Coniferous forest habitat in the Kenauk Nature Reserve. *Photo by Juliana Balluffi-Fry*

Using bird survey data to associate habitat type and bird species richness in a forest of southern Quebec

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Introduction

The effects of habitat on biodiversity have been studied extensively. Species richness is a basic measure of diversity and can be a proxy for ecosystem health (Mitchell 2006). Birds are plentiful, diverse and identifiable to the trained ear, making them a useful umbrella or indicator taxa for biodiversity studies.

Habitat largely determines breeding bird distribution as it dictates two fundamental needs: an acceptable nesting site and an ample food supply (Vickery and Arlettaz 2012). According to previous studies of bird species richness, a habitat's structural diversity, or the number and varieties of nesting and feeding niches, is positively correlated to its avian species richness (Cody 1985).

Figure 1. The study site, Kenauk Nature Reserve, shown in relation to Montreal (below) and in further detail above with lakes, rivers, streams, recently cut areas, and roads used for the bird surveys shown.

Point counts and breeding bird surveys are a convenient method for assessing bird species richness and relative abundance. A common way to collect such data is by recruiting experienced volunteer birders (Sauer *et al.* 2001), as did the managers of this paper's study site. The study site of this paper is a private game reserve located in Montebello, Quebec, whose recent owners have collaborated with Nature Conservancy of Canada (NCC) to catalogue the biodiversity of their reserve. They have done so in part by using volunteer birders to conduct bird surveys and create an inventory of all bird species present.

This paper is the culmination of a 2015 attempt to inventory the diurnal avian diversity in the Kenauk Nature Reserve and its association with habitat type. It is an example of one of the many achievable uses for bird inventory data collected by volunteers and the possible ecological effects of certain land management practices.

Materials and Methods

Study area

The Kenauk Nature Reserve study site of this paper is a 260 km² private game reserve located in Montebello, Quebec, halfway between Montreal, Quebec, and Ottawa, Ontario, just north of the Ottawa River (Figure 1). The reserve sits on the border between the sugar maple-basswood (*Acer saccharum-Tilia Americana)* and the sugar maple-yellow birch (*Acer saccharum-Betula alleghaniensis*) forest zones (Belanger *et al.* 1992).

Bird survey data were collected from all drivable roads inside the Kenauk Nature Reserve.
Photo by Juliana Balluffi-Fry

The property has a history of strip-cut forest harvesting. Most regrowth is natural regeneration, however, there are plots that have been seeded with coniferous species. This has caused the property to be a heterogeneous patchwork of both coniferous and naturally occurring forest stands varying in age. Along with a wide range of forests, the land also includes wetlands, lakes, ponds, rivers, streams and some recently cleared areas. The road system in the Kenauk Nature Reserve (Figure 1) is a tertiary one, meaning all of the roads are narrow and unpaved (McCarthy 2012).

Bird data

Avian species richness data were collected from the faunal surveys by NCC volunteers. The goal of NCC's surveys was to complete an overall bird species inventory for conservation planning purposes and to determine whether any endangered, threatened or special concern bird species inhabited the property. Sampling occurred in the summer of 2015 on 6, 7, 19, 20, 21 June. The morning and evening birding sessions were conducted between 5:00 and 11:00 and 16:00 and 22:00, respectively. Some volunteers chose to bird between the hours of 11:00 and 16:00; we used these point counts as well, since we needed to account for the variable of "time of day". Volunteers worked in pairs, with each of the volunteers having at least 10 years of point count experience.

NCC volunteers at Kenauk. *Photo by Mike Dembeck*

Bird survey data were collected from all drivable roads inside the property. The literature suggests that tertiary road systems such as Kenauk's do not affect bird populations enough to change point count accuracy (McCarthy 2012). Since the original purpose of the bird surveys was to observe the most avian species possible, volunteers did not use the typical stationary point count method. Instead, their collection was much more like that of surveys consisting of driving and birding specific lengths of roads with stops for further observation.

Volunteers used the detailed maps of the property's 30 divisions to mark their routes' starting and ending locations and times. They proceeded slowly down the roads in their vehicles and recorded any bird heard while driving. The birders would stop and conduct a point count every 0.3 kilometers along the drive or until there was a noticeable habitat change (for example, a roadside marsh or pond). The point count stops would last for a maximum of 5 minutes, unless extra time was needed to identify certain challenging bird calls.

