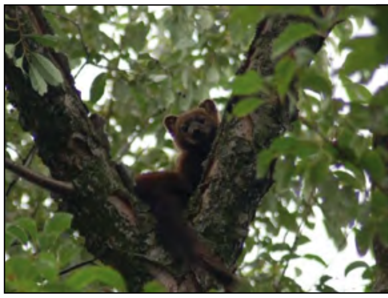

# Chapter 11: Reforestation to Enhance Appalachian Mined Lands as Habitat for Terrestrial Wildlife

Petra Wood, Jeff Larkin, Jeremy Mizel, Carl Zipper, and Patrick Angel

## INTRODUCTION

Surface mining is widespread throughout the Appalachian coalfields, a region with extensive forests that are rich in wildlife. Game species for hunting, nongame wildlife species, and other organisms are important contributors to sustainable and productive ecosystems. Although small breaks in the forest canopy are important to wildlife diversity, most native Appalachian wildlife species require primarily forested habitats (Wickham and others 2013). This Forest Reclamation Advisory provides guidance on reforestation practices to provide high-quality habitat for native forest wildlife on Appalachian coal mines.

Mined lands reclaimed under the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) with conventional methods—smooth-grading mine spoil and seeding fast-growing ground covers—are used by a few wildlife species and can increase species diversity. But expansive areas of these lands have little habitat value to most native wildlife species in the Appalachian region. Conventional reclamation also inhibits forest succession (a term used to describe natural changes in plant community composition over time) and causes most native plant species to have poor colonization, growth, and survival. As a result, high-quality wildlife habitat rarely develops away from the forest–mine edge on surface mines reclaimed with conventional methods. Even popular game species often observed on conventionally reclaimed mined lands such as deer, elk, bear, and wild turkey are rarely seen far from the forest edge. (Please see the Appendix starting on p. A-1 for scientific names of species mentioned in this chapter.) However, improved wildlife habitat is a postmining goal for many landowners and is achievable through application of the Forestry Reclamation Approach (FRA) to enhance natural succession (Chapter 8, this volume) on active mines (Chapter 2, this volume),

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**Publication History**

This chapter is based on Forest Reclamation Advisory No. 10, which originally appeared in November 2013 on the Appalachian Regional Reforestation Initiative's Web site (http://arri.osmre.gov) hosted by the U.S. Department of the Interior's Office of Surface Mining Reclamation and Enforcement. (Note that authors' affiliations were current when the Advisory was originally written.)

and through soil mitigation and planting of trees and shrubs on older mine sites that were reclaimed by using conventional methods years ago ("legacy mines") (Chapter 10, this volume).

## APPALACHIAN FOREST AND MINED LAND HABITATS

Appalachian hardwood forests are some of the most biologically diverse temperate forests in the world (Hinkle and others 1993). They provide habitat for numerous wildlife species that require young forest conditions, as well as those that require mature forest.

Many wildlife species (amphibians, reptiles, birds, and mammals) that depend on young forests for foraging, cover, or breeding (Gilbart 2012) are declining in population (Litvaitis 1993). Native young forest communities consist of dense herb, vine, sapling, and shrub growth that exists for a relatively short time (12 years or less). Therefore, patches of young forest must be continuously created and dispersed across the landscape to ensure long-term viability of the many species dependent on these habitats. Wildlife agencies in every state of the Appalachian coalfields list young forest communities as high-priority habitats.

More than 1 million acres of mined lands have been reclaimed in the eastern United States (Zipper and others 2011) and additional mined lands are being created. Reforestation of mined lands has the potential to provide extensive areas of young forest habitat interspersed among unmined mature forests. Through succession, these young forests will become mature forests. A regional, landscape-scale effort to reforest mined lands has great potential to benefit wildlife species dependent on young and mature forest habitats.

Golden-winged warbler, brown thrasher, and eastern whip-poor-will are a few of the nongame bird species that breed in young forests and are undergoing long-term population declines in the Appalachian region (Sauer and others 2014). Like many species that are young-forest specialists, these birds require habitat with dense patches of native shrubs interspersed with trees of varying size and herbaceous cover. Patches of young forest also provide important foraging habitat and cover for several Appalachian game species including cottontail, black bear, white-tailed deer, elk, ruffed grouse, northern bobwhite, and American woodcock (Fig. 11-1). Within most surface mines reclaimed under SMCRA by using non-FRA methods, nonnative shrub and grass species predominate and areas of dense native woody vegetation are typically absent or restricted to forest–mine edges.

