNaturalist ▲

FIRE MANAGEMENT CONSIDERATIONS

FRUIT FROM FIRE

Fire topkills leguminous forbs but stimulates fruit production and encourages shoot growth from dormant buds. Mid-winter and early spring burning are ideal timing to promote the growth of legumes.

FLOWERING

Flowering is subdued during years without fire, and burning can decrease the percentage of seeds that germinate in the year goat's rue is burned.

MIX IT UP

Fire affects the duration and timing of flowering in legumes and other forbs, but timing varies considerably regardless of fire. If maximum floral diversity is a management goal, varying burn season avoids favoring specific species or groups. Variation enhances wildlife food availability over a greater period of time.

Goldenrod and mixed herbs in a high light environment.
© Tom Potterfield, Flickr ▲

Fragrant Goldenrod

CHEROKEE NAME: *Na'tsiyústĭ útana*
SCIENTIFIC NAME: *Solidago odora*

GROWTH FORM
Forb

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
Moderate

LOCATION
Full sun to light shade of woodlands, open forests, old fields and grasslands.

SOIL
Well-drained, loamy, acidic to neutral soil.

ECOLOGY & LIFE HISTORY

This clonal herbaceous perennial is composed of several smooth stems, 2 to 4 feet tall and rising from rhizomes to form loose clumps. It has dark green anise-scented leaves.

Goldenrod reproduces by rhizomes and wind-dispersed seed. Plume-like yellow clusters of flowers bloom from middle to late summer. Ramets die back to the rhizome each winter.

Allelopathic chemicals in goldenrod suppress competition from other plants, which creates patches.

Over 50 goldenrod species in the southern U.S. provide an important source of nectar for native bees as well as moths and beetles, which draws predators like the praying mantis. Larval insects feed on the stem.

Deer, rabbits, grouse and turkeys may eat the leaves, while American goldfinches, dark-eyed juncos and song sparrows eat the seeds. Downy woodpeckers and chickadees forage insects from the plant.

FIRE MANAGEMENT CONSIDERATIONS

RESPONSE TO FIRE

Recovery following fire is vegetative, via clonal spread and rapid resprouting from rhizomes and stem crowns. Spring burns favor taller growth.

WAITING FOR AN OPPORTUNITY

Flowering declines over time if there is shade from woody stem encroachment. Individuals can persist in a suppressed state storing resources for post-fire sprouting.

FIRE IMPROVES VIGOR

Following fire, clonally produced individuals are larger and likely to flower earlier and produce more seeds than seedlings.

FORBS CARRY FIRE

Green summer growth is generally unlikely to ignite. Senesced, cured late-summer fall foliage will contribute to fire intensity through winter and into the following spring.

MORE TO LEARN

Effects of season, frequency and intensity of fire on fragrant goldenrod and other forbs and ferns need further research.

Cultural Uses

Goldenrod was important to the Cherokee as a cold remedy, cough medicine, diaphoretic, antipyretic, and remedy for tuberculosis, measles and neuralgia. Today, chemicals derived from plants are an ingredient in 25% of all prescription medications in the U.S.

Despite a bloom of similar color and timing as ragweed, goldenrod does not generally cause the itching and sneezing associated with hayfever. Goldenrod pollen is too heavy to be carried in the air.

Caterpillars feed on goldenrod leaves. © Tom Potterfield, Flickr ▶

Late May to early June is a good time to find turkeybeard flowering.
© Tom Potterfield, Flickr ▲

Eastern Turkeybeard

CHEROKEE NAME: *Unknown*

SCIENTIFIC NAME: *Xerophyllum asphodeloides*

GROWTH FORM
Forb

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION

Generally western aspects and ridge top pine woodlands and bluffs as well as pine heath balds.

SOIL

Rocky, coarse texture, well-drained acidic and infertile.

ECOLOGY & LIFE HISTORY

This uncommon grass-like lily is in the same family as trilliums. It is a clump-forming perennial that occurs in areas with historically frequent fire and is among the definitive fire-adapted forbs of the Blue Ridge.

Eastern and western turkeybeard (*Xerophyllum tena*) are the only two North American species in the genus. Western turkeybeard is commonly known as beargrass and it has been studied more extensively.

Reproduction is both via sprouting from rhizomes and flowering. May-June flowers do not produce nectar, but the pollen is consumed by a variety of flies, cerambycid beetles and bees. Reproduction appears to depend on soil temperature, largely as a function of disturbance, light transmission, elevation and aspect.

Turkeybeard is long-lived and it may be several years before an individual flowers. The clump then dies and new sprouts emerge.

Eastern turkeybeard phenology (growth, development, fire effects, climate change response) is not well understood. It is threatened in Tennessee and rare in Georgia. Threats include development or habitat conversion to pine plantation, canopy closure, fire exclusion and subsequent shrub encroachment as a result of fire exclusion.

Cultural Uses

Turkeybeard has been used by the Cherokee for clothes and basketry. Western tribes, including the Yurok, Karuk and Hupa, burn to maintain beargrass. It is used extensively in basketry and regalia and is an edible delicacy.

Basketry is an art and a medium through which identity and cultural knowledge are passed down through generations. Baskets are "symbols of identity" for families and tribes. A basket showcases the skill of the weaver and often portrays tribal history and mythology.

FIRE MANAGEMENT CONSIDERATIONS

FIRE INDICATOR

Turkeybeard is representative of eastern montane fire-adapted natural communities.

REPRODUCTION NEEDS LIGHT

Fire manages shrub encroachment, reduces duff and leaf litter, and increases sunlight. Synchronous flowering and seed production are significantly reduced in shade.

FIRE ADAPTED

Basal leaves protect the apical meristem from fire similar to grass-stage longleaf pine. Roots can survive high heat and leaves sprout within five months of high-severity fire.

WHEN IS THE BEST TIME?

While ideal burn season is not well understood, not burning is more detrimental than fire in any specific season. Spring sprouts invariably follow dormant-season burns. Growing-season fire better manages hardwoods to enhance light for forbs.

HOT FIRE...NO PROBLEM

Soil buffers rhizomes from heat. While high-intensity fire can damage the meristematic tissue situated between organic matter and mineral soil, seedlings can germinate and establish in areas with exposed mineral soil. Vigorous populations can be found in areas burned by wildfire.

Small patches of turkeybeard can survive, but growth and flowering is greatly reduced as shrubs encroach. © Eric Ungberg, iNaturalist ◀

ECOLOGICAL ZONE

Shortleaf Pine-Oak

ECOZONE	RESTORATION-FIRE FREQUENCY	MAINTENANCE-FIRE FREQUENCY
SOUTHERN APPALACHIAN LOW-ELEVATION PINE	2-3 YEARS	3-5 YEARS

EXTENT
626,000 acres

ELEVATION
Below 2,400 feet

LANDFORM
Lower, middle and upper convex slopes, exposed or sheltered; low hills and ridges.

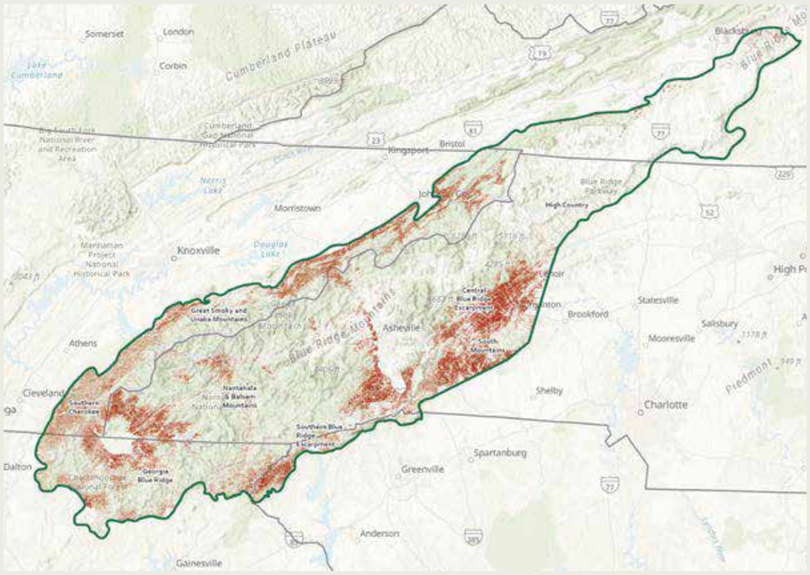
CONTEXT
Blends with acidic and rich cove, Dry and Dry-Mesic Oak, Pine-Oak Heath and alluvial floodplain.

SOIL
Well-drained, acidic and low to moderate fertility.

NATURAL DISTURBANCE
Wind, ice, frequent fire and co-occurrence of drought.

EMBEDDED COMMUNITIES
Spray cliffs, low-elevation granitic domes, seeps, bogs and fens, canebrakes, and glades.

Grass response following thinning and burning in Shortleaf Pine-Oak. Foothills Wildlife Management Area, Tennessee. ▲



Shortleaf Pine-Oak can largely be found throughout the Blue Ridge, but to the greatest extent in the escarpment landscapes (Georgia, Southern and Central Blue Ridge) and western slopes of Great Smoky Unaka Mountains landscape. ▶

ECOLOGY

The physical setting, fire regime and management history determine vegetation structure and composition. Models suggest 3% of this ecozone should be closed canopy. Shortleaf and white oak often co-dominate, with more oak on fertile sites and/or where fire may be less frequent and severe. Other canopy trees include pitch and Virginia pine, hickory, black gum, chestnut oak and various red oaks. A greater proportion of white pine and red maple is characteristic of fire-excluded sites. Lower exposed slopes and rocky ridges in the peripheral Southern Blue Ridge often contain more southern red oak, chestnut oak and sourwood.

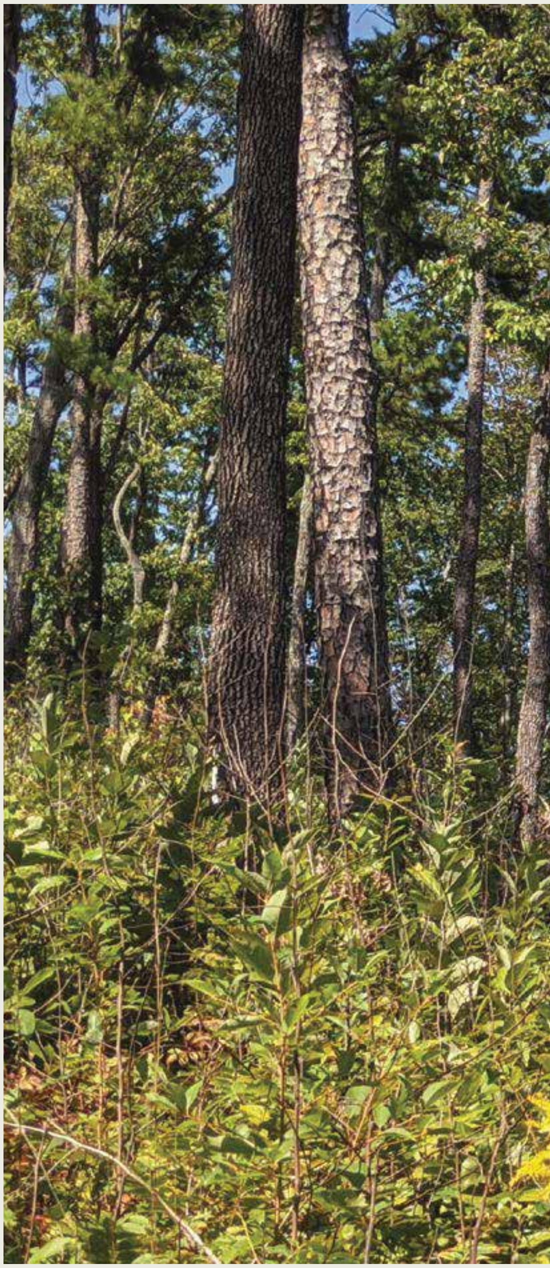
The understory is composed of various forbs characteristic of dry sites with grasses, mountain laurel and blueberry in the understory. Shortleaf Pine-Oak sites are conducive to agriculture and timber management, so land-use history has influenced the composition of most sites.

Understory structure greatly influences the bird species present. Since 1970, no bird guild in North America has experienced a greater decline (53%) than grassland birds due in part to fire exclusion and loss of nesting and foraging habitat; 74% of grassland birds are declining. The range of red-cockaded woodpeckers once included the Blue Ridge, but it has not been seen there since the 1970s. Northern bobwhite have nearly disappeared from the mountains in large part due to the loss of brood-rearing and nesting habitat in open pine woodlands; historical presence suggests an open landscape of diverse forbs and grasses with patches of shrubs and bare ground.

Eastern whip-poor-will and chuck-will's-widow have declined precipitously since 1960. Both species prefer open ground for nesting and uncluttered forest to provide for efficient foraging for moths and beetles. Similarly, an open midstory under mature pines and hardwoods provides hoary bats and other large-bodied bats efficient maneuverability. Both species richness and density of small mammals and songbirds are greater in mature, fire-maintained shortleaf woodlands, compared with closed-canopy forest.

Beetle outbreaks and mortality events are likely more widespread than what occurred historically. Trees stressed from competition in fire-excluded forest and overstocked pine plantations are vulnerable to drought, pests and disease.

SHORTLEAF PINE-OAK COMPOSITION



Shortleaf Pine-Oak woodlands are very rare in the Blue Ridge. Pine Mountain, Sumter National Forest, South Carolina. ▶

CULTURAL IMPORTANCE

Bluffs situated above river floodplains near historical villages are largely shortleaf and white oak, which would have provided abundant seasonal foods. Native people annually burned in late summer and fall to facilitate chestnut and acorn harvest.

Frequent burning promotes lush plant growth, fundamental deer forage high in protein, phosphorus and calcium. Burned areas likely would have attracted deer, elk, bison and various game animals because the nutrition, palatability, and availability of grasses and forbs are enhanced.

Indigenous burning promoted disturbance-dependent plants for food and other uses. The first military and missionaries described abundant woodland strawberries that stained the horses' hoof and pastern. Hog peanut was reportedly a common vine climbing tall trees. The beans were prepared similar to pintos.

Turpentine extract was used as an antiseptic for wounds, and pine needles were used in various decoctions (boiling in liquid). Pine was commonly used for construction as well as fuelwood.

CONSERVATION CHALLENGES

VANISHING WOODLANDS

Prior to European settlement, pure and mixed shortleaf forests covered 70 to 80 million acres of the South, but only 6 million acres, or about 10%, remain.

DENSE WOODY VEGETATION

High stem density is characteristic of fire-excluded sites, with white pine, Virginia pine and red maple in all layers and extensive shrubs; relict small patches of sun-loving grasses, legumes, asters and other pollinator-friendly forbs are scattered and relegated to mowed rights of way.

FIRE RECEPTIVITY DECLINING

Leaves of the common mesophytic trees absorb and hold more moisture and require longer to dry and become available to burn. Minimal sunlight and diminished air flow within dense forest further inhibits ignitability, thereby limiting the number of burn days.

NO REFERENCES – NOVEL FIRE

The Blue Ridge contains very few high-quality sites where an open canopy and understory have been maintained with frequent burning. Departure from the historic vegetation

OUT OF WHACK

Models suggest that currently more than 90% of Shortleaf Pine-Oak is closed canopy forest and historically just 3% was closed canopy.

