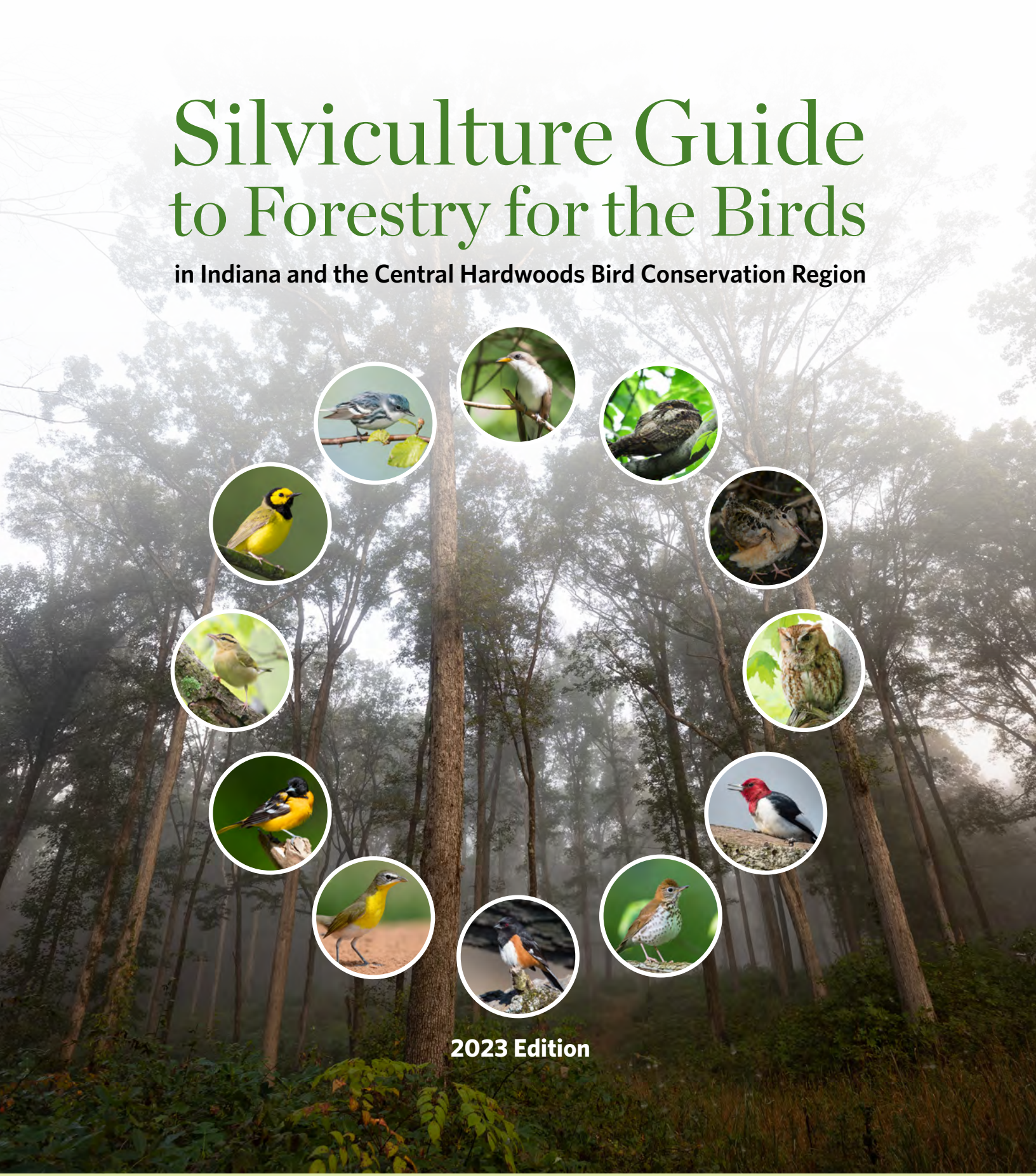
Silviculture Guide to Forestry for the Birds

in Indiana and the Central Hardwoods Bird Conservation Region



2023 Edition

The Nature Conservancy

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Welcome to the Silviculture Guide for Forestry for the Birds!

This is one of two publications, the other being the Pocket Guide for Forestry for the Birds for landowners. *Forestry for the Birds* was developed by The Nature Conservancy in Indiana in collaboration with birders, ornithologists, foresters and wildlife biologists. The goal is to provide strategies that can benefit both forest management and bird communities, facilitating and simplifying the management of bird-friendly forests.

As King et al. (2001) put it "There is an emerging consensus among conservationists that for forest management to most effectively conserve biodiversity, disturbances created during the course of forest practices should mimic, to the greatest extent possible, the frequency and scale of the natural disturbance regimes in which the ecosystem evolved . . .."

This guide is intended as a support document for writing forest and wildlife management plans. Information for each species is cross-referenced with silvicultural practices of benefit to those species adapted to pre-settlement natural disturbances such as frequent fire, tornado, and windthrow. Further information for accessing relevant USDA cost-share programs is provided along with selected reference publications that provide research support for these practices.

New information about forest birds and their habitats is continuously being published in scholarly journals. As such, this publication has been given an edition date of 2023 with the intention that it will be updated periodically. The next edition is planned for the year 2028. Practices recommended here are as specific to the Central Hardwoods Bird Conservation Region as practical and may not be relevant elsewhere in North America.

Long-term Population Changes

There has been a net loss of nearly 3 billion birds since 1970 (Rosenberg, et al. 2019). Forty-six species have lost half of their population.

The range-wide population change for each bird found in this guide, except American Woodcock, was taken directly from the Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States (Rosenberg, et al. 2016), and represents the 44-year interval between 1970 and 2014. The population trend for the American Woodcock was derived from the 2022 American Woodcock population status report by the U.S. Fish and Wildlife Service (Seamans and Rau 2022), covering the 54-year period between 1968 and 2022.

How the Birds were Selected

The birds highlighted in this publication were carefully selected for inclusion by The Nature Conservancy and an independent team of birders, ornithologists, and conservationists. In general, the species on this list meet the following criteria:

- Nest in Indiana and have declining populations.
- Are relatively easy to identify by sight and/or sound.
- Benefit from conservation action through targeted management

Management options are presented for each of the twelve birds. However, these options will benefit wildlife beyond these species. It is important to note that there is no guarantee that these silviculture practices will result in the focal birds using the treated area. However, the odds are greatly increased that they will find and use the habitat. Finally, because some of these focal species are disturbance-dependent their presence may be brief, as measured in years, before they move on to newly suitable habitats, unless the disturbance is on-going. For example, periodic prescribed fire can prolong the value of habitats for some birds where appropriate.

USDA Natural Resources Conservation Service Cost-share Programs

NRCS Conservation Practices and Enhancement Activities have been listed for each of the songbirds profiled to assist with identifying cost-share opportunities for landowners. Information regarding EQIP and descriptions of the primary conservation practices can be found in the following resources:

Environmental Quality Incentives Program
https://www.nrcs.usda.gov/sites/default/files/2022-06/EQIP-Factsheet%20%282%29.pdf

Conservation Practice 666: Forest Stand Improvement https://efotg.sc.egov.usda.gov/api/CPSFile/14401/666_IN_CPS_Forest_Stand_Improvement_2018

Conservation Practice 612: Tree/Shrub Establishment
https://efotg.sc.egov.usda.gov/api/CPSFile/12848/612_IN_CPS_Tree-Shrub_Establishment_2016

Conservation Practice 338: Prescribed Burning
https://efotg.sc.egov.usda.gov/api/CPSFile/34235/338_IN_CPS_Prescribed_Burning_2022

NRCS Forestry Technical Note #5 Forest Stand Improvement
https://efotg.sc.egov.usda.gov/references/public/IN/Technical_Note_5_Forestry_Forest_Stand_Improvement_Methods.pdf

Acknowledgments

This work was sponsored by a generous grant from the Alcoa Foundation, and was inspired by *Foresters for the Birds*, produced and distributed by Audubon Vermont and the Vermont Department of Forests, Parks, and Recreation. Initial funding was provided by the Indiana Forestry Educational Foundation, without which the project could not have succeeded. Numerous people provided helpful guidance and feedback, and we are grateful for their support. In determining the list of species—Brad Bumgardner and members of the Indiana Audubon Society; Dr. Jane Fitzgerald, Dr. Kyle Brazil, and Dr. Cara Joos from the American Bird Conservancy; Robert Ripma from Amos Butler Audubon; Allisyn-Marie Gillet from Indiana Department of Natural Resources, Division of Fish and Wildlife; Jeffrey Kiefer from the US Fish and Wildlife Service; Dr. Michael Baltz, coordinator of Let the Sun Shine In; and several representatives from Purdue University, including Elizabeth Jackson and Dr. John B. Dunning, Jr.

Photographs of the birds were generously provided by Matt Williams Nature Photography unless otherwise credited.

Range maps by Clay Jackson of the Sam Shine Foundation. Line drawings of bird habitats by Jessica Outcalt PhD. The talents of both are greatly appreciated.

Research into birds and their habitats is ongoing and new insights are constantly emerging. As such, this publication is tentatively scheduled to be updated in 2028. Information and recommendations included here are specific to the Central Hardwoods Bird Conservation Region to the extent practical and may or may not be appropriate for other areas of North America.

Primary Habitats Needed

Yellow-billed and Black-billed Cuckoos
- Open woodlands, shrubby, riparian habitats on edges of or near forests

Eastern Whip-poor-will
- Young forests with open understories and open canopies, possibly close to large forest tracts (rather than isolated patches)

American Woodcock
- Young forests or old fields with openings for displaying and foraging habitat. Shrubby patches required for shelter

Eastern Screech-Owl
- Woodlands and forests with a suitable cavity tree, ideally with open subcanopy space for hunting

Red-headed Woodpecker
- Woodlands or forests, usually open and edge habitats; occupy savannas and woodlands consistently; in winter, mature stands of oak forest

Wood Thrush
- Interior of deciduous and mixed forests with open floors and moist leaf litter

Eastern Towhee
- Edges with dense shrub cover, open canopies, and a well-developed litter layer for ground foraging

Yellow-breasted Chat
- Low, dense, shrubby areas with open canopies in early successional forests

Baltimore Oriole
- Deciduous woodland edges, open areas with large trees, riparian zones

Worm-eating Warbler
- Understory of shrub patches in large, mature forests, often on slopes, as well as regenerating clearings during post-fledging period

Hooded Warbler
- Gaps such as tree fall or selectively cut areas in mature forests, small clearings within large tracts of forest

Cerulean Warbler
- Structurally diverse canopies of mature, deciduous forests; area-sensitive, often needing tracts of 75 acres or more

Birds and NRCS Programs

Forest Songbird Habitat Maintenance (E666R)
- Yellow-billed and Black-billed Cuckoos
- Eastern Whip-poor-will
- American Woodcock
- Eastern Screech-Owl
- Red-headed Woodpecker
- Wood Thrush
- Eastern Towhee
- Yellow-breasted Chat
- Baltimore Oriole
- Worm-eating Warbler
- Hooded Warbler
- Cerulean Warbler

Forest management to enhance understory vegetation (E666D)
- Yellow-billed and Black-billed Cuckoos
- Red-headed Woodpecker
- Baltimore Oriole
- Hooded Warbler
- Cerulean Warbler

Reduce Forest Stand Density to Create Open Stand Structure (E666F)
- Eastern Whip-poor-will
- American Woodcock
- Eastern Screech-Owl
- Red-headed Woodpecker
- Wood Thrush
- Eastern Towhee
- Yellow-breasted Chat
- Baltimore Oriole
- Cerulean Warbler

Crop Tree Management for Mast Production (E666I)
- Eastern Screech-Owl
- Red-headed Woodpecker
- Baltimore Oriole
- Hooded Warbler
- Cerulean Warbler

Creating Structural Diversity with Patch Openings (E666K)
- Yellow-billed and Black-billed Cuckoo
- American Woodcock
- Wood Thrush
- Eastern Towhee
- Yellow-breasted Chat
- Baltimore Oriole
- Worm-eating Warbler (nesting)
- Hooded Warbler
- Cerulean Warbler

Snags, Den Trees, and Coarse Woody Debris for Wildlife Habitat (E666O)
- Eastern Screech-Owl
- Red-headed Woodpecker

Cropland Conversion to Trees or Shrubs for Long Term Improvement of Water Quality (E612A)
- Eastern Whip-poor-will
- American Woodcock
- Eastern Towhee
- Yellow-breasted Chat
- Worm-eating Warbler (post-fledging)

Tree/Shrub Planting for Wildlife Food (E612G)
- Eastern Whip-poor-will
- American Woodcock
- Eastern Towhee
- Yellow-breasted Chat
- Worm-eating Warbler (post-fledging)

The value of oak to forest songbirds in eastern North America is hard to overstate. **Cerulean Warblers** have been shown to preferentially nest in stands dominated by white oak. **Red-headed Woodpeckers** and Blue Jays rely on acorns for overwintering and will select sites characterized by oak. However, for most songbirds the abundance and diversity of insects as a food source is the primary draw. According to Tallamy (2021) ". . . oaks support the development of 897 species of moths in the United States that we know of . . .." The caterpillars of these moths are greatly sought after by insect-foraging songbirds. This is true not only during the growing season, but also across the winter months for songbirds that are winter residents.

Lack of oak recruitment into the canopy is a range-wide and widely-recognized phenomenon, though the impact to songbirds is both slow-moving and cumulative. That is, the loss of mature oak without adequate recruitment will make reversal of the problem increasingly difficult and will likely have widespread and long-lasting negative effects for decades. Thoughtful actions by forest managers to perpetuate oak are strongly encouraged.

