

**BENEFICIAL MANAGEMENT PRACTICES
FOR SOUTHWESTERN ONTARIO FOREST BIRDS AT RISK: A Guide
for Woodlot Owners and Forest Practitioners**





Bird Studies Canada is Canada's leading national charitable organization dedicated to bird science and conservation. Our mission is to conserve wild birds of Canada through sound science, on-the-ground actions, innovative partnerships, public engagement, and science-based advocacy.

In southwestern Ontario, Bird Studies Canada has undertaken various research and conservation initiatives for forest birds at risk since the 1980s. In 2011, BSC formalized the **Southern Ontario Forest Birds at Risk Program**. The program's ultimate goal is to conserve southwestern Ontario's forest birds at risk through stewardship.

Bird Studies Canada
P.O. Box 160, 115 Front Street, Port Rowan, ON N0E 1M0
Tel. 1-888-448-2473 or 519-586-3531
generalinfo@birdscanada.org
www.birdscanada.org

Canadian co-partner of



Recommended Citation : Stewart, B. 2017. Beneficial Management Practices for Southwestern Ontario Forest Birds at Risk: A Guide for Woodlot Owners and Other Forest Practitioners. Published by Bird Studies Canada. Pp. 21.

ACKNOWLEDGEMENTS

Thank-you to the many experts, listed below, who reviewed all or parts of the document.

Jody Allair (Bird Studies Canada)

Gregor Beck (Bird Studies Canada)

John Brett (Environment and Climate Change Canada)

William Draper (Consulting Services in Botany Incorporated)

Ken Elliot (Ontario Ministry of Natural Resources and Forestry)

Audrey Heagy (Private Woodlot Owner and Conservation Biologist)

Myles Falconer (Bird Studies Canada)

Karla Falk (Independent Contractor)

Jon McCracken (Bird Studies Canada)

Brian Naylor (Ontario Ministry of Natural Resources and Forestry)

Joe Nocera (University of New Brunswick)

Doug Tozer (Bird Studies Canada)

Petra Wood (United States Geological Survey West Virginian Fish and Wildlife Unit)

Thank-you to the agencies that financially support to the Southern Ontario Forest Birds at Risk Program.

The Government of Canada

The Government of Ontario

United States Fish and Wildlife Service

This project (guide) was undertaken with the financial support of the Government of Canada.

The logo for the Government of Canada, featuring the word "Canada" in a large, black, serif font. A small red maple leaf is positioned above the letter 'a'.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS3

INTRODUCTION AND DOCUMENT PURPOSE5

SOUTHWESTERN ONTARIO FOREST BIRDS AT RISK.....6

 ACADIAN FLYCATCHER 6

 CERULEAN WARBLER 8

 CHIMNEY SWIFT 10

 EASTERN WHIP-POOR-WILL 11

 EASTERN WOOD-PEWEE 12

 LOUISIANA WATERTHRUSH 13

 PROTHONOTARY WARBLER 15

 WOOD THRUSH 16

REFERENCES17

INTRODUCTION AND DOCUMENT PURPOSE

Southwestern Ontario, also known as the Carolinian Region, is one of the most bio-diverse and unique regions in all of Canada. Here, North America's eastern deciduous forests reach their northern boundary. As a result, the area supports a number of flora and fauna more typical of southern climes and found nowhere else in Canada. This includes some of Canada's rarest birds: Acadian Flycatcher (Endangered)¹, Cerulean Warbler (Endangered), Louisiana Waterthrush (Threatened), and Prothonotary Warbler (Endangered). All of these at-risk birds need large tracts of mature forest. But, there is little such habitat left in southwestern Ontario; less than 0.01% of what once covered the landscape. What remains is subject to many pressures, from logging to all-terrain vehicle use. Plus, much of the region is privately owned and thus the onus of conservation rests on individual citizens and woodlot owners. These individuals' management efforts are critical to species conservation and recovery.

The purpose of this document is to establish standard Beneficial Management Practices (BMPs), for forest birds at risk occurring in southwestern Ontario, which woodlot owners, land managers, forest planners, and tree markers can use to help guide management decisions. Here, we present a series of tables, one for each of eight priority bird species, including the four species listed above, as well as Chimney Swift (Threatened), Eastern Whip-poor-will (Threatened), Eastern Wood Pewee (Special Concern), and Wood Thrush (Threatened). Other birds at risk, for which the bulk of their breeding population occurs elsewhere, are not included. The information presented is based on peer-reviewed, science-based research and expert opinion. Each table has: a habitat description, ecological information relevant to habitat management, natural processes that create habitat, known responses to silviculture, and potential BMPs. Note that **the suggested BMPs are specific to southwestern Ontario's Carolinian Forest**, and may not be appropriate elsewhere in the species' range. For example, in the case of Cerulean Warbler, we do not recommend "creating" Cerulean Warbler habitat in mature, closed canopy forest that may be appropriate for Acadian Flycatcher because there is very little closed canopy forest available in the region. Elsewhere in the Cerulean Warbler range, habitat creation may be an appropriate conservation practice. In general, which BMPs are most relevant will vary by stand and site based on the species present, the current state of the stand and the desired management outcomes. Also note that for most species, there is limited to no information related to habitat preferences and responses to silviculture specific to southwestern Ontario. Thus, if harvesting in an area with birds at risk, gathering pre- and post- harvest information would be beneficial to further refining BMPs (and BSC can help).

