Population trend status of Ontario's forest birds

by Peter J. Blancher¹, R. Dean Phoenix², Debra S. Badzinski³, Michael D. Cadman⁴, Tara L. Crewe³,
Constance M. Downes⁵, Don Fillman⁶, Charles M. Francis⁵, Jack Hughes⁶, David J.T. Hussell⁷, Denis Lepage³,
Jon D. McCracken³, Donald K. McNicol⁶, Bruce A. Pond⁷, R. Ken Ross⁶, Rich Russell⁶, Lisa A. Venier⁸ and Russ C. Weeber⁶

ABSTRACT

Recent population trends of Ontario's forest birds were assessed by integrating results across 8 bird surveys to provide an estimate of trend status for all of Ontario, and for 2 forested regions of Ontario separately. Surveys with mid- and long-term trends were relied on most extensively in this assessment. Comparison of the first and second Breeding Bird Atlases was especially important for estimating trends in northern forests, but overall reliability of status assessments in the north was considered poor due to limited coverage and significant potential for bias. Trends of most forest birds were stable or positive at the Ontario-wide scale, with trends at least as positive as forest birds elsewhere in North America, and showing more positive trends overall than birds of agricultural landscapes. Nevertheless, individual species trends ranged from large declines to large increases, and several forest birds have been added to Species at Risk lists largely because of population declines. There were few differences in trend status among forest birds grouped by habitat association or migratory guild, although all 5 aerial insectivore species have declined. Better monitoring coverage of the boreal will be needed if improved reliability of trends is desired in the near future.

Key words: Ontario, forest birds, boreal forest, population trend, bird surveys, monitoring reliability

RÉSUMÉ

Les fluctuations récentes des populations d'oiseaux forestiers de l'Ontario ont été évaluées au moyen de l'intégration des résultats de 8 relevés d'oiseaux pour produire un estimé de la tendance actuelle pour tout l'Ontario ainsi que particulièrement pour 2 régions forestières de la province. Les relevés indiquant les fluctuations à moyen et à long terme ont fait l'objet d'une utilisation plus poussée pour cette évaluation. La comparaison entre le premier et le second atlas des oiseaux nicheurs a été particulièrement importante pour pouvoir estimer les fluctuations dans les forêts boréales, mais la fiabilité générale des tendances actuelles dans le nord de la province a été jugée faible compte tenu de la couverture restreinte et du potentiel significatif de biais. Les fluctuations de la plupart des populations d'oiseaux forestiers se sont révélées être stables ou positives pour l'ensemble de la province, ces fluctuations étant au moins aussi positives par rapport aux oiseaux forestiers ailleurs en Amérique du Nord et elles étaient encore plus positives dans l'ensemble par rapport aux oiseaux des milieux agricoles. Néanmoins, les fluctuations des espèces individuelles variaient entre des déclin importants et des accroissements majeurs et quelques oiseaux forestiers ont été ajoutés à la liste des espèces en péril principalement suite à un déclin des populations. Peu de différence a été relevée pour ce qui est des tendances chez les oiseaux forestiers regroupés en fonction de leur habitat ou de leur regroupement migratoire, même si 5 espèces insectivores se nourrissant en vol sont en déclin. Une meilleure étude des territoires nordiques sera requise afin d'améliorer au besoin la fiabilité des tendances dans un proche avenir.

Mots clés : Ontario, oiseaux forestiers, forêt boréale, fluctuation des populations, relevés ornithologiques, fiabilité des relevés

¹Environment Canada, Science & Technology Branch, National Wildlife Research Centre, 1125 Colonel By Drive, Ottawa, Ontario K1A 0H3.
E-mail: Corresponding author. E-mail: peter.blancher@ec.gc.ca

²Ontario Ministry of Natural Resources, 5520 Hwy 101 East, South Porcupine, Ontario P0N 1H0.

³Bird Studies Canada, 115 Front Street, Port Rowan, Ontario, N0E 1M0.

⁴Environment Canada, Canadian Wildlife Service (Ontario), 867 Lakeshore Road, Burlington, Ontario L7R 4A6.

⁵Environment Canada, Canadian Wildlife Service, National Wildlife Research Centre, 1125 Colonel By Drive, Ottawa, Ontario K1A 0H3.

⁶Environment Canada, Canadian Wildlife Service (Ontario), 335 River Road, Ottawa, Ontario K1A 0H3.

⁷Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, Ontario K9J 7B8.

⁸Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, 1219 Queen St. E., Sault Ste. Marie, Ontario P6A 2E5.

Introduction

There is considerable interest in the population status of birds, in part because of federal responsibility for migratory birds under the Migratory Birds Conservation Act⁹, provincial responsibility for wildlife monitoring (OMOE 2003), forest health and sustainability (CFSA 1994, EAB 1994, OMNR 2005) for which birds provide a measure, and general concerns about reported declines in bird populations (e.g., Butcher 2007, BirdLife International 2008). Several species recently assessed as “at risk” in Canada are forest-dependent birds (e.g., Rusty Blackbird [*Euphagus carolinus*], Olive-sided Flycatcher [*Contopus cooperi*], Common Nighthawk [*Chordeiles minor*], Canada Warbler [*Wilsonia canadensis*], COSEWIC 2008a), and in each case, recent population trends were a large contributor to their “at risk” designation (COSEWIC 2006; 2007a, b; 2008b). Bird conservation plans use population trend data to develop conservation priorities and identify species in need of conservation action (e.g., Ross *et al.* 2003; Rich *et al.* 2004; Ontario Partners in Flight 2006a, b).

Ontario is a large province with a high diversity of birds and bird habitats. There are currently several bird monitoring projects that provide trend data for Ontario birds, each differing in methodology, geographic scope, species targeted, and habitats sampled. No individual survey provides comprehensive bird trend information for the entire province as each survey has spatial or temporal constraints and/or design biases that influence their usefulness (Francis *et al.* 2009). For these reasons (policy needs, conservation planning, single survey limitations), we have undertaken a comprehensive assessment of recent population trends for Ontario’s forest birds.

Our main objective was to assess species trend status by integrating results from all relevant and accessible monitoring programs. This effort is 1 part of a larger, multi-agency project to assess trend status for all Ontario birds. A secondary objective was to assess the reliability of current trend information for forest birds. Most bird surveys, particularly those involving volunteer participants, have concentrated activity in southern Ontario, while coverage in the north has been less intensive. Methods and potential biases vary among surveys. Assessing the reliability of trend information from each survey provides a measure of confidence in current bird status, and can also be used as a tool for designing improvements to monitoring in Ontario.

To put trend status of Ontario’s forest birds into a larger context, we used data from the North American Breeding Bird Survey (BBS) to compare trends for Ontario’s forest birds with trends for forest birds elsewhere in North America. Finally, we identified forest birds that have exhibited large population changes but are not listed as species of conservation importance in Ontario (e.g., formally as Species at Risk, or as “priority” birds in other bird conservation planning initiatives).

Materials and Methods

Scope

Trends for Ontario’s birds are currently being assessed for the province as a whole and for each of the 4 Bird Conservation Regions (BCRs; U.S. NABCI Committee 2000) that occur in

Fig. 1. Map showing 2 Bird Conservation Regions (BCRs) that cross Ontario and are the focus of this paper (BCR 8 = Boreal Softwood Shield; BCR 12 = Boreal Hardwood Transition). Ontario’s Area of the Undertaking (AOU) (i.e., area of active forest management) is shown for comparison.

Ontario. For this paper, we present results for forest birds Ontario-wide and for the 2 BCRs most relevant to forest management: the Boreal Softwood Shield and Boreal Hardwood Transition regions (BCRs 8 and 12 respectively; Fig. 1). These 2 regions together encompass the area of commercial forest management on Crown land, known as the “Area of the Undertaking (AOU)” and include additional boreal forest in northwestern Ontario (Fig. 1).

We report trend status for forest birds with at least 30% of their Ontario population in the 2 forested BCRs considered here, plus an additional few species that are considered a priority for attention in these 2 BCRs (i.e., in Ontario bird conservation plans), despite lower proportions of population. This excluded 20 to 25 species of forest birds, with Ontario populations, mainly in the Hudson Bay Lowlands (BCR 7, e.g., Blackpoll Warbler [*Dendroica striata*]) or in the Lower Great Lakes – St. Lawrence Lowlands (BCR 13, e.g., Tufted Titmouse [*Baeolophus bicolor*]). Estimates of percent of population in BCRs were based on relative abundance data from Ontario Breeding Bird Atlas point counts (for species with abundance maps in Cadman *et al.* 2007), or else based on proportion of range based on atlas squares occupied in each BCR. The term “forest bird” was applied to any species using the forest in a way that could make them responsive to forest management. This included birds restricted to forest wetlands and those nesting in riparian or early successional habitats. Birds primarily reliant on open water, grassland / agricultural landscapes, or urban habitats were excluded.

Bird surveys

Data from 8 main bird surveys were analysed and considered in our assessment (Table 1). These surveys monitor population change for at least some of Ontario’s forest birds, had data available for analysis, and could be analysed to determine trends of Ontario birds, in most cases specific to the 2 forested regions (BCRs) of interest. Most are breeding season surveys. Trend estimates from migration monitoring stations were considered to apply to breeding regions north of the stations.