Furthermore, studies have indicated that pre-settlement oak forest and woodland habitats were often associated with an open midstory due to the prevalence of frequent low-intensity pre-settlement fires. As such, many plants and animals were adapted to low density forest structure and higher light levels nearer the forest floor than often now exist. Several birds featured in this publication such as **Eastern Whip-poor-will**, **Red-headed Woodpecker**, and **Yellow-billed Cuckoo** are attracted to open forests and woodlands.

Nemes, Claire E., and Kamal Islam. 2017. "Breeding Season Microhabitat Use by Cerulean Warbler (Setophaga Cerulea) in an Experimentally-Managed Forest." Forest Ecology and Management 387 (March): 52–63. https://doi.org/10.1016/j.foreco.2016.11.008.

"As elsewhere in the range, white oak was an important nest tree species. In developing forest management strategies, land managers must strive to balance small-scale microhabitat preferences with the need for regenerating oak-hickory forests to sustain **Cerulean Warbler** breeding populations."

Hanberry, Brice B. "Trajectory from beech and oak forests to eastern broadleaf forests in Indiana, USA." Ecological Processes 8, no. 1 (2019): 1-8. https://doi.org/10.1186/s13717-018-0155-3

"Multiple lines of evidence indicate that the "forest primeval" of the eastern United States was in actuality open forests, which are bilayered, with an overstory canopy and herbaceous ground layer, and an absence of woody vegetation under the overstory canopy. For example, fire-tolerant oak and pine species were dominant in historical forests (as presented in this study; Hanberry and Nowacki 2016; Hanberry et al. 2018), and surface fire is a mechanism that removes tree regeneration, thinning forests; surface fires were widespread in the past, based on fire scars and other evidence (Williams 2002; Varner et al. 2016)."

"Researchers who have examined historical accounts have concluded that most accounts point to widespread open forest structure of savannas and woodlands in both the Northeastern and Southeastern United States, albeit there are accounts of dark, dense forests (Bromley 1935; Day 1953; Rostlund 1957). For example, Bromley (1935) wrote: "The picture which may be gained from the writings of the early travelers is fragmentary, but at least it gives a basis for surmise as to the character of the forest at the time of settlement by the whites. On one subject, all are in accord and that is the observation that the original forest was, in most places, extremely open and parklike, due to the universal factor of fire, fostered by the original inhabitants to facilitate travel and hunting."

"Loss of historical forest ecosystems has widespread consequences to dependent species, particularly herbaceous vegetation with high light or fire requirements, pollinators that rely on forbs, animals that forage on herbaceous plants and associated insect populations, and animals that use open structure (e.g., early successional birds) or acorns and beech mast (e.g., Gilliam 2007; McShea et al. 2007; Wood et al. 2011)."

"Indiana's historical oak and beech forests and current diverse eastern broadleaf forests are representative of the transition in state from forests dominated by a few species to closed forests composed of many tree species. Historical open forests of fire-tolerant oaks have become closed eastern broadleaf forests, and American beech trees are rare and succumbing to beech bark disease. The transition in Indiana is representative of most forests of the eastern United States, which have become more diverse and closed through tree densification, due to uncontrolled tree regeneration without the filtering effect of fire (Hanberry and Abrams 2018)."

Hanberry, Brice B.; Thompson, Frank R. 2019. Open forest management for early successional birds. Wildlife Society Bulletin. https://doi.org/10.1002/wsb.957

"We suggest that greater emphasis be placed on the management of open forests for early successional birds and that more open forest management is needed in the eastern United states in addition to ongoing closed forest management if we want to have a positive effect on the declines in many early successional birds"

Nickley, Benjamin, and Lesley P. Bulluck. "Red-headed Woodpecker (*Melanerpes erythrocephalus*) winter roost-site selection in a burned forest stand." *The Wilson Journal of Ornithology* 131, no. 4 (2019): 774-788. https://doi.org/10.1676/1559-4491-131.4.774

"Our results are consistent with Smith and Scarlett (1987), who showed **Red-headed Woodpecker** abundance was positively correlated with acorn production in Missouri."

Smith, K. G., & Scarlett, T. (1987). Mast Production and Winter Populations of Red-Headed Woodpeckers and Blue Jays. *The Journal of Wildlife Management*, 51(2), 459–467. https://doi.org/10.2307/3801034

". . . a positive relationship existed between acorn abundance and wintering numbers of **red-headed woodpeckers** (*Melanerpes erythrocephalus*), a species that relies heavily on acorns as a winter food source."

Wood, Petra, James Sheehan, Patrick D. Keyser, David A. Buehler, Jeff Larkin, Amanda D. Rodewald, Scott H. Stoleson et al. *Management guidelines for enhancing Cerulean Warbler breeding habitat in Appalachian hardwood forests*. American Bird Conservancy, 2013. http://amjv.org/wp-content/uploads/2018/06/cerulean_guide_1-pg_layout.pdf

[**Cerulean warbler**]: "Maintaining white and chestnut oak dominance in the residual stand is a primary consideration in implementing management strategies for ceruleans. Thus, site productivity and the presence of sufficient advance regeneration of white and chestnut oaks are important considerations in management."

Yellow-billed and Black-billed Cuckoos *(Coccyzus americanus and Coccyzus erythropthalmus)*

Primary Habitat

Open woodlands, often near streams and rivers

Silvicultural Practices

- Single Tree and Group Selection
- Crop Tree Release and FSI

Suggested NRCS Conservation Practices and Enhancement Activities

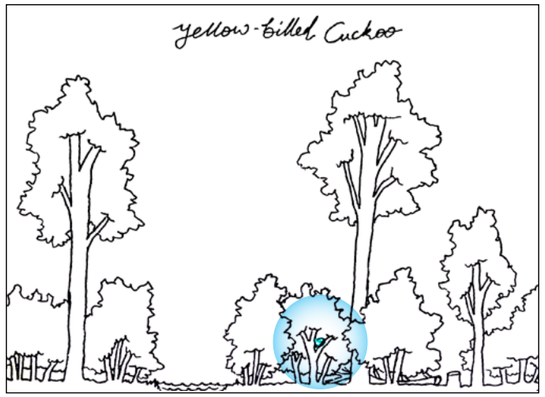
Forest Stand Improvement: CP 666

- Forest management to enhance understory vegetation (E666D)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

Yellow-billed cuckoo © Paul Sparks/Adobe Stock

Black-billed cuckoo © Wirestock Creators/Adobe Stock

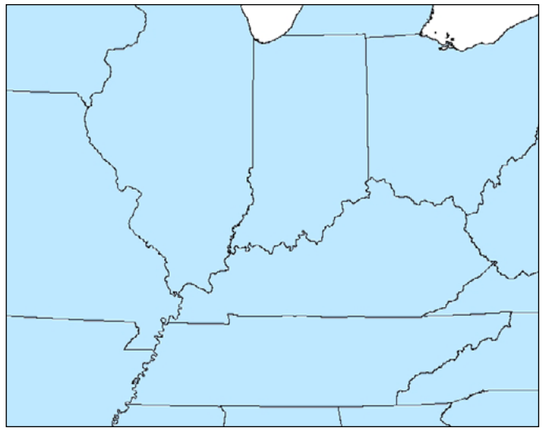
Long Term Population Change -54% (YEBC), -68% (BLBC)



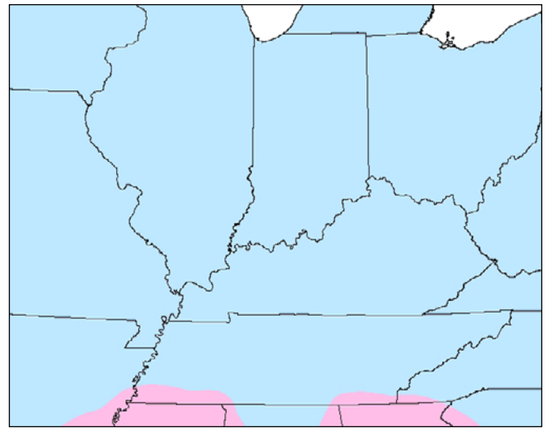
The foraging habitat for cuckoos is often riparian shrub and open woodlands near water. Cuckoos nest in dense deciduous areas, often near the ground (Hughes 2020). Though they are often found near rivers, eastern populations of cuckoos are not restricted solely to these areas and may nest in hardwood groves with consistent humidity.

Though considered a shrubland species by many, Yellow-billed Cuckoos showed a positive relationship with the amount of nearby forest cover on a landscape scale in one study (Reiley and Benson 2019). Management for both species of cuckoo thus should include both forest management to create nesting and foraging habitats as well as creation of openings and shrubby areas for foraging, particularly if nearby riparian zones are available and can be restored.

Expected Range



Yellow-billed cuckoo



Black-billed cuckoo

Nesting only

Present all year

Thru-migration only

Wintering, not nesting

Eastern Whip-poor-will *(Antrostomus vociferus)*

Primary Habitat

Open areas in early successional forests

Silvicultural Practices

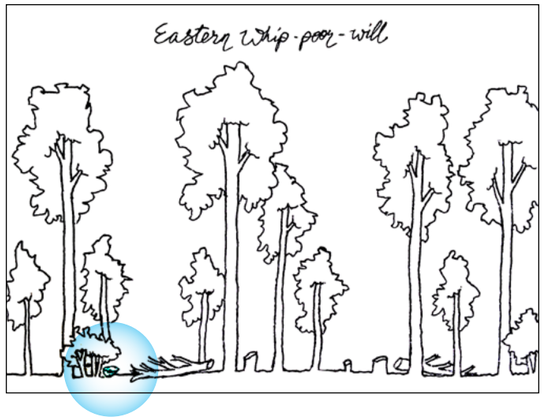
- Reforestation, Thickets, and Clearcuts
- First Stage Shelterwood
- Prescribed Fire

Suggested NRCS Conservation Practices and Enhancement Activities

Prescribed Burning: CP 338
Forest Stand Improvement: CP 666

- Reduce forest stand density to create open stand structure (E666F)
- Forest songbird habitat maintenance (E666R)

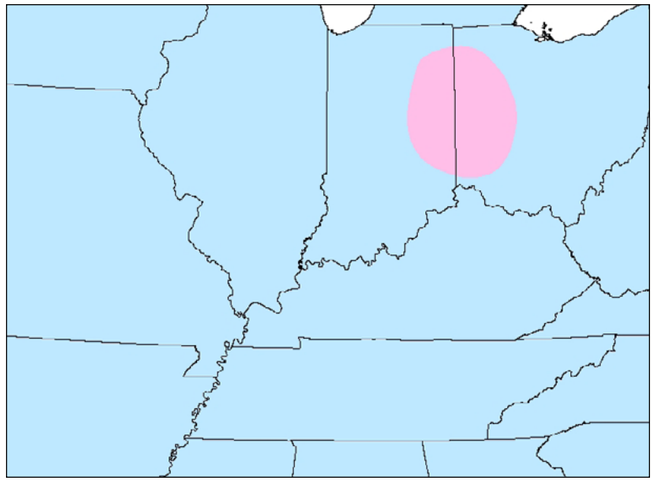
Long Term Population Change -69%



Open forests, usually in early successional stages, are important for whip-poor-wills (Cink et al. 2020). Dense forests with closed canopies as well as isolated woodlots are used in much lower densities than forests with gaps and little underbrush (Cink et al. 2020). Though whip-poor-wills forage by dawn and dusk in low light conditions, they are visual predators. As such, open areas in early successional stages are important habitat characteristics for foraging (Slover and Katzner 2016).

Maturation of forests as well as habitat conversion to agriculture and developed land has been cited as reasons for loss of whip-poor-will habitat. In addition, whip-poor-wills are ground-nesting birds so available shrub cover for protection from predators will benefit whip-poor-will conservation. Managers have recommended creation and maintenance of early successional shrubland forests with open canopies for foraging and remnant large trees for perches (Akresh and King 2016).

Expected Range



American Woodcock *(Scolopax minor)*

Primary Habitat
Young forest with clearings

Silvicultural Practices
Reforestation, Thickets, and Clearcuts

Suggested NRCS Conservation Practices and Enhancement Activities
Prescribed Burning: CP 338
Forest Stand Improvement: CP 666

- Reduce forest stand density to create open stand structure (E666F)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

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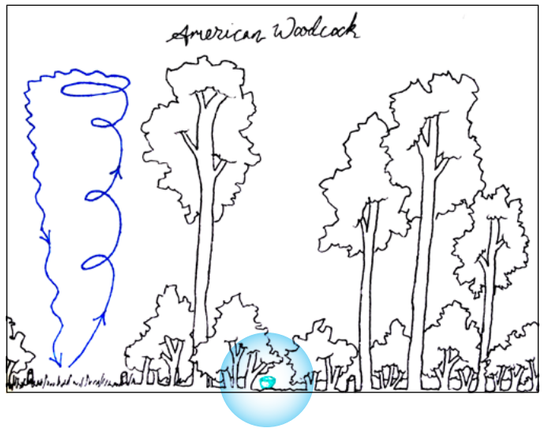
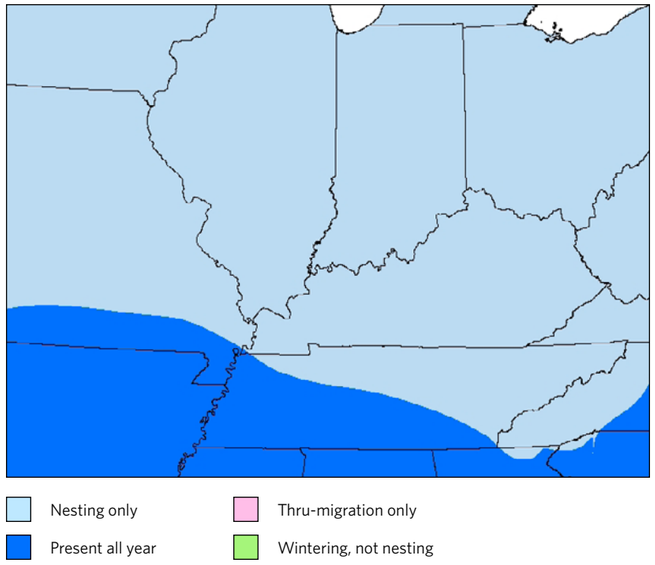
Long Term Population Change -88% (Indiana) -29% (USFWS Central Management Region)



Male woodcocks have an elaborate courtship display in which they call from a forest opening or clearing with an average area of 70 m^2, (~27 x 27 ft.) then begin an aerial dance, sometimes flying in spirals as high as 100 meters (328 feet) and steeply descending back to the ground (McAuley et al. 2020). In addition, woodcocks often roost in these openings, though their nests are located on the ground in shrubby, early successional woodlands (Desseker and McAuley 2001). One of the greatest risks for ground-nesting birds is predation, both of eggs and nestlings, so shelter in the form of dense shrubs is important.

