



Guidelines for Managing American Marten Habitat in New York and Northern New England



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Introduction

Species profile

The American marten is a medium-sized member of the weasel family that inhabits large blocks of intermediate to old forest across northern North America. Its eastern range once extended south from Canada through the Appalachian states to West Virginia,¹ but now reaches only into northern New York and New England. In the West, martens continue to occur down the spine of the Sierra Nevada and Rocky Mountains into California and Colorado (Fig. 1).²

Martens in the northeastern United States utilize coniferous, deciduous, and mixed forests that feature an interconnected canopy reaching above 30 ft in height.

This canopy structure enables tree-to-tree movement and offers protection from predators.³ Resting and denning sites are also important for marten survival and may be supplied by large trees and snags, downed wood, and rocks.^{3,4} In addition to providing cover, near-ground structure makes it possible for martens to access prey hidden beneath the snowpack.⁵

Status and conservation concerns

Martens were extirpated from most of the Northeast by the early 20th century through a combination of forest clearing for agriculture and unregulated trapping. Contributing factors also included intensive logging, accidental fire, and conversion of most remaining woodlands to young age classes.⁶⁻⁸ Habitat loss and fragmentation are still principal causes of concern.⁹⁻¹¹



Figure 2. Martens are light enough to hunt on top of the snowpack and small enough to tunnel in search of prey. Their relatively large feet also help ensure high mobility in winter.

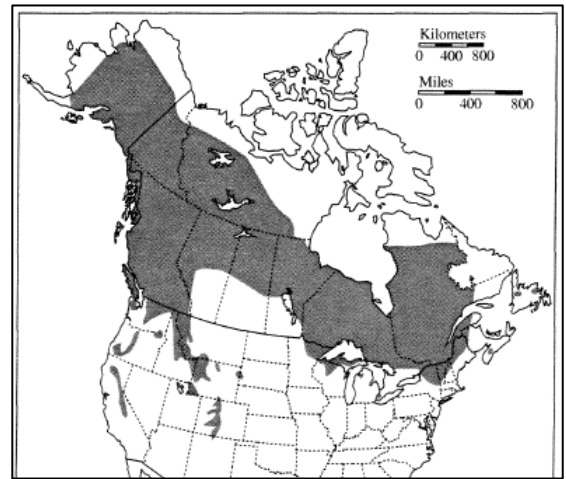


Figure 1. Range of American marten (from Powell et al. 2003).

Martens currently inhabit most of the Adirondacks, where forests are largely preserved,¹² and northern Maine, where the supply of habitat has been sharply reduced since 1970.¹³ The species is legally endangered in Vermont, occurring at low levels in the Northeastern Highlands and southern Green Mountains.¹¹ In New Hampshire, where a northern population appears to be expanding,¹⁴ it is expected to be down-listed from threatened to a species of special concern in 2017 (J. Kilborn, pers. comm.). Throughout the Northeast, martens occupy large home ranges, averaging 0.6 - 2.2 square miles or about 400-1,400 acres.^{12,15,16}

Incidence of marten varies with local and regional forest conditions,¹⁷⁻¹⁹ availability of food (primarily voles, mice, red squirrels, snowshoe hare, berries, and beech nuts),^{2,20,21} and the presence of fisher, a larger member of the weasel family that preys on and competes with marten.^{22,23}

Therefore, factors affecting the distribution of these mammals also influence marten. For example, high volumes of down wood²⁴ and autumn mast boost rodent populations,^{25,26} even as they enhance marten foraging opportunities in other ways. Deep snow also provides multiple benefits, offering martens cover for hunting subnivean prey while impairing the hunting efficiency of larger carnivores. Because martens are light and have relatively large feet, they are able to hunt on top of snow, as well as beneath it (Fig. 2).²² Reductions in snow depth or days of snow cover, which may result from changes in the Northeast's climate,²⁷ could curb these advantages and expose martens to greater energetic costs and predation risk.

Purpose of the guidelines

The purpose of this document is to promote stand- and landscape-level conditions that sustain American martens, as well as other native species that depend on American marten habitat. Managers of private and public lands can use the information to plan timber harvests, delineate ecological reserves, and coordinate activities across management units. The contents could also inform siting of transportation and energy infrastructure.

Where to Create and Sustain Habitat

Landscape characteristics

These guidelines apply to heavily forested regions of the US Northeast that are already occupied by marten, as well as adjacent areas that hold potential for colonizing populations. Appropriate settings for marten management and conservation span a wide range of elevations, from low basins to wooded ridgelines. Because of frequent disturbance and limited harvesting, riparian zones and mountain forests commonly contain valuable habitat elements, such as snags, stumps, downed wood, and exposed root masses (Fig. 3). In addition, topographically rugged areas often contain scattered boulders and rock piles, which provide permanent, ground-level structure for denning and subnivean access. Upper elevations (> 1,600 ft) appear to be especially important to marten along the southern edge of its range, from New York's Central Adirondacks through the Green and White Mountains to the Mahoosuc Range in Maine. This is likely due to higher snow accumulation in these areas compared to surrounding lands.¹²



Figure 3. Woody structure and dense growth near the forest floor boost prey abundance and increase opportunities for denning and subnivean access.

Martens in the Northeast typically avoid openings and regenerating forest, instead selecting pole-sized or larger stands with at least 30% canopy closure.^{3,16,18,28} Individuals occupying intensively harvested landscapes may experience an elevated risk of mortality due to reduced hunting success in young

forests²⁹ and increased energetic costs of long-distance movement among suitable habitat patches.³⁰ Therefore, prospects for marten conservation are greatest in landscapes that supply large blocks of intermediate to old forest and a matrix that enables movement among them. Landscapes with less than 60-70% of the area in suitable habitat have a low likelihood of supporting martens.³¹⁻³³ Above this threshold, probability of occupancy increases sharply with prevalence of suitable habitat (Fig. 4).³¹

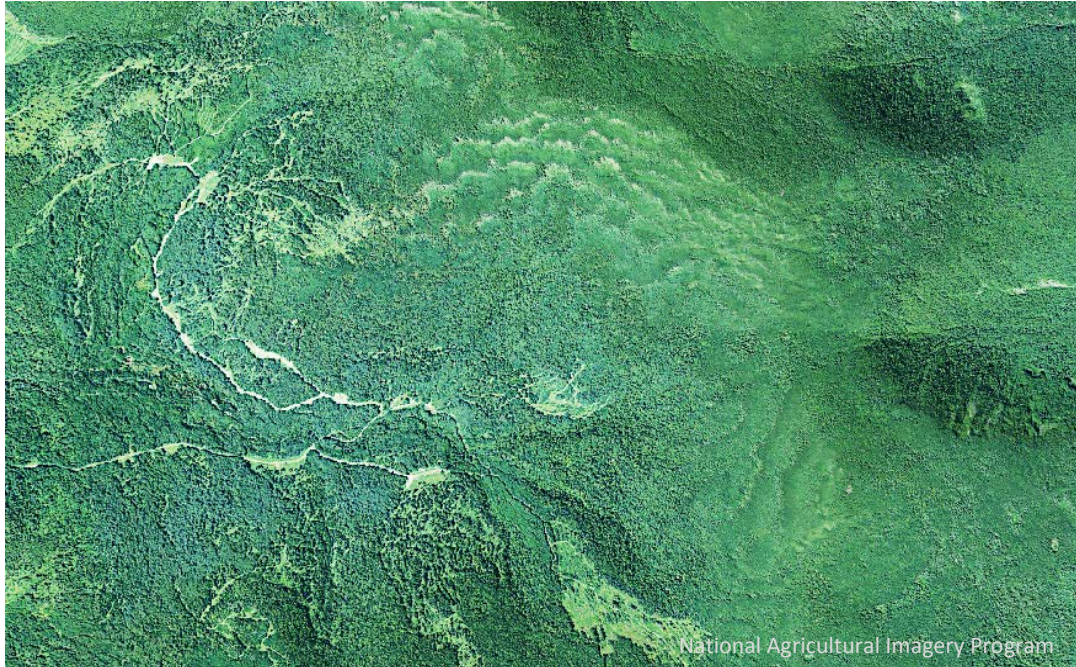


Figure 4. Landscapes with > 60-70% of the forest in intermediate to old age classes are most likely to support American marten.

Desired Habitat Conditions

Forest composition

American martens inhabit a variety of forest types, including northern hardwoods, eastern hemlock, red spruce-balsam fir, northern white cedar, and mixed coniferous-deciduous forests (Fig. 5).^{3,18,19,21,34} Although oak forests are uncommon in currently occupied areas of the Northeast, oaks provide high-quality habitat for martens in Michigan⁴ and appear to be shifting north in eastern forests.³⁵ In northern New Hampshire, martens preferentially select mixed-wood and coniferous landscapes during the leaf-off season, but shift toward mixed-wood and deciduous forest types in the spring.¹⁶ Mast-producing trees enhance habitat quality for martens and their prey. Some types of mast, including mountain ash berries and American beechnuts make up a significant portion of the marten diet when they are available.^{12,36}

Forest structure

- Canopy height: > 30 ft^{3,18}
- Canopy closure: > 30 % in all seasons^{3,18,37}
- Basal area of live trees and snags: > 80 ft²/acre^{3,18,28}
- Snag basal area: > 10 ft²/acre

- An uneven dispersion of large trees (> 16 in dbh) and snags (> 13 in dbh), creating patches with total basal area > 100 ft²/acre⁴
- Abundant boulders or rock piles,¹⁹ low branches, root masses, stumps, woody material, and/or downed logs > 9 in in diameter³

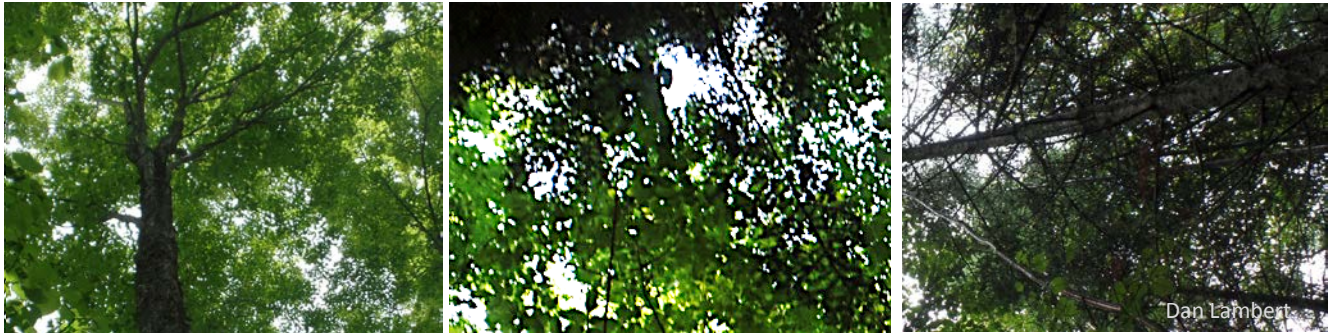


Figure 5. Martens utilize a variety of forest types provided that the canopy is at least 30 ft high.

Recommended Practices

Designing landscapes that support marten populations calls for an understanding of the regulatory and socio-economic context that is unique to each state. Likewise, methods to produce desired conditions at the stand scale must draw on local knowledge of forest dynamics. Nonetheless, some measures may consistently promote the landscape- and stand-level characteristics associated with high marten use.

Conservation and management planning

Large-scale planning is key to conserving and expanding marten populations in the northern forest's multi-functional landscape. We recommend that land stewards coordinate reserve and harvest plans across management units in order to provide a complex of mature to old forest cores, forests of mixed or intermediate age that conform to the desired conditions, and young forests that will mature into the desired conditions and replace recently harvested habitat. The following strategies may be used to realize this over-arching vision and safeguard against forest loss and fragmentation.

- Provide a continuous supply of stable or shifting marten habitat cores, each measuring > 1,250 acres. Simple shapes with large interiors are preferable to complex or narrow shapes.
- Within core areas, maintain at least 60% of the landscape in the desired condition for marten.
- Connect core areas with either permanent or shifting movement corridors that measure > 250 ft wide and conform to the desired conditions.
- When planning and connecting core areas, build on existing reserves (*e.g.*, inoperable areas and riparian zones), as well as areas where physical conditions naturally maintain horizontal and vertical complexity (*e.g.*, forested wetlands and mountainous terrain).
- Incorporate topographic features that channel animal movement into corridor design, such as ridgelines and mountain passes.
- When planning even-aged management, aggregate harvests to minimize habitat fragmentation.

- Minimize construction of roads and other permanent infrastructure to reduce habitat loss, fragmentation, and the risk of mortality associated with increased exposure to competing generalist species.¹⁹ Use temporary or seasonal roads, when necessary.
- In marten-occupied areas where development is permitted, measure baseline conditions, assess effects of new construction, and apply findings to mitigation and adaptive management.

Forest management

Strategies to conserve martens may incorporate a variety of forest management methods, provided that overall landscape objectives are met. The practices described here are presented in order of increasing harvest intensity. They range from small-scale and broadly applicable treatments to larger-scale techniques that should be applied with careful consideration of tradeoffs between habitat suitability and revenue from forest products.

- Utilize single-tree selection, small-group selection, irregular shelterwood systems, or variable retention harvesting in core habitat areas to maintain canopy characteristics above the thresholds required by marten (height > 30 ft, leaf-off closure > 30%, and basal area of trees and snags > 80 ft²/ac).
- Retain a small number of large-diameter trees (>16 in dbh) and snags (> 13 in dbh) during harvest operations as potential resting and denning sites. Martens utilize trees with large horizontal branches, multiple tops, and large nests for resting and scanning for prey. Trees with cavities provide both concealment and protection from the elements (Fig. 6). When feasible, maintain a treed buffer up to 50 ft around these retained features.⁴
- Where snag volume is low, retain or girdle medium to large, low-vigor trees.
- When conducting partial harvests in mixed stands, retain a sufficient number of conifers to ensure > 30% canopy closure during the leaf-off season.
- In mature forest landscapes, harvest trees in groups or patches (< 2.5 acres) to create or enhance pockets of cover and forage for snowshoe hare, an important winter prey species (Fig. 7).
- Leave a dispersion of mast-producing trees (*e.g.*, mountain ash, American beech, red spruce, and balsam fir).



Figure 6. Martens hide from predators, find shelter from the weather, and rear young in the cavities of dead or damaged trees.



Figure 7. Patches of young growth within a mature forest may increase abundance of an important winter prey species, snowshoe hare.

- In areas where even-aged management is planned, provide shifting connections among core habitat areas. The value of these connections may be enhanced through long rotations and large cutblock sizes. If appropriately configured, high-acreage clearcuts and shelterwood harvests can contribute to marten habitat targets after the regenerating forest reaches an intermediate stage of development.

Managing for Multiple Benefits

Associated species

Managing forests for marten in northern New England and New York could benefit other species of regional conservation concern that also depend on forests of intermediate to old age (Table 1, Fig. 8). This group includes area-sensitive species like scarlet tanager and black-throated blue warbler, as well as species adapted to natural disturbance, such as black-backed woodpecker, Bicknell’s thrush, and bay-breasted warbler. The southern red-backed vole and eastern red-backed salamander are among the more common vertebrate species that stand to gain from implementation of these guidelines. Both use down wood for protective cover and their combined biomass makes up a significant component of the northern forest food web.³⁸ Even the rare Canada lynx, which preys on snowshoe hare in young forests, benefits from retention of mature stands since they facilitate movement between hunting areas.³⁹

Ecosystem services

Large forest tracts are popular for recreational activities like hiking, camping, wildlife viewing, fishing hunting, and trapping. Management and conservation practices that maintain high forest cover support these culturally important pursuits and associated economic activity. In addition, forested landscapes contribute to the resilience of natural and human communities by controlling floods, supplying clean air and water, and storing carbon. Woodlands that span wide ranges of elevation and latitude are especially valuable during this era of climate change because they enable future migration of plant and animal species as well as the stable transformation of forest communities over time.

Table 1. A partial list of Species of Greatest Conservation Need that could benefit from implementation of these guidelines. Species of high regional concern are indicated in bold. Species co-occurrence varies across the region.

Species	Overlapping habitat(s)
Barred owl	Mixed forest
Bay-breasted warbler	Boreal coniferous forest
Bicknell’s thrush	Densely structured spruce-fir forest at upper elevations
Black-backed woodpecker	Boreal coniferous forest
Blackburnian warbler	Coniferous and mixed forests
Black-throated blue warbler	Deciduous forest
Black-throated green warbler	Coniferous and mixed forests
Blue-headed vireo	Coniferous and mixed forests
Brown creeper	Coniferous and mixed forests
Cape May warbler	Boreal coniferous forest
Scarlet tanager	Deciduous and mixed forests
Three-toed woodpecker	Boreal coniferous forest, especially following beetle infestation
Canada lynx	Coniferous forest
Southern flying squirrel	Deciduous and mixed forests with large trees and abundant snags
Southern red-backed vole	Coniferous, deciduous and mixed forests with abundant woody material



Figure 8. Southern flying squirrels, black-throated green warblers, and bay-breasted warblers could all benefit from management focused on conserving marten populations.

Comprehensive planning

Long-range, comprehensive planning that is focused on American marten could help maintain conditions for most of the northern forest's native species through a dynamic mosaic of cover types and age classes.⁴⁰ Wide-ranging and area-sensitive animals could benefit, in particular, from habitat stewardship that is coordinated across large ownerships. Although joint planning is not always feasible, past and ongoing collaborations in the focal region have demonstrated that dialogue among neighboring landowners can help accomplish shared conservation objectives. State biologists and foresters may be available to support coordination by providing technical knowledge or assistance in the development of easements, memoranda of understanding, and other tools for cooperative wildlife management.