⁹Migratory Birds Convention Act, 1994; http://www.cws-scf.ec.gc.ca/legislations/laws1_e.cfm

Table 1. Bird surveys used to assess trend status, including 8 main surveys (trends analysed for this report) and additional surveys (trends used as reported)

Bird Surveys analysed	Trend Years	Data Source
Ontario Breeding Bird Atlases	1981–85 to 2001–05	Ontario Breeding Bird Atlas
North American Breeding Bird Survey	1968 to 2006	Environment Canada
Canadian Migration Monitoring Network:		
Long Point Bird Observatory	1968 to 2006	Bird Studies Canada
Thunder Cape Bird Observatory	1996 to 2006	Bird Studies Canada
Forest Bird Monitoring Program	1989 to 2006	Environment Canada
Ontario Nocturnal Owl Survey	1995 to 2006	Bird Studies Canada
Black Duck Joint Venture Survey	1991 to 2007	Environment Canada
Southern Ontario Breeding Waterfowl Pair and Habitat Survey	1971 to 2006	Environment Canada
Great Lakes Marsh Monitoring Program	1995 to 2004	Bird Studies Canada
Additional Bird Surveys	Trend Years	Trend Source
Project FeederWatch	1988 to 2006	http://www.birds.cornell.edu/pfw
Christmas Bird Count	1966 to 2005	Butcher and Niven 2007
Red-shouldered Hawk and Spring Woodpecker Survey	1991 to 2006	Badzinski 2007
Hawk Migration Counts	1974 to 2004	Farmer <i>et al.</i> 2008
COSEWIC Status Reports	various	http://www.cosewic.gc.ca
Woodcock Singing-ground Survey	1968 to 2007	Kelley <i>et al.</i> 2007

Trend results from a variety of other sources were considered for individual species when especially pertinent (additional surveys in Table 1), but data from these other sources were not analysed specifically for our assessment.

Trend analyses

Trends from individual surveys were calculated in several ways to aid comparison among surveys and to provide information on changes in trend trajectory over time, as follows:

- **Short-term trend (~10 years):** To compare as many surveys as possible, including those initiated in the 1990s, a trend was calculated for the most recent 9 to 12 years, depending on availability of data and analyses (trend period varied slightly among surveys, with start years ranging from 1995 to 1997 and ending in 2004 to 2007).
- **Change over the past 20 years:** Twenty years was the interval between the 2 Ontario breeding bird atlases; data for 2 other long-term surveys (BBS and Migration Monitoring at Long Point (LPBO)) were analysed for the same period, for comparison.
- **Long-term trend:** For surveys with more than 10 years of annual data, trends were calculated for the longest period available after excluding years with low sample sizes. Trend periods ranged from 16 to 38 years.
- **Current level vs. past levels:** For 3 surveys (LPBO, BBS, Forest Bird Monitoring Program), abundance indices were averaged for each 5-year period to provide a historical context to the current population level, that is, by indicating if the current 5-year population index was higher or lower than in all previous 5-year periods. This measure was intended to aid interpretation of status of species with non-linear or cyclical change.

Analytical approaches differed by survey, typically using approaches developed independently. Trends from most surveys were calculated from count data, and measured change in relative abundance over time. However, change between the 2 Ontario breeding bird atlases was measured as the

change in probability of detection in 10×10 km atlas squares after 20 hours of search effort (see pp. 7–8, in Cadman *et al.* 2007), as an index of change in abundance. Trends for species detected in Black Duck Joint Venture surveys were calculated in 2 ways; from count data as in most other surveys (mainly for target waterfowl species), and from occurrence data at individual water bodies (for waterfowl and other wetland birds).

Changes were assigned to 1 of 5 status categories according to the magnitude and direction of change over the full trend period, as follows:

- **Large decline:** $\geq 50\%$ decline ($\ln$ change ≤ -0.69)
- **Moderate decline:** $\geq 25\%$, $< 50\%$ decline ($\ln$ change > -0.69 , ≤ -0.28)
- **Stable:** $< 25\%$ decline, $< 33\%$ increase ($\ln$ change > -0.28 , $< +0.28$)
- **Moderate increase:** $\geq 33\%$, $< 100\%$ increase ($\ln$ change $\geq +0.28$, $< +0.69$)
- **Large increase:** $\geq 100\%$ increase ($\ln$ change $> +0.69$)

The above criteria for declines and increases are symmetrical about zero in logarithmic scale, and are equivalent in magnitude, as a 100% increase (Large increase) is needed to reverse a 50% decline (Large decline) and vice-versa. The same number of birds is gained as is lost for a long-term stable population that cycles between 100% increases and 50% declines. Short trend periods required a higher annual rate of change to meet these criteria; for example a 50% decline is equivalent to an annual rate of $-6.7\%/year$ over a 10-year trend period, or $-2.3\%/year$ over 30 years.

For most species, trends based on detection/non-detection in atlas squares underestimated the magnitude of population change relative to trends based on abundance data. This was confirmed by comparing the 20-year effort-adjusted change in detection probability from the atlas, with changes in abundance over the same time period from the BBS in southern Ontario. BBS change in abundance for 64 reasonably widespread species (those present in 20% to 80% of atlas squares)

was correlated with change in atlas detection ($r = 0.85$), but was on average almost 3 times larger in magnitude. For 41 common birds present in 80% or more of atlas squares, BBS change in abundance was still correlated with the atlas change ($r = 0.60$), but was on average 8 times as large as the atlas change. For this reason, when integrating trend status across surveys (see below), magnitude of atlas change was considered a conservative estimate for widespread species.

Trend reliability

Assessment of trend reliability was an important aspect in deciding how to integrate results across surveys. Three individual components of reliability were assessed for each species sampled by each survey: Trend Precision, Range Coverage, and Survey Design. Reliability was then assigned to 3 categories: Reliable, Acceptable, and Poor, as follows:

- **Trend Precision** – was measured as the difference between the annual trend and 90% lower confidence limit on the annual trend, and thus a reflection of both sample size and variance in counts/species detections.
 - Reliable: 90% confidence limit $\leq 2.6\%/year$ (for 20-year trends, this rate reflects monitoring criteria suggested by Bart *et al.* (2004), i.e. $\geq 80\%$ power to detect a 50% decline over 20 years at $P \leq 0.1$)
 - Acceptable: 90% confidence limit $\leq 4.4\%/year$ (based on 50% power to detect a 50% decline over 20 years at $P < 0.1$)
 - Poor: 90% confidence limit $> 4.4\%/year$
- **Range Coverage** – was measured as the proportion of a species' range sampled within a region by a particular survey, at the resolution of 1° of latitude by 1° of longitude.
 - Reliable: $\geq 50\%$ coverage
 - Acceptable: $\geq 25\%$ coverage
 - Poor: $< 25\%$ coverage

For migration monitoring, coverage of breeding regions north of the station was based on the best evidence to date, including isotope studies (Dunn *et al.* 2006, Allen 2007), band recoveries (Brewer *et al.* 2000), and knowledge of species distribution, as follows:

 - Reliable: samples predominately Ontario populations
 - Acceptable: samples mainly Ontario and adjacent region populations
 - Poor: samples relatively little of Ontario's populations
- **Survey Design** – was a subjective assessment of potential for methodological bias, based on consideration of several factors evaluated for each survey: the degree to which data collection is standardized, representativeness of site selection, number of sites and observers, observer skill, analytical limitations, species-specific limitations of the survey, and any other survey-specific factors.
 - Reliable: Survey design likely resulted in limited potential for bias for this species in this region.
 - Acceptable: Potential for moderate bias from 1 or more sources, but overall bias was not likely to reverse large increases or declines.
 - Poor: Large bias with potential to obscure large trends—sources of bias may have obscured or reversed even large increases or declines.
- **Overall Reliability** – was usually assigned as the minimum reliability for a species trend in any of the above 3 reliability components (trend precision, range coverage or

survey design). Once integrated across all surveys for a species in a region (see integration below), overall reliability was expected to have the following meaning:

- Reliable: trend status category was likely to be correct, or at worst within 1 status category of the actual species status.
- Acceptable: some uncertainty about the status category, but in most cases actual species status was likely to be within 1 status category of that assigned, and not incorrect by more than 2 status categories.
- Poor: substantial uncertainty in status, such that actual status of the species often may have been at least 2 status categories different than that assigned.
- Data-deficient: No data, or else excessive uncertainty in the data, or potential bias was too large in magnitude to support any status category.

Assessment integration

Trend data were available from multiple surveys for most species in most regions of Ontario. Teams of 3 to 5 authors were assigned to each species who reviewed trend status and reliability data for each species and assigned an overall status and reliability for species in the region. We placed an emphasis on surveys with highest reliability for the species (primary surveys), but also considered results from other surveys with relevant data (secondary surveys). Among surveys with similar reliability we placed more emphasis on longer-term trends, as short-term trends are often rapidly reversed (Dunn 2002). Where survey data were few, trend data from neighbouring regions were sometimes considered as a secondary survey. For migration monitoring trends at LPBO, we relied more on spring trends, especially for neotropical migrants, as these birds are apt to follow a more direct north–south route in spring than in fall, according to recoveries of banded birds (Brewer *et al.* 2000) and isotopic signatures of species studied (Dunn *et al.* 2006, Allen 2007). Fall surveys are typically dominated by hatch-year birds so are more likely to reflect trends in breeding productivity than trends in breeding population. Written guidelines with details on the above approach were distributed to authors prior to review, to help with consistency. Team discussions were subsequently used to reach consensus for each species on trend status, trend reliability, and the assignment of primary and secondary survey(s) for the species in the region.

