Silviculture with Birds in Mind

Options for Integrating Timber and Songbird Habitat Management in Northern Hardwood Stands in Vermont

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Over 100 foresters collaborated in the creation of this document and others created through the **Foresters for the Birds** *project.*

Introduction

This publication has been prepared to assist foresters interested in silviculture that integrates timber and songbird habitat management in northern hardwood and associated forest stand types in Vermont. Information provided here is intended to support both the creation of Stewardship and Use Value Appraisal forest management plans and subsequent implementation of on-the-ground, stand-level management activities that can benefit breeding bird populations while producing timber products.

This document was created as one of three components of the *Foresters for the Birds* project, a collaborative partnership between the Vermont Department of Forests, Parks, and Recreation and Audubon Vermont. These three documents were developed over a period of two years by staff of these two organizations in collaboration with over 100 foresters participating in the project. This document is intended to be used in conjunction with its two companion documents: *Forest Bird Habitat Assessment Guide: A Guide to Integrating Bird Habitat Data into a Vermont Forest Inventory* and *Birds with Silviculture in Mind: Birder's Dozen Pocket Guide for Vermont Foresters*.

We assume users of these documents already have at least some experience with silviculture for timber production and an interest in managing for bird habitat as well. Our purpose is to provide guidance on integrating bird habitat management concepts with accepted and widely applied silvicultural treatments. This is not a guide to managing for songbird habitat. These are options for managing timber with birds in mind.

We do not describe all the potential forest management activities that could be conducted to achieve desired habitat conditions for birds. Instead, we offer descriptions of some basic management practices that incorporate accepted songbird habitat concepts into silvicultural practices. These are intended to compliment the

forester's application of existing silvicultural guides such as "Silvicultural Guide for Northern Hardwood Types in the Northeast (revised)" (NE-603). The silvicultural options described herein combine information from a wide range of sources including primary literature in silviculture, forest ecology, avian ecology, habitat management, and conservation biology as well as from the experience of practicing foresters and biologists in Vermont and other New England states.

Timber management has a direct and significant influence on bird populations. Subtle shifts in management objectives and strategies can bring important bird benefits in the residual stand, especially when these subtleties are discovered during inventory, spelled out in the management plan, and implemented during layout, marking, and operations.

In many cases, implementing these options and considerations involves changes that will be more subtle than sweeping. Indeed, many such considerations are already being incorporated into stand-level silviculture in Vermont. While this document focuses on northern hardwood and associated community and cover types, it is intended to be adaptable for use in other forest types as well.

Vermont Forest Birds

Hundreds of species of birds breed in Vermont every year. Identifying all of them by sight and sound is a daunting task, even for expert birders. A simpler starting and focal point for those interested in managing forests with birds in mind is Audubon Vermont's Birder's Dozen. The Birder's Dozen is twelve of the 40 forest songbirds that have been identified by Audubon Vermont as being high priorities for protection in Vermont and the northeast (see complete list on page 18). These twelve species were selected because they:

- Are simple to identify by sight and/or sound.
- Collectively use a wide range of forest types and conditions for feeding and for breeding.
- Are showing a decline in their glabal breeding populations or are at risk for decline.
- Have a significant proportion of their global breeding population in the Northern Forest.

Although the silvicultural options discussed in this document have the potential to affect a wide diversity of forest birds and other wildlife, for simplicity and consistency, the Birder's Dozen are referenced most often.

Non-Native Invasive Plant Species

Non-native, invasive plants, such as bush honeysuckles, buckthorn, autumn olive, and Japanese barberry, present a variety of threats to forest health in Vermont and the northeast. Although some species of native forest birds successfully use these shrubby, woody plant species as nesting sites and eat their fruits, the fruits generally have low nutritional value and the invasive plants reduce the diversity of other nesting and foraging options in forest ecosystems. Overall, non-native, invasive plant species degrade the quality of native forest bird habitat in our region. We assume that consideration and control of non-native, invasive plant species is a management objective for every forester practicing in Vermont, and may affect opportunities for implementing silvicultural treatments discussed in this publication and its companion documents.

Contact your county forester or Audubon Vermont with questions about how to become involved in the Foresters for the Birds *project or for further assistance.*

Acknowledgements

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We envision healthy forests that provide suitable breeding and post-breeding habitat conditions for a suite of Vermont birds and sustained yields of timber and other forest products and services.

Stand-level silvicultural treatments - such as the options presented in a later section of this publication - are intended to reach short-term (10-15 years) management objectives. Repeated application of these treatments over the long-term (100-300 years) is intended to move overall forest conditions toward achieving the following goals for a range of important forest attributes.

Complex Horizontal Structure

Although the majority of the forest may be relatively old, it will contain a variety of patches in different age classes and developmental stages; it is not uniform throughout. This diversity of age classes provides a variety of bird species with a range of nesting and foraging opportunities. Across the landscape, enhanced horizontal structure should support all twelve Birder's Dozen species if the landscape includes wetlands and riparian areas.

Complex Vertical Structure (in older stands)

All forest layers will be present in moderate to high amounts distributed throughout the stand: canopy, midstory, understory, and ground layer. Enhanced vertical structure provides the greatest number of bird species with the greatest number of nesting and foraging opportunities. Patches of very dense native shrub and understory layers (0-5 feet in height) are of particular nesting importance to bird species such as the black-throated blue warbler.

Generally Closed Canopy (in older stands)

The canopy will be generally closed (>75-80% closure) with relatively small gap openings (diameters up to two times canopy height) throughout. These openings will be caused by or mimic small, single- to few-tree disturbances and create opportunities for regenerating intermediate- and shade-tolerant species. Regeneration in these smaller openings also provides a continual supply of an ephemeral nesting habitat type for birds such as black-throated blue warbler, wood thrush, and veery. The distribution and concentration of these small openings may vary, but interior forest conditions will be maintained on the whole. Closed canopy conditions favor a suite of interior-nesting bird species that include: the ovenbird, black-throated green warbler, and scarlet tanager.

