



APPALACHIAN  
MOUNTAINS  
JOINT VENTURE

# OAK-HICKORY FOREST MANAGEMENT RECOMMENDATIONS

for Priority Species in the  
Virginia Highlands Focal Landscape



The Appalachian Mountains Joint Venture (AMJV) is a regional partnership of over 55 state and federal agencies, conservation organizations, and universities. Our mission is to restore and sustain viable populations of native birds and their habitats in the Appalachian Mountains Joint Venture region through effective, collaborative partnerships. Guided by our mission, we are committed to the conservation of habitat for the benefit of birds, wildlife, and people in the core of the Appalachian Region. Our partnership stretches from the southwestern Appalachians in Alabama to the northeastern highlands in southern New York. This area encompasses 103 million acres across portions of Tennessee, Kentucky, Ohio, Alabama, Georgia, North Carolina, Virginia, Maryland, Pennsylvania, New Jersey, New York, and all of West Virginia and contains some of the largest expanses of forest remaining in the eastern United States.

This guidance document was produced through the efforts of our Virginia Highlands Focal Landscape Committee. The AMJV Focal Landscape Initiative strategically targets our capacity and resources to high-priority regions established by our partners within the AMJV geography. This approach maximizes our conservation impacts and make concrete steps towards improving habitat for our priority species. Our objective with this initiative is to achieve landscape-level benefits for our priority birds, demonstrated by stabilizing or increasing populations within the focal landscapes.

**We thank our cooperating partners on the Virginia Highlands Focal Landscape Committee:**

Virginia Department of Wildlife Resources  
Virginia Department of Forestry  
Virginia Department of Conservation and Recreation, Natural Heritage  
Mountain Soil and Water Conservation District  
Virginia Natural Resources Conservation Service  
The Nature Conservancy  
National Wild Turkey Federation  
US Forest Service  
Virginia Outdoors Foundation

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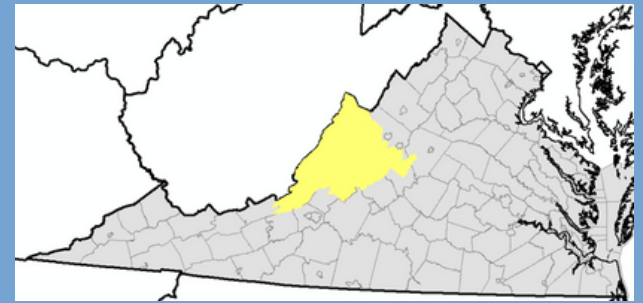
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## Virginia Highlands Focal Landscape



# OVERVIEW

The Appalachian Mountains Joint Venture (AMJV) partnership is focused on preserving, managing, and restoring diverse, healthy forest habitats in the region to benefit not only birds, but the diversity of Appalachian plants and wildlife. We have adopted a Focal Landscape approach to strategically target our capacity and resources to high priority regions, maximizing conservation impacts and making concrete steps toward improving habitat for priority species. In Virginia, our AMJV partners identified an approximately 2.3 million acre area in the western portion of the state as the highest priority area to establish an AMJV Focal Landscape (see map above). This area is named the Virginia Highlands Focal Landscape.

# OBJECTIVE

Within our Focal Landscapes, the AMJV is leading our partners in developing management recommendations for priority species to be used by land managers and foresters within the region. Most commonly, habitat management for priority species begins with biologists researching and compiling stand-level management recommendations for each species and sharing these recommendations with land managers. It is then left to land managers to assess a stand and decide which priority species they should target in the stand, and then apply the recommended best management practices when planning the harvest or other treatment. This is problematic for a few reasons. First, this approach usually offers no guidance to land managers about where in the landscape the management should be planned. Also, this approach leads to the idea that priority species are competing with one another. Land managers may assume that only one target species can be selected in a stand, and that this species must remain the target over time. To overcome these obstacles, the AMJV is piloting an approach called Full Rotation Conservation Planning. This approach offers management guidance at both the landscape and stand level for a suite of multiple priority species, helping to create high-quality habitat throughout all forest ages.

# A NEW APPROACH

The goal of Full Rotation Conservation Planning is to prioritize forest management in stands with the greatest potential to benefit multiple priority species. Full Rotation Conservation Planning is different from a single-species management approach in three important ways.

