

Modification of Point Counts for Surveying Cropland Birds¹

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Abstract: As part of a comparative study of agricultural impacts on wildlife, modifications to the point count method were evaluated for surveying birds in, and adjacent to, cropland during the breeding season (May to early July) in Ontario. Location in the field, observation direction and distance, number of visits, and number of study sites per farm were examined using point counts of 5-minute duration in 1989 and 10-minute duration in 1990. Bird species number and abundance were not significantly different between point counts conducted from field-edge and field-interior (100 m or less from the edge) locations at the same study site (median field size = 6 ha). At each field-edge location, semicircular counts detected significantly fewer, but still about 85 percent of species and 80 percent of individuals detected in circular counts. We attributed the poor performance of circular counts to poor visibility through wooded field-edges, poor habitat quality, and an edge-effect on bird activity. Limited-distance (within 100 m of observer) point counts detected significantly fewer, and only 59 percent and 69 percent of species and individuals detected with unlimited-distance (but still on farm) point counts per study site in 1989 and 1990. Species number of each study site was still increasing significantly for all point count methods after three visits in 1989 and four visits in 1990. Bird abundance at each site was not significantly different among visits in 1989 or among the last three of four visits in 1990. We argue these results reflect spatial dynamics in the distribution of birds and species in cropland throughout the breeding season. Our study farms appeared to be well-sampled by field-edge, semicircular, unlimited-distance point counts at a sampling intensity of one study site per 26 ha based on comparisons with point counts from a larger number of study sites, search (walk-about) surveys of study sites, and noncrop areas on farms. Relevance of our results to recommended point count standards is discussed.

The extensive use of commercially synthesized pesticides and fertilizers in modern agriculture has significant implications for farmland wildlife (Freemark and Boutin 1995, Fry 1991, O'Connor and Shrubbs 1986, Sheehan and others 1987). The Canadian Wildlife Service has used the recent trend toward alternative agriculture (NRC 1989) to develop a comparative field study for evaluating the ecotoxicological impact of agrichemical use. A point-count based study by Brae and others (1988) in Denmark indicated the potential usefulness of comparing avifauna on organic and chemical farms. In adapting the Danish approach for Canada, we evaluated point counts as a method for surveying birds potentially exposed to agrichemicals in, and adjacent to, cropland (Rogers and Freemark 1991).

The point count method has not often been used for bird surveys on farms. Of 43 studies reviewed by Freemark and others (1991) to document bird use of croplands and field-edge habitats (excluding woodlots) in the Great Lakes-St. Lawrence region, only two (Stone and others 1974, Conover 1982) used off-road point counts, and a third study

used a combination of field transects and point counts (Ashton and Jackson 1983). More recently, Bryan and Best (1991) used point counts to survey birds in Iowa farmland. Despite limited use, we selected point counts over other survey methods for the following reasons:

(1) Study sites were to be paired between farm types on the basis of habitat similarity to separate habitat effects from other agrichemical effects. With only one observer in 1989 and two in 1990, a larger sample of paired sites could be surveyed by point counts than by more intensive methods, such as territory mapping, which require more time per visit and more visits per study site.

(2) Brae and others (1988) found that point counts recorded similar differences in birds between farm types as those shown by territory mapping. Since then, Cyr and others (in this volume) have also found that point counts and territory mapping provide similar results for farmland birds.

(3) Survey sites could be more easily paired for habitat similarity at a point than along a transect in a field.

(4) Lastly, a stationary observer could follow bird movements more closely and was less likely to disturb birds or damage crops compared to the territory mapping and field transect methods in which the observer moves through the area.