Large-Diameter Trees

Some large-diameter (24"+ DBH) trees will be present in the forest. Some of these may be financially mature or nearing mature acceptable growing stock (AGS), and others may be senescent or declining unacceptable growing stock (UGS) that may be retained as legacy and wildlife trees. Structurally-sound, large-diameter trees are important stick nest sites for woodland raptors, such as the northern goshawk. Large-diameter cavity trees are critical for larger cavity-nesting species including owls and pileated woodpeckers.

Dead Woody Material

Dead woody material will be present in moderate to high amounts. Large downed coarse woody material (>4" DBH) is an important habitat feature for some forest birds, such as ruffed grouse which use downed logs as drumming sites during the breeding season. Downed tree tops and brush piles provide foraging habitat, singing perches, and cover for a variety of bird species, such as the white-throated sparrow and veery. Downed woody material also provides important habitat for other organisms (e.g. insects) which are important food sources for song birds.

Snags and Cavity Trees

Standing trees that are dead and/or contain cavities will be present in all diameter classes, with at least six snags per acre with one tree > 18" DBH and three > 12" DBH. Snags and cavity trees provide important nesting and foraging sites for bird species such as nuthatches, owls, and woodpeckers, like the yellow-bellied sapsucker.

Native Species Diversity

A diversity of native tree species will be present and invasive, non-native species will be absent, with a desirable proportion of commercial species present. Species composition will reflect the range of species that are part of the natural community type. Native species diversity is important for regeneration, forest health, and for forest birds that rely on the structure certain species provide for foraging and nesting. For example, yellow birch has been shown to be preferentially chosen by several species of insect-eating songbirds for foraging.

Softwood Inclusions

In a northern hardwood forest, softwoods diversify habitat conditions available to birds and other wildlife species. Softwood inclusions often provide increased structural complexity as well as a varied foraging and nesting opportunities. Softwood inclusions are particularly beneficial for species such as the black-throated green warbler, blackburnian warbler, and blue-headed vireo.

Litter Layer

The litter layer will be thick, well-developed, and moist. This forest layer is an important habitat attribute for birds, including the ovenbird which builds its nest using deciduous litter, and wood thrushes, which forage for soil macroinvertebrates on the forest floor.

Birds and Wildlife

A diversity of native species will be present and successfully reproducing. There will be evidence that the forest is being used.

Stand Stocking and Stem Form/Quality

The forest will be well stocked with dominant and co-dominant acceptable growing stock (AGS).

- AGS (mature and immature) > 40 ft^2 (hard wood) or 60 ft^2 (mixedwood)
- AGS (mature and immature) 12+ in > 25 ft^2 (hardwood) or 40 ft^2 (mixedwood)
- Total BA between 70 and 100 ft^2 (hardwood) or 90 and 130 ft^2 (mixedwood)
- Minimum residual basal area of at least 85-90 sq. ft./acre, with at least 30- 35 sq. ft. /acre composed of sawtimber >14" DBH, should maintain suitable conditions for interior forest bird species sensitive to disturbance, including ovenbird (Holmes and Pitt 2007).

NOTE: *This preceding list and descriptions of long-term goals for forest condition does not consider special habitat features (streams, wetlands, proximity to fields) or landscape considerations (diversity and distribution of forest age classes across the landscape) that may be important to particular bird species. For information on habitat features that are of particular importance to individual bird species, see the companion document,* Birds with Silviculture in Mind.

This publication is intended to be used with the forester's inventory and assessment of stand conditions to help design stand treatments. The companion document *Forest Bird Assessment: A Guide to Integrating Bird Habitat Data into a Vermont Forest Inventory* is designed to help foresters integrate inventory and assessment of forest attributes particularly important to breeding birds into a conventional forest inventory. Since forest bird survival and breeding success is dependent not only on the habitat conditions at the stand level, but also the surrounding landscape, it is necessary to consider the proportions and sizes of stand types and successional stages on the parcel and associated landscape.

THE SILVICULTURAL OPTIONS PRESENTED IN THIS DOCUMENT WILL WORK BEST WHEN TIMBER INVENTORIES INCLUDE CONSIDERATION OF HABITAT FEATURES IMPORTANT TO SONGBIRDS.

The silvicultural options presented in this document will work best when timber inventories include consideration of habitat features important to songbirds, including:

- Understory vegetation, including presence of invasive, non-native species (0-5 feet from the ground).
- Midstory vegetation (6-30 feet from the ground).
- Coarse and fine woody material.
- Snags and cavity trees.
- Deciduous leaf litter.
- Canopy height of dominant and co-dominant.
- Canopy closure of dominant and co-dominant.
- Presence of rocky bottom streams.
- Presence and condition of forested wetlands.
- Plant species composition, including presence of *Rubus spp.* and other soft-mast producing species.
- Abundance and diversity of bird nests.

This section presents generalized descriptions of three different hypothetical – but commonly encountered – forest stand conditions. These include even-aged or uneven-aged poletimber and sawtimber stands as described in Leak, Solomon, and DeBald (1987) (NE-603). Additional example stand descriptors are also included for each condition to more fully mirror typical stand descriptions as presented in forest management plans.

Each of the three example stand conditions is then followed by two silvicultural options for integrating timber and songbird habitat management in such a stand. These are not prescriptions and are not intended to be applied indiscriminately. They are, however, intended as options for consideration. The forester is encouraged to compare the outputs of his or her own stand inventory and assessment with these example stand conditions. If found to be similar to any of the example stands, the forester may consider the accompanying silvicultural options for possible application or adaptation under the example management objectives provided that they reflect those of the forester and landowner.