In contrast, forest reclamation can create a dense undergrowth of native shrubs, saplings, and forbs that species such as cottontail require for protective cover from predators. These patches of dense woody and herbaceous cover provide abundant forage for game and nongame species in the form of insects, mast, seeds, buds, foliage, and fruits from vines and shrubs. Young forest habitat adjacent to mature forest also may benefit fisher, a forest-dependent predator that has been reintroduced to several Appalachian states (Fig. 11-2). Many mammal and bird species that are preyed upon by fisher and other carnivores use areas where young forest next to mature forest creates structurally diverse habitat (Litvaitis 1993).

Figure 11-1.—American woodcock. This species of high conservation concern inhabits moist, young forest habitats. Photo by A. Newman, Eastern Kentucky University, used with permission.

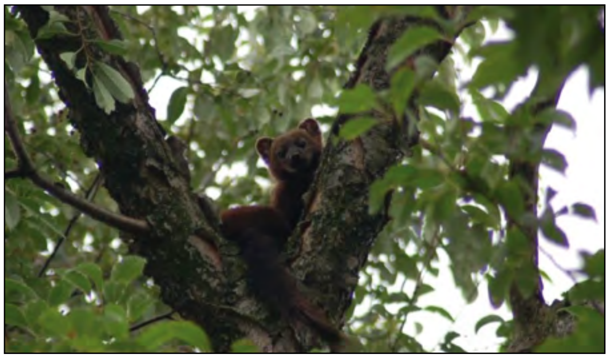

Figure 11-2.—A fisher. This forest-dependent carnivore is colonizing many Appalachian states after reintroductions in West Virginia, Tennessee, and Pennsylvania. Young forest along mature-forest edges provides habitat for many of the fisher's favorite prey. Photo by J. Larkin, Indiana University of Pennsylvania, used with permission.

Ultimately, surface mines that persist as nonforest cover lead to forest fragmentation and reduced forest cover on the landscape, which negatively affect wildlife species that require large, continuous blocks of forest (Wood and Williams 2013, Wood and others 2006). One such species is the cerulean warbler (Fig. 11-3), a declining forest songbird (Sauer and others 2014) with a breeding range that has considerable overlap with the Appalachian coalfields (Fig. 11-4). Cerulean warblers, and probably other mature forest songbirds as well, are less abundant near the abrupt edges created by surface mines reclaimed to grassland (Wood and others 2006). For some species of woodland salamander, grassland patches act as barriers to movement between forest patches (Rittenhouse and Semlitsch 2006). Thus, reforestation of surface mines may benefit mature-forest wildlife in the short term by creating more transitional forest–mine edges (feathered edges) and reducing forest fragmentation, and in the long term by compensating for the loss of mature forest habitat.

Figure 11-3.—Male cerulean warbler. Photo by M. Shumar, Ohio State University, used with permission.

## GUIDELINES FOR WILDLIFE HABITAT ENHANCEMENT ON MINED LANDS

### 1. Increase Structural Complexity of the Soil Surface; Avoid or Remediate Soil Compaction

Structurally complex forest floors are important habitat features for many types of wildlife, such as small mammals, snakes, and salamanders (Fig. 11-5). Forested rock outcrops are unique

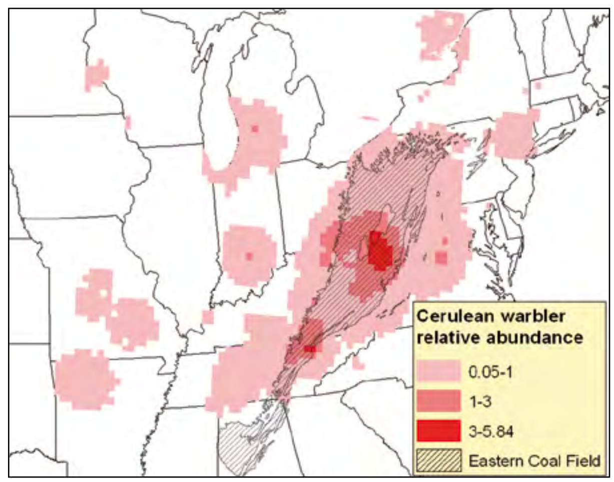


Figure 11-4.—The Appalachian coalfield and the breeding range of cerulean warbler (derived from Breeding Bird Survey counts, Sauer and others 2011).