We provide 3 examples of how survey data were integrated (Table 2). For Red-Eyed Vireo (*Vireo olivaceus*), province-wide survey data were in broad agreement that there had been a population increase (Table 2a), particularly among trends 20 years and longer, with current indices at or near long-term maximums. There was some uncertainty in the size of increase, hence the overall reliability score of "Acceptable" for the "Moderate increase" trend status. Much of the Tennessee Warbler (*Vermivora peregrina*) population in Ontario is in remote northern forests (Crins 2007), so that the most reliable trend data were from spring migration monitoring at LPBO, and change between Ontario Atlases (Table 2b). The resulting "Moderate decline" trend status had poor to acceptable reliability because of the difference in status indicated by the 2 primary surveys, and the less reliable nature of survey coverage in northern forests. The "Stable" trend status for Ovenbird (*Seiurus aurocapilla*) in BCR 12 was based pri-

Table 2. Examples of trend assessment integration across surveys

Survey	~10-year change	~20-year change	Long-term change	Current vs. past	Overall reliability	Survey weight
a) Red-eyed Vireo (<i>Vireo olivaceus</i>), Ontario-wide						
Breeding Bird Survey	-4% ns Stable	+25%* Stable	+58%* Mod. Increase	97% of maximum	Reliable	Primary
Ontario Atlas	–	+10%* Stable	–	–	Acceptable	Primary
Long Point – Spring	+9% ns Stable	+48%* Moderate increase	+120%* Large increase	91% of maximum	Acceptable	Primary
Long Point – Fall	+48%* Moderate increase	+15% ns Stable	+2% ns Stable	At maximum	Acceptable	Secondary
Forest Bird Monitoring	+5% ns Stable	+7% ns Stable	–	At maximum	Acceptable	Secondary
Thunder Cape – Spring	+5% ns Stable	–	–	–	Acceptable	–
Thunder Cape – Fall	+12% ns Stable	–	–	–	Poor	–
Overall Trend Status	Moderate Increase	–	–	–	Acceptable Reliability	
b) Tennessee Warbler (<i>Vermivora peregrina</i>), Ontario-wide						
Long Point – Spring	-43%* Moderate decline	-68%* Large decline	-43%* Moderate decline	36% below past minimum	Acceptable	Primary
Ontario Atlas	–	- 1% ns Stable	–	–	Poor to acceptable	Primary
Breeding Bird Survey	-92%* Large decline	-88%* Large decline	-70% ns Large decline	10% below past minimum	Poor	Secondary
Forest Bird Monitoring	- 91% ns Large decline	+ 67% ns Moderate increase		Near past minimum	Poor	Secondary
Long Point – Fall	+7% ns Stable	-48%* Moderate decline	-19% ns Stable	Near past minimum	Acceptable	–
Thunder Cape – Spring	- 44% ns Moderate decline	–	–	–	Poor	–
Thunder Cape – Fall	+110%* Large increase	–	–	–	Poor	–
Overall Trend Status	Moderate Decline	–	–	–	Poor to Acceptable Reliability	
c) Ovenbird (<i>Seiurus noveboracensis</i>), Boreal Hardwood Transition						
Breeding Bird Survey	-4% ns Stable	-12%* Stable	-11% ns Stable	7% below past minimum	Reliable	Primary
Ontario Atlas	– –	+4% ns Stable	–	–	Acceptable	Secondary
Forest Bird Monitoring	0% ns Stable	-28%* Mod. Decline	–	Near past minimum	Acceptable	Secondary
Long Point – Spring	+5% ns Stable	+12% ns Stable	+20% ns Stable	Closer to minimum than maximum	Acceptable	Secondary
Long Point – Fall	+49%* Mod. Increase	-9% ns Stable	-6% ns Stable	Between minimum and maximum	Acceptable	–
Thunder Cape – Spring	+5% ns Stable	–	–	–	Acceptable	–
Thunder Cape – Fall	+20% ns Stable	–	–	–	Poor	–
Overall Trend Status	Stable	–	–	–	High Reliability	

*P≤0.1; nsP>0.1

marily on trends from BBS (Table 2c), which samples this species reliably in the region (good trend precision, good range coverage, limited potential for bias).

In addition to considering current reliability of trend, all species were assigned a reliability category for anticipated ability to assess their status 10 years in the future, and 20 years in the future. An assumption of these assignments was that current surveys would continue with similar coverage as now, including another atlas within 20 years using a similar methodology to the second atlas.

Other bird status information

Several Ontario forest birds have been listed as "Species at Risk," federally and/or provincially, and may have been identified as a priority for attention in bird conservation plans for Ontario or for regions that include Ontario. Lists of these species were obtained from COSEWIC (2008a), Ontario Ministry of Natural Resources (OMNR 2008), the Ontario Shorebird Conservation Plan (Ross *et al.* 2003), Canada's Waterbird Conservation Plan (Milko *et al.* 2003), the Ontario Eastern Habitat Joint Venture (OEJV 2007), and landbird conservation plans (Ontario Partners in Flight 2006a, b). We compared these lists to our results to identify species not yet listed as priorities for attention, despite large population changes.

For comparison of Ontario trends with trends elsewhere, BBS trends for the forest guild were obtained for Ontario and other Canadian provinces (from Downes and Collins 2007), and for BBS-wide coverage of North America (Sauer *et al.* 2007). In these comparisons, species included in the forest guild were defined more strictly, as in Downes and Collins (2007), and excluded birds primarily associated with wetlands, shrub / successional and other open habitats. For comparisons of trends among birds associated with different forest types within Ontario, species were assigned to 1 of 7 habitat types (coniferous forest, deciduous forest, mixed forest, open woodlands, shrub and early successional forests, wetlands, and other open habitats; see Appendix 1 for species assignments) based on habitat associations assembled for the second Ontario Atlas (*cf.* Appendix 3, Cadman *et al.* 2007). Similarly, species were assigned to 1 of 4 migration strategies (neotropical migrant, short-distance migrant, year-round resident, and nomadic species with varying migration strategies among years; see Appendix 1), based largely on assignments in Environment Canada's WildSpace natural history database¹⁰.

Results

Ontario trend status was evaluated for 136 forest bird species (Appendices 1 and 2). Of these, 131 species were evaluated for the Boreal Hardwood Transition region of Ontario (BCR 12), and 121 species were evaluated for the Boreal Softwood Shield region of Ontario (BCR 8).

General results for forest birds

In Ontario, as a whole, more forest bird species increased (47%) than declined (21%) in recent decades (Fig. 2), and large increases (18 species) outnumbered large declines (10 species). There was regional variation in this result. In BCR 12, forest bird species were almost equally likely to be declining as

Fig. 2. Proportion of Ontario forest bird species by trend category, Ontario-wide, in the Boreal Hardwood Transition region (BCR 12), and in the Boreal Softwood Shield region. Percents total slightly <100% as data-deficient species are not shown.

Fig. 3. Breeding Bird Survey trends for forest bird species, comparing survey-wide trend (U.S. and Canada) vs. Ontario trend for the same species. The forest bird guild in this comparison excluded species associated mainly with wetlands, shrub, riparian and other open habitats in the forested landscape.

increasing (Fig. 2). Farther north in BCR 8, more species increased than declined, with more than 50% of species in Moderate increase or Large increase categories (Fig. 2).

Breeding Bird Survey trends for the forest bird guild indicated that Ontario forest bird trends have been at least as positive as those in most other Canadian provinces and territories (Table 3). Trends for individual forest bird species in Ontario were strongly correlated with their continental trends (Fig. 3, $r = 0.74$, $P < 0.0001$), and there was no significant difference in trends for Ontario versus continent-wide (paired t -test; $t = 1.17$, 58 df, $P = 0.25$).

Trend source and reliability

The comparison of change between the first and second Ontario breeding bird atlases was a primary source of trend

¹⁰Environment Canada WildSpace Web site; <http://wildspace.ec.gc.ca/intro-e.html>

Table 3. Comparison of Breeding Bird Survey (BBS) trends for the forest bird guild across Canada (adapted from Downes and Collins 2007). Trends are expressed as an annual trend (%/year); N indicates number of BBS routes that contributed to the trend

	1968–2006 ^a			1996–2006		
	Trend (%/year)	P	N	Trend (%/year)	P	N
Yukon	–	–	–	1.7	–	25
Alberta	1.7	*	135	-2.1	*	122
Saskatchewan	1.2	*	74	-3.2	*	53
ONTARIO	0.3	–	144	-0.1	–	125
Quebec	0.2	–	112	-0.6	–	88
Manitoba	0.0	–	58	-1.4	–	58
CANADA	-0.1	–	783	-0.9	*	677
Nova Scotia	-0.4	–	32	-4.0	*	31
British Columbia	-0.5	–	125	-0.7	*	112
New Brunswick	-1.1	*	37	-1.7	*	31
Newfoundland and Labrador	-1.5	–	26	-4.1	–	20

^aexcept 1966–2006 in NB and NS; 1973–2006 in NL

*P < 0.10

status for most forest birds in Ontario (86%, Fig. 4a). The Breeding Bird Survey and migration monitoring at Long Point Bird Observatory also served as primary sources of trend status for many species (50% and 27%, respectively). These 3 programs have methods appropriate for a wide spectrum of bird species, and each has operated for at least 20 years. Waterfowl and owl surveys were sources for the smaller number of species targeted by those surveys. The Ontario Forest Bird Monitoring Program was a secondary source of trends for many species. That program focuses on trends within protected forests, so is addressing a slightly different question than surveys that sample the general landscape.

There were important differences in primary sources of trends for the 2 forested regions of interest. In the Boreal Hardwood Transition, BBS trends were a primary source for the majority of forest birds (60%), as most of this region is covered by BBS routes, and with atlas change (66% of species) were the 2 primary sources (Fig. 4b). Trends for individual species from these 2 sources were highly correlated ($r = 0.82$, 100 df, $P < 0.0001$) for this region. Migration monitoring trends were used mainly as a secondary source in this region, as few species have the majority of their Ontario breeding population in BCR 12 and it is not possible to distinguish birds migrating from outside of BCR 12.

In contrast, in the Boreal Softwood Shield, BBS was used mainly as a secondary source of trend status (Fig. 4c) because this survey is limited to the southern edge of the region where there are roads and volunteers to conduct the surveys. BBS trends were still positively correlated with atlas changes in the Boreal Softwood Shield ($r = 0.47$, 53 df, $P = 0.0003$), but more weakly than in regions to the south. Atlas change was a primary source for 93% of forest birds on the Boreal Softwood Shield. Migration Monitoring was also a primary source for many boreal birds in this region (26% of species), in part because many migrant species do breed primarily in this region, and because few other region-specific trends were available for this part of Ontario.

Trend reliability was assessed as acceptable, or better, for most species (93%) in the Boreal Hardwood Transition zone, because coverage by most bird surveys was sufficiently inten-

sive. In contrast, trend reliability in the Boreal Softwood Shield was poor for the majority of species (60%), reflecting a low degree of coverage, and limited control over potential biases and limitations of methods. In the long-term future (20+ years), trend reliability is expected to improve in both regions, as current surveys collect more data, to 95% and 78% of species with acceptable or better reliability in BCR 12 and BCR 8, respectively. However, because atlas change was a primary source for so many species and because results from another atlas are not anticipated before 2025, there is likely to be a reduction in reliability of trends in the short-term as the most recent atlas data become out-dated; proportion of species with trends of acceptable or better reliability is predicted to fall to 76% in 10 years in BCR 12, and to 35% in BCR 8.