Stand Condition I Northern Hardwood (or Mixedwood) Poletimber Stands with Small Sawtimber and High Stem Quality and High Stocking

AGS > 40ft^2/acre (hardwood) or 60ft^2/acre (mixedwood)

But, AGS 12"+ < 25ft^2/acre AGS (hardwood) or 40ft^2/acre (mixedwood)

Total BA > 100ft^2/acre (hardwood) or 130ft^2/acre (mixedwood)

Example Stand Data

Mean Stand Diameter: 8.5"
Trees Per Acre: 240
Total Basal Area/Acre (BA): 115 ft^2
AGS Basal Area/Acre: 72 ft^2
Overstocked, above B-line
Site Class: I-II
Current Age Class Distribution:
even-aged or two-aged

Example Stand Notes

Stem exclusion stage. Lacking significant regeneration; 0-5-foot layer minimally occupied and where present it is heavily browsed and/or of non-commercial species. Minor and scattered softwood component. Minimal recent disturbance. Generally a closed canopy exists and large-diameter (>20" DBH) trees are lacking. Coarse woody material is lacking. Snags exist but in low densities and typically of small diameter (<16" DBH).

Example Silvicultural Objectives

integrating timber and forest bird habitat:

Increase sawtimber quantity, quality, and volume increment.

Maintain a diversity of plant species in all forest layers, with particular attention toward both commercial tree species (e.g. yellow birch, red oak) and non-commercial species (e.g. hobblebush, striped maple) valuable to wildlife.

Manage seed-producing trees and shrubs for a continuous source of wildlife food and high-quality seed for regeneration.

Maintain 70-85% canopy cover, using openings to enhance horizontal structure and understory development.

Maintain or create inclusions of early- to mid-successional tree species and partially open midstories.

Increase softwood component where viable.

Increase abundance of large-diameter (>16" DBH) snags, cavity trees, and downed woody material.

Identify 30-70 crop trees per acre with particular value for timber and wildlife.

Release crop trees from competing vegetation.

- Pole-sized crop trees should receive a 2-3-sided, 5-10-foot crown release.
- Sawtimber-sized crop trees should receive a 1-3-sided crown release.

Between crop trees, create circular canopy gaps ranging from 30 -75 feet in diameter on 5-15% of the area at each entry. Within gaps, all poor-quality stems >1 inch DBH should be cut.

CANOPY GAPS BETWEEN CROP TREES SHOULD RANGE IN DIAMETER FROM 30-75 FEET.

Notes & Considerations

Expand crop tree definition to include:

- tree species of particular value for foraging birds (e.g. yellow birch).
- tree conditions of particular value for forest birds (e.g. large crowns for perching, nesting, foraging).
- under-represented species (especially soft-mast producers) in more pure hardwood stands.

Manage to increase the production of seed and wood volume increment; favor a diversity of seed-producing native tree and shrub species and free them from overtopping and less-productive individuals.

Give consideration to potential for stem sprouting on best-quality sawtimber and veneer stems, adjust extent of release accordingly.

Trees with cavities or dens should only be cut to release high-quality crop trees. Consider girdling to release the crop trees without removing cavity or den trees.

Locate gaps to release advance regeneration, to remove clusters of high-risk, low-vigor, or low-value trees, and to avoid easily disturbed, sensitive sites.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Improved foraging gaps in open mid-story associated with full-sided releases	1-30 years	Eastern Wood-Pewee
Increased understory density	3-15 years	Black-throated Blue Warbler Canada Warbler Veery Wood Thrush
Enhanced softwood component	5+ years	Black-throated Green Warbler Blue-headed Vireo Canada Warbler
Increased growth and vigor in canopy trees	5+ years	Scarlet Tanager Wood Thrush
Increased midstory density	15+ years	Wood Thrush Canada Warbler

Thin throughout the stand with variable retention by removing trees of low-vigor and poor quality, reducing crown cover to 70-75% in small poles and 75-85% in larger poles and small sawtimber. Remove most overtopped individuals, 50-60% of intermediate crown class and 10-25% of co-dominant crown class.

AFTER HARVEST, CLUSTERS OF LOW-RISK, HIGH VIGOR TREES REMAIN INTACT WITH MIXED-SIZED OPENINGS SCATTERED THROUGHOUT.

Notes & Considerations

Focus removals on suppressed, intermediate, and the poorest quality co-dominant trees (least desirable competitiors, high risk, low vigor).

Retain some senescent paper birch, aspen, or dry hardwood cavity trees >9" DBH in which yellow-bellied sapsuckers and/or northern flickers may excavate nesting cavities.

Recruit snags by girdling some poor quality dominants; leave worst-quality cut stems in woods as downed woody material.

Identify and retain trees with well-developed heart rot in the bole or with dead limbs greater than 4" in diameter as potential cavity trees.

Strive for relatively even distribution of cavity trees; most cavity users are territorial.

When faced with two cavity trees of equal value, leave the one that will have the least impact on the development of the residual growing stock.

Consider pre-treatment for control of non-native, invasive species.