These methods provided flexibility for experienced observers to increase the number of point counts across the many habitat changes while maximizing habitat covered by following roads. Increasingly, observer flexibility has become recognized as an important component of biodiversity inventories, as observers can maximize time in regions of high abundance, such as by following calls to locate flocks (Rompre *et al.* 2007, Bart *et al.* 2012). Accurate community-level data can be obtained from more flexible study designs as well as purely random point counts and line transects (Rompre *et al.* 2007, Bart *et al.* 2012).

The end result was one survey record per birding route, which listed all detected species and their observed abundance tallies. Birds encountered while driving were included in the analysis. We extracted the total avian species richness, passerine richness (number of passerine species observed) and *at risk* richness (number of species listed by COSEWIC as Threatened or Special Concern) for each birding route.

Habitat data

We drove all of the NCC birding routes by following their paths marked in detail on property maps, and measured their lengths to the nearest 0.1 km (100m) using an odometer. We classified each route's habitat composition using eight categories: deciduous (>90%), coniferous (>90%), deciduous-dominated mixed forest (50-89%), conifer-dominated mixed forest (50-89%), wetlands (peatlands, marshes, swamps), permanent waterbody (lakes, ponds, rivers), rocky outcropping and recently cleared, which we defined as non-wetland openings with vegetation no greater than shrub level. As we drove, we categorized the road-side habitat and recorded the location of each habitat change, i.e., its distance in kilometers from the starting location. This gave us the distribution of habitats along the roadsides of each birding route. For each bird survey route, we calculated the total length (km) of each habitat present and then divided by the total length of the route to get percentages for each. We then arcsine-transformed the habitat percentages. Time of day was not controlled for on each birding survey, therefore we added this variable by using the median time between each birding route's start and stop times.

Statistical analysis

Each data point in our model is one bird survey route since the volunteers only provided the species and total numbers of each species observed per each birding route. This caused each data point to vary in length (km), duration (i.e., how long it took them to conduct the survey from start to finish), time of day, observer (the observer chosen to represent the route was the most experienced birder) and habitat proportions. A generalized linear mixed model was run using these data with observer as a random effect (Bolker *et al.* 2008). The fixed effects for each data point were duration, length, time of day and the percentages of each of the eight habitat categories listed. We ran the model three times for the three different response variables: total richness, passerine richness and *at risk* richness.

We analyzed the data using the R package lme4 (Bates 2010). To achieve normality, we log-transformed total and passerine richness and fit a Poisson distribution in the lme4 package for *at risk* richness. To determine which fixed variables significantly affected total richness and songbird richness, we ran the model using the function lmer (glmer for *at risk* richness to accommodate a Poisson distribution) and obtained effect sizes (t-values).

We eliminated all insignificant effects using a significance level of $P<0.05$, which was executed within the lmer function using the criterion $|t|<2$, and re-ran the model until all effects were significant.

To prove our total species richness was justified and to conduct a meaningful comparison across the varying habitat proportions, we created a sample-based rarefaction curve using the number of new species heard in each driven route over the total amount of time birding (Gotelli and Colwell 2001). We extrapolated how many bird species could potentially occur at Kenauk, to further determine how conclusive the data were, using the *Chao1* index. The *Chao1* index is given by the following expression (Chao 1984):

$$S_{est} = S_{obs} + \left(\frac{(f_1)^2}{2f_2}\right)$$

Where: f_1 is the number of singletons (species observed once), and f_2 is the number of doubletons (species observed twice) and S_{obs} equals the total number of species observed regardless of abundance (Gotelli 2008).

Results

Observed species

A total of 99 species was observed on the property including 68 passerines, 13 waterfowl, and 18 others (Appendix 1). Of the 99 species, eight were listed as *at risk* by COSEWIC (2015). These included the Eastern Whip-poor-will, Olive-sided Flycatcher, Eastern Wood-Pewee, Barn Swallow, Wood Thrush, Canada Warbler, Bobolink and Eastern Meadowlark (see Appendix 1 for scientific names).

Habitats

The total number of birding routes (data points) used in this study was 48. Of the 48 total routes, not all were unique; there was much overlap and eight had the exact same start and ending locations. The average length of the routes was 3.17 km. The average amounts of each habitat present per birding route were as follows: deciduous-dominated mixed forest (34.8%), deciduous forest (28.1%), wetlands (11.7%), permanent waterbody (9.9%), coniferous forest (6.7%), rocky outcropping (3.8%), coniferous-dominated mixed forest (2.8%) and lastly recently cleared (2.2%).