Whether conducted within or across property lines, spatially explicit planning is key to conserving martens since their populations are largely shaped by coarse-scale factors such as forest maturity and overall extent.^{3,18} In recent decades, universities, natural resource agencies, and landowners throughout the region have worked together to quantify marten habitat needs, evaluate effects of management, and apply new knowledge to stewardship decisions. This adaptive approach is key to achieving marten conservation objectives in New York and northern New England.

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Field Guide to Managing American Marten Habitat

Companion to *Guidelines for Managing American Marten Habitat in New York and Northern New England*



The American marten is a medium-sized member of the weasel family with a range extending from Maine to California and north to the limit of tree line in arctic Canada and Alaska. Once common throughout New York and New England, it is now limited to remote, northern forests.

Status: Species of Greatest Conservation Need in NH, NY, and VT

Habitat: Large tracts of coniferous, deciduous, and mixed forests of intermediate to old age, especially where winter snowpack is deep

Home range: Varies with age, sex, season, habitat, and prey availability; averages 0.6-2.2 sq mi. Exclusive male home ranges overlap those of females.

Special Requirements: Complex forest floor with logs, down wood, and low branches providing cover for prey and subnivean access for hunting and escape from predators. Also, stumps, snags, root balls, or rocky terrain for denning.

Diet: Voles, mice, squirrels, snowshoe hare, ruffed grouse, berries and seeds

Associated species: Varies geographically and includes barred owl, bay-breasted warbler, Bicknell’s thrush, black-backed woodpecker, Blackburnian warbler, black-throated blue warbler, black-throated green warbler, blue-headed vireo, brown creeper, Cape May warbler, northern goshawk, ovenbird, pileated woodpecker, red-eyed vireo, scarlet tanager, three-toed woodpecker, northern and southern flying squirrels, red squirrel, and snowshoe hare.

Recommended forest management practices: When conducted in the appropriate context, some forestry practices can promote or maintain desired conditions for American marten and associated species. However, conservation benefits may be low in areas where suitable habitat occurs naturally. For more discussion of where to create and sustain habitat, consult the complete guidelines. The following table summarizes options for maintaining or creating the desired stand-level conditions.

Starting Condition	Objective	Management options	Desired condition
Sawtimber or all-aged stand (in an uneven-aged management scenario)	Simulate natural disturbance dynamics to maintain moderate to high canopy closure, snags, and down wood.	Single-tree selection Small-group selection Crop tree release Expanding-gap group shelterwood Variable retention harvesting Retention or girdling of medium to large, low-vigor trees	Canopy height: > 30 ft Leaf-off canopy closure: > 30% Basal area of live trees and snags: > 80 ft ² /acre Snag basal area: > 10 ft ² /acre
Sawtimber or all-aged stand (in an even-aged management scenario)	Stock future stands with large trees, snags, and woody material.	Retain residual trees and snags, including large stems	Patches of large trees (>16 in dbh) and snags (>13 in dbh) totaling >100 ft ² /acre
Pole-sized to sawtimber stand with low snag volume and/or low ground-level complexity	Increase the volume of snags and woody material for denning, subnivean access, and small mammal/prey cover	Retention or girdling of medium to large, low-vigor trees Felling and leaving small trees	Abundant root masses, logs, stumps, woody material, boulders, and/or low branches

Additional Considerations

- Leave a dispersion of mast-producing trees (mountain ash, American beech, red spruce, balsam fir).
- Retain softwood regeneration to enhance habitat for snowshoe hare and subnivean access to smaller prey.
- Configure clearcuts and shelterwood harvests in a way that contributes to targets for future marten habitat.

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Single-tree selection in the area to the left has maintained high canopy closure. Narrow transport paths minimize disturbance, while winter harvests and the use of forwarders limit compaction of woody material.



Even-aged harvests that reserve medium to large trees and snags will enhance future resting and denning opportunities for marten.



Large group or small patch cuts in predominantly mature forests can benefit marten by creating habitat for snowshoe hare, an important winter food source. Rodent prey, such as the southern red-backed vole, concentrate in areas with high levels of down wood. Because mountain ash berries and American bechnuts support both marten and rodent populations, mast-producing trees of these species should be retained when possible.



Guidelines for Managing Bicknell's Thrush Habitat in the United States



Guidelines for Managing Bicknell’s Thrush Habitat in the United States

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Introduction

Species profile

Bicknell's thrush is one of the most rare and range-restricted songbirds in the United States, breeding only at upper elevations in New York and northern New England.¹ Isolated patches of habitat extend along the Laurentian and northern Appalachian highlands into southeastern Canada and include a diminishing number of Atlantic coastal sites.²

Bicknell's thrushes typically nest in dense, low-canopy forests dominated by balsam fir, but they also breed in paper birch-balsam fir sapling stands following timber harvest or fire.^{3,4} Beginning in early October, adults and young migrate to the Greater Antilles, where most winter on the island of Hispaniola in high-elevation broadleaf forests of the Dominican Republic.^{5,6}

Bicknell's thrushes resemble other northeastern forest thrushes (Fig. 1), but can be readily distinguished by their unique songs and calls. They forage on the ground and in low vegetation for invertebrate prey and also consume fruits when they are available.^{6,7}

Status and conservation concerns

Bicknell's thrush is a Species of Greatest Conservation Need and a special concern species in New York, Vermont, New Hampshire, and Maine. Canada has designated it as threatened under the Species at Risk Act, while Partners In Flight considers it to be among the highest bird conservation priorities in North America. Concerns center on its small population size, limited breeding and wintering distributions, and continuing deforestation of non-breeding habitat, particularly on Hispaniola.^{8,9} Local extirpations in several states and provinces and severe declines in Nova Scotia have added a sense of urgency to conservation efforts.^{2,10,11}

A population decline observed in the White Mountains between 1993 and 2003¹² appears to have been followed by a period of recovery.¹³ Surveys from 2001 to 2010 found stable to increasing numbers across most of the northeastern US, except in the southern Green Mountains.¹⁴

As the climate warms, encroachment of northern hardwoods on high-elevation fir and spruce could eventually reduce the extent of Bicknell's thrush breeding habitat.¹⁵ However, such a change is likely to be slow and inconsistent due to the many factors that affect mountain ecotones.¹⁶ A more immediate risk may be an increase in aggression and competition from Swainson's thrush.^{17,18} This species, which is less tolerant of cold than Bicknell's thrush,¹⁹ has shifted upslope in recent years²⁰ and become more abundant in Bicknell's thrush habitat.¹⁴ It is not clear whether this shift will affect Bicknell's thrush populations.

Other potential stressors on the breeding grounds include mercury contamination²¹ and disruption of the balsam fir masting cycle, which could result in consistently higher rates of nest predation by red squirrels.²² By comparison, habitat removal and alteration could influence Bicknell's thrush populations more directly. Although most US breeding areas occur on conserved lands, recreational development, wind energy facilities and commercial timber management are permissible in some habitat units. Effects of these activities vary with the type and scale of disturbance as well as the broader landscape context.



Figure 1. A Bicknell's thrush delivering food to its young.

Purpose of the guidelines

The purpose of these guidelines is to promote the habitat conditions and processes that sustain Bicknell's thrushes and other disturbance-adapted mountain birds in the US Northeast. They may be useful to stewards of high-elevation forests who wish to identify, maintain, or restore habitat. The guidelines are also intended for foresters and loggers who work in Bicknell's thrush breeding areas, although these sites are limited in the US due to regulatory and practical constraints on harvesting at upper elevations. A common understanding of the habitats and practices that benefit this vulnerable species will help secure its future as an icon of the Northeast's most remote forests.

Where to Create and Sustain Habitat

Landscape characteristics

Efforts to maintain or create Bicknell's thrush habitat should focus on periodically or chronically disturbed forests located above an elevation threshold that decreases by approximately 270 ft for every one-degree increase in latitude, from 3,425 ft in the Catskills to 2,300 ft in northern Maine (Fig. 2).¹ Bicknell's thrush populations in the Adirondack, northern Green, and White Mountains generally occur above 3,000 ft, with highest densities between 3,700 and 4,600 ft.^{1,14,23,24}

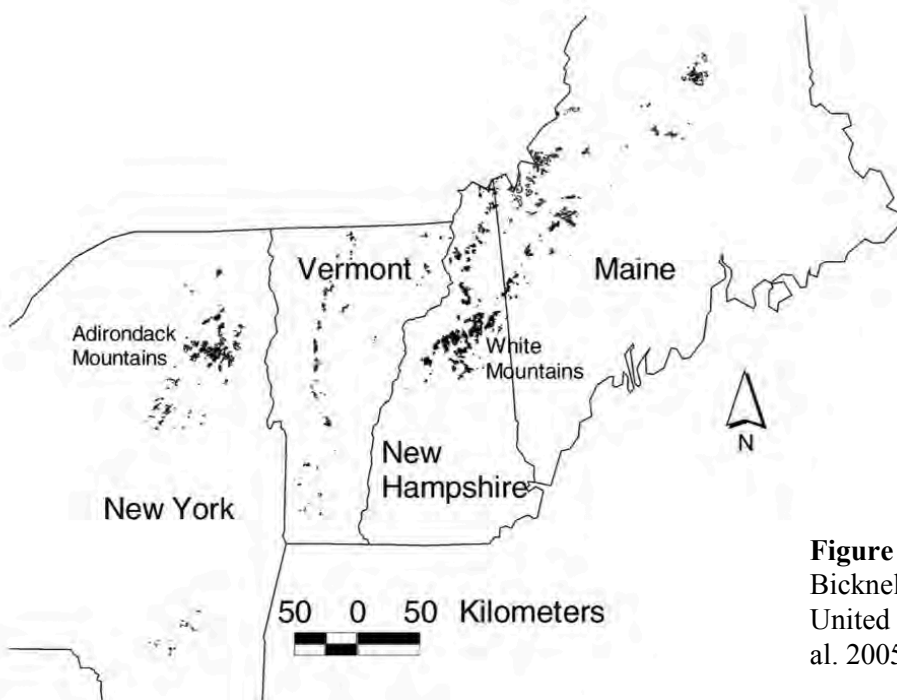


Figure 2. Predicted distribution of Bicknell's Thrush in the northeastern United States (reprinted from Lambert et al. 2005).

The upper and lower limits of Bicknell's thrush habitat are influenced by the continental climatic gradient, as well as site-specific factors that govern forest structure, such as topography, soil characteristics, and exposure to disturbance. Forests that are shaped by wind, ice, or regular timber harvesting are more likely than undisturbed areas to provide a steady supply of suitable habitat (Fig. 3). Bicknell's thrushes may even occur in stands below the elevation threshold if a recent canopy disturbance has stimulated dense understory growth.²⁵ Such stands may warrant consideration for experimental habitat treatments, particularly if future studies produce evidence of successful breeding in regenerating harvest zones.



Figure 3. Forests growing on steep slopes with shallow soils (l) are prone to natural disturbances that generate vigorous understory growth. Suitable habitat may also develop on broad, boreal plateaus after a fire, spruce budworm outbreak, or timber harvest (r).

Sites with more than 10 ac of contiguous or clustered habitat should be sufficient to support a social group consisting of at least one female and two or more males. Habitat patches > 20 ac are very likely to be continuously occupied while those < 5 ac may only be used intermittently.²² Although large and connected habitat units offer the most value to Bicknell's thrush, spatial characteristics should not be the principal consideration in selecting sites for implementing these guidelines. In general, stand characteristics appear to influence Bicknell's thrush colonization and persistence rates more strongly than patch size and configuration.²⁶

Spatial assessments of Bicknell's thrush habitat have thus far produced models of current distribution¹ and landscape capability²⁷ for the entire US range, as well as estimates of occupancy and/or density for the White Mountain National Forest,²⁴ northeastern Vermont,²² and northwestern Maine.¹⁴ A forthcoming analysis of more recent and comprehensive field data will make available density and occupancy estimates for all of the states where this species breeds (J. Lloyd, pers. comm.)

Desired Habitat Conditions

Forest composition

Bicknell's thrushes primarily breed in balsam fir forests with lower levels of paper birch, mountain ash, and red spruce.^{6,17,28,29} White spruce may also mix in at northern latitudes.³⁰ While balsam fir predominates in the most productive breeding areas, red spruce, paper birch, and yellow birch tend to be more common in the lower band of sparsely occupied habitat that encircles high mountains.^{24,25} Regenerating paper birch and pin cherry stands may provide suitable cover during the breeding season,⁴ particularly if patches of balsam fir are present.³¹

Understory plants that occur in montane fir-spruce forests include mountain maple, striped maple, hobblebush, Bartram's shadbush, mountain wood fern, and bunchberry.³² Sphagnum mosses and horsehair fungus grow on the forest floor and are used for nesting material.³³

Forest structure

Bicknell's thrushes breed in forests with high densities of saplings or small trees, and low, open, or semi-open canopies, including multi-aged and even-aged stands. These areas occur as ephemeral patches undergoing forest succession after the canopy has been opened by wind-throw, snow or ice damage, timber harvest, insect outbreak, or fire. Persistence of suitable habitat is greatest at high elevations, where thin soils, short summers, and relatively frequent disturbance limit tree growth. Productive habitat also occurs along the edges of chronically disturbed openings, including ski trails, roadways, rockslides, and exposed ridges (Fig. 4). Wherever they breed, Bicknell's thrushes concentrate in patches of thick understory foliage and nest mainly in small balsam fir trees.^{2,6} They may preferentially select areas where forest structure is patchy³⁴ and where snags provide elevated and exposed song perches.^{24,26,35}



Figure 4. Bicknell's thrushes breed in dense thickets of balsam fir that grow along exposed ridgelines and sheltered trails. Snags provide valuable song perches, especially where canopy trees are absent.

Forests typically begin to provide suitable structure once the regenerating layer grows above 6 ft.^{31,36} Timing of succession is influenced by site factors, including soil characteristics, browsing pressure, and amount of retained understory; however, desired conditions are likely to develop 10-20 years after disturbance.^{4,34} Bicknell's thrushes have been observed in stands managed for wood products up to 40 years after harvest³⁵ and may be more abundant in areas where stand ages are mixed.³⁴ Recently thinned stands generally support lower densities than dense, regenerating stands.^{4,17,30,34,35}

Although habitat selection varies with context, the following attributes generally characterize Bicknell's thrush breeding habitat in the focal region.

- Saplings and small trees form densely foliated thickets that measure > 6 ft in height (Fig. 5).^{29,31,37}
- The density of small woody stems (< 4 in dbh) averages > 4,000 stems/ac and may range up to 25,000 stems/ac in patches used for nesting.^{28,29,31,34,36,38}
- Canopy trees may or may not be present. When they are, heights range from 15-30 ft on average, but sometimes reach up to 50 ft.^{28,29,39}
- Standing dead trees are present and may be abundant for use as song perches.^{24,26,28,29,35}
- Herbaceous plants are relatively sparse, enabling efficient ground foraging.^{7,28,34,36}
- Sphagnum moss and horsehair fungus are present, providing essential nesting material.^{6,33}



Figure 5. Bicknell’s thrush habitat often features complex vertical structure and horizontal patchiness (l), however relatively uniform stands of regenerating fir also provide suitable cover for nesting (r). Snags serve as prominent song perches.

Recommended Practices

Appropriate measures to maintain or enhance Bicknell’s thrush habitat will depend on ecological setting and locally prevalent land uses. Therefore, stewardship planning ought to involve natural resource professionals with local knowledge of wildlife values and forest dynamics. Environmental regulations will also shape site-based decisions, since most occupied areas occur in sensitive or protected mountain terrain. Although each project calls for a tailored approach, some of the following recommended practices may apply.

Land conservation

These recommendations are intended for conservation planners and land trust personnel interested in adding to the Northeast’s already extensive network of conserved mountain lands. They may also be appropriate for designating reserves or special treatment areas in managed forest landscapes.

- Focus conservation resources on contiguous or clustered habitat patches > 20 ac, especially where low and dense forest structure is naturally maintained (*e.g.*, exposed ridges and steep, northwest-facing slopes).
- Favor areas where forests are most likely to be resistant to climate change, such as higher elevations on northern exposures or higher elevations at northern latitudes.
- Develop easements and stewardship plans that allow for forest management where it has potential to enhance or supplement Bicknell’s thrush habitat. Limit this approach to areas that are sheltered from large disturbances, but already accessible via well-designed roads.

Forest management

These recommendations are intended for foresters and loggers operating in areas where access and growing conditions enable ecologically and economically sustainable forestry. They should not be applied to areas where climate or soil conditions strongly limit tree growth, including the region’s highest mountain forests.

- Plan harvest intervals that ensure a continuous supply of sapling-dominated stands (Fig. 6). These areas may occur beneath open or semi-open canopies.
- Implement silvicultural systems and intermediate treatments that are most likely to promote or maintain high stem densities, balsam fir regeneration, and stand patchiness, such as: clearcutting with reserves, group shelterwoods, and variable retention thinning.



Fig. 6. In forests managed for wood products, unthinned stands (l) and stands thinned with variable retention are more likely than uniformly thinned stands (r) to provide productive breeding habitat for Bicknell’s thrush.