Sun-loving plants are largely absent under a closed canopy. ▲

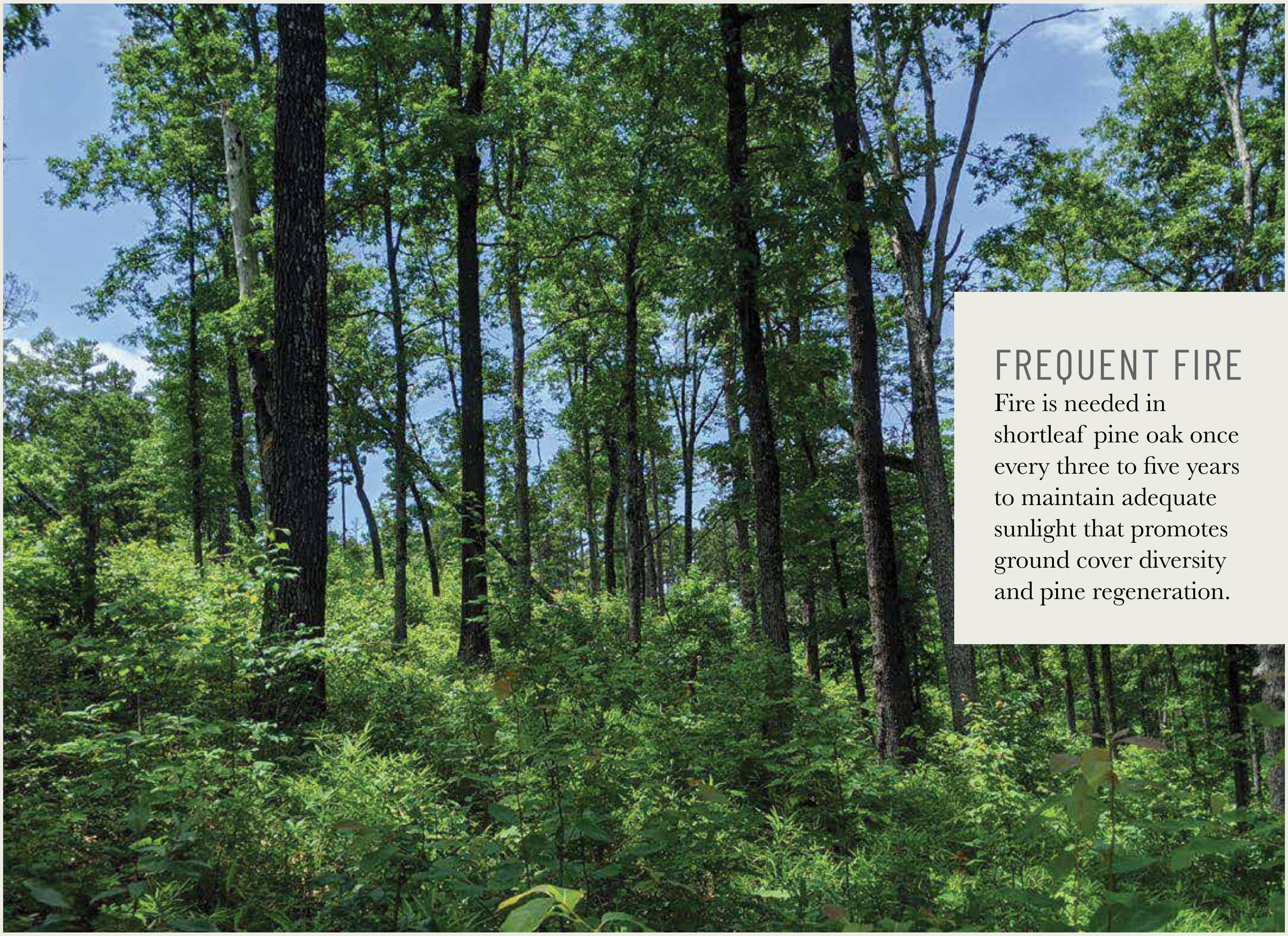
structure and composition has altered expected fire behavior. Where fire is infrequent, live and dead vegetation accumulate and drought-induced wildfire can result in significant morality of valuable, mature trees.

PINE BEETLES

Outbreaks in the 1990s decimated large swaths of shortleaf across the range. Beetle defense and stand resilience are often compromised in overstocked stands. The compounding effects of mild winters, drought, ice and wind events are exacerbated in such stands. Diminished air flow in dense stands can allow beetles to detect other feeding beetles, which facilitates spread. However, better resin flow has been observed in the vigorous trees within appropriately stocked stands, which helps trees expel beetles and lessen the likelihood of stand mortality.

PATIENCE

Many cycles of fire have been missed. Restoration, especially using fire alone, will require multiple burns to transition from closed to open structure and species composition characteristic of open forest or woodland.



FREQUENT FIRE

Fire is needed in shortleaf pine oak once every three to five years to maintain adequate sunlight that promotes ground cover diversity and pine regeneration.

Open canopy, abundant light, hardwood tree regeneration and herb ground cover. Sumter National Forest, South Carolina. ▲

Low-intensity, winter burning can help reduce fuels before higher intensity, growing-season burning can be incorporated to restore ground cover and improve conditions for shortleaf regeneration. Sumter National Forest, South Carolina. ▲

FIRE MANAGEMENT

OPENING UP WITH FIRE AND CUTTING

Restore open conditions by removing plantation pines and reestablishing frequent, mixed-severity fire across varying seasons. Herbaceous ground cover responds favorably to stand improvements that allow sunlight to penetrate the canopy. Recurrent fire steadily reduces woody stem density over time and maintains high ground cover productivity with goldenbanner, asters, coneflowers, little bluestem, lespedeza, sunflowers and legumes.

SUNLIGHT AND WILDLIFE

A variety of plants enhances pollinator habitat, deer browse, and attracts small mammals and their predators. Recurring, frequent fire maintains habitat for grassland birds, in addition to mid- and late-successional species. Increased available nitrogen following fire often stimulates a flush of forbs and grasses, even under closed canopy; long-term maintenance of diverse herb ground cover will be limited unless at least 20% to 30% of full sunlight reaches the ground.

CONDUCIVE TO THINNING

The terrain where Shortleaf Pine-Oak often occurs is gentler, so sites are generally accessible relative to Blue Ridge topography. Mechanical stand improvement can be profitable, and shortleaf can be burned frequently to promote forbs integral to breeding and brood-rearing habitat for northern bobwhite and songbirds that require similar vegetation structure.

MECHANICAL ADVANTAGE

Midstory mastication can cost anywhere from $300 to $1,400 per acre and may be feasible for up to a 45% slope. A small saw crew can greatly improve the light environment for up to about five acres of forest at the cost of around $3,000 per day.

FREQUENCY

One low-intensity restoration burn following extended fire exclusion often does little to reduce the shrub and sapling competition. A minor increase in light should be expected.

Abundant shortleaf seedlings under mature tree and full sun. One burn every three to five years. Rifle Range, Sumter National Forest, South Carolina. ◀

Shortleaf seedling establishment is improved by burning once every three to four years. Annual and biennial burning favors grasses over forbs and generally results in fewer surviving seedlings. A burning hiatus of one fire over eight to 12 years may be necessary, if management goals are to increase seedling survival and/or overstory recruitment.

INTENSITY

Fuel moisture, composition and arrangement determine fire intensity, along with weather and topography. During a burn, the ignition strategy is the only variable that can be adjusted to alter the fire intensity for desired objectives.

A mature shortleaf pine is at least as fire resistant as a longleaf. Pitch pine is also highly resistant, so frequent moderate- to high-intensity fire in will favor shortleaf and pitch pine over oaks. Lower-intensity burning (flame lengths below 2 feet) can effectively manage shrub density and increase forbs and grasses, if it is consistent and frequent.

Canopy openings created by high-intensity fire are more likely to occur on dry, sun- and wind-exposed sites. Dense pine regeneration often results from hotter fires.

SEASONALITY

Seasonal timing has less effect on the growth or mortality of yellow pines and overall vegetation structure, compared with the frequency of burning. Burning every three to five years, varying intensity and timing, maintains suitable conditions for shortleaf and herb ground cover.

Two or more winter burns may be needed to reduce heavy fuel loads in fire-excluded sites, more or less depending on the fuel consumption of burns.

If relatively frequent and repeated, spring and summer burns have been effective for managing shrub and hardwood sprouting. Carbohydrate reserves in the roots of woody plants decrease during active growth, from spring to midsummer; then recover until the following spring. Sprouting after growing-season fire is often less vigorous because there are fewer available resources.

In spring, consideration is given to the potential for rapid drying of duff because transpiration is high; fine roots can be killed by high heat and result in tree death. Fine roots generally grow farther down through mineral soil during the summer dry periods. The benefits of late-summer burns include increasing available light for shortleaf seedlings and consuming most of the leaf litter just before seed fall.

Historically, open forests and woodlands would have facilitated fuel drying. But modern Appalachian forest conditions of closed canopy and dense evergreen shrubs limit ignitability and the intensity of spring and summer burns. Slow-drying fuels lead to fewer burn days per year, and the shade from dense woody vegetation diminishes the likelihood of obtaining desired fire behavior throughout the year.

Shortleaf characteristics: short needles 3 to 5 inches long in bundles of two or three; thick, reddish-brown, platy bark with resin pockets and small cones that mature in the second year. ▲

PLANTS OF Shortleaf Pine-Oak

Early settlers and government land office surveys describe pine dominated and mixed pine-oak forests as open woodlands where sunlight reached the ground and a diverse assortment of native wildlife flourished. These forested landscapes represent an extraordinary diversity of cultural, ecological and economic values centered on wildlife and recreation, water quality, and a high-value wood products industry. With millions of people depending on the values and benefits of this imperiled ecosystem, the need to develop a range-wide conservation strategy is more compelling than ever.

— The Shortleaf Pine Restoration Initiative

Shortleaf Pine

CHEROKEE NAME: *Natsĭ'*
SCIENTIFIC NAME: *Pinus echinata*

GROWTH FORM
Tree

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION
Dry, rolling hills below 2,500 feet elevation; preference for south- and west-facing slopes.

SOIL
Deep, well-drained, coarse to loam texture is best, but widely variable; tolerant of wet environments.

ECOLOGY & LIFE HISTORY

This slow-growing conifer can reach 130 feet tall and 36 inches in diameter. Fossilized charcoal and pollen supports co-evolution of shortleaf with mixed-severity fire once every two to 18 years.

Shortleaf has the broadest range of the southern pines, but pure stands are not nearly as common as those codominated by oaks and pines.

Early foresters recorded old-growth shortleaf stands with various age classes and numerous canopy gaps. Areas with greater fire frequency had fewer trees and were more open.

A few months after germination, shortleaf and pitch pine form “J”-shaped crooks just below ground. Dormant buds are protected from flames, which allows rapid sprouting after fire. Sprouting recurs until it reaches 8 inches in diameter or about 30 years old.

Resinous needles facilitate fire spread and the maintenance of fire-adapted ecosystems. Thick, platy bark insulates the cambium from fire. Shortleaf cones are typically not produced until the tree is 20 years old. Abundant seed in autumn can disperse about 150 feet.

Suitable sites for shortleaf have been lost to development, fire exclusion, conversion to loblolly plantation, and pine beetle and disease outbreaks in poorly managed stands.

Shortleaf in appropriately managed stands are better able to repel pests;

Cultural Uses

Shortleaf is a resinous hard pine. The strong, straight-grained wood was important to Indigenous people for canoe and home construction as well as carving wood. Turpentine was used as a wound ointment and rich "pine knots" were used as torches. Turpentine was later used to seal roofs of homes and waterproof ships and ropes, as pines were integral to early European settlement.

By the 1770s, naval stores (products derived from pine resin) were North Carolina's most important industry and responsible for 70% of the tar and 50% of the turpentine exported from North America. Today, the primary use of shortleaf is in log home construction.

Young shortleaf endure frequent fire, so light-loving herb ground cover is maintained. © Toby Gray ◀

resist wildfire, ice and wind damage; and endure drought and flooding. No wildlife species require shortleaf pine specifically, but many wildlife species depend on pines. An open tree canopy with herb-dominated ground cover, meets habitat requirements for several breeding birds.

Patches of bare ground in herbaceous vegetation make seed available to birds. Ground-nesting bees benefit from the close proximity of nesting and foraging habitat. Open ground heats up first in the morning and provides warming areas for lizards and snakes.

FIRE MANAGEMENT CONSIDERATIONS

SUNLIGHT: THE LIMITING FACTOR
Young shortleaf trees have ended up surviving up to 50 years shaded by a closed canopy, but without fire and sunlight they cannot compete with shade-tolerant hardwoods. Anything less than 50% full sunlight is generally inadequate for seedling growth and development. Sites that support continuous recruitment have abundant light maintained with fire, dry soil, scattered shrubs and copious grasses and forbs.

MINERAL SOIL
Fire exposes bare ground critical for pine seedling establishment. Good survival results with sunlight and 2 to 4 inches of duff; the radicle of a pine seed cannot infiltrate deep litter to mineral soil.

HOW OFTEN? HOW HOT?
To restore and maintain diverse herbaceous vegetation under mature shortleaf, the fire-return interval should be at least one burn every three to five years. Moderate- to high-intensity fire may be needed to topkill larger hardwoods. Shortleaf can endure high-intensity fire; it is less susceptible to wounding than longleaf pine.

THE TOOLBOX
Management goals to expedite restoration of open conditions and encourage regeneration for shortleaf-pitch-oak sites often require canopy-thinning basal area to around 60 square feet per acre. Retaining oak and hickory benefits wildlife and the litter facilitates fire spread. Herbicide application to undesirable trees is helpful for expediting restoration of a good light environment.

FIRE-EXCLUDED SITES
Duff accumulated from fire exclusion can smolder under dry conditions — roots anchored into the duff can be killed, as can the cambium near the root collar.

VULNERABLE TO BEETLES
Shortleaf pine is susceptible to pine bark beetle infestation. Stressors include fire exclusion and consequent competition in dense forest, and drought predisposes forests to infestations that can result in stand-level mortality.

STARTING OVER
If shortleaf establishment is a goal in a site where few mature shortleaf exist, a hot burn about six months after tree removal consumes slash, exposes soil and topkills hardwood sprouts to provide a good conditions for planted trees. Young shortleaf can resprout several times after topkill by fire, and a tree need only be 1.5 inches in diameter to survive fire, and topkill is often minimal for trees over 3 inches in diameter. Once a stem reaches four inches in diameter, sprouting potential begins to decline. A hiatus from fire for eight to 12 years may be warranted for recruitment, but may be necessary only once every 150 years.

YOUNG SHORTLEAF
Fire topkills most shortleaf seedlings, but survival is good even if the crown is scorched. Repeated topkill can prevent maturation to sapling stage. Improved survival of one- to three-year-old seedlings has been observed after spring and late-summer burns, compared with mid-summer.

Smoke production from first-entry burns in long fire-excluded sites is an important consideration. At most, smoke can linger one to two days following, but emissions decrease over successive burns. Whereas wildfires can burn for weeks or months and have serious implications for human health. Tallulah Gorge State Park, Georgia. ▲

At least 50% of full sun is required for maximum berry production. ▲

Hillside Blueberry & Hairy Blueberry

CHEROKEE NAME: *Kuwáya'*
SCIENTIFIC NAME: *Vaccinium pallidum*

CHEROKEE NAME: *Kuwáya'*
SCIENTIFIC NAME: *Vaccinium hirsutum*

GROWTH FORM
Shrub

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
Moderate

LOCATION

Wide variety of elevation, solar exposure and water availability.

SOIL

Widely tolerant but commonly shallow, acidic and well-drained.

ECOLOGY & LIFE HISTORY

Ericaceous shrubs of hillside blueberry are widespread throughout eastern pine and dry oak woods. Hairy blueberry is endemic to the Southern Blue Ridge.

Hillside blueberry grows up to around 21 inches in height; hairy blueberry may reach 28 inches. Shallow, fibrous roots form extensive colonies to maximize water absorption. The taproot can be 3 feet below ground.

Blueberries are pioneer plants that establish after major disturbance but persist through late-successional stages of forests and woodlands.

Blueberry plants reproduce by seed, but clonal expansion via rhizomes is the primary mode of regeneration, especially in the absence of disturbance. Individuals sprout from the base of burned (or unburned) stems.

Flowers were historically pollinated by wild bumble bees (*Bombus*) and mining bees (*Andrena*). European honeybees (*Apis*) are most common today, but about four times less effective at pollination than wild bees.

Fruit production is influenced by sunlight, weather, pollinator availability, genetics and available nutrients when buds begin growing. Black bear reproduction is influenced by berry crops; ruffed grouse, northern bobwhite, black-capped chickadees, red foxes, red-backed voles, skunks and mice consume berries; and rabbits and deer browse the leaves.