Sampling effort

The plot of our species accumulation-effort curve almost asymptotes by the end of the study's sampling period (73.46 hours) with an accumulated total of 99 species (Figure 2). Hence, a very large increase in sample effort would be needed to reach a higher total species richness.

This is important because as Gotelli and Colwell (2001) state: "Raw species richness counts… can be validly compared only when taxon accumulation curves have reached a clear asymptote." Therefore, our total species list is a strong representation of the Kenauk diurnal bird diversity.

If we substitute our findings into the *Chao1* equation:

$$S_{est} = 99 + \left(\frac{(14)^2}{2(7)}\right)$$

$$S_{est} = 113$$

the results concur that theoretically there should be 113 species inside the Kenauk forest. Gotelli (2008) explains that this equation equates to "a conservative estimate", so a minimum of 14 species went undetected by our point counts.

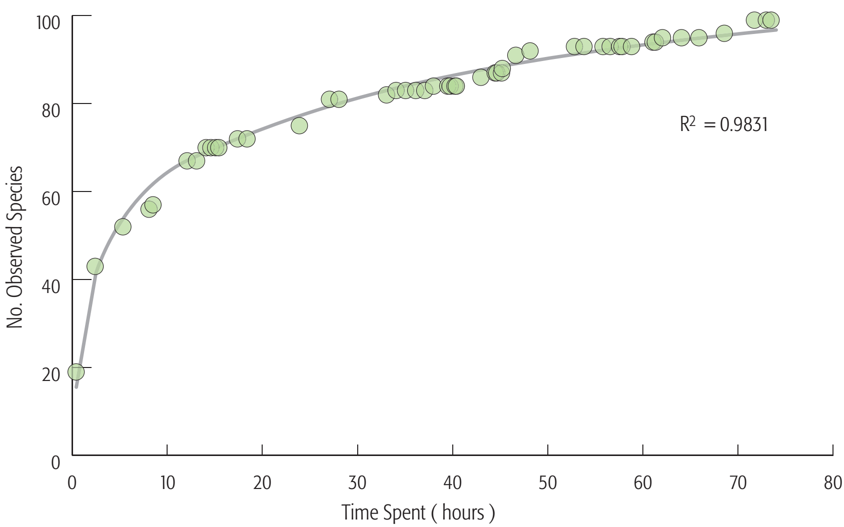
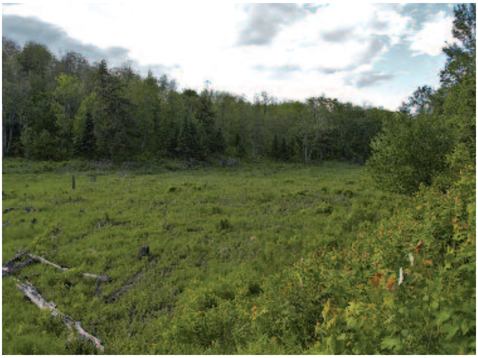


Figure 2. Total number of species detected by sampling effort (hours), fitted to a logarithmic line.



Top: **Sugar maple habitat with dense understory.**
Left: **A tertiary road through coniferous habitat.**
Above: **An open shrub dominated wetland.**
Photos by Juliana Balluffi-Fry

The percent of recently cleared area was positively correlated with the number of *at risk* species detected. *Photo by Juliana Balluffi-Fry*

Effects of habitat

Two habitat types were associated with at least one type of richness: coniferous forest and recently cleared (Table 1 and Figure 3).

The total species richness was significantly affected by the duration and length of the point count route, with route length having a greater effect than duration; total richness was negatively affected by the amount of coniferous forest (Table 1). No other fixed effects were significant.

Passerine richness was significantly affected by time of day in addition to duration of point count and amount of coniferous forest. Passerine richness declined with time of day. *At risk* richness also declined with time of day, but was not related to either length or coniferous factors. However, the habitat parameter "percent recently cleared area" was positively correlated with this type of diversity. Regardless, the amount of variation associated with habitat was relatively low (R^2 = 0.01-0.07) (Figure 3).

