



# Considerations *for* Wildlife & Fire *in the* Southern Blue Ridge

*2025 Revision*

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Cover photo: A shortleaf pine woodland in the Foothills WMA of Tennessee is maintained with frequent prescribed fire and provides habitat for a multitude of wildlife species.

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Above: Prescribed fire commonly is used to maintain various vegetation communities required by many wildlife species.  
Left: Open woodlands managed with frequent fire provide habitat for many wildlife species.

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**F**ire is being used increasingly to manage various vegetation communities in the southern Appalachians. Restoration of pine/oak woodlands and savannas represents an ecosystem management approach that may provide many ecological benefits. An objective frequently included in burn plans is “to improve wildlife habitat.”

However, species often are not identified in the burn plan, and “wildlife” is an ambiguous objective, as all wildlife species have different habitat requirements. In other instances, focal species management is used to benefit one or more particular wildlife species. With either approach, it is critical to understand the biological requirements of the species of interest and the effects of management on those species. Nearly all Appalachian wildlife that require nonforest communities for habitat are declining as a result of fire suppression and lack of

forest management. However, not all are affected similarly when fire moves across the landscape. Other species, such as white-tailed deer and wild turkey, are generalists. They do not necessarily require nonforest communities in order to occur on a property. However, their habitat is enhanced and their populations are more robust when a mixture of vegetation types and successional stages, including herbaceous openings, are present and maintained and managed with fire.

Prescribed fire practitioners should consider the biology of various wildlife species when wildlife is an objective. Specifically, more precise applications of prescribed fire can be used to better manage for certain species.

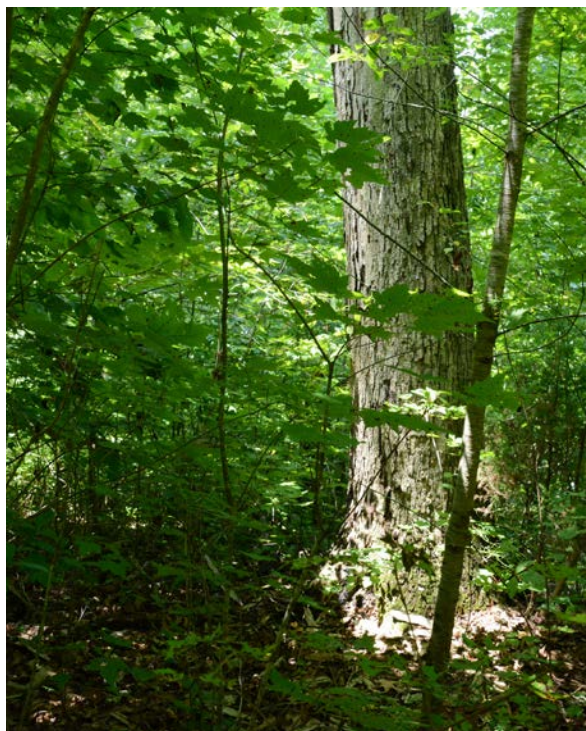
The four fire parameters considered most influential on fire effects are fire intensity, fire frequency, fire timing or seasonality, and available sunlight. Each of these strongly influence fire effects on wildlife, but other parameters that also

influence fire effects on wildlife include scale of burning and firing technique. The effect of each of these can vary tremendously. When combinations of each of these parameters are considered carefully, the influence or effect on wildlife can be much more precise.

This publication provides brief summaries of the biology and the most recent science related to fire effects for select wildlife species. The recommendations we provide are based entirely on the scientific literature, and the supporting research publications are provided in the references list at the back of the publication. We include photos as well as locations where habitat management for those species can be viewed on public lands in the southern Appalachian region as well as the Ridge and Valley and Cumberland Plateau.



Frequent fire every 2 years during the late growing season promotes high plant species diversity with plentiful warm-season forbs.



Infrequent fire every 4–6 years maintains dense woody stems, which enhances cover for species such as ruffed grouse, especially when mature oaks are retained in the stand, such as this 2-aged shelterwood that retained a basal area of approximately 30 sq ft per acre of overstory oaks.



Frequent fire during the early growing season typically favors grasses as seen here. This site has been burned annually during the dormant or early growing season for 20+ years.



# Northern bobwhite | *Colinus virginianus*

**Status:** Near threatened

**Population Trend:** ↘ 3–5 percent annually

## Life history and ecology

- 🌿 Gamebird that lives on the ground day and night, will fly if threatened.
- 🌿 High annual mortality, rapid population turnover, short lifespan (80 percent die annually) and high breeding capacity.
- 🌿 Nests on the ground April to September; peaks in June/July.
- 🌿 Young can make short flights in 1–2 weeks.
- 🌿 William Brewster described bobwhite as “abundant everywhere” in western North Carolina in 1886.
- 🌿 Eastern US populations have decreased by 3 percent annually since 1966 because of openings aging into forest, industrial agriculture, fire suppression, declining timber harvest, and urbanization.



Northern bobwhite require open landscapes and frequent disturbance. Photo: Ben Robinson

## Habitat

- 🌿 Requires an open landscape for population maintenance.
- 🌿 Herbaceous groundcover dominated by forbs, well intermixed with scattered shrub cover is ideal (old-fields, agricultural field edges, oak/pine savanna); coverage of grass should not be more than about 30 percent.
- 🌿 Responds to habitat improvement quickly in the appropriate landscape.
- 🌿 Areas managed for bobwhite should consist of a minimum of 500 acres with no closed-canopy forest.
- 🌿 Woodlands should not have more than 40 percent canopy cover.
- 🌿 Nests on the ground amongst herbaceous vegetation.
- 🌿 Diet consists of seeds, leaves, and invertebrates.

