ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

I-90 CORRIDOR

POST-CONSTRUCTION AVIFAUNAL MONITORING OF THE I-90 CORRIDOR

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ILLINOIS STATE TOLL HIGHWAY AUTHORITY

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Biological monitoring associated with Illinois tollway construction activities (2015–2019)

EXECUTIVE SUMMARY

- Conducted 11.75 and 19 person-hours of variable circular plot counts and intensive searches, respectively
- Detected 61 species
- Detected Ospreys three times between 2–30 September at Baumann Park, Swanson Park, and Lib Conservation Area
- Density of pooled bird species at Ipsen Road and Lib Conservation areas was 26.8 ± 7.0 and 34 ± 7.7 SE birds per hectare, respectively
- Density of pooled species was highest in edge habitat
- Sparrows were the densest species group overall
- Diversity (using Shannon-Weiner Index) was comparable at Ipsen Road and Lib Conservation Area (H = 2.78 vs. 2.58, respectively)
- Species numbers at Ipsen Road and Lib Conservation areas were comparable to numbers at our IL-53/120 sites
- Species composition at Lib Conservation Area had lower forest bird diversity compared to other forested habitats in the Midwest
- Ipsen Road Conservation Area provides fall stopover habitat for grassland birds
- We summarized only bird use during fall migration, and assessments of bird use in spring and during the breeding season are necessary
- In 2016, we will assess use of I-90 sites by threatened and endangered species during spring and summer, and estimate breeding bird density and diversity during summer

INTRODUCTION

The Illinois State Toll Highway Authority (ISTHA) is undertaking the construction of new facilities and improving existing facilities following a long-term plan. The ISTHA maintains a contract with the Illinois Natural History Survey (INHS) to meet the environmental requirements for construction projects. Initial surveys conducted by the INHS began in 2006, focusing on the corridor from O'Hare International Airport to Illinois Route 47 (Tiemann et al., 2007a). In 2007, (Tiemann et al., 2007b) surveys were conducted at the corridor from IL Route 47 to I-39. Preconstruction surveys in 2012 were conducted at 14 stream crossings for amphibians, fishes, mussels, and reptiles for the section of the corridor from IL Route 47 west to the Kishwaukee River crossing near Rockford, Illinois, (Dreslik et al., 2013). No avifaunal surveying was conducted preconstruction.

Urban sprawl poses a major threat to avian biodiversity (Concepción et al., 2015; Ikin et al., 2013), with effects of roadways being a major concern for many bird communities. Car collisions (Erritzoe et al., 2003) and traffic noise (Forman and Deblinger, 2000; Ware et al., 2015) are two of the most documented causes of bird disturbance resulting from highways. Therefore, assessing avifauna use of areas adjacent to highways is necessary. In addition, monitoring avifauna use of areas adjacent to highways for the purpose of assessing biodiversity loss, demographic rates of threatened and endangered species near roadways must be assessed to minimize impacts to already threatened bird populations.

The following report describes avifaunal research conducted near I-90 by the INHS under contract by the Tollway for the purpose of meeting environmental requirements for the construction and maintenance of tollways. The research described here was conducted in the fall of 2015, and therefore, it only assessed resident bird use of our study areas or use by migratory birds as stopover habitat or molting-grounds.

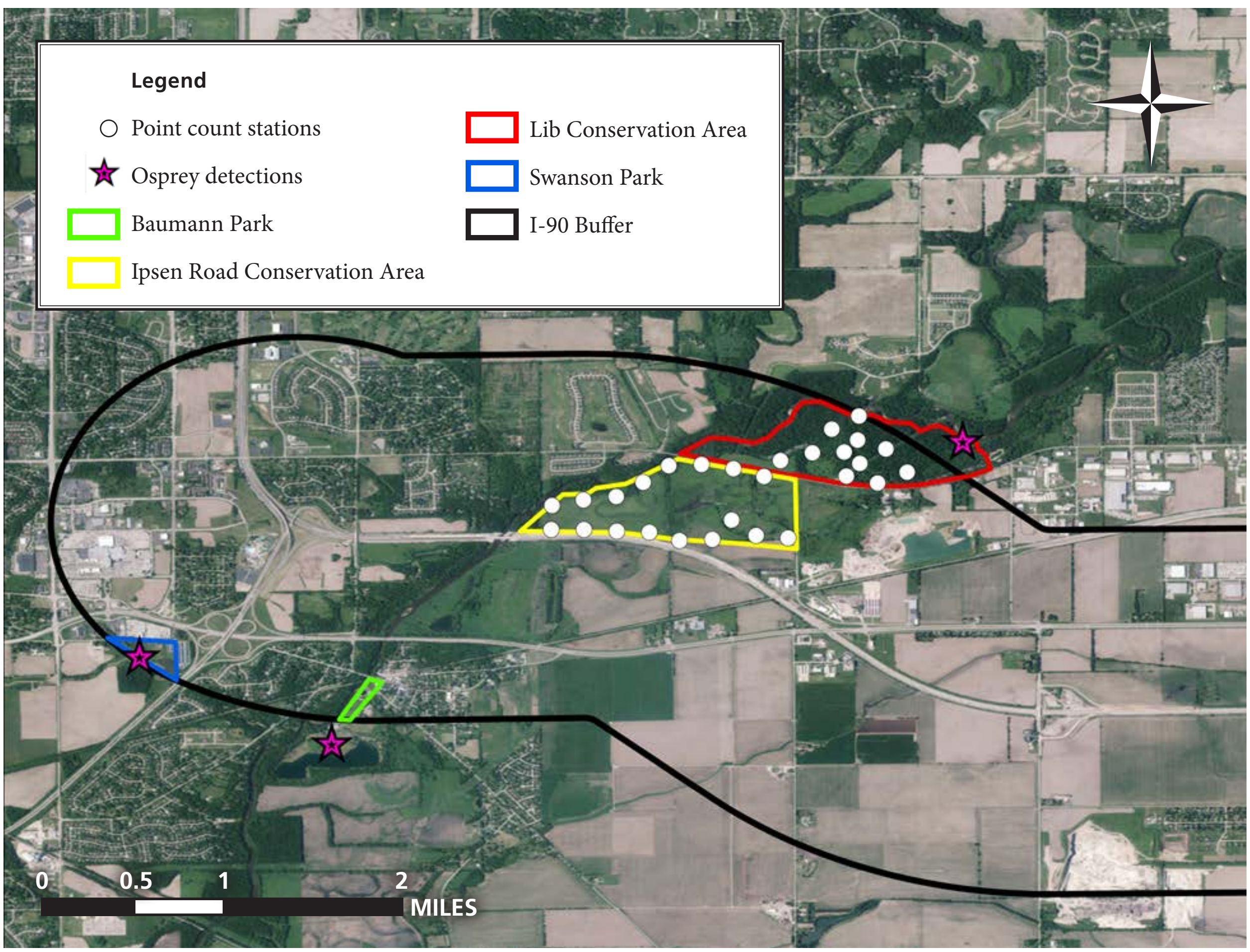
The scope of our research included three components:

1. Derive estimates of bird density and abundance
2. Conduct intensive searches for state threatened or endangered bird species, and compile an inventory of all species using the study area
3. Estimate bird diversity/species richness

MATERIALS & METHODS

Field sites.—We conducted research within the buffer zone surrounding I-90 from 2 September–16 October 2015 (Map 1). We conducted all research at four study sites and defined habitat at each of the sites based on the dominant vegetation type (e.g., prairie, forest, wetland) (Table 1).

Field methods and analyses.—*Bird density and abundance:* Bird density and abundance were estimated by conducting variable circular plot (VCP) surveys (Reynolds et al. 1980) from 30 Sep–16 Oct 2015 at stations es-



Map 1. Map of the I-90 study area including study area boundary, study site boundaries, variable circular plot (VCP) stations, and detections of Ospreys.

tablished along existing trails at Lib Conservation Area (Lib) and Ipsen Road Conservation Area (Ipsen) (Appendix I). For each study site, stations were established by first generating a random point along the trail system using the program ArcMap 10.3. The randomly generated point was marked as the first VCP station. From the first station, we established consecutive stations along the trail system at 200 m intervals. We placed stations 200 m apart to prevent double-counting individuals at different stations. We assigned each station a coarse habitat classification (Appendix I):

1. Forest, when within a 50 m radius from the station, 75% of the area was covered by forest,
2. Prairie, when within a 50 m radius from the station, 75% of the area was covered by prairie,
3. Edge, when within a 50 m radius from the station, no single habitat type comprised a portion as great as 75% of the area,
4. Wetland, when within a 50 m radius from the station, at least, 50% of the area was covered by water and/or wetland vegetation, and
5. Scrub, when within a 50 m radius from the station, 75% of the area was covered by early-succession forest.

We conducted VCP surveys in the morning between 15 minutes before sunrise and 11:00. At each station, we counted all birds or groups of birds belonging to the same species over a 5-minute period. When birds were detected, we recorded the following data: 1) time of detection, 2) species, 3) number of individuals, 4) type of detection (e.g., heard or seen), and 5) estimated distance of bird(s) from the VCP station. Distance was estimated by using a laser rangefinder, and by observer estimation. Before conducting VCP surveys, the experienced observer used the rangefinder to calibrate her ability to estimate distances of objects without the use of an instrument.

We used bird detections from VCP surveys to derive estimates of bird abundance and density using the "Distance" package in R (Buckland et al., 2010, R Core Team). Our estimates of bird abundance and density only included detections of passerines and near-passerines (i.e., songbirds) because habitats for other groups of birds (e.g., waterfowl, gruiforms, shorebirds, wading birds) were not ubiquitously distributed among our study sites.

We conducted two statistical analyses. First, we derived a pooled estimate of density and abundance by combining detections of all species encountered during surveys. Before beginning the analysis, we removed the largest 15% of detections (i.e., observations of birds recorded at the furthest distances from the observer) to exclude detections occurring at abnormally great distances. The pooled analysis was conducted using the multiple covariate distance sampling (MCDS) engine to model the effects of two variables on detection rates (e.g., study site and coarse habitat classification; Marques and Buckland, 2004; Buckland et al., 2015). Before estimates of density and abundance were derived, we modeled the fit of the data to a detection function [g(y)] using two types of key functions: half-normal and hazard-rate. The models of each of the half-normal and hazard-rate functions were then compared using Akaike's Information Criteria (AIC), and we typically selected the key function of the model with the lowest AIC (Burnham and Anderson, 2002). However, we did not select the model with the lowest AIC when evaluation of histograms and results of a Kolmogorov-Smirnov (K-S) goodness-of-fit test did not corroborate the model with the lowest AIC was best. After selecting the best-performing key function model, we constructed four additional models of the best key function including 1) additive effects of study site, 2) additive effects of habitat, 3) additive effects of both study site and habitat, 4) interactive effects of study site and habitat. We then evaluated all models and again selected the model with the lowest AIC as best if histograms and a K-S test corroborated AIC results. After selecting the best model, we used the detection function derived from the best model to estimate pooled bird density and abundance at each study site and within each habitat type. Estimates of the probability of detection (p) were reported ± standard error (SE). Density estimates (D) were reported as birds ha^{-1} ± SE, and abundance was estimated as birds $site^{-1}$ ± SE, based on the area surveyed at each study site (Table 2).