Table 1. The relationships between each type of species richness and its fixed effects. Only the fixed effects that proved significant to at least one richness type are shown. Significant relationships are represented by the estimated regression slope ± standard error from the generalized mixed model. Deciduous, deciduous-dominated mixed, coniferous-dominated mixed, wetlands, permanent waterbodies, rocky outcroppings were not included in the table as they showed no significant relationship to any type of species richness.

	Time of Day	Duration	Birding Route Length	Coniferous	Recently Cleared
Total Species Richness	Not Significant	0.0023 ± 0.00040	0.045 ± 0.016	-0.32 ± 0.11	Not Significant
Passerine Richness	-0.41 ± 0.16	0.0017 ± 0.00046	0.042 ± 0.018	-0.36 ± 0.13	Not Significant
At Risk Richness	-2.8 ± 0.93	*	Not Significant	Not Significant	1.3 ± 0.51

* Duration was excluded for *at risk* richness because the model would not converge.

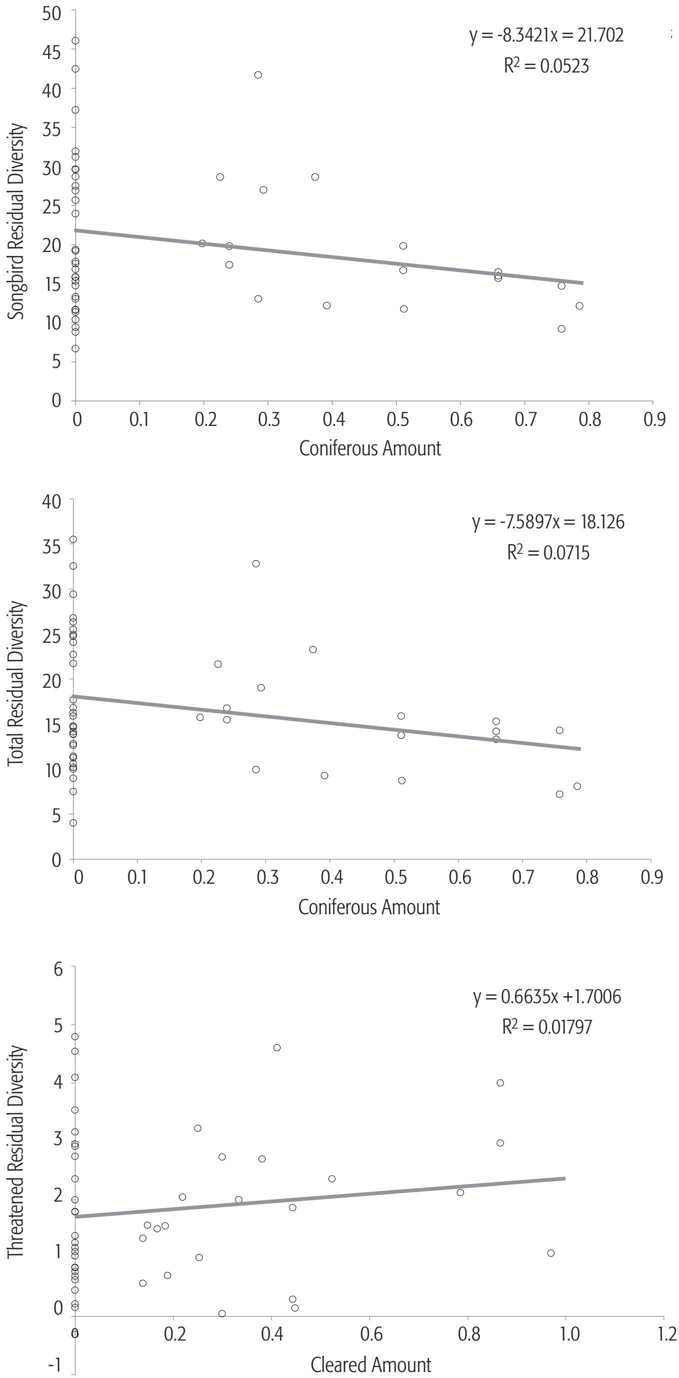


Figure 3. The residual plots using the same significant habitats as in Table 1. These residual plots show the relationships between the habitats of interest and species richness after accounting for all other significant variables. All slopes are significantly different from zero (Table 1).