## Methods for monitoring

- 🌿 Point counts in spring/summer to detect whistling males
- 🌿 Point counts in fall to detect coveys

## Local areas for bobwhite

- 🌿 Sandy Mush Game Land, NC (NC Wildlife Resources Commission)
- 🌿 South Mountains Game Land, NC (NC Wildlife Resource Commission)
- 🌿 Bridgestone-Firestone WMA, TN (TN Wildlife Resources Agency)
- 🌿 Kyker Bottoms Refuge, TN (TN Wildlife Resources Agency)
- 🌿 Long Creek Tracts WMA, SC (SC Department of Natural Resources)

## Fire effects & conservation challenges

🔥 Prescribed fire can maintain early successional communities required by quail; fire also consumes leaf litter, creating an open structure at ground level, essential for bobwhite.

🔥 A fire-return interval of 1–2 years in the late dormant or early growing season maintains early successional conditions for bobwhite.

🔥 It is not necessary to protect patches of dense shrub cover from dormant-season or early growing-season fire; low-intensity fire often will not spread under shrub cover, and if it does and shrubs are top killed, they will sprout back, and the dead stems continue to maintain protective cover for birds as new growth sprouts.

🔥 Late growing-season fire (September–October) after peak nesting may be used to help set back woody composition and encroachment, but burn areas should be less than 30 acres (unless fire is low-intensity and patchy) because burning at this time may reduce low woody escape cover available into winter.

🔥 Recently harvested forest provides short-term habitat, but is not a sustainable solution considering the region-wide reduction in forest management. However, recently harvested forest can be maintained as bobwhite habitat if it is burned every 1–2 years and not allowed to regenerate into a young forest.



Forb-dominated vegetation community with scattered shrub cover at Kyker Bottoms Refuge.



Optimum structure at ground level for bobwhite.



Low woody escape cover, well-interspersed throughout the management area, is requisite for bobwhite.

# Golden-winged warbler | *Vermivora chrysoptera*

**Status:** Near threatened

**Population Trend:** ↘ 2.6 percent annually

## Life history and ecology

🌿 Migratory songbird that nests in Appalachian mountains and Great Lakes regions and winters in Central America (Great Lakes population) and South America (Appalachian population).

🌿 Once considered widespread and common in open oak woodlands in the southern Appalachians; now has one of the smallest populations of any bird not on the endangered species list.

🌿 Nesting occurs in May and June.

🌿 Clutch averages 4–5 eggs with young leaving the nest within 9 days.

🌿 Migrates at night in April and August.

🌿 Blue-winged warblers have expanded distribution in northeastern US and regularly hybridize with golden-winged warblers for breeding areas.



Golden-winged warbler. Photo: Audubon.org

## Habitat

🌿 Nest in herbaceous openings with scattered shrubs and young trees in forested landscapes. Fledglings will use all forest age classes.

🌿 Female builds the nest in herbaceous groundcover at the base of shrubs, often within goldenrod and blackberry.

🌿 Birds will glean insects from leaves; leafroller caterpillars are important.

🌿 Nest site includes a “fire pole,” a plant that has a taller, thicker stem that adults land upon when arriving at the nest.

## Methods for monitoring

🌿 Point count surveys during May breeding season

🌿 Detection increases with playback recordings

## Local areas for golden-winged warbler

🌿 North Cumberland WMA, TN (TN Wildlife Resources Agency)

🌿 Roan Mountain State Park, TN (TN State Parks)

🌿 Hampton Creek Cove State Natural Area, TN (TN Department of Environment and Conservation and Southern Appalachian Highlands Conservancy)

🌿 North Cherokee WMA, TN (TN Wildlife Resources Agency)

🌿 Cheoah Ranger District, NC (Nantahala National Forest)



Herbaceous openings with scattered shrubs and young trees (Grassy Ridge; Pisgah National Forest). Photo: Southern Appalachian Highlands Conservancy

## Fire effects & conservation challenges

- 🔥 Early successional openings dominated with forbs, brambles, grasses, and scattered shrub cover can be maintained with dormant season fire every 3–4 years.
- 🔥 Late growing-season fire (August–October) may be used to reduce woody component.
- 🔥 Burning should be avoided during May and June.
- 🔥 Mechanical disturbance combined with herbicide applications and prescribed fire often is required to create early successional openings in a forested landscape.



Golden-winged warbler nest location. Photo: Curtis Smalling



Female builds the nest amongst herbaceous groundcover at the base of shrubs and young trees at Hampton Creek Cove (TN).

# Wild turkey | *Meleagris gallopavo*

**Status:** Least Concern

**Population Trend:** →

## Life history and ecology

- 🦃 Ground-dwelling gamebird that flocks in winter.
- 🦃 Turkeys fly to roost in trees at night. They also may fly when threatened.
- 🦃 Males attract females in spring by gobbling and strutting.
- 🦃 Nesting peaks in mid-April through May in the southern Appalachians.
- 🦃 Chicks are precocial and brood through summer; chicks begin to fly and tree roost at 10–14 days.
- 🦃 Wild turkey distribution is limited in areas with a lack of roosting sites and where snow cover persists for more than 2 weeks.
- 🦃 Nearly extinct in 1920s. Restocking wild birds by state wildlife agencies restored the wild turkey population.