Patterns in trend status

Species were grouped by breeding habitat to test for differences in trend status among forest types. In the Boreal Hardwood Transition region, all forest types included species with increases and declines (Table 4), and there was no significant difference in median trend status among the forest types (Kruskal-Wallis test, $\chi^2 = 7.7$, 6 df, $P = 0.26$). In the Boreal Softwood Shield there was also no significant difference among forest association in trend status (Table 4, Kruskal-Wallis test, $\chi^2 = 1.9$, 6 df, $P = 0.93$). Pooling the number of forest types from 7 to 3 (mature forest vs. open woods and early succession vs. wetland and other open habitats) to increase sample size in each forest type did not alter the lack of significant difference among forest types in either region.

When birds were grouped by migration strategy, there was a significant difference in median trend status in the Boreal Hardwood Transition region (Kruskal-Wallis test, $\chi^2 = 13.1$, 3 df, $P = 0.004$), with proportionally more declines among neotropical and nomadic migrants relative to resident species and short-distance migrants (Table 4). However, this difference was not observed in the Boreal Softwood Shield region, where trend status for neotropical migrants included many increases (32 species). There was no significant difference in median trend status among groups with different migration strategies in this region (Kruskal-Wallis test, $\chi^2 = 5.6$, 3 df, $P = 0.13$).

Fig. 4. Source of trend status for forest birds in a) Ontario (136 species), b) BCR 12 (131 species), and c) BCR 8 (121 species). Primary surveys were the principal source(s), subject to minor consideration of results from secondary surveys.

Comparison of data between the first and second Ontario Breeding Bird Atlases showed declines among species of aerial-foraging insectivores (swifts, swallows, nighthawks and whip-poor-wills; Blancher *et al.* 2007). Four of those species (Common Nighthawk, Whip-poor-will [*Caprimulgus vociferus*], Chimney Swift [*Chaetura pelagica*], and Tree Swallow [*Tachycineta bicolor*]) are birds of forest landscapes, as is

the Olive-sided Flycatcher, which captures flying insects at long distances from perches. In our analyses, all 5 species showed moderate to large recent trend declines, wherever there were sufficient data to assess trend. Declines were apparently stronger in the Boreal Hardwood Transition region (all 5 with Large declines), than in the Boreal Softwood Shield region (1 Large decline, 2 Moderate declines, 1 Data-deficient), or in Ontario as a whole (3 Large declines, 2 Moderate declines) (see Appendix 2).

The majority of 26 forest bird species that showed large trend declines in Ontario have already been identified as priorities for conservation, through species-at-risk listings, or by bird conservation planning initiatives that include Ontario (Table 5). Eleven species with large declines have not been identified as conservation priorities, or have been identified for stewardship responsibility reasons, but not specifically owing to concern over declines (boldface in Table 5), and 4 of these species exhibited declines in both forested regions and for Ontario as a whole (Tree Swallow, Tennessee Warbler, Scarlet Tanager [*Piranga olivacea*] and Evening Grosbeak [*Coccothraustes vespertinus*]).

Of the 32 forest bird species that showed large trend increases in Ontario and/or in individual regions (see Appendix 2), a single species has been identified as a priority for management as a result of concern over recent increases (Canada Goose [*Branta canadensis*]). Two listed species at risk showed large recent increases in Ontario, both birds of prey recovering from previous threats and small populations: Peregrine Falcon (*Falco peregrinus*), Bald Eagle (*Haliaeetus leucocephalus*).

Discussion

Forest cover remains the dominant land cover in the regions assessed in this paper, with forestry operations being the dominant land use (Crins *et al.* 2007). Without any substantial loss of forest to non-forest land uses on the Precambrian shield, and an increase in forest cover in southern Ontario in recent decades (Crins *et al.* 2007), it is not surprising that trends for forest birds were predominantly stable and increasing in Ontario. BBS trend indices showed a relatively stable trend for the forest bird guild in Ontario over the past 4 decades, in contrast to the strong decline (>50% loss) in the grassland and agricultural bird guild in Ontario over the same period (Downes and Collins 2007). Ontario breeding bird atlas comparisons also indicated that forest and wetland birds have fared well in the past 20 years relative to birds of agricultural and other open landscapes (Blancher *et al.* 2007).

It is perhaps more interesting not to find significant differences in proportions of increasing and declining trends among birds associated with different forest types, given that forest management is not expected to perfectly emulate natural disturbances in forested landscapes (McRae *et al.* 2001, Crins *et al.* 2007, Cyr *et al.* 2009), and owing to the legacy of early management practices. However, the sensitivity of our data to detect differences among forest types was limited by the relatively low reliability of changes in bird populations from the Boreal Softwood Shield. Analyses at a finer spatial resolution would be more effective in detecting differences among forest types, given that tree species composition, silvicultural approaches, wildfire return intervals, and timing of budworm impacts can differ greatly among portions of each region that we assessed here.

Table 4. Number of forest bird species in the 5 trend categories according to habitat association and migration strategy, for each bird conservation region. The "Other open lands" habitat association included a mix of birds not clearly associated with other listed habitat types, e.g., Peregrine Falcon, Chimney Swift, Tree Swallow

	Boreal Hardwood Transition					Boreal Softwood Shield				
	Large decline	Moderate decline	Stable	Moderate increase	Large increase	Large decline	Moderate decline	Stable	Moderate increase	Large increase
Habitat association										
Coniferous forest	3	3	4	7	6	0	1	8	9	5
Deciduous forest	6	2	3	5	0	1	1	2	6	1
Mixed forest	1	3	5	2	3	0	2	5	6	1
Open woodland	3	5	4	3	5	0	4	4	8	2
Shrub /successional	4	6	4	4	1	0	1	6	6	2
Other open lands	3	1	1	1	2	1	2	1	0	3
Wetlands	2	6	10	7	5	2	1	11	9	8
Migration strategy										
Neotropical migrant	12	12	14	9	4	0	5	14	17	15
Short-distance migrant	8	8	11	14	12	3	3	14	17	5
Nomadic	2	2	0	1	0	0	3	0	1	1
Year-round resident	0	4	6	5	6	1	1	9	9	1

Table 5. Species experiencing large declines Ontario-wide, and/or in BCRs 12 and 8, showing species-at-risk status and regional priority listings. Names in bold are species not listed as species at risk or as species of concern.

Common name	Ontario-wide		Boreal Hardwood Transition (BCR 12)		Boreal Softwood Shield (BCR 8)	
	Trend status	Species at risk	Trend status	Regional priority	Trend status	Regional priority
American Black Duck	LD	–	ST	Conc, Stew	ST	Conc, Stew
Great Blue Heron	ST	–	ST	–	LD	–
Northern Goshawk	MD	–	ST	Conc	LD	–
Solitary Sandpiper	MD	–	MI	Stew	LD	Stew
American Woodcock	LD	–	LD	Conc	MI	–
Black Tern	LD	ON	LD	Conc, Sar	ST	Conc, Sar
Common Nighthawk	LD	CA	LD	Conc, Sar	LD	Sar
Whip-poor-will	LD	(CA)	LD	Conc	DD	–
Chimney Swift	LD	CA	LD	Conc, Sar	–	–
Red-headed Woodpecker	LD	CA, ON	LD	Conc, Sar	–	–
Olive-sided Flycatcher	MD	CA	LD	Conc, Sar	MD	Conc, Sar
Eastern Wood-Pewee	MD	–	LD	Conc	MI	–
Least Flycatcher	ST	–	LD	Stew	ST	–
Tree Swallow	MD	–	LD	–	MD	–
Ruby-crowned Kinglet	MI	–	LD	–	MI	Stew
Wood Thrush	ST	–	LD	Conc	–	–
Gray Catbird	ST	–	LD	–	MD	–
Brown Thrasher	LD	–	LD	Conc	–	–
Tennessee Warbler	MD	–	LD	–	MD	Stew
Connecticut Warbler	MI	–	LD	Conc	LI	Conc, Stew
Scarlet Tanager	MD	–	LD	–	MD	–
Eastern Towhee	ST	–	LD	–	–	–
Rose-breasted Grosbeak	LD	–	LD	Stew	ST	–
Purple Finch	MD	–	LD	Conc	MD	Conc, Stew
Red Crossbill	ST	–	LD	Conc	LI	–
Evening Grosbeak	LD	–	LD	–	MD	Stew

Trend status: LD = large decline, MD = moderate decline, ST = stable, MI = moderate increase, LI = large increase, DD = data deficient

Species at risk: ON = in Ontario (SARO list); CA = in Canada (COSEWIC list); (CA) = in review

Regional priority: Conc = species of concern; Stew = high regional stewardship responsibility; Sar = at risk

The difference in trends among birds employing different migration strategies suggested that some bird trends are being driven by factors outside of the breeding grounds. The main difference noted was the greater predominance of declines among neotropical migrants in the Boreal Hardwood Transition region relative to short-distance migrants and resident species. Many of the neotropical migrants showing large declines in this region winter in northern South America in whole (Common Nighthawk, Chimney Swift, Olive-sided Flycatcher, Eastern Wood-Pewee [*Contopus virens*], Connecticut Warbler [*Oporornis agilis*], Scarlet Tanager) or in part (Black Tern [*Chlidonias niger*], Tennessee Warbler, Rose-breasted Grosbeak [*Pheucticus ludovicianus*]), and thus face very long migrations to and from their breeding grounds in Ontario. The Partners in Flight landbird program assigned similar breeding and non-breeding threat scores to most of these species (Rich *et al.* 2004). With relatively few data on survival of these birds over winter, a link between migration strategy and declines remains speculative.