BSC is available to assist woodlot owners and forest practitioners manage for forest birds at risk. We can:

- Identify areas and sites occupied by birds at risk;
- Identify features and habitats important to birds at risk;
- Provide advice about birds at risk for management planning;
- Help implement stewardship and conservation activities on your land base;
- Monitor species responses to silviculture.

Please contact us for further information at speciesatrisk@birdscanada.org or 519-586-3531.

In addition, woodlot owners managing for forest birds at risk are likely eligible for Ontario's Managed Forest Tax Incentive Program. Visit www.ontario.ca/page/managed-forest-tax-incentive-program for more information.

Lastly, we understand that forest practitioners face competing priorities and the recommendations presented should be considered along with other management guidelines and regulations.

¹ Status presented is based on assessments by the Committee on the Status of Endangered Wildlife in Canada.

SOUTHWESTERN ONTARIO FOREST BIRDS AT RISK

ACADIAN FLYCATCHER

Habitat description with key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Mid-aged (in the Norfolk Sand Plain; median diameter breast height [DBH] ~ 41 cm)² to mature, undisturbed, and closed-canopy deciduous or mixed forest in moist to swampy woodlands, or along shaded ravines and streams.</p> <p>Little to no ground cover.</p> <p>Associated with Eastern Hemlock, as well as beech, but also nests in other shade-tolerant hardwoods.</p> <p>Presence of young hardwood saplings appears to be an important feature in southwestern Ontario (SW ON).</p> <p>Long, horizontal and forking branches, often overhanging water, are important.</p>	<p>Area-sensitive; needs large tracts of undisturbed forest; at least 25 ha but most are substantially larger (>100 ha).</p> <p>Nests in forest interior (>100m from forest edge), often on steep ravines.</p> <p>Often nests in hardwood trees and shrubs with small DBH (median 12 cm), in the 3 – 5m in height class, in stands otherwise dominated by larger diameter trees (median stand DBH: 37 cm). But, this pattern is not seen when Acadian Flycatcher nests in hemlock.</p> <p>Nests are placed in an elongated, horizontal, and forking branch, often overhanging water.</p> <p>Species occupancy “blinks on” and “off” (i.e., suitable sites not be occupied every year).</p>	<p>Forest maturation. Intact hydrological processes.</p>	<p><i>All silviculture</i> in suitable habitat – negative impact; in SW ON Acadian Flycatchers do not occupy woodlots subject to disturbance (including skid roads and light silviculture). Removal of large-diameter trees eliminates closed canopy conditions.</p>	<p>DO NOT HARVEST³</p> <p>Avoid cutting in suitable habitat.</p> <p>Avoid placing off-road vehicle trails and skid roads in suitable habitat.</p> <p>Protect interior forest; avoid creating “edges” in or within 100m of suitable habitat.</p> <p>Maintain sites previously occupied by Acadian Flycatchers, with suitable habitat, even in years when the species is absent.</p> <p>In mature stands without understory, particularly historically occupied sites, it may be possible to enhance/restore habitat by thinning the midstory to allow sufficient light for the regeneration of young saplings while keeping the canopy intact. Such steps should be taken as part of a restoration program with further input and monitoring.</p>

² Based on an Ecological Land Classification of lands adjacent to 33 active and historically occupied Acadian Flycatcher nests in southwestern Ontario.

³ Grey highlighted area is a summary of the key recommendation(s).

Habitat description with key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
				<p>Maintain forest hydrology and wet or swampy forest.</p> <p>Protect and restore large, intact blocks of mature, closed canopy, wet forest, and restore forest beside such blocks (i.e., buffer).</p> <p>Harvest outside the nesting period (May through August)</p>

CERULEAN WARBLER

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Mature deciduous forest with a diverse vertical structure that includes tall trees that form an upper or “super” canopy and an open understory.</p> <p>Key association with forest gaps, especially ones with vegetation growing within them, within the larger forest matrix.</p> <p>In less forested landscapes elsewhere (similar to SW ON), Cerulean Warblers prefer greater canopy closure.</p> <p>White Oaks, Hard Maples and Bitternut Hickories preferred.</p> <p>Needs interior habitat; avoids “hard” edges (e.g., power line right of way).</p>	<p>Typically prefers large tracts (>250 ha) but will occupy patches as small as 10 ha in a forested landscape.</p> <p>Nests and territories near canopy gaps. Gaps in territories are typically 40 to 100 m², at densities of ~1/0.5 ha.</p> <p>Typically place nests in trees with higher DBH (~38 to 48 cm) than surrounding trees.</p> <p>In the Frontenac Arch, species more likely to be present in areas with a BA of ~23m²/ha and absent in areas with BA <20m²/ha. BUT optimal BA and other preferences vary by region.</p>	<p>Forest maturation combined with gap dynamics.</p>	<p><i>No harvest in mature forest with preferred gap dynamics</i> – positive or no impact (i.e., maintains habitat and likely to maintain current Cerulean Warbler occupancy levels).</p> <p><i>Single tree selection or crop tree release in habitat occupied or suitable for Cerulean Warbler</i> – likely little impact (although no harvesting is recommended)</p> <p><i>Light or moderate group selection in mature forest</i> – positive impact; occupancy increase if vertical structural diversity and large trees are maintained (but not recommended in Carolinian Forest, see adjacent column).</p> <p><i>“High grading”, diameter limit cuts, shelterwood, even-aged management systems, clear-cutting</i>– negative impact (deplete large canopy trees and/or reduce forests structural diversity).</p>	<p>NO HARVEST TO LIGHT SELECTIVE HARVEST (DEPENDING ON FOREST/STAND CONDITIONS); MAINTAIN SUPER CANOPY AND GAPS</p> <p>Avoid cutting in suitable habitat, already occupied by Cerulean Warbler.</p> <p>If harvesting, retain large-diameter (> 38 cm DBH), full canopy trees. Retain a residual BA of at least 23 m²/ha.⁴ BUT do not harvest in closed canopy forest suitable for Acadian Flycatcher.</p> <p>Maintain canopy gaps of 40 to 100m² (diameter of 7 to 11m or one large crown tree). Maintain gap densities of 1/0.5ha. Do not create gaps in closed canopy forest suitable for Acadian Flycatcher.</p> <p>If harvesting, keep forest’s uneven age and diverse species structure.</p> <p>Protect forest interior (forest > 100m from edge); limit trails and skid roads and avoid creating more “edge” or larger gaps than necessary.</p> <p>Use longest cutting rotations possible. Protect and restore large blocks of mature deciduous forest and restore forest beside</p>