The wild turkey is a popular gamebird throughout most of the US. Photo: Tes Jolly

## Habitat

- 🦃 Wild turkeys are generalists and use a wide variety of vegetation types, from mature hardwood forest to grasslands.
- 🦃 Populations are greatest where a mixture of forest and openings occur, including agricultural areas.
- 🦃 In general, properties managed for wild turkeys should consist of 30–60 percent openings that are dominated by native early successional plant communities.
- 🦃 Wild turkeys tend to avoid dense cover, except for nesting.
- 🦃 Nests often are placed in areas with low brushy cover.

## Methods for monitoring

- 🦃 Gobbling and poult-count indices
- 🦃 Hunter harvest numbers

## Local areas for wild turkey

- 🦃 Green River Game Land, NC (NC Wildlife Resources Commission)
- 🦃 Chuck Swan WMA, TN (TN Wildlife Resources Agency)
- 🦃 Catoosa WMA, TN (TN Wildlife Resources Agency)
- 🦃 North Cumberland WMA, TN (TN Wildlife Resources Agency)



Frequently burned shortleaf pine woodlands can provide the appropriate open understory structure and foods for wild turkey broods.

### **Fire effects & conservation challenges**

- 🔥 Turkeys are attracted to recently burned sites to forage and dust.
- 🔥 Open areas, such as old-fields, require frequent fire; burning every 1–2 years maintains groundcover important for foraging and brooding.
- 🔥 Areas burned on a 3-year interval will maintain more low woody cover, which is attractive for nesting.
- 🔥 Woodlands and forest that allow at least 30 percent sunlight and burned every 1-3 years will provide brooding and nesting cover. Hens with broods typically select areas burned within the past 2 years, whereas nesting may be concentrated more in areas 2-3 years after burning. Burning during the early growing season (late April–May) creates open conditions that are selected for use by turkeys, but burning at this time should be limited in scale to avoid large-scale disruption of nests.
- 🔥 Prescribed fire can be implemented during the dormant season or late in the growing season without affecting nest success at the property level.



Frequent prescribed fire can maintain optimal turkey nesting structure, diverse foods, and brooding cover in hardwood forests with a broken canopy that allows at least 30 percent sunlight.



Old-fields maintained with fire are used for nesting and brood-rearing. Scattered shrub cover may make openings more attractive for nesting.

# Ruffed grouse | *Bonasa umbellus*

**Status:** Least Concern

**Population Trend:** ↘ 1.2 percent annually

## Life history and ecology

- 🌿 Ground-dwelling gamebird found only in forested areas.
- 🌿 Males attract females by drumming atop logs or other structure.
- 🌿 Nests on ground in leaf litter.
- 🌿 Chicks are precocial and brood with the hen through summer.
- 🌿 Annual survival is less than 30 percent.
- 🌿 Primary predators in southern Appalachians include hawks, owls, and bobcats.



Males drum atop logs in an established territory.  
Photo: World Wildlife Photography

## Habitat

- 🌿 Require dense cover such as that provided in 5- to 20-year-old forest. Mature forest also used for foraging, especially when adjacent to young forest cover.
- 🌿 Populations decline when availability of young forest is limited.
- 🌿 Feed on variety of green leaves, fruits, and insects. When snow covers the ground, grouse feed almost exclusively on buds of trees.
- 🌿 Lack of nutritious foods and dense cover are limiting factors for grouse in the central and southern Appalachians. Acorns are an important food source in fall/winter. Interspersion of mature hardwood forest with young regenerating forest is particularly important in the southern Appalachians.
- 🌿 Brood survival typically is greater in forest with a lush herbaceous understory and within moderately dense young forest. Dormant- and late growing-season fire can be used to increase the forb component.

## Methods for monitoring

- 🌿 Drumming surveys in spring

## Local areas for grouse

- 🌿 Wine Spring Creek Ecosystem Management Area, NC (Nantahala National Forest)
- 🌿 Flat Branch Habitat Improvement Area, GA (Chattahoochee National Forest)
- 🌿 Thurmond Chatham Game Land, NC (NC Wildlife Resources Commission)
- 🌿 Jocassee Gorges WMA, SC (SC Department of Natural Resources)



Areas where fire, ice, tree harvests, or wind events have removed most overstory trees can be prioritized for restoration of grouse habitat using prescribed fire.



A young birch/maple stand in the Nantahala National Forest provides excellent cover for brooding and escape for ruffed grouse.

### **Fire effects & conservation challenges**

- 🔥 Repeated disturbance is critical for the long-term persistence of ruffed grouse.
- 🔥 Forest maturation and a reduction in forest management has led to precipitous population decline of ruffed grouse in the southern Appalachians.
- 🔥 Cover for grouse declines when stands reach 20-25 years of age.
- 🔥 Low-intensity, dormant-season fire every 3-5 years can be used in mature oak-hickory stands with a broken canopy (allowing at least 30-50 percent sunlight to enter the stand) to maintain desirable stem density and understory cover for grouse.
- 🔥 Young forest stands without overstory trees can be managed explicitly for grouse cover with moderate- to high-intensity, dormant-season fire on a 10- to 15-year fire-return interval.
- 🔥 Where ruffed grouse is a focal species, early growing-season fire (mid-April through early June) is not advised, especially if burn units are large, because of nesting disruption.
- 🔥 Re-nesting rate of ruffed grouse in the central and southern Appalachians is extremely low, and fecundity is a limiting factor for grouse in the southern Appalachians.