Table 1. I-90 study sites, coarse habitat classification, number of species detected during the study, and effort expended (in person-hours) conducting variable circular plot (VCP) surveys and intensive searches.

Site	Dominant Habitat Type	# Species	Effort (person hrs)
Baumann Park	Wetland	18	1.9
Swanson Park	Wetland	12	1.9
Ipsen Road Conservation Area	Prairie	42	11.7
Lib Conservation Area	Forest	47	15.4
Total		**61**	**30.8**

Table 2. Bird density ± SE, abundance ± SE, and 95% confidence intervals (CI) by site and habitat at the Lib and Ipsen Road Conservation areas at I-90.

Study Site	Species/Group	Site Area (ha)	D	CI (D)	N	CI (N)
Ipsen Road Conservation Area	Pooled species	92.8	26.8 ± 7.0	15.9–45.5	2491 ± 652	1471–4218
	American Goldfinch	92.8	4.7 ± 1.2	2.8–7.8	436± 114	261–731
	American Robin	92.8	1.8 ± 0.5	1.0–3.1	168 ± 47	97–290
	Chickadees and Kinglets	92.8	-	-	-	-
	Sparrows	92.8	18.3 ± 5.8	9.7–34.2	1694 ± 541	904–3174
Lib Conservation Area	Pooled species	73.0	34.0 ± 7.7	21.4–54.4	2481 ± 562	1550–3973
	American Goldfinch	73.0	2.9 ± 1.4	1.1–7.2	208 ± 103	82–531
	American Robin	73.0	8.3 ± 2.0	5.2–13.2	608 ± 143	384–964
	Chickadees and Kinglets	73.0	5.7 ± 1.9	2.9–11.1	415 ± 140	214–807
	Sparrows	73.0	-	-	-	-
Habitat type						
Forest	Pooled species	-	19.4 ± 4.0	12.4–30.5	-	-
Prairie	Pooled species	-	21.0 ± 3.4	15.3–28.9	-	-
Edge	Pooled species	-	39.7 ± 12.7	19.5–81.0	-	-
Scrub	Pooled species	-	75.9 ± 5.5	50.6–113.9	-	-

Our second analysis estimated bird density and abundance of species or species groups (i.e., species occupying similar niches and/or foraging together) with ≥ 45 detections during the study. Again, we used the MCDS engine to model the detection function, but we only modeled the additive effects of the study site because sample sizes were too small to estimate the effect of habitat on bird detection. After compiling all data for species and species groups, we removed outlying detections at abnormally great distances from the observer. For each species or group, we modeled the fit of the dataset to a detection function using the same methods we used to evaluate pooled species data, except modeling the additive and interactive effects of habitat. After selecting the best model for each species or group, we used the best model to derive estimates of D and N for each species at each site.

Intensive searches: We conducted intensive searches for birds on and off-trail at I-90 to determine what species used the survey sites, and to locate threatened and endangered species. While conducting searches, we took note of every species encountered and compiled a list of species using our study areas by combining bird detections during intensive searches with encounters during VCP surveys. When we found threatened and endangered species, an element of occurrence record (EOR) was recorded by the observer using a Global Positioning System (GPS) unit, and the number and age of the birds encountered, when possible.

Species diversity and species richness: Bird detections from VCP surveys were used to evaluate bird diversity and species richness. We could not use observations from intensive searches to calculate species diversity and richness indices because we only recorded the type of species detected, as opposed to counting the number of individuals encountered for each species. We calculated diversity using the Shannon-Weiner Index, and richness using the Menhinick's Index. Both formulas estimate diversity, but the Shannon-Weiner Index provides a more robust estimate because it accounts for the proportion of each species comprising a community. We calculated the Shannon-Weiner Index using the following formula:

$$H = \sum p_i ln(p_i)$$

The Shannon-Weiner Index value is H, and (p_i) is the proportion of total individuals in the i^{th} population, or species. The Menhinick's Index was calculated using the following formula:

$$D = \frac{s}{\sqrt{N}}$$

The value of the Menhinick's index is represented by D, s equals the total number of species encountered, and N equals the total number of individuals (birds) encountered.

RESULTS

Bird density and abundance.—We spent 11.75 person-hours establishing and conducting VCP surveys. Most stations were surveyed on two occasions during the study period. We recorded 431 bird detections of 38 species during VCP surveys, of which 409 detections representing 31 passerine and near-passerine species were used for the pooled analysis.