Given limited use of point count methodology in the existing literature, we needed to evaluate conduct of point counts in croplands. In addition, we needed to evaluate how well cropland birds at each study site were sampled by point counts at a set of study sites that were paired between organic and chemical farms for habitat similarity. In this paper, we compare results between point counts conducted from the field edge versus the field interior to evaluate the importance of location of sample points in the field. Results are also compared between circular and semicircular (hereafter 360° and 180°, respectively) point counts in which the diameter was oriented along field edges. We considered this comparison necessary because many field edges in our study area and on our study sites were wooded. At most study sites, the observer had only an unobstructed view into fields in the 180° toward the field. Results for a limited versus an unlimited (but still on farm) distance from the observer are also compared. Patterns in bird species richness and mean abundance at each study site with replication of counts over the breeding season are also compared to evaluate the precision of point count samples at that temporal scale. Lastly, we evaluate the number of study sites required to adequately sample bird species composition on farms by comparing results among different sets of point count sites and search surveys of study sites and noncrop areas (e.g., farmsteads, woodlands, and riparian) on each farm.

Methods

In 1989, 20 study sites were established in cropland on three organic and three conventional (chemical) farms within 200 km of Ottawa, Ontario. Farms averaged 87 ha (s.d. = 39 ha) in size. Study sites on organic farms were paired with

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study sites on chemical farms on the basis of habitat similarity. There were three or four study sites at each farm for an average sampling intensity of one study site per 26 ha (range 13-41 ha) with woodland areas included. Fields at study sites averaged 16 ha (s.d. = 14 ha). The minimum distance between study sites averaged 474 m (s.d. = 378 m, range 150-1410 m). An additional five unpaired study sites (one on each of five farms) were established in cropland to evaluate how well point counts at paired sites sampled birds.

By 1990, we had established a total of 72 study sites in cropland paired between 10 organic and 10 chemical farms in eastern (same farms as 1989) and southwestern Ontario. Farms averaged 84 ha (s.d. = 45 ha) in size. Two to six study sites were established on each farm. Fields at study sites averaged 18 ha (s.d. = 14 ha). The minimum distance between study sites averaged 374 m (s.d. = 218 m, range 120-1410 m).

In both years, one farm pair was surveyed per observer on each day to minimize weather effects in our comparative data. In 1989, each farm pair was surveyed three times between June 13 and July 7 by a single observer. In 1990, each farm pair was surveyed twice in May and twice in June with observers alternating. On alternate visits, the order of visitation was reversed for the farms in the pair and for the study sites on each farm to minimize effects related to time of day.

Birds were surveyed by point counts conducted between dawn and 0930 (in 1989) or 1015 (in 1990). The weather was good (i.e., no rain, winds <13 mph) for most surveys.

Point counts were conducted from field edges. In 1989, bird registrations were mapped such that they could be separated into 180° and 360° directions (as defined above) and limited (100 m radius) and unlimited distances from the observer (but still on farm). During each point count, the observer rotated slowly to face all directions. In 1990, birds were surveyed by 180°, limited- and unlimited-distance point counts only.

In 1989, point counts were conducted from field edges and from field interiors at seven study sites to compare levels of bird activity. Five study sites were visited three times; two study sites only twice. Field-interior point counts were conducted at locations 100 m from the edge for larger fields (32 and 35 ha) at two study sites, and at the center for smaller fields (3-11 ha) at five study sites. The 180° recording direction for field-edge and field-interior point counts overlapped.

In 1989, we used point counts of 5-minute duration. Point count durations of 5 minutes (Bryan and Best 1991), 10 minutes (Ashton and Jackson 1983, Brae and others 1988) and 15 minutes (Conover 1982, Stone and others 1974) have all been used to survey cropland birds. In five trial point counts, we found that 50 percent to 86 percent (mean = 70 percent) of species and 53 to 92 percent (mean = 73 percent) of the individuals detected in 10 to 20 minutes had been observed within 5 minutes. Our choice of count duration, though based on the limited data available at the time, is consistent with the recommendation by Ralph and others, in this volume, to use 5-minute point counts as a compromise between greater accuracy at a study site and increasing the number of study sites sampled. In 1989, point counts of longer duration were not practical given the number of study sites which had to be surveyed by midmorning by one observer. In 1990, fewer study sites were

surveyed on each farm, but travel times between study sites and farms were often longer than 15 minutes. Given these logistical constraints, point count duration was extended to 10 minutes to improve sampling efficiency (particularly for species, see below).