Discussion

Species observed

Our total observed species list reveals that this forest holds a diverse diurnal bird fauna. The 99 species found, representing 90% of 114 species estimated to occur in mid-June, is a minimum estimate of richness, but it covers many avian orders and families. The Kenauk property is considered a diverse landscape, because it has many types of habitats in large areas. The landscape diversity theory states that the more heterogeneous a landscape is, the more species it will have (Dolman 2012). In our study, richness was not strongly associated with any particular habitat feature (relationships with habitat composition were weak), implying that the high species richness at Kenauk is associated with the mosaic of habitats present on the property.

The majority of the observed species were passerines, which is predictable because Passeriformes is the most species rich of the avian orders and contains many species often found in forests (Sibley 2003). There were also 13 species of waterfowl due to the many lakes, marshes and ponds. Few nocturnal species (e.g., owls, nightjars) were detected because of method bias (i.e., birding occurred between 05:00 and 22:00) (Sibley 2003). Eight (8.8%) of the species observed were either Threatened or of Special Concern (COSEWIC 2015).

Total and passerine richness

We found that there was a significant negative correlation between bird species richness and percent of coniferous forest. A widely accepted and supported theory in ecology is that habitat diversity is reflected in wildlife species diversity (Tews *et al.* 2004). This theory holds that less diverse habitats hold fewer niches, such as nesting sites and food sources (Cody 1985). This property was an ideal study site to investigate these effects because it holds areas which were once seeded with coniferous species and therefore, are now homogenous in tree species and height. Our findings support the theory because we found that the bird survey routes with the more homogenous and less-diverse coniferous seeded stands showed lower total and passerine species richness. We believe this is because the coniferous stands tend to have less diverse understories which would equate fewer food and nesting site options (Ramovs and Roberts 2003, Barbier *et al.* 2008). It is also suggested that tree height diversity as well tree species diversity of a forest stand is positively correlated with avian richness (MacArthur and MacArthur 1961, Karr and Rothland 1972).

At risk species richness

The number of observed *at risk* species increased with percent cleared area. Most of the Threatened species listed do in fact prefer nesting or foraging in fields, clearings or forest edges. Two recorded *at risk* grassland species, Eastern Meadowlark (Sibley 2003, Guzy and Ribic 2007) and Bobolink (Sibley 2003, Diemer and Nocera 2014), breed and nest almost exclusively in agricultural or abandoned fields. Likewise, aerial insectivores use open areas to forage, e.g., Barn Swallows prefer to nest in man-made structures surrounded by open habitat (Brown and Bomberger Brown 1999). The Olive-sided Flycatcher chooses meadows, forest openings and edges over dense undisturbed woods (Altman and Sallabank 2012) and the Eastern Whip-poor-will prefers sparser woodlands, such as areas with strip cuts or selected harvests (Cink 2002). All of these species were observed in Kenauk Nature Reserve.

Future monitoring and research

Homogeneous coniferous forest stands decreased overall bird diversity while many of the *at risk* species at Kenauk were found in edge and field habitats. Both of these findings can be helpful for the management of the property by knowing the direct effects that plantations and strip cuts have on bird species and potentially on other taxa. More research must be done in this area to better understand the effects of plantations and forest cuts on biodiversity. Moreover, this property in particular must continue bird surveys if the owners wish to confirm and elaborate our results, as well as observe rarer species since species with low detection probability are more likely to be observed when point counts last longer (Dettmers *et al.* 1999).

Population estimates of species of interest could be made if more point counts were done each year. Experienced volunteers would have to work evenly across the territory, with more survey points revisited for many years (Thompson *et al.* 2002). We suggest that static point count sites should be chosen representatively across the property's varying habitats for long term comparison studies along with NCC's informal inventories. If the sites are revisited multiple times each year, with standardized methods of point counts, variables such as duration and extent of habitat, could be eliminated and the effects of habitat on the bird diversity of this forest would be more apparent.

Overall, biodiversity is a critical indicator of ecosystem health and important field of ecological study. Therefore, land and forestry managers should ideally monitor these forms of diversity to understand the effects of management (Hartley 2002). As this paper shows, it is in fact possible to use general survey data to explore deeper topics.

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Literature Cited

Altman, B. and **R. Sallabanks**. 2012. Olive-sided Flycatcher (*Contopus cooperi*). *In* The Birds of North America Online (A. Poole, ed.). Cornell Lab of Ornithology. Ithaca, New York. Retrieved from: http://bna. birds.cornell.edu/bna/species/502

American Ornithologists' Union. 2016. Checklist of north and middle American birds. Retrieved October 2015 from: http://checklist. aou.org/

Barbier, S., F. Gosselin and **P. Balandier**. 2008. Influence of tree species on understory vegetation diversity and mechanisms involved—a critical review for temperate and boreal forests. Forest Ecology and Management 254:1-15.