Figure 11-5.—A red eft, the terrestrial life stage of the eastern newt. Photo by K. Aldinger, West Virginia University, used with permission.

habitats important to many species of Appalachian wildlife, particularly the Allegheny woodrat and green salamander. However, because rock outcrops are usually located along ridgetops or upper side slopes, mining often removes these habitat features. Conventional reclamation generally fails to restore these important, structurally and biologically diverse components of eastern forests.

On sites with active reclamation, avoid excessive smoothing and compacting of soil. A rough-graded soil surface with loose-soil conditions, exposed rocks, and surface relief provides a more structurally diverse habitat than conventional smooth grading.

On legacy mines, compacted spoil can be loosened by a dozer equipped with a ripper tooth (Chapter 5, this volume). Ripping compacted spoil not only improves water infiltration and rooting conditions for trees and shrubs, but it also benefits burrowing species such as salamanders, earthworms (which are food for American woodcock and other wildlife), and small mammals. These animals need loose, moist soil to burrow and forage. Small mammals and salamanders occur in greater abundance where spoil is not compacted (Larkin and others 2008, Wood and Williams 2013). These animals in turn are a food source for many predator species.

Incorporating rocks on the surface (Figs. 11-6 and 11-7) can provide additional structure and cover for ground-dwelling and burrowing species. After young forest and some tree canopy develop, large boulder piles (Fig. 11-7) may provide habitat for Allegheny woodrat (Chamblin and others 2004) and many other species that use wooded rock outcrops, particularly if they are close to nearby forested areas that contain rock outcrops. One study found that reintroduced fishers in Pennsylvania occasionally rested in ground dens within rock outcrops, including an area of large boulders along a forest-reclaimed mine edge (Gess and others 2013).

Figure 11-6.—A rock exposed by ripping of compacted mine soils. Ripping reduces compaction and increases structural complexity of the surface by exposing large rocks. Such features provide habitat for small mammals, amphibians, and reptiles. Photo by P. Wood, U.S. Geological Survey.

Figure 11-7.—Boulders on a reclaimed mine site in eastern Kentucky. After trees become established, piles of boulders can provide habitat needed by wildlife that use wooded rock outcrops, such as Allegheny woodrat, bobcat, and bear. Photo by P. Wood, U.S. Geological Survey.

### 2. Apply Native Forest Soils with Organic Debris or High-quality Substitutes During Reclamation

Salvaging and reapplying topsoil on active mines or bringing in topsoil for reclamation on legacy mines can accelerate development of high-quality young forest habitat (Chapter 3, this volume). Native topsoil can contribute a seedbank of plant species such as river birch, blackberry, yellow-poplar (tuliptree), grapevine, and many others that contractors do not commonly plant during reclamation. Occasionally, oaks and hickories will sprout from seeds present in topsoil (Hall and others 2010). These volunteer species provide food sources and increase structural complexity of vegetation on reclaimed mines (Fig. 11-8), often enabling greater wildlife diversity. Blackberry, for example, provides fruit for many wildlife species including seed predators, provides preferred nest patches for young forest songbirds such as golden-winged warbler, and serves as cover for cottontail and other wildlife species. Salvaging native soils, with their organic matter and living creatures, may increase abundance of soil invertebrates (Richards and others 1993), which are prey for woodland salamanders, songbirds, and small mammals. One study found American woodcock using reclaimed mines, where better soil conditions resulted in complex vegetative structure and higher biomass of earthworms (Gregg and others 2000). Salvaging native soils would help produce these conditions.

Figure 11-8.—Young forest on a West Virginia surface mine with a dense undergrowth of volunteer shrubs. Mine operators salvaged and reapplied the topsoil, used reduced grading, and planted native hardwoods including white, chestnut, black, and northern red oaks. Trees are 10 years old in this photo. Photo by J. Mizel, National Park Service.

When a limited amount of topsoil is available, distribute it across the mine surface, either by mixing it with mine spoil intended for surface construction (Chapter 3, this volume) or by dumping piles across the mine-site surface (Hall and others 2010), particularly away from edges on large mines. These seedbank patches could yield dense shrubby vegetation in areas where forest seed sources are distant and plant colonization is limited. Soil also is an important inoculation source for mycorrhizal fungi, which most woody species need to grow and thrive.