All birds seen or heard were mapped during point counts. Birds in, and adjacent to, croplands or feeding over fields were included because they are potentially affected by agrichemical use. Birds flying over fields were excluded. After a point count visit, each species observed at a study site was given an index of abundance. For a given species, birds had to be seen and/or heard simultaneously to score as different individuals. A bird exhibiting territorial behavior, such as a singing male, was scored as 2; a male or female seen or heard calling scored as 1. This method follows the conventions currently being used by the Ontario Forest Bird Monitoring Program (Welsh, in this volume). The number of species per study site was accumulated over visits. The number of individuals per study site was averaged over visits.

In 1989, three search (walk-about) surveys were also conducted at each study site to help evaluate how well point counts sampled birds. Only species and individuals not detected during point counts at the site were recorded. Three search surveys were also conducted in noncrop areas (e.g., woodlands, farmsteads, and riparian areas) on each farm to provide data which might explain any differences in point count and search survey results between a farm pair. Most study sites and noncrop areas were searched after point counts for the farm pair had been completed (typically 0930-1230). A few study sites and noncrop areas were searched while the observer was en route from one point count to the next. Each search survey on a farm lasted about 1.5 hours. Search effort at each point count site and noncrop area within a farm was proportional to the amount of bird activity.

The Wilcoxon matched-pairs signed-ranks test was used to determine whether the number of species or individuals differed between field-edge and field-interior point counts at the same study site. The number of species detected on each study site was compared between point count methods and between visits by calculating the 95 percent confidence interval on the square root of the difference with upper and lower bounds back-transformed by squaring. The square root transformation was used to stabilize the variance of the count data. The mean number of individuals on each study site was compared between point count methods by calculating the 95 percent confidence interval for the difference. The differences in species number (square-root transformed) and mean number of individuals between visits were further analyzed in a one-way ANOVA with repeated measures ($P = 0.05$) and with posterior comparisons using Tukey HSD (Keppel 1982) to detect significant differences among time periods.

Results and Discussion

In 1989, 64 bird species were observed on study farms (see Appendix for species composition). Forty-nine species (77 percent) were recorded in, and adjacent to, cropland during unlimited-distance point counts. The other 15 species (23 percent) were recorded only during search surveys in noncrop areas on farms. In 1990, 68 species were observed during

unlimited distance point counts on study fauns. Species composition was similar to 1989.

Bird species number and abundance were not significantly different for point counts conducted from field-edge and field-interior locations at the same study site (*table 1*). At least for fields of this size (median = 6 ha), bird activity within crops can be adequately surveyed from field edges. Since bird activity is often greatest at the field edge (Best and others 1990; personal observation), it is perhaps best to survey from this vantage point, particularly for evaluating effects of farming practices such as pesticide use. Given a significant edge effect, the results of surveys conducted from field edges should be less affected by differences in field sizes among study sites than results of surveys conducted from the inside of fields (especially the center). In contrast, field-edge surveys will be more affected by differences in edge habitat among study sites (Best and others 1990). An observer backed by field-edge habitat (e.g., woody plants or fence-posts) may be less disruptive to bird activity than an observer standing in the crop proper. Others have tried to minimize observer effects on cropland birds by conducting point counts from sites located away from experimental plots (Bryan and Best 1991, Conover 1982). Lastly, surveys conducted from the field edge have the added advantage of minimizing observer damage to crop plants.

At field-edge locations, 180° point counts detected significantly fewer, but still about 85 percent of species, and 80 percent of individuals detected in 360° point counts at each study site (*table 2*). The following factors may account for the few additional species and individuals in 360° point counts:

(1) At one-half of the study sites, point counts were conducted from woody fencerows between fields. Because only the 180° view was unobstructed, the remaining part of the 360° point count was based solely on vocal cues. In our experience (but not quantified), many birds in, and adjacent to, cropland are detected by visual rather than vocal cues.