Caution: thinning in only one stratum may reduce vertical structure, especially in even-aged, mixed species stands.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Enhanced foraging in open midstory and gaps	1-30 years	Eastern Wood-Pewee
Increased understory density	3-15 years	Wood Thrush
Enhanced softwood component	5+ years	Black-throated Green Warbler
		Blue-headed Vireo
Increased growth and vigor in canopy trees	5+ years	Scarlet Tanager
		Wood Thrush
Enhanced cavity tree nest sites	5+ years	Yellow-bellied Sapsucker
Increased midstory density	15+ years	Wood Thrush

Stand Condition 2 Northern Hardwood (or Mixedwood) Poletimber Stands with Small Sawtimber with Poor Stem Quality and High Stocking

AGS <40 ft^2/acre (hardwood) or <60 ft^2/acre (mixedwood)

Example Stand Information

Mean Stand Diameter: 8.6"
Trees Per Acre: 210
Total Basal Area/Acre (BA): 105 ft^2
AGS Basal Area/Acre: 38 ft^2
Overstocked, above B-line
Site Class: II-III
Current Age Class Distribution: even-aged

Example Stand Notes

Species mix is not ideal. Bad site match and/or low proportion of desirable commercial species. Stem quality is fair to poor. Stem exclusion stage with scattered, small pockets of understory regeneration. Generally closed canopy. Large-diameter (>20" DBH) trees lacking. Minimal coarse woody debris. Snags exist but in low densities and of small (<16") diameters. Evidence of past high-grading. Site conditions not ideal, including shallow to ledge, dry, or excessively wet areas.

Example Silvicultural Objectives

integrating timber and forest bird habitat:
Increase sawtimber quantity, quality, and volume increment.

Reduce proportion of unacceptable growing stock.

Increase understory density.

Increase both horizontal and vertical heterogeneity.

Increase tree species diversity; maintain softwood inclusions where possible.

Increase amounts of downed woody material of all sizes.

Retain some large unmerchantable trees especially those with visible rot/defects for future cavity/snag trees.

Given poor stem-quality, strive for intermediate canopy closure of 30-80% canopy cover of dominants and co-dominants.

Use successive cuttings with long 20+ year or indefinite regeneration periods to establish new cohorts or release advance regeneration in groups and/or patches (0.1ac – 0.25 ac) which are gradually expanded at each successive entry. Use crop tree release in stand matrix between groups to increase growth and quality and initiate advance regeneration.

GAPS CREATED DURING FIRST ENTRY WILL BE GRADUALLY EXPANDED AT EACH SUCCESSIVE ENTRY.

Notes & Considerations

Particularly applicable in degraded stands as transition strategy to more complex structure and composition.

May appear similar to group selection but only after first entry; thereafter new cohorts are established immediately adjacent to previous ones.

At each entry, harvest no more than 1% of the stand for each year between entries.

Dominant cover must contain an adequate quantity and distribution of seed trees of desirable species, vigor, and quality.

Stand must be relatively wind firm.

Retain groups of acceptable growing stock.

Locate and create gaps/patches through removal of clusters of high-risk, low-vigor, low-value trees, to release advance regeneration, and to avoid sensitive sites.

Offers increased opportunity to regenerate mix of species including less shade tolerant species.

Recruit snags by girdling some poor-quality dominants; leave worst-quality cut stems in woods as coarse woody debris.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Enhanced foraging in open midstory and gaps	1-30 years	Eastern Wood-Pewee
Increased understory density	3-15 years	Black-throated Blue Warbler Canada Warbler Veery White-throated Sparrow
Enhanced softwood component	5+ years	Canada Warbler White-throated Sparrow

Use variable-sized openings from 0.10 acre to 2.0 acres on a 12-15 year cutting cycle with single-tree selection and crop tree release in the matrix between groups to control quality and recruit advance regeneration.

A GROUP 1X TREE HEIGHT IN DIAMETER PLACED TO MIRROR AERIAL EXTENT OF ADVANCE REGENERATION. FINE WOODY DEBRIS PILES WILL PROVIDE COVER AND FORAGING OPTIONS FOR SONGBIRDS.

Notes & Considerations

Owing to disturbance patterns and variations in site conditions, trees inititate and establish themselves in groups. Look for, identify, and manage such groups that occupy the stand.

Locate groups for removal to release advance regeneration, to remove clusters of high-risk, low-vigor, low-value trees, and to avoid sensitive sites.

Harvest no more than 1% of the stand's area for each year between entries (e.g., 12% of stand harvested on 12-year entry period). Determine number, size, and spacing of groups to be removed at each entry accordingly.

Mid- and tolerant-species are particularly dependent on advance regeneration – use groups to release.

Leave 70 ft^2/acre in matrix between groups, including >35 ft^2/acre in sawtimber.

Concentrate matrix stand tending along existing skid trails and around edges of new groups.

Recruit snags by girdling some poor-quality dominants; leave worst-quality cut stems in woods as coarse woody debris.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Enhanced foraging in open midstory and gaps	1-30 years	Eastern Wood-Pewee
Increased understory density	3-15 years	Black-throated Blue Warbler Canada Warbler Veery White-throated Sparrow
Creation of young forest in groups 1+ acres in size	5-15 years	Chestnut-sided Warbler American Woodcock
Enhanced softwood component	5+ years	Canada Warbler White-throated Sparrow

Stand Condition 3 Northern Hardwood (or Mixedwood) Small Sawtimber Stands with Poor Stem Quality and Variable Stocking

Example Stand Information

Mean Stand Diameter: 11.2”
Trees Per Acre: 145
Total Basal Area/Acre (BA): 110 ft^2
AGS Basal Area/Acre: 48 ft^2
Overstocked, above B-line, but highly variable Site Class: I-II
Current Age Class Distribution: even-aged

Example Stand Notes

Degraded stand. Species mix is not ideal. Bad site match and/or low proportion of desirable commercial species. Stem quality is good to poor, with lesser proportion good. Overstocked, above B-line on hardwood stocking guide, but highly variable across stand. Regeneration is lacking in areas, often patchy; 0-5’ layer present in scattered pockets, but largely absent, often with undesirable or non-commercial species. Coarse woody material is generally lacking but may include smaller fragments from senescent early-successional species and damaged individuals of others. Snags exist but are scattered and typically are of small diameters.