- Where other management objectives call for uneven-aged or natural dynamics forestry, harvest trees in 0.5- to 2-acre groups or utilize an expanding-gap group shelterwood system. Cluster the harvests to emulate natural disturbance and increase the probability of occupancy by Bicknell’s thrush (Fig. 7).
- When practical, retain other within-stand features that could enhance habitat quality for Bicknell’s thrush, including snags (Fig. 8) and fruit-bearing trees, such as mountain ash.



Figure 7. Forest managers seeking to emulate patterns of natural disturbance could mimic the scale and patchiness of natural fir waves, like those shown on Mount Moosilauke, NH (l). These irregular bands of open canopy are usually separated by 100-175 ft and measure < 12 ac in total extent.⁴⁰ The disturbance interval in stands shaped by fir waves averages 60 years or less.⁴¹



Figure 8. Forest structure in a regenerating group cut with retained snags (l) closely resembles that of a naturally disturbed stand where the canopy has been opened by icing and high winds (r).

- If thinning is applied to stands < 25 ft in height, retain dense balsam fir patches > 0.5 ac and < 150 ft from the nearest unthinned patch or forest edge. If more than one pre-commercial treatment is planned, stagger the entries by 10 or more years.^{38,42}
- To protect soils and regeneration, harvest on dry or frozen ground, maximize trail-spacing, and restrict heavy machines to temporary routes and landings.

Infrastructure siting and mitigation

- When possible, locate new infrastructure in areas that have already been developed or where mature hardwoods make up at least one-third of the forest canopy.
- Minimize the size of permanent openings in chronically or recurrently disturbed forests, which are most likely to occur along exposed ridgelines, on west-facing slopes, and in areas subject to fir waves.
- Restore temporary openings or the unused margins of permanent openings (Fig. 9) through passive reforestation or high-density, native planting. If possible, transplant seedlings from highly stocked, nearby stands.
- Prepare the soil if it is not adequate to support regenerating trees, bearing in mind that red spruce is more likely than balsam fir to become established in full sun and on mineral soils. If soil amendments are needed, use local sources and avoid introducing invasive plants.
- Erect and maintain barriers and/or educational signage to protect restoration zones from vehicle, foot, and skier traffic.



Figure 9. Restoration of forest along road margins helps minimize the permanent footprint of high-elevation infrastructure.

- Maintain fir-spruce thickets in 10-20 ft-wide bands along the edge of permanent openings. A gradual increase in tree height from the opening to the adjacent forest may improve nesting cover.
- Maximize the size of forest patches between ski trails and limit trail width to < 150 ft (Fig. 10).
- Create new glades only in hardwood forests. In existing glades, minimize understory removal and ensure continual recruitment of seedlings and saplings to older age classes.
- Post, monitor, and enforce restrictions on unauthorized creation and maintenance of glades or other ski trails.
- Adhere to the US Fish and Wildlife Service’s voluntary guidelines for the siting and lighting of wind turbines and transmission towers.⁴⁴
- Minimize the developed footprint of wind energy installations by micro-siting turbines and using narrow-tracked cranes, when possible.
- Mitigate permanent forest removal through reforestation of nearby anthropogenic openings. Capitalize on opportunities to consolidate small habitat fragments into blocks > 0.5 ac.



Figure 10. Bicknell’s thrushes regularly utilize densely structured forest edges and are known to cross trails and roads < 150 ft wide.^{28,43}

General Recommendations

- Minimize earthwork and forest clearing for skid trails, haul roads, ski trails, crane pads, and service roads. Utilize existing access routes, when they are available.
- If possible, avoid timber harvesting and road construction in likely Bicknell’s thrush habitats during the nesting and fledgling periods (June 1 through Aug 15). Seasonal limits do not apply to maintenance of roadbeds and are not as critical in stands that lack dense understory structure.

Managing for Multiple Benefits

Associated species

More than fifty species of vertebrate wildlife use montane fir-spruce forests in the Northeast.^{28,45,46} This group is comprised largely of migratory birds such as winter wren, magnolia warbler, and yellow-rumped warbler, but it also includes a small number of resident birds (*e.g.*, spruce grouse and gray jay), mammals (*e.g.*, American marten, porcupine, snowshoe hare), and amphibians (*e.g.*, northern spring and mountain dusky salamanders). Maintaining the landscape- and stand-level features that support Bicknell’s thrush could benefit at least twenty Species of Greatest Conservation Need (Table 1).

Table 1. A partial list of Species of Greatest Conservation Need that could benefit from implementation of these guidelines. Species of high regional concern are indicated in bold. Species co-occurrence varies across the region.

American three-toed woodpecker
Black-backed woodpecker
Blackpoll warbler
Boreal chickadee
Canada warbler
Fox sparrow
Gray jay
Olive-sided flycatcher
Purple finch
Ruby-crowned kinglet
Rusty blackbird
Spruce grouse
Swainson’s thrush
White-throated sparrow
Yellow-bellied flycatcher
American marten
Canada lynx
Long-tailed or rock shrew
Rock vole
Northern spring salamander



Olive-sided flycatcher



White-throated sparrow



Rock vole

Ecosystem Services

Stewardship practices that maintain the integrity of high-elevation ecosystems yield a variety of benefits to society beyond the conservation of wildlife. Mountain forests capture, filter, and deliver clean water to downstream communities, while moderating stream flow and reducing the severity of floods. They provide opportunities for skiing, hiking, and other outdoor activities that promote human health and well-being. And they create business and employment opportunities in the tourism, recreation, and retail sectors. In addition to anchoring local economies, mountain forests of the US Northeast play an important role in stabilizing the climate. Northern Appalachian and Adirondack forests contain the region’s largest stocks of sequestered carbon⁴⁷ and are expected to moderate the long-term ecological effects of climate change. Elevation- and latitude-spanning forests are particularly valuable for enabling future migration of plant species and the stable transformation of natural communities over time.

Comprehensive planning

When implementing recommendations for conserving Bicknell’s thrush, land managers should weigh the potential effects of their decisions on other forest values and species of concern. For example, conversion of older forests to young stands may adversely affect mature forest associates, such as American marten and black-throated green warbler, unless measures are taken to sustain older stands in the surrounding landscape. Regional conservation partnerships and managers of large timberlands can deliver a broad

range of wildlife benefits concurrently by shifting through a mosaic of cover types and age classes over time and managing ecologically sensitive areas as reserves. This approach also strengthens the wood products industry since it conforms with forest certification standards and sustainable financial practice.

Wherever Bicknell's thrushes breed, local understanding of conservation issues and forest dynamics will help ensure sound management decisions. Forest and wildlife stewards who assess effects of their decisions and adjust practices accordingly are in the best position to achieve their conservation objectives.

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INTERNATIONAL
BICKNELL'S THRUSH
CONSERVATION GROUP



Field Guide to Forest Management for Bicknell's Thrush

Companion to *Guidelines for Managing Bicknell's Thrush Habitat in the United States*



Bicknell's thrush resembles several other woodland thrushes and can be distinguished most reliably by song. Note also the gray cheek, olive-brown back, and absence of spectacles seen on co-occurring Swainson's thrushes.

Status: Species of Greatest Conservation Need in NY, VT, NH, and ME

Habitats: High-elevation balsam fir-paper birch-red spruce forests in the northeastern US and adjacent areas of southeastern Canada. Nests in dense conifer thickets, along forest edges, and in sapling stands of mixed composition. May prefer areas with abundant snags and patches of forest in different age classes.

Home range size: Highly variable, averaging 8-13 ac for females and 13-30 acres for males, whose ranges often overlap.

Nest: Constructed mainly of fir twigs and sphagnum moss on 1-4 horizontal branches against the stem of a small tree. Placed 2-30 ft above the ground; most often between 5 and 7 ft in mountain forests. Interior cup lined with horsehair fungus.

Diet: Primarily beetles, ants, flies, and caterpillars captured on or near the ground by probing, pecking, or gleaning; berries of fruiting shrubs and small trees, such as mountain ash and elderberry, when available

Associated species: Varies geographically and includes black-backed woodpecker, blackpoll warbler, boreal chickadee, Canada warbler, gray jay, magnolia warbler, Nashville warbler, olive-sided flycatcher, purple finch, ruby-crowned kinglet, spruce grouse, Swainson's thrush, white-throated sparrow, winter wren, yellow-bellied flycatcher, American marten, Canada lynx, long-tailed shrew, rock vole, mountain dusky salamander, and northern spring salamander

Recommended forest management practices: When conducted in the appropriate context, some methods of timber harvesting can enhance conditions for Bicknell's thrush. However, conservation benefits may be low in areas where suitable habitat occurs naturally. For more information, please consult the complete guidelines.

Starting Condition	Objective(s)	Management Options	Desired Condition
Mature fir-spruce forest with high canopy cover and sparse to moderate understory	<p>Open canopy and increase light to the understory</p> <p>Create within- or between-stand patchiness</p> <p>Enhance important within-stand features</p>	<p>Clearcut with reserves</p> <p>Group shelterwood</p> <p>Group selection (0.5-2 ac)</p> <p>Expanding-gap group shelterwood</p> <p>Retention of snags and low-vigor trees, fruit-bearing trees, and regenerating conifers</p>	<p>A high density of conifer saplings and small trees form a thicket > 6 ft in height</p> <p>Canopy is open or semi-open</p> <p>If present, canopy trees measure 15-30 ft in height</p> <p>Snags and/or fruit-bearing trees are present</p>
Young fir-spruce forest with low canopy (< 25 ft) and high density of saplings and small poles	<p>Retain dense understory structure and softwood dominance</p> <p>Create patchiness if thinning is applied</p>	<p>No thinning</p> <p>Variable retention thinning, w/ conifers left in patches</p>	<p>Sphagnum moss is present</p> <p>Forest structure is heterogeneous within and/or between stands</p>

Additional considerations

- Protect understory structure during harvest operations by harvesting on dry or frozen ground, minimizing travel, and maximizing trail spacing and machine reach.
- If practical, avoid felling and skidding during nesting and fledgling periods (Jun 1 to Aug 15).
- Retain dense conifer patches > 0.5 ac and < 150 ft from the nearest unthinned patch or edge.

Field Guide to Forest Management for Bicknell's Thrush



Bicknell's thrushes nest in regenerating fir-spruce stands dominated by saplings (>4,000 stems/ac).



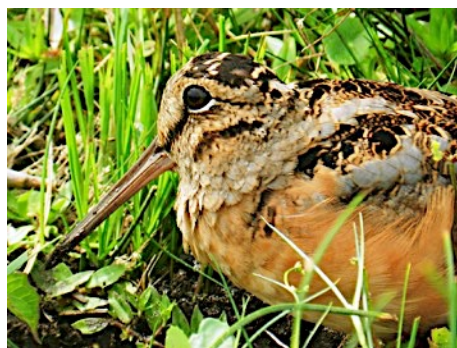
Young mixed-woods may also be used for nesting, especially if softwood thickets, snags, and other open perches are available. Mountain ash provides high-calorie fuel for migration and should be retained, when practical.



In cases where pre-commercial thinning or partial harvests are used, variable retention (l) and staggered entries are recommended to promote the patchy structure typical of forests most preferred by Bicknell's thrush (r).



Guidelines for Managing Canada Warbler Habitat in the Northeast and Mid-Atlantic Regions



Guidelines for Managing Canada Warbler Habitat in the Northeast and Mid-Atlantic Regions

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High Branch
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Cover photos: top row (l-r) by Dan Lambert, Len Reitsma, and Dan Lambert; center by William H. Majoros (CC BY-SA 3.0), bottom row (l-r) veery by Kelly Colgan Azar (CC BY-ND 2.0), American woodcock by Nancy Magnusson (CC BY-NC 2.0), and olive-sided flycatcher by Andy Reago and Chrissy McClarren (CC BY 2.0).
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Introduction

Species profile

The Canada warbler is a small, active songbird with a slate-colored back, bright yellow underparts, and a distinct whitish eye-ring. A necklace of bold, black streaks adorns males of the species, but is less distinct on females and young birds. This long-distance migrant nests in deciduous, coniferous, and mixed woodlands from eastern British Columbia across southern Canada and the US Great Lakes region to Nova Scotia. Its breeding range extends south through New England and along the Appalachian highlands to northern Georgia (Figs. 1 and 2). Canada warblers overwinter in northwestern South America, primarily in and east of the Andean foothills.¹

In the northeastern United States, Canada warblers are most abundant in moist deciduous and mixed forests that feature openings in the canopy,^{2,3} a leafy understory,^{4,5} exposed song perches,⁵ and uneven ground littered with woody debris.^{6,7} Swamps, bogs, riparian thickets, regenerating timber cuts, and natural canopy gaps provide suitable habitat for this insectivore.⁸⁻¹¹ Canada warblers sometimes inhabit pockets of disturbed spruce-fir forest in the northern mountains,¹² but they are more common in forested, headwater wetlands and rhododendron thickets of central and southern Appalachia.^{13,14} Nests are usually built on the ground, where they are concealed among root masses, stumps, fallen logs, ferns, and mossy hummocks.^{7,15} Breeding territories often occur in clusters, which are referred to as neighborhoods.¹⁶

Status and conservation concerns

The Canada warbler is listed as threatened in Canada under the Species at Risk Act and as a Species of Greatest Conservation Need in nearly every state where it breeds in the US. Although population increases are underway from northeastern Pennsylvania to northern Georgia, negative trends predominate across most of its range. Since 1966, population declines have been especially pronounced in the Atlantic Northern Forest, along the New England-Mid-Atlantic Coast, and across the central Allegheny Plateau (Fig. 2).¹⁷ Contributing factors likely include forest loss and fragmentation on both the breeding and wintering grounds resulting from urban, residential, and agricultural development.¹ Many of the remaining breeding areas

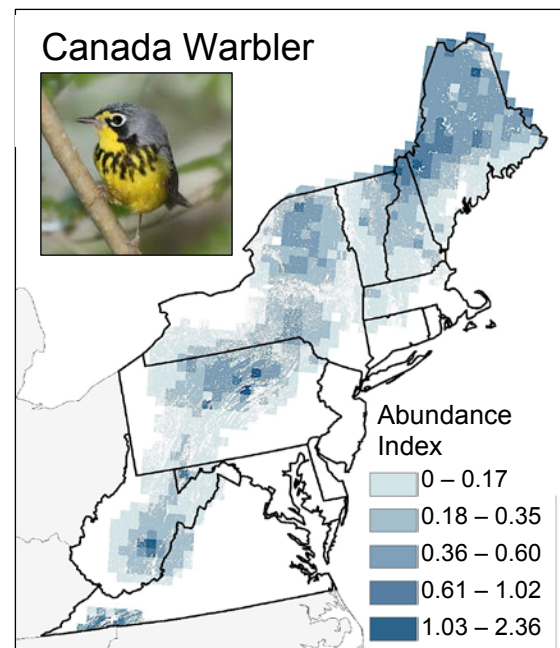


Figure 1. Canada warbler relative abundance in northeastern forests based on a five-year mean of Breeding Bird Survey route counts (2008 to 2012; Sauer et al. 2014).

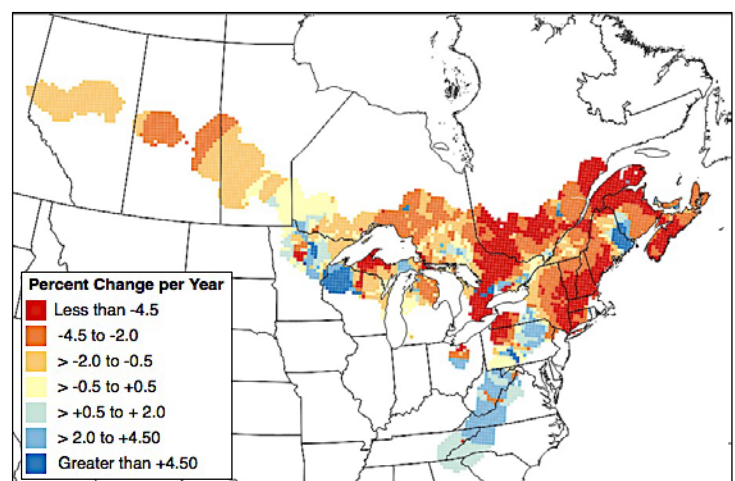


Figure 2. Canada warbler population trends, 1966-2012 (Sauer et al. 2014).

currently lack vertical layering and patchiness due to heavy deer browsing, the spread of invasive plants, and/or management approaches that reduce structural complexity. Another source of concern is the Canada warbler's relatively high risk of mortality from collisions with buildings during migration.¹⁸

Purpose of the guidelines

The purpose of these guidelines is to promote the conditions and processes that benefit Canada warblers, as well as other native species that depend on similar habitats in the US Northeast and Mid-Atlantic regions. Public and private land managers, forestry professionals, and conservation planners may find them useful in accomplishing their stewardship objectives. Effective approaches to conserving Canada warblers and associated species will vary throughout the region, depending on prevailing land uses, stressors, and wildlife management priorities. In recognition of this heterogeneity, these guidelines offer forest management and conservation strategies that should be selectively applied based on local knowledge and stewardship objectives.

In general, harvest-based strategies are likely to be most useful in areas of active forest management, particularly large ownerships that include forested wetlands. Forest preservation may also be effective at sustaining Canada warbler populations on large tracts that contain the requisite soils, stem densities, and ground complexity. Combined approaches can be applied to areas where harvesting is limited but conservation objectives call for some level of habitat manipulation.