Management plans for American Woodcock often recommend creation of forests with dense midstories for shelter and little ground cover, which benefits earthworms (Straw et al. 1986). Thinning, canopy opening, and creation of clearings for display and roosting areas can also benefit these birds. In addition, the landscape context of targeted management areas can be important; management for young forest within 1 km (0.62 mi.) of old fields, openings, and young, shrubby forest can greatly benefit woodcock (Brenner et al. 2019). McAuley and colleagues (2020) suggest that natural forest aging over the last few decades have likely played a role in the woodcock's population decline, so management for young forest can have beneficial impacts on this species.

Expected Range



Eastern Screech-Owl *(Megascops asio)*

Primary Habitat

A suitable cavity tree in a range of forested landscapes

Silvicultural Practices

- Snags and Den Trees
- Prescribed Fire

Suggested NRCS Conservation Practices and Enhancement Activities

Prescribed Burning: CP 338
Forest Stand Improvement: CP 666

- Reduce forest stand density to create open stand structure (E666F)
- Crop tree management for mast production (E666I)
- Snags, den trees, and coarse woody debris for wildlife habitat (E666O)
- Forest songbird habitat maintenance (E666R)

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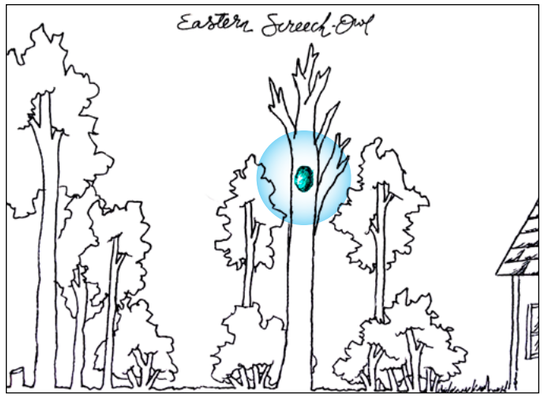
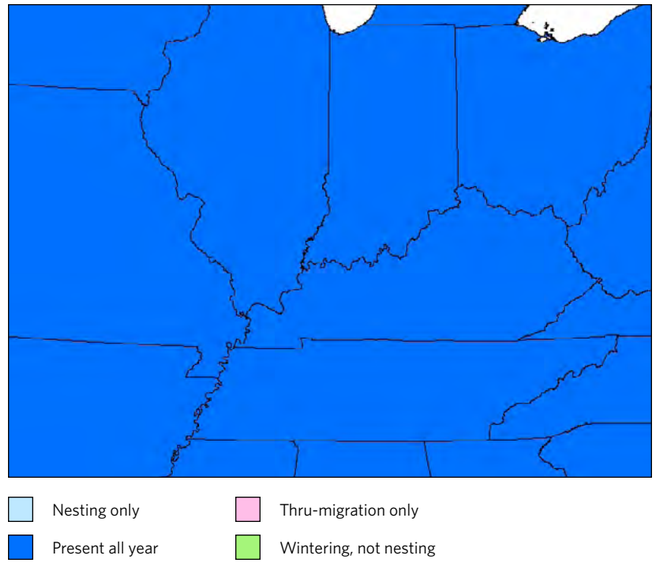
Long Term Population Change -41%



Though its habitat is relatively general and owls are dependent only on a cavity tree or nest box, this species is also influenced by food availability and adequate hunting habitat. One study in southern Indiana found a decline in screech-owl occupancy following a decline in white-footed mice abundance (Leonard et al. 2015). Rodents and songbirds are the screech owl's principal prey, though invertebrates are also important. The Eastern Screech-Owl is a sit-and-wait predator, so open subcanopies and thin shrub layers promote prey detection and capture (Ritchison et al. 2020).

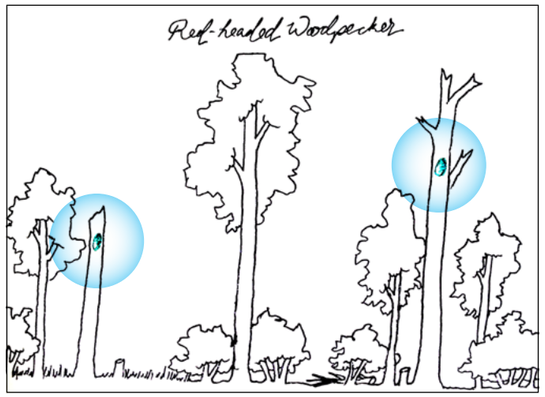
Nonmigratory and largely solitary, even a small forest patch may support Eastern Screech-Owls. In a study in Kentucky, Eastern Screech-Owls used primarily deciduous woodlots and edge habitats, particularly in the non-breeding seasons (Sparks et al. 1994). Another study found owls preferred upland and maple woodlands, and used lawns and evergreen woodlands less frequently (Smith and Gilbert 1984). Management for screech-owls, then, should include retention of trees with cavities or provision of nest boxes, as well as encouraging open woodlands for hunting.

Expected Range



Red-headed Woodpecker *(Melanerpes erythrocephalus)*

Long Term Population Change -67%



Red-headed Woodpecker depends on openings and edge habitats, as well as dead trees for foraging and nesting (Frei et al. 2020). They are regularly present in savannas and woodland areas, as well as forested areas opened by disturbances (Frei et al. 2020). In the breeding season, these omnivorous woodpeckers eat primarily seeds and nuts, though insects and small vertebrate prey are often taken as well; in the non-breeding season, hard mast such as acorns are their primary food (Frei et al. 2020). Most foraging and nesting occurs on dead limbs and trunks. Red-headed Woodpeckers are primary cavity nesters, which means they excavate their own nest holes which are occasionally re-used by the same breeding pair and often used by a variety of species in subsequent years (Frei et al. 2020).

Prescribed fire can serve to create woodpecker habitat, fostering an open forest or woodland habitat type. Beaver-caused damming of streams can also create a flooded forest habitat type with plenty of snags. One study found that density of medium and large snags with less bark was the most influential predictor of Red-headed Woodpecker density, regardless of other cover types (Nickley and Bulluck 2019). Retention of snags and creation of clearings, as well as encouraging growth of oak and other mast crop species, can greatly benefit this bird.

Primary Habitat

Forested, relatively open areas with large snags present

Silvicultural Practices

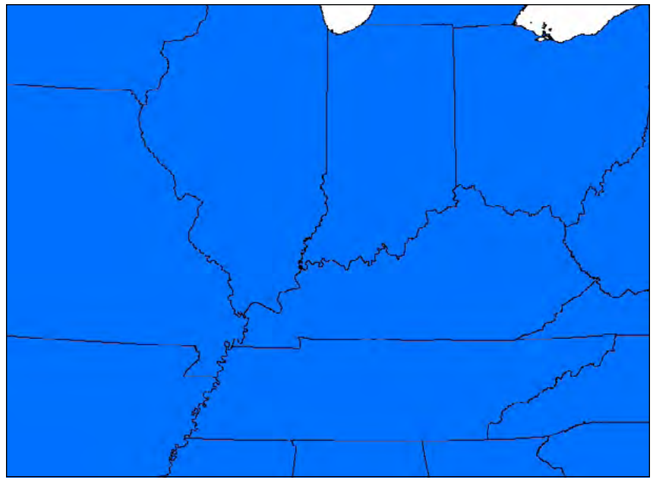
- First Stage Shelterwood
- Crop Tree Release and FSI
- Snags and Den Trees
- Prescribed Fire

Suggested NRCS Conservation Practices and Enhancement Activities

Prescribed Burning: CP 338
Forest Stand Improvement: CP 666

- Forest management to enhance understory vegetation (E666D)
- Reduce forest stand density to create open stand structure (E666F)
- Crop tree management for mast production (E666I)
- Snags, den trees, and coarse woody debris for wildlife habitat (E666O)
- Forest songbird habitat maintenance (E666R)

Expected Range



Wood Thrush (*Hylocichla mustelina*)

Primary Habitat

Large, interior forest patches with moderately open floor

Silvicultural Practices

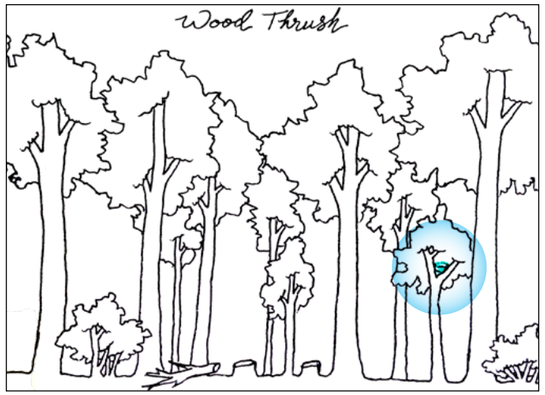
- Single Tree and Group Selection
- Crop Tree Release and FSI

Suggested NRCS Conservation Practices and Enhancement Activities

Forest Stand Improvement: CP 666

- Reduce forest stand density to create open stand structure (E666F)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

Long Term Population Change -60%

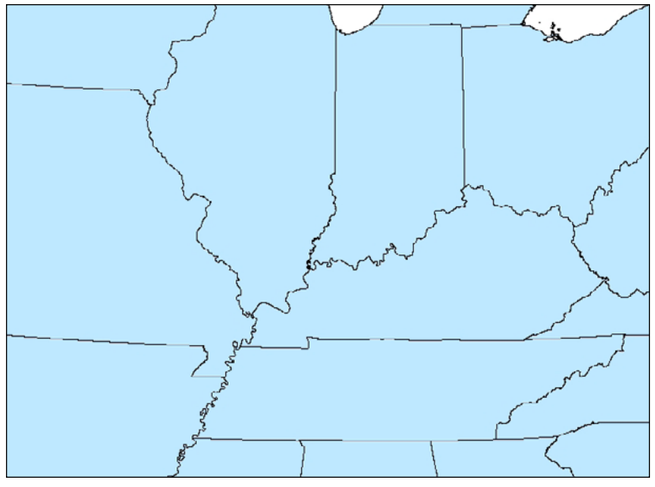


The Wood Thrush is an interior forest resident, particularly of diverse habitats with a shady, open forest floor and decaying leaf litter for invertebrate foraging (Evans et al. 2020). Mature forest patches, rather than small isolated fragments, provide protection from edge-specializing nest parasites such as Brown-headed Cowbirds.

Wood Thrushes nest in shrubs or young trees, usually in areas with denser shrubs than the surrounding forest (Evans et al. 2020). Mature areas with moist forest floors and understory cover are consistently used by Wood Thrushes and similar species. Large trees are used for singing perches and production of leaf litter for foraging microhabitat (Bertin 1977). Nesting success is often determined by protection from predators, and large fragments, larger than 100 ha (247 acres) in one study, have significantly lower predation rates (Hoover et al. 1995).

Despite dependence on large, mature forest patches, Wood Thrushes also use edge habitats during migration seasons, where high-fat fruit such as dogwood and elderberry are more abundant (Evans et al. 2020). Smaller patches that may be used less in the breeding season may still be used in other seasons or as overflow habitat from larger patches, thus management such as invasive plant control can still benefit Wood Thrush.

Expected Range



Eastern Towhee *(Pipilo erythrophthalmus)*

Primary Habitat
Dense, shrubby edges

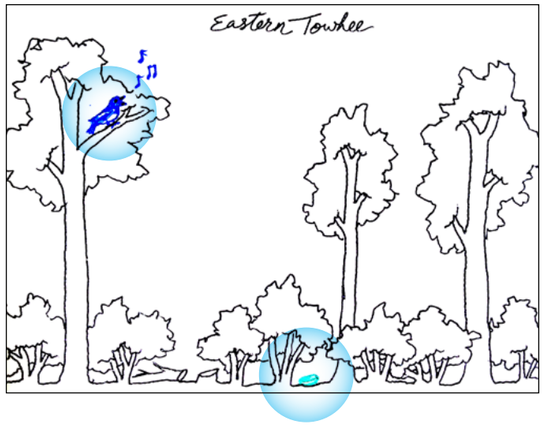
Silvicultural Practices
- Reforestation, Thickets, and Clearcuts
- First Stage Shelterwood

Suggested NRCS Conservation Practices and Enhancement Activities
Tree/Shrub Establishment: CP 612
- Cropland conversion to trees or shrubs for long term improvement of water quality (E612A)
- Tree/Shrub planting for wildlife food (E612G)

Forest Stand Improvement: CP 666
- Reduce forest stand density to create open stand structure (E666F)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

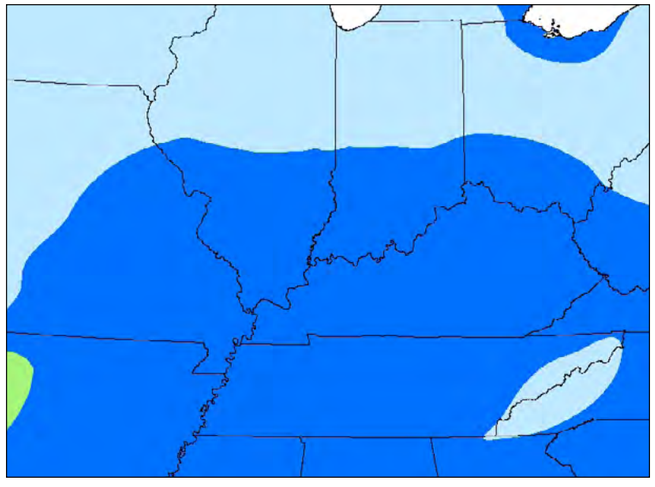
Long Term Population Change -43%

Eastern Towhees prefer habitats with open canopies and dense shrub cover, as well as a well-developed litter layer for foraging (Greenlaw 2020). Invertebrate prey is especially important during the breeding season, when protein is a necessary part of the diet. Later in the summer and during the migratory seasons, plants, especially seeds and high-lipid fruit, become important (Greenlaw 2020). Regenerating clearcuts and naturally maintained openings are consistently used habitats by towhees and other shrubland species, likely because these dense habitats with high food availability, shelter from predation, and vegetative diversity can support a high number of species (Fink et al. 2006).