Additional blueberry species of the Southern Blue Ridge include: southern mountain cranberry (*V. erythrocarpum*), deerberry (*V. stamineum*), highbush blueberry (*V. corymbosum*), mountain highbush blueberry (*V. simulatum*) and southern blueberry (*V. tenellum*).

Cultural Uses

Crop diversity was important to Indigenous agrarian society. A variety of shrubs and forbs facilitated cross-pollination between cultivated and idle fields and gardens. A diverse blend of plants with complementary flowering times promotes a diversity of beneficial insects and enhances fruit production.

Sun-dried blueberries were used in bread and various stews. Leaves, stems, flowers and roots had medicinal uses and were steeped for tea. Applications included blood purification, treating infant colic and inducing labor.

Topkill by fire or cutting stimulates vigorous sprouting as expansive root systems allocate abundant belowground resources to stem growth. ◀

FIRE MANAGEMENT CONSIDERATIONS

FIRE ADAPTED

Vacciniums are well adapted to fire. Clones are rejuvenated by fire, and, following topkill, plants will readily regenerate from rhizomes and root crowns. Young, healthy plants regenerate more successfully than older plants.

INTENSITY

Low- to moderate-intensity fire enhances fruit production with little mortality. High-intensity summer fire, whether prescribed burning or drought-induced wildfire, limits fruit production. Rhizomes in duff exposed to high heat produce shoots, but mortality increases with depth of heat penetration into the soil.

SPRING BURNING

Long-term, repeated burning promotes blueberry, regardless of season. Native Appalachians burned in the late winter or early spring to promote soft mast. Greater coverage and more sprouts and flowers follow spring fire, compared with winter and summer burning.

Lowbush and other blueberry species thrive in harsh environments. © Nicholas A. Tonelli, Flickr ▲

FREQUENT FIRE

Annual burning limits the number of plants and inhibits fruiting. For maximum berry production, commercial growers burn in late winter every other year. New growth is stimulated from dormant buds on the rhizome in the months that follow, and peak berry production comes the next growing season, then declines over time.

LEAVES AND SUNLIGHT

Fresh leaf growth following fire is high in nitrogen and phosphorus, and thus more nutritious for browsers. Fruit growth is determined by the daily production of carbohydrates by leaves. For optimum fruit production and growth, greater than 50% of full sun is required.

NEW PLANTS FIND GAPS

Timber removal or thinning can result in vigorous expansion of blueberry into open areas. Survival improves if plants grow and increase in vigor before burning.

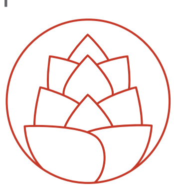
Wind-dispersed seed allows colonization of burned area.
© Joshua Mayer, Flickr ▲

Little Bluestem

CHEROKEE NAME: *Kanéska (grasses)*
SCIENTIFIC NAME: *Schizachyrium scoparium*

GROWTH FORM
Grass

FIRE TOLERANCE
High



FIRE ADAPTEDNESS
High

LOCATION
Wide variety of sites exposed to full sun.

SOIL
Wide variety, but best growth on acidic, well-drained and infertile.

ECOLOGY & LIFE HISTORY

The tufted, warm-season perennial grass grows up to 2 feet tall; blue-green leaves turn to a rust color in autumn.

Growth begins in late spring. Length and color of leaves, flowering, and clump diameter vary widely.

Little bluestem can be a dominant understory species in open pine forest and woodlands, and it may occur from early to late-successional stages if sunlight remains plentiful.

Wind can disperse seeds 5 to 6 feet, and best germination occurs when they deposit on mineral soil. Seed-bank persistence is uncertain.

The root system of little bluestem is deep and fibrous. Native grasses can root down to 5 feet and below-ground biomass can be twice that above ground. Ecosystem services include facilitating water infiltration and mitigating flooding and erosion.

Bluestem is among the plants grassland birds prefer for nesting: Small mammals and game birds consume seeds. Grazers prefer early spring growth, but palatability decreases as the grasses cure.

Cultural Uses

The Cherokee used grasses and bluestem switches in ceremonial sweat lodges. Dried leaves and stems were also rubbed into soft fiber for lining moccasins and insulation.

Bluestem is often found in very dry, nutrient-poor sites. © Patrick Alexander, Flickr ▲

FIRE MANAGEMENT CONSIDERATIONS

BURN TOO OFTEN?

Little bluestem can tolerate annual burning. Fire enhances available light and increases soil temperature as well as available nitrogen to improve growth rate.

FULL SUN

Succession rapidly reduces understory light. Bluestem declines in the absence of fire and will vanish from all but mowed areas and rights of way if more than 10 years elapses between fire or disturbance.

EARLY GROWING SEASON

While winter burning helps maintain open conditions, optimal timing is in the spring to bolster flowering and productivity. Mid- to late-summer fires may kill plants if drought precipitates intense fire that consumes the crowns and injures basal buds and meristems just below the soil surface.

CLUMPS OFFER PROTECTION

Bunch grasses form tussocks that resist moderate ground fire and protect the base of the clumps.

A flower appears as small white, pink or purple tube with three sepals from May to July.
© William Moye, Flickr ▲

Appalachian Small Spreading Pogonia

CHEROKEE NAME: *Unknown*
SCIENTIFIC NAME: *Cleistesiopsis bifaria*

GROWTH FORM
Other

FIRE TOLERANCE
Moderate

FIRE ADAPTEDNESS
Moderate

LOCATION
Seasonally wet open bogs and meadows within pine and oak forest; rocky pine oak heath.

SOIL
Wet-dry, acidic, well-drained.

ECOLOGY & LIFE HISTORY

This flower is an uncommon southern Appalachian-endemic orchid that grows up to 1 foot tall.

It features a large network of tough fibrous roots and a single, narrow lanceolate leaf that comes off the upper half of the stem, topped by one large flower.

Bumble bee (*Bombus*) species are attracted to the yellow on the flower, but it is a mimic of pollen. The flower emits a sticky liquid that coats the head and thorax and allows pollen to stick, which is transferred to the stigma of the next flower visited. Although the bee is "tricked," the pollen may be can transferred from one flower to the next and also back to the hive.

Cultural Uses

This species contributes to Blue Ridge biodiversity and provides ecosystem services. Southern Appalachian bogs have declined by 90%. Remnants of these unique communities are sometimes embedded within fire-adapted ecozones. Unique plant assemblages arise with species adapted to wet soils but requiring disturbance.

Threats include collection, habitat loss (fire exclusion) and overbrowsing. © Bruce Roberts ▲

FIRE MANAGEMENT CONSIDERATIONS

RESEARCH NEEDED

Effects of fire season, intensity and frequency are not well understood.

POSITIVE RESPONSE TO FIRE

Observations suggest that pogonia responds favorably to increased light and nutrients following fire and/or mechanical clearing.

LOCAL MANAGEMENT OBSERVATIONS

This plant can be found anywhere from dry sites in the vicinity of Linville Gorge to small bogs, such as some on the Chattahoochee National Forest; there it occurs slightly mounded above the surrounding wet depressions and sphagnum. The shade-suppressed bog population responds to spring burning with prolific flowering in the following months and expanded through the adjacent stream corridor. An observable decline each year since fire suggests some reliance on disturbance.

Hillcane response to thinning and burning once every four to five years.
Sumter National Forest, South Carolina. ▲

Appalachian Hillcane & Rivercane

CHEROKEE NAME: *I'ya*
SCIENTIFIC NAME: *Arundinaria appalachiana*

CHEROKEE NAME: *I'ya*
SCIENTIFIC NAME: *Arundinaria gingantea*

GROWTH FORM
Grass

FIRE TOLERANCE
High

FIRE ADAPTEDNESS
High

LOCATION

Rivercane
Natural levees in alluvial floodplains.

Hillcane
Oak and pine forests on dry hillsides below 3,000 feet elevation.

SOIL

Rivercane
Very wet; prone to frequent flooding.

Hillcane
Shallow, acidic and well-drained.

Cultural Uses

Indigenous settlements were often spread along river floodplains where cane was abundant. Canebrakes were indicative of fertile soil and easily cleared for agriculture.

Canebrakes were highly coveted for pasture. The foliage contains about 15% crude protein and is rich in calcium and phosphorous. The shoots are preferred, and cane patches were uniquely valuable in providing food and cover throughout winter. European settlers and Indigenous people fought over grazing rights and the combined pressure led to a region-wide decline of canebrakes.

Cane (i'ya) arrows had fire-hardened barbed points made of gar scales, sharpened antlers or turkey spurs; cane fishing spears doubled as weapons; and knives, blowguns and bird traps were made of cane.

Rivercane © Adam Griffith ◀

ECOLOGY & LIFE HISTORY

These are perennial, evergreen grasses. Arundinaria is a genus of three temperate bamboos endemic to the eastern U.S.

Hillcane is a southern Appalachian endemic with poorly understood range and ecology. Rivercane has been studied extensively throughout its range out to Kansas and north to Ohio.

European explorers described rivercane up to 40 feet tall with stems (culms) 4 inches in diameter.

Canebrakes are clones connected by a network of large rhizomes, which grow laterally before turning up to form a new culm. Some rhizomes are known to have laid dormant for decades until a canopy disturbance provided light for growth. Rivercane flowering is uncommon, but appears to be stimulated by fire or other disturbance; otherwise, fire may burn into floodplains only about once every 50 to 60 years. Entire canebrakes often die after seedset.

Flooding and fire are disturbances that commonly affect rivercane. Hillcane thrives following fire or a disturbance that creates a light gap.

Paper-like hillcane leaves fall off in autumn, whereas the subcoriaceous or “leather-like” leaves of rivercane remain attached throughout the year.

Canebrakes flourish after burning. These communities once provided extensive food and cover for mammals, birds, reptiles and invertebrates.

Bears denned in this “inner chamber of the great hunting ground.” From dense canebrakes mountain lions could stalk elk and deer herds drawn to the nutritious leaves and shoots.

While the historical scale of disturbance from massive flocks of passenger pigeons is uncertain, fecal deposits below roosts reportedly covered thousands of acres. A tremendous nutrient influx deadened nearly all vegetation to allow for canebrake expansion.

FIRE MANAGEMENT CONSIDERATIONS

FIRE FOR MANAGING CANE

The nutrient-rich flush of growth stimulated by fire attracted bison, elk and deer, especially in winter. An additional purpose for burning canebrakes was to flush game animals to waiting hunters, and fire was used to manage competing woody plants.

BURNING FOR FOOD

Burning canebrakes promoted the growth and expansion of canebrakes into adjacent fields. Fire was used to stimulate flowering and the growth of young, nutrient-rich shoots.

Cultural Uses

Canebrakes provided ambush cover and hid the movements of war parties. An incendiary arrow was made by wrapping dried moss around a cane shaft and used to ignite structures.

Cane was the primary material used to make rafts for crossing large rivers. Air-filled internodes made rafts very buoyant.

Musical instruments were also made from cane.

Culms were used to support beans and other climbing vegetables. Both interior and exterior walls were made of cane, colored with plant dyes, and woven tightly and impenetrable to water. Beds, floors and palisades were all made of cane.

The weight-to-tensile strength ratio makes bamboo stronger and lighter than most wood used in construction today. Today, bamboo flooring is usually imported from Asia.

LEFT: Appalachian hillcane can be a prominent understory grass in the Southern Blue Ridge escarpments. ◀

RIGHT: Dense canebrakes provide escape cover for birds and mammals. © Adam Griffith ◀

HOW OFTEN WAS CANE BURNED?

Canebrakes are reported to have been burned once every seven to 10 years. Fire kills aboveground plant parts but maintains canebrakes by stimulating sprouting and suppressing competition. Fire can have deleterious effects if a stand lacks vigor. Annual or semiannual burning is detrimental to cane stands because the continual removal of the stems and leaves depletes reserves in the rhizomes and limits sprout growth.

FIRE EXCLUSION

Fire exclusion results in low-vigor cane stands, culm death and succession by other plant species exceeding cane's rate of regeneration.

HILLCANE FIRE EFFECTS

There is little or no published evidence of fire effects on hillcane. Anecdotal observations suggest that canopy opening or managing competition increases culm production. Regional monitoring has found hillcane to be among the most frequently encountered plants in fire-adapted ecozones.

INTENSITY

Fire intensity in canebrakes was historically greater than in adjacent forest, although fire effects were generally low-severity except during drought.

ECOLOGICAL ZONE

High-Elevation Red Oak

ECOZONE	RESTORATION-FIRE FREQUENCY	MAINTENANCE-FIRE FREQUENCY
HIGH-ELEVATION RED OAK	5-10 YEARS	20-25 YEARS

EXTENT
124,000 acres

ELEVATION
3,500 – 5,900 feet

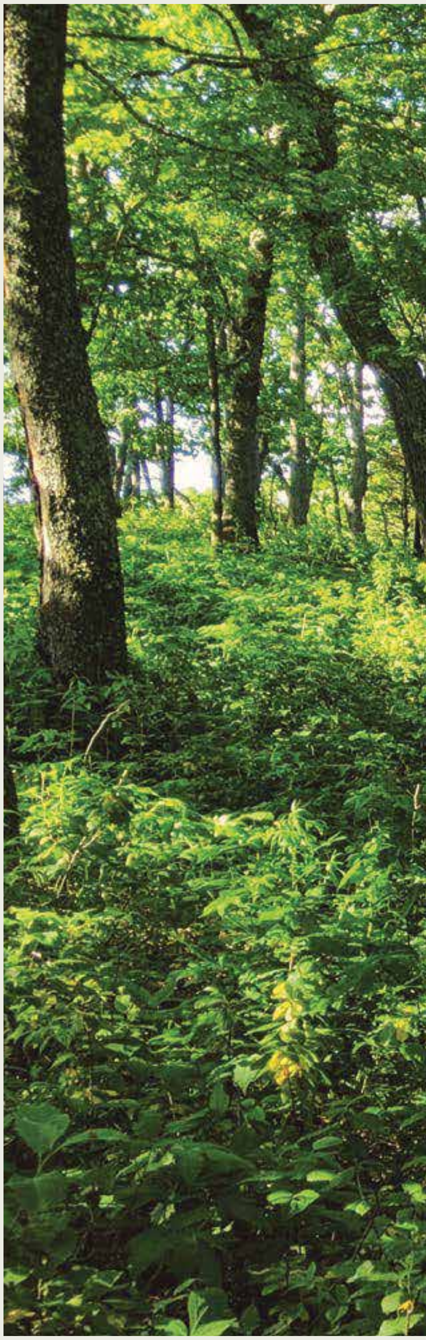
LANDFORM
Broad primary ridges and spur ridges, south- and west-facing convex slopes.

CONTEXT
Lower elevation or intermixed with spruce-fir and northern hardwoods; blending with Mesic Oak and cove forest. Many are on south and west aspects, although some cooler and wetter aspects are at lower elevations.

SOIL
Shallow and well-drained, but mesic with cool, wet conditions; often rich and fertile but variable and low in organic matter.

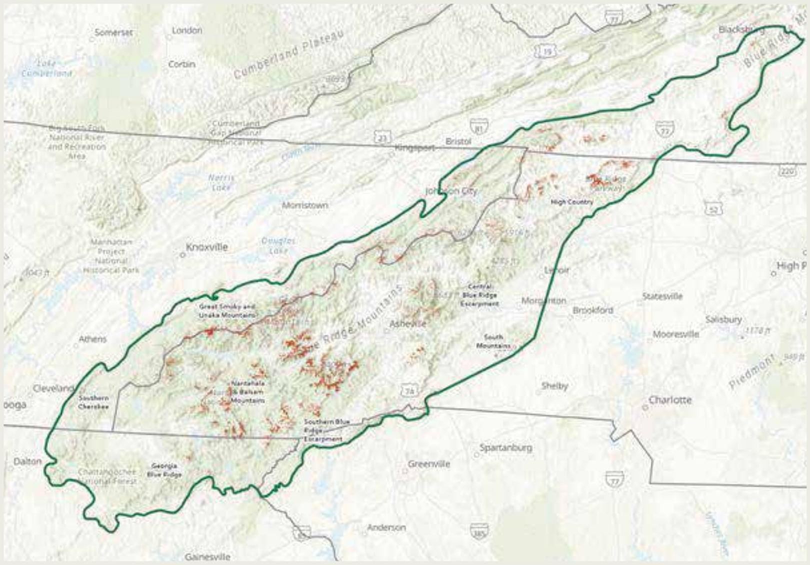
NATURAL DISTURBANCE
Freezing temperatures, ice and/or high-wind events, occasional wildfires and recently gypsy moth outbreaks.