⁴ Note the suggested BMPs differ from the standards in the OMNRF in the Forest Management Guide for Maintaining Biodiversity at Stand and Site Scales (p. 122, Table 4.3f; OMNR 2010) and the Ontario Tree Marking Guide (p. 100-101, p. 155 Table 6.4). The residual BA and gap size presented here are larger and smaller, respectively. These recommendations are based on our best understanding of species-specific habitat preferences, as described in the primary literature, and of habitat-use and availability in SW ON.

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
				<p>existing blocks (i.e., buffer).</p> <p>Harvest outside of the nesting period (May through July).</p>

CHIMNEY SWIFT

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Forests with large (~ 13m in height), old trees (DBH >125cm) that attain age and size required for heart rot which results hollow cavities; often White Pine.</p> <p>Cavity trees have decayed or broken tops and are usually dead although live trees are also used.</p>	<p>Use large vertical cavities for nesting and roosting.</p> <p>Cavities must have a porous but stable surface interior to which swifts can cling.</p>	<p>Forest maturation.</p> <p>Heart rot.</p>	<p>Little information available but swift densities higher in unlogged forests in comparison with logged forests.</p>	<p>MAINTAIN LARGE, OLD OR DEAD TREES</p> <p>Maintain tall (~13 m) large-diameter (DBH > 50 cm⁵) trees as part of the forest cover to allow old large trees to reach age and size needed for heart rot.</p> <p>Retain (i.e., do not cull) hollow, sick or decaying trees with high DBH. If these pose a safety hazard (e.g., potential blow down), do not harvest within a radius equal to the height of the tree.</p> <p>Harvest outside the roosting and nesting periods (May through late-September).</p>

⁵ A 50 cm DBH is recommended to reflect the potential trees available in SW ON's forest landscape.

EASTERN WHIP-POOR-WILL

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Open canopy habitats within a larger forest complex (at a landscape scale whip-poor-will is associated with forest cover), such as forest edges, forests at early successional stages, sparse conifer plantations and forest gaps, with well-drained soils, moderate tree cover and moderate to sparse shrub and herbaceous cover.</p> <p>Other habitats occupied within or adjacent to a forest matrix include: old fields, sand and rock barrens with scattered trees, old burns, and alvar.</p>	<p>When woodlots are used for nesting, smaller isolated woodlots are not occupied, thus Eastern Whip-poor-will likely require some minimum forest patch size although the specific size is unknown.</p> <p>Forest cover must be be open to allow for moonlight foraging.</p> <p>Nests directly on the forest floor.</p>	<p>Fires and other disturbances that create open canopy habitats.</p>	<p><i>Practices that create gaps in uneven-aged forest (e.g., clearcuts) – positive impact (creates habitat and can potentially increase Whip-poor-will occupancy levels, although note the importance of forest cover at the landscape scale).</i></p> <p>At a site level, suitable habitat is unlikely to be harvested (e.g., open areas with little cover) however, skids roads and other harvesting-related disturbances during the breeding season could have negative impacts such as incidental take.</p> <p>At a landscape level, large reductions in forest cover are likely to have negative impacts.</p>	<p>HARVEST OUTSIDE NESTING PERIOD</p> <p>Although most woodlot owners cannot manage at landscape scales, they can contribute to overall forest cover. Since there are many open canopy habitats in SW ON, to help conserve Eastern Whip-poor-will, manage for large blocks of uneven-aged mature forest wherever possible. This will help maintain or increase forest cover in the region which will ultimately benefit the whip-poor-will as well as other forest birds at risk.</p> <p>Harvest outside the nesting period to avoid creating skid roads or other trails through potentially occupied nesting habitat (May through August).</p>