After truncating the data by 15% (see Materials and Methods), 348 detections of 30 species were used to

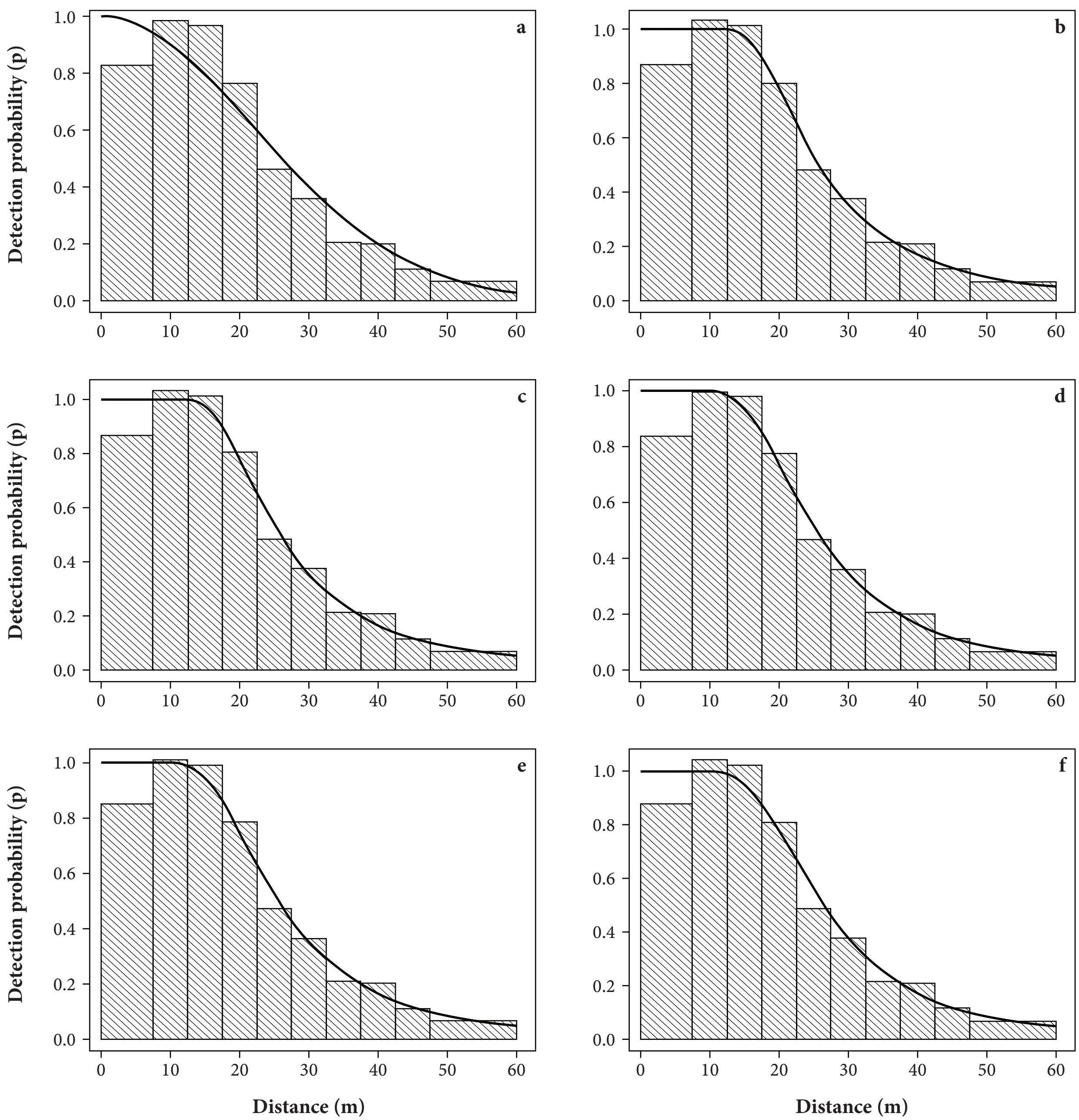


Figure 1. Fit of modeled detection functions to a histogram of variable circular plot (VCP) data for pooled species at I-90: (a) half-normal key, (b) hazard-rate key, (c) hazard-rate key + site, (d) hazard-rate key + habitat, (e) hazard-rate key + site + habitat, (f) hazard-rate key, site*habitat.

Table 3. Candidate models evaluating effects of half-normal (hn) and hazard-rate (hr) key functions, and the variables habitat and site, on the detection function. All key functions were modeled with zero adjustment terms; w_i = model weight, L = model likelihood, k = number of parameters, D = deviance, K-S = Kolmogorov-Smirnov test statistic (p-value), p=detection probability ±SE.

Model	AIC	ΔAIC	w_i	L	k	D	K-S	p
hr, site*habitat	2724.39	0.00	0.556	1.000	5	2714.39	0.028 (0.94)	0.28 ± 0.03
hr, site+habitat	2725.98	1.59	0.251	0.452	4	2717.98	0.033 (0.84)	0.27 ± 0.02
hr, habitat	2726.52	2.13	0.192	0.345	3	2720.52	0.029 (0.92)	0.27 ± 0.03
hr	2737.63	13.24	0.001	0.001	2	2733.63	0.038 (0.69)	0.28 ± 0.03
hr, site	2739.01	14.62	0.000	0.001	3	2733.01	0.032 (0.88)	0.28 ± 0.03
hn	2745.98	21.59	0.000	0.000	1	2743.98	0.065 (0.11)	0.26 ± 0.01

model the detection function and derive density and abundance estimates for pooled species. The model of the hazard-rate key function and the interactive effects of site and habitat received the lowest AIC (Table 3), and histograms (Figure 1) and K-S test results (Table 3) confirmed model fit. Estimates of D and N derived using the interactive effects model suggested bird densities were greater at Lib than at Ipsen, and bird densities were greater in edge and scrub habitats than in forests and prairies (Table 2; Figure 2). The differences in density among sites and habitats were likely the result of greater bird diversity in edge and scrub habitats. For example, edge and scrub may accommodate the needs, at least in part, of generalist, prairie, and forest species because edge and scrub may include a mix of grassland and forest vegetation components. However, specialized habitats such as forest and prairie are not used by specialist bird species that typically thrive elsewhere (i.e., grassland species do not use forests and vice versa). Generalist species may also use specialized habitats to a lesser extent than intermediate habitats (e.g., edge and scrub). Further, most VCP stations at Ipsen were in prairie habitat, whereas at Lib most VCP stations were in edge and scrub, thus corroborating the relationship between bird use and habitat.