Management for Eastern Towhees should include techniques that open the canopy and foster increased shrub density (Reidy et al. 2013). Forest maturation and habitat fragmentation have contributed to decreasing populations of towhees. Management that targets increased diversity on a landscape scale can benefit a wide range of species, including those that require transient habitats like regenerating openings.

Expected Range



Yellow-breasted Chat *(Icteria virens)*

Long Term Population Change -11%

In its breeding range, the Yellow-breasted Chat is an early successional forest obligate (Eckerle and Thompson 2020). Regenerating clearcuts, old fields, and other forest openings or edges are consistently used by chats, particularly areas with high availability of fruits and invertebrates. This habitat usage, especially if near streams and wetlands, overlaps with other species such as Common Yellowthroat, Prothonotary Warbler, and Prairie Warbler.

Almost 50% of nests in one study were in blackberry shrubs (Eckerle and Thompson 2020). Dense thickets with shelter from predation are among the most important characteristics that management can target for Yellow-breasted Chats. Management techniques that create early successional forest patches with dense foliage and an open canopy are important tools that can benefit this charismatic species (Ricketts and Ritchison 2000).

Primary Habitat

Open, shrubby areas of early successional forests

Silvicultural Practices

- Reforestation, Thickets, and Clearcuts
- First Stage Shelterwood

Suggested NRCS Conservation Practices and Enhancement Activities

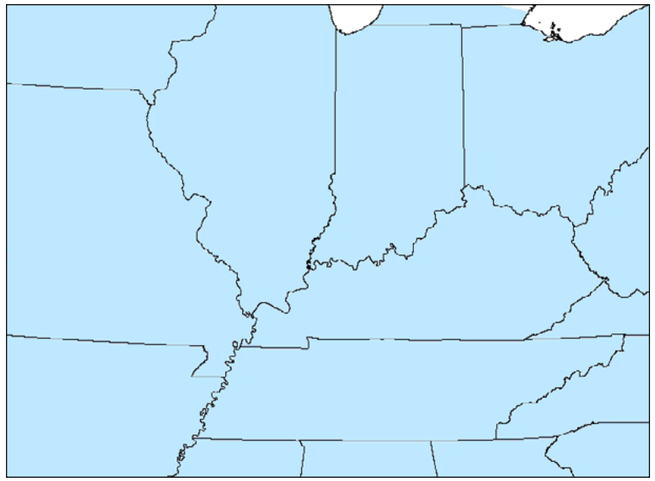
Tree/Shrub Establishment: CP 612

- Cropland conversion to trees or shrubs for long term improvement of water quality (E612A)
- Tree/Shrub planting for wildlife food (E612G)

Forest Stand Improvement: CP 666

- Reduce forest stand density to create open stand structure (E666F)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

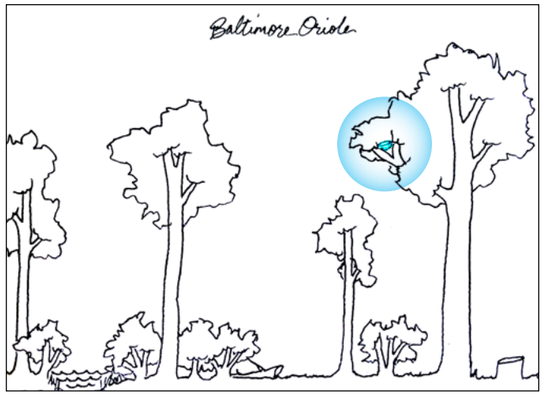
Expected Range



Baltimore Oriole *(Icterus galbula)*

Long Term Population Change -42%

The Baltimore Oriole's preferred breeding habitat is open areas, orchards, riparian woodlands, and similar deciduous habitats (Rising and Flood 2020). These bright orange and black birds often forage high in large trees or on fruit-bearing shrubs. Their primary foods are soft invertebrates like caterpillars and plant matter such as fruits and nectar. It is possible that, due to these food preferences, orioles are sensitive to effects of insecticides and herbicides sprayed in woodland, edge, or orchard areas (Rising and Flood 2020).



Orioles often nest in large or isolated trees such as elm, sycamore, or cottonwoods; management that creates woodland habitats and leaves these types of trees standing can benefit oriole populations (Rising and Flood 2020).

Primary Habitat

Open, deciduous woodlands

Silvicultural Practices

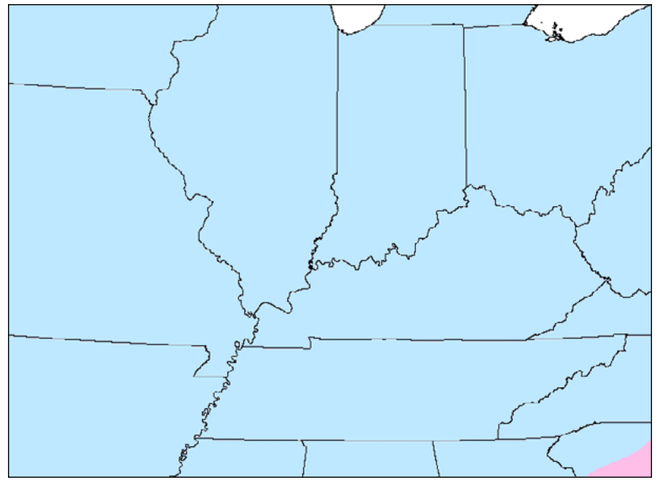
First Stage Shelterwood

Suggested NRCS Conservation Practices and Enhancement Activities

Forest Stand Improvement: CP 666

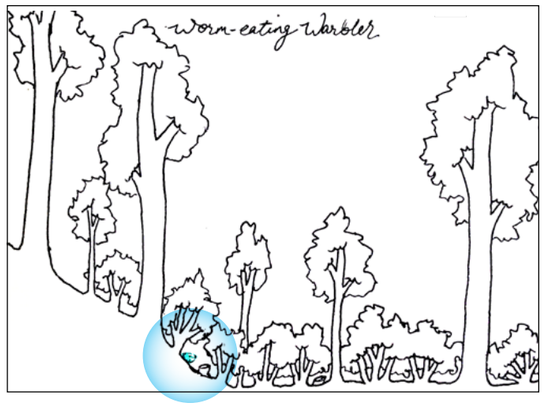
- Forest management to enhance understory vegetation (E666D)
- Reduce forest stand density to create open stand structure (E666F)
- Crop tree management for mast production (E666I)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

Expected Range



Worm-eating Warbler *(Helmitheros vermivorum)*

Long Term Population Change +26%



Primarily considered a mature forest specialist, the Worm-eating Warbler often spends time in dense, shrubby patches within forest landscapes. Vitz and colleagues (2020) write that the Worm-eating Warbler is found primarily where large areas of mature forest intersect with slopes and patchy shrubs. Sensitive to the overall area of a forest, these warblers nest on the ground hidden in low shrubs or leaf litter (Vitz et al. 2020).

Despite this pattern of interior forest utilization, habitat use during the post-fledging period in this species is quite different. In some areas, Worm-eating Warblers during the post-fledging period are among the most abundant species mist-netted in regenerating clearcuts (Ruhl et al. 2018a, Vitz et al. 2020). Dense understories with open canopies, such as those found in clearcuts, are used in high densities by these and other mature forest species, likely due to food availability and shelter from predation.

Management for Worm-eating Warbler should be informed by both landscape- and microsite-level characteristics. Large mature forests and presence of steep slopes are important landscape-level characteristics predicting warbler densities, and leaf-litter depth and shrub cover are important at microsite levels (Ruhl et al. 2018b). In addition, presence of early successional, open areas near large tracts of forest can benefit warblers during the post-fledging and migratory periods.

Primary Habitat

Shrub patches in mature forests

Silvicultural Practices

- Reforestation, Thickets, and Clearcuts (post-fledging/breeding)
- Single Tree Selection (nesting)
- Mature Forest (nesting)

Suggested NRCS Conservation Practices and Enhancement Activities

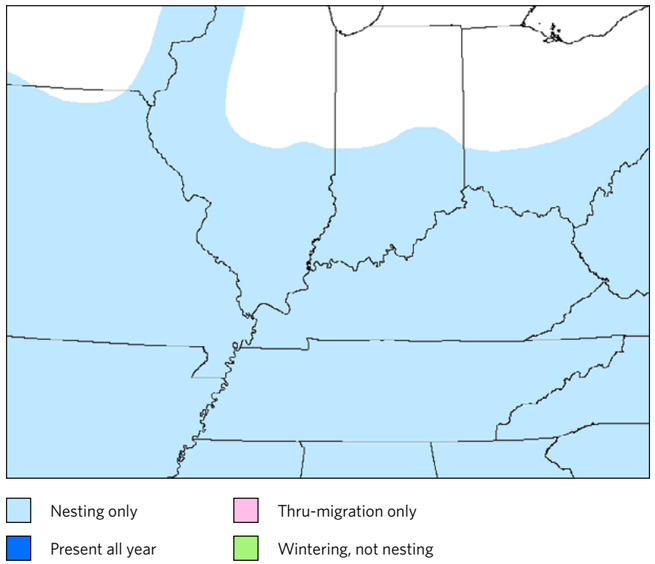
Tree/Shrub Establishment: CP 612

- Cropland conversion to trees or shrubs for long term improvement of water quality (E612A)
- Tree/Shrub planting for wildlife food (E612G)

Forest Stand Improvement: CP 666

- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

Expected Range



Hooded Warbler *(Setophaga citrina)*

Primary Habitat
Gaps or edges in forests

Silvicultural Practices
- First Stage Shelterwood
- Single Tree and Group Selection
- Crop Tree Release and FSI

Suggested NRCS Conservation Practices and Enhancement Activities
Forest Stand Improvement: CP 666
- Forest management to enhance understory vegetation (E666D)
- Crop tree management for mast production (E666I)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

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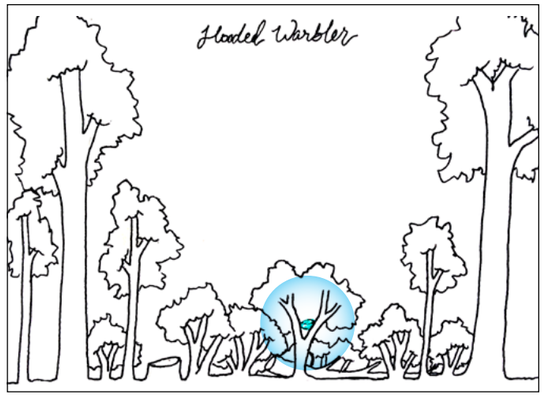
Long Term Population Change +103%

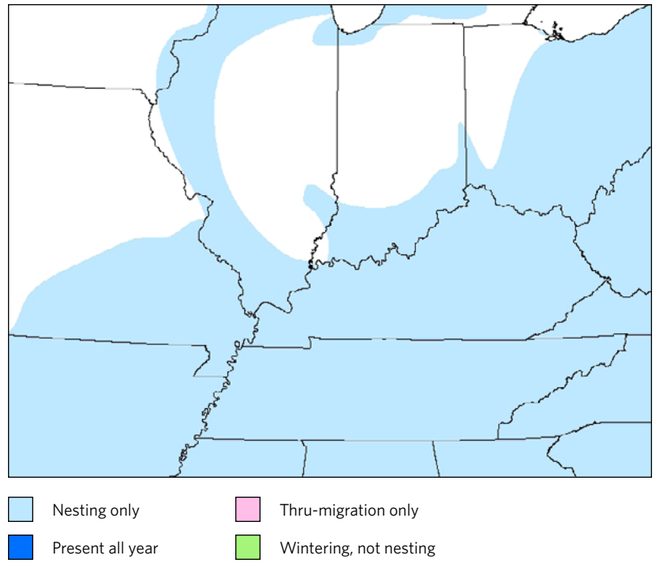
During the breeding season, Hooded Warblers occupy a range of forested habitats, from tree fall gaps in large forest areas to edges of small, isolated fragments (Chiver et al. 2020).



High shrub density is one of the most important characteristics of nesting sites. Though insectivorous often nests near fruit-bearing shrubs like blackberry (Chiver et al. 2020). Shrubby habitats rich in food resources, such as regenerating clearcuts, are also used heavily during the post-fledging period (Vitz and Rodewald 2007).

Though the Hooded Warbler uses shrubby edge habitats, it is typically found in or near large tracts of forest (Chiver et al. 2020). Forest management that creates gaps and edges can provide beneficial nesting and foraging habitat for these warblers, as well as other species that occupy similar niches.