# American woodcock | *Scolopax minor*

**Status:** Least Concern

**Population Trend:** ↘ 1.6 percent annually

## Life history and ecology

- 🔥 Ground-dwelling migratory gamebird.
- 🔥 Peak nesting occurs late February–March in southern Appalachians.
- 🔥 Males perform “sky dance” from dusk to dawn in openings late January through early March to attract females. A nasal “peent” call precedes an erratic display flight that includes a twittering sound.
- 🔥 Young can leave the nest soon after hatching, though the hen feeds them for the first week.
- 🔥 Woodcock have large eyes positioned high on their heads, allowing them to scan for danger while foraging for earthworms.



Woodcock begin nesting in late February in the southern Blue Ridge region. Photo: Mark Cunningham

## Habitat

- 🔥 Summer distribution of woodcock includes the northern Appalachians, and the wintering range includes the southern Appalachians. Breeding, wintering, and migrating woodcock may be found in the Central Appalachians.
- 🔥 Woodcock thrive in young forest and shrubland, usually on moist sites where they can probe for earthworms, which must be within about 2 inches below ground.
- 🔥 Nests are exposed on the ground, usually in young upland woods where available.
- 🔥 Diet consists primarily of earthworms; insects also are consumed.
- 🔥 A mixture of forest and sparse herbaceous groundcover is ideal, as woodcock spend daylight hours in the woods and often in openings at night.
- 🔥 Alder produces the best litter to feed the woodcock’s preferred worm species; pines provide poor litter for worms, and worms decline as soil becomes more acidic.

## Local areas for woodcock

- 🔥 Kyker Bottoms Refuge, TN (TN Wildlife Resources Agency)
- 🔥 Lick Creek WMA, TN (TN Wildlife Resources Agency)
- 🔥 Watson-Cooper Heritage Preserve, SC (SC Department of Natural Resources)



Moist shrubland provides ideal cover for woodcock.



High stem density with an open structure at ground level is ideal for woodcock foraging, hiding, and escape cover.

### **Methods for monitoring**

- 🔥 Surveys on singing grounds

### **Fire effects & conservation challenges**

- 🔥 Loss of young forest structure and shrubland contributes to declining populations.
- 🔥 Fire can maintain young forest structure used by foraging woodcock, but the best sites often require mechanical treatment because they may be too moist to burn.
- 🔥 A fire-return interval of 1–3 years can maintain openings that woodcock may use for breeding and roosting.
- 🔥 Disking may reduce the density of vegetation, which can be beneficial for woodcock.
- 🔥 Woodcock use burned forest openings soon after fire, especially for mating rituals.
- 🔥 Nest destruction from fire is unlikely to cause population decline because nests often are in areas that are unlikely to burn, and woodcock readily re-nest.

## Indiana bat | *Myotis sodalis*

**Status:** Near threatened

**Population Trend:** ↘



Indiana bat. Photo: US Fish and Wildlife Service

### Life history and ecology

- 🦇 A small bat with mouse-like ears and dark brown to black fur.
- 🦇 Cluster in large numbers during hibernation.
- 🦇 Males mate once yearly with multiple females during the “fall swarming” period (October–November).
- 🦇 Females birth only one pup. Pups rely on mother’s care when born, but become fully independent within 2–3 months.
- 🦇 Diet consists of beetles, moths, and flies.
- 🦇 Helps control insect populations.

### Habitat

- 🦇 Indiana bats hibernate in cool, humid, limestone caves; similar to little brown bat.
- 🦇 Forage and roost in forests from spring through fall, roosting mostly under bark of dead Southern yellow pine trees, live white oaks, and shagbark hickory.
- 🦇 Foraging occurs in canopy gaps in forest and woodlands as well as forested wetlands.

### Methods for monitoring

- 🦇 Winter: counts in caves
- 🦇 Spring–fall: Acoustic monitoring (bat detectors) and mist-netting

### Local areas for Indiana bat

- 🦇 Great Smoky Mountains National Park, TN (National Park Service)
- 🦇 Cherokee National Forest, TN (US Forest Service)

## Fire effects & conservation challenges

🔥 White nose syndrome (fungal disease) poses a serious threat to hibernating groups.

🔥 Restoring pine-oak woodlands may be critical for Indiana bat population recovery.

🔥 Controlled burning reduces midstory clutter and enhances foraging conditions.

🔥 Fire improves foraging conditions in the year following fire through its effects on insect prey abundance; increased use of prescribed fire may be necessary to help species recover.

🔥 Indiana bats forage around open tree crowns and selectively use burned stands.

🔥 Burning May–August can put maternal colonies at risk. However, fire in forested areas at this time is rare in the southern Appalachians and should not be viewed as a concern for populations.

🔥 Growing-season fire intensity should be relatively low so as not to disturb bats roosting at heights of >30 feet. Dormant-season and late growing-season fire does not impact maternal colonies.

🔥 The ears are the most vulnerable body part because of lack of hair and downward orientation when roosting. Models predict injury may occur only if crown scorch occurs, which is a relatively rare occurrence or objective with prescribed fire in the southern Appalachians.



Canopy reduction coupled with prescribed fire reduces midstory clutter and enhances foraging conditions for Indiana bat.



Male Indiana bat under loose bark of pine snag. Photo: Stephen Brandenbura



Pine snags are used by Indiana bat for summer roost sites.

## Eastern cottontail | *Sylvilagus floridanus* Appalachian cottontail | *Sylvilagus obscurus*

**Status:** Common (Eastern)  
Near threatened (Appalachian)

**Population Trend:** ↗ Eastern  
↘ Appalachian

### Life history and ecology

🌿 Appalachian cottontails are slightly smaller than Eastern cottontails, and they have black-edged ears and a black spot on their head. Appalachian cottontails typically are not found below 2,500 feet in elevation, and they are rare throughout most of their distribution.