For our second analysis, four groups were evaluated, including two species (83 American Robin detections and 47 American Goldfinch detections) and two species groups (53 chickadee and kinglet detections and 55 sparrow detections). Black-capped Chickadee, Ruby-crowned Kinglet, and Golden-crowned Kinglet were included in the Chickadees and Kinglets Group; and White-crowned Sparrow, White-throated Sparrow, Song Sparrow, and other prairie and edge using sparrows of unknown identity were included in the Sparrows Group. The model of the hazard-rate key function and additive effects of the site was best for American Robin and American Goldfinch groups (Table 4; Figure 3). The model of the hazard-rate key function was best for the Chickadee and Kinglets and Sparrows groups (Table 4; Figure 4). Our two prairie associated groups, American Goldfinches and Sparrows, occurred in greater densities at the prairie site Ipsen compared to the forested site Lib, with American Goldfinches being inestimable at

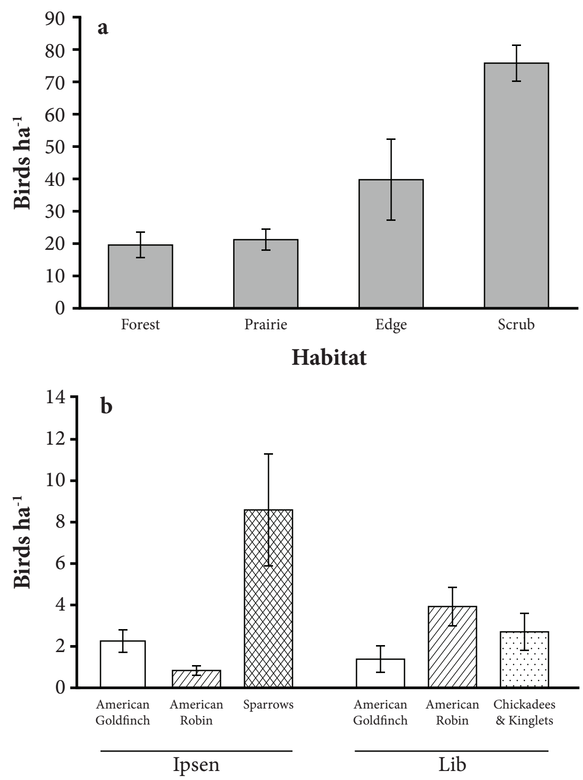


Figure 2. Bird density for (a) pooled species by habitat across study sites and (b) species/ species group at each of Ipsen and Lib Conservation areas at I-90.