Bart, J., B.A. Andres, K.H. Elliott, C.M. Francis, V. Johnston, R.I.G. Morrison, E.P. Pierce and **J. Rausch**. 2012. Small-scale and reconnaissance surveys. Studies in Avian Biology 44:141-148.

Bates, D. 2010. Lme4: mixed-effects modeling with R. Springer. Madison, Wisconsin. 131 pp.

Belanger, L., Y. Bergeron and **C. Camire**. 1992. Ecological land survey in Quebec. The Forestry Chronicle 68:42-52.

Bolker, B., M. Brooks, C. Clark, S. Geange, J. Poulsen, M. Stevens and **J. White**. 2008. Generalized linear mixed models: a practical guide for ecology and evolution. Trends in Ecology and Evolution 24:127-135.

Brown, C.R. and **M. Bomberger Brown**. 1999. Barn Swallow (*Hirundo rustica*), *In* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology. Ithaca, New York. Retrieved from: http://bna.birds.cornell.edu/bna/species/452

COSEWIC. 2015. Canadian wildlife species at risk. Ottawa, Ontario. 116 pp. Available from: http://www.cosewic.gc.ca/eng/sct0/rpt/csar_fall_2015_e.pdf

Chao, A. 1984. Nonparametric estimation of the number of classes in a population. Scandinavian Journal of Statistics 11:265-270.

Cink, C.L. 2002. Eastern Whip-poor-will (*Antrostomus vociferus*). *In* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology. Ithaca, New York. Available from: http://bna.birds.cornell.edu/bna/species/620/articles/introduction

Cody, M.L. 1985. An introduction to habitat selection in birds. Pages 4-46 *In* Cody, M.L. Habitat selection in birds. Academic Press. Orlando, Florida. 539 pp.

Dettmers, R., D. Buehler, J. Bartlett and **N. Klaus**. 1999. Influence of point count length and repeated visits on habitat model performance. Journal of Wildlife Management 63:815-823.

Diemer, K.M. and **J.J. Nocera**. 2014. Associations of Bobolink territory size with habitat quality. Annales Zoologici Fennici 51:515-525.

Dolman, P. 2012. Mechanisms and processes underlying landscape structure effects on bird populations. Pages 150-176 *In* Fuller, R.J. (ed). Birds and habitat, relationships in changing landscapes. Cambridge University Press. New York. 576 pp.

Gotelli, N.J. 2008. A primer of ecology (4th ed). Sinauer Associates. Sunderland, Massachusetts. 291 pp.

Gotelli, N.J. and **C.K. Colwell**. 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecology Letters 4:379-391.

Guzy, M. and **C.A. Ribic**. 2007. Post-breeding season habitat use and movements of Eastern Meadowlarks in southwestern Wisconsin. Wilson Journal of Ornithology 119:198-204.

Hartley, M.J. 2002. Rationale and methods for conserving biodiversity in plantation forests. Forest Ecology and Management 155:81-95.

Karr, J.M. and **R.R. Rothland**. 1972. Vegetation structure and avian diversity in several New World areas. The American Naturalist 105:423-435.

MacArthur, R.H. and **J.W. MacArthur**. 1961. On bird species diversity. Ecology 42:594-598.

McCarthy, K., R. Fletcher Jr., C. Rota and **R. Hutto**. 2012. Predicting species distributions from samples collected along roadsides. Conservation Biology 26:68-77.

Mitchell, M., S. Rutzmoser, T. Wigley, C. Loehl, J. Gerwin, P. Keyser, R. Lancia, R. Perry, C. Reynolds, R. Thill, R. Weih, D. White and **P. Wood**. 2006. Relationships between avian richness and landscape structure at multiple scales using multiple landscapes. Forest Ecology and Management 221:155-169.

Ramovs, B.V. and **M.R. Roberts**. 2003. Understory vegetation and environment responses to tillage, forest harvesting, and conifer plantation development. Ecological Applications 13:1682-1700.

Rompre, G., W. D. Robinson, A. Desrochers and **G. Angehr**. 2007. Environmental correlates of avian diversity in lowland Panama rain forests. Journal of Biogeography 34:802-815.