The observed large declines among all aerial-foraging insectivorous birds suggested a single cause related to insect food supply. Since other non-forest birds in this foraging guild are also declining in Ontario (Blancher *et al.* 2007), a single cause related to the forest landscape itself seems unlikely. Insectivorous birds that forage within the forest canopy show a mix of declines and increases.

The relatively low trend reliability of birds breeding in the Boreal Softwood Shield underscores the dearth of effective monitoring in that region. There are important limitations of all surveys in this region related to geographic coverage, potential for bias, and ability to assign birds detected to a specific breeding area (Francis *et al.* 2009). Given that the Ontario atlas was a primary source of trend for over 90% of forest birds in BCR 8, the lack of results from a third atlas until at least 2025 will be a significant limitation to updating trend status, unless other surveys are expanded or initiated in the region. The same is likely true in northern parts of the Boreal Hardwood Transition region. Ideally, an unbiased survey not restricted to roads is required to monitor trends of forest birds in this landscape; for example using a random grid-based design such as was developed for Alberta (Alberta Biodiversity Monitoring Institute 2007). Off-road point counts collected during the second Ontario atlas could provide a basis for evaluating such an approach. The Breeding Bird Survey does have some potential for enhancement to derive better trends in BCR 8. For example, D. Phoenix and others (OMNR, personal communication) estimated that if 50 BBS routes were run continuously, representing an increase of about 40 routes, reliable trends could be detected for between 19 and 23 species.

The current assessment of trend status is useful in updating priorities for conservation attention and also helps to focus research into mechanisms, or monitoring of potential stressors. Priority species assessments typically put strong weight on recent trend information, but also consider other factors, such as small population size, extent of range, threats to future population health, and whether the region holds a high proportion of the species population (e.g., IUCN 2001, Panjabi *et al.* 2005), so that a decline alone may not trigger a conservation listing or priority for action. Species showing large population increases are rarely listed as “species of con-

cern” by bird conservation initiatives, perhaps because many do not cause obvious harm to other species, or because a more direct measure of the impact of these species may be declines in other species or their habitat. Several bird species with large declines reported here have not yet been assessed as conservation priorities for Ontario but should warrant further consideration (Table 5). In most cases, they are species whose large declines were specific to a region but not reflected as strongly declining elsewhere. In a few cases, the species have cyclic or highly variable populations, so it is not yet clear whether or not recent declines have exceeded earlier population increases (e.g., Tennessee Warbler and Evening Grosbeak populations are influenced by levels of spruce budworm infestation, which have decreased in recent decades [Crins 2007, Hoar 2007]). Nevertheless, these are species that could become conservation priorities in the future, if declines continue. For example, the Tennessee Warbler is at its lowest level in 39 years according to migration monitoring data from LPBO (Table 2b), and Evening Grosbeak has been listed as a candidate for detailed status assessment by COSEWIC¹¹.

Our assessment of trends relied on a combination of objective measures of trend precision and range coverage from individual surveys, subjective assessments of potential for bias, and a team approach to integration of results across surveys. Other assessments that rely on many sources of data also tend to rely on an assessment of best available data (e.g., COSEWIC status reports). Butcher and Niven (2007) used a more objective rule-based approach to integrate long-term trend data from BBS and the Christmas Bird Count to assess trend status of North American birds. They averaged trends if both surveys had similar reliability, using categories of reliability similar to those used in our study, and relied on 1 survey alone where there was a difference in trend reliability. Their approach has the advantage of being easily repeated by others, but is less applicable in the current situation in Ontario, where there is a greater diversity of bird surveys, with reduced ability to match trend years, and areas sampled, across all surveys.

Bird trends are dynamic. The current assessment will need to be repeated at regular intervals to be most useful, not only to keep bird status information current, but also to evaluate the effectiveness of sustainable forest management, and to evaluate efforts to improve reliability of trend information for each region of Ontario.

Acknowledgements

Brian Collins (Environment Canada – Canadian Wildlife Service) provided the software program that was used for trend analysis of Breeding Bird Survey and Forest Bird Monitoring data. We especially thank the many thousands of survey volunteers and staff who collected the data summarized here, and those who helped make them available for our use. Ken Abraham (Ontario Ministry of Natural Resources) helped with early stages of this assessment. We thank Steve Holmes and an anonymous reviewer who provided valuable comments on an earlier draft of the paper.

¹¹COSEWIC Prioritized Candidate Species List, October 07, 2008;

References

- Alberta Biodiversity Monitoring Institute.** 2007. Terrestrial field data collection protocols (10001), Version 2007-12-13. Alberta Biodiversity Monitoring Institute, AB. Available at <http://www.abmi.ca/abmi/reports/reports.jsp?categoryId=0>.
- Allen, M.L.** 2007. Isotope-derived origins of migratory birds passing through Long Point, Ontario. MSc. Thesis. Trent University, Peterborough, ON.
- Badzinski, D.** 2007. Red-shouldered Hawk and Spring Woodpecker Survey 1990-2006 Final Report for Ontario Ministry of Natural Resources – Terrestrial Assessment Unit. Bird Studies Canada, Port Rowan, ON. 33 p. Available at <http://www.bsc-eoc.org/download/RSHAfinalreport2007.pdf>.
- Bart, J., K.P. Burnham, E.H. Dunn, C.M. Francis and C.J. Ralph.** 2004. Goals and strategies for estimating trends in landbird abundance. *J. Wildl. Manage.* 68: 611–626.
- BirdLife International.** 2008. Common birds are declining in North America [online]. BirdLife International. Available at <http://www.biodiversityinfo.org/sowb/casestudy.php?r=state&id=24>.
- Blancher, P., M.D. Cadman, B.A. Pond, A.R. Couturier, E.H. Dunn, C.M. Francis and R.S. Rempel.** 2007. Changes in Bird Distributions between Atlases. In M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.). *Atlas of the Breeding Birds of Ontario, 2001–2005*. pp. 32–48. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, ON.
- Brewer, D., A. Diamond, E.J. Woodsworth, B.T. Collins and E.H. Dunn.** 2000. Canadian Atlas of Bird Banding. Volume 1: Doves, Cuckoos, and Hummingbirds through Passerines, 1921–1995. Canadian Wildlife Service, Ottawa, ON.
- Butcher, G.** 2007. Common birds in decline, a state of the birds report. *Audubon* 109: 58–62.
- Butcher, G. and D. Niven** 2007. Combining data from the Christmas Bird Count and the Breeding Bird Survey to determine the continental status and trends of North America birds. National Audubon Society, Ivyland, PA. Available at <http://stateofthebirds.audubon.org/cbid/report.php>.
- Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.).** 2007. *Atlas of the Breeding Birds of Ontario, 2001–2005*. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, ON. xxii + 706 p.
- CFSA.** 1994. The Crown Forest Sustainability Act. S.O. 1994. Chapter 25. Available at http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_94c25_e.htm#BK0.
- COSEWIC.** 2006. COSEWIC assessment and status report on the Rusty Blackbird *Euphagus carolinus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. Available at www.sararegistry.gc.ca/status/status_e.cfm.
- COSEWIC.** 2007a. COSEWIC assessment and status report on the Common Nighthawk *Chordeiles minor* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 25 pp. Available at www.sararegistry.gc.ca/status/status_e.cfm.
- COSEWIC.** 2007b. COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 25 pp. Available at www.sararegistry.gc.ca/status/status_e.cfm.
- COSEWIC 2008a.** Canadian Wildlife Species at Risk. Committee on the Status of Endangered Wildlife in Canada, December 2008. 87 p. Available at http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf.
- COSEWIC.** 2008b. COSEWIC assessment and status report on the Canada Warbler *Wilsonia canadensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 35 pp. Available at www.sararegistry.gc.ca/status/status_e.cfm.
- Crins, B.** 2007. Tennessee Warbler. In M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.). *Atlas of the Breeding Birds of Ontario, 2001–2005*. pp. 466–467. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, ON.
- Crins, W.J., B.A. Pond, M.D. Cadman and P.A. Gray.** 2007. The Biogeography of Ontario, with Special Reference to Birds. In M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.). *Atlas of the Breeding Birds of Ontario, 2001–2005*. pp. 11–22. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, ON.
- Cyr, D., S. Gauthier, Y. Bergeron and C. Carcaillet.** 2009. Forest management is driving the eastern North American boreal forest outside its natural range of variability. *Frontiers in Ecology and the Environment*. (in press).
- Downes, C.M. and B.T. Collins.** 2007. Canadian Bird Trends Web site Version 2.2 [online]. Canadian Wildlife Service, Environment Canada, Gatineau, QC. Available at <http://www.cws-scf.ec.gc.ca/mgbc/trends>.
- Dunn, E.H.** 2002. Using Decline in Bird Populations to Identify Needs for Conservation Action. *Conservation Biology* 16: 1632–1637.
- Dunn, E.H., K.A. Hobson, L.I. Wassenaar, D.J.T. Hussell and M.L. Allen.** 2006. Identification of summer origins of songbirds migrating through southern Canada in autumn. *Avian Conservation and Ecology – Écologie et conservation des oiseaux* 1: 4. [online]. Available at <http://www.ace-eco.org/vol1/iss2/art4/>.
- Environmental Assessment Board (EAB).** 1994. Reasons for decision and decision. Class Environmental Assessment by the Ministry of Natural Resources for Timber Management on Crown Lands in Ontario. Anne Koven, Chair, Ontario Ministry of the Environment, Toronto, ON.
- Farmer C.J., R.J. Bell, B. Drolet, L.J. Goodrich, E. Greenstone, D. Grove, D.J.T. Hussell, D. Mizrahi, F.J. Nicoletti and J. Sodergren.** 2008. Trends in autumn counts of migratory raptors in northeastern North America, 1974–2004. In K.L. Bildstein, J.P. Smith, E. Ruelas Inzunza and R.R. Veit (eds.). *State of North America's Birds of Prey*. pp. 179–215. American Ornithologists' Union and Nuttall Ornithological Club Series in Ornithology No. 3. Cambridge, MA.
- Francis, C.M., P. Blancher and D. Phoenix.** 2009. Bird monitoring programs in Ontario: what have we got and what do we need? *For. Chron.* 85(2): 202–217.
- Hoar, T.** 2007. Evening Grosbeak. In M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.). *Atlas of the Breeding Birds of Ontario, 2001–2005*. pp. 626–627. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, ON.
- IUCN.** 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.
- Kelley, J.R., Jr., R.D. Rau and K. Parker.** 2007. American woodcock population status, 2007. U.S. Fish and Wildlife Service, Laurel, MD. 17 p.
- McRae, D.J., L.C. Duchesne, B. Freedman, T.J. Lynham and S. Woodley.** 2001. Comparisons between wildfire and forest harvesting and their implications in forest management. *Environmental Reviews* 9: 223–260.
- Milko, R., L. Dickson, R. Elliot and G. Donaldson.** 2003. *Wings Over Water: Canada's Waterbird Conservation Plan*. Environment Canada, Ottawa, ON. 28 p. Available at <http://www.cws-scf.ec.gc.ca/publications/wow/Wings-EN-2003.pdf>.
- Ontario Eastern Habitat Joint Venture (OEHV).** 2007. Ontario Eastern Habitat Joint Venture Five-year Implementation Plan 2006–2010. 94 p.
- Ontario Ministry of the Environment (OMOE).** 2003. Order under the Environmental Assessment Act. MNR-71. Declaration Order regarding MNR's Class Environmental Assessment Approval for Forest Management on Crown Lands in Ontario. Ministry of the Environment. Toronto, ON.
- Ontario Ministry of Natural Resources (OMNR).** 2005. *Protecting What Sustains Us: Ontario's Biodiversity Strategy, 2005*. Ministry of Natural Resources, Peterborough, ON. 44 p.