Where to Create and Sustain Habitat

Landscape characteristics

Efforts to conserve Canada warbler habitat should focus on forested landforms that are likely to maintain suitable conditions over time, especially poorly drained areas where saturated soils and standing water favor the growth of shrubs over large trees. Wetland and riparian forest canopies are frequently disturbed by beaver activity and mortality of shallow-rooted trees. These create canopy gaps and promote growth of protective cover and leafy, foraging structure. In addition, swamps and streamside forests supply abundant flying insects to breeding adults and their offspring.

Ridges, steep hillsides, and ravines are also important to Canada warblers, especially in the Allegheny and Blue Ridge Mountains. These features often maintain canopy openings that expose the understory to sunlight. In areas with high topographic relief, Canada warblers appear to prefer east-facing slopes that are lit early in the day (promoting soil warming and understory growth) and are shaded later in the day (conserving moisture) (Fig. 3).¹⁹



Figure 3. Early light in a Blue Ridge oak-heath forest, where Canada warbler numbers are increasing in rhododendron thickets.

Landscapes managed for forest products, among other values, offer high potential for improving and sustaining Canada warbler habitat. This is because well-planned harvest regimes ensure a spatially dynamic, but continuous supply of young forest. A viable forest products industry also safeguards against

the agricultural, residential, and urban development that has degraded habitat in more densely populated regions.

Silvicultural approaches to habitat management can be most effective on commercial, state, and national forests, because of the opportunity to provide desired conditions across major management units (Fig. 4). Large individual holdings, as well as county and town forests, also offer good opportunities for managing Canada warblers and associated species. Small woodlots and forest reserves can play a complementary role if they uphold high regional forest cover and wetland integrity.

Although their minimum area requirements are not known, Canada warblers appear to be sensitive to forest fragmentation. Levels of abundance and occupancy are positively correlated with forest area and continuity.^{9,10,20} Canada warblers preferentially select landscapes with > 50% forest cover²¹ and woodland tracts of 1,000 acres or more.⁹ Canada warblers may be more likely to inhabit small swamps surrounded by forest than large swamps isolated by development. Also, swamps with heterogeneous edges and long and irregular perimeters seem to offer higher value than those with simple boundaries.¹⁰

Desired Habitat Conditions

Forest composition

Composition of Canada warbler habitat varies by elevation and latitude. In the central Appalachian portion of its range, the bird is found primarily above 2,800 ft in northern hardwoods and conifer forests (eastern hemlock, red spruce, black spruce, and tamarack), especially in association with headwater shrub swamps and woody peatlands.^{7,14} Canada warblers also occur in cove hardwoods below 2,800 ft and high-elevation oak-heath forests of southern Appalachia.^{1,7} In the North, they inhabit red maple, black spruce, and cedar-fir swamps as well as oak-hickory, northern hardwood, spruce-fir (Fig. 5), and mixed upland forests.^{1,4,10} Canada warblers observed in a predominantly deciduous Wisconsin forest preferentially foraged in aspens and conifers, including white pine, black spruce, and balsam fir.²² Studies in Maine have found Canada warblers to be more common in mixed forests than in pure stands.^{2,23}

The shrub and small tree species that predominate in Canada warbler territories include, from south to north, rhododendron, mountain laurel, Labrador tea, bog rosemary, leatherleaf, and various species of alder, holly, and viburnum.^{1,5,13,14} However, breeding sites are selected based on the structure of the understory, not its composition.^{23,24}



Figure 4. A commercially managed forest in New Hampshire provides shifting patches of breeding habitat for Canada Warblers.



Figure 5. Shrubs, saplings, and small trees (6-20 ft high) provide ideal cover for Canada warbler nesting and foraging.

Forest structure

Throughout the eastern US, Canada warblers select moist and structurally complex forests featuring an open or broken canopy with exposed song perches elevated above a leafy understory and uneven forest floor. Specific elements contributing to this complexity differ somewhat among regions, landforms, and forest types. Still, the following features generally characterize high-quality habitat from Virginia to Maine.

- Canopy height (overstory): < 50 ft ^{5,6,23}
- Canopy cover (overstory): 5-85% ^{3,6,8}
- Basal area of overstory trees: < 70 ft²/ac ³
- Subcanopy height: 6-20 ft ^{8,23,25}
- Subcanopy cover: > 60% ⁷
- High volume of subcanopy foliage ⁵
- Moderate to high density of woody shrubs and saplings ^{5,7,8,23}
- ≥ 5 song perch trees per acre, emerging ≥ 10 ft above the subcanopy; dispersed individually, aggregated in groups, or located at the edge of a forest opening
- ≥ 15 ft of open canopy around/adjacent to each of these song perch trees (Fig. 6) ⁵
- Uneven forest floor with down woody material (logs, branches, stumps, and root masses) comprising > 10% of the ground cover ^{6,7,15}
- Moderate to high herbaceous plant, fern and moss cover (but not strictly ferns) ^{6,21}



Figure 6. Males choose prominent perches for singing and visual display.



Figure 7. Females tuck nests into the sides of mossy hummocks, root balls, or other ground-level structures.

To function as Canada warbler habitat, suitable structure should predominate over at least half an acre, the average size of a territory core. Because full territories average between 2.5 and 3 acres and are frequently clustered in neighborhoods,¹⁶ large patches with >10 acres of suitable habitat offer more value than small patches. Forested connections among habitat patches also enhance their value.

Forest age

- Canada warblers breed in uneven-aged forests, including old forests, and in young, even-aged stands (saplings to poles).⁴
- In managed forests, they are most abundant in partially or heavily harvested areas after regenerating saplings become well established among residual trees.^{2,7,8}
- Suitable structure typically appears 5 years after timber removal or natural gap formation and persists for 15-20 years.^{2,26,27} Timing is influenced by site conditions, the amount of pre-existing and retained understory, and browsing pressure.
- The positive response of Canada warblers to harvesting may be muted in clearcuts > 3 acres, where no trees are retained. Here, males resort to perimeter trees for song perches and visual display.⁷ Still, regenerating clearcuts with no residuals support higher densities than mature stands.^{2,7,28,29}
- Forested wetlands and naturally disturbed areas within old forests often provide sustained habitat without the ephemerality that can disrupt longer-term occupancy of harvested areas.

Recommended Practices

Methods to maintain and create Canada warbler habitat will depend on regional context, site conditions, and other management considerations. For certain areas, prioritizing conservation of forested tracts with mosaics that include suitable habitat may be the best approach to sustaining Canada warblers and associated species. Elsewhere, active management may be more effective at promoting the desired conditions. Forest managers who encounter difficulty in selecting among land conservation and forest management practices are encouraged to consult their state wildlife agency for guidance.

Land conservation

The following strategies are recommended for conservation planners and land trust personnel working in regions with low to moderate levels of human development. Some may also be appropriate for designating reserves or special treatment areas in managed forest landscapes, particularly where natural Canada warbler habitat overlaps ecologically sensitive features.

- Focus conservation resources on large forested areas (>1,000 acres) where Canada warblers are known to breed or stop over, especially where moist forest, dense understory, and relatively open canopy are naturally maintained (*e.g.*, headwater swamps, boreal peatlands, ravines, and steep, east-facing slopes). Minimize forest loss and fragmentation within such areas and consider reforestation of adjacent lands as opportunities allow.
- Conserve forest blocks with low edge-to-interior ratios to maximize forest cores and minimize edge effects such as nest predation and penetration of invasive plants.
- Connect suitable habitat patches with forested corridors to allow future breeders to discover potential breeding sites during post-breeding dispersal. Shrubby utility rights-of-way may also serve this connecting function.
- Develop easements and stewardship plans that allow for forest management where it has potential to improve Canada warbler habitat.

Forest management planning

The following strategies are intended for landowners, land managers, and forestry professionals.

- To provide a steady supply of suitable habitat, continuously maintain 12-20% of managed forestland in the desired condition.
- Build on natural population centers (*e.g.*, red maple, northern white cedar, and spruce-fir swamps) by harvesting a nearby mature stand at least every 15 years.
- Implement silvicultural systems that are most likely to produce the desired conditions: shelterwood cuts or expanding-gap group shelterwoods, seed-tree cuts, and clearcutting with reserves. Because occupancy and abundance levels are positively correlated with treatment area, benefits to Canada warbler increase with harvest size.
- Where other management objectives align more closely with natural dynamics forestry, harvest trees in 0.5- to 2-acre groups, with mid-story trees left scattered in the openings. Cluster the harvests to increase the probability of occupancy.
- Maintain a mix of hardwoods and softwoods at the stand and landscape levels through use of natural regeneration forestry and limits on use of hardwood herbicides on softwood sites.
- Implement variable retention thinning and/or crop-tree release after the stand height exceeds 15-20 ft to open the canopy and enhance understory structure (Fig. 8).

Forestry operations

- In harvest areas > 2 acres, retain at least 5 standing trees per acre, dispersed individually or in several clumps. These may range from large saplings to trees under 50 ft in height. Provide at least 15 ft of separation among these singing/visual display centers. Choose stems that reach at least 10 ft above the subcanopy (if present).
- In larger harvests, maintain these conditions in 2- to 3-acre portions of the cut (better if each portion is greater than 10 acres).
- If practical, avoid felling and skidding operations in likely Canada warbler habitats during periods of nesting and fledgling activity (mid-May to mid-August), especially in previously entered shelterwood stands. Seasonal limits are not as critical in mature stands, where use by Canada warblers is lower.
- Minimize compaction of down woody material, stumps, hummocks, and root masses of ferns and trees. These essential habitat features conceal nests and offer protective cover to parents tending eggs and young. Possible measures include harvesting on snowpack and restricting heavy machines to temporary routes and landings.



Figure 8. Gaps created by natural disturbance or variable retention thinning enhance conditions for Canada warbler by increasing layering and patchiness.

- Protect patches of advanced regeneration and woody material by minimizing travel and maximizing trail-spacing and machine reach. Patches measuring 0.25-0.5 acres may serve as future territory cores.
- If practical, top and delimb trees near the stump to enhance woody debris and forest floor structure (Fig. 9).

General Recommendations

- Restrict off-road use of all-terrain vehicles.
- Promote hunting to reduce browsing pressure by moose and deer.
- Limit beaver trapping in wetlands where beavers are not causing damage to road infrastructure or valuable timber.
- Follow best practices in invasive plant control in areas where invasive plants are common or a threat.



Figure 9. Manual and cut-to-length harvesting affords opportunities to enhance forest floor structure by topping and limbing at the stump. Harvests conducted by feller-buncher call for other approaches to retain debris on site.

Managing for Multiple Benefits

Current understanding of Canada warbler ecology is incomplete, particularly with respect to area requirements, site fidelity, population characteristics, and reproductive performance. However, detailed knowledge of this bird’s habitat requirements provides a strong basis for stewardship actions that benefit Canada warbler and co-occurring species.

Associated species

Throughout the year, a wide variety of native wildlife makes use of the dense cover and abundant food resources that characterize regenerating forests and canopy gaps within mature forests (Table 1).³¹ The list includes young forest specialists (*e.g.*, golden-winged warbler and New England cottontails), mature forest associates that utilize sapling-dominated areas during a particular stage of the life cycle (*e.g.*, scarlet tanager and blue-headed vireo), and species primarily associated with multi-age forests (*e.g.*, cerulean warbler and moose). Swamps and riparian woodlands share many of the structural attributes of recently disturbed forests, since poor drainage inhibits canopy development. Maintaining these areas as Canada warbler habitat could benefit other species that inhabit forested wetlands, such as American woodcock and olive-sided flycatcher.

Table 1. A partial list of Species of Greatest Conservation Need that could benefit from implementation of these guidelines. Species of high regional concern are indicated in bold. Species co-occurrence varies across the region.

Species	Overlapping habitat(s)
Alder flycatcher	Moist riparian thickets and young forests
American redstart	Young deciduous forest
American woodcock	Young deciduous forest, shrubby streamsides
Black-billed cuckoo	Mixed woodlands and thickets near lakes, streams, wetlands and bogs
Blue-headed vireo	Mixed mature forest during nesting; mature and young forest after nesting
Blue-winged warbler	Young deciduous forest
Cerulean warbler	Mature deciduous forest with canopy gaps and well-developed understory
Chestnut-sided warbler	Young deciduous forest
Eastern towhee	Areas with few large trees, an open canopy, and dense shrub layer
Golden-winged warbler	Young forests and swamps with dense understory, open canopy, and emergent song perches
Indigo bunting	Young forest, sometimes near wetlands, swamps, rivers
Magnolia warbler	Dense, young conifer forest
Nashville warbler	Young mixed forests near bogs and forest openings with dense undergrowth
Northern waterthrush	Shrubby wetlands and riparian forests with abundant logs and stumps
Olive-sided flycatcher	Wetlands and young forest with tall snags
Ruffed grouse	Regenerating deciduous forest with high density of woody debris such as fallen logs
Scarlet tanager	Mature deciduous forest during breeding; young and mature forest after breeding
Spruce grouse	Spruce-fir forests and bogs with a thick layer of low vegetation
Rusty blackbird	Young spruce-fir forest near low-gradient streams and bogs
Veery	Young deciduous or mixed stands with dense understory adjacent to streams
Willow flycatcher	Dense, shrubby thickets near standing or running water
Yellow-bellied flycatcher	Damp northern forests (mixed and conifer) with mossy ground and down woody material
Yellow-breasted chat	Dense shrubby tangles and moist, streamside areas
Appalachian cottontail	Montane forest and forest-shrub wetlands with dense understory
Bobcat	Young deciduous, coniferous, or mixed forest
Lynx	Young spruce-fir forest
Moose	Young forest and forested wetlands
New England cottontail	Young forest thickets
Snowshoe hare	Moist, dense, young spruce-fir forest
Spotted turtle	Bogs, shrub swamps, and forested wetlands
Wood turtle	Streamside thickets with open canopies
Mtn. dusky salamander	Moist forest near headwater streams and seeps
Wehrle's salamander	Mixed and conifer forests at upper elevations



Figure 10. Managing forests for Canada warblers may also benefit numerous Species of Greatest Conservation Need, including Eastern towhees, Canada lynx, and wood turtles.

Ecosystem services

In addition to wildlife conservation, a number of other ecological and societal benefits arise from sustainable management of Canada warbler habitat. These include: water quality protection, flood regulation, enhanced pollinator populations within shrubby openings, and support for local economies that rely on the forest products industry and nature-based recreation. Furthermore, Canada warblers and other birds help maintain tree vigor and growth by controlling invertebrate pests, including up to 84% of spruce budworms.^{31,32}

Comprehensive planning

When implementing these guidelines, forest stewards should weigh the possible impacts on other species of concern that are not associated with Canada warbler habitat. For example, conversion of older forests to young stands may adversely affect mature forest birds, such as northern goshawk and Blackburnian warbler, unless measures are taken to sustain mature forests in the surrounding landscape. Regional conservation partnerships and managers of large properties can deliver a broad range of benefits concurrently by shifting through a mosaic of cover types and age classes over time. Adaptive management that considers regional context, monitors the status of wildlife, and regularly incorporates new information can help forest managers balance multiple conservation objectives. Ultimately, local knowledge of conservation issues and forest dynamics is key to making sound decisions related to location, extent, and intensity of management activity.

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Field Guide to Managing Canada Warbler Habitat

Companion to *Guidelines for Managing Canada Warbler Habitat in the Northeast and Mid-Atlantic Regions*

Status: Species of Greatest Conservation Need in all eastern states from NC to ME

Habitats: Moist deciduous, coniferous, and mixed forests with thick understory and open or broken canopy, including swamps, shrub thickets, riparian woodlands, bushy ravines, young forests, and tree-fall gaps. Special requirements include: complex forest floor, leafy subcanopy with trees 6-20 ft high, and open song perches.

Territory size: Typically 2.5-3 acres, ranging between 0.5 and 8 acres

Diet: Primarily mosquitoes, flies, moths, and caterpillars captured by flycatching, gleaning, and hover gleaning

Nest: On or near the ground, hidden in mossy hummocks or beneath root masses, down wood, and clumps of grass

Associated species: Varies geographically and includes alder flycatcher, American redstart, American woodcock, black-and-white warbler, chestnut-sided warbler, Louisiana waterthrush, magnolia warbler, Nashville warbler, northern waterthrush, olive-sided flycatcher, veery, yellow-bellied flycatcher, bobcat, moose, wood turtle

Recommended Forest Management Practices: When conducted in the appropriate context, some methods of timber harvesting can enhance habitat quality for Canada warblers and associated species. However, conservation benefits may be low in areas where suitable habitat occurs naturally, especially if invasive plants present a significant threat. For more discussion of where to create and sustain habitat, consult the complete guidelines. The following table summarizes options for creating the desired stand-level conditions.



from *Eastern Birds*, St. Martin's Press, 1981
jamescoo.com

Starting Condition	Objective	Management Options	Desired Condition
High canopy cover and low shrub/sapling density	Open canopy and increase light to the understory	Clearcut with reserves Seed-tree harvest Shelterwood Clearcut Patch cut with reserves Expanding-gap group shelterwood Group selection	Canopy height: < 50 ft Canopy cover: 5-85% Canopy tree basal area: < 70 ft ² /ac Subcanopy height: 6-20 ft Subcanopy cover: > 60% Moderate to high density of woody shrubs and saplings Low density of pole-sized and larger stems (> 5 in dbh) ≥ 5 song perch trees per acre, emerging ≥ 10 ft above the subcanopy, including trees along edge of forest openings
Open or even forest floor	Enhance forest floor structure	Leave/recruit snags Top and delimb felled trees near the stump Leave slash and logs Girdling	Uneven forest floor with down wood covering > 10% of the ground Moderate to high herbaceous plant, fern and moss cover (not just ferns)

Additional Considerations

- Where desired conditions exist, protect saplings, shrubs, and forest floor structure by minimizing travel and maximizing trail spacing and machine reach. If practical, harvest on snowpack or frozen ground and avoid felling and skidding during periods of nesting and fledgling activity (mid-May to mid-August).
- In timber harvests > 2 acres, retain 5 or more song perch trees per acre, scattered such that individuals and clumps are surrounded by > 15-ft openings. Choose stems that reach at least 10 ft above the regenerating layer. In larger cuts, consider creating blocks of 10 acres or more with these conditions.