Sauer, J.R., J.E. Hines and **J. Fallon**. 2001. The North American breeding bird survey, results and analysis 1966-2000. USGS Patuxent Wildlife Research Center, Laurel, MD. Retrieved October 2015 from: https://www.mbr-pwrc.usgs.gov/bbs/bbs00.html

Sibley, D.A. 2003. The Sibley field guide to birds of Eastern North America. National Audubon Society. Alfred A. Knopf, New York. 431 pp.

Tews, J., U. Brose, V. Grimm, K. Tielbörger, M.C. Wichmann, M. Schwager and **F. Jeltsch**. 2004. Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. Journal of Biogeography 31:79-92.

Thompson, F. III, D. Burhans and **B. Root**. 2002. Effects of point count protocol on bird abundance and variability estimates and power to detect population trends. Journal of Field Ornithology 73:141-150.

Vickery, J. and **R. Arlettaz**. 2012. The importance of habitat heterogeneity at multiple scales for birds in European agricultural landscapes. Pages 177-205 *In* Fuller, R.J (ed.). Birds and habitat, relationships in changing landscapes. Cambridge University Press. New York. 542 pp.

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APPENDIX 1. Species (American Ornithologists' Union 2016) recorded on Kenauk Nature Reserve point counts collected between the 6th-21st of June 2015. All species with the COSEWIC status as Threatened ("T") or Special Concern ("SC") are in bold.

Species per Route	No. Occupied Routes	Avg No Ind per Route
Canada Goose (*Branta canadensis*)	5	6.8
Wood Duck (*Aix sponsa*)	8	2.9
American Black Duck (*Anas rubripes*)	2	1.5
Mallard (*Anas platyrhynchos*)	1	1
Ring-necked Duck (*Aythya collaris*)	3	3.7
Common Goldeneye (*Bucephala clangula*)	1	5
Hooded Merganser (*Lophodytes cucullatus*)	4	2
Common Merganser (*Mergus merganser*)	1	1
Ruffed Grouse (*Bonasa umbellus*)	12	1.8
Common Loon (*Gavia immer*)	2	1.5
American Bittern (*Botaurus lentiginosus*)	4	1.3
Great Blue Heron (*Ardea herodias*)	9	4.3
Green Heron (*Butorides virescens*)	1	1
Turkey Vulture (*Cathartes aura*)	11	1.8
Red-shouldered Hawk (*Buteo lineatus*)	3	1
Broad-winged Hawk (*Buteo platypterus*)	1	1
Red-tailed Hawk (*Buteo jamaicensis*)	2	1
American Woodcock (*Scolopax minor*)	1	1
Mourning Dove (*Zenaida macroura*)	5	1.6
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	7	1.7
Great Horned Owl (*Bubo virginianus*)	2	1
Barred Owl (*Strix varia*)	1	1
Eastern Whip-poor-will (*Antrostomus vociferus*) T	**1**	**8**
Ruby-throated Hummingbird (*Archilochus colubris*)	7	1.6
Belted Kingfisher (*Megaceryle alcyon*)	4	1
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	15	1.9
Downy Woodpecker (*Picoides pubescens*)	4	1
Hairy Woodpecker (*Leuconotopicus villosus*)	6	1.2
Northern Flicker (*Colaptes auratus*)	17	1.9
Pileated Woodpecker (*Hylatomus pileatus*)	6	1.5
Olive-sided Flycatcher (*Contopus cooperi*) T	**7**	**1.1**
Eastern Wood-Pewee (*Contopus virens*) SC	**13**	**1.5**
Alder Flycatcher (*Empidonax alnorum*)	16	1.6
Least Flycatcher (*Empidonax minimus*)	9	2
Eastern Phoebe (*Sayornis phoebe*)	8	1.5
Great Crested Flycatcher (*Myiarchus crinitus*)	19	2
Eastern Kingbird (*Tyrannus tyrannus*)	9	1.4
Yellow-throated Vireo (*Setophaga dominica*)	1	1
Blue-headed Vireo (*Vireo solitarius*)	4	1.8
Warbling Vireo (*Vireo gilvus*)	6	1.2
Red-eyed Vireo (*Vireo olivaceus*)	39	4
Blue Jay (*Cyanocitta cristata*)	23	3.0
American Crow (*Corvus brachyrhynchos*)	7	2.3