- Full Rotation Conservation Planning considers the impacts of management not only at the time it is completed, but also through time as the stand ages. Commonly, management recommendations focus only on the needs of various species who may benefit at the time of management, or shortly thereafter. By incorporating recommendations to address the future needs of species that may use the stand as it grows, we can ensure the stand will remain high-quality habitat as it ages through its harvest rotation.
- Full Rotation Conservation Planning brings together the landscape-level habitat needs of multiple priority species. These features are used to create a map of stands where management or protection should be prioritized.
- Full Rotation Conservation Planning gathers stand-level best management practices for all priority species into a single guidance document, organized by management practice. The resulting approach offers land managers guidance on where they should be prioritizing management, and how they can tweak management activities in those stands to benefit multiple priority species through time.



Wood Thrush (Photo by Mike Parr)

Just as biologists have recognized that we need to manage for birds and other species while considering their full annual cycles, we are planning the management of forests by considering the entirety of their harvest rotation. Managing forests in rotation is simply the cycle of harvesting trees, allowing them to age while tending them to promote healthy growth, and then harvesting them again. In Eastern deciduous forests like the oak-hickory forests of western Virginia, this process typically occurs on the order of 100-120 years. However, it is important to recognize that not every stand must be managed on a similar

rotation length. Even within a block dominated by oak-hickory forest, there will likely be stands of other forest types which may require different approaches (i.e. aspen with shorter rotations, hemlock with longer or no-harvest).

Maintaining a variety of ages of forests on the landscape is key to managing for wildlife because different species use different ages of forest throughout their lives. Some species, such as Eastern cottontails, rely on young forest, while others, like fishers, benefit from features found in older forests. Many species, like Cerulean Warblers, use different ages of forest throughout different times in their life cycles. To make sure that we can meet the habitat needs of all these species, it is important to have forest blocks of a variety of ages on the landscape at any given time.

Full Rotation Conservation Planning includes planning at two scales: landscape-scale and stand-level. It is important to note that the landscape-scale prioritization and stand-level management recommendations presented in this guide do not replace the need for comprehensive forest management plans based on site-level forest inventory data. The landscape-scale prioritization model identifies areas of forest within the landscape to be prioritized for management or protection. Within these prioritized areas, AMJV and partners are designating Dynamic Forest Restoration Blocks of approximately 5,000-25,000 acres where planning and management efforts are concentrated. Forest management plans are written for these areas to guide on-the-ground management and help managers evaluate age-class diversity and set goals for long-term management within the block. Stand-level management recommendations can then be used to guide the implementation of management activities called for in the plan.

## LANDSCAPE-SCALE PRIORITIZATION

The landscape-scale prioritization process begins with the development of a list of priority species. For our Virginia Highlands Focal Landscape, our planning committee used resources such as the State Wildlife Action plan and recommendations from species experts to generate a list of priority species for the region. From this full priority species list, the committee selected a subset of species known to use oak-hickory forest to be considered for this planning effort (Table 1).

Landscape-scale prioritization is used to highlight areas which have landscape features that are most likely to offer habitat suitable for multiple priority species. The first step is to identify the landscape-level features associated with the habitat of each of the priority species.

**Table 1: Landscape-Scale Habitat Features of Virginia Focal Landscape Priority Species**

Species	Landscape-scale Features (if known)
Allegheny Woodrat	*South-facing slopes located <2.5 km from occupied sites in a surrounding matrix of unfragmented forest
American Woodcock	<b>Within 1/2 mile of a stream, wetland or waterbody</b>
Bats (Summer Roosting)	*Forested ridge tops and south-facing slopes within 5 miles of a cave entrance.
Black-billed Cuckoo	
Cerulean Warbler	<b>&gt;70% forest cover within 6 miles</b> Large blocks (>60 acres) of closed canopy forest <b>Within 5 miles of CERW detection</b>
Eastern Spotted Skunk	Forest patch >200 acres
Eastern Whip-poor-will	
Fisher	
Golden Eagle (Wintering)	*North-south oriented cliff lines
Kentucky Warbler	Forest blocks over 125 acres Near streams
Ruffed Grouse	<b>Within 5 miles of grouse detection</b> >75% forest cover
Rusty Patched Bumble Bee	
Timber Rattlesnake	*Areas with numerous large rock outcrops with multiple crevices on south to southwest-facing slopes located <2.5 km from occupied sites in a surrounding matrix of unfragmented forest
Wood Thrush	<b>Forest blocks over 250 acres</b> <b>&gt;80% forest cover within 1 mile</b> <b>&gt;65% forest cover within 3 miles</b>
Yellow-billed Cuckoo	