Expected Range



Cerulean Warbler *(Setophaga cerulea)*

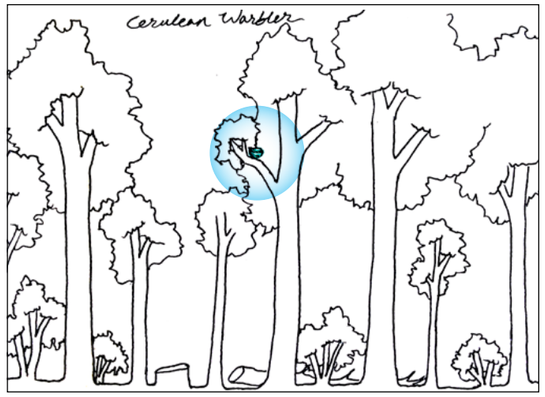
Primary Habitat
Canopies of mature deciduous forests

Silvicultural Practices
- Group Selection
- First Stage Shelterwood
- Crop Tree Release

Suggested NRCS Conservation Practices and Enhancement Activities
Forest Stand Improvement: CP 666
- Forest management to enhance understory vegetation (E666D)
- Reduce forest stand density to create open stand structure (E666F)
- Crop tree management for mast production (E666I)
- Creating structural diversity with patch openings (E666K)
- Forest songbird habitat maintenance (E666R)

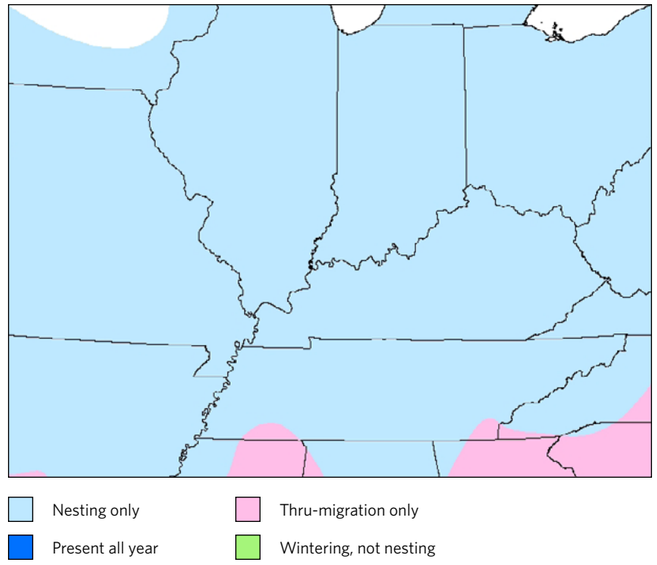
Long Term Population Change -72%

This warbler forages on insects, typically in the highest canopy as well as areas next to canopy gaps (Buehler et al. 2020). It needs large forested landscapes, possibly due to a greater risk from Brown-headed Cowbird parasitism and predation elsewhere. There is evidence that Cerulean Warblers use openings in canopies as well as undisturbed canopy cover, though the difference may be landscape-dependent (Buehler et al. 2020). White oak and bitternut hickory trees are preferred, and red maples are avoided.



Nests of Cerulean Warblers are found on limbs in mid- to overstory canopy levels, often near canopy gaps or areas with dense foliage cover (Jones and Robertson 2001). Recommendations for silviculture that benefits Cerulean Warblers on breeding grounds include encouraging growth of large trees with full crowns, creating a vertically diverse canopy (Buehler et al. 2020), and ensuring some grapevines are available as nest material (Wood et al. 2013). The Cerulean Warbler is drawn to large forested landscapes such as found in the Brown Co. Indiana area. Do not expect Cerulean Warblers to nest in isolated woodlots. For more information see *Enhancing Cerulean Warbler Habitat in the Appalachians: A Guide for Foresters*. https://efotg.sc.egov.usda.gov/references/public/WV/Cerulean_FS_Foresters_Version_Final_(1).pdf

Expected Range



Single Tree and Group Selection
- Wood Thrush
- Hooded Warbler
- Yellow-billed Cuckoo
- Worm-eating Warbler (nesting)
- American Woodcock

First-Stage Shelterwood
- Red-headed Woodpecker
- Cerulean Warbler
- Baltimore Oriole
- Hooded Warbler
- Yellow-breasted Chat
- Eastern Towhee
- Eastern Whip-poor-will

Reforestation, Thickets, and Clearcuts
- Eastern Towhee
- Yellow-breasted Chat
- Eastern Whip-poor-will
- American Woodcock
- Worm-eating Warbler (post fledging/breeding)

Crop Tree Release and Forest Stand Improvement (FSI)
- Wood Thrush
- Hooded Warbler
- Cerulean Warbler
- Yellow-billed Cuckoo
- Red-headed Woodpecker

Snags and Den Trees
- Eastern Screech-Owl
- Red-headed Woodpecker

Prescribed fire
- Eastern Whip-poor-will
- Eastern Towhee
- Eastern Screech-Owl
- Red-headed Woodpecker
- Yellow-breasted Chat

Sugar Maples, Single Tree Selection Harvest, Harrison Co., Indiana © Ron Rathfon/Purdue University

Single Tree and Group Selection

- Wood Thrush
- Hooded Warbler
- Yellow-billed Cuckoo
- Worm-eating Warbler (nesting)
- American Woodcock

Definitions

Single Tree Selection is a method of creating new age classes in uneven aged stands in which individual trees of all size classes are removed more or less uniformly throughout the stand to achieve desired stand structural characteristics. The goal is not to create large canopy openings, but to remove individual trees to allow other trees to grow and expand their crowns. This system maintains a heavier, high canopy, and promotes the growth of shade tolerant tree species.

Group Selection is a method of regenerating uneven aged stands in which trees are removed, and new age classes are established, in small groups, creating small openings in the forest canopy. The maximum width of groups is approximately twice the height of the mature trees, with small openings providing microenvironment suitable for shade-tolerant regeneration and the larger openings providing conditions suitable for more shade-intolerant regeneration. In the Group Selection System, the management unit or stand in which regeneration, growth, and yield are regulated consists of a landscape containing an aggregation of groups, often in association with areas managed with single tree selection. Small openings are used for foraging by many species of birds including those in an adjacent closed forest.

Things to Consider

- Single tree selection is not a compatible silvicultural strategy to regenerate oak forest types. It is a valid intermediate treatment to thin and develop stands but must be combined with a regeneration harvest or prescribed fire of sufficient frequency and intensity.
- Consider the height of surrounding trees when planning the opening size to meet regeneration goals of shade tolerant vs intolerant species. Larger groups can have a gradation of shade tolerant to intolerant regeneration moving from the edge toward the center of the opening.

Cited Research regarding Single Tree and Group Selection

Ford, R., S. Carr, C. Hunter, J. York, and M. Reodel. "Partners in Flight bird conservation plan for the Interior Low Plateaus, version 1.0." (2000). https://partnersinflight.org/wp-content/uploads/2017/02/PA-14-Interior-Low-Plateaus.pdf

"Another species assemblage with high concern scores requires a well-developed forest mid-story for nesting, foraging, and singing perches. Within this species assemblage are **yellow-billed cuckoo**, **wood thrush**, red-eyed vireo, and **hooded warbler**. **Yellow-billed cuckoos** are most numerous around forest openings and in shrubby woodlots resulting from fire and other disturbances, although cuckoos occur in extensive forest patches as well (Castrale et al. 1998). In Tennessee, nests vary from 0.9 m to 6.7 m above the ground (average of 3.1 m). The plant most often used was hackberry, but cedars, elms, willows, and pine were also used (Nicholson 1997). **Cuckoos** seem most numerous in semi-open habitats where thickets are intermixed with patches of woods (Palmer-Ball 1996)"

King, David I., Richard M. Degraaf, and Curtice R. Griffin. 2001. "Productivity of Early Successional Shrubland Birds in Clearcuts and Groupcuts in an Eastern Deciduous Forest." The Journal of Wildlife Management 65 (2): 345. https://www.fs.usda.gov/nrs/pubs/jrnl/2001/ne_2001_king-d_003.pdf

"Because the habitat created by group selection does not satisfy the habitat requirements of a subsstantial proportion of the early successional shrubland bird community, and the creation of groupcuts disrupts bird communities in the remaining mature forest in managed stands, sole reliance on group selection represents an ineffective compromise between the habitat requirements of early successional and mature forest birds. We suggest that a more effective strategy would be to consolidate mature and regenerating forest into larger blocks as suggested by Hagan et al. (1997), which would maximize the utility of the resulting habitat for both mature forest and early successional shrubland species."

Morris, Dana L., Paul A. Porneluzi, Janet Haslerig, Richard L. Clawson, and John Faaborg. "Results of 20 years of experimental forest management on breeding birds in Ozark forests of Missouri, USA." *Forest Ecology and Management* 310 (2013): 747-760. https://doi.org/10.1016/j.foreco.2013.09.020

"The decline of **Wood Thrush** on NH [no harvest] sites could be explained by increasing successional age as **Wood Thrushes** have disappeared from undisturbed mature second growth forests in the northeast (Holmes and Sherry, 2001)."

Owen, R. B., J. M. Anderson, J. W. Artmann, E. R. Clark, T. G. Dilworth, L. E. Gregg, F. W. Martin, J. D. Newsom, S. R. Pursglove, and G. C. Sanderson. "American Woodcock. In Management of Migratory Shore and Upland Game Birds in North America." (1977): 149-186.

"In the evening, **woodcock** leave diurnal coverts to roost in fields and in small forest openings; these same areas often serve as courtship sites in the spring."

"Most nests are located within a few yards (meters) of brushy field edges. However, nest cover varies from open fields to young or middle-aged hardwoods of mixed types of light-to-medium density."

"Minor changes in land-use practices often have beneficial effects on **woodcock** numbers. For example, the provision of small openings in the forest canopy creates singing grounds and roosting fields."

Perry, Roger W., and Ronald E. Thill. "Long-term responses of disturbance-associated birds after different timber harvests." *Forest Ecology and Management* 307 (2013): 274-283. https://doi.org/10.1016/j.foreco.2013.07.026

[**Hooded warbler**]: "Over all post-harvest years combined, single tree selection stands had greater detection rates than all other treatments except group-selection stands."

Robinson, W. Douglas, and Scott K. Robinson. "Effects of selective logging on forest bird populations in a fragmented landscape." *Conservation biology* 13, no. 1 (1999): 58-66. https://doi.org/10.1046/j.1523-1739.1999.97226.x

"Populations of gap-dependent species such as **Hooded Warbler** (*Wilsonia citrina*), Indigo Bunting (*Passerina cyanea*), White-eyed Vireo (*Vireo griseus*), and Carolina Wren (*Thryothorus ludovicianus*) were dramatically larger in recently cut forest, with populations of most species reaching a peak 2–3 years after cutting. Between 5 and 10 years after cutting, nearly all gap-dependent species had returned to population levels comparable to those in uncut forest."

"We conclude that the first cutting cycle in selective logging had only a minor effect on the forest bird community composition and created a short-lived availability of habitat for gap species. In the southern Illinois landscape, selective logging appeared to add little to the existing effects of forest fragmentation. Effects of perforation may differ in more continuously forested landscapes, however, and may be influenced by total basal area of timber removed and by the length of the inter-cut interval."

Wood, Petra, James Sheehan, Patrick D. Keyser, David A. Buehler, Jeff Larkin, Amanda D. Rodewald, Scott H. Stoleson et al. *Management guidelines for enhancing Cerulean Warbler breeding habitat in Appalachian hardwood forests*. American Bird Conservancy, 2013. http://amjv.org/wp-content/uploads/2018/06/cerulean_guide_1-pg_layout.pdf

"Group selection as part of an uneven-aged system can improve **cerulean** habitat and would likely be effective longer than single-tree selection. The small group openings provide for diverse canopy structure and understory development. This approach has been shown to advance stands toward late successional structure beneficial to many avian species"

"**Ceruleans** preferentially use canopy gaps that are ~400-1000 ft^2 in size, particularly those with advanced vegetative growth within them. Thus, group-selection harvests that allow already established regeneration to grow into a stratified canopy may benefit this species."

First Stage Shelterwood Harvest with mid-story thinning, Brown Co., Indiana © Chris Neggers/The Nature Conservancy

First-Stage Shelterwood

- Red-headed Woodpecker
- Cerulean Warbler
- Baltimore Oriole
- Hooded Warbler
- Yellow-breasted Chat
- Eastern Towhee

Definitions

In a **shelterwood** system trees are progressively removed to promote the development of an even-aged group of seedlings under the protection of the older thinned overstory. The primary objective is to create conditions that allow a new group of seedlings to advance so they can replace the stand once the overstory is removed. The **First-Stage Shelterwood** involves primarily the removal of a stagnant or shade-tolerant midstory to allow moderated sunlight to reach the forest floor and stimulate the growth and advancement of tree species that are mid-tolerant.

Shelterwood with Reserves is a variant of the Shelterwood Method in which some or all the shelter trees are retained well beyond the normal period of retention to attain goals other than regeneration such as the creation of a forest structure beneficial to some of the birds listed above.

Things to Consider

- If the objective is encouraging the development of oak patience and intermediate treatments like prescribed fire may be needed to achieve the desired results.
- Combine a shelterwood with prescribed fire for targeted songbird habitat along with a higher likelihood of recruiting fire-tolerant seedlings like oaks and hickories.
- By deadening the midstory and some co-dominant trees, a large number of snags in the 4-to-16-inch diameter classes are created to the benefit of snag-using birds and bats, including Red-headed Woodpeckers and Indiana Bats.