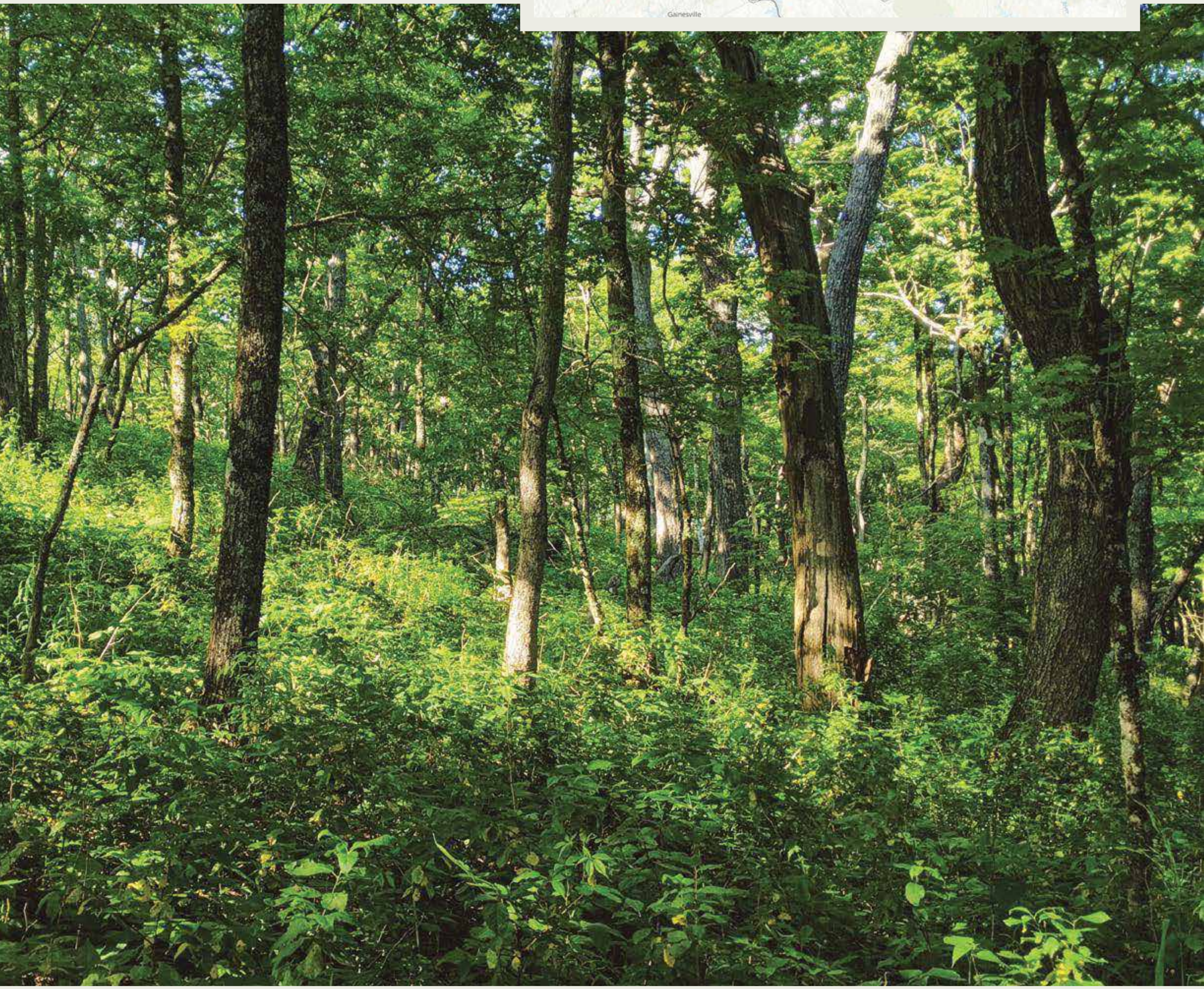
EMBEDDED COMMUNITIES
Heath and grass balds generally on south aspects; Carolina hemlock bluffs, granitic domes, seeps, fens, and rocky outcrops and summits.



Lush forb growth in rich High-Elevation Red Oak forest. Bluff Mountain Preserve, North Carolina. ▶

High-Elevation Red Oak forest is patchily distributed throughout the Southern Blue Ridge Mountains. It is most prevalent in Nantahala-Balsam, high country, and Great Smoky-Unaka Mountains landscapes. ▶





TOP LEFT: Diverse herb response in High-Elevation Red Oak woodland. © Andrew Kornylak ▶

BOTTOM LEFT: Rough blazing star is one of many sun-loving forbs adapted to colder high-elevation climate. ▼

RIGHT: Juvenile Eastern newt. © Kelly Clampitt ▶

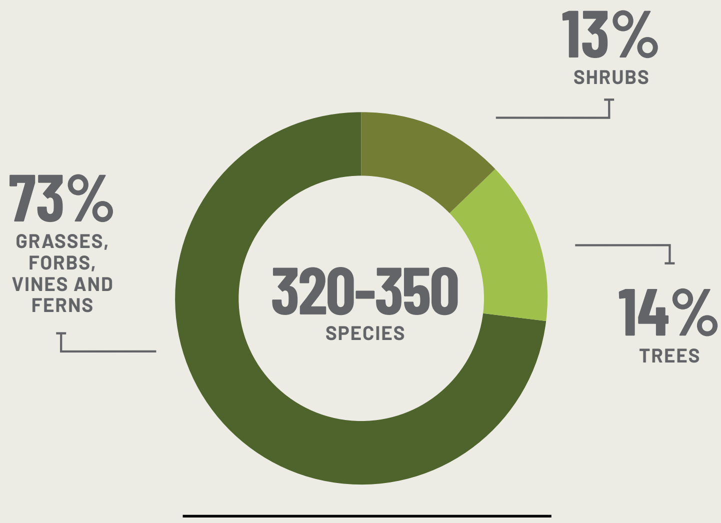
ECOLOGY

The structure and composition of present-day, high-elevation oak forests can, in part, be attributed to the loss of American chestnut. Northern red oak typically comprises over half of the canopy on most sites, along with a variable mix of red spruce, white oak, sugar maple, sweet birch and yellow birch. Understory species richness can range from a dozen species in the shrub-dominated sites to more than 100 species in rich, herb-dominated sites.

Shrub species such as flame azalea, highbush blueberry, highbush cranberry and mountain laurel can dominate sites with acidic soils. Base-rich sites tend to support a greater proportion of forbs and some are dominated by oak sedge. Other sites are similar in composition to Rich Cove ecozones, but for red oak on exposed, convex slopes, high winds and icing on such sites may create stunted, windswept trees, partial canopy gaps of various sizes, and canopy height of less than 25 feet.

Nearly half of the rare boreal relict plants in high-elevation sites require open ground such as wet meadows and fens, cliff faces, and grassy balds. A fen embedded within Bluff Mountain's high-elevation oak forest contains one of the highest densities of rare species in the southern U.S.

Some high forests have a history of lightning-caused fires about once every 40 to 60 years. In the absence of fire and influence of chestnut allelopathy, it is accepted that ericaceous shrubs are likely more abundant today than before chestnut blight and the fire-suppression era.



HIGH-ELEVATION RED OAK COMPOSITION

Minimal mast is produced in northern hardwood and spruce-fir forest. Oak ecozones provide hard mast and natural cavities for rare, high-elevation endemics: Carolina northern flying squirrels, yellow-bellied sapsuckers, black-capped chickadees and northern sawwhet owls.

Hard mast and diverse vegetation structure understory benefit grouse. Ruffed grouse chicks forage for arthropods among rich herb cover in high-elevation forest. High-elevation shrubland and early successional vegetation are important for golden-winged warblers and Appalachian cottontail rabbits.

CULTURAL IMPORTANCE

The cultural history of Blue Ridge high-elevation oak forests is not well understood. Indigenous Appalachians traveled ridgelines and used them as hunting trails. Some experts conjecture that people traveled to the high elevations for summer hunting and autumn nut harvests. Records indicate that the Cherokee managed Mount Sterling Bald to promote herbaceous plants and draw game into the open where they could harvest from the surrounding forest.

American chestnut could have made up as much as 70% of the trees in high-elevation forests. It was the single most important plant for humans and wildlife in the eastern U.S.

Forest pasturing of livestock was introduced in the 19th century, and grazing has influenced the development of many high forests. Broad, rounded summits were conducive to pasture, and herdsmen cleared forests by girdling trees and burning the understory.

Most of the Southern Blue Ridge balds and high-elevation ecozones are permanently protected and attract thousands of people each year for hiking and backpacking, birding, camping and photography.

The canopy of most Appalachian oak ecosystems is closed, inhibiting sunlight penetration. ▶

CONSERVATION CHALLENGES

CLOSED CANOPY

Models suggest the proportion of closed canopy High-Elevation Red Oak forest 300 years ago to be less than 50%. Shade- and acid-loving plants are favored in present-day forests, 90% of which have been modeled to be closed canopy.

MISSING A FIRE FACILITATOR

Historically, this ecozone was likely more receptive to fire. Loss of chestnut and fire exclusion beginning in the early 1900s has altered the structure and composition of the natural communities. High shrub density and northern hardwood subcanopy increasingly characterize a greater proportion of the forest. Fire-maintained examples are very rare.

WEATHER LIMITS WINDOWS

Annual precipitation ranges from 60 to 90 inches. Frequent heavy snow compacts oak litter, so opportunities for spring burning can be difficult to come by for this ecozone.

TO MANAGE OR NOT

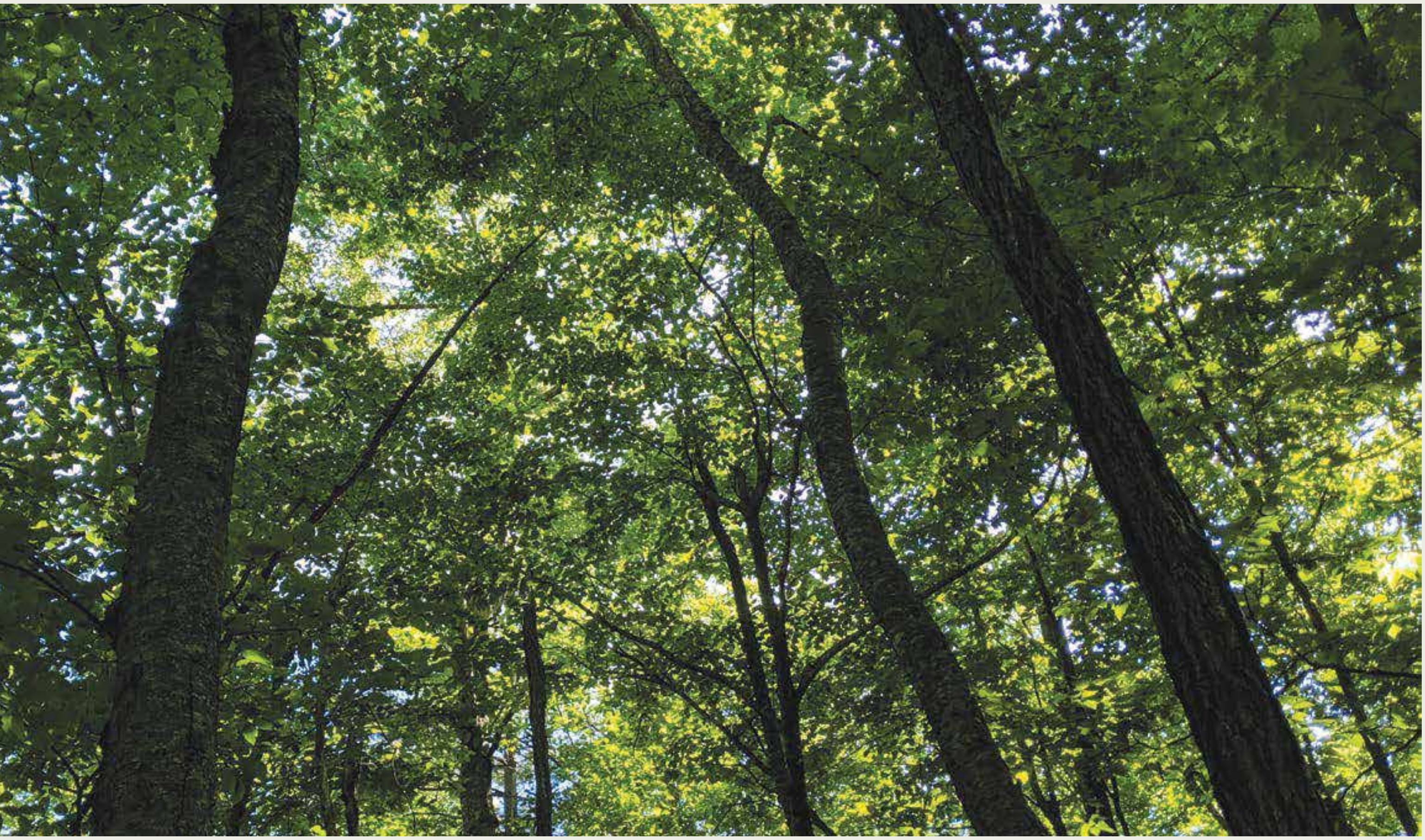
Passive management may favor an overstory increasingly composed of beech, yellow birch and maple species. It appears that these species will largely displace oaks, which are increasingly stressed by pests and disease.

MECHANICAL TREATMENTS

Financial return for timber from high elevations is generally low because of terrain and inaccessibility, as well as poor form and commercial value. The deleterious effects of high grading (logging that leaves behind inferior or defective individuals for genetically superior trees) are difficult to overcome in restoring oak woodlands. High grading has favored red maple proliferation, especially on sites where strongly acidic soil stymies the growth of oaks.

CLIMATE CHANGE

Warmer summer temperatures favor the growth of northern red oak, and it could begin to supplant northern hardwoods. Late-summer droughts that extend into autumn leaf often increase the wildfire potential. Greater stress will likely be imposed on the rare plants adapted to cooler conditions.



A canopy gap allows light to facilitate oak regeneration and herbaceous growth. ◀

FIRE MANAGEMENT

HOW OFTEN?

Fire likely occurred in High-Elevation Red Oak as frequently as once every 10 to 25 years, but the fire regime is the least understood of the ecozones.

THE CURL

Curl is the leaf height lying horizontally on the ground. Air movement is facilitated around curled leaves, which is the primary determinant of how quickly leaf litter will dry and how many days per year a site will be receptive to fire.

DEAD LEAVES MATTER

Accumulated leaf litter under closed-canopy forest acidifies soil and leaches aluminum that is toxic to plants. Acid deposition limits available calcium and magnesium, and thus the establishment and growth of forbs, grasses and trees. Moisture retained by mesophytic leaf litter reduces the probability of ignition, but also suppresses fire spread and intensity when fires do occur.

FLAMMABLE CHESTNUT LEAVES?

Chestnut leaves are very flammable, and chestnut's historical presence among oak ecozones suggests at least moderately frequent fire; the disappearance has likely contributed to the impacts of fire as a crucial ecological process.

GROUND COVER RESTORATION

Burning generally increases the vigor of herbaceous plants, and senesced vegetation contributes to fire spread. Restoration of forb ground cover to shrub-dominated oak forests occurs slowly over many fire cycles. Compared with unmanaged stands, thinning and repeated burning have been found to restore 100 times the forb cover and 20 times the herbaceous diversity in oak ecosystems.