\*Restrictive features that will only be incorporated into stand-level guidance

We used published research and expert opinion to identify these features for each priority species, whenever possible. After compiling all of these species' landscape-level habitat features, we classified them into four main categories: forest cover, forest patch size, distance to known populations, and distance to water features. Where possible to reduce redundancy, we kept only the most selective landscape-scale requirement in each category (bolded in Table 1). For example, there are three priority species with patch size requirements. The most selective is Wood Thrush, with a 250 acre patch size requirement. If we prioritize forests that meet this stricter requirement, we will also be meeting the requirements for Kentucky Warbler and Eastern spotted skunk, which are less selective.

Some landscape-scale features were too limiting to be included in the landscape-scale prioritization (indicated by asterisk in Table 1). Including these features in the landscape-scale model would reduce the prioritized stands so significantly that many opportunities for



Allegheny Woodrat.  
Photo by Alan Cressler, CC BY-SA 2.0, via Wikimedia Commons

management to benefit the broader set of species would be missed. For example, including the landscape-scale requirement for Allegheny Woodrat of being within 2.5 km of an existing Woodrat population would result in only a very limited number of stands in the final prioritization model due to the small number of Woodrat colonies documented in the region. Instead of being included in the landscape-scale model, these features will be incorporated into stand-level guidance, encouraging managers to take specific steps to benefit these species should their targeted area meet these selective features.

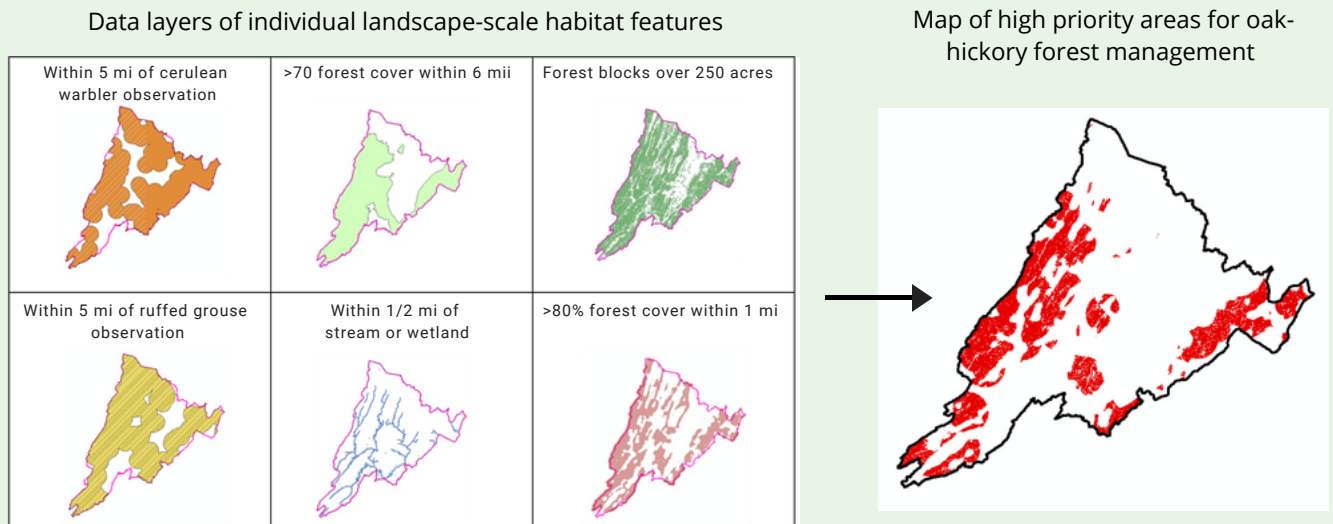
## SPECIES WITH HIGHLY SELECTIVE HABITAT FEATURES

During the landscape-scale prioritization, some species landscape-scale habitat features were deemed too selective to be included in the landscape-scale analysis. However, land managers should consider the areas targeted for management to see if they meet the potential habitat criteria below.

**Allegheny Woodrat:** Identify potential habitat sites with numerous large rock outcrops with multiple crevices on south-facing slopes located <2.5 km from occupied sites in a surrounding matrix of unfragmented forest.