EASTERN WOOD-PEWEE

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Mature and intermediate-aged deciduous or mixed forest with an open understory with structural heterogeneity, snags and dead limbs. Higher densities of Eastern Wood Pewees often occur in forests with oaks but species is more of a forest generalist than other birds at risk in SW ON.</p>	<p>Presence of mature trees important for nest site selection.</p> <p>Uses dead branches as hunting perches and forages in open space below or within the canopy.</p> <p>Needs horizontal branches for nesting and has greater nesting success in mature forest where nests are placed further out on horizontal branches.</p>	<p>Forest maturation combined with gap dynamics (e.g., wind throw).</p> <p>Insect defoliation of the canopy.</p> <p>Long-lived tree species that develop complex canopies.</p>	<p><i>No harvest</i> – positive or no impact.</p> <p><i>Light selection or partial harvests</i>, such as <i>single tree selection</i> or <i>moderate crop release</i> – positive impact (increased occupancy) if large tracts of old or mid-aged forest with higher BAs and with small canopy gaps are created</p> <p><i>Clear-cutting</i> - negative impact (species absent)</p> <p><i>Red Pine Plantations</i> – conflicting information; negative impacts, specifically lower nesting success, may be masked by high occupancy and abundance in plantations.</p>	<p>USE LIGHT HARVEST THAT MAINTAIN LARGE TREES AND FOREST STRUCTURE</p> <p>If harvesting, use light selective harvests and maintain large, mature trees (> 40 cm DBH in deciduous forests and >32 cm DBH in pine). BUT do not harvest in closed canopy forest suitable for Acadian Flycatcher.</p> <p>Maintain RBA of $24 \text{ m}^2 \text{ ha}^{-1}$.</p> <p>Maintain gap dynamics.</p> <p>Retain dead trees/residual trees as hunting perches.</p> <p>Harvest outside the nesting period (May through August).</p>

LOUISIANA WATERTHRUSH

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Forested ravines and wooded swamps or wetlands within mature, closed canopy forest.</p> <p>In SW ON, often associated with Eastern Hemlock and occupies sites occupied by Acadian Flycatcher.</p>	<p>Forages for aquatic insects along clean flowing streams or in pools.</p> <p>Territories along streams can range from 90 to 1440m in length.</p> <p>Nests in ravines, on steep stream banks; in swamps on the roots of uprooted trees; or, in mossy logs or stumps.</p> <p>May be area-sensitive. Elsewhere, densities have been found to be highest along streams through mature deciduous forest tracts >350 ha. However, minimum patch size may be lower (25 to 100 ha) depending on surrounding forest matrix.</p>	<p>Forest maturation. Intact hydrological processes.</p>	<p>Little information available; none for SW ON.</p>	<p>NO HARVEST TO LIGHT SELECTION</p> <p>Where Acadian Flycatcher and Louisiana Waterthrush co-occur, use BMPs for Acadian Flycatcher.</p> <p>Avoid cutting in suitable habitat.</p> <p>If harvesting, use single tree selection and avoid removing any trees that provide shade over waterways and nest sites.</p> <p><i>Stream habitat</i> - Avoid harvesting within at least 50 m on either side of stream and 400 m along stream bank above and below the site occupied by Louisiana Waterthrush⁶. Maintain shade trees over waterways. If possible, leave a large buffer, e.g., 100 m, that maintains a closed canopy (~70% closure) and diverse tree structure, on either side of the stream.</p> <p><i>Swamp, pond and wetland habitat</i> – Avoid harvesting within 50 m of the waterbody, maintain shade trees. If</p>

⁶ In general, for streams, OMNRF recommends that woodlot owners adopt a minimum 3m no disturbance zone with buffers of 30 m to 90 m based on bank steepness, with steeper slopes having a larger buffer. In the case of Louisiana Waterthrush, a minimum 50 m buffer, on either side of the stream, and 400 m above and below an area of concern (AOC; essentially where the species occurs), is required (OMNR 2010). Regulations allow selective harvests within this 50 m zone outside of the breeding season. We recommend that suitable habitat be left unharvested year round. For wetlands and woodland pools, OMNRF recommends adopting 15 m buffer zone. Selection harvest, as well as renewal and tending operations, are permitted within a Louisiana Waterthrush AOC outside the breeding season, although wildlife trees and downed woody material should be retained. We recommend expanding the no-disturbance and buffer zones, to the maximum extent possible, to maintain canopy closure and minimize disturbance to what may be an area-sensitive species.

				<p>possible, leave a large buffer, e.g., 100 m to maintain a closed canopy.</p> <p>Maintain uprooted trees, mossy logs and stumps near waterways.</p> <p>Avoid dumping. Remove garbage, contaminants, and other pollutants from ravines, streams and wetlands.</p> <p>Eliminate off-road vehicle use, skid roads and trails through waterways and surrounding suitable habitat.</p> <p>Maintain stream/wetland hydrology and hydrological linkages.</p> <p>Maintain a large and diverse forest matrix, e.g., > 100 ha, around occupied areas.</p> <p>Protect and restore large tracts of mature, closed canopy forest along streams and wooded wetlands, ponds and swamps.</p> <p>Harvest outside the nesting period (nests April through July).</p>
--	--	--	--	---