(2) At an additional 25 percent of our sites, bird abundance in the remaining area of the 360° point count may have been depressed by two-lane gravel roads adjacent to the field-edge location.

Table 1—Results for point counts conducted from field-edge and field-interior locations at the same study site. Based on 1989 surveys using limited-distance (LD) and unlimited-distance (ULD), 180° and 360° point counts.

	Mean (± 1 s.d.)			
	LD180°	LD360°	ULD180°	ULD360°
<i>n</i> Species ¹				
Edge	5.4 (2.2)	6.7 (2.4)	8.6 (2.6)	10.6 (2.0)
Interior	4.3 (2.8)	6.4 (3.3)	9.4 (3.4)	11.1 (3.2)
Mean <i>n</i> Individuals ¹				
Edge	7.9 (2.1)	10.0 (2.3)	12.8 (3.9)	17.9 (3.7)
Interior	6.9 (2.5)	8.8 (2.4)	12.3 (2.2)	16.3 (2.1)

¹ Paired Wilcoxon $P > 0.05$ for edge vs. interior

(3) Birds detected along the field edge from which point counts were conducted were included in the 180° results. Because bird activity is highest along edges (particularly wooded edges), fewer birds (and therefore species) are likely to be detected in the remaining area of the 360° point count, even if visibility is good in all directions.

For comparing between farm types, we used 180° point counts as a compromise between slightly lower sampling efficiency and greater flexibility in locating study sites on farms (particularly farms that were small or narrow) and matching habitat characteristics between farm types. By using 180° point counts, we were also able to visually survey bird activity more intensely. In more open farmland or in studies with fewer design constraints, 360° point counts may be a more viable method.

In 1989, limited-distance point counts detected significantly fewer and only about 59 percent of species, and individuals detected with unlimited distances at each study site (*table 2*; see *Appendix for species*). Even with more visits of longer duration in 1990, limited-distance point counts still detected significantly fewer and still only 69 percent of species and 70 percent of individuals detected with unlimited distances at each study site. For comparing between farm types, we used unlimited-distance (but still on farm) point counts because of their higher sampling efficiency. At our study sites, an unlimited distance typically spans 200 m or less because of spatial constraints imposed by farm size, field size, or the detectability of many species. Ralph and others (in this volume) briefly discuss the use of limited-distance point counts to estimate abundance for among species comparisons. The limited distance of 50 m they recommended is not likely far enough for the open environments in farmland, given the drop in sampling efficiency we observed at 100 m (see also Cyr and others in this volume).

In 1989, species number per study site increased significantly between visits for all point count methods (*fig. 1a*). The number of species added between visit 1 and 2 versus

Table 2—Comparisons of different point count methods on each study site. Based on field-edge, 180° and 360° point counts at a limited-distance (LD) and unlimited distance (ULD) from the observer at the study sites paired between farm types.

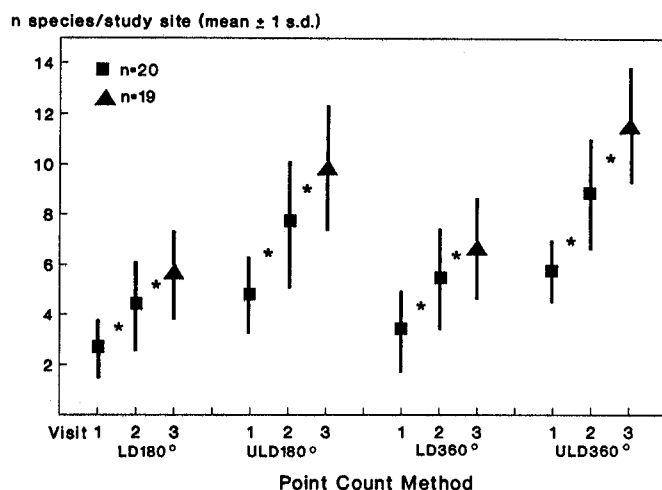
Methods compared	Mean % (± 1 s.d.)			
	<i>n</i> Species		Mean <i>n</i> Individuals	
	1989	1990	1989	1990
180° vs. 360°				
LD	85*(17)	-	79*(17)	-
ULD	86*(13)	-	80*(11)	-
LD vs. ULD				
180°	58*((18)	69*(12)	59*(11)	70*(17)
360°	59*(17)	-	61*(13)	
<i>n</i> study sites	19	72	19	72
<i>n</i> visits/site	3	4	3	4
<i>n</i> minutes/site	15	40	15	40

* Significant difference between methods. See Methods for test details.