🌿 Breed March–August, producing 3 litters of 4–8 young per year.

🌿 Young leave the nest after 2 weeks and reproduce after 1–2 months.

🌿 Very short life spans, usually less than one year. Survival may relate to abundance and distribution of low woody escape cover, especially in winter.



Appalachian cottontail at Gregory Bald in Great Smoky Mountains National Park. Photo: Kris Light

### Habitat

🌿 Appalachian cottontails inhabit higher elevation, dense heath shrubland to conifer forest mosaic.

🌿 Found in shrubby cover of mountain laurel and blueberry, as well as young regenerating forest and around herbaceous openings surrounded with low woody escape cover.

🌿 Diet consists mainly of forbs and grasses in summer, and more woody browse in winter. Appalachian cottontails often select serviceberry, chokeberry, and blueberry, and do not eat rhododendron or mountain laurel. Appalachians consume more forbs and less grass than Eastern cottontails, though forbs in herbaceous openings are selected by Eastern cottontails also.

### Methods for monitoring

- 🌿 Hunter collections and road kills
- 🌿 Careful examination of trapped animals

### Local areas for cottontails

- 🌿 Eastern cottontail:  
Sandy Mush Game Land, NC  
Long Creek Tracts WMA, SC
- 🌿 Appalachian cottontail:  
Elliot Knob, VA  
Carvers Gap, TN  
Roan Mountain State Park, TN  
Andrew Pickens Ranger District, SC  
Long Creek Tracts WMA, SC  
Brasstown Bald, GA



Scattered openings maintained with fire provide habitat for Eastern cottontails in a forested landscape.



Scattered shrub cover intermixed with openings dominated by forbs provide habitat for Appalachian cottontail at higher elevations of the southern Appalachians. Here, patches of blackberry, blueberry, azalea, and rhododendron provide cover for Appalachian cottontail on Roan Mountain.

Shrubby or low woody cover intermixed with forbs and grasses is requisite for cottontails during all seasons.



## Fire effects & conservation challenges

🔥 Both species have declined over the last 60 years because of habitat degradation (forest maturation, reduction in forest management, and fire suppression).

🔥 Recently harvested stands should be burned on a 2- to 4-year fire-return interval to maintain forage with low woody cover for cottontails.

🔥 A fire-return interval of 1–3 years will maintain herbaceous openings.

🔥 Burning during March and April may destroy rabbit nests but is unlikely to cause population reduction because they continue to nest and are prolific breeders.

🔥 Burning during the latter portion of the growing season (October/November) mitigates nest disruption and will stimulate additional forb cover the following spring/summer.

# White-tailed deer | *Odocoileus virginianus*

**Status:** Least Concern

**Population Trend:** →

## Life history and ecology

- 🦌 The most popular game species in North America.
- 🦌 Peak of mating (rutting) occurs in late November to early December in the southern Appalachians.
- 🦌 Females give birth to 1–2 fawns in late May–June.
- 🦌 Fawns remain hidden, lying solitary amongst relatively dense cover (where available) for the first four weeks of life, visited 3–4 times per 24-hour period by the mother to nurse. Fawns become functional ruminants at about 8 weeks of age, but remain largely separated from the mother until about 12 weeks of age.
- 🦌 Few deer live beyond 7 years of age; most bucks are harvested by hunters by year 3.
- 🦌 Deer were essential to Native Americans and settlers, providing food, hides, sinews for bowstrings, and bones for tools.



The white-tailed deer is the most popular game animal in the country. Hunting license sales for deer provide more revenue for state wildlife agencies in the eastern US than all other species combined. Photo: Bill Lea

## Habitat

- 🦌 The white-tailed deer is considered a generalist species and uses a wide variety of vegetation types, including forests, woodlands, savannas, old-fields, and agricultural areas, to meet their habitat requirements.
- 🦌 Deer are concentrate selectors, foraging primarily on select plants and select plant parts, including forbs and leaves of brambles, vines, shrubs, and trees. They also eat various hard mast, fleshy fruits, and mushrooms.
- 🦌 Forbs, where and when available, represent the primary diet during the growing season and provide the greatest nutritional value during spring and summer, which is the period of greatest nutritional demand for deer while they are replenishing body weight lost over winter, gestating and lactating, and growing antlers.

## Methods for monitoring

- 🦌 Spotlight counts
- 🦌 Browse surveys
- 🦌 Hunter harvest data
- 🦌 Camera-trap surveys

## Local areas for deer

- 🦌 Green River Game Land, NC (NC Wildlife Resources Commission)
- 🦌 Kyker Bottoms Refuge, TN (TN Wildlife Resources Agency)
- 🦌 North Cumberland WMA, TN (TN Wildlife Resources Agency)
- 🦌 Catoosa WMA, TN (TN Wildlife Resources Agency)



Woodland managed for deer providing more than 1,400 lbs/acre (dry weight) of selected forage for deer.

### **Fire effects & conservation challenges**

🔥 Fire maintains forage within the reach of deer and stimulates seedbank germination.

🔥 Early successional openings can be burned on a 1- to 3-year fire-return interval to maintain forage availability and cover for fawning.

🔥 Low-intensity fire every 1–3 years may be used in forests with a broken canopy allowing at least 30 percent sunlight to stimulate forage.

🔥 Using low-intensity fire in closed-canopy stands may typically provide little or no increase in forage availability.