Native trees and shrubs also can colonize and grow rapidly when favorable mine spoil materials are used as a topsoil substitute (Chapter 3, this volume). After 1 to 2 years post-planting, young-forest bird species such as indigo bunting and common yellowthroat (Fig. 11-9) had colonized the interior of a surface mine that was reclaimed by using FRA methods and salvaged topsoil (Fig. 11-10).

Figure 11-9.—Male common yellowthroat. Photo by D. Becker, West Virginia University, used with permission.

Figure 11-10.—An Ohio surface mine reclaimed by using the Forestry Reclamation Approach. Herbaceous plants and shrubs rapidly developed 1 to 2 years after planting. Photo by J. Mizel, National Park Service.

Figure 11-11.—Native vegetation sprouting from root wads that were left on a reclaimed mine surface. Incorporating woody residues benefits ground-dwelling and burrowing species by providing surface cover and increasing surface complexity. Photo by OSMRE.

### 3. Add Coarse Woody Debris to Further Promote Surface Complexity and Provide Cover for Wildlife

Incorporating woody residues (for example, roots, stumps, logs, and branches) on and into mine surfaces accelerates forest development by improving water infiltration, decreasing soil temperature, increasing the soil water-holding capacity, and increasing soil colonization by nutrient-cycling micro-organisms (Chapter 3, this volume). The addition of coarse woody debris (Fig. 11-11) also benefits ground-dwelling wildlife by providing surface cover and greater overall surface complexity. Decomposition of woody residues incorporated into the growth medium creates subsurface channels which burrowing species can use as retreats (Carrozzino and others 2011). Through the addition of woody residues, moisture-limited species such as salamanders and earthworms benefit from increased organic matter and water-holding capacity in soils.

### 4. Locate Reforestation Efforts Where They Maximize Benefits for Wildlife

If an entire mine site cannot be planted to trees and shrubs, select areas to reforest that maximize benefits for wildlife. Greatest benefits for wildlife include reducing forest fragmentation, reducing the amount of forest–grassland edge, and connecting remnant forest patches.

Changes in microclimate caused by forest loss can penetrate from edges into mature forests (Matlack 1993). These changes, such as increased wind, light, and ambient temperatures, can negatively affect ground-foraging species by reducing litter depth and densities of litter-dwelling arthropods near forest edges (Ortega and Capen 1999). Some mature forest-dependent species such as the cerulean warbler reach their highest densities in large tracts of mature forest and away from abrupt edges (Wood and others 2006). Conversely, species that depend on young forest, such as the golden-winged warbler, establish breeding territories in young-forest transition zones (Fig. 11-12) but generally within 150 feet of the mature forest edge (Patton and others 2010). Therefore, reforestation that extends from the

Figure 11-12.—A young forest transition zone between reclaimed mine land (foreground) and unmined mature forest (background). When the resources needed to reforest entire legacy mine sites are not available, establishing such transition zones can improve habitat. Photo by S. Bosworth, West Virginia University, used with permission.

forest–mine edge and creates a transitional, feathered edge (Figs. 11-12 and 11-13) can reduce edge effects for cerulean warblers and other mature-forest species while also providing young forest habitat for shrubland-dependent species. If the development of cerulean warbler habitat is a postmining goal, reforestation efforts should also target ridgetops and north- and east-facing slopes, where cerulean warblers are most abundant in the Appalachian Mountains (Wood and others 2006).

Small mammal and woodland salamander species can move only short distances to reach suitable habitat (Waldrick 1997), and grassland patches are barriers to such movement (Rittenhouse and Semlitsch 2006). Therefore, reforesting areas that extend from the forest–mine edge, that interconnect mature forest patches, or that connect