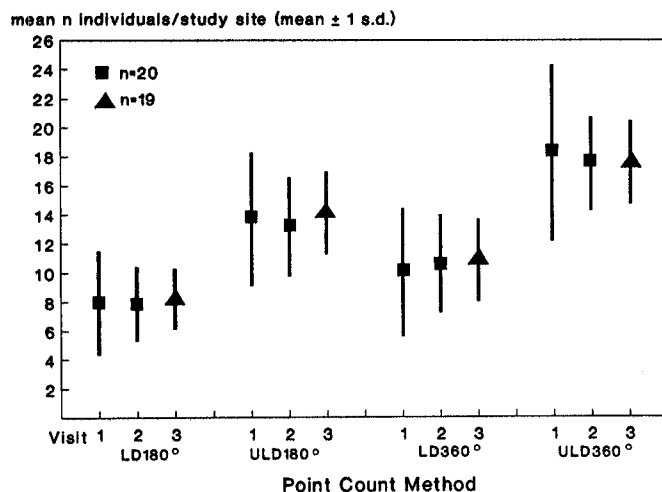
visit 2 and 3 was not significantly different within methods; 95 percent confidence intervals ranged from 0.3 to 3.7 additional species at each study site. Bird abundance at each study site was not significantly different among visits (*fig. 1b*). To improve sampling efficiency (particularly for species), we increased the number of visits to four (two each in May and June) and extended the point count duration to 10 minutes in 1990. After four visits, species number at each study site was still increasing significantly for both limited-distance and unlimited-distance point counts (*fig. 2a*). Significantly more species per study site were added between visit 1 and 2 (CI = 2.4-4.8 additional species) than between subsequent visits (CI = 0.6-2.1 additional species). Bird abundance at each study site increased significantly between visit 1 and 2 but was not significantly different between subsequent visits (*fig. 2b*). In Ontario, many species are still migrating in early May when our first visit was conducted. This, coupled with typically cool and wet weather, likely accounted for the significantly

fewer species and birds seen during our first visit. Cyr and others, in these Proceedings, found that after four visits, 10-minute point counts had detected more than 80 percent of the species and birds observed in seven visits. Species number per site had not reached an asymptote, however, even after seven visits. It is unlikely that the continued increase in species number was simply because of insufficient sampling since bird species composition and relative abundance detected by their point counts were similar to results from more intensive territory mapping. More likely, these results reflect spatial dynamics in the distribution of birds and species in cropland throughout the breeding season.

Our study farms appeared to be well-sampled by field-edge, 180°, unlimited-distance point counts at the set of 20 study sites paired between farm types (representing a sampling intensity of 3 to 4 study sites per farm or one study site per 26 ha, including woodland). The field-edge, 180°, unlimited-distance point counts at these study sites detected 86 percent of

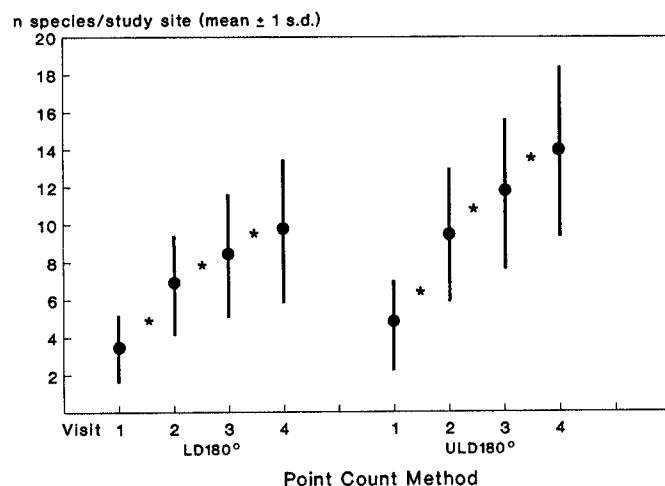


(A)