PROTHONOTARY WARBLER

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Permanent or semi-permanent pools of standing or slow-moving water, of at least 1 ha, within mature forest (> 25 ha block) or riparian floodplain.</p> <p>Surrounding tree cover often includes Silver Maple, Ash, Yellow Birch, and Willows and Buttonbush is usually present.</p> <p>Canopy cover must be extensive (> 50%) to limit an herbaceous and/or shrubby understory and to shade the nest for at least part of the day.</p>	<p>Nests over water in tree cavities (created by other birds like woodpeckers) in old or dead standing trees.</p> <p>May be area-sensitive; probability of detection positively related to riparian corridor width.</p>	<p>Forest maturation. Intact hydrological processes.</p>	<p><i>No harvest</i> – positive or no impact.</p> <p><i>Single tree selection</i> – may not impact species if key habitat features (e.g., closed canopy) are maintained.</p> <p>All other harvesting practices – negative impact.</p>	<p>NO HARVEST TO SINGLE TREE SELECTION</p> <p>Avoid harvesting in or within 50 m of swamp forests in areas near occupied and historic sites, as well as in areas with suitable habitat.</p> <p>Leave a large forest buffer around suitable habitat that maintains a canopy closure at 50% or greater (25 ha minimum).</p> <p>Put up and maintain nest boxes in suitable nesting habitat (i.e., swamp forests).</p> <p>Eliminate off-road vehicle use and skid roads in suitable habitat.</p> <p>Maintain water quantity and water quality in forested swamps. Maintain hydrological linkages and/or avoid changing topography and drainage patterns.</p> <p>Protect and maintain mature forest swamps including standing dead trees.</p> <p>Harvest outside the nesting period (nests May through August).</p>

WOOD THRUSH

Habitat description/ key features	Ecology related to habitat	Natural processes that create habitat	Responses to silviculture	Potential BMPs
<p>Moist, deciduous or mixed, mature or second-growth forests with a disturbance regime (e.g., gap dynamics) that produces a complex vertical structure with a moderate to dense understory of saplings and shrubs.</p> <p>Fairly open forest floor with leaf litter.</p> <p>Requires a relatively closed canopy (upper and sub-canopy combined; ~ as much as 80%). Degree of required closure varies but must be sufficient to maintain moisture levels.</p>	<p>Forage in decaying leaf litter.</p> <p>Species has high site fidelity between years.</p> <p>Nest success higher in larger forest mosaics (>100 ha) and compromised in fragments (e.g., increased predation).</p> <p>At a landscape scale, forest cover, including the availability of, and distance to, interior forest, impacts Wood Thrush abundance and occupancy in smaller woodlots.</p>	<p>Forest maturation combined with gap dynamics.</p>	<p><i>No harvest in mature or second growth forest with preferred gap dynamics – positive or no impact (i.e., maintains habitat and likely to maintain current Wood Thrush occupancy levels).</i></p> <p><i>Light partial harvest - no to positive impact; tolerant of, or may increase in response to, small scale harvest, such as single tree selection, which creates favourable habitat condition 5 to 10 years post-harvest.</i></p> <p><i>Group selection/diameter limit/shelterwood/clear-cut - negative impact (species absent).</i></p> <p><i>Even-aged plantations - negative impact (species absent).</i></p>	<p>SINGLE TREE SELECTION; MAINTAIN LARGE FOREST COMPLEXES</p> <p>If harvesting, use single tree selection.</p> <p>Maintain interior or core forest habitat (>100 ha) with a relatively closed canopy and intact gap dynamics to retain a complex and dense understory.</p> <p>Avoid creating “edges” in or within 100m of suitable habitat.</p> <p>Restore large, intact blocks of heterogeneous mature forest, and restore forest beside already-existing blocks (i.e., buffer).</p> <p>Harvest outside the nesting period (May through August).</p>