**Timber Rattlesnake:** Identify potential habitat sites with numerous large rock outcrops with multiple crevices on south to southwest-facing slopes located <2.5 km from occupied sites in a surrounding matrix of unfragmented forest

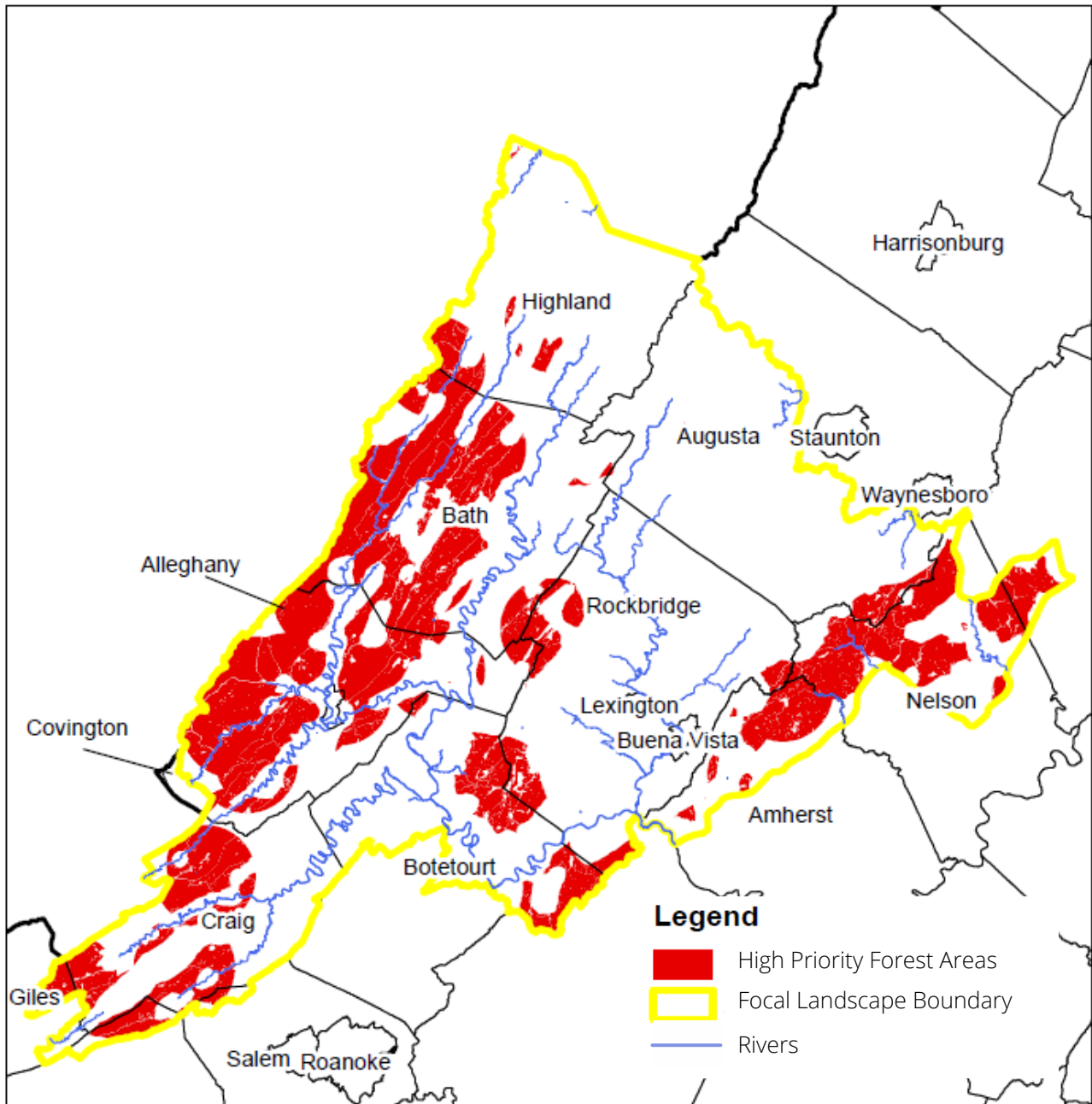
**Summer Roosting Bats:** Identify cave entrances and surrounding forested ridge tops and south-facing slopes.