Field Guide to Managing Canada Warbler Habitat



Harvests that retain residual trees and woody material (left) provide two key habitat elements, prominent song perches and complex ground structure. Clearcuts and first-cut shelterwoods (above right) may develop suitable subcanopy structure within five years (below left). Regenerating patch and group cuts (below right) may also support breeding Canada warblers, especially if clustered or located near rivers or swamps (bottom right).





Guidelines for Managing Rusty Blackbird Habitat in New York and Northern New England



Guidelines for Managing Rusty Blackbird Habitat in New York and Northern New England

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Text by Carol R. Foss (Audubon Society of New Hampshire) and J. Daniel Lambert (High Branch Conservation Services)



High Branch
Conservation Services

Cover photos of rusty blackbird and habitat by Rachel Rabinovitz, snowshoe hare by Tim Rains (CC BY 2.0), Swainson's thrush by Jeff Bryant (CC BY 2.0), and Nashville warbler by Bill Majoros (CC BY-SA 2.0). Maps by Andrew Toepfer Natural Resource Mapping and Cartographic Services.

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Introduction

Species profile

The rusty blackbird is an inconspicuous songbird, slightly larger than the more familiar red-winged blackbird, but noticeably smaller than the common grackle. Breeding males are glossy black, sometimes with a greenish sheen, and females are dull charcoal black. Both have bright yellow eyes. In late summer they molt into the rusty non-breeding plumage for which the species is named.

Rusty blackbirds spend their entire lives in North America (Fig. 1). The breeding range includes the boreal region from Alaska to Labrador and extends south through the Acadian forest into northern New England and New York. The wintering distribution lies primarily within the United States east of the Rocky Mountains.¹

In northeastern North America, rusty blackbirds breed in softwood-dominated stands in forested landscapes with an abundance of wetlands and low-gradient streams. Occupied landforms range from extensive lowland flats to mountainous terrain, at elevations from 980 to 2,600 ft. Typical nesting habitat consists of dense, young or stunted softwoods in or near a wetland.

Status and conservation concerns

Historical accounts suggest that Rusty Blackbird populations have been declining since at least the 1920s, and Breeding Bird Survey and Christmas Bird Count data indicate declines of more than 80% since the 1960s.^{2,3} Clearing of wintering habitat for agricultural uses may have been a primary cause of the long-term decline. Blackbird control efforts in southern states aimed at common grackles and red-winged blackbirds may also have affected wintering rusty blackbirds. Mercury contamination and acidification of breeding habitat may be contributing factors; however, their effects on rusty blackbirds are not well known. Available data suggest retractions to the north and higher elevations in the eastern part of the breeding range.⁴⁻⁸ Climatic influences are likely to be involved, but the mechanism underlying the shift has not yet been demonstrated.⁹

The rusty blackbird is listed as Endangered in Vermont, a Species of Special Concern in Maine and New Hampshire, and a high-priority Species of Greatest Conservation Need in Maine, New Hampshire, Vermont, and New York. The Committee on the Status of Endangered Wildlife in Canada designated the rusty blackbird a Special Concern species in 2006.

Purpose of the guidelines

These guidelines are designed to provide forest landowners and managers with an understanding of the habitat conditions and management actions that sustain rusty blackbird breeding populations in the Acadian Forest. They also describe how habitat conditions that benefit rusty blackbirds can benefit other native wildlife as well. Public and private land managers, forestry professionals, and conservation planners should find the information useful in accomplishing their stewardship objectives.



Figure 1. Rusty blackbird breeding and wintering ranges (based on Peterson 2008, Powell 2008, Fisher and Powell 2013, Audubon Society of NH unpubl. data, and BirdLife International and NatureServe 2015)

Where to Create and Sustain Habitat

Landscape characteristics

Rusty blackbirds inhabit large home ranges (10 to 430 acres) in extensive spruce-fir and mixed spruce-fir/northern hardwood forests with abundant wetlands and low gradient streams.¹⁰ Beaver-influenced wetland complexes are particularly favorable.^{11,12} Inhabited landforms range from extensive lowland flats to mountains interspersed with valleys.

In low-relief landscapes, rusty blackbirds often nest in forested wetlands that contain stunted conifers and surround shallow, open-water wetlands (Fig. 2). These areas typically appear as wetlands on stand maps or the National Wetlands Inventory. In high-relief landscapes with well-defined wetland/upland edges, rusty blackbirds may nest in regenerating softwood stands up to 800 ft from a mapped wetland where they travel to forage (Fig. 3). While these nest sites are not in mapped wetlands, they typically occur in seepage areas on partially hydric soils.



Figure 2. Rusty blackbird nest sites in a forested wetland surrounding shallow, open-water wetlands



Figure 3. Rusty blackbird nest sites in regenerating softwoods on uplands surrounding a beaver impoundment

Within the rusty blackbird's northeastern US range, management opportunities exist primarily in areas of Boreal Upland Forest and Northern Swamp, as classified by the Northeastern Terrestrial Habitat Classification System (Figure 4).¹³ Areas appropriate for considering this species' habitat needs in planning forest management include the following characteristics:

- softwood and mixed stands
- within 800 ft of a shallow wetland or low gradient stream
- hydric or partially hydric soils
- at elevations of 980 to 2,600 ft
- with slopes less than 40% (or 22°)

Rusty blackbird planning units should maximize inclusion of spruce-fir and mixed forest and minimize inclusion of hardwood stands. Blocks of suitable nesting habitat may occur within a mosaic of softwood, hardwood, and mixed-wood stands and age classes.

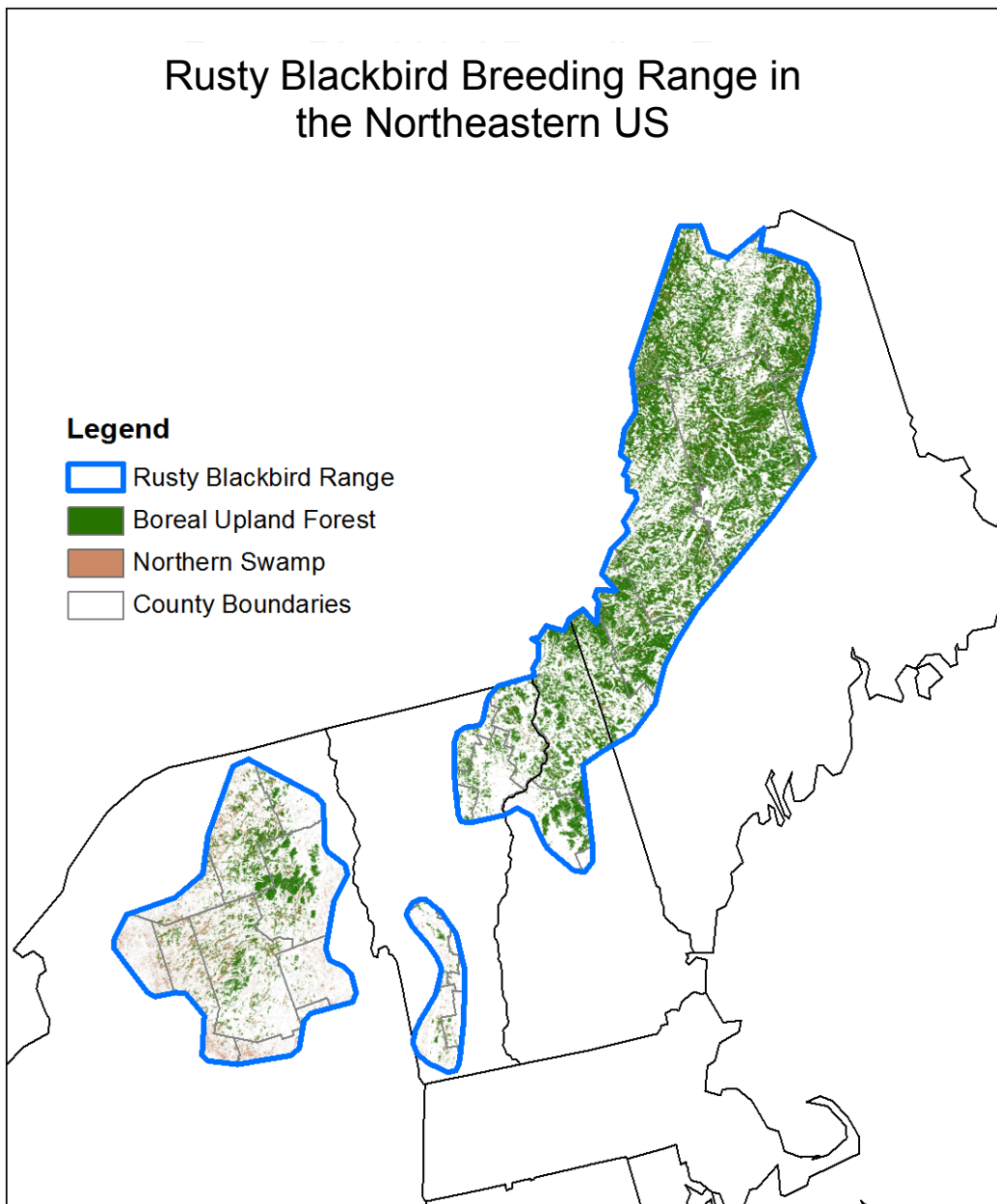


Figure 4. Rusty blackbird breeding range in the northeastern US with favored habitat classes

Desired Nesting Habitat Conditions ^{14,15}

Typical nesting habitat consists of dense, young or stunted softwoods (Fig. 5). In managed forests, rusty blackbirds usually nest in stands between approximately 5 and 15 years post-harvest. Tree growth rates vary depending on site conditions, and some patches may grow more or less rapidly than the majority of a stand. Such patches may extend the availability of suitable rusty blackbird nest sites at either end of the typical age range of suitability. The size of stands surrounding rusty blackbird nests varies widely from less than an acre to more than 100 acres. In commercial forests of Maine and New Hampshire, the stand size averages around 20 acres.



Figure 5. Dense softwood regeneration with seepage area in the foreground and emergent snags in the background

Scattered, live and dead residual overstory trees exceeding 13 ft in height are very important in rusty blackbird nest stands (Fig. 6). Species may include red and white spruce, balsam fir, tamarack, white pine, yellow and white birch, and red maple. Males watch for approaching predators from high perches near the nest site while the female is building the nest and laying and incubating eggs. When a male delivers food to an incubating female, she leaves the nest inconspicuously and joins him on a high perch to collect the food, returning by a circuitous route to avoid drawing attention to the nest location. Both adults check the vicinity from a series of high perches before delivering food to nestlings.



Figure 6. Multiple-aged regenerating softwoods with live and dead canopy trees available for high perches

Forest Composition and Structure

Forest type

- Spruce-fir

Age class structure

- Young, even-aged stands with scattered older trees

Overstory characteristics

- Canopy: open with trees dispersed individually and in clumps
- Composition: live or dead red spruce, white spruce, balsam fir, tamarack, white pine, white birch, yellow birch, and/or red maple
- Height: ≥ 13 ft

Regenerating stand characteristics

- $\geq 34\%$ softwood composition (primarily red spruce, white spruce and/or balsam fir; may also include white pine, tamarack) (Fig. 7)
- Height: 8-12 ft
- Diameter at breast height (dbh): 1.5-2 in
- Total horizontal cover (softwood and hardwood, all classes): $> 95\%$
- Total softwood cover: 35-100%
- Softwood seedling/sapling cover: 20-55%
- Total hardwood cover: up to 65%
- Patches of softwood saplings (dbh ≤ 4 in) with basal area ≥ 85 ft²/acre to provide cover for nesting (Fig. 8).

Recommended Practices

Methods to produce suitable forest composition and structure will vary by physiographic setting and each stand's starting condition. However, any practice that regenerates spruce and fir in the appropriate context has potential to benefit rusty blackbirds.

- The size and shape of a harvest area that creates nesting habitat will be dictated by topography and site conditions. Sizes may range from 2.5 to 100 acres; narrow, linear blocks should be avoided to the extent possible, especially adjacent to roads or mature softwood stands.
- Overstory removal with residual tree retention, in the presence of ample advance softwood regeneration, will consistently produce the desired conditions.
- Shelterwood harvests and clearcuts with retention can also be effective, but will take longer to reach the desired conditions.
- Retain mature dead and live trees, dispersed individually and in clumps, to maintain a scattering of overstory perch sites.
- Schedule harvests to provide a sapling softwood stand within 800 ft of a shallow wetland or low gradient stream throughout a rotation of the area.



Figure 7. Mixed-species softwood regeneration



Figure 8. Most rusty blackbird nests (70-80%) are supported by branches of 2-4 saplings.

Managing for Multiple Benefits

Most even-aged silvicultural strategies used to manage spruce-fir forests in the Northeast benefit rusty blackbirds directly by creating the young forest conditions they prefer for nesting. Special management considerations for this species include: applying silvicultural practices that maintain or increase the softwood component of the stand; implementing a harvest schedule that maintains at least one softwood stand in a sapling stage within 800 ft of a wetland; and retaining scattered snags for perching. Many wildlife species benefit from access to a diversity of age classes within their home ranges. Standing dead trees provide nesting and denning/roosting cavities for birds and mammals and foraging perches for raptors and aerial insectivores.

Associated species

While a diversity of bird and mammal species use regenerating softwood and mixed-wood stands during some part of their annual cycle, a few benefit particularly from these habitat conditions. Evidence of heavy use by moose and snowshoe hare is abundant in rusty blackbird nest stands. Other bird species that frequently nest in these stands include alder and olive-sided flycatchers, magnolia and chestnut-sided warblers, dark-eyed junco, and Swainson's thrush. Management to benefit rusty blackbirds in mixed forests also complements best management practices for American woodcock promoted by the Young Forest Project, a partnership of state and federal wildlife agencies, the Wildlife Management Institute, and a number of forest landowners.

Table 1. A partial list of Species of Greatest Conservation Need that could benefit from implementation of these guidelines. Species of high or very high regional concern are indicated in bold.

Species	Overlapping habitat(s)
Alder flycatcher	Moist riparian thickets, shrublands and young forests with high density of trees
Blackpoll warbler	Young spruce-fir forest at high elevations and latitudes
Canada warbler	Young mixed spruce-fir/northern hardwood forest, swampy areas
Chestnut-sided warbler	Young mixed spruce-fir/northern hardwood forest
Dark-eyed junco	Young coniferous and mixed forests
Magnolia warbler	Dense young spruce-fir forest
Nashville warbler	Second-growth mixed forests, moist openings with dense undergrowth
Olive-sided flycatcher	Wetlands and young forest with tall snags
Purple finch	Coniferous forest edges
Spruce grouse	Dense lowland conifers (especially spruce, fir, and tamarack) with small
Swainson's thrush	Damp, young spruce-fir forests
Tennessee warbler	Moist areas of young mixed spruce-fir/hardwood forest
Pygmy shrew	Moist forest floors with accumulated debris in coniferous and mixed forests
Bobcat	Young spruce-fir forest
Lynx	Young spruce-fir forest
Moose	Lowland softwoods, young forest, and beaver ponds
Snowshoe hare	Moist, dense, young spruce-fir forest



Figure 9. Species that often utilize rusty blackbird habitat include (l-r) magnolia warbler, olive-sided flycatcher, and moose.

Comprehensive planning

Rusty blackbirds are highly mobile and readily colonize recently disturbed forests. Young stands favored by this species are not suitable for some spruce-fir specialists associated with more mature forests, such as northern parula and Cape May and bay-breasted warblers. However, maintaining a patchwork of age classes within management units enables wildlife species to move among suitable habitat patches as stands age into and out of favorable conditions. Local knowledge of stand conditions, landscape context and long-term landowner goals for size and age-class structure will be the most effective guides to the selection and timing of silvicultural treatments.

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Field Guide to Managing Rusty Blackbird Nesting Habitat

Companion to *Guidelines for Managing Rusty Blackbird Habitat in New York and Northern New England*

Status: Endangered in Vermont, Species of Special Concern in Maine and New Hampshire, and a Species of Greatest Conservation Need in Maine, New Hampshire, Vermont, and New York.