REFERENCES

- Augenfeld K. H., S. B. Franklin, and D. H. Snyder. 2008. Breeding bird communities of upland hardwood forest 12 years after shelterwood logging. *Forest Ecology and Management* 255: 1271 – 1282.
- Barber D. R., T. E. Martin, M. A. Melchoirs, R. E. Thill, and T. B. Wigley. 2001. Nesting success of birds in different silvicultural treatments in southeastern US pine forests. *Conservation Biology* 15: 196-207.
- Barnes K. W., K. Islam, and S. A. Auer. 2016. Integrating LIDAR-derived canopy structure into cerulean warbler habitat models. *The Journal of Wildlife Management* 80:1, 101-116.
- Bird Studies Canada. 2015. Ecological Land Classification of Lands Adjacent to 33 Active and Historic Nests of Acadian Flycatcher n Norfolk, Elgin, Lambton Counties and Chatham-Kent, 2013 – 2015. Report prepared by Consulting Services in Botany Incorporated for Bird Studies Canada. Pp. 190.
- Blake, J. G. and J.R. Karr. 1987. Breeding birds in isolated woodlots: area and habitat relationships. *Ecology* 68(1): 724-1734.
- Boves, T. J., D. A. Buehler, J. Sheehan, P. B. Wood, A. D. Rodewald, J. L. Larkin, P. D. Keyser, F. L. Newell, A. Evans, G. A. George, and T. B. Wigley. 2013. Spatial Variation in Breeding Habitat Selection by Cerulean Warblers (*Setophaga cerulea*) Throughout the Appalachian Mountains. *Auk* 130(1): 46-59.
- Buehler, David A., Paul B. Hamel and Than Boves. (2013). Cerulean Warbler (*Setophaga cerulea*), *The Birds of North America* (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: <https://birdsna.org/Species-Account/bna/species/cerwar>.
- Burke, D., K. Elliott, K. Falk, and T. Piraino. 2011. A land manager’s guide to conserving habitat for forest birds in southern Ontario. Ontario Ministry of Natural Resources, Science and Information Resources Division. 140 pp.
- Campbell, S.P., J.W. Witham, and M.L. Hunter, Jr. 2007. A long-term study on the effects of a selection timber harvest on a forest bird community in Maine. *Conservation Biology* 21(5): 1218–1229.
- Carignan, V. 2006. Détermination de la valeur écologique des forêts du sud-ouest du Québec pour l’avifaune sensible à la fragmentation. Thèse de doctorat en sciences de l’environnement, UQAM. 307 pp.
- Cink, C.L., 2002. Eastern Whip-poor-will (*Antrastomus vociferous*). In: Poole, A. (Ed.), *The Birds of North America Online*. Cornell Lab of Ornithology, Ithica, NY.
- Collard, A., L. Lapointe, J-P. Ouellet, M. Crête, A. Lussier, C. Daigle, and S. D. Côté. 2010. Slow responses of understory plants of maple-dominated forests to white-tailed deer experimental exclusion. *Forest Ecology and Management* 260: 649–662.
- COSEWIC 2007a. COSEWIC assessment and status report on the Chimney Swift *Chaetura pelagica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49pp.
- COSEWIC 2007b. COSEWIC assessment and status report on the Prothonotary Warbler *Protonotaria citrea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 31pp.
- COSEWIC. 2009. COSEWIC assessment and status report on the Whip-poor-will *Caprimulgus vociferous* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp.
- COSEWIC. 2010a. COSEWIC assessment and status report on the Acadian Flycatcher *Empidonax virescens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 38 pp.
- COSEWIC. 2010b. COSEWIC assessment and status report on the Cerulean Warbler *Dendroica cerulea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 40 pp.
- COSEWIC. 2012a. COSEWIC assessment and status report on the Eastern Wood-pewee *Contopus virens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 39 pp.
- COSEWIC. 2012b. COSEWIC assessment and status report on the Wood Thrush *Hylocichla mustelina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 46 pp.
- COSEWIC. 2015. COSEWIC assessment and status report on the Louisiana Waterthrush *Parkesia motacilla* in Canada.

- Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 41 pp.
- Crawford, H.S., R.G. Hooper, and R.W. Titterington. 1981. Songbird population response to silvicultural practices in central Appalachian hardwoods. *Journal of Wildlife Management* 45:680-692.
- DeGraaf, R.M., W.M. Healy, and R.T. Brooks. 1991. Effects of thinning and deer browsing on breeding birds in New England oak woodlands. *Forest Ecology and Management* 41: 179-191.
- deCalesta, D.S. 1994. Effect of white-tailed deer on songbirds within managed forests in Pennsylvania. *Journal of Wildlife Management* 58:711-718.
- Driscoll M. J. L., T. Donovan, R. Mickey, A. Howard, and K. K. Fleming. 2005. Determinants of Wood Thrush Nest Success: a multi-scale, model selection approach. *Journal of Wildlife Management* 69(2):699–709.
- Duguay, J. P., P. B. Wood, and J. V. Nichols. 2001. Songbird abundance and avian nest survival rates in forests fragmented by different silvicultural treatments. *Journal of Conservation Biology*. 15(5): 1405-1415.
- English, P.A., J. J. Nocera, B. A. Pond, and D. J. Green. 2017. Habitat and food supply across multiple spatial scales influence the distribution and abundance of a nocturnal aerial insectivore. *Landscape Ecology*. 32:343–359.
- Environment Canada. 2011a. Management Plan for the Cerulean Warbler (*Dendroica cerulea*) in Canada. *Species at Risk Act Management Plan Series*. Environment Canada, Ottawa. iii + 19 pp.
- Environment Canada. 2011b. Recovery Strategy for the Prothonotary Warbler (*Protonotaria citrea*) in Canada. *Species at Risk Act Recovery Strategy Series*. Environment Canada, Ottawa. v + 26 pp.
- Environment Canada. 2012. Recovery strategy for the Acadian Flycatcher (*Empidonax virescens*) and the Hooded Warbler (*Wilsonia citrina*) in Canada. *Species at Risk Act Recovery Strategy Series*. Environment Canada, Ottawa, Ontario. viii + 32 pp.
- Evans, M., E. Gow, R. R. Roth, M. S. Johnson and T. J. Underwood. 2011. Wood Thrush (*Hylocichla mustelina*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/246>.
- Finity, L. and J. J. Nocera. 2012. Vocal and visual conspecific cues influence the behaviour of chimney swifts at provisioned habitat. *The Condor* 114 (2): 323-328
- Falconer C. M. 2010. Eastern Wood-pewee (*Contopus virens*) nest survival and habitat selection in deciduous forest and pine plantations. MSc thesis, Trent University, Peterborough, ON. 64 pp.
- Falconer, C. M., D. Tozer, and B. Stewart. 2014. Developing a Recovery Monitoring Program for Cerulean Warbler: To track distribution, abundance, and population trends, and inform habitat conservation and management. *Bird Studies Canada*, Port Rowan. 25pp.
- Freemark, K. and B. Collins. 1992. Landscape ecology of birds breeding in temperate forest fragments. Pp. 443-454 in J. M. Hagen III and D. W. Johnston (eds.). *Ecology and Conservation of Neotropical Migrant Landbirds*. Smithsonian Institution Press, Washington, DC.
- Friesen, L. E., V. E. Wyatt, M. D. Cadman, R. J. Mackay, E. D. Cheskey, M. L. Allen, and D. Ramsay. 2000. Extent of double-brooding and seasonal movement of nesting females in a northern population of Wood Thrushes. *Wilson Bulletin* 112:505-509.
- Friesen, L., M. D. Cadman, and R. J. MacKay. 1999. Nesting success of neotropical migrant songbirds in a highly fragmented landscape. *Conservation Biology* 13 : 338 – 346.
- Garlapow, R. M. 2007. Whip-poor-will prey availability and foraging habitat: implications for management in pitch pine/scrub oak barrens habitats. Master dissertation, Univ. of Massachusetts, Amherst, Massachusetts. 47 pp.
- Hagenbuch, S. et al. 2012. *Managing Your Woods with Birds in Mind: A Vermont Landowners guide*. Audubon Vermont and the Vermont Department of Forests, Parks, and Recreation.
- Hines, R. E., T. J. Bader, and G. R. Graves. 2013. Chimney Swifts nest in tree cavities in Arkansas. *Southeastern Naturalist*, 12: N18-N20.