**Figure 1: GIS Analysis of Landscape-Scale Habitat Features of Virginia Focal Landscape Priority Species**

Lastly, GIS was used to highlight areas within the focal landscape that met all the complementary landscape-level habitat features we identified. Data layers showing areas exhibiting each of the complementary landscape-scale habitat features were overlaid to create a map of areas that exhibited all these features (Figure 1). This map is intended to guide land managers toward prioritizing management in forest stands with the greatest potential to offer habitat for priority species throughout the full harvest rotation (Figure 2).





**Figure 2: Landscape-scale Prioritization Model for Oak-Hickory Forests in the Virginia Highlands Focal Landscape**

Web-based version of this map available at: <https://www.arcgis.com/apps/webappviewer/index.html?id=4365e4ae72004c1c8e4d72fa2ebd170a>





## STAND-LEVEL MANAGEMENT GUIDANCE

In addition to the landscape-scale prioritization, which offers land managers guidance on where management should take place, Full Rotation Conservation Planning includes recommendations for stand-level management for priority species. These recommendations are compiled for all species and then assembled by management practice. This approach allows forest managers to evaluate management needs within a stand based on silvicultural principles, then incorporate recommendations to improve habitat for a suite of priority species while implementing that practice.

Due to the potential impacts of climate change to forest ecosystems and the priority species that rely on them, this guide also incorporates considerations to reduce losses of carbon to the atmosphere through forest management activities. As carbon held in the soil represents the largest pool of carbon in a forest system, the recommendations presented here focus on factors that can reduce losses of carbon held in the soil during forest management activities.

### General Harvest Recommendations

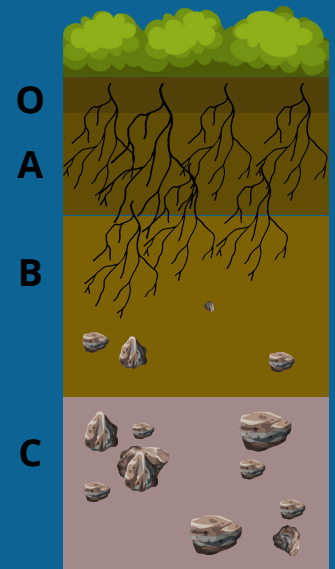
- When possible, harvest trees in winter. Especially avoid harvesting during periods of nesting and fledgling activity (May to mid-August) and minimize management that may destroy spring blooming flowers during their bloom periods.
- Use irregularly-shaped harvest units.
- Where not a risk to human safety, retain standing snags, downed dead wood, and slash in some areas.
- On slopes, orient skid trails perpendicular to slope aspect as much as possible. This is especially important for concave slopes, which incise and gather water and gravity-transported soil materials more effectively.
- Avoid harvesting on slopes that are convex, south-facing, or have soils that are shallow, Spodosols or Inceptisols (for more information, see "Soil Basics" box on next page).

- Chip and spread residues, especially on steep slopes or Spodosols.
- On sites with steep slopes or limited O horizon (layers with high organic matter) development, fell trees as perpendicular as possible to slope aspect.
- Avoid harvesting in areas where trees have recently re-established on formerly cultivated soils.
- On slopes, maintain or create contour strips (perpendicular to slope aspect) of residues or untreated forest. If slopes are compound, configure these surface control features to connect, collect, and stabilize mobilized surface soils or residues.
- In coves, depositional landforms, or slow-moving stream settings that are in or below harvested or burned areas, create residue or debris dams perpendicular to the flow direction.
- Do not remove or burn harvest residues, especially from sites with soils that are considered vulnerable for topographic or soil taxonomic reasons.
- Deer browse can depress tree regeneration and severely limit habitat in some areas, and consideration should be given to lowering deer densities or otherwise protecting habitats from browse. Creating pockets of slash may impede deer movement and restrict access to young growth.

## SOIL BASICS

### Horizons

Soils are comprised of different layers, or horizons. Most soils have three major horizons: A (topsoil), B (subsoil), and C (parent material). Some soils also have an organic (O) horizon above the A horizon.



### Orders

Soils can be classified using a system called Soil Taxonomy, which places soils into one of 12 categories known as "orders." Each order is based on one important diagnostic feature related to the land use or management of all soils in that order.