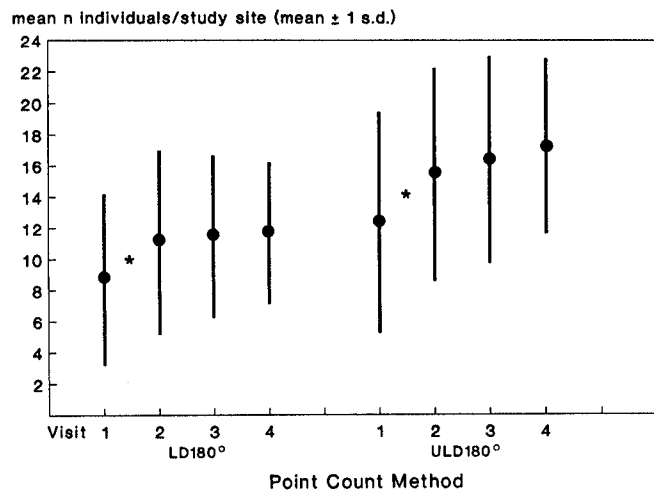


(B)

Figure 1--(A) Number of species and (B) number of individuals detected during 5-minute, limited-distance (LD) and unlimited-distance (ULD), 180° and 360° point counts conducted from field edges at 1989 study sites paired between farm types (number of study sites (n) as shown). * indicates a significant ($P < 0.05$) difference between visits.



(A)



(B)

Figure 2--(A) Number of species and (B) mean number of individuals detected using 180° limited-distance (LD) and unlimited-distance (ULD), 10-minute point counts conducted from field edges at 72 study sites in 1990. * indicates a significant ($P < 0.05$) difference between visits.

species detected by all point count methods combined. Extending point counts to 360° added only four more species. Point counts at five study sites, riot paired between farm types, added only two more species. A single species was observed only during field-interior point counts (*Appendix*). Search surveys of study sites did not add any new species. The minimum distance between study sites paired between farm types averaged 474 m in 1989 and 374 m in 1990. At these distances, we did not have a problem with double counting of birds between study sites (personal observation). We agree with Ralph and others, in these Proceedings, that distances greater than 250 m between study sites are needed to ensure statistical independence of point counts in open environments. In our opinion, the 500-m distance recommended for roadside counts is also appropriate for offroad point counts in farmland.

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Appendix--Bird species composition from point count and search surveys of six farms in the 1989 Ontario field study.

Species		Point Count ¹		Search ²
Common Name	Scientific Name	180°	360°	
American Bittern	<i>Botaurus lentiginosus</i>			r
Great Blue Heron	<i>Ardea herodias</i>			r
Red-tailed Hawk	<i>Buteo jamaicensis</i>	e+	e+	
American Kestrel	<i>Falco sparverius</i>	e+	e+	
Ruffed Grouse	<i>Bonasa umbellus</i>			w
Killdeer	<i>Charadrius vociferus</i>	e	e	
Spotted Sandpiper	<i>Actitis macularia</i>		e+	
Upland Sandpiper	<i>Bartramia longicauda</i>	e	e	
Common Snipe	<i>Gallinago gallinago</i>	e+	e+	
American Woodcock	<i>Scolopax minor</i>		i	
Ring-billed Gull	<i>Larus delawarensis</i>	e+	e+	
Rock Dove	<i>Columba livia</i>	e	e	
Mourning Dove	<i>Zenaida macroura</i>	e	e	
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	e+	e+	
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	e+	e+	
Hairy Woodpecker	<i>Picoides villosus</i>			w
Northern Flicker	<i>Colaptes auratus</i>	e	e	
Eastern Wood-Pewee	<i>Contopus virens</i>	e	e	
Least Flycatcher	<i>Empidonax minimus</i>	e+	e+	
Eastern Phoebe	<i>Sayornis phoebe</i>	e+	e+	
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	e+	e+	
Eastern Kingbird	<i>Tyrannus tyrannus</i>	e	e	
Horned Lark	<i>Eremophila alpestris</i>	e	e	
Tree Swallow	<i>Tachycineta bicolor</i>	e	e	
Barn Swallow	<i>Hirundo rustica</i>	e	e	
Blue Jay	<i>Cyanocitta cristata</i>	e	e	
American Crow	<i>Corvus brachyrhynchos</i>	e	e	
Black-capped Chickadee	<i>Parus atricapillus</i>			w,f
Red-breasted Nuthatch	<i>Sitta canadensis</i>			w
White-breasted Nuthatch	<i>Sitta carolinensis</i>			w