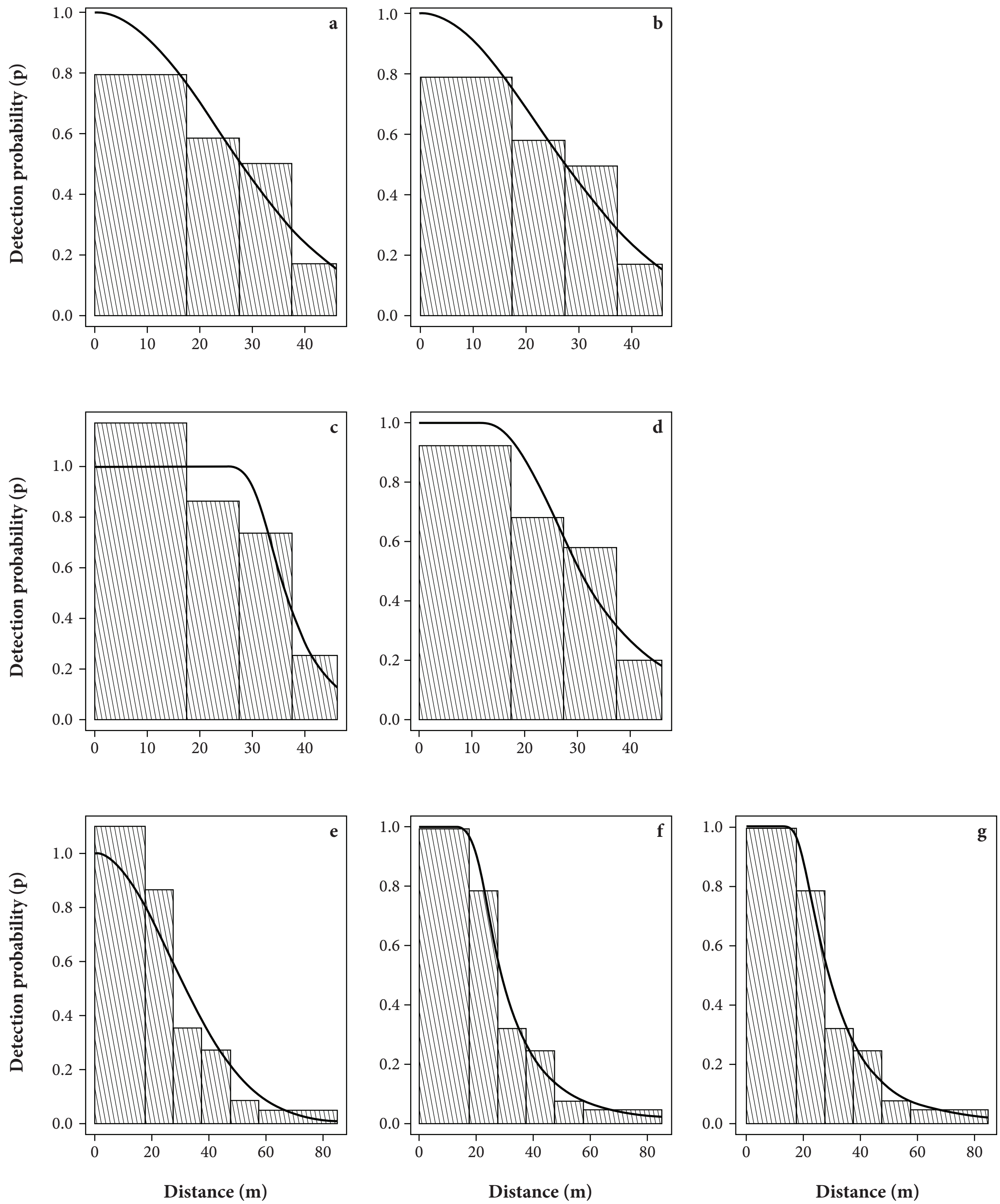


Figure 3. Fit of modeled detection functions to a histogram of variable circular plot (VCP) data for American Goldfinch and American Robin species groups at I-90: (a) American Goldfinch with half-normal key, (b) American Goldfinch with half-normal key + site, (c) American Goldfinch with hazard-rate key, (d) American Goldfinch with hazard-rate key + site, (e) American Robin with half-normal key, (f) American Robin with hazard-rate key, (g) American Robin with hazard-rate key + site.

Table 4. Candidate models evaluating effects of half-normal (hn) and hazard-rate (hr) key functions, and the variable site, on the detection function of four bird groups at I-90. All key functions were modeled with zero adjustment terms; w_i = model weight, L = model likelihood, k = number of parameters, D = deviance, K-S = Kolmogorov-Smirnov test statistic (p-value), p=detection probability ±SE.

Species/Group	Model	AIC	ΔAIC	w_i	L	k	D	K-S	p
American Goldfinch	hn	348.04	0.00	0.418	1.00	1	346.04	0.101 (0.73)	0.45 ± 0.09
	hr	349.12	1.08	0.244	0.58	2	345.12	0.104 (0.68)	0.66 ± 0.08
	hn, site	349.51	1.47	0.201	0.48	2	345.51	0.094 (0.80)	0.45 ± 0.09
	hr, site*	350.27	2.23	0.137	0.33	3	344.27	0.092 (0.82)	0.52 ± 0.13
American Robin	hr, site*	693.03	0.00	0.861	1.00	3	687.03	0.067 (0.86)	0.18 ± 0.03
	hr	696.72	3.70	0.136	0.16	2	692.72	0.072 (0.78)	0.18 ± 0.04
	hn	704.02	10.99	0.004	0.00	1	702.02	0.154 (0.04)	0.20 ± 0.02
Chickadees and Kinglets	hr*	441.75	0.00	0.701	1.00	2	437.75	0.064 (0.98)	0.15 ± 0.04
	hr, site	443.75	2.00	0.258	0.37	3	437.75	0.063 (0.98)	0.15 ± 0.04
	hn	447.41	5.66	0.041	0.06	1	445.41	0.172 (0.09)	0.19 ± 0.02
Sparrows	hr*	435.94	0.00	0.545	1.00	2	431.94	0.051 (0.99)	0.07 ± 0.01
	hr, site	436.30	0.36	0.455	0.83	3	430.30	0.063 (0.98)	0.06 ± 0.01
	hn	462.16	26.22	0.000	0.00	1	460.16	0.238 (0.004)	0.11 ± 0.01

Table 5. Element occurrence records (EORs) for Ospreys detected during variable circular plot (VCP) surveys and intensive searches at I-90.

Date	Preserve	Longitude	Latitude	Adults	Juveniles	County
2-Sep-2015	Baumann Park	-88.95750	42.23063	1	0	Winnebago
2-Sep-2015	Swanson Park	-88.97298	42.23762	1	0	Winnebago
30-Sep-2015	Lib Conservation Area	-88.90671	42.25497	1	0	Boone

Lib (Table 2; Figure 2). Likewise, American Robins and chickadees and kinglets are associated with intermediate and forest habitats and were denser at Lib compared to Ipsen. Chickadee and kinglet detections were inestimable at Ipsen.

Intensive searches.—We conducted 19 person-hours of intensive searches. Combined with species detected while conducting VCP surveys (see Results: Bird Density and Abundance), 61 species were detected during our field season (Table 1; Appendix II). The number of species was greater at Ipsen and Lib compared to Baumann and Swanson Parks, but higher richness likely occurred due to our surveying a relatively small area at Baumann and Swanson Parks (Map 1). There were some differences among species occurring at Ipsen and Lib due to their differing habitat components, but considerable overlap existed among the sites and number of species at each site was similar (Table 1; Appendix III). The overlap of species lists at Ipsen and Lib probably occurred because the sites are close in proximity (i.e., they abut at Newburg Rd.) Additionally, although we classified Lib as a forested area, much of the area is covered by early successional forest. Therefore, intermediate bird habitat along edges of the expansive prairie at Ipsen and the young forest at Lib yielded the presence of many generalist bird species, and birds using intermediate habitats as stopover grounds at both sites.

We collected three EORs, all of which were of Ospreys, during intensive searches and/or VCP surveys between 2–30 September (Table 5). The Ospreys were not suspected to be breeding considering the time of year (Poole et al., 2002) and because no breeding behavior was observed. We, therefore, believe individuals detected were either preparing to migrate south or were using the area as stopover habitat during migration.