To determine the soil order for an area, use the Web Soil Survey tool available at: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

Source: Soil Science Society of America

- All machinery and equipment capable of carrying invasive plant propagules should be cleaned prior to moving on and off site. Major areas of equipment to be cleaned include tires, wheels, tracks, rollers, track shoes, radiator grids/screens, blades, grapple and articulating unions, trailers, knuckles, cutting head pivot points, and sprockets, along with the steps into and out of the cab.

- When stands containing spring seeps are regenerated, a 50-100' buffer should be left uncut.
- Retain a greater proportion of residual basal area on south-facing slopes.

***If harvest area includes features for Timber Rattlesnake:***

- Avoid ground disturbance in rocky areas.
- Educate loggers to not kill snakes.

***If harvest area includes features for Allegheny Woodrat:***

- Retain intact forest immediately covering rock outcrops and on at least one adjacent side.
- Retain a forested buffer between rock outcrop and timber harvest on remaining sides.

***If harvest area includes site features for summer roosting bats:***

- Promote management to maintain mature forest characteristics on ridge tops and south facing slopes. In these areas, retain tree species that have sloughing bark (shagbark hickory, sugar maple), as well as wolf trees and snags.





A shelterwood harvest with some slash left behind.

## Shelterwood Harvest

- Favor white oak, chestnut oak, hickories, and cucumber magnolia in the residual stand. Retain the largest diameter individuals of the preferred species as residual trees.
- Retain native species of high value to birds, such as yellow birch, hophornbeam, dogwood, spicebush, serviceberry, and fruit-bearing shrubs.
- Retain some grape vines when possible. One potential strategy is to leave undesirable or non-commercial trees covered in grapevines to create small "grape arbors".
- Plan a series of adjacent shelterwood cuts so that similar habitat is available nearby when one stand is ready for an overstory removal.

## Roads and Landings

- Replant forest roads with legumes and other forbs including annual cool-season grains (wheat, rye, and oats), clovers, and birdsfoot trefoil.
- Scarify and add surface organic matter amendments to log decking and loading areas, especially if soils are low in organic matter and high in clay (Ultisols and Alfisols).
- If possible, allow regeneration of landings by native seedbank. Avoid planting of sod-forming grasses.



Golden-winged Warbler. Photo by Mike Parr.

## Overstory Removal

- When feasible and allowable, create harvest units of 30 acres and larger.
- Leave some large-diameter residual stems (>15" dbh) in a harvest unit (10-20 sq ft/ac of dominate/co-dominate crown classes). Up to 30 sq ft/ac may be retained but may impact oak regeneration success.
- Favor white oak, chestnut oak, hickories, and cucumber magnolia for the residuals.
- Retain some (2-10 per block) old, mature, live deciduous trees with apparent cavities or individuals of species susceptible to heart-rot or broken branches that may form cavities in the future.
- Retain a small proportion of midstory trees to provide multi-storied canopies as new stands regenerate, prioritizing species such as serviceberry and dogwood.
- Consider setting aside stands with a high abundance of hard-mast producing species as reserve areas, especially if the surrounding landscape is without nearby stands containing mast-producing species.
- In stands with aspen, all aspen trees in the patch should be cut to maximize sprout growth. Time the cutting to occur after leaf-fall and make the harvested area larger towards the south (bell-shaped).



Overstory removal with slash left on-site.



## Prescribed Fire

- Prescribed burns should be planned and carried out by a certified burn manager. Consult the Virginia Department of Forestry for current Virginia fire laws and contact local authorities prior to burning.
- Only burn from mid-October through mid- March, if possible. If feasible to achieve your management objectives, conduct spring burns as early as is possible, or late fall burns. Late spring burns may reduce the nectar and pollen sources available to newly emerged queen bees that are gathering food to establish their colonies.
- Execute burn prescriptions that reduce woody and litter materials while retaining materials in the Oe horizon (partially decomposed layer beneath the upper layer of leaves and needles) and Oa horizon (very dark layer of well decomposed humus).
- On sub-mesic sites where yellow poplar, red maple, and others are serious competitors impacting oak regeneration, a growing-season prescribed fire three to five years after the initial shelterwood harvest may be needed to top-kill all trees in the stand. Young oaks arising from an existing root system are then able to send up a vigorous stem the year following fire and compete with other species.
- On more xeric sites, especially south- and west-facing slopes and ridgetops, where establishment of oak regeneration is less difficult, moderate or repeated low-intensity fires can be applied to maintain understory structure suitable for nesting and post-fledging cover for target bird species.
- Consider the landscape in which the fire will occur, specifically approximately 200 acres surrounding the area of interest, to determine if there are nearby stands with coarse woody debris available. Prescribed fire may combust coarse woody debris, resulting in an initial decline in the abundance of snags and protective woody cover following a fire. This may negatively affect species such as eastern spotted skunks that utilize coarse woody debris for foraging and denning. However, in subsequent years, direct mortality of maples and other fire-intolerant species may lead to an increase in coarse woody debris from downed logs and branch fragments.