continued

Appendix--continued

Species		Point Count ¹		Search ²
Common Name	Scientific Name	180°	360°	
Brown Creeper	<i>Certhia americana</i>			w
House Wren	<i>Troglodytes aedon</i>	e+	e+	
Eastern Bluebird	<i>Sialia sialis</i>			f
Veery	<i>Catharus fuscescens</i>	e+	e+	
Hermit Thrush	<i>Catharus guttatus</i>			w
Wood Thrush	<i>Hylocichla mustelina</i>			w
American Robin	<i>Turdus migratorius</i>	e	e	
Gray Catbird	<i>Dumetella carolinensis</i>			w
Brown Thrasher	<i>Toxostoma rufum</i>	e+	e+	
Cedar Waxwing	<i>Bombycilla cedrorum</i>	e	e	
European Starling	<i>Sturnus vulgaris</i>	e	e	
Warbling Vireo	<i>Vireo gilvus</i>		ue	
Red-eyed Vireo	<i>Vireo olivaceus</i>	e	e	
Yellow Warbler	<i>Dendroica petechia</i>	e	e	
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>		e	
Black-throated Green Warbler	<i>Dendroica virens</i>			w
Black-and-white Warbler	<i>Mniotilta varia</i>		e	
Ovenbird	<i>Seiurus aurocapillus</i>		e	
Mourning Warbler	<i>Oporornis philadelphia</i>	e+	e+	
Common Yellowthroat	<i>Geothlypis trichas</i>	e	e	
Northern Cardinal	<i>Cardinalis cardinalis</i>		ue	
Rufus-sided Towhee	<i>Pipilo erythrophthalmus</i>			w
Chipping Sparrow	<i>Spizella passerina</i>	e+	e+	
Savannah Sparrow	<i>Passerculus sandwichensis</i>	e	e	
Song Sparrow	<i>Melospiza melodia</i>	e	e	
White-throated Sparrow	<i>Zonotrichia albicollis</i>			w
Bobolink	<i>Dolichonyx oryzivorus</i>	e	e	
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	e	e	
Eastern Meadowlark	<i>Sturnella magna</i>	e	e	
Common Grackle	<i>Quiscalus quiscula</i>	e	e	
Brown-headed Cowbird	<i>Molothrus ater</i>	e	e	
Northern Oriole	<i>Icterus galbula</i>	e	e	
American Goldfinch	<i>Carduelis tristis</i>	e	e	
House Sparrow	<i>Passer domesticus</i>	e	e	

¹ Point count survey:

180° = unlimited-distance semicircle

360° = unlimited-distance circle

e = paired field-edge (i.e., at study sites paired between farm types for habitat similarity, n = 20)

i = inside-field (100 m or less from the field edge, n = 7)

ue = unpaired field-edge (i.e., study sites not paired between farm types, n = 5)

+ = detected at >100 m only

² Search (walk-about) survey of point count sites (n = 25) and the following noncrop areas on farms:

r = near river

w = woodlot

f = farmstead