- It is best to carry out the first-stage shelterwood when you have at least 300 competitive seedlings per acre of desirable species in the understory. If the desirable regeneration has lost apical dominance or is not present, it is best to delay the first-stage shelterwood until a few years after a significant mast crop establishes a new cohort of seedlings that have reached at least 2 feet tall.
- A first-stage shelterwood with no competitive regeneration present will typically stimulate more early successional species or shade tolerant species that will take advantage of the diffuse sunlight and occupy the site.
- Think big! 10+ acres for greatest habitat benefits and increased regeneration success. The most benefit occurs when this is used as a stand level treatment rather than applied in patches.

Cited Research regarding First-Stage Shelterwood

Harper, C.A., Ford, W.M., Lashley, M.A. et al. Fire Effects on Wildlife in the Central Hardwoods and Appalachian Regions, USA. fire ecol 12, 127–159 (2016). https://doi.org/10.4996/fireecology.1202127

"Bat activity was greater in stands that had been regenerated via shelterwood harvest and later burned than in unharvested and unburned Appalachian hardwoods in Ohio (Silvis et al, 2016)"

Perry, Roger W.; Thill, Ronald E. 2013. Long-term responses of disturbance-associated birds after different timber harvests. *Forest Ecology and Management* 307:274–283. https://doi.org/10.1016/j.foreco.2013.07.026

"Shelterwoods may offer the closest approximation to clearcuts in providing habitat for most early successional birds. In addition, shelterwoods and single-tree selection stands provided habitat to species that were rare in both unharvested controls and clearcuts, such as Kentucky warbler and **hooded warbler**.

Wood, Petra, James Sheehan, Patrick D. Keyser, David A. Buehler, Jeff Larkin, Amanda D. Rodewald, Scott H. Stoleson et al. *Management guidelines for enhancing Cerulean Warbler breeding habitat in Appalachian hardwood forests*. American Bird Conservancy, 2013. http://amjv.org/wp-content/uploads/2018/06/cerulean_guide_1-pg_layout.pdf

"Shelterwood harvests are often compatible with promoting oak regeneration and, in the CWFMP (Cooperative Cerulean Warbler Forest Management Project), generally resulted in increased cerulean density and intermediate levels of nest success. However, complete overstory removal during the second stage of a shelterwood harvest will substantially reduce numbers of mature forest species including **Cerulean Warbler**, **Wood Thrush**, Acadian Flycatcher, and **Worm-eating Warbler**. If managing for forest birds, retain the residual canopy as long as possible and until adjacent habitat has been enhanced with shelterwood or other types of harvests and colonized by ceruleans."

Drone image of First Stage Shelterwood Harvest, Brown Co. Indiana © Ryan Goetz/The Nature Conservancy

High Density Tree Planting 6-8 years of age, Montgomery Co., Indiana © Lenny Farlee/Purdue University

Reforestation, Thickets, and Clearcuts

- Wood Thrush
- Eastern Towhee
- Yellow-breasted Chat
- Eastern Whip-poor-will
- American Woodcock
- Worm-eating Warbler (post fledging/breeding)
- Cerulean Warbler (post fledging/breeding)

Definitions

Reforestation is the establishment of woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration. The species planted, type of plant material planted, location, layout, and density of planting should be decided based on the landowners' objectives and site conditions such as soils, existing vegetation, floodplain position, and surrounding land use.

To improve reforestation efforts all planted species should be native to the local area and include a diverse mix of hardwood species that produce both hard and soft mast (food) for wildlife as well as native shrubs to add structure and additional food resources. Typically, 6-8 tree species and 3-4 shrub species create a diverse bird-friendly tree planting. Spacing should vary by landowner objective with a minimum goal of 436 trees and shrubs per acre planted when using bare root seedlings. For additional guidance on tree planting, direct seeding, and natural regeneration see the Purdue Extension publication Designing Hardwood Tree Planting for Wildlife: https://www.extension.purdue.edu/extmedia/FNR/FNR-213.pdf.

Thicket is an area of tangled and vigorously growing native trees, shrubs, brambles, and vines often following a forest disturbance such as a clearcut harvest, tornado, windstorm, other regeneration practices, or land use changes leading to brushy tangles and briars. The area may persist in a shrubby state or progress toward a new stand of young timber.

Clearcut with stump sprouts and seedlings, Monroe Co., Indiana
© Lenny Farlee/Purdue University

Clearcutting is a method of regenerating an even-aged stand in which a new age class develops in a fully exposed microclimate after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, sprouts, and/or advance reproduction. Clearcuts are areas larger than two acres and would logically be managed as separate stands following treatment. Large openings are for management purposes other than regeneration of a new stand of trees, although that may be an outcome of the practice. In the clearcutting system, the management unit or stand in which regeneration, growth, and yield are regulated consists of the individual clearcut stand.

Note: *reserves can be used in any regeneration system where live or dead trees are left standing, individually or in groups, to meet management objectives other than regeneration. Consider carefully how reserves may impact regeneration goals. Terminology used here would be "clearcutting with reserves".*

Things to Consider

- A clearcut is typically greater than 2 acres in size. If smaller than 2 acres use the term "group selection" for uneven-aged systems or otherwise call it a "small opening".
- The structure created by these practices will be ephemeral. Birds such as **Yellow-breasted Chat** will peak early but decline rapidly and eventually disappear as the site moves toward the stand exclusion phase.
- Post-fledging and post-nesting habitats can be very different from breeding habitat for some species. In one study, **Worm-eating Warblers** were one of the most often captured birds in clearcuts following nesting and fledging. Scarlet Tanagers, Red-eyed Vireos, and **Cerulean Warblers** otherwise thought of as mature forest birds will also use these sites.
- Create dead snags from a number of unharvested trees rather than having them felled to the ground.
- Though not common, a "clearcut with reserves" leaves some large trees scattered sparsely (<15 ft^2 of basal area per acre) throughout an area otherwise completely clearcut. The appearance will be more akin to a seed tree harvest though the purpose of the action is not to produce seed from the remaining trees but to create structure that will be used by a greater number of songbirds. If possible, retain some larger oaks in the harvested area.
- Young hardwood tree plantings will attract shrubland and open forest songbirds such as **Yellow-breasted Chats** and **Eastern Towhees**.
- Within tree plantings, small groups or clusters of trees will fail to grow or compete due to subtle changes in soils, topography, and water availability. Embrace these openings within a tree plantation as an opportunity to add diversity of structure to a tree plantation. Control non-native invasive plants, but allow native grasses, forbs and shrubs to take over those areas.

Cited Research regarding Reforestation, Thickets, and Clearcuts

Kelley, James R. Jr.; Williamson, Scot; and Cooper, Thomas R., "American Woodcock Conservation Plan: A Summary of and Recommendations for Woodcock Conservation in North America" (2008). US Fish & Wildlife Publications. 430. https://digitalcommons.unl.edu/usfwspubs/430

"Proper habitat management for **woodcock** involves careful consideration of the juxtaposition of various covers that serve different purposes. For example, clearings (more than 0.5 acre [more than 0.2 hectare]) provide singing ground for males. But, it is critical that such clearings be placed near suitable nesting and brood-rearing cover consisting of young, second-growth hardwoods. Creating feeding covers of dense shrubs and stands of young hardwoods on moist, rich soil is also important. Finally, nocturnal roosting areas consisting of old fields or of recently harvested woodland of at least 3 to 5 acres (1.2 to 2.0 hectares) should be located within 0.5 mile (0.8 km) of suitable feeding cover. Active forest-management programs in hardwood and mixed-hardwood forests can provide all of these necessary components."

Delancey CD, Islam K. 2019. Post-fledging habitat use in a declining songbird. *PeerJ* 7:e7358 https://doi.org/10.7717/peerj.7358.

"We found that fledgling habitat differed from other habitats that **Cerulean Warblers** utilize during the breeding season. Clearcuts or smaller patch-cuts near breeding sites can also benefit **Cerulean Warblers** in the post-fledging period as areas with plentiful food and protection from predators."

Perry, Roger W.; Thill, Ronald E. 2013. Long-term responses of disturbance-associated birds after different timber harvests. *Forest Ecology and Management* 307:274–283. https://doi.org/10.1016/j.foreco.2013.07.026

[**Yellow-breasted Chat**]: "In years 3 and 5 after harvest, clearcut and shelterwood stands had significantly greater detection rates than control or group-selection stands, and detection rates were significantly greater in clearcuts than other treatments in years 8 and 12 after harvest."

Porneluzi, P. A., Brito-Aguilar, R., Clawson, R. L., & Faaborg, J. (2014). Long-term dynamics of bird use of clearcuts in post-fledging period. *The Wilson Journal of Ornithology*, 126(4), 623-634. https://doi.org/10.1676/14-002.1

"As a group, early succession species' use of regenerating clearcuts peaked in year 3 after harvest and then steadily declined."

"The five early succession species that showed a pattern of early peak followed by decline (Blue-winged Warblers, Indigo Buntings, Prairie Warblers, White-eyed Vireos, and **Yellow-breasted Chats**) generally nest on the ground or in low shrubs. The two early succession species that showed a gradual increase to a later peak in year 7–9 (**Hooded Warblers** and Northern Cardinals) nest in low shrubs and small trees."

"Capture rates suggest that large numbers of birds use clearcuts in the decade after the clearcuts are formed. The abundance of forest-breeding birds in clearcuts in late summer equals or even exceeds the abundance of clearcut-breeding birds found there. This suggests that clearcuts may be an important habitat for mature forest breeding birds after they breed in mature habitats."

Stoleson, S.H. Condition Varies with Habitat Choice in Postbreeding Forest Birds, *The Auk*, Volume 130, Issue 3, 1 July 2013, Pages 417–428, https://doi.org/10.1525/auk.2013.12214

"My results and those of previous studies on postbreeding habitat use indicate that many mature forest birds use two different habitat types on their summering grounds, one for breeding and another for postbreeding. This dichotomy creates an "interesting conservation dilemma" (Vitz and Rodewald 2006), in that clearcutting may reduce the area or quality of mature-forest breeding habitat, yet may provide critical habitat and resources for adult and young birds after breeding. Some have suggested that within extensively forested landscapes, the presence of regenerating clearcuts may increase the suitability of habitat for some forest interior birds; declines in such species may be due in part to the increasing maturity and homogenization of forests (e.g., Ahlering and Faaborg 2006)."

"My results and those of prior studies provide strong evidence that these anthropogenically created early-successional habitats are used heavily by many forest birds after breeding. Birds may use these relatively novel habitats readily because they probably differ little in plant species composition and structure from early-successional habitats created by natural disturbances such as windstorms, ice storms, and fire. In addition, the alternative postbreeding habitat of dense forest understory (e.g., Vitz and Rodewald 2010) has become sparse in many areas, primarily because of overbrowsing by deer (McShea and Rappole 1997, Rooney et al. 2004, Holt et al. 2011)."

Thompson, Frank R. III; Fritzell, Erik K. 1990. Bird densities and diversity in clearcut and mature oak-hickory forest. Research Paper NC-293. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station https://www.nrs.fs.usda.gov/pubs/rp/rp_nc293.pdf.

"Northern cardinals, Kentucky warblers, indigo buntings, **rufous-sided towhees**, **yellow-breasted chats**, and blue-winged warblers . . . occurred at high densities in the 3-year-old clearcut stands."

"Total bird density was nearly two times greater in clearcuts than in mature forest."

"Although clearcut stands had lower species diversity (alpha diversity) than the mature forest, they provided habitat for a group of early successional birds that were previously absent or limited to a few, naturally occurring canopy breaks."

Black Oak crop tree, Crawford Co., Indiana. © Allen Pursell/Sam Shine Foundation

Crop Tree Release and Forest Stand Improvement (FSI)

- Wood Thrush
- Hooded Warbler
- Cerulean Warbler
- Yellow-billed Cuckoo
- Red-headed Woodpecker

Definition

Crop Tree Release is an intermediate treatment creating space around the crowns of designated trees that are typically determined to be better to retain and grow based on species, quality, form, and wildlife benefits. General guidelines for crop tree release involves harvesting or killing all trees whose crowns touch the crown of the crop tree on four sides (three sides if adjacent to another crop tree) and leave additional space for large crown development of mast crop trees.

Forest Stand Improvement is the manipulation of species composition, stand structure, or stand density by cutting or killing selected trees or understory vegetation to achieve desired forest conditions or obtain ecosystem services.

Things to Consider

- While there is often merit in controlling grapevines there is also value to intentionally leaving some, especially in mature stands. **Cerulean warblers** are known to use grapevines for shelter and as material for constructing nests.
- Crop trees should have greater than 15 feet of space on all treated sides. The crop trees to release should be determined by the landowners' objectives and the structural needs of the bird species being managed. Target releasing 20-75 trees per acre depending on the size and age of crop trees.
- If Crop Tree Release is carried out non-commercially through Forest Stand Improvement a great number of snags can be created.
- Dominant trees may not show an increased growth rate from crop-tree release due to their superior canopy position providing an already bountiful amount of sunlight. However, it may make such trees more resistant to severe drought if the release results in decreased demand for below-ground competition for water.

Cited Research regarding Crop Tree Release and FSI

Delancey, Clayton D., and Kamal Islam. "Post-fledging habitat use in a declining songbird." *PeerJ* 7 (2019): e7358. https://peerj.com/articles/7358/

"Although **Cerulean Warblers** rely on grapevine, which is usually considered to grow best in even-aged forest stands and known to reduce timber quality, growth of grapevines should be encouraged to benefit Cerulean Warblers. Grapevine is vital for nesting Cerulean Warblers, as it is for fledglings as cover. Riparian corridors should be protected to allow for greater development of canopy cover for Cerulean Warbler fledglings."