Species per Route	No. Occupied Routes	Avg No Ind per Route
Common Raven (*Corvus corax*)	11	1.6
Tree Swallow (*Tachycineta bicolor*)	3	2.7
Barn Swallow (*Hirundo rustica*) T	**3**	**3.3**
Black-capped Chickadee (*Poecile atricapillus*)	14	1.7
Red-breasted Nuthatch (*Sitta canadensis*)	7	2
White-breasted Nuthatch (*Sitta carolinensis*)	7	1.4
Winter Wren (*Troglodytes hiemalis*)	6	1.5
Sedge Wren (*Cistothorus platensis*)	1	1
Marsh Wren (*Cistothorus palustris*)	1	1
Golden-crowned Kinglet (*Regulus satrapa*)	1	1
Veery (*Catharus fuscescens*)	33	3.2
Swainson's Thrush (*Catharus ustulatus*)	1	1
Hermit Thrush (*Catharus guttatus*)	12	1.6

Species per Route	No. Occupied Routes	Avg No Ind per Route
Wood Thrush (*Hylocichla mustelina*) T	**7**	**1.7**
American Robin (*Turdus migratorius*)	27	2.6
Gray Catbird (*Dumetella carolinensis*)	3	2.3
Brown Thrasher (*Toxostoma rufum*)	1	1
Cedar Waxwing (*Bombycilla cedrorum*)	16	3.5
Ovenbird (*Seiurus aurocapilla*)	36	4.0
Northern Waterthrush (*Parkesia noveboracensis*)	7	1.6
Black-and-white Warbler (*Mniotilta varia*)	15	2.3
Nashville Warbler (*Leiothlypis ruficapilla*)	12	1.4
Mourning Warbler (*Geothlypis philadelphia*)	1	2
Common Yellowthroat (*Geothlypis trichas*)	33	3.1

Species per Route	No. Occupied Routes	Avg No Ind per Route
American Redstart (*Setophaga ruticilla*)	12	2.3
Cape May Warbler (*Setophaga tigrina*)	2	1
Northern Parula (*Setophaga americana*)	4	1.8
Magnolia Warbler (*Setophaga magnolia*)	7	3.3
Bay-breasted Warbler (*Setophaga castanea*)	1	2
Blackburnian Warbler (*Setophaga fusca*)	5	1.2
Yellow Warbler (*Setophaga petechia*)	15	1.7
Chestnut-sided Warbler (*Setophaga pensylvanica*)	29	2.6
Black-throated Blue Warbler (*Setophaga caerulescens*)	14	2
Palm Warbler (*Setophaga palmarum*)	1	2
Pine Warbler (*Setophaga pinus*)	3	1.3
Yellow-rumped Warbler (*Setophaga coronata*)	9	1.6
Black-throated Green Warbler (*Setophaga virens*)	15	2.3
Canada Warbler (*Cardellina canadensis*) T	**13**	**1.9**
Chipping Sparrow (*Spizella passerina*)	8	2.4
Song Sparrow (*Melospiza melodia*)	12	2.7
Swamp Sparrow (*Melospiza georgiana*)	12	1.4
White-throated Sparrow (*Zonotrichia albicollis*)	25	2.0
Dark-eyed Junco (*Junco hyemalis*)	2	1.5
Scarlet Tanager (*Piranga olivacea*)	9	2
Northern Cardinal (*Cardinalis cardinalis*)	1	2
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	20	3.0
Indigo Bunting (*Passerina cyanea*)	11	1.4
Bobolink (*Dolichonyx oryzivorus*) T	**2**	**3.5**
Red-winged Blackbird (*Agelaius phoeniceus*)	16	2.8
Eastern Meadowlark (*Sturnella magna*) T	**1**	**1**
Common Grackle (*Quiscalus quiscula*)	15	3.9
Brown-headed Cowbird (*Molothrus ater*)	1	1
Baltimore Oriole(*Icterus galbula*)	3	1
Purple Finch (*Haemorhous purpureus*)	4	1.8
American Goldfinch (*Carduelis tristis*)	13	1.5
European Starling (*Sturnus vulgaris*)	2	1.5

Corrections

Ontario Birds, Volume 34 Number 3, December 2016:

The cover incorrrectly identified this Volume as 33.

Coady, G. Consumption of amphibian prey by a Piping Plover:

On page 243 under Observation, change date 25 July 1998 to 25 July 2016.