Species diversity and species richness.—Menhinick's Index suggested species richness was greater at Ipsen than Lib (D = 2.07 vs. 1.55, respectively), but the more robust estimate of diversity provided by the Shannon-Weiner Index suggested comparable species diversity among sites (H = 2.78 at Ipsen vs. 2.58 at Lib).

CONCLUSIONS

Species numbers at sites where we spent most of our time (Ipsen and Lib) were comparable to species numbers at similar sites in our larger study. However, diversity of forest migrants was low compared to other fall migration studies in the Midwest. Lib only differed in number by three species when compared to two forested sites near Chicago, and had 16 fewer species compared to our forested site near North Chicago, where we expended twice as much effort as at Lib. However, species composition at Lib differed from the Chicago and North Chicago sites in that diversity of wood warblers and other forest species was low. The difference may have been due, in part, to Lib consisting of younger forest in comparison to our other sites, thus enticing fewer species preferring older forests with more closed canopies. Our species list was less diverse when comparing forest-dwelling species composition to studies of similar parks in the Midwest. Less than half of the commonest species in Kalamazoo, Michigan, were also common at Lib (Dunn et al., 1997), and more than 20 species detected at Lincoln Park, Chicago were absent at Lib (Bennett, 1952). Factors such as forest gaps (Martin and Karr, 1986), understory shrub density (Rodewald et al., 2004; France et al., 2012), and proximity to the Great Lakes (France et al., 2012) are known to affect fall migratory songbird use of hardwood forests in the Midwest and eastern U.S. Although we

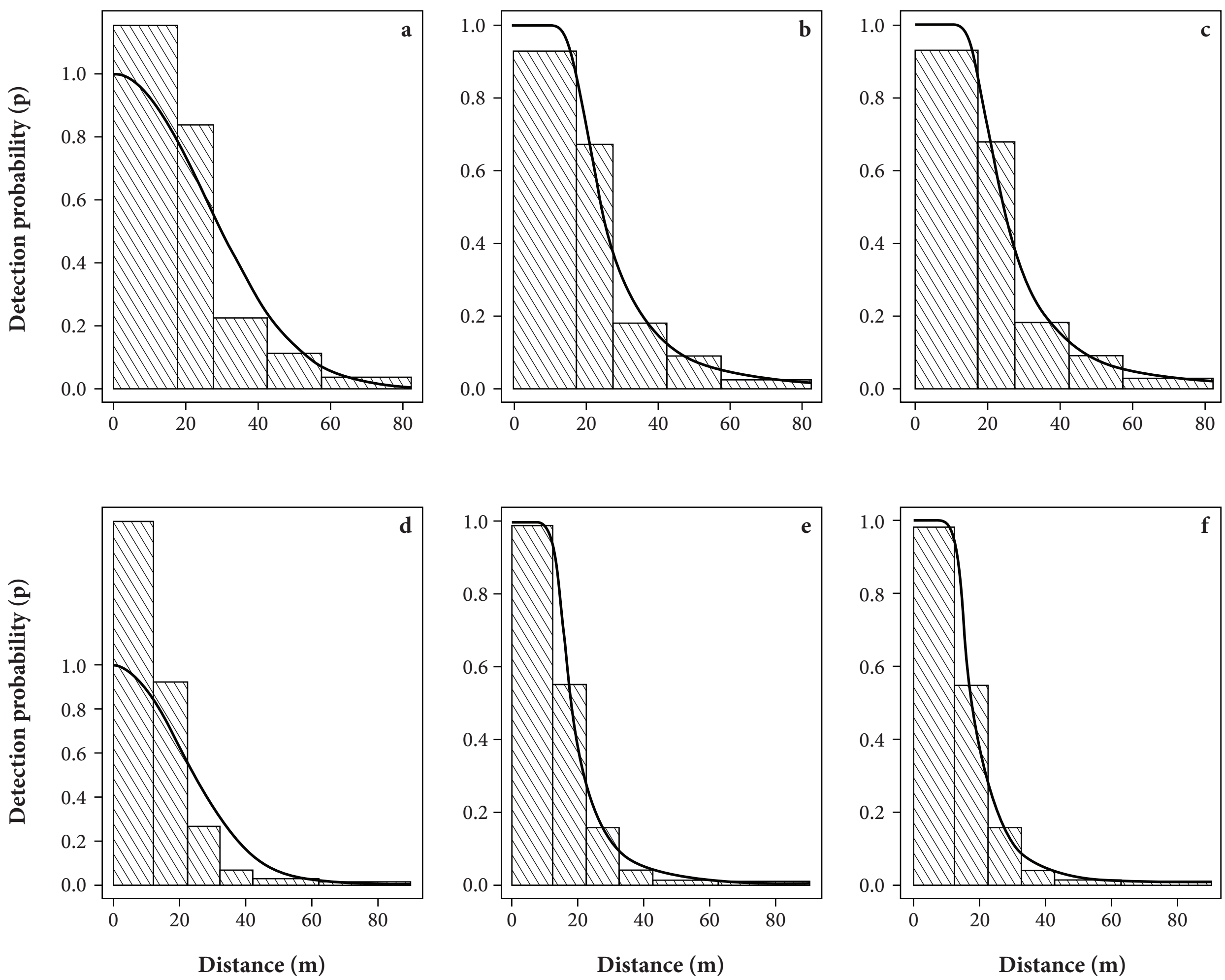


Figure 4. Fit of modeled detection functions to a histogram of variable circular plot (VCP) data for Chickadees and Kinglets and Sparrows groups at I-90: (a) Chickadees vs. Kinglets with half-normal key, (b) Chickadees and Kinglets with hazard-rate key, (d) Chickadees and Kinglets with hazard-rate key + site, (e) Sparrows with half-normal key, (f) Sparrows with hazard-rate key, (g) Sparrows with hazard-rate key + site.

cannot compare Lib bird habitat to other Midwest studies, Lib did have a less-dense understory in high-canopy forested areas compared to our Chicago and North Chicago study sites. Additionally, our Chicago and North Chicago sites are ~ 13 and 6 miles, respectively, from Lake Michigan, whereas Lib lies ~ 60 miles away.