Nickley, Benjamin, and Lesley P. Bulluck. "Red-headed Woodpecker (*Melanerpes erythrocephalus*) winter roost-site selection in a burned forest stand." *The Wilson Journal of Ornithology* 131, no. 4 (2019): 774-788. https://doi.org/10.1676/1559-4491-131.4.774

"**Red-headed Woodpeckers** are nomadic and responsive to resource pulses, be it snags generated from fire or girdling (Kilgo and Vukovich 2014), or a bumper crop of acorns or beechnuts (Smith and Scarlett 1987)."

For additional information on Crop Tree Release implementation refer to:

Miller, Gary W., Jeffrey W. Stringer, David C. Mercker. 2007. Technical guide to crop tree release in hardwood forests. Southern Regional Extension Forestry SREF-FM-011. https://www.fs.usda.gov/treesearch/pubs/14228

FSI, Monroe, Co, Indiana (c) Ron Rathfon/Purdue University

Intentionally created red maple snag that later became a verified Indiana bat maternal roost tree, Brown Co., Indiana. © Chris Neggers/The Nature Conservancy

Snags and Den Trees

- Eastern Screech Owl
- Red-headed Woodpecker

Definition

Snags and Den Trees can be favored by silvicultural treatments that produce or retain standing dead and damaged trees or existing den trees on the stand. This can include regeneration treatments with reserves, or intermediate treatments like Timber or Forest Stand Improvement and thinning that creates standing dead trees. Crop Tree Release can be used to select and favor retention of live den trees as part of the stand and creates snags in the process of releasing crop trees from competition.

Things to Consider

- Landowners with very small, wooded acreage (<1 acre) can contribute to bird conservation by creating even a small number of snags over time.
- Include snags in timber inventories. Determine if snags from various size classes are missing. Tracts should contain snags across all size classes and include large snags over 20 inches DBH. A minimum of 8-10 snags/den trees, spread across size classes and 5 downed logs 12 inches or greater in diameter at the largest end, per acre will meet the needs of many birds, reptiles, small mammals, and amphibians (from USDA NRCS Conservation Enhancement Activity E666O, 2020).
- The benefits of live den trees are often overlooked in the forest management process. Retention of damaged trees with cavities and hollow trees provides many benefits to birds and other wildlife, and will persist in the stand longer than girdled trees.
- Snags are another ephemeral resource for wildlife. When possible, consider slowly extending this treatment across the managed area in periodic treatments to ensure presence and variability of this important feature over time.

Large American beech snag several years after girdling. Crawford Co., Indiana. © Allen Pursell/Sam Shine Foundation

- Chainsaw girdles that are excessively deep might ensure quick death of the tree, but greatly reduce the longevity of the snag. Alternate methods of tree deadening such as basal bark applied herbicide, hack and squirt, or stem injection can provide more durable snags.
- Avoid creating snags which could pose threats to the human environment such as roads, trails, powerlines, and structures.

Cited Research regarding Snags and Den Trees

Belthoff, James R., and Gary Ritchison. "Nest-site selection by Eastern Screech-Owls in central Kentucky." *The Condor* 92, no. 4 (1990): 982-990. https://doi.org/10.1093/auk/107.3.567

"Eastern Screech-Owls (Otus asio) are small, nocturnal owls found throughout much of the eastern United States. Like other secondary cavity nesting species, they cannot excavate their own cavities and are limited to either natural tree cavities or old woodpecker holes."

"Our results suggest that Eastern Screech-Owls in central Kentucky are selective in their use of nest cavities. Important features include cavity depth and, to a lesser degree, cavity height and entrance size. Nest-site vegetation parameters did not appear to be important. If, as suggested by some authors (Mengel 1965, Bull 1974, Tate 1981), Eastern Screech-Owl populations are declining, a shortage of suitable nest cavities may be one contributing factor."

Belthoff, James R., and Gary Ritchison. "Roosting behavior of postfledging eastern screech-owls." *The Auk* 107, no. 3 (1990): 567-579. https://doi.org/10.1093/auk/107.3.567

"We located 1,107 **screech-owl** roost sites in 39 species of trees, shrubs, and vines. Nearly half (47.8%) were in eastern red cedar (*Juniperus virginiana*), shagbark hickory (*Carya ovata*), black locust (*Robinia pseudoacacia*), and black walnut (*Juglans nigra*). Owls used open limb roosts (46.4%), tangle roosts (36.2%), and conifer roosts (17.4%)."

"**Eastern Screech-Owls** typically selected roost sites that provided concealment. Trees frequently used for roosting were often those with dense foliage. In contrast, available trees rarely or never used for roosting appeared to provide little cover. Tangles (vines) also provided cover and were frequently used for roosting. In addition to concealing birds from potential predators, the dense cover of most roost sites probably provided favorable microclimates (e.g. shade and shelter from precipitation)."

"**Eastern Screech-Owls** in Kentucky frequently roost in tree cavities during the autumn and winter. The increased use of cavities during the autumn and winter in part reflects changes in the amount of cover (VanCamp and Henny 1975). Cavities may also provide a more favorable microclimate (McComb and Noble 1981, Smith et al. 1987) and, therefore, even those trees that provide cover throughout the year (e.g., eastern red cedar) are rarely used during late autumn and winter (pers. obs.)."

"Reduced cover from leaf fall during the autumn

months plus the use of favorable microclimates during cold winter months probably limits the number of suitable roost sites available to **screech-owls** during winter. This could lead to the repeated use of especially favorable sites (e.g., certain cavities)."

Nickley, Benjamin, and Lesley P. Bulluck. "Spanning the habitat gradient: Red-headed woodpecker nest-site selection in three distinct cover types." *Forest Ecology and Management* 444 (2019): 115-126. https://doi.org/10.1016/j.foreco.2019.04.048.

"Managers charged with promoting **red-headed woodpecker** populations would do well to manage for large, partially decayed snags while also considering context-specific habitat needs."

"We also found a single variable, medium/large snag density, was highly influential in models for all cover types at the patch scale, indicating the importance of suitable snags for nesting, irrespective of cover type. Models at the tree scale showed similar results for all cover types: **red-headed woodpeckers** consistently preferred large snags with less bark."

Nickley, Benjamin, and Lesley P. Bulluck. "Red-headed Woodpecker (Melanerpes erythrocephalus) winter roost-site selection in a burned forest stand." *The Wilson Journal of Ornithology* 131, no. 4 (2019): 774-788. https://doi.org/10.1676/1559-4491-131.4.774

"The roost trees selected by **Red-headed Woodpeckers** in this study were almost exclusively snags: of the 42 roosts we found, only one was in a living tree."

"Beyond functioning as potential roost sites, snags also act as substrates for storing mast (Hay 1887). **Red-headed Woodpeckers** are hoarders, collecting acorns and beech nuts in the fall, depositing them centrally near their roost, then redistributing them among various cache sites within their territories (Kilham 1983, Doherty et al. 1996)."

Fire ignition in mixed oak stand, Brown Co., Indiana. © Chris Neggers/The Nature Conservancy

Prescribed Fire

- Eastern Whip-poor-will
- Eastern Screech Owl
- Eastern Towhee
- Red-headed Woodpecker
- Yellow-breasted Chat

Definition

Prescribed fire is a management tool that can be integrated into many silvicultural systems to assist with regeneration, intermediate treatments, or meet other management objectives. Prescribed fire may be useful to influence stand structure, regeneration, and species composition, particularly in the understory and mid-story layers of stands.

Things to Consider

- Fire beneficial to declining songbirds must be a multi-year, multi-fire commitment to have the desired outcome on ground-level and mid-story composition and structure. Initially, the fire-return interval may need to be brief to have a significant effect. According to Guyette et al. (2006) fire frequencies averaged =<12 years for much of the eastern United States based on fire scars and more frequent low-intensity fires occurred that did not scar trees
- Eastern Whip-poor-will has been shown to respond positively to increasing amounts of fire.
- Like all management decisions using fire presents a trade-off, especially to ground-nesting birds. But, depending on fire interval the impact may be relatively short-lived and ground-nesting birds may return within a few years.
- Prescribed fire with varied intensities across the burn unit is desirable. This variation with unburned areas might look "unfinished", but the microrefugia and interspersed habitat differences are valuable.

First Stage Shelterwood and mid-story thinning followed by fire, Brown Co., Indiana © Lenny Farlee/Purdue University

Cited Research regarding Prescribed Fire

Artman, Vanessa L., Elaine K. Sutherland, and Jerry F. Downhower. "Prescribed burning to restore mixed-oak communities in southern Ohio: effects on breeding-bird populations." *Conservation Biology* 15, no. 5 (2001): 1423-1434. https://doi.org/10.1111/j.1523-1739.2001.00181.x

"We studied the effects of repeated burning (1–4 years of annual burning) and recovery (1 year after burning) on the breeding bird community. Burning resulted in incremental but temporary reductions in the availability of leaf litter, shrubs, and saplings, but it did not affect trees, snags, or understory vegetation cover. Of 30 bird species monitored, 4 were affected negatively and 2 were affected positively by burning. Population densities of Ovenbirds (*Seiurus aurocapillus*), **Worm-eating Warblers** (*Helmitheros vermivorus*), and **Hooded Warblers** (*Wilsonia citrina*) declined incrementally in response to repeated burning and did not recover within 1 year after burning, suggesting a lag time in response to the changes in habitat conditions. In general, burning resulted in short-term reductions in the suitability of habitat for ground- and low-shrub-nesting birds, but it improved habitat for ground- and aerial-foraging birds."

"Ovenbirds were not eliminated from burned areas but continued to occur at low densities even after 4 successive years of burning."

"Overall, we observed no changes in the composition of the breeding bird community: no species was eliminated or added as a result of prescribed burning."

Brawn, Jeffrey D. "Effects of restoring oak savannas on bird communities and populations." *Conservation Biology* 20, no. 2 (2006): 460-469. https://doi.org/10.1111/j.1523-1739.2006.00310.x

"Efforts to restore and maintain oak savannas in North America, with emphasis on the use of prescribed fire, have become common. Little is known, however, about how restoration affects animal populations, especially those of birds. I compared the breeding densities, community structure, and reproductive success of birds in oak savannas maintained by prescribed fire (12 sites) with those in closed-canopy forests (13 sites). All sampling was conducted in Illinois (U.S.A.). Of the 31 bird species analyzed, 12 were more common in savannas, 14 were not affected by habitat structure, and 5 were more common in forest habitat. The species favored by disturbance and restoration included Northern Bobwhites (*Colinus virginianus*), Mourning Doves (*Zenaida macroura*), **Red-headed Woodpeckers** (*Melanerpes erythrocephalus*), Indigo Buntings (*Passerina cyanea*), and **Baltimore Orioles** (*Icterus galbula*)."

Hanberry, Brice B.; Thompson, Frank R. 2019. Open forest management for early successional birds. Wildlife Society Bulletin. https://doi.org/10.1002/wsb.957.

"For example, oak and pine–oak woodland management in Missouri and Arkansas, USA, benefits many early successional birds (Reidy et al. 2014, Roach 2016). Abundance of field sparrow (*Spizella pusilla*), blue-winged warbler, **eastern towhee**, prairie warbler, white-eyed vireo, and **yellow-breasted chat** is positively related to management practices (prescribed fire, tree thinning) or the resulting vegetation structure (reduced canopy cover, tree density). Although abundance of most of these species was negatively related to canopy closure, abundances were still relatively high (0.1–0.4 males/ha) at 60% canopy cover. We believe this is because the combination of thinning and prescribed fire maintained moderate canopy cover, but virtually no midstory, a variable understory, and abundant ground cover."

Harper, C.A., Ford, W.M., Lashley, M.A. et al. Fire Effects on Wildlife in the Central Hardwoods and Appalachian Regions, USA. *fire ecol* 12, 127–159 (2016). https://doi.org/10.4996/fireecology.1202127

"Birds that favor more open-canopy, woodland structure (e.g., **yellow billed cuckoo**, **red-headed woodpecker**, eastern wood-pewee, least flycatcher, great-crested flycatcher, eastern kingbird, pine warbler, summer tanager, and orchard oriole) benefit from both dormant- and growing-season fire. A fire return interval within 6 yr to 7 yr will be necessary on most sites to retain desirable structure for these birds. All of these species nest either in cavities or at least 3 m to 6 m aboveground. Burning openings with considerable shrub cover on a 6 yr to 7 yr return interval can be used to maintain habitat for songbirds that require such structure (e.g., white-eyed vireo, gray catbird, brown thrasher, yellow warbler, chestnut-sided warbler, common yellowthroat, and **yellow-breasted chat**). Late growing season fire may be useful when some reduction in woody stem density is desired."

"... based on our experience and review of the literature, we contend that burning during any season and within a relatively wide range of fire intensity is better than not burning at all for species that require fire to maintain or enhance their habitat"

"Habitat for various forest songbirds (e.g., black-and-white warbler, **worm-eating warbler**, Kentucky warbler, **hooded warbler**, and **eastern towhee**) that require a developed understory for nesting and foraging can be maintained with low-intensity fire on a 5 yr to 7 yr return interval. Burning outside late April to July will not disturb nesting, which should not limit burning hardwood systems in the Central Hardwoods and Appalachians because burn days during that time are relatively rare. Burning closed-canopy forests is unlikely to improve conditions for these birds unless the fire is intense enough to kill some overstory trees. Stands should have a broken canopy, allowing at least 20% sunlight to the forest floor or sufficient structure may not develop (McCord et al, 2014)."

Thompson, Frank R.; Roach, Melissa C.; Bonnot, Thomas W. 2022. Woodland restoration and forest structure affect nightjar abundance in the Ozark Highlands. *The Journal of Wildlife Management*. 86(2): e22170. 15 p. https://doi.org/10.1002/jwmg.22170. (PDF also available at www.fs.usda.gov/nrs/pubs/jrnl/2022/nrs_2022_thompson_001.pdf)

"**Eastern whip-poor-will** abundance was negatively related to hardwood basal area and canopy cover, positively related to percent forest cover and percent

of area burned, and peaked at low to moderate levels of percent of area thinned."