Example Silvicultural Objectives

integrating timber and forest bird habitat:

Increase sawtimber quantity, quality, and volume increment (on best stems).

Maintain a diversity of plant species in all forest layers, with particular attention toward both commercial tree species (e.g. yellow birch, red oak) and non-commercial species (e.g. hobblebush, striped maple) valuable to wildlife.

Reduce proportion of unacceptable growing stock.

Increase understory density of desirable species.

Increase vertical heterogeneity.

Increase amounts of downed woody material of all sizes.

Retain some large unmerchantable trees; girdle some to recruit new snags.

Retain softwood inclusions where present.

Establish or release a new cohort, creating two-aged (or multi-aged) residual structure using seed cutting to remove 40-60% of original basal area, leaving 40-50 ft^2/acre in residual sawtimber class to shade/protect seedling development. Initiate removal cut when at least 5,000 new trees per acre reach free to grow positions (4-6'). Leave a portion (5-15%) of the older age class (especially large-diameter trees) for more than 25% of the rotation (or indefinitely), irregularly dispersed.

DENSE UNDERSTORY CONDITIONS CREATED POST SEED CUTTING AND PRIOR TO REMOVAL CUTTING ENHANCE HABITAT CONDITIONS FOR SOME SONGBIRD SPECIES.

Notes & Considerations

Select reserve trees carefully based on species, size, vigor, form, and windfirmness.

Reserve trees should be of dominant or upper co-dominant crown classes, with few dead or dying main branches and expected to live 50-80 years longer.

Best success when used with desirable advance regeneration.

Where interfering vegetation is abundant, site preparation/weeding may be necessary prior to seed cutting.

Use good initial access layout so it can be used again and to minimize damage to new age class.

Leaving patches and bands of undisturbed overstory to protect special microsite features such as seeps, ledges, shallow soils will add diversity and structure to the new, even-aged forest.

Pre-treat for control of non-native, invasive plants.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Creation of intermediate canopy and potential nest sites	0-15	Yellow-bellied Sapsucker
Increased understory density	3-15 years	Black-throated Blue Warbler Canada Warbler Veery White-throated Sparrow
Creation of young forest in groups 1+ acres in size	5-15 years	Chestnut-sided Warbler American Woodcock

Use a combination of free thinning with liberation cuttings, cleanings, and weedings to treat groups of trees within the stand, as dictated by existing stand conditions.

FREE THINNING OF HIGH QUALITY DOMINANTS AND CO-DOMINANTS WITH LIBERATION CUTTING TO RELEASE ADVANCE REGENERATION.

Notes & Considerations

Particularly applicable in highly variable stands with high proportion of unacceptable growing stock and scattered occurrences of desirable species.

Expand croptree criteria to include specis of particular value for foraging birds (eg. yellow birch), or condition (eg. large crowns for perching, nesting, foraging), overstory inclusions of softwooods in hardwood dominated stands or under-represented species (especially soft mast producers such as black cherry) in more pure hardwood stands.

Focus removals on defective, high-risk, and low-value trees especially to release an understory of more desirable species.

Favor most vigorous, best-formed dominant and co-dominant individuals.

Forest Bird Species that Might Benefit

Condition	Duration Post-treatment	Benefiting Bird Species
Enhanced foraging in open midstory and gaps	1-30 years	Eastern Wood-Pewee
Increased understory density	3-15 years	Black-throated Blue Warbler Canada Warbler Veery Wood Thrush
Enhanced softwood component	5+ years	Canada Warbler Black-throated Green Warbler Blue-headed Vireo
Increased growth and vigor in canopy trees	5+ years	Scarlet Tanager Wood Thrush
Increased midstory density	15+ years	Wood Thrush Canada Warbler

Silviculture

Retain, release, and regenerate soft mast species such as black cherry, serviceberry, and apple that produce food sources in late summer which are critical for preparing for successful migration. Rubus spp that dominate openings are also important sources of soft mast for birds.

Retain, release, and regenerate yellow birch (*Betula alleghaniensis*) whenever possible since the branches and foliage of this species are preferentially chosen foraging substrates for many insect-eating bird species including blackburnian warbler,black-throated green warbler, and scarlet tanager.

Retain softwood inclusions in hardwood stands and hardwood inclusions in softwood stands. Overstory inclusions resulting from site conditions are more practical to maintain than those that are a result of disturbance history.

Control and monitor invasive plants. Migratory songbirds will eat buckthorn, autumn olive, barberry, and honeysuckle berries during the post-breeding season when they are fueling up for fall migration, but the berries are not nutritious.

When non-native invasive plants are present, strive to **locate larger groups/patches near already disturbed areas** (e.g. agricultural lands) and away from interior sections.

Maintain closed-canopy buffers along beaver ponds, wetlands, and riparian areas. Layout riparian buffers to have variable widths based on stream morphology; avoid abrupt edges. If property is enrolled in the Vermont Use Value Appraisal program, consider the feasibility of designating forested wetlands and riparian areas as Ecologically Significant Treatment Areas (ESTAs).

Retain a minimum of six snags per acre with one tree > 18" DBH and three > 12" DBH and designate 3-5% of total stocking as potential cavity trees and source of future snags.

Where lacking, actively recruit snags through girdling.

Use snags and potential cavity trees as nuclei for retained patches during larger cuttings. Retained patches may be islands or peninsulas extending from adjacent stands.

Use woodland seeps and springs, which are early-season sources of insects, green vegetation, and earthworms as nuclei for uncut patches to retain snags, cavity trees, and other site-specific features. Retained patches may be islands or peninsulas extending from adjacent stands.

Recognize that vertical structure is naturally limited in early and mid-successional stages. Look for opportunities to enhance vertical structure over time.