THE SEEDBANK

The longevity of light-demanding plants in seedbanks is widely variable among species. Years of closed-canopy forest have depleted the seedbank of sun-loving plants. Those with the greatest shade tolerance may have a chance to remain viable. Repeated fire over many years and possibly outplanting may be required to restore some plants.

FREQUENCY

Effects of aspect on fire frequency in high-elevation oak forest can be pronounced, but the historic fire return interval is not well understood. An initial low-intensity burn following extended fire exclusion may have little impact on shrub and sapling competition.

Maintenance burning done about once every 20 years, varying seasonality and intensity, can restore and maintain diversity.

INTENSITY

Little is known about the effects of fire intensity on high-elevation natural communities. Fuel structure and composition suggest regular low-intensity fire with periodic high-intensity stand-replacement fire once every 100 years or more.

SEASONALITY

Leaf abcision occurs earlier in high-elevation forests, so freshly fallen leaves and senesced herbs facilitate October and November burning — optimal timing to avoid winter litter compaction by snow. Frequent, overnight freezes inhibit drying of fine fuels, and thus offer few burn days in winter. Fall burning aligns with the presumed historical fire regime.

In most years, snow compacts leaf litter in high-elevation forests and may not be burnable until May. Compared to lower elevations, the later green up offers spring burning conditions into June, but this burn timing has rarely been attempted in high-elevation oak forests by contemporary fire practitioners, so further study is warranted.

The likelihood of fire decreases from early to late summer especially where lush forbs and oak sedge dominate the ground cover.

Open oak forest at Warm Springs Preserve, Virginia. © Nikole Simmons ▲

TOP LEFT: Fall color of northern red oak. © Joe Walewski, iNaturalist ▶

BOTTOM LEFT: Small-mammal population fluctuation coincides with annual acorn production. © Marv Elliott, iNaturalist ▼

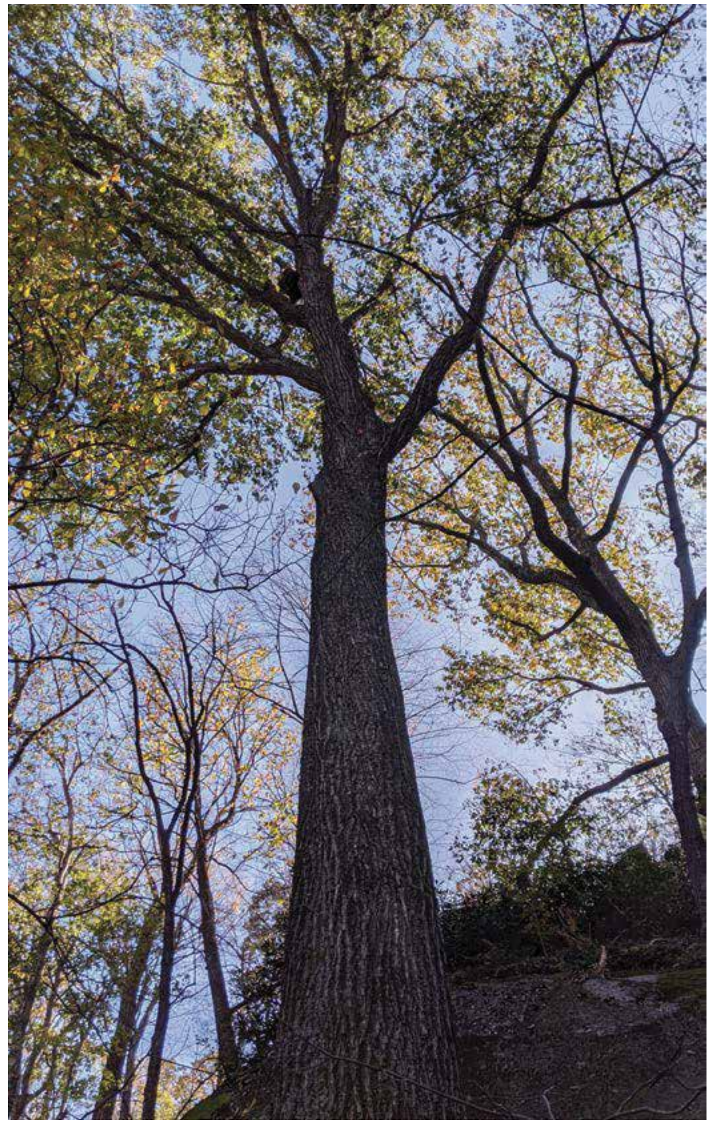
RIGHT: Northern red oak grow straight and tall up to around 120 feet in good soil. ▶

PLANTS OF

High-Elevation Red Oak

We know less about the historical fire regime of High-Elevation Red Oak than any of the other systems discussed in this book. What we do know is that wherever oaks are found there is a relationship to fire. We also see similar trends of increasing canopy closure, shrub cover and maple encroachment in this and other fire-dependent systems. It is very likely that the boundaries of other high-elevation systems are determined by the interaction of physical setting and fire. Without fire, some old-growth, high-elevation forests are transitioning to red spruce and northern hardwoods dominance, such as Noland Divide and Thomas Divide in Great Smoky Mountains National Park. With fire, this ecozone may maintain woodland conditions with relatively infrequent fire while also benefiting some high-elevation wildlife species.

– Josh Kelly, MountainTrue



Northern Red Oak

CHEROKEE NAME: *Tsugwû' nstătsâ'lĭ*
SCIENTIFIC NAME: *Quercus rubra*

GROWTH FORM
Tree

FIRE TOLERANCE
Moderate

FIRE ADAPTEDNESS
Moderate

LOCATION
Low cove forest and mesic slopes to high-elevation ridges.

SOIL
Widely tolerant; moist, rich and well-drained is optimal.

ECOLOGY & LIFE HISTORY

This large tree has alternate, simple leaves with seven to 11 lobes, each with a bristle tip. It is widely distributed in both pure and mixed stands throughout the eastern U.S. and ranges the farthest north of any oak. It occupies the highest elevations relative to the Appalachian oaks.

Flowering is from April to May, and acorns ripen August through October. The stout egg-shaped acorn is rich in tannins and contains high fat and protein, relative to plant foods. Northern red oak produces a good to excellent mast crop every two to five years, and an excellent mast year can produce over 200,000 acorns per acre.

Northern red oak is the fastest-growing Blue Ridge oak and allocates more biomass to stem growth, relative to oaks. It is also the most susceptible to drought and potentially vulnerable in a warming climate.

Northern red oak's durability allows it to grow well in an urban environment. Carbon is sequestered as trees grow, and the shade reduces ground surface temperatures, decreasing the energy demand for cooling homes and businesses. Additional ecosystem services include soil protection and stabilization as well as cover and food for wildlife.

The wood has large pores and is decay resistant. However, the red oak borer, oak wilt and combinations of stressors (oak decline), including gypsy moth, damage and kill trees.

The striped caterpillar of the oakworm moth feeds on red oak leaves. Many species of caterpillars feed on oak foliage, but damage is usually not severe.

FIRE MANAGEMENT CONSIDERATIONS

FAILURE TO REGENERATE

Common impediments to oak regeneration are shade, deer depredation, drought and competition from shrubs and herbaceous plants. The leading cause of failure is inadequate sunlight reaching the understory.

LIGHT REQUIREMENT

Northern red oak can survive with less than 5% sunlight — a condition prevalent in contemporary Blue Ridge forests. It tolerates shade better than chestnut oak and nearly as well as white oak. At least 20% full sunlight is necessary for photosynthesis and growth. Diameter and height growth increase proportionately up to about 70% full sunlight.

SEASON AND SEEDLINGS

Large oak seedlings 1 to 5 feet tall are generally not affected differently by the season of burning.

THIN BARK

Mature northern red oak have tight, thin bark, thus the cambium is less insulated from heat relative to Blue Ridge oaks. The species presence suggests a historical regime of generally less-frequent, low-intensity fire.

FIRE FREQUENCY

Regular fire is valuable for promoting red oak regeneration, but the optimal frequency varies by site. Hardwood competition management may often be required between burns if maximizing oak reproduction is an objective.

GOOD SOIL — MORE COMPETITION

It is less likely that a red oak seedling will eventually become a dominant canopy tree on higher-quality sites (with greater soil depth and better nutrient and water availability). Mesophytic hardwoods, like poplar, grow faster than oaks on better sites. Prescriptions that have successfully promoted red oak regeneration on rich sites have integrated chemical and mechanical hardwood management between burns.

Cultural Uses

Tannic acid had to be leached from acorn flour, which was traditionally done by digging a shallow pit near a creek. The flour was then spread in the bottom of a basket in the pit and water was continuously poured over it for hours until it turned sweet.

Strong, coarse-grained wood makes red oak an important source of hardwood lumber. Railroad ties, fence posts, veneer, furniture, cabinets, paneling, flooring, caskets and pulpwood are among its many uses.

Symmetrical growth and attractive leaves make northern red oak a valued ornamental tree in parks and along streets.

Northern red oak is an important tree in the urban landscape. ◀

Chestnuts form inside burs.
© Rachid S. Homsany, Flickr ▲

American Chestnut

CHEROKEE NAME: *Tilĭ’*
SCIENTIFIC NAME: *Castanea dentata*

GROWTH FORM
Tree

FIRE TOLERANCE
Uncertain

FIRE ADAPTEDNESS
Moderate

LOCATION
Wide variety, from coves to dry ridges up to 5,500-foot elevation; intermediate shade tolerance.

SOIL
Variable, dry to mesic but commonly acidic and well-drained.

ECOLOGY & LIFE HISTORY

Chestnut was once a widespread, dominant tree throughout eastern North America; it grew up to 10 feet in diameter, 120 feet in height, and is reported to have made up 30% to 70% of the Appalachian forest canopy.

Growing about one inch in diameter each season, chestnut reportedly grew faster than any of the commercially valuable species in the southern Appalachians.

Chestnut was also present on dry ridges with chestnut oak, hickory and yellow pines. Its drought tolerance suggests chestnut grew well across a wide range of moisture regimes. Whittaker characterized five types of sites where chestnut occurred in the western Smoky Mountains: chestnut oak-chestnut, chestnut oak-chestnut heath, white oak-chestnut and high-elevation red oak-chestnut.

Mature chestnut trees are very rare. © Nicholas A. Tonelli, Flickr ◀

Some trees could produce over 600 pounds of nuts, and a forest floor of chestnuts 4 inches deep each season. Chestnut made forest food production more stable historically, in part because chestnut flowers in late spring, so frost damage is less likely. Also, it is pollinated by both wind and insects.

Two to three nuts develop within a prickly bur, maturing from September to October. Of all Appalachian hard mast produced, chestnuts are among the highest in protein and carbohydrates and are relatively low in tannins, which reduce digestibility. A mature tree could produce around 70,000 nuts per square meter every year. Collectively, northern red oak, white oak and chestnut oak produce around 8,000 acorns per square meter each year.

Chestnut can survive in a shaded understory for many years. Most sprouts are from either mature trees cut before blight or seedlings that repeatedly sprout following infection. Reproduction starts earlier and more nuts are produced by copious, fast-growing sprouts, compared with trees that grow from seed.

Cryphonectria parasitica is a fungal disease that causes chestnut blight; in combination with industrial logging, mature trees were largely eliminated from the eastern U.S. by 1950.

Today, some mature relicts exist, and younger trees may grow up to 40 feet tall before dying, but they are most commonly found in shrub form.

The American Chestnut Foundation develops blight-tolerant, genetically engineered trees. “Darling 58” is a hybrid undergoing federal review for release into the wild. Researchers are also developing trees that can donate hypovirulent strains of the blight fungus to weaken and/or halt the fungus in infected trees.

FIRE MANAGEMENT CONSIDERATIONS

INDICATIONS OF FIRE RELATIONSHIP

Sediment pollen has indicated fire preceded abrupt increases in the proportion of chestnut in pre-European forests. Early foresters described chestnut occurring on dry sites and southern aspects alongside chestnut oak, shortleaf and pitch pine suggesting fire tolerance.

FIRE: CHESTNUT VS. OAKS

Physiology suggests a lower tolerance for frequent fire compared with oaks, yet chestnut leaves dry quickly and are similar to oak leaves in fire receptivity. Dormant buds are positioned near the ground surface and more susceptible to fire damage. The critical tissues of seedlings and saplings are not insulated as well as oaks and are prone to heat damage. Bark thickness of mature trees is comparable to that northern red oak, suggesting limited tolerance for moderate- to high-intensity fire.

DRY SITES

Chestnut was reported to have been largely absent from Pine-Oak Heath and sites that burn most often. However, sprouts are often abundant on dry, fire-prone slopes and ridges. Soil-inhabiting pathogens (*Phytophora*, or root rot) are less likely to infect chestnut on dry sites.

SPROUTING AND GROWTH STRATEGY

Chestnut sprouts emerge soon after topkill, and chestnut's capacity for sprouting and energy investment in aboveground growth over roots is similar to red maple. But it may lack the carbohydrate reserves needed to persist through frequent fires.

MUCH MORE TO LEARN

Very little is known about the effects of fire season, intensity and frequency on chestnut.

Cultural Uses

Few, if any, plants have provided greater ecosystem services than the American chestnut. It was a vital to Indigenous Appalachians as medicine, construction material and dye. It was a dietary staple, and forests were burned in early fall to facilitate chestnut harvest.

People have consumed chestnuts raw, boiled, baked or roasted, and often added nuts to cornmeal dough. Hogs were turned loose in the fall to feed on chestnuts; sausage from chestnut-fed hogs had a superior taste and was highly sought-after. Nuts were shipped across the eastern U.S.

Leaf extracts have been used to treat heart conditions, and the sprouts were sometimes made into an astringent tea to heal wounds. Tanbark (tannic acid derived from chestnut bark) was important for treating leather.

Chestnut was one of the most valued hardwood timber trees. The wood is uniform density, rot resistant, straight grained and sought after for lumber, shingles, railing, fuelwood, pianos, bridges and cabinets.

Insects are attracted to chestnut flowers and facilitate pollination in addition to wind. © Kerry Woods, Flickr ▲

Small patch of fine-textured oak sedge and mixed forbs in high-elevation oak forest. ▲

Oak Sedge

CHEROKEE NAME: *Ganága tsăninahita & kanéska tsăninahita*
SCIENTIFIC NAME: *Carex pennsylvanica*

GROWTH FORM
Grass

FIRE TOLERANCE
Moderate-High

FIRE ADAPTEDNESS
Moderate

LOCATION
Medium- to high-elevation deciduous forest.

SOIL
Widely tolerant, but prefers well-drained, rocky, loamy and acidic.

ECOLOGY & LIFE HISTORY

This is a low-growing, shade-tolerant, cool-season sedge that occurs in dense, clustered tufts with leaves 4 to 18 inches in length. It is commonly found in woodlands and prairies of the Midwest with big and little bluestem.

It's wind pollinated, but primary reproduction is vegetatively. Long rhizomes facilitate spread and rapid colonization of cleared areas. In some cases, this species can be an aggressive competitor often found as pure stands inhibiting the establishment of trees, shrubs and forbs.

Short rhizomes form tufts. Shoots form in autumn-winter, and growth begins during the late winter, before most grasses. Oak sedge completes its life cycle before summer.

Up to 36 species of butterfly and moth larvae and a variety of grasshopper species feed on this sedge. It supplies nesting habitat for such birds as wild turkey and ruffed grouse. Various sparrows will eat the seeds and voles will feed on foliage.

Clusters of brown seed capsules cling to on the stem oak sedge flower. © Ulrich Lorimer, Flickr ▲

Cultural Uses

Early observations included sedge leaves used in making rope and rhizomes used in baskets, mats and clothing.

Sedges are important for stabilizing riparian soils, and many species are used in ornamental gardens. Species that grow at high elevations provide livestock forage in summer.

FIRE MANAGEMENT CONSIDERATIONS

TOPKILL AND SPROUT

Fires typically topkill this plant, but the majority of individuals sprout quickly to colonize gaps. Shallow roots and rhizomes make the plant susceptible to high-intensity fire.