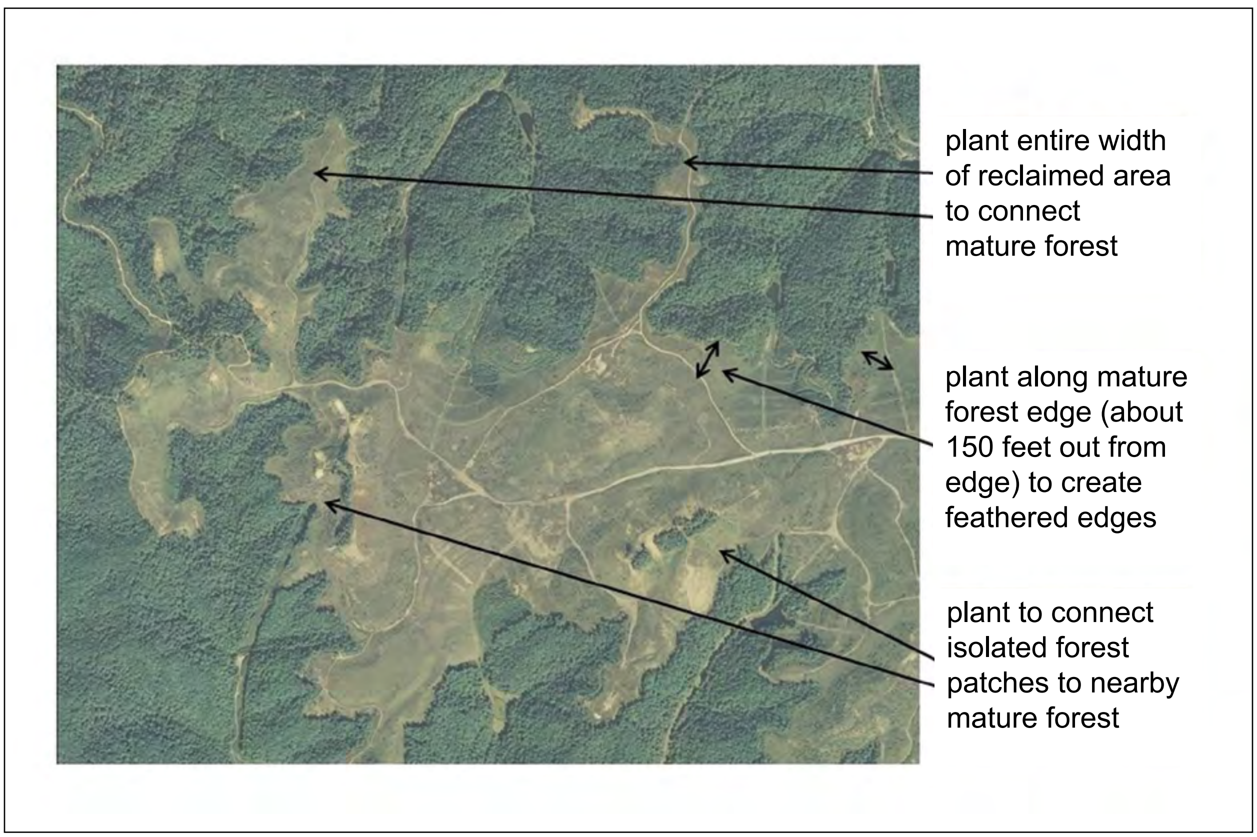


Figure 11-13.—Aerial photograph indicating areas on legacy mine lands where reforestation efforts could be focused. When the resources needed to reforest entire legacy mine sites are not available, focus reforestation efforts on areas adjacent to mature forest to create young-forest transitions (see Figure 11-12) and on areas that interconnect mature forest or that connect isolated forest patches to nearby mature forest. This will increase forest patch size and decrease edge effects, improving habitat for mature-forest wildlife. It also creates transitions between forest and reclaimed mine sites which are beneficial for young-forest species. Photo by Google® Earth.

isolated forest patches to intact forest (Fig. 11-13) will expand habitat for woodland salamanders and small mammals. Reforestation in these locations also benefits many forest wildlife species by increasing forest patch size. Further, planting native trees and shrubs within extensive areas of reclaimed grasslands can benefit elk as this species rarely uses open habitats farther than 1,000 feet from a forest edge (Skovlin and others 2002).

### 5. Plant a Variety of Native Trees and Shrubs, Particularly Heavy-seeded (Hard Mast-producing) Tree Species

Many of the plant species that become established readily as volunteers on mined lands have small seeds that are spread relatively easily by wind and birds. Heavy-seeded species such as oaks and hickories are less easily dispersed and rarely colonize the interior of large mining complexes unless planted. Reestablishing heavy-seeded native tree species provides an important food source for wildlife, a seed source to maintain habitat diversity, and habitat for the many wildlife species that depend on these tree species.

Some forest songbirds prefer to forage and nest in hickory and white oak species, but they avoid red oak species and red maples (Wood and others 2013). Oaks are hosts for large populations of many leaf insect species in their canopies (Summerville and Crist 2008), and those insects are a food source for forest songbirds. Oak-hickory forests have deeper leaf litter because their leaves decompose slowly, and thus have greater abundance of litter-foraging species, such as ovenbird, than do forests dominated by red maple and yellow-poplar (Mizel 2011). The mast (hard-shelled seeds) from oaks and hickories is an important part of the diet for gamebirds, deer, black bear, and many other wildlife species. Planting tree species that develop exfoliating bark such as white oak, hickory, and black locust provides future roost trees for bats. Several bat species, including the endangered Indiana bat, are dependent on mature trees of these and other species for roosting and maternity sites. Where the Indiana bat is found pre-mining, federal regulations require forestry postmining land use.