Consider and protect vernal pools and riparian buffers when laying out extent and location of openings.

Cluster intermediate treatments conducted in the matrix in between groups along trails, and away from openings and sensitive sites.

Manage for age-class diversity over larger ownerships (>200 acres) where opportunities exist.

Operations

Keep woods roads and skid trails <20 feet wide to avoid creating fragmenting barriers for interior forest species, such as the wood thrush and ovenbird.

Incorporate bends and twists into woods roads and skid trails when laying out a new network. Nest parasites such as brown-headed cowbirds will travel into forest interiors along straight openings, but will avoid bends.

When feasible, avoid operating during peak breeding season (15 May to 15 August in Vermont). See table of breeding dates in the companion document *Birds with Silviculture in Mind* for individual species.

Operate during winter under frozen conditions when appropriate to protect habitat features such as understory layers, leaf litter, forest floor topography, soils, and woody debris.

Leave as much woody debris on site as possible. Avoid whole-tree harvesting when feasible. When appropriate, return landing debris to the woods.

Leave several large downed logs well-distributed throughout the stand to serve as drumming sites for ruffed grouse and important habitat for many life forms.

Avoid disturbing existing tip-ups, stumps, and logs during harvest and operations.

Create scattered slash piles of fine woody debris where possible post-harvest to enhance songbird cover and foraging opportunities.

Protect shrub patches as well as tree seedlings and saplings during harvesting. Avoid damage to understory layers during harvest and skidding operations by:

- Using directional felling techniques.
- Carefully laying out skid trails to avoid patches of advance regeneration.
- Winching instead of skidding from each stump, when feasible.
- Harvesting when a heavy snowpack is present.

OPERATING IN WINTER, WHEN FEASIBLE, PROTECTS HABITAT FEATURES IMPORTANT TO FOREST SONGBIRDS.

Responsibility Birds of the Northern Forest

Bicknell's Thrush
Wood Thrush
Canada Warbler
Bay-breasted Warbler
American Woodcock
Olive-sided Flycatcher
Rusty Blackbird
Cape May Warbler
Chestnut-sided Warbler
Veery
Eastern Wood-Pewee
Purple Finch
Yellow-bellied Sapsucker
American Redstart
Boreal Chickadee
Black-throated Blue Warbler
Chimney Swift
Ruffed Grouse
Blackpoll Warbler
Louisiana Waterthrush
Northern Parula
Blackburnian Warbler
Black-throated Green Warbler
Ovenbird
Yellow-bellied Flycatcher
Gray Jay
Palm Warbler
Northern Flicker
Black-backed Woodpecker
Tennessee Warbler
White-throated Sparrow
Mourning Warbler
Spruce Grouse
Magnolia Warbler
Alder Flycatcher
Nashville Warbler
Lincoln's Sparrow
Swamp Sparrow
Blue-headed Vireo
Scarlet Tanager

Birders Dozen

American Woodcock
Black-throated Blue Warbler
Black-throated Green Warbler
Blue-headed Vireo
Canada Warbler
Chestnut-sided Warbler
Eastern Wood-Pewee
Scarlet Tanager
Veery
White-throated Sparrow
Wood Thrush
Yellow-bellied Sapsucker

The Birder's Dozen
Disturbance and Bird Habitat*

Natural Disturbance Regime	Management Objective	Canopy Over (co-dominant and dominant trees)	Deciduous to Mixed Forest	Coniferous to Mixed Forest
Stand-replacing disturbances >1 acre in size	Maintain patches of young forest, 5-15 years old, 1-50 acres in size	Open (0-30%)	American Woodcock Chestnut-sided Warbler	Magnolia Warbler
Canopy gaps and pockets of regeneration 0.25 – 0.75 acre in size	Create canopy gaps to encourage dense regeneration in pockets 0.25 to 0.75 acres in size	Intermediate (30-80%)	Black-throated Blue Warbler Wood Thrush Veery Eastern Wood-pewee Canada Warbler	White-throated Sparrow Canada Warbler Blue-headed Vireo
Small and infrequent disturbances that maintain average of >80% canopy cover	Minimize gap size and frequency. Favor large, old trees and snags. Maintain >80% canopy cover on average over the stand	Closed (80-100%)	Scarlet Tanager Yellow-bellied Sapsucker Canada Warbler Black-throated Blue Warbler Wood Thrush Eastern Wood-Pewee	Black-throated Green Warbler Blue-headed Vireo Canada Warbler

*Responsibility birds are grouped according to habitat features with which they have been shown to be strongly associated. Birds may be found in a wider variety of conditions than shown here.

References

We have relied heavily on the following list of publications and sources. The information in this document reflects our integration and application of such information, along with the input of many contributing foresters. In most cases, it is not based on primary research on the impacts of silvicultural treatments on bird populations, simply because there are still many unanswered questions in this area of study.

Anderson, H.W. and J.A. Rice. 1993. A tree-marking guide for the tolerant hardwoods working group in Ontario. Ont. Min. Natl. Res., Science and Technology Series, Vol. 8.

Baker, M. D., and M. J. Lacki. 1997. Short-term changes in bird communities in response to silvicultural prescriptions. Forest Ecology and Management, 96:27-36.

Bennett, K.P. (editor). 2010. Good forestry in the granite state: recommended voluntary forest management practices for New Hampshire (second edition). University of NH Cooperative Extension, Durham, NH.

Bryan, R. 2004. Focus species forestry: a guide to integrating timber and biodiversity management in maine. Maine Audubon. 92pp.

Campbell, S. P., J. W. Witham, and M. L. Hunter, Jr. 2007. Long-term effects of group-selection timber harvesting on abundance of forest birds. Conservation Biology, 21(5):1218-1229.