### ***If harvest area includes features for Timber Rattlesnake:***

- In areas where basking habitat (rock outcrops or talus) has shaded over, prescribed fire can be used to open these areas to allow for increased sunlight.

## Thinning and Crop-tree Release

- Target species for removal that do not produce preferred food resources (e.g., maples, yellow poplar, ashes, and sourwood), while retaining more desirable species (e.g., oaks, black cherry, serviceberry). In subxeric and xeric mixed hardwoods, retain soft and hard-mast producing species (e.g., oaks, serviceberry, blackgum) in the overstory. In mesic stands where oaks are less prominent, retain black and pin cherry, birch, American beech, and serviceberry in the overstory.
- Promote high diversity of hard mast producing species (chestnut oak, red oak, white oak, American beech, and hickory), as well as cucumber magnolia.
- Decrease canopy cover in select areas by incorporating group openings into the thinning to promote patchily distributed, dense understory (see Group Openings section below).
- Target areas to promote high diversity of hard mast (chestnut oak, red oak, white oak, hickory, and cucumber magnolia), native fruiting shrubs, and increased herbaceous vegetation (forbs and grasses).
- Promote native trees and shrubs whose flowers are good early season pollen and nectar sources (e.g., willows, serviceberry).
- Thinning between shelterwood or overstory removal stands can help to improve habitat connectivity and may diffuse deer browsing pressure.

## Herbicide and Pesticide Use

- Target herbicide applications to achieve less than 30% cover of native invasive plants, and as high a level of control on non-native invasive species as is feasible.
- Retain native wild blueberries, cranberries (*Vaccinium* spp.), and raspberries (*Rubus* spp.).
- Use selective application methods in wooded areas that contain highly diverse (10+) spring-time native flowering herbaceous plants, shrubs, and/or spring flowering trees.
- Reduce use of chemical or other control of “undesirable” insect species to maintain prey base for insectivorous species.
- Avoid insecticide use within 5 miles of a cave entrance.

Herbicides being applied following a harvest to reduce undesirable vegetation. (Photo by K. Yoder)



## Group Openings

- Create group-selection openings between harvest units to soften edge effects, increase understory stem density, and improve groundcover conditions and connectivity between harvest units. Group cuts should be well interspersed to increase cover and foraging opportunities in mature stands. The group selection method should not be viewed as a substitute for even-aged management, but rather as a complement, serving to connect young forest stands.



View of the forest canopy above a group opening.

- In areas lacking desirable understory vegetation, create small canopy openings (~5 adjacent trees removed) to increase the understory shrub layer.
- In heavily forested areas without active annual management, or where management is not even-aged, cut and maintain openings of 5-acre or larger in size with sparse ground cover.
- Do not plant or revegetate, especially with sod forming grasses. The objective is to allow the site to revegetate with patchy, naturally occurring native weeds and forbs/warm season grasses. Allow a 100-foot border of the opening to regenerate into dense sapling sized deciduous shrubs and trees.
- Along ridgelines that are primarily forested, create small scattered openings.



Timber rattlesnake (*Crotalus horridus*). Photo by K. Duren

### ***If harvest area includes features for Timber Rattlesnake:***

- Identify den sites to limit potential disturbance. Potential den site features include rocky hillsides, ledge fissures, fallen rock talus and scree, and talus and scree partly covered by soil. Basking/gestating habitat is characterized as an open rocky place which may have a prominent rock outcrop, slide, or individual slab in a forest clearing.
- Create openings in areas where basking habitat (rock outcrops or talus) has shaded over through periodic cutting of tree limbs and trees preventing sunlight from reaching the basking site. When possible, harvest trees in winter.



## SUPPORTING LITERATURE

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