American chestnut, a consistent and prolific producer of hard mast, once provided food for numerous bird and mammal species. The American Chestnut Foundation has developed potentially blight-resistant chestnut varieties, and surface mines are now being used for reintroduction of American chestnut to eastern forests. These chestnut varieties have shown excellent survival on mined lands reclaimed by using the FRA (Chapter 12, this volume) and on previously compacted mined lands that were prepared by using deep soil ripping (McCarthy and others 2010). Establishing mined land forests with blight-resistant American chestnut would have substantial value for Appalachian wildlife.

Native mast-producing shrubs are important wildlife food sources. Pin cherry and shrubs such as blackberry and raspberry, for example, have high numbers of caterpillars and were selected as foraging sites by golden-winged warblers (Bellush 2012). American hazelnut, black chokeberry, common chokecherry, common elderberry, mapleleaf viburnum, gray dogwood, serviceberry, blackhaw, and hawthorns are just some of the native shrub species that can be included in the tree planting mix. Plant them singly among tree seedlings or in groups to help create patchy habitat structure. When planting shrubs in patches, we suggest patches no larger than 24 feet × 24 feet. To select which specific tree and shrub species to plant, follow the guidelines in Chapter 7 of this volume and plant native species that provide hard mast or soft mast (fleshy, perishable fruit) as recommended by Apsley and Gehrt (2006). Planting a variety of native trees and shrubs in their native range will provide habitat for a diverse wildlife community. Control competing nonnative vegetation to increase survival of planted trees. In high elevation areas within the native range of red spruce, planting red spruce will provide a critical component of habitat for northern flying squirrel.

## SUMMARY

When operators of active mines follow FRA reclamation guidelines (Chapter 2, this volume), they create lands where forest development can occur more rapidly. On legacy mines, ripping when needed to loosen compacted soil, planting native trees and shrubs, and controlling competing vegetation as needed for planted trees' survival will facilitate ecological succession (Burger and others 2013). Thus, forest reclamation can produce habitat that has the structural and compositional features needed by young-forest wildlife in the short term. Over longer time periods, the mature forest that results from these efforts will benefit mature-forest wildlife by reducing forest fragmentation and helping to compensate for habitat loss caused by mining. Surface mine reforestation is an opportunity for landowners and mine operators to conduct reclamation that provides direct and far-reaching benefits by aiding conservation of Appalachian wildlife.

### Summary of Reforestation Guidelines on Mined Lands to Enhance Habitat for Appalachian Wildlife

#### Burrowing and ground-dwelling species (for example, salamanders, earthworms, small mammals)

- Create loose, moist soil for burrowing by end-dumping or ripping
- Include single boulders or clusters of boulders on the surface for protective cover
- Incorporate woody residues for surface complexity, aboveground cover, and subsurface retreats
- Apply native soils with organic matter to increase invertebrate prey
- Treat sites and plant native trees and shrubs in areas that connect to mature forest to promote colonization by wildlife species.

#### Young-forest species (for example, cottontail, blue-winged warbler, golden-winged warbler, ruffed grouse)

- Use native soils, which provide seedbanks to quickly increase structural and compositional diversity of vegetation
- Use tree-compatible groundcover species that will enable colonization by native plants
- Plant a variety of native shrubs and trees
- On legacy mines where reforestation resources are limited, treat and plant areas that connect to mature forest for increased habitat complexity across the landscape.

#### Mature-forest species (for example, cerulean warbler, fisher, woodland salamanders)

- On legacy mines, treat and plant areas that connect to mature forest (especially isolated patches in mine interiors) to reduce edge effects and forest fragmentation and to increase forest patch size
- On active mines, reforest the complete mining disturbance, when possible
- Plant heavy-seeded (hard mast-producing) tree species (for example, American chestnut, oaks, and hickories) throughout the reclaimed area to provide food resources for many species (for example, bear, deer), preferred nest sites for forest songbirds, and roost trees for bats
- Reforest mines near areas with high density of cerulean warbler.

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