🔥 Coupling fire with canopy disturbance can provide more than eight times as much deer forage compared to unthinned, unburned areas.

🔥 Burning different areas of a property through the growing season disperses and provides continual resprouting and germination of vegetation, which provides optimal forage quality throughout the growing season.



Forests with low light availability contain low species richness and very little forage for deer. Positive effects of burning are limited unless >30 percent is allowed to enter the forest canopy.



The importance of early successional openings for white-tailed deer cannot be overstated. Prescribed fire every 1–3 years maintains high-quality forage and excellent fawning cover.



## Eastern spotted skunk | *Spilogale putorius*

### Appalachian Eastern spotted skunk | *Spilogale p. putorius*

**Status:** Vulnerable

**Population Trend:** ↘

#### Life history and ecology

🦉 IUCN Status: Vulnerable; species is rare today; populations have declined more than 99 percent across distribution since the 1940s for reasons not well understood; likely combination of habitat degradation and mammalian predator competition. Outbreaks of distemper also have been noted to lower some local populations.

- 🦉 Spotted skunks are smaller than striped skunks; squirrel size.
- 🦉 Hunt and move mostly at night or early morning.
- 🦉 Excellent climbers
- 🦉 Begin breeding at one year old (March–

April); young born in late May–June.

- 🦉 Have well-developed scent glands used for defense.
- 🦉 Majority of predation is from raptors (e.g., great horned owl)



Eastern spotted skunk. Photo: Damon Lesmeister

#### Habitat

- 🦉 Critical habitat requirement is groundcover and dense low woody cover for protection from predators.
- 🦉 Dry oak forest with patches of mountain laurel, colluvial rock, and coarse weedy debris; young regenerating forest; riparian zones with dense rhododendron.
- 🦉 Den in crevices of emergent rock and scree/talus, brushpiles, hollow logs, down woody debris, and snags (often arboreal).
- 🦉 Opportunistic omnivore; will consume earthworms, grasshoppers, mice, and birds.
- 🦉 Old-fields that are advancing in succession; brushy areas; and thinned, mature stands with dense, young regenerating stems may be important sources of cover and prey.

#### Methods for monitoring

- 🦉 Live-capture with box traps and camera traps
- 🦉 Track-plate boxes

#### Local areas for spotted skunk

- 🦉 Whitetop Mountain, VA (Jefferson National Forest)
- 🦉 Ellicott Rock Wilderness, SC (Sumter National Forest)
- 🦉 Unaka Mountains, TN (Cherokee National Forest)
- 🦉 Chestnut Ridge Heritage Preserve, SC (SC Department of Natural Resources)
- 🦉 Foothills Wildlife Management Area, TN (TN Wildlife Resource Agency)

## Fire effects & conservation challenges

🔥 Ever-maturing forest with relatively open understories fragment distribution of areas with dense, woody stems where spotted skunks are most often found.

🔥 Following canopy disturbance, prescribed fire on a 3- to 5-year return interval can maintain dense, woody understory structure used by spotted skunks.

🔥 Prescribed fire may be concentrated on south- and west-facing slopes where fire naturally occurs more frequently.

🔥 Mesic forests and riparian areas with dense rhododendron are unlikely to burn unless fire is forced into these areas during exceptionally dry periods.



Rhododendron thicket used by spotted skunks.  
Photo: David Jachowski



Spotted skunks may be found in upland mixed hardwood stands with dense low woody cover in the understory. A spotted skunk was captured at this site on the Foothills WMA in Blount County, TN.

Xeric mixed hardwood forest with dense stem structure and exposed colluvial rock provide habitat for spotted skunks.



# Timber rattlesnake | *Crotalus horridus*

**Status:** Least Concern

**Population Trend:** ↘



Timber rattlesnake at den site.  
Photo: Brian Gratwicke

## Life history and ecology

- 🦁 Large, stout-bodied pit viper that reaches 60 inches in length.
- 🦁 May live longer than 40 years.
- 🦁 Females do not mature until 5–10 years old and then reproduce every 3–4 years.
- 🦁 Typically mate in fall prior to hibernation.
- 🦁 Emerge from den in mid-April and disperse up to 2 miles into adjacent forests.
- 🦁 Predators include kingsnakes, opossums, coyotes, hawks, skunks, and foxes. Mortality also occurs from automobiles and human persecution.
- 🦁 Diet is 90 percent small mammals, including squirrels, rabbits, voles, mice, and rats.

## Habitat

- 🦁 Generally found in mature and regenerating deciduous forest in rugged terrain. Gestating females spend the summer at open, rocky birthing sites, either near the dens or on ridges above them.
- 🦁 Forest composition can vary but mast-producing trees (such as oak, beech, hickory) and shrubs provide food for prey.
- 🦁 Hibernate during cold weather; den in crevices of rocky outcrops typically on south- and west-facing slopes
- 🦁 *Crotalus*: “hollow in the rocks”

## Methods for monitoring

- 🦁 Occupancy and abundance surveys at summer gestation and denning sites.

## Local areas for timber rattlesnake

- 🦁 Linville Gorge, NC (Pisgah National Forest)
- 🦁 South Mountains Game Land, NC (NC Wildlife Resources Commission)
- 🦁 Catoosa WMA, TN (TN Wildlife Resources Agency)
- 🦁 Bridgestone/Firestone WMA, TN (TN Wildlife Resources Agency)



Rattlesnakes congregate at dens around mid-April before dispersing to nearby foraging grounds. Photo: Chris Camacho

## Fire effects & conservation challenges

🔥 Timber rattlesnakes rely on their surroundings to maintain body temperature. Canopy removal and controlled burning on rocky ridges can help maintain the suitability of gestation sites.