- Hodges, M.F., Jr. and D.G. Krementz. 1996. Neotropical migratory breeding bird communities in riparian forests of different widths along the Altamaha River, Georgia. *Wilson Bull.* 108:496–506.
- Hoover, J. P., M. C. Brittingham, and L. J. Goodrich. 1995. Effects of forest patch size on nesting success of Wood Thrushes. *Auk* 112:146-155.
- Hunt, P.D. 2009. Whip-poor-will territory mapping at two New Hampshire sites. Nuttall Ornithological Club and Norcross Wildlife Foundation. 16 pp. Retrieved from the New Hampshire Audubon Online: <http://www.nhaidubon.org/wp-content/uploads/2011/05/2009-WPWI-report.pdf>
- Johnston, D.W. 1971. Niche relationships among some deciduous forest flycatchers. *Auk* 88:796-804.
- Kaiser, S. A., and C. A. Lindell. 2007. Effects of distance to edge and edge-type on nestling growth and nest survival in the wood thrush. *Condor* 109(2):288-303.
- Kilgo, J.C., R.A. Sargent, B.R. Chapman, and K.V. Miller. 1998. Effect of stand width and adjacent habitat on breeding bird communities in bottomland hardwoods. *J. Wildl. Manage.* 62:72–83.
- Lanham, J.D., and D. C. Gwynn, Jr. 1996. Influences of coarse woody debris on birds in Southern Forests. Pages 101-107 in J. W. McMinn and D. A. Crossley, editors. *Biodiversity and coarse woody debris in southern forests: effects on biodiversity*. U.S. Forest Service Technical Report SE-94. Washington, DC: United States Forest Service.
- Loss S. R., and R. B. Blair. 2011. Reduced density and nest survival of ground-nesting songbirds relative to earthworm invasions in northern hardwood forests. *Conservation Biology* 25:983–992.
- Mattsson, Brady J., Terry L. Master, Robert S. Mulvihill and W. Douglas Robinson. (2009). Louisiana Waterthrush (*Parkesia motacilla*), *The Birds of North America* (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: <https://birdsna.org/Species-Account/bna/species/louwat> DOI: 10.2173/bna.151
- McDermott M. E., P. B. Wood, G. W. Miller, and B. T. Simpson. 2011. Predicting breeding bird occurrence by stand- and microhabitat-scale features in even-aged stands in the Central Appalachians. *Forest Ecology and Management* 261: 373–380.
- Nemes C. E., and K. Islam. (2016) Breeding season microhabitat use by Cerulean Warbler (*Setophaga cerulea*) in an experimentally-managed forest. *Forest Ecology and Management*.
- Nol, E., C. M. Francis, and D. M. Burke. 2005. Using distance from putative source woodlots to predict occurrence of forest birds in putative source sinks. *J. Conservation Biology*. 19, (3): 836-844.
- Oliarnyk, C.J., and R. Robertson, R., 1996. Breeding behavior and reproductive success of Cerulean Warblers in Southeastern Ontario. *Wilson Bulletin* 108, 673–684.
- Ontario Ministry of Natural Resources. 2010. *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales*. Toronto: Queen’s Printer for Ontario. 211 pp.
- Ontario Woodlot Association. 2009. *A Landowner’s Guide to Careful Logging*. Kempville, Ontario. v + 89pp.
- Peckford, M. 2015. Eastern Wood-Pewee, pp. 310 – 311 in Stewart, R.L.M., K.A. Bredin, A.Couturier, A. G. Horn, D.Lepage, S. Makepeace, P.D. Taylor, M.A. Villard, and R.M. Whittam (eds). 2015. *Second Atlas of Breeding Birds of the Maritime Provinces*. Bird Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, Nova Scotia Bird Society, Nova Scotia Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville.
- Perkins Kelly A. Perkins and Petra Bohall Wood. (2014) Selection of forest canopy gaps by male Cerulean Warblers in West Virginia. *The Wilson Journal of Ornithology* 126:2, 288-297.
- Robbins, C.S., D.D. Dawson, and B.A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic States. *Wildlife Monograph* 103:1-34.
- Rosenberg, K.V., S.E. Barker, and R.W. Rohrbaugh. 2000. An atlas of Cerulean Warbler populations. Final report to the