Foraging habitat: shallow wetlands, seeps, exposed mud, puddles, ditches, moist leaf litter

Nesting habitat: sapling softwood or mixed stands, stunted softwoods on hydric soils

Nest site: nest typically concealed in a dense clump of spruce-fir saplings 3-10 ft above the ground, often supported by branches of multiple saplings

Special requirements: scattered, tall, standing live or dead wood in nesting and foraging areas

Territory or home range size: highly variable, depending on proximity of nest site to wetlands, estimated at 10 to 430 acres from radio telemetry

Diet (breeding season): primarily aquatic macroinvertebrates captured by probing or flicking aside dead vegetation; also flying insects and berries

Associated species: magnolia warbler, Nashville warbler, northern waterthrush, olive-sided flycatcher, Swainson's thrush, moose, snowshoe hare

Recommended Forest Management Practices: When conducted in the appropriate context, some methods of timber harvesting can enhance habitat quality for rusty blackbirds and associated species. However, conservation benefits may be low in areas where suitable habitat occurs naturally. For more discussion of where to create and sustain habitat, consult the complete guidelines. The following table summarizes options for creating the desired, stand-level conditions.



Adult rusty blackbirds in breeding plumage: charcoal gray female on left, glossy black male on right.

Eian Prohl

Starting Condition	Objective	Management Options	Desired Condition
Mature softwood stand High canopy closure	Regenerate stand	Overstory removal with retention of scattered dead and/or live trees Shelterwood harvest Clearcut harvest with retention	Thick regenerating stand of mixed or softwood saplings (1.5- 2 in DBH) measuring 8-12 ft in height Open canopy Residual overstory \geq 13 ft, composed of live and/or dead trees, dispersed individually and in clumps Softwood patches of saplings to small poles with basal area \geq 85 ft ² /acre

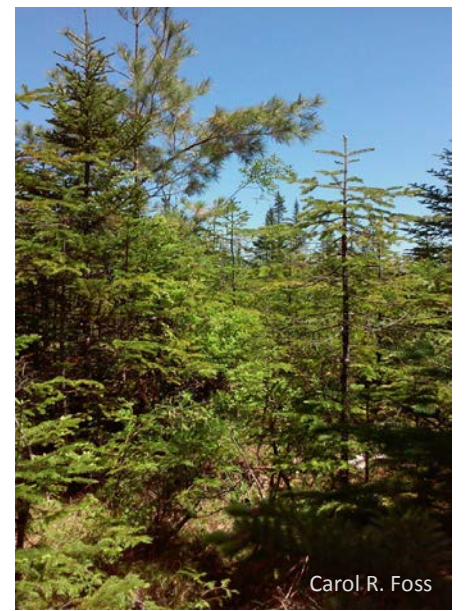
Field Guide to Managing Rusty Blackbird Nesting Habitat



Winter harvest in a mature softwood stand (l) and a mosaic of hardwood and softwood stands in various age classes (r)



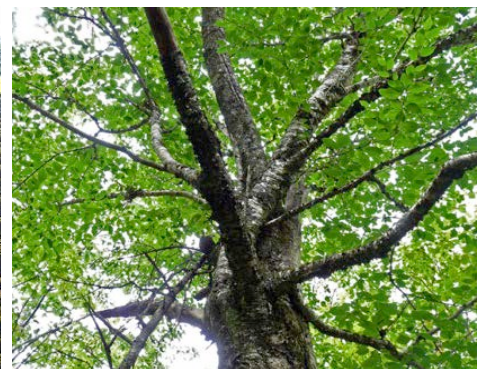
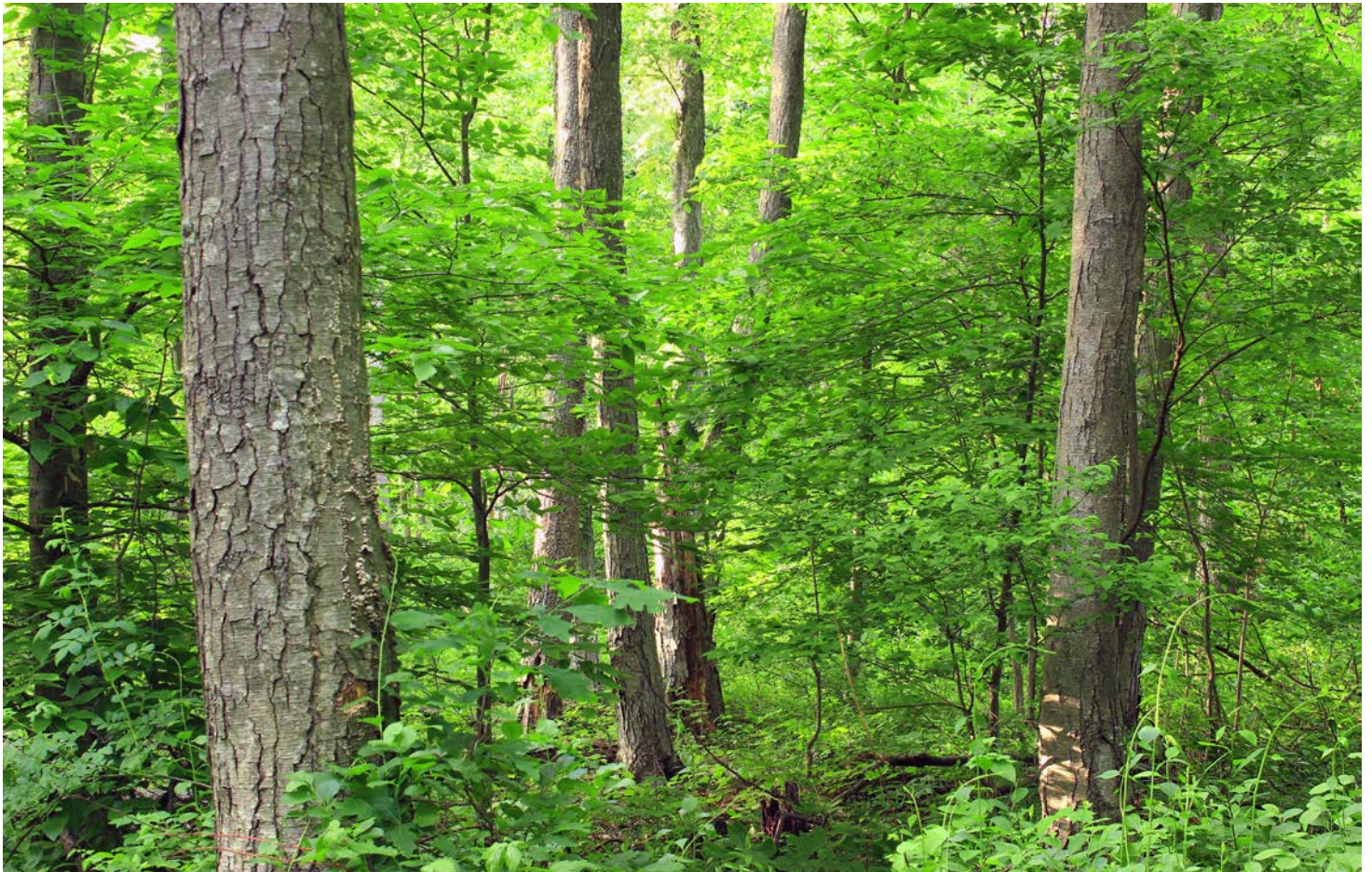
Softwood regeneration with snags in background (l) and mixed regeneration with live and dead trees retained (r).



Regeneration adjacent to seep (l), nest supported by branches of multiple saplings (center), and mixed species softwood regeneration (r).



Guidelines for Managing Wood Thrush and Scarlet Tanager Habitat in the Northeast and Mid-Atlantic Regions



Guidelines for Managing Wood Thrush and Scarlet Tanager Habitat in the Northeast and Mid-Atlantic Regions

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High Branch
Conservation Services



Cover photos: (top row l to r) by Kelly Colgan Azar (CC BY-ND 2.0), northcountrypublicradio.org, and Dan Lambert; (center) by Nicholas Tonelli (CC BY 2.0); (bottom l to r) by Kelly Colgan Azar (CC BY-ND 2.0), Carolyn Faught, and David Patriquin (WREO) (CC BY-NC-SA 2.0). Page 1 photos by Jerry Oldenettel (CC BY-NC-SA 2.0).

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Introduction

Species profiles

The wood thrush and scarlet tanager are Neotropical migratory songbirds that breed in deciduous and mixed forests of the eastern United States and southeastern Canada. Both species reproduce most successfully in extensive forests with heterogeneous structure, including a mix of large and small trees.¹⁻⁴ Wood thrushes nest in understory shrubs and trees and forage for invertebrates in loose leaf litter,^{1,5} whereas scarlet tanagers usually nest and forage above 25 ft.^{6,7} After the breeding period, wood thrushes and scarlet tanagers concentrate in sapling-dominated areas, where they molt and build fat reserves for migration.⁸⁻¹⁰ Wood thrushes overwinter in lowland tropical forests from southern Mexico to Panama,¹¹ while Scarlet tanagers migrate further south to the rainforests of Peru, Ecuador, and Colombia.¹²

Status and conservation concerns

In the US Northeast, both species reach their highest densities in the central Appalachian region and occur at relatively low numbers in northern forests. Compared to scarlet tanagers, wood thrushes are more abundant overall, especially across the Middle Atlantic Coastal Plain (Fig. 1).

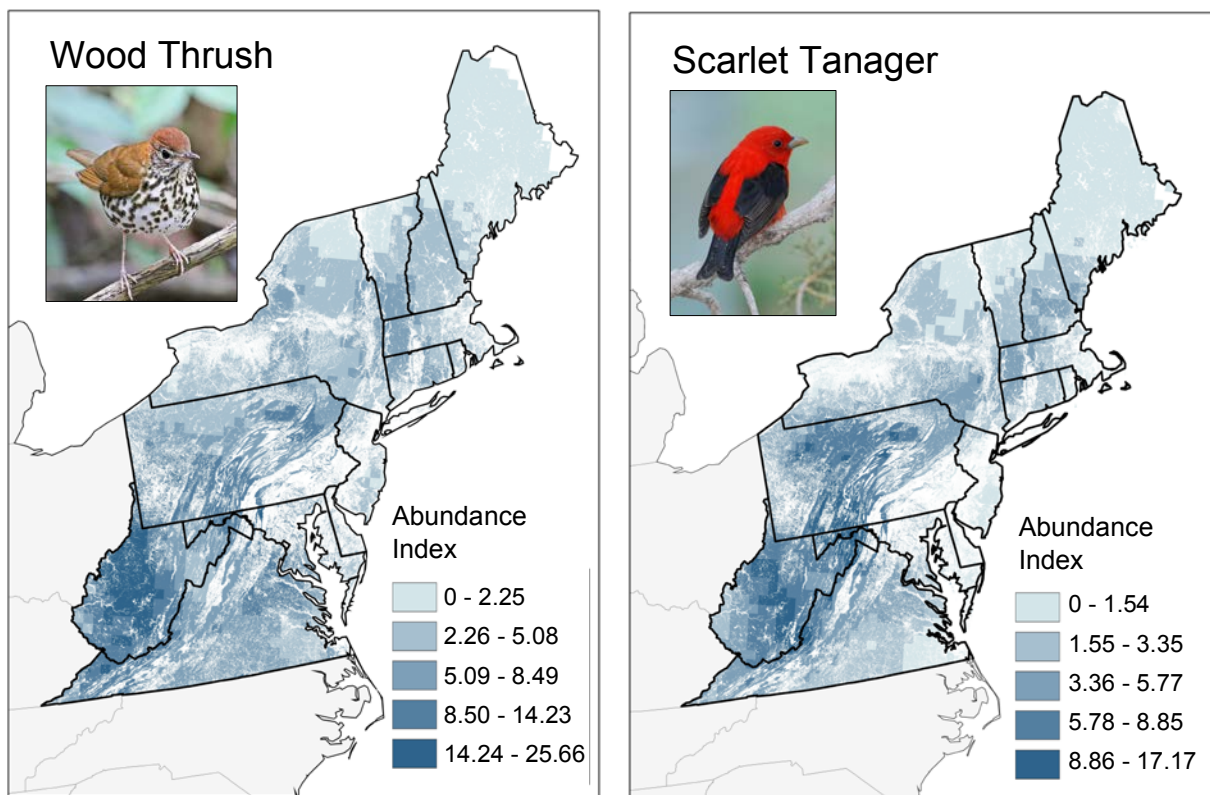


Figure 1. Relative abundance of wood thrush and scarlet tanager in northeastern forests based on a five-year average of Breeding Bird Survey route counts (2008 to 2012). Survey routes consist of 50 roadside sampling stations located at 0.5-mi intervals.¹³ Values categorized by natural breaks in the data.

Since 1966, numbers of wood thrush have been decreasing throughout most of its breeding range (Fig. 2), with particularly severe declines in the Atlantic Northern Forest (-4.55% per year) and along the New England-Mid-Atlantic Coast (-2.77% per year).¹³ The persistent, negative trends have prompted every state from Virginia to Maine to designate the wood thrush a Species of Greatest Conservation Need (SGCN).

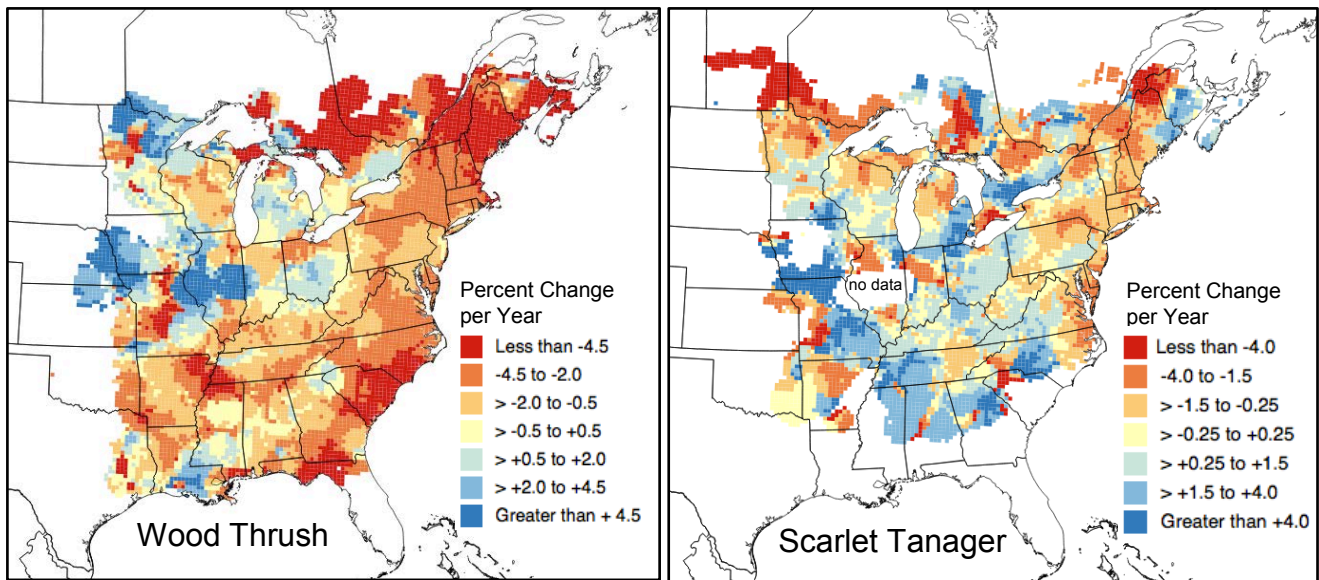


Figure 2. Wood thrush and scarlet tanager population trends, 1966-2012 (Sauer et al. 2014).

Scarlet tanager populations are stable or increasing in much of the southern Appalachian region, but annual declines of more than 1.5% have been observed in the Atlantic Northern Forest, across the eastern Allegheny Plateau, and along the New England-Mid-Atlantic Coast (Fig. 2). The species has received SGCN designations in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and the District of Columbia.

Factors contributing to these regional declines include loss of nesting habitat to development and impaired reproduction in remaining forest fragments.¹⁴⁻¹⁸ Thrushes and tanagers breeding in developed landscapes are exposed to elevated risk of nest predation by crows, jays, and squirrels as well as brood parasitism by brown-headed cowbirds.^{15,19-21} Some studies also link wood thrush decline to: over-browsing of the understory by deer;²² the depletion of calcium from forest food webs, resulting from acid deposition;^{23,24} and low overwinter survival, which may stem from loss of non-breeding habitat or changes in tropical precipitation.²⁵ Threats to scarlet tanager during migration and on the wintering grounds are not well understood.^{12,25} However, both the wood thrush and scarlet tanager are among the bird species most frequently killed by collision with buildings.²⁶

Purpose of the guidelines

The purpose of these guidelines is to promote the conditions and processes that sustain wood thrushes, scarlet tanagers, and other species that depend primarily on mature deciduous and mixed forest habitat in the Northeast and Mid-Atlantic regions. Information presented here may be useful to conservation planners, land managers, and forestry professionals who are working to foster the many ecological and societal values of healthy forest ecosystems.

Effective approaches to conserving these species will vary throughout the region, depending on prevailing land uses, stressors, and wildlife management priorities. In recognition of this heterogeneity, these guidelines offer forest management and conservation strategies that should be selectively applied based on local knowledge and stewardship objectives. In general, harvest-based strategies are likely to be most useful in areas of active forest management. Forest preservation may also be effective at sustaining wood thrush and scarlet tanager populations on large tracts that contain the requisite soils, forest types, and

natural disturbance agents. Combined approaches can be applied to areas where harvesting is limited but conservation objectives call for some level of habitat manipulation.

Where to Create and Sustain Habitat

Landscape characteristics

Efforts to protect and/or manage habitat for wood thrushes and scarlet tanagers should focus primarily on forested landscapes, especially forest blocks over 250 acres^{2,3,27} with > 80% forest cover within 0.6-1.2 mi^{28,29} and > 65% forest cover within 3.1 miles.⁴ Local information about development pressure and avian productivity can help forest stewards tailor these parameters to areas where they work.