_____. 2008. Species at risk in Ontario (SARO) list [online]. Available at <http://www.mnr.gov.on.ca/en/Business/Species/2Column-SubPage/246809.html>.

Ontario Partners in Flight. 2006a. Ontario Landbird Conservation Plan: Boreal Hardwood Transition (North American Bird Conservation Region 12), Priorities, Objectives and Recommended Actions. Version 1.0. Environment Canada, Ontario Ministry of Natural Resources.

Ontario Partners in Flight. 2006b. Ontario Landbird Conservation Plan: Boreal Softwood Shield (North American Bird Conservation Region 8), Priorities, Objectives and Recommended Actions. Version 1.0. Environment Canada, Ontario Ministry of Natural Resources.

Panjabi, A.O. et al. (22 other authors). 2005. The Partners in Flight handbook on species assessment. Version 2005. Partners in Flight Technical Series No. 3. Rocky Mountain Bird Observatory [online]. Available at <http://www.rmbo.org/pubs/downloads/Handbook2005.pdf>

Rich, T. D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C.

Hunter, E.E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt and T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, NY. 88 p. Available at http://www.partnersinflight.org/cont_plan/default.htm.

Ross, K., K. Abraham, R. Clay, B. Collins, J. Iron, R. James, D. McLachlin and R. Weeber. 2003. Ontario Shorebird Conservation Plan. Environment Canada, Canadian Wildlife Service, Downsview, ON. 48 p. Available at <http://www.on.ec.gc.ca/wildlife/plans/shorebirdplan-e.html>.

Sauer, J. R., J.E. Hines, and J. Fallon. 2007. The North American Breeding Bird Survey, Results and Analysis 1966–2006. Version 10.13.2007 [online]. USGS Patuxent Wildlife Research Center, Laurel, MD. Available at <http://www.mbr-pwrc.usgs.gov/bbs/bbs2006.html>.

U.S. NABCI Committee. 2000. North American Bird Conservation Initiative Bird Conservation Region Descriptions. A Supplement to the North American Bird Conservation Initiative Bird Conservation Regions Map. U.S. Fish and Wildlife Service, Arlington, VA. 38 p. Available at <http://www.nabci-us.org/aboutnabci/bcrdescrip.pdf>.

Appendix 1. Forest birds whose Ontario trend status was assessed in this paper, indicating habitat guild and migration strategy assignments for analyses, and at risk status in Ontario and Canada

Common name	Scientific name	Habitat association	Migration strategy	Species at risk
Canada Goose	<i>Branta canadensis</i>	Wet	ShDist	–
Wood Duck	<i>Aix sponsa</i>	Wet	ShDist	–
American Black Duck	<i>Anas rubripes</i>	Wet	ShDist	–
Bufflehead	<i>Bucephala albeola</i>	Wet	ShDist	–
Common Goldeneye	<i>Bucephala clangula</i>	Wet	ShDist	–
Hooded Merganser	<i>Lophodytes cucullatus</i>	Wet	ShDist	–
Common Merganser	<i>Mergus merganser</i>	Wet	ShDist	–
Red-breasted Merganser	<i>Mergus serrator</i>	Wet	ShDist	–
Ruffed Grouse	<i>Bonasa umbellus</i>	Mix	Resident	–
Spruce Grouse	<i>Falcapennis canadensis</i>	Con	Resident	–
Sharp-tailed Grouse	<i>Tympanuchus phasianellus</i>	Wet	Resident	–
Great Blue Heron	<i>Ardea herodias</i>	Wet	Neotrop	–
Turkey Vulture	<i>Cathartes aura</i>	Wds	ShDist	–
Osprey	<i>Pandion haliaetus</i>	Wet	Neotrop	–
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Wet	ShDist	ON
Northern Harrier	<i>Circus cyaneus</i>	Wet	ShDist	–
Sharp-shinned Hawk	<i>Accipiter striatus</i>	Con	ShDist	–
Northern Goshawk	<i>Accipiter gentilis</i>	Dec	Resident	–
Red-shouldered Hawk	<i>Buteo lineatus</i>	Dec	ShDist	–
Broad-winged Hawk	<i>Buteo platypterus</i>	Mix	Neotrop	–
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Opn	ShDist	–
Golden Eagle	<i>Aquila chrysaetos</i>	Wds	ShDist	ON
American Kestrel	<i>Falco sparverius</i>	Opn	ShDist	–
Merlin	<i>Falco columbarius</i>	Con	ShDist	–
Peregrine Falcon	<i>Falco peregrinus</i>	Opn	ShDist	CA, ON
Sandhill Crane	<i>Grus canadensis</i>	Wet	ShDist	–
Spotted Sandpiper	<i>Actitis macularia</i>	Wet	Neotrop	–
Solitary Sandpiper	<i>Tringa solitaria</i>	Wet	Neotrop	–
Greater Yellowlegs	<i>Tringa melanoleuca</i>	Wet	ShDist	–
Wilson's Snipe	<i>Gallinago delicata</i>	Wet	ShDist	–
American Woodcock	<i>Scolopax minor</i>	Shr	ShDist	–
Bonaparte's Gull	<i>Larus philadelphia</i>	Wet	ShDist	–
Black Tern	<i>Chlidonias niger</i>	Wet	Neotrop	ON
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	Shr	Neotrop	–
Great Horned Owl	<i>Bubo virginianus</i>	Wds	Resident	–
Northern Hawk Owl	<i>Surnia ulula</i>	Wds	Resident	–
Barred Owl	<i>Strix varia</i>	Mix	Resident	–
Great Gray Owl	<i>Strix nebulosa</i>	Con	Resident	ON
Long-eared Owl	<i>Asio otus</i>	Con	Resident	–
Boreal Owl	<i>Aegolius funereus</i>	Mix	Resident	–
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	Mix	Resident	–
Common Nighthawk	<i>Chordeiles minor</i>	Opn	Neotrop	CA
Whip-poor-will	<i>Caprimulgus vociferus</i>	Dec	Neotrop	(CA)
Chimney Swift	<i>Chaetura pelagica</i>	Opn	Neotrop	CA
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	Wds	Neotrop	–
Belted Kingfisher	<i>Megascyle alcyon</i>	Wet	ShDist	–
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	Wds	ShDist	CA, ON
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	Mix	ShDist	–
Downy Woodpecker	<i>Picoides pubescens</i>	Dec	Resident	–
Hairy Woodpecker	<i>Picoides villosus</i>	Wds	Resident	–
American Three-toed Woodpecker	<i>Picoides dorsalis</i>	Con	Resident	–
Black-backed Woodpecker	<i>Picoides arcticus</i>	Con	Resident	–
Northern Flicker	<i>Colaptes auratus</i>	Wds	ShDist	–
Pileated Woodpecker	<i>Dryocopus pileatus</i>	Wds	Resident	–
Olive-sided Flycatcher	<i>Contopus cooperi</i>	Wds	Neotrop	CA
Eastern Wood-Pewee	<i>Contopus virens</i>	Dec	Neotrop	–
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	Wet	Neotrop	–
Alder Flycatcher	<i>Empidonax alnorum</i>	Wet	Neotrop	–
Willow Flycatcher	<i>Empidonax traillii</i>	Shr	Neotrop	–
Least Flycatcher	<i>Empidonax minimus</i>	Dec	Neotrop	–
Eastern Phoebe	<i>Sayornis phoebe</i>	Opn	ShDist	–
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	Wds	Neotrop	–
Yellow-throated Vireo	<i>Vireo flavifrons</i>	Dec	Neotrop	–
Blue-headed Vireo	<i>Vireo solitarius</i>	Mix	ShDist	–
Philadelphia Vireo	<i>Vireo philadelphicus</i>	Dec	Neotrop	–
Red-eyed Vireo	<i>Vireo olivaceus</i>	Dec	Neotrop	–
Gray Jay	<i>Perisoreus canadensis</i>	Con	Resident	–
Blue Jay	<i>Cyanocitta cristata</i>	Wds	ShDist	–
American Crow	<i>Corvus brachyrhynchos</i>	Wds	ShDist	–

Appendix 1. (continued)