"We concur with others who suggest **eastern whip-poor-will** is a disturbance-dependent species . . .."

"Some combination of tree cover with open to dense understory, low to moderate tree density and canopy cover, and openings in the landscape seem to be important structural components for breeding habitat. This structure likely facilitates penetration of the canopy by moonlight, the location and capture of prey (English et al. 2017, Spiller and King 2021), and perhaps increased food resources for their insect prey. Disturbance is required to prevent the succession and densification of these open forests and redevelopment of the midstory."

Ovenbirds (*Seiurus aurocapillus*) exhibit the most negative response to nesting where there has been recent canopy removal. This does not imply they are absent from areas that have been harvested, especially when the harvest is light, but that they have significantly greater abundances in stands with high hardwood basal areas. Overall, the range-wide population change for ovenbirds was 0% between 1970 and 2014 (Rosenberg, et al. 2019). As hardwood forests have trended toward maturity across the region ovenbird populations may have been buffered from the simultaneous population declines incurred by many otherwise disturbance-dependent forest birds.

Studies on this subject have not always produced uniform findings but Acadian Flycatcher, Scarlet Tanager, **Worm-eating Warbler**, and red-eyed vireo may also be sensitive during nesting season to a reduction in basal area or changes in forest structure. Furthermore, while **Cerulean Warblers** tend to benefit from more than one silvicultural practice, the Appalachian Mountains Joint Venture cautions,

"Where cerulean densities are high (>5 territories/ 20 acres), habitat management is not likely to be needed. (Wood, 2016)."

Meier, A. R., Pizzo, A., Malloy, M., Riegel, J. K., & Dunning Jr, J. B. (2015). Breeding Birds and Forest Management: the Hardwood Ecosystem Experiment and the Central Hardwoods Region. *Department of Forestry and Natural Resources, Purdue University, Purdue Extension FNR-501-W*, 1-888. https://extension.purdue.edu/extmedia/FNR/FNR-501-W.pdf

"In general, relative to unharvested areas, populations of mature forest birds were not negatively impacted by uneven-aged management such as single-tree or group selection, and some species responded positively. In landscapes that included even-aged harvests, some mature forest species increased in abundance during the breeding season, others decreased, and others stayed the same. Though many species appeared to strictly use mature forest habitat for nesting, a few studies noted that a large proportion of mature forest species also utilize harvested areas, especially uneven-aged treatment areas."

Perry, R. W., Jenkins, J. M., Thill, R. E., & Thompson III, F. R. (2018). Long-term effects of different forest regeneration methods on mature forest birds. Forest Ecology and Management, 408, 183-194. https://doi.org/10.1016/j.foreco.2017.10.051

"Ovenbird (*Seiurus aurocapill*a) and scarlet tanager (*Piranga olivacea*) responded negatively to all timber harvests; ovenbird appeared to be particularly susceptible to timber harvest, especially more intensive harvests such as clearcut and shelterwood. A variety of regeneration methods, including some more intensive treatments, along with maintenance of mature forest stands that retain well-developed midstories can be used to maintain the full suite of forest birds."

Robinson, W. D., & Robinson, S. K. (1999). Effects of selective logging on forest bird populations in a fragmented landscape. *Conservation biology*, 13(1), 58-66. https://doi.org/10.1046/j.1523-1739.1999.97226.x

"Openings of 0.02–0.4 ha were created by group and single-tree selection logging within a 2000-ha tract of forest. Most species of forest birds were not significantly less common in logged tracts. Only Red-eyed Vireos (*Vireo olivaceus*) and Ovenbirds (*Seiurus aurocapillus*) were significantly more numerous in uncut forest, but the vireo responded negatively to cuts at sites on ridges only, not in ravines . . .."

Silvicultural activities can result in an enhanced risk for cowbird nest parasitism. This risk is not uniform and is determined in part by the size and relative isolation of the forested tract being treated, the extent of forest area found in the larger landscape, the degree to which agricultural lands are intermixed with the forested areas, and time elapsed since disturbance. Songbirds nesting in young stands established through reforestation will also experience cowbird parasitism, thus it is important to weigh the risks and acknowledge a trade-off between the benefits of creating habitat for early-successional birds and the risk that some nests will be parasitized.

Cited Research regarding Brown-headed Cowbirds

Meier, A. R., Pizzo, A., Malloy, M., Riegel, J. K., & Dunning Jr, J. B. (2015). Breeding Birds and Forest Management: the Hardwood Ecosystem Experiment and the Central Hardwoods Region. *Department of Forestry and Natural Resources, Purdue University, Purdue Extension FNR-501-W*, 1-888. https://extension.purdue.edu/extmedia/FNR/FNR-501-W.pdf

"The brown-headed cowbird is considered an early successional species because it requires open, disturbed ground in which to forage. Cowbirds are nest parasites; they do not build their own nests but instead lay their eggs in the nests of other species. The parent birds that end up with the cowbird eggs (called hosts) are often forest species, which then usually do very poorly in raising their own young. Increased cowbird parasitism of the nests of mature forest bird species is often cited as a problem associated with creating large openings in forested areas even though cowbirds frequently parasitize host species from both the early successional and mature forest guilds. It was noteworthy, therefore, that numbers of brown-headed cowbirds did not increase across the HEE treatments and that large cowbird numbers were not associated with clearcuts or patch cuts in particular. The data collected on the HEE project prior to the harvests showed that cowbirds were already common throughout the forests that were sampled. It is important to emphasize that cowbird use of forest openings is dependent on the character of the surrounding landscape; edges associated with small forest patches in a largely agricultural landscape tend to have more cowbirds than do edges and openings in contiguous forested landscapes."

Morris, Dana L., Paul A. Porneluzi, Janet Haslerig, Richard L. Clawson, and John Faaborg. "Results of 20 years of experimental forest management on breeding birds in Ozark forests of Missouri, USA." *Forest Ecology and Management* 310 (2013): 747-760. https://doi.org/10.1016/j.foreco.2013.09.020

"Brood parasitism rates remained low from pre-harvest to late post-harvest, but parasitism rates were higher for early-successional species (4%) than mature forest species (1%)."

Petit, Lisa J. and Petit, Daniel R.. "31. Brown-headed Cowbird Parasitism of Migratory Birds: Effects of Forest Area and Surrounding Landscape". *Ecology and Management of Cowbirds and Their Hosts: Studies in the Conservation of North American Passerine Birds*, edited by James N. M. Smith, Terry L. Cook, Stephen I. Rothstein, Scott K. Robinson and Spencer G. Sealy, New York, USA: University of Texas Press, 2021, pp. 265-270. https://doi.org/10.7560/777385-033

". . . in some species, individuals breeding in small forest fragments are more susceptible to cowbird parasitism than individuals occupying unbroken forest."

Robinson, Scott K., Hoover, Jeffrey P. and Herkert, James R.. "33. Cowbird Parasitism in a Fragmented Landscape: Effects of Tract Size, Habitat, and Abundance of Cowbirds and Hosts". *Ecology and Management of Cowbirds and Their Hosts: Studies in the Conservation of North American Passerine Birds*, edited by James N. M. Smith, Terry L. Cook, Stephen I. Rothstein, Scott K. Robinson and Spencer G. Sealy, New York, USA: University of Texas Press, 2021, pp. 280-297. https://doi.org/10.7560/777385-035

"The best way to reduce parasitism levels may be to increase host populations through landscape-level management practices. Managers in Illinois, for example, should strive to create and/or protect contiguous forest tracts of 200 ha or greater. Restoration efforts should work outward from existing tracts, especially when they involve conversion of nearby pastures to forest habitat."

"Forest-dwelling neotropical migrants appear to be the group of species most vulnerable to cowbird parasitism, which partially justifies the level of conservation concern this group of species has attracted."

Some of the management activities described for birds will create or maintain habitat for bats as well. Prescribed fire, shelterwood management, snag creation, and group selection have all been documented as having a positive effect on bats, though the response to a particular forestry technique is often determined by the species of bat. Not unlike birds, bats have specific habitat preferences.

The US Fish and Wildlife Service Indiana Field Office publication, "Forest Management Guidelines for Avoiding Incidental Take of Indiana Bats and Northern Long-eared Bats within the State of Indiana", is available here and should be consulted for further information. **https://www.fws.gov/sites/default/files/documents/INFO%20Forest%20Management%20Guidelines%2023%20May%202019.pdf**

Caldwell, Katherine L., Timothy C. Carter, and Jason C. Doll. "A comparison of bat activity in a managed central hardwood forest." *The American Midland Naturalist* 181, no. 2 (2019): 225-244. https://doi.org/10.1674/0003-0031-181.2.225

"Based on identification of acoustic calls, eastern red bats and hoary bats were more active in harvest treatments than control treatments. Big brown, eastern red, and tri-colored bats were most active at harvest edges. Northern long-eared and Indiana/little brown bats were most active at harvest edges and in adjacent forest and hoary bats were most active at harvest centers. Differences in bat activity across these managed forests suggest bat assemblages benefit from management that employs an array of silvicultural methods, provides edge habitat, and maintains adjacent forest stands."

Divoll, Timothy J., Stephen P. Aldrich, G. Scott Haulton, and Joy M. O'Keefe. "Endangered Myotis bats forage in regeneration openings in a managed forest." *Forest Ecology and Management* 503 (2022): 119757. https://doi.org/10.1016/j.foreco.2021.119757.

"*Myotis septentrionalis* space use averaged 176 ha and bats selected water, historic thinning, and patch cuts (≤4 ha) over other habitats, with all but one bat avoiding larger openings (≥4-ha clearcuts). *Myotis sodalis* space use averaged 343 ha and bats selected 4-ha patch cuts, historic openings, and historic thinning over other habitats. In contrast to *M. septentrionalis*, one-third of the *M. sodalis* foraged over larger clearcuts, while two-thirds foraged over smaller openings and thinnings. We showed that bats were attracted to small regeneration harvests of varying structural ages. Forests maintained for a mix of mature stands, thinned stands, shelterwoods, small regenerative cuts (<7 ha), and small water sources should provide suitable foraging habitat for these endangered Myotis species, while also promoting forest regeneration."

Michael J. Lacki, Daniel R. Cox, Luke E. Dodd, Matthew B. Dickinson, Response of Northern Bats (Myotis septentrionalis) to Prescribed Fires in Eastern Kentucky Forests, Journal of Mammalogy, Volume 90, Issue 5, 15 October 2009, Pages 1165–1175, https://doi.org/10.1644/08-MAMM-A-349.1

[Northern Long-eared Bat]: "Examination of our data shows that females preferentially chose roost trees in burned compared to unburned habitats, similar to evening bats in Missouri, which used snags in burned stands more frequently than in unburned stands (Boyles and Aubrey 2006)."

"We believe female northern bats exhibit behaviors consistent with being fire-tolerant as they foraged and roosted extensively in burned habitats after prescribed burning."

Titchenell, Marne A., Roger A. Williams, and Stanley D. Gehrt. "Bat response to shelterwood harvests and forest structure in oak-hickory forests." *Forest Ecology and Management* 262, no. 6 (2011): 980-988. https://doi.org/10.1016/j.foreco.2011.05.032.

"Overall bat activity did not differ significantly between shelterwood harvest levels, but was significantly different between harvested and control sites, with more passes detected within the harvested sites. *Lasiurus borealis* (red bat), *Eptesicus fuscus* (big brown bat), and *Lasionycteris noctivagans* (silver-haired bat) activity was significantly greater in harvested versus control sites, but did not differ between shelterwood harvest levels. *Myotis spp.* (*Myotis lucifugus* (little brown bat) and *Myotis septentrionalis* (northern Myotis)) and *Perimyotis subflavus* (tri-colored bat) activity did not vary between shelterwood harvest levels or between harvested and control sites."

"Our results suggest that shelterwood harvests provide quality foraging habitat for bats, particularly *L. borealis*, *E. fuscus*, and *L. noctivagans*. These species are likely responding to the decreased structural volume in the understory and mid-canopy, which allows for energy efficient foraging."

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For additional information the following resources are recommended:

Managing Forest Birds in Southeast Ohio: A Guide for Land Managers. https://obcinet.org/uploads/ForestManagement_web.pdf

Breeding Birds and Forest Management: the Hardwood Ecosystem Experiment and the Central Hardwoods Region. Purdue University Extension FNR-501-W https://extension.purdue.edu/extmedia/FNR/FNR-501-W.pdf

Management plans that seek to benefit native, breeding bird species such as the twelve presented here would benefit greatly from including plans for treatment and removal of invasive species. Resources about management of invasive species for landowners can be found at http://www.sicim.info.

Videos:

Hardwood Ecosystem Experiment, Managing Woodlands for Birds https://www.youtube.com/watch?v=ypWb2OU5Ezc&list=PLtXSf1tu3Jd_xCssHlIRPEhAGTx-Y5AMq&index=3

The Nature Conservancy in Indiana, Forestry for the Birds https://www.youtube.com/watch?v=M8BcRQoLPr0

	Thickets, Large Openings, Clearcuts	First-Stage Shelterwood	Single Tree Selection and Small Openings/ Group Selection	Snags and Den Trees	Crop Tree Release/ Forest Stand Improvement	Prescribed Fire
Yellow-billed and Black-billed Cuckoo			X		X	
Eastern Whip-poor-will	X	X				X
American Woodcock	X		X			
Eastern Screech Owl				X		X
Red-headed Woodpecker		X		X	X	X
Wood Thrush			X		X	
Eastern Towhee	X	X				X
Yellow-breasted Chat	X	X				
Baltimore Oriole		X				X
Worm-eating Warbler	X		X			
Hooded Warbler		X	X		X	
Cerulean Warbler		X			X	

The Nature Conservancy