Area-sensitive birds may persist for some time in forest fragments, despite marginal conditions, thanks to immigration from larger forests.^{17,30} However, low rates of pairing¹⁷ and reproduction^{15,16,19} in these areas may destabilize regional populations. Therefore, efforts to support wood thrush and scarlet tanager populations should avoid residential, commercial, and agricultural landscapes except where recommended forest thresholds could be achieved through habitat restoration.

Suitable landforms for wood thrush include broad valleys, coastal plains, and uplands that contain open water, streams, and wetlands (Fig. 3a).^{31,32} Moist soils in these areas help maintain damp leaf litter and a supply of invertebrate prey.³³ Wood thrushes breed up to about 2,500 ft in New York and northern New England and up to 4,000 ft in the southern Appalachian Mountains.³⁴

Scarlet tanagers also breed across a wide range of physical settings from the Atlantic Coastal Plain to the Appalachian Mountains.¹³ However, they show an affinity for hilly areas,^{32,35,36} where wind-throw and topographic relief help maintain an uneven canopy (Fig. 3b).

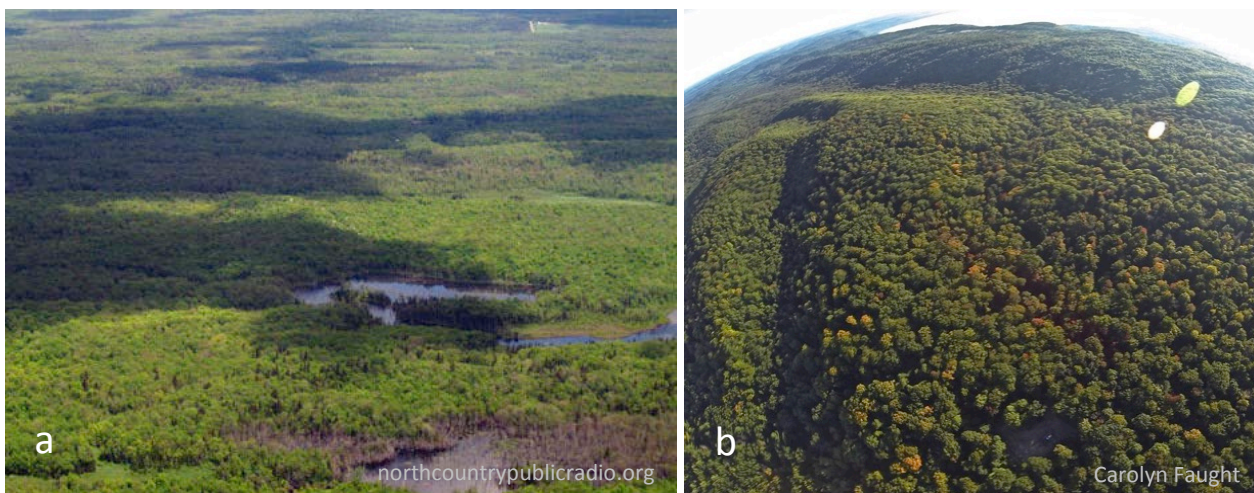


Figure 3. Large blocks of moist forest (a) provide excellent habitat for breeding wood thrushes. Scarlet tanagers tend to be most abundant in hilly forest landscapes (b).

Desired Habitat Conditions

For birds of woodland interiors, forest extent may be more important than stand-level habitat features in shaping patterns of abundance and productivity.^{4,37} Still, wood thrushes and scarlet tanagers consistently reach their highest breeding densities in mature to old forests that are dominated by hardwoods and contain a mix of large and small trees. The layered vertical structure may result from canopy openings created by forest management or natural disturbance.

Although desired conditions for wood thrushes and scarlet tanagers overlap substantially, a number of subtle distinctions have been observed. Below, we describe the breeding habitat of each species separately and then summarize common attributes in Table 1. Because differences in use of post-breeding habitat are less apparent, we present a single set of desired conditions for this phase of the annual life cycle.

Wood thrush breeding habitat

Wood thrushes primarily breed in hardwood forests, but also occur in hardwood-dominated mixed woods.^{27,38,39} Common canopy species include oaks, hickories, maples, pines, American beech, American basswood, black birch, and tulip trees. Spicebush, sassafras, witch hazel, honeysuckle, rhododendron, maple-leafed viburnum, striped maple, and flowering dogwood are some of the smaller trees commonly found in wood thrush territories.^{1,31,40} Fruit-bearing trees and shrubs are particularly valuable because they provide high-calorie food for migration.⁴¹

Wood thrushes usually select forests of intermediate to old age, including multi-aged stands in which partial timber harvests and natural tree-fall gaps have contributed to the development of adequate subcanopy structure (Fig. 4).^{36,42} Nesting may also occur in large regenerating stands if 10-20% of the original stand is retained.⁴³ If all trees have been removed from a site, wood thrushes may begin to colonize the regrowth once it reaches about 40 ft in height and succeeds beyond the pole stage.^{31,28,44}

The following structural features generally characterize productive habitat for breeding wood thrushes.

- Canopy height: > 50 ft^{1,31,38}
- Upper canopy cover: 45-75%⁴⁵
- Subcanopy height: 10-20 ft⁴⁰
- Subcanopy cover: 55-80%^{40,45}
- Total canopy cover (upper canopy and subcanopy, combined): > 80% (Fig. 5)^{1,36,38,40,46}
- Basal area of trees ≥ 4 in dbh: 90-130 ft²/ac^{38,44}
- Tree diameters: Wide-ranging^{4,36}
- Forest floor: Semi-open or open with a thick layer of leaves (Fig. 5)^{5,33,38}



Figure 4. Tall shrubs and saplings provide concealment for wood thrush nests and dispersing young.



Figure 5. A well-developed, layered canopy delivers a steady supply of leaf litter to the forest floor. Prey density and foraging efficiency is greatest on open forest floors that feature a thick layer of decaying leaves.

Scarlet tanager breeding habitat

In the Mid-Atlantic and Northeast regions, scarlet tanagers breed in oak-hickory, oak-pine, and beech woodlands, as well as northern hardwood, eastern hemlock, and hardwood-hemlock forests.^{12,47} In New England, they also occur in aspen-birch stands and red maple swamps.^{47,48} In central Appalachian hardwoods, white oak is most frequently used for nesting, while red oak and red maple are avoided.³⁵ Further north, where white oak is uncommon, scarlet tanagers regularly use red oak stands.⁴⁶ In northern hardwood forests, scarlet tanagers preferentially forage in yellow birch, due to high prey density, but tend to avoid sugar maple when feeding.⁴⁹

Subcanopy composition varies geographically, but may include hophornbeam, serviceberry, striped maple, and sumac, in addition to saplings of the canopy species.^{36,47,50}

Scarlet tanagers nest and forage in leafy, overhead cover across a range of heights, usually above 25 ft.^{6,7} During breeding, they are most abundant in mature to old forests where openings in the upper canopy have enabled the development of layers below (Fig. 6).^{36,47,50,51} Once a stand reaches the poletimber size class, with tree diameters measuring 5-11 in at breast height, it may begin to attract scarlet tanagers during the nesting season.⁵⁰

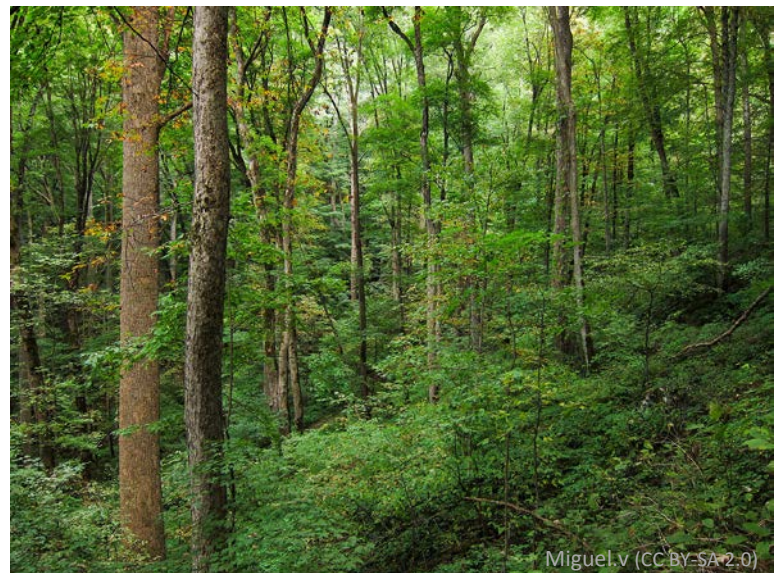


Figure 6. Scarlet tanagers inhabit a variety of deciduous and mixed forests with well developed, mid-canopy and understory layers.

The following features generally characterize productive habitat for breeding scarlet tanagers.

- Canopy height: > 50 ft ^{17,35,36,38}
- Total canopy cover (upper canopy and subcanopy, combined): 40-95% ^{17,35,36,38,47,53}
- Basal area of live trees (≥ 4 in dbh): > 90 ft²/ac in unharvested stands ^{17,35,38,44,53} and > 40-70 ft²/ac in recently harvested stands ^{35,44,53}
- Tree diameters: wide-ranging, including large trees (>15 in dbh) for nesting (Fig. 7) ^{9,35,50}
- Moderate to high density of small trees forming a well-developed mid-canopy layer ^{36,38,47}



Figure 7. Large canopy trees provide sizeable support branches for scarlet tanager nests while full, sunlit crowns often contain abundant invertebrate prey.

Wood thrushes and scarlet tanagers both inhabit mature, hardwood-dominated forests with trees in multiple diameter classes and high total canopy cover (upper canopy and subcanopy, combined). But compared to wood thrushes, scarlet tanagers are associated with a broader range of canopy and basal area conditions (Table 1).

Table 1. A comparison of major structural attributes of wood thrush and scarlet tanager breeding habitat.

Structural Attribute	Wood thrush	Scarlet tanager	Overlap
Canopy height	> 50 ft	> 50 ft	> 50 ft
Tree diameters	Wide-ranging	Wide-ranging	Wide-ranging
Basal area of live trees (≥ 4 in dbh)	90-130 ft ² /ac	> 40-70 ft ² /ac	90-130 ft ² /ac
Total canopy cover	> 80%	40-95%	80-95%

Post-breeding Habitat

Like most birds that breed in mature forests, wood thrushes and scarlet tanagers utilize areas of high sapling density during the post-breeding period, including regenerating harvest zones. ^{8-10,54-57} These thickets offer protective cover at a time when risk of mortality is high. ⁵⁸ They may also contain abundant fruits and invertebrates, which provide essential nutrients for molting and migration. ^{41,59,60} Forests that meet the following criteria may provide high-quality post-breeding habitat for the focal species and for other migratory songbirds, as well.

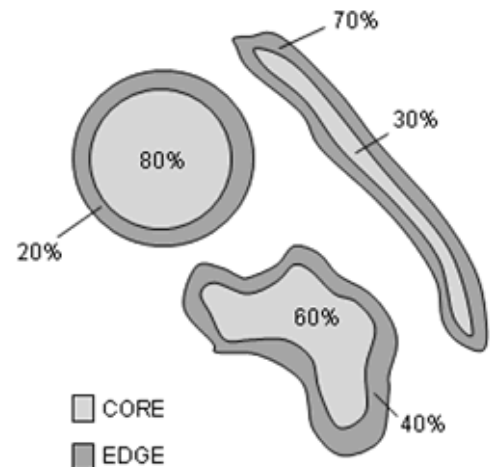
- Deciduous saplings and/or woody shrubs occur in high density ^{8,10,57}
- Native, fruit-bearing trees and shrubs are present ^{41,59,60}
- Canopy characteristics vary, but open or semi-open canopies are most compatible with desired understory structure

Recommended Practices

Methods to promote the desired landscape- and stand-level conditions will vary based on each site's characteristics and surrounding context. In general, land stewards are advised to apply local understanding of forest dynamics, assess effects of management and conservation activities, and make adjustments as new knowledge is gained. Still, several strategies are likely to maintain or create habitat for wood thrushes, scarlet tanagers, and associated species when applied to the appropriate setting.

Land conservation

- Direct conservation resources toward forests with known populations of the focal species, especially where productive soils naturally sustain high tree vigor and tall canopies.
- Give special consideration to sites with features that naturally maintain vertical layering and horizontal patchiness, such as hillsides, streams, and wooded wetlands.
- Conserve habitat blocks > 250 acres in landscapes with > 65-80% forest cover.^{2,4,27,28}
- Favor forest units with large core areas and low edge-to-area ratios in order to reduce the risk of predation and brood parasitism originating from surrounding agriculture or development (Fig. 8).^{3,61}
- Develop easements and stewardship plans that allow forestry practices that maintain or enhance wood thrush habitat.



© Kennedy et al. 2003

Figure 8. Circular patches offer more core habitat than other shapes.

Infrastructure siting and mitigation

- Cluster new construction near existing roads (Fig. 9) and make use of previously disturbed lands.⁶²
- Avoid developing forests with embedded wetlands or high topographic relief.
- Minimize the footprint of residential, commercial, and energy development.
- Mitigate conversion of forest to non-forest with strategic reforestation.
- Reduce the amount of impervious surface within 0.3 mi of forested areas.⁶³

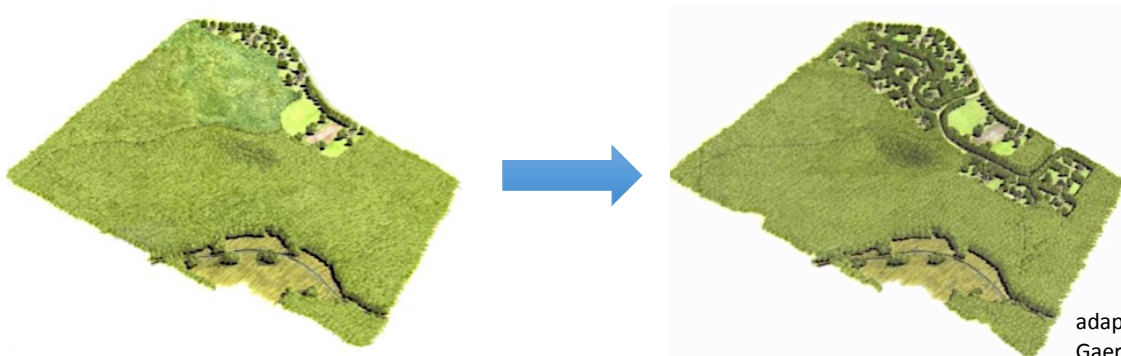


Figure 9. Clustering development near existing roads minimizes forest fragmentation.

Forest management

- In pole-sized stands, accelerate the development of a high, vigorous canopy with light or variable retention thinning, crop-tree release, or crop-tree release with canopy gap formation (Fig. 10).^{47,64}



Figure 10. Methods of release and thinning that increase light to the understory can improve habitat, along with timber value, by increasing canopy vigor and adding layers to even-aged stands. Thinning at variable densities may simulate natural disturbance and add horizontal complexity.

- In mature stands, maintain or create understory structure and horizontal patchiness with single-tree selection, variably sized group selection (up to 0.5 ac), and/or expanding gap group shelterwoods.^{42,43,46,64,65} Larger group cuts (up to 2 ac) could be used sparingly to meet targets for post-fledging cover and to provide habitat for young forest breeders (Fig. 11).



Figure 11. Differently sized group cuts with variable retention can enhance the patchy and layered structure favored by wood thrushes and scarlet tanagers, particularly if conducted in homogeneously structured forests. Small group cuts (< 0.25 ac) simulate natural tree-fall gaps while larger harvests fall within the historic size range of infrequent disturbance events such as microbursts, ice storms, severe fires, and major hurricanes.⁶⁵

- In areas where uneven-aged methods do not meet goals for timber production, consider implementing a shelterwood or shelterwood-with-reserves system (Fig. 12). Although most mature forest associates are likely to decline, an initial cut that retains > 50% stocking may help regenerate oak and provide suitable conditions for breeding tanagers until the canopy is eventually removed.⁵⁰
- In central Appalachian oak forests where shelterwood cutting is followed by prescribed fire, apply moderate or repeated low-intensity fires to maintain understory structure suitable for nesting and post-fledging cover.⁶⁶⁻⁶⁸
- Where clearcuts are used to meet management objectives, retain trees > 50 ft in height, either scattered or in clumps, so that residual basal area exceeds 10-20 ft²/ac.⁴² Also, consider long rotations

and intermediate treatments (e.g., variable retention thinning) to enable the development of layered forest structure.^{46,64}

- Leave some deciduous trees > 15 in dbh.⁵⁰ Increased vigor of these and other remaining crowns may enhance nesting cover and foraging opportunities for canopy-dwellers, like scarlet tanager. Higher foliage volumes could also benefit wood thrush and other species that either nest in the lower canopy or forage for invertebrates in moist leaf litter.



Figure 12. View of the canopy in a first-cut, oak shelter-wood that meets the stocking and basal area requirements of scarlet tanager breeding habitat.