Common name	Scientific name	Habitat association	Migration strategy	Species at risk
Common Raven	<i>Corvus corax</i>	Wds	Resident	–
Tree Swallow	<i>Tachycineta bicolor</i>	Opn	ShDist	–
Black-capped Chickadee	<i>Poecile atricapillus</i>	Wds	Resident	–
Boreal Chickadee	<i>Poecile hudsonica</i>	Con	Resident	–
Red-breasted Nuthatch	<i>Sitta canadensis</i>	Mix	Resident	–
White-breasted Nuthatch	<i>Sitta carolinensis</i>	Dec	Resident	–
Brown Creeper	<i>Certhia americana</i>	Con	ShDist	–
Winter Wren	<i>Troglodytes troglodytes</i>	Con	ShDist	–
Golden-crowned Kinglet	<i>Regulus satrapa</i>	Con	ShDist	–
Ruby-crowned Kinglet	<i>Regulus calendula</i>	Con	ShDist	–
Eastern Bluebird	<i>Sialia sialis</i>	Opn	ShDist	–
Veery	<i>Catharus fuscescens</i>	Dec	Neotrop	–
Swainson's Thrush	<i>Catharus ustulatus</i>	Mix	Neotrop	–
Hermit Thrush	<i>Catharus guttatus</i>	Wds	ShDist	–
Wood Thrush	<i>Hylocichla mustelina</i>	Dec	Neotrop	–
American Robin	<i>Turdus migratorius</i>	Wds	ShDist	–
Gray Catbird	<i>Dumetella carolinensis</i>	Shr	ShDist	–
Brown Thrasher	<i>Toxostoma rufum</i>	Shr	ShDist	–
Cedar Waxwing	<i>Bombicilla cedrorum</i>	Shr	ShDist	–
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	Shr	Neotrop	CA, ON
Tennessee Warbler	<i>Vermivora peregrina</i>	Wds	Neotrop	–
Orange-crowned Warbler	<i>Vermivora celata</i>	Shr	ShDist	–
Nashville Warbler	<i>Vermivora ruficapilla</i>	Wds	Neotrop	–
Northern Parula	<i>Parula americana</i>	Con	Neotrop	–
Yellow Warbler	<i>Dendroica petechia</i>	Shr	Neotrop	–
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	Shr	Neotrop	–
Magnolia Warbler	<i>Dendroica magnolia</i>	Shr	Neotrop	–
Cape May Warbler	<i>Dendroica tigrina</i>	Con	Neotrop	–
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	Mix	Neotrop	–
Yellow-rumped Warbler	<i>Dendroica coronata</i>	Con	ShDist	–
Black-throated Green Warbler	<i>Dendroica virens</i>	Con	Neotrop	–
Blackburnian Warbler	<i>Dendroica fusca</i>	Con	Neotrop	–
Pine Warbler	<i>Dendroica pinus</i>	Con	ShDist	–
Kirtland's Warbler	<i>Dendroica kirtlandii</i>	Shr	Neotrop	CA, ON
Prairie Warbler	<i>Dendroica discolor</i>	Shr	Neotrop	–
Palm Warbler	<i>Dendroica palmarum</i>	Wet	ShDist	–
Bay-breasted Warbler	<i>Dendroica castanea</i>	Con	Neotrop	–
Cerulean Warbler	<i>Dendroica cerulea</i>	Dec	Neotrop	CA, ON
Black-and-white Warbler	<i>Mniotilta varia</i>	Mix	Neotrop	–
American Redstart	<i>Setophaga ruticilla</i>	Dec	Neotrop	–
Ovenbird	<i>Seiurus aurocapilla</i>	Mix	Neotrop	–
Northern Waterthrush	<i>Seiurus noveboracensis</i>	Wet	Neotrop	–
Louisiana Waterthrush	<i>Seiurus motacilla</i>	Dec	Neotrop	CA, ON
Connecticut Warbler	<i>Oporornis agilis</i>	Wet	Neotrop	–
Mourning Warbler	<i>Oporornis philadelphia</i>	Shr	Neotrop	–
Common Yellowthroat	<i>Geothlypis trichas</i>	Wet	Neotrop	–
Wilson's Warbler	<i>Wilsonia pusilla</i>	Wet	Neotrop	–
Canada Warbler	<i>Wilsonia canadensis</i>	Mix	Neotrop	CA
Scarlet Tanager	<i>Piranga olivacea</i>	Dec	Neotrop	–
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	Shr	ShDist	–
Chipping Sparrow	<i>Spizella passerina</i>	Wds	ShDist	–
Clay-colored Sparrow	<i>Spizella pallida</i>	Shr	Neotrop	–
Le Conte's Sparrow	<i>Ammodramus leconteii</i>	Wet	ShDist	–
Song Sparrow	<i>Melospiza melodia</i>	Shr	ShDist	–
Lincoln's Sparrow	<i>Melospiza lincolni</i>	Shr	ShDist	–
Swamp Sparrow	<i>Melospiza georgiana</i>	Wet	ShDist	–
White-throated Sparrow	<i>Zonotrichia albicollis</i>	Shr	ShDist	–
Dark-eyed Junco	<i>Junco hyemalis</i>	Shr	ShDist	–
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	Dec	Neotrop	–
Indigo Bunting	<i>Passerina cyanea</i>	Shr	Neotrop	–
Rusty Blackbird	<i>Euphagus carolinus</i>	Wet	ShDist	CA
Pine Grosbeak	<i>Pinicola enucleator</i>	Wds	Nomadic	–
Purple Finch	<i>Carpodacus purpureus</i>	Mix	ShDist	–
Red Crossbill	<i>Loxia curvirostra</i>	Con	Nomadic	–
White-winged Crossbill	<i>Loxia leucoptera</i>	Con	Nomadic	–
Pine Siskin	<i>Carduelis pinus</i>	Wds	Nomadic	–
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	Con	Nomadic	–

Habitat association: Con = Coniferous forest; Dec = Deciduous forest; Mix = Mixed forest; Wds = Open woodlands; Shr = Shrub/early succession; Wet = Wetlands; Opn = other open habitats.

Migration strategy: Neotrop = Neotropical migrant; ShDist = Short-distance migrant; Resident = Resident year-round; Nomadic = varies from year to year

Species at risk: ON = at risk in Ontario (SARO list); CA = at risk in Canada (COSEWIC list); (CA) = in review by COSEWIC

Appendix 2. Assessments of trend status and reliability of trend status for Ontario's forest birds, Ontario-wide and in 2 forested Bird Conservation Regions (BCRs). Conservation priority status (from other sources, see methods) is also show for each region.

Common Name	Ontario-wide				Boreal Hardwood Transition (BCR 12)				Boreal Softwood Shield (BCR 8)			
	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years
Canada Goose	LI	2.5	2	2.5	LI	3	2	3	LI	2	2	2
Wood Duck	LI	2	2	2	MI	3	3	3	LI	2	2	2
American Black Duck	LD	2	2	2	ST	3	3	3	ST	2	1	2
Bufflehead	LI	1	0	1	LI	1	0	1	LI	1	0	1
Common Goldeneye	ST	2.5	2	2.5	MI	3	3	3	ST	2.5	2	2.5
Hooded Merganser	MI	2	2	2	MI	2.5	2	2.5	MI	2	2	2
Common Merganser	ST	2	2	2	ST	3	2	3	ST	2	2	2
Red-breasted Merganser	ST	1.5	1	1.5	ST	2.5	0	2.5	ST	1.5	0	1.5
Ruffed Grouse	ST	2	2	2	ST	2	1.5	2	ST	1.5	1	2
Spruce Grouse	ST	1.5	1	2	ST	2	1	2	ST	1.5	1	2
Sharp-tailed Grouse	MI	1	0	1	ST	2	1	2	MI	1	0	1
Great Blue Heron	ST	3	3	3	ST	3	3	3	LD	2	1	2
Turkey Vulture	LI	3	2	2	LI	3	2	2	LI	3	1	2
Osprey	ST	2	1	2	ST	2	1	2	ST	1.5	1	2
Bald Eagle	LI	2	1	1.5	LI	3	1	2.5	LI	2	1	1.5
Northern Harrier	MI	2	2	2	MD	2	1	2	MI	1.5	1	1
Sharp-shinned Hawk	ST	2	2	2	ST	2	1	2	ST	1.5	1	2
Northern Goshawk	MD	2	1	2	ST	2	1	2	LD	1	0	2
Red-shouldered Hawk	MI	2	2	2	MI	2	2	2	-	-	-	-
Broad-winged Hawk	ST	2	2	2	ST	2	2	2	MI	1.5	1	2
Red-tailed Hawk	ST	2	2	2	ST	2	1	2	LI	2	1	2
Golden Eagle	MI	1	1	1	-	-	-	-	-	-	-	-
American Kestrel	MD	2	2	2	MD	2	2	2	ST	1.5	1.5	2
Merlin	LI	2	0	2	LI	2	0	2	LI	2	0	2
Peregrine Falcon	LI	3	2	2	LI	3	2	2	LI	2	1	1
Sandhill Crane	LI	3	2	2	LI	3	2	2	LI	2	1	1
Spotted Sandpiper	ST	1.5	1	2	MD	1	2	2	ST	1.5	1	2
Solitary Sandpiper	MD	1.5	1	2	MI	2	2	2	LD	1	1	2
Greater Yellowlegs	MI	1.5	1	2	-	-	-	-	LI	2	0	1
Wilson's Snipe	ST	1.5	1	2	MD	2	2	2	ST	1.5	1	2
American Woodcock	LD	2	2	2	LD	2	2	2	MI	1	1	1
Bonaparte's Gull	MI	1	1	2	MI	1	1	2	MI	1	1	2
Black Tern	LD	2	2	2	LD	2	1	2	ST	1	0	1
Black-billed Cuckoo	ST	2	2	2	MD	1.5	2	2	LI	1	1	1
Great Horned Owl	MD	2	2	2	MD	2	2	2	ST	2	2	2
Northern Hawk Owl	DD	0	0	0	DD	0	0	0	DD	0	0	0
Barred Owl	MI	2	2	2	MI	3	3	3	ST	2	2	2
Great Gray Owl	ST	1	1	1	MI	1	1	1	MI	2	2	2
Long-eared Owl	MI	1.5	1	1.5	LI	2	0	2	MI	1	0	1