🔥 Prescribed fire can maintain herbaceous groundcover and low woody cover to enhance conditions for rattlesnake prey.

🔥 Canopy reduction and prescribed fire on south- and west-facing slopes maintain and enhance rattlesnake habitat.

🔥 Prescribed fire can have a direct effect on large numbers of snakes if implemented during post-hibernation dispersal in spring.

🔥 Burning during the dormant season avoids direct effects, as snakes are underground or under logs or rocks when burning occurs. Direct effect of burning during late growing season is much less likely but unknown.



Early successional openings (above) as well as young, regenerating forests provide habitat for rattlesnake prey.



Numerous timber rattlesnakes were found in this young stand on the North Cumberland WMA owned and managed by the TN Wildlife Resources Agency. This structure and composition is maintained by burning on a 2- to 3-year fire-return interval.

## Lungless salamanders | *Plethodontidae*

**Status:** Varies by species

**Population Trend:** →

### Life history and ecology

- 🌿 More than 50 species of salamanders occur in the southern Appalachians, making this one of the world's most diverse regions.
- 🌿 Salamanders may comprise more biomass in some forested areas than all other vertebrate species combined.
- 🌿 The Plethodontids are lungless ectotherms, and their ecology is governed by temperature and precipitation; they breathe through their skin.
- 🌿 Terrestrial salamanders lay eggs in concealed damp locations on land and small salamanders later hatch from the eggs.
- 🌿 Predators include hogs, raccoons, snakes, and birds.

### Habitat

- 🌿 Require damp forest soil, leaf litter, and coarse, woody debris for moisture to respire; usually found beneath logs or rocks and venture out in humid weather.
- 🌿 Diet consists of crustaceans, insects, and worms.
- 🌿 Salamander species assemblage differs across a mountain or range depending on elevation, aspect, and microclimate.
- 🌿 Southern Appalachian Plethodontids range from fully aquatic to entirely terrestrial. Terrestrial forms range from semi-burrowing to tree-dwelling.



The gray-cheeked salamander finds refuge from fire under logs, rocks, and damp leaf litter. Photo: Jamie Harrelson

### Methods for monitoring

- 🌿 Point counts and litter searching, flipping logs
- 🌿 Pitfall traps

### Local areas for lungless salamanders

- 🌿 Bat Cave Preserve, NC (The Nature Conservancy)
- 🌿 Great Smoky Mountains National Park, TN (National Park Service)
- 🌿 Wine Spring Creek Ecosystem Management Area (Nantahala National Forest)
- 🌿 Bent Creek Experimental Forest (Pisgah National Forest)

## Fire effects & conservation challenges

- 🦎 Terrestrial salamanders are sensitive to changes in the forest floor microclimate.
- 🦎 Fire results in a drier environment, which can have a negative effect on Plethodontid salamanders.
- 🦎 Southern Appalachian sites prioritized for fire restoration (e.g., dry oak and pine woodlands; south- and west-facing slopes) are not critical areas for salamanders.
- 🦎 Dormant-season controlled burning typically avoids negative effects, such as interrupting breeding.
- 🦎 Late growing-season fire generally avoids any direct effect because salamanders are underground when fire is implemented (during the day and during dry conditions).
- 🦎 There has been no evidence of population-level reduction following low-intensity, low-severity fire.
- 🦎 Soil and large logs are typically cool and damp when burns are conducted, so soil temperatures are well below lethal levels for salamanders.



Plethodontids require damp forest soil, leaf litter, and coarse woody debris for moisture to respire.

Generally, salamanders are not directly harmed by fire as they are underground or under large debris during burns. It is estimated that at any given time, less than 15 percent of a population is in or near the litter layer.



## Bees | Hymenoptera

**Apidae** (honey bees, bumble bees, carpenter bees, Southeastern blueberry bees)

**Megachilidae** (mason bees and leaf-cutter bees)

**Halictidae** (sweat bees)

**Status:** Varies by species

**Population Trend:** ↘



The rusty-patched bumble bee has declined by 87 percent over the last 20 years, but habitat can be provided for this and other bee species by maintaining a diversity of flowering plants. Photo: Dan Mullen

### Habitat

- Greater species richness and abundance occur in early successional plant communities and open woodlands as opposed to closed-canopy forest with little shrub cover, which is maintained by overstory reduction and frequent prescribed fire.
- Bees require both foraging and nesting resources in same area.
- About 70 percent of North America's 2,800 native bee species are ground nesters, preferring sandy or loamy soils.
- About 30 percent of solitary bees are wood-nesters, often nesting in soft-pithed twigs (elderberry, blackberry) or beetle tunnels in dead trees.
- Ground-nesting bees are mostly solitary species that dig nest tunnels in areas of bare ground.

### Life history and ecology

- In some systems, up to 50 percent of the bee species historically known to occur have been lost.
- Bees pollinate approximately 70 of the 100 crop species that feed 90 percent of the world; they require nectar and pollen to support energy needs of the individual as well as the brood; energy only obtained from flowering plants.
- Populations of many species of North American bumble bees are in decline because of habitat loss and the spread of pathogens from commercially-reared colonies.
- Pollination mechanism varies amongst species.
- Honey bees (nonnative) are less efficient wildland plant pollinators compared to natives, such as mason and carpenter bees, and require intensive hive management to thrive.
- Natives often “buzz pollinate” by grabbing onto a flower and rapidly moving flight muscles to dislodge pollen, which is inadvertently deposited at the next flower; in this manner, a single Southeastern blueberry bee can visit 50,000 flowers over a 3-week life span.