MATS LIMIT DIVERSITY

Sedge-dominated understories typically support lower plant diversity, forb cover, and seedling and sapling densities than those with small, scattered tufts. In the Midwest, fire has been used to increase floral diversity by topkill of sedge mats, but this has not been well studied.

LATE GROWING SEASON

Mid- to late-summer fire can benefit grasses and sedges that grow during the cool seasons.

FRESH FOLIAGE

New growth following fire is palatable to herbivores because it contains less lignin, silicates and tannins. New shoots have more crude protein than mature leaves.

Whorled Loosestrife © Tom Potterfield, Flickr ▲

Fraser's Loosestrife © Joey Shaw, iNaturalist ▲

Whorled Loosestrife & Fraser's Loosestrife

CHEROKEE NAME: *Gigatsúya-hĭ*
SCIENTIFIC NAME: *Lysimachia quadrifolia*

CHEROKEE NAME: *Gigatsuyá iyústĭ*
SCIENTIFIC NAME: *Lysimachia fraseri*

GROWTH FORM
Forb

FIRE TOLERANCE
Moderate-High

FIRE ADAPTEDNESS
Moderate

LOCATION

Fraser's Loosestrife
Dry Oak and High-Elevation Oak; scoured river edges and mowed areas.

Whorled Loosestrife
Dry Oak, Dry-Mesic Oak, and High-Elevation Oak.

SOIL

Moist; poor to moderate drainage.

ECOLOGY & LIFE HISTORY

Fraser's loosestrife is a globally imperiled, herbaceous perennial that is endangered in North Carolina and Tennessee. The gorges of the Southern Blue Ridge Escarpment are the center of the range. Whorled loosestrife ranges from southern Georgia to Canada.

Stems 2 to 5 feet tall, and whorls of lance-shaped leaves characterize both species, but Fraser's is often whorls of three, rather than four to six. Yellow flowers appear from mid-June to July in a loosely branched cluster that can reach 10 inches high.

Fraser's has been documented in rocky streamsides and rock outcrop seepages, but is also found in open oak forest. Whorled loosestrife is commonly encountered in pine and dry oak forest. Pollinators are attracted to fragrant, colorful flowers; pollen and nectar are rewards for visiting. One of the world's specialized plant-insect relationships is that of oil-collecting bees (*Macropis*) and oil-secreting plants. Four species of *Macropis* bees occur in the Blue Ridge, but all are very rare and depend entirely on plants of the genus *Lysimachia*; only species whose flowers produce oil are visited. Female bees collect oil and pollen from specialized hairs on Fraser's and whorled loosestrife. Larvae are fed from a ball the bee forms by mixing oil and pollen. The bees also line nest walls with oil to regulate the humidity.

Cultural Uses

Loosestrife was dried and attached to harnessed animals for calming and repelling flies and biting insects. Loosestrife burned in homes repels insects.

***Macropis patellata.* © Erick Hernandez, USGS Bee Inventory and Monitoring Lab**

FIRE MANAGEMENT CONSIDERATIONS

POSITIVE RESPONSE

Whorled loosestrife responds favorably to fire and disturbance; the response of Fraser's to varying fire regimes is not well understood. Ramet production, growth and flowering increase following prescribed fire, and it appears to thrive with routine disturbance.

DECLINE WITHOUT DISTURBANCE

Shrub encroachment suppresses flowering and threatens many remaining Blue Ridge populations. If succession progresses without routine fire or light disturbance, Fraser's abundance declines with increasing competition and diminished sunlight.

MORE TO LEARN

Both species appear to prefer moist soil and recurrent disturbance. However, responses of these plants to fire are not well understood.

PLANTS OF

Fire-Adapted Ecozones

Nearly 2,500 plant species are known from the southern Appalachian Mountains. This list includes over 350 species known to grow in fire-adapted ecozones. This is not a complete list of species in these ecozones. Both common and uncommon species are listed, along with what we currently understand about habitats and fire response strategy.

ECOZONES

POH	SLPO	DOAK	DMOAK	HERO
Pine-Oak Heath	Shortleaf Pine-Oak	Dry Oak	Dry-Mesic Oak Mesic Oak	High-Elevation Red Oak

TABLE KEY

KEY	STRATEGY	DESCRIPTION	LIGHT	REPRODUCTION	EXAMPLES
EN	ENDURER	Plants that endure fire by sprouting from below ground after fire.	Shade intolerant	Vegetative	Oaks, pines, mountain laurel, shrubs, forbs and grasses
EV	EVADER	Plants that evade high temperatures to germinate from seed shortly after fire	Shade intolerant	Seed	Legumes with large protected seed coat and pines with sero-tinous cones
RE	RESISTER	Mature plants that can resist fire and continue to grow vegetatively following fire.	Shade inolerant Shade tolerant	Vegetative	Thick protective bark of oaks and pines
IN	INVADER	Pioneers or early successional plants with wind-dispersed seed.	Shade intolerant	Seed	Indiangrass, little bluestem, annual forbs and grasses
AV	AVOIDER	Late-successional species with few adaptations to fire; can slowly (re)invade burned areas.	Shade tolerant	Seed	Red maple, rhodo-dendron and Canadian hemlock
UN	UNCERTAIN	Species whose response to fire is not well understood and requires further research.			

FIRE TOLERANT
Plants that can withstand fire and are generally not completely killed.

FIRE ADAPTED
Plants that have adaptive traits or co-evolved with fire.

NATURAL COMMUNITIES

ROCK	GLADE	FEN	GRASS	CARO	HEATH
Rock Outcrop	Glades and Barrens	Southern Appalachian Bogs and Fens	Grassy Bald	Carolina Hemlock	Heath Bald

TREES

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN		*Acer pensylvanicum*	Striped Maple	POH DOAK DMOAK HERO	GA NC SC TN
EN, IN, RE	🔥	*Acer rubrum*	Red Maple	POH SLPO DOAK DMOAK HERO	GA NC SC TN
EN		*Acer saccharum*	Sugar Maple	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Amelanchier arborea*	Downy Serviceberry	POH SLPO DOAK DMOAK	GA NC SC TN
UN		*Amelanchier laevis*	Allegheny Serviceberry	POH	GA NC SC TN
AV, IN		*Betula alleghaniensis*	Yellow Birch	DMOAK HERO	GA NC SC TN
EN, IN	🔥	*Betula lenta*	Sweet Birch	POH DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Carya cordiformis*	Bitternut Hickory	DMOAK	GA NC SC TN
EN, RE	🔥	*Carya glabra*	Pignut Hickory	POH DOAK DMOAK	GA NC SC TN
EN, RE	🔥	*Carya ovalis*	Red Hickory	POH SLPO DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Carya pallida*	Sand Hickory	POH SLPO DOAK	GA NC SC TN
EN, RE	🔥	*Carya tomentosa*	Mockernut Hickory	POH DOAK DMOAK	GA NC SC TN
EN, RE	🔥🔥	*Castanea dentata*	American Chestnut	POH DOAK HERO	GA NC SC TN
EN	🔥🔥	*Castanea pumila*	Allegheny Chinquapin	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Cercis canadensis*	Eastern Redbud	DMOAK	GA NC SC TN
UN		*Chionanthus virginiana*	Fringetree	ROCK GLADE	GA NC SC TN
EN	🔥	*Cornus florida*	Flowering Dogwood	POH DOAK DMOAK	GA NC SC TN
EN	🔥	*Diospyros virginiana*	American Persimmon	POH DOAK	GA NC SC TN
EN	🔥	*Fraxinus americana/ biltmoreana*	White Ash	DOAK DMOAK HERO	GA NC SC TN
AV, EN		*Ilex opaca*	American Holly	SLPO DMOAK	GA NC SC TN
EN	🔥	*Juglans nigra*	Black Walnut	DMOAK	GA NC SC TN
AV		*Juniperus virginiana*	Eastern Red Cedar	ROCK GLADE	GA NC SC TN
EN, EV, RE	🔥	*Liriodendron tulipifera*	Yellow Poplar	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Magnolia fraseri*	Fraser's Magnolia	POH SLPO DOAK DMOAK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Nyssa sylvatica*	Black Gum	POH SLPO DOAK	GA NC SC TN
EN		*Ostrya virginiana*	Hop-hornbeam	DOAK DMOAK HERO GLADE	GA NC SC TN
EN	🔥	*Oxydendrum arboreum*	Sourwood	POH SLPO DOAK DMOAK	GA NC SC TN
AV		*Picea rubens*	Red Spruce	HERO	NC TN
EN ,EV, RE, IN	🔥🔥	*Pinus echinata*	Shortleaf Pine	SLPO DOAK DMOAK	GA NC SC TN
EN, EV, RE, IN	🔥🔥	*Pinus pungens*	Table Mountain Pine	POH SLPO CARO	GA NC SC TN
EN, EV, RE, IN	🔥🔥	*Pinus rigida*	Pitch Pine	POH SLPO DOAK DMOAK	GA NC SC TN
IN, RE	🔥🔥	*Pinus strobus*	Eastern White Pine	POH SLPO DOAK DMOAK	GA NC SC TN
IN, RE	🔥	*Pinus virginiana*	Virginia Pine	POH SLPO DOAK	GA NC SC TN
IN , RE	🔥🔥	*Prunus pensylvanica*	Fire Cherry	HERO	GA NC SC TN
EN, IN	🔥	*Prunus serotina*	Black Cherry	DOAK DMOAK HERO	GA NC SC TN
EN, RE	🔥🔥	*Quercus alba*	White Oak	SLPO DOAK DMOAK	GA NC SC TN
EN, RE	🔥	*Quercus coccinea*	Scarlet Oak	POH SLPO DOAK	GA NC SC TN
EN, RE	🔥🔥	*Quercus falcata*	Southern Red Oak	SLPO DOAK DMOAK	GA NC SC TN
EN, RE	🔥🔥	*Quercus marilandica*	Blackjack Oak	POH SLPO DOAK	GA NC SC TN
EN, RE	🔥🔥	*Quercus montana*	Chestnut Oak	POH SLPO DOAK HERO	GA NC SC TN
EN, RE	🔥🔥	*Quercus rubra*	Red Oak	DOAK DMOAK HERO	GA NC SC TN
EN, RE	🔥🔥	*Quercus stellata*	Post Oak	SLPO DOAK	GA NC SC TN
EN, RE	🔥🔥	*Quercus velutina*	Black Oak	POH DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Robinia pseudoacacia*	Black Locust	POH DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Sassafras albidum*	Sassafras	POH DOAK DMOAK	GA NC SC TN
AV, EN		*Tilia americana var. heterophylla*	American Basswood	HERO	GA NC SC TN
AV, EN, IN		*Tsuga canadensis*	Canada Hemlock	POH DOAK DMOAK	GA NC SC TN
AV, EN, IN		*Tsuga caroliniana*	Carolina Hemlock	POH DOAK CARO	NC SC TN

SHRUBS

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Amorpha glabra*	Appalachian Indigo-bush	POH DOAK DMOAK	GA NC SC TN
EN		*Aralia spinosa*	Devil's Walking Stick	SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Aronia sp.*	Chokeberry	POH ROCK FEN HEATH	GA NC SC TN
EN	🔥	*Calycanthus floridus*	Carolina Allspice	POH DMOAK	GA NC SC TN
EN	🔥🔥	*Ceanothus americanus*	New Jersey Tea	SLPO DOAK DMOAK ROCK GLADE	GA NC SC TN
EN	🔥	*Chimaphila maculata*	Striped Wintergreen	POH SLPO DOAK DMOAK	GA NC SC TN
AV, EN		*Clethra acuminata*	Mountain Sweet-pepperbush	POH DOAK DMOAK	GA NC SC TN
EN	🔥	*Corylus cornuta*	Beaked Hazelnut	DOAK DMOAK	GA NC SC TN
EN	🔥	*Crataegus spp.*	Hawthorn	SLPO DOAK DMOAK GRASS	GA NC SC TN
EN		*Diervilla lonicera*	Northern Bush Honeysuckle	DOAK ROCK	GA NC TN
EN	🔥	*Diervilla sessilifolia*	Smooth Southern Bush-honeysuckle	HERO ROCK HEATH	NC SC TN
EN	🔥🔥	*Epigaea repens*	Trailing Arbutus	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Eubotrys recurvus*	Redtwig Doghobble	POH DOAK	GA NC SC TN
EN		*Euonymus americanus*	Heart's a'bustin'	POH DOAK DMOAK	GA NC SC TN
EN	🔥	*Frangula caroliniana*	Carolina Buckthorn	DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Gaultheria procumbens*	Eastern Teaberry	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Gaylussacia baccata*	Black Huckleberry	POH SLPO DOAK ROCK	GA NC SC TN
EN	🔥🔥	*Gaylussacia ursina*	Bear Huckleberry	POH DOAK DMOAK HERO	GA NC SC TN
AV, EN		*Hamamelis virginiana*	Witchhazel	POH DMOAK HERO	GA NC SC TN
EN		*Hydrangea arborescens*	Wild Hydrangea	DMOAK HERO	GA NC SC TN
EN		*Hypericum stragulum*	St. Andrew's Cross	DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Ilex ambigua*	Carolina Holly	SLPO DOAK	GA NC SC TN
AV, EN		*Ilex montana*	Mountain Holly	POH DOAK DMOAK HERO	GA NC SC TN
EN	🔥🔥	*Kalmia buxifolia*	Sand Myrtle	POH ROCK HEATH	GA NC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN		*Kalmia latifolia*	Mountain Laurel	POH SLPO DOAK DMOAK HERO CARO	GA NC SC TN
EN		*Leucothoe fontanesiana*	Doghobble	DMOAK FEN	GA NC SC TN
EN		*Lyonia ligustrina var. ligustrina*	Maleberry	POH DOAK FEN HEATH	GA NC SC TN
EN		*Malus angustifolia*	Wild Crabapple	POH SLPO DOAK ROCK	GA NC SC TN
EN		*Pyrularia pubera*	Buffalo Nut	POH DOAK DMOAK	GA NC SC TN
AV, EN		*Rhododendron arborescum*	Sweet Azalea	HEATH	GA NC SC TN
EN		*Rhododendron calendulaceum*	Flame Azalea	POH DOAK DMOAK HERO	GA NC SC TN
EN		*Rhododendron carolinianum*	Carolina Rhododendron	POH DOAK	GA NC SC TN
AV, EN		*Rhododendron catawbiense*	Catawba Rhododendron	POH HERO FEN CARO HEATH	GA NC SC TN
AV, EN		*Rhododendron maximum*	Great Rhododendron	POH SLPO DOAK DMOAK HERO	GA NC SC TN
EN		*Rhododendron minus*	Gorge Rhododendron	POH ROCK CARO	GA NC SC
AV, EN		*Rhododendron viscosum*	Swamp Azalea	HERO HEATH	GA NC SC TN
IN, EN		*Rhus aromatica*	Fragrant Sumac	SLPO	GA NC SC TN
EN		*Rhus copallinum*	Winged Sumac	POH SLPO DOAK	GA NC SC TN
EN		*Rhus glabra*	Smooth Sumac	POH SLPO DOAK DMOAK ROCK	GA NC SC TN
EN		*Robinia hispida var. hispida*	Bristly Locust	POH DOAK	GA NC SC TN
EN		*Rosa caroliniana*	Carolina Rose	DOAK DMOAK GLADE	GA NC SC TN
EN		*Rubus spp.*	Blackberry	POH SLPO DOAK DMOAK HERO ROCK	GA NC SC TN
EN		*Symplocos tinctoria*	Horsesugar	POH SLPO DOAK DMOAK	GA NC SC TN
EN		*Vaccinium altomontanum*	Blue Ridge Blueberry	ROCK HEATH	GA NC SC TN
EN		*Vaccinium arboreum*	Farkleberry	SLPO DOAK GLADE	GA NC SC TN
EN		*Vaccinium corymbosum*	Highbush Blueberry	POH FEN	GA NC SC TN
EN		*Vaccinium erythrocarpum*	Highbush Cranberry	DMOAK HERO HEATH	GA NC TN
EN		*Vaccinium fuscatum*	Hairy Highbush Blueberry	FEN	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Vaccinium hirsutum*	Hairy Blueberry	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Vaccinium pallidum*	Hillside Blueberry	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Vaccinium simulatum*	Upland Highbush Blueberry	DMOAK HERO HEATH	GA NC SC TN
EN	🔥🔥	*Vaccinium stamineum*	Appalachian Deerberry	POH SLPO DOAK	GA NC SC TN
AV, EN		*Viburnum acerifolium*	Mapleleaf Viburnum	DMOAK HERO	GA NC SC TN