Carlson, Jane Cummings. 2006. Silviculture and Forest Aesthetics Handbook. Wisconsin Department of Natural Resources, Division of Forestry.

Chadwick, N. L., D. R. Progulske, and J. T. Finn. 1986. Effects of fuelwood cutting on birds in southern New England. Journal of Wildlife Management, 50(3):398-405.

Costello, C A., M. Yamasaki, P. Perkins, W.B. Leak, and C.D. Neefus. 2000. Songbird response to group selection harvests and clearcuts in a New Hampshire northern hardwood forest Forest Ecology and Management. 127: 41-54.

DeGraaf, R. M., J. B. Hestbeck, and M. Yamasaki. 1998. Associations between breeding bird abundance and stand structure in the White Mountains, New Hampshire and Maine, USA. Forest Ecology and Management, 103:217-233.

DeGraaf, R M., A. Lester, M. Yamasaki, and W.B. Leak. 2007. Northern Journal of applied Forestry. 24 (3).

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and A. Lester. 2005. Landowner's guide to wildlifehabitat forest management for the new england region. University of Vermont Press.

DeGaaf R and M. Yamasaki. 2001. New england wildlife: habitat, natural history, and distribution. University of New England Press, Hanover, NH

DeGaaf R and M. Yamasaki.2003. Options for managing early-successional forest and shrubland bird habitats in the north eastern United States. Forest Ecol Manag 185:179–191

Drummond, B.A.. 2005. The Selection of Native and Invasive Plants by Frugivorous Birds in Maine. Northeastern Naturalist, 12(1):33–44.

Duguay, J. P., P. B. Wood, and J. V. Nichols. 2001. Songbird abundance and avian nest survival rates in forests fragmented by different silvicultural features. Conservation Biology, 15(5):1405-1415.

Faccio, S. D. 2003. Effects of ice storm-created gaps on forest breeding bird communities in central Vermont. Forest Ecology and Management, 186:133-145.

Flatebo, G., C.R. Foss, and S.K. Pelletier. 1999. Biodiversity in the Forests of Maine: Guidelines for land management. University of Maine Cooperative Extension Bulletin #7147.

Franklin, J. F., R.J. Mitchell, B.J. Palik. 2007. Natural disturbance and stand development principles for ecological forestry. Gen. Tech. Rep. NRS-19. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 44 p.

Germaine, S. S., S. H. Vessey, and D. E. Capen. 1997. Effects of small forest openings on the breeding bird community in a Vermont hardwood forest. The Condor, 99(3):708-718.

Goodburn, J.M. and C.G. Lorimer. 1999. Population structure in old-growth and managed northern hardwoods: an examination of the balanced diameter distribution concept. Forest Ecology and Management. 118: 11-29.

Graves, A.T.; M.A Fajvan, and G,W. Miller. 2000. The effects of thinning intensity on snag and cavity tree abundance in an Appalachian hardwood stand. Canadian Journal of Forest Research. 30: 1214-1220.

Hanson J, and C. Lorimer. 2007. Forest structure and light regimes following moderate wind storms: Implications for multi-cohort management. Ecol Appl. 17:1325–1340

Haulton, Scott. 2008. Effects of silvicultural practices on bird communities in deciduous forests of eastern and central north america. IDNR Division of Forestry.

Holmes, S. B. and D. Pitt. 2007. Response of bird communities to selection harvesting in a northern tolerant hardwood forest. Forest Ecology and Management. 238:280–292

Holmes, R.T. and S.K. Robinson. 1981. Tree species preferences of foraging insectivorous birds in a northern hardwood forest. Oecologia 48: 31-35

Jobes, A.P, E. Nol, and D.R. Voigt. 2004. Effects of selection cutting on bird communities in contiguous eastern hard wood forests. J. Wildlife Mgmt. 68(1):51-60.

Kaya, J. and J. Buongiorno. 1989. A harvesting guide for uneven-aged northern hardwood stands. Northern Journal of Applied Forestry. 6: 9-14.

King, D.I., and R.M. DeGraaf. 2000. Bird species diversity and nesting success in mature, clearcut, and shelterwood forest in northern New Hampshire, USA. For. Ecol. and Mgmt. 129:227-235.

Keddy, P. A. and C.G. Drummond. 1996. Ecological properties for the evaluation, management, and restoration of temperate deciduous forest ecosystems. Ecological Applications, 6(3):748-762.

Keeton, W. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management. 235:129–142

Kenefic, L. S. and R.D. Nyland. 2007. Cavity tress, snags, and selection cutting: a northern hardwood case study. Northern Journal of Applied Forestry. 24(3): 192-196.

Krueger, J. A, E.K. Zenner, and K.J. Puettmann. Development of eastern white pine (Pinus strobus L.) regeneration under a reserve shelterwood intermediate removals and windthrow.