### Local areas for bees

- Shortoff Mountain, NC (Pisgah National Forest)
- Kyker Bottoms WMA, TN (TN Wildlife Resources Agency)
- Buffalo Springs WMA, TN (TN Wildlife Resources Agency)



The best bee habitat in the southern Blue Ridge includes meadows, old-fields, savannas, and open woodlands where sunlight is sufficient to promote flowering forbs. Here, the annual late growing-season fire treatment at the Bridgestone–Firestone Prescribed Fire Demonstration Area provides a plethora of flowering forbs for bee pollinators.

### **Fire effects & conservation challenges**

🌿 Pollinators are more abundant in open forests than closed canopy forests; temperature and light are the most important factors affecting bee foraging.

🌿 Bees benefit from a diversity of flowering plants that bloom throughout the growing season.

🌿 Fire suppression has resulted in forest mesophication and homogenization, unbroken tree canopies with a dark understory, and thus a lower diversity of flowering plants.

🌿 The best bee habitat in the southern Blue Ridge includes meadows, abandoned fields, savannas, and open woodlands.

🌿 Burning fields every 1–2 years is needed to maintain flower diversity. If openings cannot be burned, mowing can maintain the opening but will result in less plant species diversity.

🌿 Ground-nesting bees benefit from patches of bare ground that allow ample sun exposure. Light disking in fields following prescribed fire can increase bare ground and coverage of annual forbs.



Forest opening with a diversity of naturally occurring flowering plants.



Limited light entering closed-canopy forests greatly reduces the abundance and diversity of plants that provide nectar for bees. Opening the canopy followed by frequent fire greatly improves foraging opportunities for bees.

### **Methods for monitoring**

🌿 Observational surveys that match bee species to specific plant hosts are most informative.



# Butterflies and Moths | *Lepidoptera*

**Status:** Varies by species

**Population Trend:** Varies by species

## Life history and ecology

🦋 Lepidoptera go through a four-stage life cycle: egg, caterpillar (larva), pupa, and adult; they only require nectar as adults, whereas larvae eat leaves.

🦋 Butterflies use sight to select mates, whereas moths use scent.

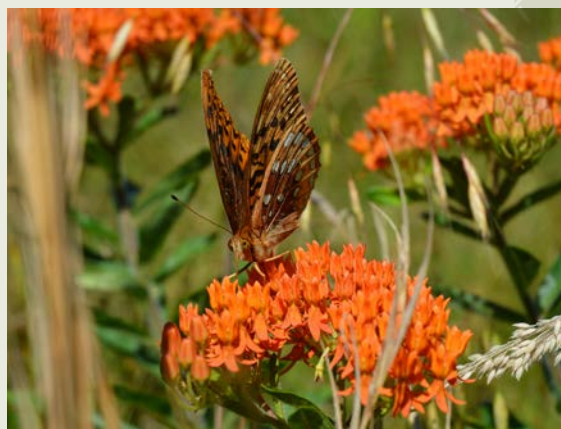
🦋 Butterflies cannot detect sound, whereas moths have ears.

🦋 Butterfly flight speed is about 12 miles/hour, whereas moths can fly 25 miles/hour. Butterflies are active during the day, moths at night.

🦋 Some adult moths never eat, using energy stored as caterpillars.

🦋 The southern Appalachians represents a corridor for monarch fall migration.

🦋 Most butterflies are host specific. A species may have one species of plant they always lay their eggs on (e.g., pipe vine swallowtail use Dutchman's pipe vine; monarchs use various milkweeds [*Asclepias* spp.]



Herbaceous openings support a diversity of forbs that provide nectar for butterflies, such as this great spangled fritillary.

## Habitat

🦋 Greater butterfly diversity and density is found in savannas and open woodlands compared to closed-canopy forest; meadows and openings provide more foraging opportunities.

🦋 Diet consists primarily of nectar from flowering plants, and eggs are laid on host plants. A greater variety of plants benefits a wider variety of species.

🦋 Road and powerline corridors can provide habitat for pollinators in areas surrounded by forest.

## Methods for monitoring

🦋 Transect surveys to determine abundance of a butterfly species

🦋 Checklist surveys are more efficient for initial determination of species' presence

## Local areas for Lepidoptera

🦋 Cades Cove, TN  
(Great Smoky Mountains National Park)

🦋 Buffalo Springs WMA, TN  
(TN Wildlife Resources Agency)

🦋 Roan Mountain State Park, TN  
(TN State Parks)



Various milkweeds are host plants for monarch butterflies. Milkweeds generally require open growing conditions and full sunlight to thrive. Butterfly milkweed is a common species in openings in the southern Appalachians.

### **Fire effects & conservation challenges**

🌿 Frequent fire every 1–3 years can maintain early successional communities and promote increased plant diversity, which is important for conservation of butterflies and moths.

🌿 Pupae that bury themselves in soil are protected from fire.

🌿 Prescribed fire has been used in Ohio and Indiana for the Karner blue butterfly and regal fritillary to increase habitat, open the forest canopy, and allow sunlight to reach the ground and regenerate native plants.



Coreopsis is a preferred forage plant for smaller butterflies as seen at Kyker Bottoms Refuge in Blount County, TN. Photo: Bill Smith



Openings such as this on the South Zone of the Cherokee National Forest contain diverse flowering plants that benefit pollinators.

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