FORBS

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN		*Actaea podocarpa*	Yellow Cohosh	HERO	GA NC TN
EN		*Actaea racemosa*	Black Cohosh	DMOAK	GA NC SC TN
EN, IN	🔥	*Ageratina altissima*	White Snakeroot	DMOAK HERO	GA NC SC TN
EN	🔥	*Aletris farinosa*	Colicroot	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Amphicarpaea bracteata*	Hog-peanut	DMOAK	GA NC SC TN
EN	🔥	*Antennaria plantaginea*	Plantain Pussytoes	POH DOAK	GA NC SC TN
UN		*Arisaema triphyllum*	Jack in the Pulpit	DMOAK	GA NC SC TN
EN	🔥	*Asclepias amplexicaulis*	Clasping Milkweed	SLPO	GA NC SC TN
EN	🔥	*Asclepias variegata*	White Milkweed	DOAK DMOAK	GA NC SC TN
EN	🔥	*Asclepias verticillata*	Whorled Milkweed	GLADE	GA NC SC TN
EN	🔥	*Aureolaria laevigata*	Appalachian Oak-leech	POH DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Aureolaria pectinata*	Southern Oak-leech	DOAK	GA NC SC TN
EN	🔥	*Aureolaria virginica*	Downy Oak-leech	DOAK DMOAK HERO	GA NC SC TN
EN, IN	🔥🔥	*Baptisia tinctoria*	Horsefly Weed	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Campanula divaricata*	Southern Harebell	POH SLPO DOAK ROCK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
UN	🔥	*Castilleja coccinea*	Indian Paintbrush	DMOAK GLADE	GA NC SC TN
EN		*Caulophyllum thalictroides*	Blue Cohosh	DMOAK HERO	GA NC SC TN
EN	🔥	*Chamaelirium luteum*	Fairywand	DOAK DMOAK	GA NC SC TN
UN	🔥🔥	*Chrysopsis mariana*	Maryland Golden Aster	DOAK	GA NC SC TN
AV		*Claytonia caroliniana*	Carolina Springbeauty	HERO	GA NC TN
AV, EN		*Clintonia umbellulata*	Speckled Wood-lily	HERO	GA NC SC TN
EN	🔥🔥	*Clitoria mariana*	Butterfly Pea	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Collinsonia canadensis*	Stoneroot or Richweed	DMOAK HERO	GA NC SC TN
EN		*Conopholis americana*	Squaw-root	DMOAK HERO	GA NC SC TN
IN	🔥	*Conyza canadensis*	Horseweed	POH SLPO DOAK DMOAK	GA NC SC TN
EN, IN	🔥	*Coreopsis major*	Stiffleaf Tickseed	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Cynoglossum virginianum*	Wild Comfrey	DMOAK	GA NC SC TN
EN	🔥	*Cypripedium acaule*	Pink Lady's Slipper	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Cypripedium parviflorum var. pubescens*	Yellow Lady's Slipper	DMOAK	GA NC SC TN
EN	🔥🔥	*Desmodium rotundifolium*	Roundleaf Ticktrefoil	DOAK	GA NC SC TN
EN	🔥	*Dioscorea villosa*	Wild Yam	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Endodeca serpentaria*	Virginia Snakeroot	SLPO DOAK DMOAK	GA NC SC TN
IN	🔥🔥	*Erechtites hieracifolia*	Fireweed	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Erigeron pulchellus*	Robin's Plantain	DMOAK	GA NC SC TN
EN	🔥	*Eryngium yuccifolium*	Rattlesnake Master	SLPO GLADE	GA NC SC TN
EN	🔥🔥	*Eupatorium sessilifolium*	Sessile-leaved Eupatorium	DOAK GLADE	GA NC SC TN
EN	🔥🔥	*Eupatorium vaseyi*	Vasey's Eupatorium	DOAK	GA NC SC TN
EN	🔥	*Euphorbia corollata*	Eastern Flowering Spurge	DOAK DMOAK	GA NC SC TN
EN	🔥	*Eurybia chlorolepis*	Blue Ridge White Heart Leaved Aster	HERO	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥	*Eurybia divaricata*	White-flowered Heart-leaved Aster	DMOAK	GA NC SC TN
EN	🔥🔥	*Eurybia surculosa*	Creeping Aster	POH DOAK ROCK	GA NC SC
EN	🔥	*Eutrochium purpureum*	Sweet Joe Pye Weed	DMOAK HERO	GA NC SC TN
EN		*Galax urceolata*	Galax	POH DOAK DMOAK HERO	GA NC SC TN
UN	🔥	*Galium circaezans*	Licorice Bedstraw	DOAK DMOAK	GA NC SC TN
EN	🔥	*Gentiana decora*	Appalachian Gentian	POH DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Gillenia trifoliata*	Bowman's Root	DOAK DMOAK	GA NC SC TN
AV		*Goodyera pubescens*	Downy Rattlesnake Plantain	POH DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Helianthus atrorubens*	Appalachian Sunflower	DOAK	GA NC SC TN
EN	🔥🔥	*Helianthus microcephalus*	Small-headed Sunflower	DOAK DMOAK HERO	GA NC SC TN
EN		*Hexastylis arifolia*	Arrowleaf Heartleaf	DMOAK	GA NC SC TN
EN	🔥	*Hexastylis heterophylla*	Variable-leaf Heartleaf	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Hexastylis shuttleworthii*	Large-flower Heartleaf	DMOAK	GA NC SC TN
EN	🔥	*Hieracium scabrum*	Rough Hawkweed	DOAK	GA NC SC TN
EN	🔥	*Hieracium venosum*	Veiny Hawkweed	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Houstonia purpurea*	Summer Bluet	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Hylodesmum glutinosum*	Pointedleaf Ticktrefoil	DMOAK	GA NC SC TN
EN	🔥	*Hylodesmum nudiflorum*	Naked-flowered Ticktrefoil (beggar's ticks)	DOAK DMOAK	GA NC SC TN
EN	🔥	*Hypopithys monotropa*	Pinesap	DMOAK	GA NC SC TN
UN	🔥🔥	*Hypoxis hirsuta*	Yellow Star Grass	POH SLPO DOAK	GA NC SC TN
UN	🔥🔥	*Ionactis linariifolia*	Narrowleaf Aster	POH SLPO	GA NC SC TN
EN	🔥🔥	*Iris verna*	Dwarf Violet Iris	POH DOAK	GA NC SC TN
EN	🔥	*Lactuca floridana*	Woodland Lettuce	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Lechea racemulosa*	Pinweed	POH SLPO	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Lespedeza hirta*	Hairy Lespedeza	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Lespedeza procumbens*	Downy Trailing Lespedeza	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Lespedeza repens*	Creeping Lespedeza	SLPO POH	GA NC SC TN
EN	🔥	*Lespedeza violacea*	Violet Lespedeza	DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Liatris spicata*	Dense Blazing Star	ROCK GLADE	GA NC SC TN
EN	🔥	*Ligusticum canadense*	Canadian Licorice-root	DMOAK HERO	GA NC SC TN
EN, IN	🔥	*Lilium michauxii*	Carolina Lily	POH DOAK DMOAK GLADE	GA NC SC TN
EN	🔥	*Linum virginianum*	Woodland Flax	POH SLPO	GA NC SC TN
EN	🔥	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife	POH SLPO DOAK DMOAK HERO	GA NC SC TN
AV, EN		*Maianthemum racemosum*	False Solomon's Seal	DOAK DMOAK HERO GLADE	GA NC SC TN
AV		*Medeola virginica*	Indian Cucumber	DMOAK	GA NC SC TN
UN	🔥	*Melampyrum lineare*	Narrowleaf Cowwheat	POH SLPO DOAK	GA NC SC TN
EN, IN	🔥🔥	*Mimosa microphylla*	Eastern Sensitive Brier	POH SLPO DOAK	GA NC TN SC
EN	🔥	*Mitchella repens*	Partridge Berry	DOAK DMOAK	GA NC SC TN
EN	🔥	*Monotropa uniflora*	Indian Pipes	DMOAK	GA NC SC TN
EN	🔥	*Nabalus species*	Rattlesnake Root	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Parthenium integrifolium*	Wild Quinine	DOAK GLADE	GA NC SC TN
UN		*Phryma leptostachya*	Lopseed	DOAK DMOAK	GA NC SC TN
EN, IN	🔥	*Phytolacca americana*	Pokeweed	DOAK DMOAK ROCK GLADE	GA NC SC TN
EN, IN	🔥🔥	*Pityopsis graminifolia*	Grass-leaved Golden Aster	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Platanthera ciliaris*	Yellow-fringed Orchid	DOAK GLADE	GA NC SC TN
AV		*Podophyllum peltatum*	Mayapple	DMOAK	GA NC SC TN
EN	🔥	*Polygonatum biflorum*	Smooth Solomon's Seal	DMOAK HERO	GA NC SC TN
EN	🔥	*Potentilla canadensis*	Dwarf Cinquefoil	POH SLPO DOAK DMOAK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥	*Potentilla simplex*	Common Cinquefoil	DMOAK	GA NC SC TN
EN	🔥	*Prosartes lanuginosum*	Yellow Mandarin	DMOAK	GA NC SC TN
UN		*Prosartes maculata*	Spotted Mandarin	DMOAK HERO	GA NC SC TN
EN	🔥	*Pseudognaphalium obtusifolium*	Rabbit Tobacco	SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Pycnanthemum montanum*	Thin-leaf Mountainmint	DMOAK HERO	GA NC SC TN
AV, EN		*Sanguinaria canadensis*	Bloodroot	DMOAK	GA NC SC TN
EN	🔥🔥	*Sericocarpus asteroides*	Toothed White-topped Aster	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Sericocarpus linifolius*	Narrowleaf White-topped Aster	SLPO GLADE	GA NC SC TN
EN	🔥	*Silene virginica*	Fire Pink	DOAK DMOAK ROCK GLADE	GA NC SC TN
EN	🔥🔥	*Silphium compositum*	Rosinweed	POH DOAK DMOAK	GA NC SC TN
EN	🔥	*Solidago bicolor*	Silverrod	POH DOAK DMOAK GLADE	GA NC SC TN
EN	🔥	*Solidago curtisii*	Curtis' Goldenrod	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Solidago erecta*	Slender Goldenrod	POH SLPO DOAK	GA NC SC TN
EN, IN	🔥🔥	*Solidago nemoralis*	Grey Goldenrod	POH SLPO DOAK ROCK GLADE	GA NC SC TN
EN	🔥🔥	*Solidago odora*	Fragrant Goldenrod	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Solidago puberula*	Downy Goldenrod	POH DOAK ROCK	GA NC SC TN
EN	🔥	*Spiranthes cernua*	Nodding Ladies'-tresses	POH DOAK	GA NC SC TN
AV		*Stellaria pubera*	Star Chickweed	DMOAK	GA NC SC TN
EN	🔥	*Stenanthium gramineum*	Eastern Featherbells	POH DOAK HERO GLADE	GA NC SC TN
EN, IN	🔥	*Stylosanthes biflora*	Pencil Flower	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Symphyotrichum cordifolium*	Heartleaf Aster	DMOAK HERO	GA NC SC TN
EN	🔥🔥	*Symphyotrichum patens*	Clasping-stem Aster	POH SLPO DOAK GLADE	GA NC SC TN
EN	🔥🔥	*Symphyotrichum undulatum*	Wavyleaf Aster	POH DOAK HERO GLADE	GA NC SC TN
EN, IN	🔥🔥	*Tephrosia spicata*	Spiked Hoary-pea	SLPO DOAK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN, IN	🔥🔥	*Tephrosia virginiana*	Goat's Rue	POH SLPO DMOAK	GA NC SC TN
AV		*Thalictrum dioicum*	Meadowrue	DMOAK	GA NC SC TN
EN	🔥	*Tradescantia subaspera*	Spiderwort	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Trillium undulatum*	Painted Trillium	HERO	GA NC SC TN
EN	🔥	*Uvularia puberula*	Appalachian Bellwort	POH DOAK DMOAK	GA NC SC TN
EN, IN	🔥	*Vicia caroliniana*	Carolina Vetch	DMOAK HERO	GA NC SC TN
EN	🔥	*Viola hastata*	Halberd-leaf Violet	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Viola pedata var. pedata*	Bird's-foot Violet	POH SLPO	GA NC SC TN
EN	🔥	*Viola sagittata*	Arrow-leaf Violet	POH SLPO	GA NC SC TN
EN, IN	🔥🔥	*Xerophyllum asphodeloides*	Eastern Turkeybeard	POH DOAK	GA NC SC TN

GRASSES-SEDGES

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Andropogon gerardii*	Big Bluestem	POH SLPO DOAK ROCK GLADE	GA NC SC TN
EN	🔥	*Andropogon ternarius*	Bluestem	SLPO	GA NC SC TN
EN	🔥🔥	*Andropogon ternarius*	Broomsedge	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Arundinaria appalachiana*	Appalachian Hillcane	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥🔥	*Arundinaria gigantea*	Rivercane	SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Aristida oligantha*	Three-awn Grass	SLPO GLADE	GA NC SC TN
EN	🔥	*Aristida purpurascens*	Arrowfeather	SLPO GLADE	GA NC SC TN
EN	🔥	*Brachyelytrum erectum*	Bearded Shorthusk	DMOAK HERO	GA NC SC TN
EN	🔥	*Bromus pubescens*	Hairy Woodland Brome	DMOAK HERO	GA NC SC TN
EN, EV		*Carex nigromarginata*	Black-edged Sedge	SLPO DOAK DMOAK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN, IN	🔥	*Carex pensylvanica*	Pennsylvania Sedge	DOAK DMOAK HERO GLADE	GA NC SC TN
EN, IN	🔥	*Carex virescens*	Ribbed Sedge	DOAK DMOAK	GA NC SC TN
EN, IN	🔥	*Chasmanthium laxum*	Slender Spikegrass	POH DMOAK FEN	GA NC SC TN
EN	🔥	*Danthonia compressa*	Flattened Oatgrass	HERO GRASS	GA NC SC TN
EN	🔥🔥	*Danthonia sericea*	Silky Oatgrass	POH DOAK ROCK	GA NC SC TN
EN, IN	🔥🔥	*Danthonia spicata*	Poverty Oatgrass	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Dichanthelium boscii*	Bosc's Panicgrass	POH SLPO DOAK DMOAK HERO	GA NC SC TN
EN, IN	🔥	*Dichanthelium commutatum*	Variable Panicgrass	POH SLPO DOAK DMOAK	GA NC SC TN
EN, IN	🔥	*Dichanthelium depauperatum*	Starved Witchgrass	POH SLPO DOAK	GA NC SC TN
EN	🔥	*Dichanthelium dichotomum var. dichotomum*	Forked Witchgrass	POH SLPO DOAK DMOAK ROCK	GA NC SC TN
EN	🔥	*Dichanthelium latifolium*	Broadleaf Witchgrass	SLPO DMOAK HERO	GA NC SC TN
UN	🔥	*Dichanthelium laxiflorum*	Open-flower Witchgrass	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Dichanthelium linearifolium*	Low White-haired Witchgrass	POH SLPO DOAK	GA NC SC TN
EN, IN	🔥	*Dichanthelium villosissimum var. villosissimum*	White-haired Witchgrass	POH SLPO DOAK GLADE	GA NC SC TN
EN, IN	🔥🔥	*Erianthus alopecuroides*	Silver Plume Grass	SLPO DOAK	GA NC SC TN
EN	🔥	*Elymus hystrix*	Bottlebrush Grass	DMOAK HERO	GA NC SC TN
EN, IN, RE		*Festuca subverticillata*	Nodding Fescue	DMOAK HERO	GA NC SC TN
EN	🔥🔥	*Melica mutica*	Two-flower Melic	DOAK GLADE	GA NC SC TN
EN	🔥	*Piptochaetium avenaceum*	Black Needle Grass	POH SLPO DOAK	GA NC SC TN
EN		*Poa autumnalis*	Early Bluegrass	DMOAK HERO	GA NC SC TN
EN	🔥🔥	*Schizachyrium scoparium*	Little Bluestem	POH SLPO DOAK GLADE	GA NC SC TN
EN, IN, RE	🔥	*Scleria ciliata var. ciliata*	Hairy Nutrush	POH SLPO GLADE	GA NC SC TN
EN		*Scleria nitida*	Shining Nutrush	POH SLPO DOAK	NC SC
EN	🔥	*Scleria oligantha*	Littlehead Nutrush	POH SLPO DOAK DMOAK	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥	*Scleria pauciflora*	Carolina Nutrush	POH SLPO GLADE	GA NC SC TN
EN, IN	🔥🔥	*Sorghastrum nutans*	Indiangrass	POH SLPO DOAK	GA NC SC TN