- Retain tree species of high value to birds, such as white oak, red oak, yellow birch, hophornbeam, spicebush, dogwood, and other native, fruit-bearing plants.
- Maintain high sapling and/or tall shrub density over 5-25% of the management unit. These areas may occur beneath open, partial, and mainly closed canopies^{8,9} and should be well distributed to increase the likelihood of encounter by moving birds.
- Individual sapling patches could range in size from 0.25 to tens of acres. Their size is less important than their overall availability and distribution. Wood thrush fledglings may move 100-125 yards between patches and range across 4 to 9 acres before migrating.⁸ Scarlet tanagers show similar mobility, but will range more broadly (up to 40 ac) unless they remain on their breeding territories until migration.⁹
- Where invasive species are a problem, apply best practices in invasive plant and earthworm control to promote regeneration of native flora and leaf-litter fauna. When possible, treat invasive plants before harvest and clean tires of forestry equipment between jobs.
- Avoid scattering large amounts of woody material in harvest zones, but if deer-browsing pressure is high, create pockets of slash to impede deer movement and restrict access to young growth.
- Encourage hunting to limit effects of deer browse on forest structure and composition, especially in areas where deer densities exceed 10-20 deer/mi².²
- To minimize disturbance of regenerating vegetation and compaction of the forest floor, restrict heavy machines to temporary routes and landings, utilize tracked vehicles when practical, and conduct harvests when the ground is dry, frozen, or covered by snowpack.
- Limit the number, length, and width of skid trails and haul roads to the minimum required to implement the management plan.
- If at all possible, avoid harvesting during periods of nesting and fledgling activity (May to mid-August).

Managing for Multiple Benefits

Associated Species

Current understanding of wood thrush and scarlet tanager ecology remains incomplete, particularly with respect to the relative influence of breeding, wintering, and migration factors on population dynamics. Still, detailed knowledge of their breeding and post-breeding habitat requirements can inform efforts to support these and many co-occurring species. This group includes species that inhabit large forest tracts (e.g., Acadian flycatcher, broad-winged hawk and American black bear); animals that forage in thick leaf litter (e.g., eastern box turtle); and wildlife associated with forest openings and understory vegetation (e.g., Canada, worm-eating, and Kentucky warblers; Table 2).

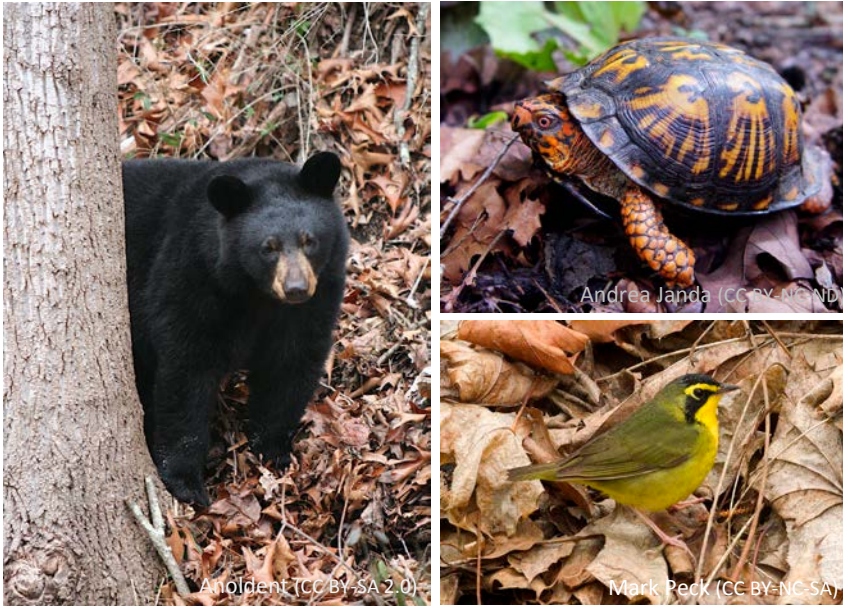


Figure 13. Managing forests for wood thrushes and scarlet tanagers may also benefit other Species of Greatest Conservation Need, including black bears, eastern box turtles, and Kentucky warblers.

Ecosystem services

Large tracts of forest that are maintained as wildlife habitat also store carbon, control floods, and provide clean air and water. In addition, wooded landscapes support culturally important recreational pursuits, such as wildlife observation and hunting, as well as livelihoods in the forest products, tourism, and outdoor industries. For these reasons, good stewardship of wood thrush and scarlet tanager habitat contributes to the resilience of natural and human communities amidst accelerating global change.

Comprehensive planning

Because the wood thrush and scarlet tanager depend on a mix of forest age classes to reproduce and survive in temperate woodlands, they serve as useful focal species for conservation and management planning. In fact, a high percentage of northeastern and mid-Atlantic species stand to gain from forest protection and harvest activities that maintain heterogeneous structure in hardwood-dominated landscapes.^{52,69,70} But since no individual set of guidelines will meet the needs of all species, land stewards should consider how implementing practices recommended in this document could affect species that are not associated with mature forest habitat. In particular, efforts to manage for late-successional or old-growth conditions should consider the needs of young-forest and disturbance-dependent species, such as golden-winged warbler, brown thrasher, eastern towhee, and New England and Appalachian cottontails.

Ultimately, science-based approaches that account for the broader geographic context are most likely to support native wildlife and the integrity of their habitats. Those with local knowledge of conservation issues and forest dynamics are in the best position to make decisions related to the location, extent, and intensity of management activity.

Table 2. A partial list of Species of Greatest Conservation Need that inhabit mature or multi-aged forests and could benefit from implementation of these guidelines. Species of high regional concern are indicated in bold. Species co-occurrence varies across the region.

Species	Habitat associations
Acadian flycatcher	Deciduous forests, especially near streams
American woodcock	Moist, young deciduous and mixed forests
Black-and-white warbler	Deciduous and mixed forests
Black-throated blue warbler	Deciduous and mixed forests with dense understory
Blackburnian warbler	Mixed and coniferous forests with high canopy
Broad-winged hawk	Deciduous and mixed forests
Brown creeper	Mixed and coniferous forests, especially with abundant snags
Canada warbler	Moist deciduous, mixed, and coniferous forests with dense understory moisture
Cerulean warbler	Deciduous forests with tall trees and canopy gaps
Eastern wood pewee	Deciduous and mixed forests
Hooded warbler	Deciduous forests with dense shrubs, especially near streams
Kentucky warbler	Deciduous forests with dense understory
Louisiana waterthrush	Hilly deciduous forests, near streams
Northern goshawk	Deciduous and mixed forests
Ovenbird	Deciduous and mixed forests
Pileated woodpecker	Deciduous and mixed forests
Red-eyed vireo	Deciduous and mixed forests
Rose-breasted grosbeak	Deciduous and mixed forests, forest edges, parks
Ruffed grouse	Deciduous and mixed forest with multiple age classes, including young forest
Veery	Deciduous forests with dense understory
Worm-eating warbler	Shrubby pockets in sloping deciduous forests
Allegheny wood-rat	Rocky areas in deciduous forests
American black bear	Deciduous and mixed forests with canopy gaps and fruiting plants
Long-tailed shrew	Moist deciduous, mixed, and coniferous forests with rocky areas
Northern flying squirrel	Deciduous, mixed, and coniferous forests, especially with abundant snags
Copperhead	Deciduous and mixed forest with open, rocky areas
Eastern box turtle	Deciduous and mixed forests with moist leaf litter
Mountain earth snake	Deciduous and mixed forests on hillsides
Timber rattlesnake	Deciduous forests with rocky areas
Jefferson salamander	Deciduous forests with moist leaf litter and vernal pools

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Field Guide to Managing Wood Thrush Habitat

Companion to *Guidelines for Managing Wood Thrush and Scarlet Tanager Habitat in the Northeast and Mid-Atlantic Regions*

The wood thrush is similar in size and shape to the American Robin, but has a cinnamon-colored back, white under-parts, and a boldly spotted breast. Males and females are similar in appearance, but immature birds have more spots than adults.



Kelly Colgan Azar (CC BY-ND 2.0)

Status: Species of Greatest Conservation Need in every state in the Northeast and Mid-Atlantic regions

Habitats: Nests in mid- to late-successional deciduous and mixed forests with a moderate to closed canopy, a layer of tall shrubs and small trees, and an open forest floor, including forested wetlands, riparian areas, and mesic uplands. Uses sapling-dominated areas for protective cover and feeding before migrating to the tropics.

Territory size: 0.2 to 7 acres with occasional movement into neighboring territories

Diet: Predominantly invertebrates probed from the leaf litter or gleaned from low vegetation. Late-summer diet shifts towards fruits like spicebush berry, fox grape, blueberry, holly, elderberry, black cherry, etc.

Nest: Placed at different heights in shrubs, saplings, and trees, usually 8-13 ft off the ground on a sheltered limb or in the branch fork of a sapling or shrub. Often concealed by foliage. May face greater predation risk in low shrubs.

Associated Species: Varies geographically and includes Acadian flycatcher, black-and-white warbler, black-capped chickadee, black-throated blue warbler, Blackburnian warbler, broad-winged hawk, cerulean warbler, eastern tufted titmouse, eastern wood pewee, great crested flycatcher, hooded warbler, Kentucky warbler, least flycatcher, Louisiana waterthrush, northern goshawk, ovenbird, pileated woodpecker, red-eyed vireo, rose-breasted grosbeak, scarlet tanager, veery, American black bear, northern flying squirrel, and eastern box turtle

Recommended Forest Management Practices: Some methods of timber harvesting and prescribed burning can enhance habitat quality for wood thrushes and associated species. However, conservation benefits may be low in forests < 250 acres and in areas where suitable habitat occurs naturally - especially if invasive plants present a significant threat. For more discussion of where to create and sustain habitat, consult the complete guidelines. The following table summarizes options for maintaining or creating the desired stand-level conditions.

Starting Condition	Objective(s)	Management Options	Desired Condition
Mature forest with a well-developed subcanopy and patches of high sapling density (same as desired conditions)	Maintain desired conditions Simulate natural disturbance events	Single-tree selection Group selection Expanding-gap group shelterwood Prescribed fire (moderate or repeated low-intensity burns)	Canopy height: > 50 ft Upper canopy cover: 45-75% Subcanopy height: 10-20 ft Subcanopy cover: 55-80% Total canopy cover: > 80 % Basal area: 90-130 ft ² /ac
Pole-sized to mature forest with: a) canopy trees exhibiting low growth and vigor; and/or b) low density of tall shrubs, saplings, and small trees	Increase the amount of light that reaches dominant crowns and the understory in order to promote canopy vigor and sub- to mid-canopy nesting structure	Light thinning Variable density thinning Crop-tree release Crop-tree release with canopy gap formation Group selection	Tree diameters: wide-ranging, from saplings to trees > 15 in dbh Moderate to high density of woody shrubs and saplings > 1 in dbh Relatively open forest floor with a thick layer of leaves Low to moderate ground cover Low level of down wood

Additional Considerations

- In even-aged silvicultural systems, retain some tall trees (> 50 ft) and ensure that residual basal area exceeds 10 ft²/ac.
- Control invasive plants before harvest and limit spread of invasive plants and earthworms by cleaning tires between jobs.
- Harvest on dry or frozen ground and restrict heavy equipment to temporary routes and landings.
- If possible, avoid felling and skidding during periods of nesting and fledgling activity (May to mid-August).

Field Guide to Managing Wood Thrush Habitat

Recommended Practices



A winter selection harvest with a forwarder minimizes leaf litter and understory damage, as well as risk to nesting birds. Cleaning soil and plant parts from equipment limits the spread of invasive plants and earthworms.



A thinning of this hardwood stand (l) created good subcanopy nesting structure. Wood thrushes usually nest 8-13 ft off the ground. Reproductive success is related to the amount of concealing foliage. This relatively exposed nest was parasitized by a cowbird. The cowbird nestling is shown begging at the edge of the cup.



Deep and moist leaf litter provides habitat for snails, beetles, and other calcium-rich invertebrates that enable ground-foraging birds to meet the nutritional demands of egg-laying.

Field Guide to Managing Scarlet Tanager Habitat

Companion to *Guidelines for Managing Wood Thrush and Scarlet Tanager Habitat in the Northeast and Mid-Atlantic Regions*

In full breeding plumage, male scarlet tanagers are bright red with solid black wings and tail. Females have an olive head, back, and rump, a dull yellow breast, and dark wings.



Status: Species of Greatest Conservation Need in CT, DE, MA, ME, MD, NH, NJ, NY, RI and District of Columbia

Habitats: Mature deciduous and mixed forests with tall trees, moderately open to closed canopy, and well-developed understory. Also found in young forests and open spaces prior to fall migration.

Territory size: 6-14 ac while breeding with territory cores 1.5-2.5 ac.

Diet: Flies, moths, butterflies, cicadas, termites, ants, spiders, fruit, and buds. Forages in the mid-story and upper canopy during breeding by hover-gleaning, flycatching, and probing bark; at lower levels when using young forest.

Nest: Made with materials from the forest floor on a junction of horizontal branches, located 8 to > 70 ft off the ground (usually > 25 ft) in a large deciduous tree. Cover from leaves and thick branches protects eggs and young.

Associated species: Varies geographically and includes Acadian flycatcher, black-and-white warbler, black-throated blue warbler, Blackburnian warbler, cerulean warbler, downy woodpecker, eastern tufted titmouse, eastern wood pewee, great-crested flycatcher, hooded warbler, Kentucky warbler, Louisiana waterthrush, northern goshawk, ovenbird, pileated woodpecker, veery, wood thrush, worm-eating warbler, and yellow-throated vireo.

Recommended Forest Management Practices: Some methods of timber harvesting and prescribed burning can enhance habitat quality for scarlet tanagers and associated species. However, conservation benefits may be low in forests < 250 acres and in areas where suitable habitat occurs naturally - especially if invasive plants present a significant threat. For more discussion of where to create and sustain habitat, consult the complete guidelines. The following table summarizes options for maintaining or creating the desired stand-level conditions.

Starting Condition	Objective(s)	Management Options	Desired Condition
Mature forest with a well-developed subcanopy and patches of high sapling density (same as desired conditions)	Maintain desired conditions Simulate small-scale natural disturbance events	Single-tree selection Small-group selection Crop-tree release with or without canopy gap formation Expanding-gap group shelterwood	Canopy height: > 50 ft Canopy cover: 40-95% Basal area: > 90 ft ² /ac Tree diameters: wide-ranging, including large trees for nesting
Pole-sized to mature forest with: a) canopy trees exhibiting low growth and vigor; and/or b) little vertical layering	Increase the amount of light that reaches dominant crowns and the understory in order to promote tree growth, canopy vigor, and mid-canopy nesting structure.	Light to heavy thinning Crop-tree release Single-tree selection Small-group selection	Moderate to high density of tall shrubs and small trees forming leafy understory
Mature forest in an even-aged management scenario (e.g., commercial timberland)	Maintain or enhance canopy nesting and foraging structure between initial entry and canopy removal. Create young forest to provide cover and food resources during the post-fledging period. Regenerate high-value oaks.	Shelterwood Shelterwood with reserves Shelterwood with prescribed burning (in oak-hickory)	- Canopy height: > 50 ft - Residual stocking: > 50% - Residual basal area: > 40-70 ft ² /ac - High density of advanced regeneration

Additional Considerations

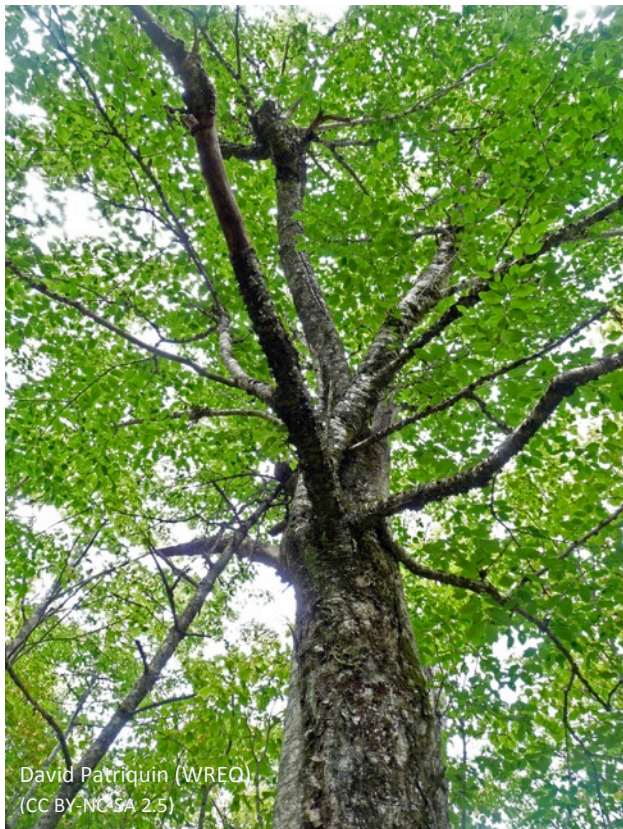
- Control invasive plants before harvest and limit spread of invasive plants and earthworms by cleaning tires between jobs.
- Harvest on dry or frozen ground and restrict heavy equipment to temporary routes and landings.
- If possible, avoid felling and skidding during periods of nesting and fledgling activity (May to mid-August)

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Recommended Practices



Tall, vigorous canopies and understory layers can be achieved or maintained by single-tree selection, crop-tree release, thinning, and winter harvests with a forwarder to minimize damage to young trees.



In northern hardwoods, scarlet tanagers prefer yellow birches (l) over sugar maples and beech for foraging. In oak-pine systems, white oaks (r) are favored for nesting. Leaving large trees of these species will support breeding tanagers.