Northern Journal of Applied Forestry 24(2):134-137.
Lambert, J.D. and S.D. Faccio. 2005. Canada Warbler population status, habitat use, and stewardship guidelines for northeastern forests. VINS Technical Report 05-4.
Lamson, N. I. and W.B. Leak. 2000. Guidelines for applying group selection harvesting. NA-TP-02-00. USDA Forest Service. 8pp. Leak, W.B. 1996. Long-term structural change in uneven-aged northern hardwoods. Forest Science. 42: 160-165.
Leak, W.B., D.S. Solomon, and P.S. DeBald. 1986. Silvicultural Guide to Northern Hardwood Types in the Northeast (revised). USDA Forest Service Research Paper NE-603.
Lent, R. A., and D. E. Capen. 1995. Effects of small-scale habitat disturbance on the ecology of breeding birds in a Vermont hardwood forest. Ecography, 18(2):97-108.
Lorimer, C. G. 1994. Timber harvest effects on nongame birds – what does the evidence show? University of Wisconsin Extension, Forest Facts no. 77.
Lorimer, Craig G., and Alan S. White. 2003. Scale and frequency of natural disturbances in the northeastern US: implications for early successional forest habitats and regional age distributions. Forest Ecology and Management 185:41-64.
Manaras Smith, K., W. S. Keeton, T.M. Donovan and B. Mitchell. 2008. Stand-Level Forest Structure and Avian Habitat: Scale Dependencies in Predicting Occurrence in a Heterogeneous Forest. Forest Science 54(1): 36-46.
North, M P. and W. S. Keeton. 2008. Emulating natural disturbance regimes: an emerging approach for sustainable forest management. R. Lafortezza et al. (eds.), Patterns and Process in Forest Landscapes. Springer Science and Business Media B.V.
Nyland, R.D. 2002. Silviculture: concepts and applications. 2nd ed. New York: McGraw-Hill Book Co. Nyland, R.D. 2005. Rehabilitating Cutover Stands: Some Ideas To Ponder. In: Kenefic, Laura S.; Nyland, Ralph D. eds. Proceedings of the conference on diameter-limit cutting in northeastern forests.; 2005 May 23-24; Amherst, MA. Gen. Tech. Rep. NE-341. Newtown Square, PA: US Forest Service, Northeastern Research Station.
O'Hara, K. L. 1998. Silviculture for structural diversity: a new look at multiaged systems. Journal of Forestry 96 (7): 4-10.
O'Hara, K.L. 2001. The silviculture transformation—a commentary. Forest Ecology and Management. 151: 81-86.
O'Hara K. and R. Gersonde. 2004. Stocking control concepts in unevenaged-silviculture. Forestry 77:131–143
Oliver C. and B. Larson. 1996. Forest stand dynamics. Updated edition. John Wiley and Sons, New York, NY
OMNR. 1998. A silvicultural guide for the tolerant hardwood forest in Ontario. Ont. Min. Nat. Resour. Queen's Printer for Ontario. Toronto. 500pp.
Pearson, C. W. 1997. Planning for the birds. Minnesota Environment and Natural Resources Trust Fund.
Perkey, A.W., B.L. Wilkins, and H.C. Smith. 1993. Crop Tree Management in Eastern Hardwoods. NA-TP-19-93. USDA For. Serv., NESPF, Morgantown, WV.
Powell, L. A., J. D. Lang, M. J. Conroy, and D. G. Krementz. 2000. Effects of forest management on density, survival, and population growth of wood thrushes. The Journal of Wildlife Management, 64(1):11-23.
Raymond, P., S. Bedard, V. Roy, C Larouche and S. Tremblay. 2009. The irregular shelterwood system: review, classification, and potential application to forests affected by partial disturbances. Journal of Forestry 107:405-413.
Roach, B. A. 1974. What is selection cutting and how do you make it work; what is group selection and where can it be used. Applied Forestry Research Institute Miscellaneous Report No.5. SUNY-ESF.
Rodewald, A. D., and R. H. Yahner. 2000. Bird communities associated with harvested hardwood stands containing residual trees. Journal of Wildlife Management, 64(4):924-932.
Roe, J.H. and A. Ruesink. Natural dynamics silviculture: a discussion of natural community based forestry practices. The Nature Conservancy. 16 pp.
Rosenberg, K. V., R. W. Rohrbaugh, Jr., S. E. Barker, J. D. Lowe, R. S. Hames, and A. A. Dhondt. 1999. A Land managers guide to improving habitat for scarlet tanagers and other forest-interior birds. The Cornell Lab of Ornithology, Ithaca, NY. 24 p.
Runkle, J.R. 1991. Gap dynamics of old-growth eastern forests: management and implications. Natl. Areas J. 11:19-25.
Seymour, R. 2005. Integrating natural disturbance parameters into conventional silvicultural systems: Experience from the Acadian forest of northeastern North America. In: Peterson C,Maguire D (eds) Balancing ecosystem values: Innovative experiments for sustainable forestry.USDA Forest Service General Technical Report PNW-GTR-635
Seymour, R. S., A.S. White, P.G. deMaynadier. 2002. Natural disturbance regimes in northeastern North America – evaluatingsilvicultural systems using natural scales and frequencies. Forest Ecology and Management 155:357-367.
Singer M and C. Lorimer. 1997. Crown release as a potential old-growth restoration approach in northern hardwoods. Can J For Res 27:1222–1232
Smith, D. 1986. The practice of Silviculture. 8th edition. John Wiley and Sons Inc., New York, NY
Smith, H.C. and N.I. Lamson. 1982. Number of residual trees: a guide for selection cutting. USDA For. Serv. Gen. Tech. Rep. NE-80.
Thompson III, F.R. and D.E. Capen. 1988. Avian assemblages in seral stages of a Vermont forest. Journal of Wildlife. Management. 52(4):771-777
Tubbs, C. H., R. DeGraaf, M. Yamasaki, and W. Healy. 1987. Guide to wildlife tree management in New England northern hardwoods. USDA For. Serv., NE For. Exp. Stn., Gen. Tech. Rep. NE-118. 30 pp.
Webster, C.R. and C.G. Lorimer. 2005. Minimum opening sizes for canopy recruitment of midtolerant tree species: A retrospective approach. Ecol. Appl. 15(4):1245-1262.
Wisconsin Department of Natural Resources. 2003. Wisconsin forest management guidelines. WDNR, Div. Of For., Madison. PUB-FR-226 2003. 306 pp.
Woodall, Christopher W.; Monleon, Vicente J. 2008. Sampling protocol, estimation, and analysis procedures for the down woody materials indicator of the FIA program. Gen. Tech. Rep. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 68 p.

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