FERNS

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
AV, EN		*Athyrium asplenioides*	Southern Lady's Fern	DMOAK	GA NC SC TN
EN	🔥	*Asplenium platyneuron*	Ebony Spleenwort	DMOAK GLADE	GA NC SC TN
AV, EN		*Botrypus virginianus*	Rattlesnake Fern	DMOAK	GA NC SC TN
IN		*Diphastriastrum digitatum*	Running Cedar	POH SLPO DMOAK	GA NC SC TN
EN	🔥	*Dennstaedtia punctilobula*	Hay-scented Fern	SLPO DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Myriopteris lanosa*	Hairy Lip Fern	ROCK	GA NC SC TN
EN	🔥	*Myriopteris tomentosa*	Wooly Lip Fern	ROCK	GA NC SC TN
EN		*Claytosmunda claytoniana*	Interrupted Fern	DMOAK HERO HEATH	GA NC SC TN
EN	🔥	*Parathelypteris noveboracensis*	New York Fern	DOAK DMOAK HERO	GA NC SC TN
EN	🔥🔥	*Pteridium latiusculum var. latiusculum*	Bracken Fern	POH SLPO DOAK	GA NC SC TN
AV, EN	🔥	*Polystichum acrostichoides*	Christmas Fern	DMOAK	GA NC SC TN
EN		*Phegopteris hexagonoptera*	Broad Beech Fern	DMOAK	GA NC SC TN

VINES

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN		*Bignonia capreolata*	Crossvine	DOAK DMOAK	GA NC SC TN
EN		*Clematis viorna*	Leather Flower	HERO	GA NC SC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN		*Clematis virginiana*	Virgin's Bower	DOAK DMOAK HERO ROCK FEN	GA NC SC TN
EN		*Lathyrus venosus*	Smooth Veiny Peavine	DOAK DMOAK HERO	GA NC SC TN
EN	🔥	*Muscadinia rotundifolia*	Muscadine Grape	SLPO DOAK	GA NC SC TN
EN		*Parthenocissus quinquefolia*	Virginia Creeper	DOAK DMOAK ROCK	GA NC SC TN
EN		*Smilax bona-nox*	Saw Greenbrier	SLPO DOAK	GA NC SC TN
EN	🔥	*Smilax glauca*	Whiteleaf Greenbrier	POH SLPO DOAK DMOAK	GA NC SC TN
EN	🔥	*Smilax rotundifolia*	Common Greenbrier	POH SLPO DOAK DMOAK	GA NC SC TN
EN, EV	🔥	*Toxicodendron radicans*	Poison Ivy	DOAK DMOAK ROCK GLADE	GA NC SC TN
EN		*Vicia caroliniana*	Carolina Vetch	DMOAK GLADE	GA NC SC TN
EN	🔥	*Vitis spp.*	Wild Grapevine	DOAK DMOAK HERO	GA NC SC TN

UNCOMMON SHRUBS

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥	*Amelanchier sanguinea*	Roundleaf Shadbush	ROCK GLADE	GA NC SC TN
EN	🔥🔥	*Comptonia peregrina*	Sweet Fern	POH SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Fothergilla major*	Large Witch Alder	POH SLPO DOAK	GA NC SC TN
UN	🔥🔥	*Hudsonia montana*	Mountain Golden Heather	ROCK	NC
EN		*Nestronia umbellula*	Nestronia	POH	GA NC SC TN
EN	🔥🔥	*Pieris floribunda*	Mountain Fetterbush	HEATH	NC TN
AV		*Pyrola elliptica*	Waxflower Shinleaf	DMOAK	NC
EN		*Rhododendron cumberlandense*	Cumberland Azalea	HERO	GA NC SC TN
EN		*Rhododendron vaseyi*	Pinkshell Azalea	DMOAK HERO	NC
EN	🔥	*Robinia hartwigii*	Hartwig's Locust	ROCK	NC SC

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
UN	🔥	*Robinia hispida var. fertilis*	Fruitful Locust	DMOAK	NC TN
EN	🔥	*Robinia hispida var. kelseyi*	Kelsey's Locust	POH	GA NC SC TN
EN		*Sorbus americana*	Mountain Ash	POH HEATH GRASS	GA NC SC TN
AV, EN	🔥	*Stewartia ovata*	Mountain Camelia	DMOAK	GA NC SC TN

UNCOMMON FORBS

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
UN	🔥🔥	*Adlumia fungosa*	Allegheny Vine	DMOAK ROCK	NC TN
IN, EN	🔥	*Cirsium carolinianum*	Soft Thistle	SLPO DOAK	GA NC SC TN
EN	🔥🔥	*Cleistes bifaria*	Spreading Pogonia	POH SLPO	GA NC SC TN
UN		*Collinsonia tuberosa*	Deepwoods Horsebalm	DMOAK	GA SC TN
EN	🔥	*Collinsonia verticillata*	Whorled Horsebalm	DOAK DMOAK	GA NC SC TN
EN	🔥	*Convallaria pseudomajalis*	American Lily of the Valley	DOAK DMOAK HERO	GA NC SC TN
UN	🔥	*Coreopsis delphiniifolia*	Larkspur-leaved Coreopsis	POH DOAK	GA TN
UN	🔥	*Crocanthemum bicknellii*	Hoary Frostweed	ROCK GLADE FEN	GA NC TN
UN	🔥	*Crocanthemum propinquum*	Creeping Sunrose	SLPO ROCK GLADE	NC TN
EN	🔥	*Cypripedium parviflorum var. parviflorum*	Small Yellow Lady's Slipper	DOAK DMOAK HERO	GA NC SC TN
AV, EN	🔥	*Draba ramosissima*	Branching Whitlowgrass	ROCK	NC TN
EN, EV	🔥	*Echinacea laevigata*	Smooth Coneflower	SLPO GLADE	GA NC SC
EN, EV	🔥	*Echinacea purpurea*	Purple Coneflower	GLADE	GA NC SC TN
UN		*Euphorbia purpurea*	Glade Spurge	DMOAK	NC
UN	🔥	*Fleischmannia incarnata*	Pink Thoroughwort	DOAK ROCK	GA NC SC TN
EN		*Gillenia stipulata*	American Ipecac	DOAK DMOAK	GA NC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN, IN	🔥	*Hackelia virginiana*	Virginia Stickseed	DMOAK	GA NC SC TN
UN		*Heuchera pubescens*	Downy Alumroot	ROCK	NC SC TN
UN	🔥	*Hexastylis contracta*	Mountain Heartleaf	DMOAK	NC TN
EN	🔥	*Isotria medeoloides*	Small Whorled Pogonia	DMOAK	GA NC SC TN
UN	🔥	*Isotria verticillata*	Large Whorled Pogonia	DMOAK	GA NC SC TN
EN	🔥	*Liatris aspera*	Rough Blazing Star	DMOAK GLADE	GA NC SC TN
EN	🔥	*Liatris helleri*	Heller's Blazing Star	ROCK	NC
EN	🔥	*Liatris microcephala*	Appalachian Blazing Star	DOAK GLADE	GA NC SC GA
EN	🔥	*Liatris squarrulosa*	Earle's Blazing Star	SLPO GLADE	GA NC SC TN
UN	🔥	*Liatris turgida*	Turgid Blazing Star Shale Barren Blazing Star	POH DOAK DMOAK	NC
EN, IN	🔥	*Lysimachia fraseri*	Fraser's Yellow Loosestrife	DMOAK ROCK	NC TN
UN	🔥	*Lysimachia tonsa*	Appalachian Loosestrife	DMOAK ROCK	GA NC SC TN
EN, IN	🔥	*Monotropsis odorata*	Sweet Pinesap	POH SLPO DOAK	GA NC SC TN
UN	🔥	*Polygala senega*	Seneca Snakeroot	DOAK GLADE	GA NC SC TN
UN	🔥	*Pycnanthemum beadlei*	Beadle's Mountain-mint	DOAK DMOAK	GA NC SC TN
UN		*Pycnanthemum torrei*	Torrey's Mountain-mint	DOAK ROCK	NC SC TN
UN		*Pyrola americana*	American Wintergreen	DMOAK HERO	NC TN
UN		*Ranunculus fascicularis*	Early Buttercup	GLADE	GA NC SC TN
UN	🔥	*Rudbeckia heliopsidis*	Sun-facing Coneflower	GLADE	GA SC
EN	🔥🔥	*Sarracenia oreophila*	Green Pitcher Plant	SLPO FEN	GA NC
UN, IN	🔥	*Silene ovata*	Blue Ridge Catchfly	DMOAK HERO	GA NC SC TN
IN	🔥🔥	*Sisyrinchium dichotomum*	White Irisette	DOAK	NC
UN		*Smilax biltmoreana*	Biltmore's Carrion-flower	POH DOAK DMOAK	GA NC SC
UN		*Solidago ptarmicoides*	White Goldenrod	GLADE	GA NC TN

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN, EV		*Stenanthium leimanthoides*	Pine Barren Death Camas	POH ROCK	NC
UN		*Symphyotrichum ericoides*	Heath Aster	GLADE	GA TN
EN	🔥🔥	*Symphyotrichum georgianum*	Georgia Aster	SLPO	GA SC
EN	🔥	*Symphyotrichum laeve*	Smooth Blue Aster	DMOAK ROCK GLADE	GA NC SC TN

UNCOMMON GRASSES-SEDGES

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥🔥	*Calamagrostis porteri*	Porter's Reed Grass	POH GLADE	NC SC
UN	🔥	*Carex hitchcockiana*	Hitchcock's Sedge	DMOAK	NC TN
EN	🔥	*Carex purpurifera*	Purple Sedge	DOAK DMOAK	GA NC TN
EN	🔥	*Carex roanensis*	Roan Mountain Sedge	DMOAK HERO	GA NC TN
EN	🔥	*Carex woodii*	Wood's Sedge	DMOAK HERO	GA NC SC TN
EN, EV, RE	🔥	*Deschampsia cespitosa ssp. glauca*	Tufted Hairgrass	DOAK GLADE	NC
EN	🔥	*Elymus trachycaulus ssp. trachycaulus*	Slender Wheatgrass	DOAK GLADE	NC
EN	🔥	*Melica nitens*	Three-flower Melic	DOAK	GA NC TN
EN	🔥	*Muhlenbergia glomerata*	Muhly	GLADE FEN	NC
EN	🔥🔥	*Sporobolus heterolepis*	Dropseed	GLADE	NC

UNCOMMON VINES

STRATEGY	FIRE ADAPTEDNESS	SCIENTIFIC NAME	COMMON NAME	ECOZONES AND NATURAL COMMUNITIES	LOCATION
EN	🔥	*Clematis occidentalis var. occidentalis*	Purple Clematis	DOAK DMOAK	NC

Acknowledgments

The Southern Blue Ridge Fire Learning Network (SBRFLN) supported the development of this book; special thanks to the leadership of Margit Bucher and Beth Buchanan. The Nature Conservancy of North Carolina and Membership Development Program allowed Chelsea and me the time and creative space to explore this important project.

Special thanks to the folks who gave their time to discuss management successes and setbacks so that others may benefit: Clarence Coffey, Dean Simon, Ryan Jacobs, Wally Akin, Pete Bates, Tom Waldrop, Don Hagan, Wes Bentley, Mike Brod, Philip Earhart and Jim McCoy. Our conservation efforts benefit from the lifelong dedication of these leaders in the conservation of Southern fire-adapted ecosystems.

Natural resource conservation and contemporary land management benefits greatly from understanding how the Cherokee lived with fire. We continue to learn from the traditional fire practices of Indigenous Appalachian people that used fire to care for these lands. The Eastern Band of Cherokee Indians holds centuries of knowledge, which is critical for effective application of fire to contemporary landscapes. Thank you for allowing us to share just some of the story about the origins of cultural burning and modeling how natural resources should be stewarded. Thanks especially to Mike Lavoie and Tommy Cabe who reviewed the book.

Special thanks to Mike Schafale that provided both content review and authored important publications provided by the North Carolina Natural Heritage Guides to Natural Communities. The botanical expertise of Ed Schwartzman, Josh Kelly and Gary Kauffman was invaluable in ensuring accuracy and plant table. The SBRFLN is fortunate to have them among the membership. Others who supported this effort with their time and the information they provided include: Mark Pistrang, Greg Philipp, Robin Mackie, Felix Stith, Carrie Radcliffe-Brod, Jennifer Lamb, Greg Cooper, Brian Parr, Jessica Wells, Steve Simon, Pat Cloninger, Mike Black, Rob Klein, Matthew Keyes and Rachel Dickson.

The effort required to pull off Blue Ridge mountain burning is immense. Burn days are long and preparation time measured in weeks and months. Without the dedication, blood and sweat of conservationists, Appalachian fire management could not have been sustained and we would not have model sites to study and tailor fire management programs. For this we are grateful to the following organizations and staff: North Carolina Wildlife Resources Commission: Ryan Jacobs, Jim Keepfer, Dean Simon, Gordon Warburton, among others; USDA Forest Service Fire Management: Greg Philipp, Forrest Sutton and Chase Frisbee (Pisgah National Forest); Brian Browning (Nantahala National Forest); Marty Bentley, Ben Ingram, Brian Matoy, Amy McClave and Greg Salansky (Cherokee National Forest); Wes Bentley (Sumter National Forest); Mike Brod and Mike Davis (Chattahoochee National Forest); Tennessee Wildlife Resources Agency: Wally Akins, Aubrey Deck, Bill Smith and others. We also thank Malcolm Hodges from The Nature Conservancy in Georgia and Mark Hall from South Carolina Department of Natural Resources who have dedicated their careers to Appalachian fire management. All are truly dedicated professionals and leaders in natural resource conservation.

Personally, I am especially thankful for the guidance provided by supervisor and mentor, Megan Sutton. Megan and Margit Bucher inspire creativity, and their support helped provide the energy to produce this book. This book was also inspired by the work of Craig Harper and Joint Fire Science Program leaders like Helen Mohr and Joe Marschal — conservationists as well as gifted communicators that translate complex scientific concepts so that conservation can truly be a collective effort.

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For help with gaining access to any of the articles referenced, please reach out to the Southern Blue Ridge Fire Learning Network.

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The Southern Blue Ridge Fire Learning Network is open to those interested in restoring fire to conserve biodiversity. The Fire Learning Network (FLN) helps people work together to increase the capacity and social capital needed to build ecosystem and community resilience. FLN collaboratives engage in a range of multi-agency, community-based projects to restore landscapes that depend on — or are susceptible to — fire. By sharing decision-making and responsibility among stakeholders, the ecological, economic and social values provided by healthy landscapes are maintained, and the negative consequences of wildfire can be reduced.

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