- U.S. Fish and Wildlife Service: 1997–2000 breeding seasons. Cornell Laboratory of Ornithology, Ithaca, NY.
- Rosenberg, K.V., R.S. Hames, R.W. Rohrbaugh, Jr., S. Barker Swarthout, J.D. Lowe, and A.A. Dhondt. 2003. A land manager's guide to improving habitat for forest thrushes. The Cornell Lab of Ornithology.
- Roth, R.R. 1987. Assessment of habitat quality for Wood Thrush in a residential area. Pages 139-149 in L. W. Adams and D. L. Le, editors. Integrating man and nature in the metropolitan environment. Natl. Inst. Urban Wildl., Columbia, MD.
- Sample, B. E., R. J. Cooper, and R. C. Whitmore. 1993. Dietary shifts among songbirds from a diflubenzuron-treated forest. *Condor* 95: 616-624.
- Sheehan, J., P. B. Wood, D. A. Buehler, P. D. Keyser, J. L. Larkin, A. D. Rodewald, T. B. Wigley, T. J. Boyes, G. A. George, M. H. Bakermans, T. A. Beachy, A. Evans, M. E. McDermott, F. L. Newell, K. A. Perkins, and M. White. Avian response to timber harvesting applied experimentally to manage Cerulean Warbler breeding populations. *Forest Ecology and Management* 321 (2014): 5–18.
- Stauffer, D.L. and L. B. Best. 1980. Habitat selection by birds of riparian communities: evaluating effects of habitat alterations. *Journal of Wildlife Management*. 44:1-15.
- Tanentzap, A. J., D. R. Bazely, S. Koh, M. Timciska, E. G. Haggith, T. J. Carleton, and D. A. Coome. 2011. Seeing the forest for the deer: Do reductions in deer-disturbance lead to forest recovery? *Biological Conservation* 144: 376–382
- Tirpak, J.M., D.T. Jones-Farrand, F.R. Thompson III, D.J. Twedt, W.B. Uihlein III. 2009. Multiscale Habitat Suitability Index Models for Priority Landbirds in the Central Hardwoods and West Gulf Coastal Plain/Ouachitas Bird Conservation Regions. General Technical Report NRS-49. U.S Department of Agriculture Forest Service, Northern Research Centre, Newton Square, PA. 195 pp.
- Tittler, R., L. Fahrig, and M-A. Villard, 2006. Evidence of large-scale source-sink dynamics and long-distance dispersal among wood thrush populations. *Ecology*, 87(12): 3029–3036.
- Tozer, D. C., J. C. Hoare, J. E. Inglis, J. Yaraskavitch, H. Kitching, and S. Dobbyn 2014. Clearcut with seed trees in red pine forests associated with increased occupancy by Eastern Whip-poor-wills. *Forest Ecology and Management* 330 (2014) 1–7.
- Trine, C. 1998. Wood thrush population sinks and implications for the scale of regional conservation strategies. *Conservation biology* 12: 576 – 585.
- Twedt, C. J. and S. G. Somershoe. 2008. Bird response to prescribed silvicultural treatments in bottomland hardwood forests. *Journal of Wildlife Management* 73(7):1140 – 1150.
- Wakeley, J.S., and T. H. Roberts. 1996. Bird distributions and forest zonation in a bottomland hardwood wetland. *Wetlands* 16: 296-308.
- Weinberg, H. J. and R. R. Roth. 1998. Forest area and habitat quality for nesting Wood Thrushes. *Auk* 115:879-889.
- Whittam, B. 2015. Wood Thrush, pp. 396 - 397 in Stewart, R.L.M., K.A. Bredin, A. Couturier, A. G. Horn, D. Lepage, S. Makepeace, P.D. Taylor, M.A. Villard, and R.M. Whittam (eds). 2015. Second Atlas of Breeding Birds of the Maritime Provinces. Bird Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, Nova Scotia Bird Society, Nova Scotia Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville.
- Wilson, M.D., and B. D. Watts. 2008. Landscape configuration effects on distribution and abundance of Whip-poor-wills. *Wilson Journal of Ornithology* 120: 778-783. <http://dx.doi.org/10.5751/ACE-00677-090201>.
- Wood, P.B., S.B. Bosworth, and R. Dettmers. 2006. Cerulean Warbler abundance and occurrence relative to large-scale edge and habitat characteristics. *Condor* 108: 154-165.
- Wood, P.B., J. Sheehan, P. Keyser, D. Buehler, J. Larkin, A. Rodewald, S. Stoleson, T.B., Wigley, J. Mizel, T. Boves, G. George, M. Bakermans, T. Beachy, A. Evans, M. McDermott, F. Newell, K. Perkins, and M. White. 2013. Management guidelines for enhancing Cerulean Warbler breeding habitat in Appalachian hardwood forests. American Bird Conservancy. The Plains, Virginia. 28 pp.

Zanchetta, C., D. C. Tozer, T. M. Fitzgerald, K. Richardson, and D. Badzinski. 2014. Tree cavity use by Chimney Swifts: implications for forestry and population recovery. *Avian Conservation and Ecology* 9(2): 1.