Appendix 2. (continued)

Common Name	Ontario-wide			Boreal Hardwood Transition (BCR 12)			Boreal Softwood Shield (BCR 8)		
	Trend status	Current reliability	Reliability in 10 years	Trend status	Current reliability	Reliability in 10 years	Trend status	Current reliability	Reliability in 10 years
Boreal Owl	MD	2	2	MD	2	2	MD	2	2
Northern Saw-whet Owl	ST	1.5	2	ST	2	2	MI	2	2
Common Nighthawk	LD	2	1	LD	3	1	Conc, Sar	1.5	0
Whip-poor-will	LD	3	1	LD	3	1	DD	0	0
Chimney Swift	LD	3	2	LD	3	2	Conc, Sar	-	-
Ruby-throated Hummingbird	LI	2	2	MI	2	2	LI	2	1
Belted Kingfisher	MD	2	1	MD	2	2	ST	1.5	1
Red-headed Woodpecker	LD	3	2	LD	3	1	Conc, Sar	-	-
Yellow-bellied Sapsucker	MI	3	2	MI	3	2	MI	2	2
Downy Woodpecker	MI	2	2	MI	2	2	MI	1.5	1
Hairy Woodpecker	MI	2	2	LI	2	2	ST	1.5	1
American Three-toed Woodpecker	ST	1.5	1	MI	1	0	MI	1.5	1
Black-backed Woodpecker	ST	1.5	1	ST	2	1	ST	1.5	1
Northern Flicker	ST	2	2	MD	3	3	ST	2	2
Pileated Woodpecker	LI	2	2	LI	2	2	MI	1	1
Olive-sided Flycatcher	MD	2	2	LD	3	2	Conc, Sar	1.5	1
Eastern Wood-Pewee	MD	2	3	LD	3	3	Conc	1.5	1
Yellow-bellied Flycatcher	MI	2	1.5	ST	2	1	MI	1.5	1.5
Alder Flycatcher	MI	1.5	1	MI	2	2	MI	1.5	1
Willow Flycatcher	MI	3	3	MI	2	1	Conc	-	-
Least Flycatcher	ST	2	2	LD	3	3	ST	2	2
Eastern Phoebe	MI	3	3	MI	3	3	MD	1	1
Great Crested Flycatcher	MD	2	3	MD	3	3	-	-	-
Yellow-throated Vireo	ST	2	2	ST	2	1	-	-	-
Blue-headed Vireo	LI	3	2	LI	2	2	LI	2	2
Philadelphia Vireo	ST	2	1	MI	2	2	MI	1.5	1
Red-eyed Vireo	MI	2	2	ST	3	3	MI	2	2
Gray Jay	ST	1.5	1	MD	3	2	ST	1.5	1
Blue Jay	MI	3	3	MD	3	3	MI	2	1
American Crow	MI	3	3	MI	3	3	MI	1.5	1
Common Raven	MI	2	2	LI	3	3	ST	2	1
Tree Swallow	MD	3	3	LD	2	2	MD	1.5	1
Black-capped Chickadee	LI	3	3	LI	3	3	MI	2	1
Boreal Chickadee	MD	1.5	1	MD	2	1	ST	1.5	1
Red-breasted Nuthatch	MI	2	2	LI	3	3	MI	1.5	1
White-breasted Nuthatch	MI	3	3	MI	3	2	LI	2	0
Brown Creeper	LI	1.5	1.5	MI	2	2	LI	1.5	1.5
Winter Wren	MI	2	2	MI	3	3	MI	2	2
Golden-crowned Kinglet	MI	2	2	MI	2	2	MI	1.5	2
Ruby-crowned Kinglet	MI	1.5	2	LD	2	3	MI	1.5	2
Eastern Bluebird	LI	3	3	LI	3	2	LI	1	1

Appendix 2. (continued)

Common Name	Ontario-wide				Boreal Hardwood Transition (BCR 12)				Boreal Softwood Shield (BCR 8)			
	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years	Trend status	Current reliability	Reliability in 10 years	Reliability in 20 years
Veery	ST	2	3	3	MD	2	3	3	MI	1.5	1	2
Swainson's Thrush	ST	2	2	3	MD	3	3	3	ST	2	2	3
Hermit Thrush	MI	2	2	3	MI	3	3	3	MI	1.5	2	3
Wood Thrush	ST	3	3	3	LD	3	3	3	Conc	–	–	–
American Robin	MI	3	3	3	ST	3	3	3	MI	2	2	3
Gray Catbird	ST	3	3	3	LD	3	3	3	MD	1	0	1
Brown Thrasher	LD	3	3	3	LD	3	3	3	Conc	–	–	–
Cedar Waxwing	MI	2	3	3	ST	2	3	3	MI	1.5	1	2
Golden-winged Warbler	ST	2	2	2	MD	1	1	2	Conc, Stew, Sar	–	–	–
Tennessee Warbler	MD	1.5	1.5	2	LD	2	2	2	MD	1.5	1.5	2
Orange-crowned Warbler	MI	1.5	1	2	–	–	–	–	ST	1.5	1	1
Nashville Warbler	MI	3	2	3	ST	3	3	3	MI	2	2	3
Northern Parula	LI	2	2	2	LI	2	2	2	LI	1.5	1	2
Yellow Warbler	MI	2	2	2	MD	2	2	3	ST	1.5	1	2
Chestnut-sided Warbler	ST	2	3	3	ST	2	3	3	ST	1.5	2	2
Magnolia Warbler	MI	3	2	2	LI	3	3	3	MI	2	2	3
Cape May Warbler	ST	2	1	2	ST	2	2	2	ST	1.5	1	2
Black-throated Blue Warbler	LI	3	3	3	LI	3	3	3	MI	1.5	1	2
Yellow-rumped Warbler	MI	2	2	3	MI	3	3	3	MI	2	2	3
Black-throated Green Warbler	MI	2	2	2	LI	3	3	3	ST	1.5	1	2
Blackburnian Warbler	MI	2	2	3	MI	2	2	3	MI	1.5	1	2
Pine Warbler	LI	3	3	3	LI	3	3	3	LI	2	1	1
Kirtland's Warbler	–	–	–	–	–	–	–	–	Conc, Stew, Sar	–	–	–
Prairie Warbler	ST	2	1	2	ST	2	1	2	Conc	–	–	–
Palm Warbler	MI	2	2	3	MI	1	1	1	MI	2	2	2
Bay-breasted Warbler	ST	1.5	1.5	1.5	MD	2	2	2	Conc	1.5	1.5	1.5
Cerulean Warbler	MD	2.5	1	2.5	MD	2.5	1	2.5	Sar	–	–	–
Black-and-white Warbler	MI	3	2	2	ST	3	3	3	MI	2	2	2
American Redstart	MI	3	2	3	MI	3	3	3	MI	2	2	3
Ovenbird	ST	3	2	3	ST	3	3	3	ST	3	1	3
Northern Waterthrush	ST	2	2	2	MD	1	2	2	MI	2	2	2
Louisiana Waterthrush	ST	2	2	2	–	–	–	–	Sar	–	–	–
Connecticut Warbler	MI	1.5	1	2	LD	2	2	2	Conc	1.5	1	2
Mourning Warbler	ST	2	2	2	MD	3	3	3	MI	1.5	1	2
Common Yellowthroat	ST	2	2	3	MD	2	3	3	ST	1.5	1	2
Wilson's Warbler	MI	2	2	2	ST	2	1	2	MI	2	2	2
Canada Warbler	MD	2	2	2	MD	2	2	2	Conc, Stew, Sar	2	2	2
Scarlet Tanager	MD	2	3	3	LD	2	3	3	MD	1.5	1	1

Appendix 2. (continued)

Common Name	Ontario-wide			Boreal Hardwood Transition (BCR 12)			Boreal Softwood Shield (BCR 8)		
	Trend status	Current reliability	Reliability in 10 years	Trend status	Current reliability	Reliability in 10 years	Trend status	Current reliability	Reliability in 10 years
Eastern Towhee	ST	2	2	LD	2	2	-	-	-
Chipping Sparrow	MI	2	2	ST	3	3	MI	2	3
Clay-colored Sparrow	MI	2	2	MI	2	2	LI	1	0
Le Conté's Sparrow	LI	2	1	LI	2	1	LI	1	0
Song Sparrow	ST	3	3	MD	3	3	ST	1.5	1
Lincoln's Sparrow	MI	2	2	MI	2	2	MI	2	2
Swamp Sparrow	ST	2	2	ST	2	2	ST	2	2
White-throated Sparrow	ST	2	2	ST	3	3	ST	2	2
Dark-eyed Junco	ST	2	2	MD	3	3	ST	1.5	2
Rose-breasted Grosbeak	LD	2	3	LD	3	3	ST	1.5	1
Indigo Bunting	MI	3	3	MI	3	3	MI	1	0
Rusty Blackbird	MD	1	1	MD	2	0	MD	1.5	1
Pine Grosbeak	ST	1.5	1	MD	2	0	MD	1	1
Purple Finch	MD	2	2	LD	3	3	MD	1	1
Red Crossbill	ST	2	1	LD	2	1	MD	1.5	1
White-winged Crossbill	MI	2	1	MI	2	2	MI	1.5	1
Pine Siskin	MD	1	1	MD	2	1	MD	1	1
Evening Grosbeak	LD	3	2	LD	3	2	MD	2	2

Trend status: LD = large decline, MD = moderate decline, ST = stable, MI = moderate increase, LI = large increase, DD = data deficient; blank=absent or very few birds present.

Reliability: 1 = Poor, 1.5 = Poor to Acceptable; 2 = Acceptable; 2.5 = Acceptable to Reliable; 3 = Reliable.

Regional priority: Conc = Species of concern and/or in need of management action, from bird conservation plans (Ontario Eastern Habitat Joint Venture, Ontario Partners in Flight, Ontario Shorebird Conservation Plan, Wings over Water (Canada)); Stew = Species of high regional responsibility (Stewardship); Sar = species at risk (COSEWIC or SARO) with significant populations in the region