Illinois was once dominated by prairie ecosystems supporting grassland birds (Walk et al., 2011), a group declining across North America for decades. What little remains of prairie habitats in Illinois may vary in its ability to support bird communities due to factors such as patch size and irrigation (Herkert, 1994). Therefore, documenting the use of Ipsen by migrant grassland species is important. The number of bird species at Ipsen varied only by a few species compared to two of our North Chicago prairie sites and had ~ 30% more species compared to another North Chicago prairie site. There were species differences among Ipsen and the North Chicago prairie sites largely due to the greater presence of wetlands, and thus wetland species, at North Chicago sites. However, sparrow densities at Ipsen were ~ 2–10 times greater than for other species/species groups in our study, suggesting Ipsen apparently provides important stopover habitat for some grassland species in fall. We were unable to locate other studies documenting fall migratory bird use of Midwest prairies.

Future research.—Our study suggested, at least, one endangered species uses areas adjacent to I-90, and our Ipsen Road study site may be an important area for migratory sparrows. However, because our study only encompassed the fall period, it is necessary to monitor bird use of our sites during other important times of the year when species composition will differ. To assess year-round bird use and to determine if other threatened and endangered species use our study sites, we will conduct intensive searches for migratory birds at Ipsen and Lib in spring and summer of 2016. We will also derive density estimates of birds during the breeding season to compare to other breeding bird surveys in Illinois and elsewhere in the Midwest.

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APPENDIX I

Variable circular plot (VCP) stations at Ipsen Road and Lib Conservation Areas, and their respective coarse habitat classification.

Study Site	Station ID	Habitat
Ipsen Road Conservation Area	IPSE-01	Prairie
	IPSE-02	Prairie
	IPSE-03	Prairie
	IPSE-04	Prairie
	IPSE-05	Prairie
	IPSE-06	Prairie
	IPSE-07	Prairie
	IPSE-08	Prairie
	IPSE-09	Prairie
	IPSE-10	Prairie
	IPSE-11	Prairie
	IPSE-12	Prairie
	IPSE-13	Prairie
	IPSE-14	Edge
	IPSE-15	Prairie
	IPSE-16	Prairie
	IPSE-17	Prairie
Lib Conservation Area	LIBC-01	Edge
	LIBC-02	Edge
	LIBC-03	Edge
	LIBC-04	Forest
	LIBC-05	Forest
	LIBC-06	Forest
	LIBC-07	Scrub
	LIBC-08	Scrub
	LIBC-09	Edge
	LIBC-10	Edge
	LIBC-11	Forest

APPENDIX II

Species code, common name, and scientific name for all bird species detected during variable circular plot (VCP) surveys and intensive searches at I-90.

Species Code	Common Name	Scientific Name
AMCO	American Coot	*Fulica americana*
AMCR	American Crow	*Corvus brachyrhynchos*
AMGO	American Goldfinch	*Spinus tristis*
AMRO	American Robin	*Turdus migratorius*
BCCH	Black-capped Chickadee	*Poecile atricapillus*
BEKI	Belted Kingfisher	*Megaceryle alcyon*
BHCO	Brown-headed Cowbird	*Molothrus ater*
BLJA	Blue Jay	*Cyanocitta cristata*
BRCR	Brown Creeper	*Certhia americana*
BRTH	Brown Thrasher	*Toxostoma rufum*
CANG	Canada Goose	*Branta canadensis*
CARW	Carolina Wren	*Thryothorus ludovicianus*
CEDW	Cedar Waxwing	*Bombycilla cedrorum*
CHSW	Chimney Swift	*Chaetura pelagica*
COGR	Common Grackle	*Quiscalus quiscula*
COHA	Cooper's Hawk	*Accipiter cooperii*
COYE	Common Yellowthroat	*Geothlypis trichas*
DEJU	Dark-eyed Junco	*Junco hyemalis*
DOWO	Downy Woodpecker	*Picoides pubescens*
EABL	Eastern Bluebird	*Sialia sialis*
EAPH	Eastern Phoebe	*Sayornis phoebe*
EATO	Eastern Towhee	*Pipilo erythrophthalmus*
EAWP	Eastern Wood-Pewee	*Contopus virens*
EUST	European Starling	*Sturnus vulgaris*
FISP	Field Sparrow	*Spizella pusilla*
FOSP	Fox Sparrow	*Passerella iliaca*
GBHE	Great Blue Heron	*Ardea herodias*
GCKI	Golden-crowned Kinglet	*Regulus satrapa*
GRCA	Gray Catbird	*Dumetella carolinensis*
GRHE	Green Heron	*Butorides virescens*
GWTE	Green-winged Teal	*Anas crecca*
HAWO	Harry Woodpecker	*Picoides villosus*
HOWR	House Wren	*Troglodytes aedon*
KILL	Killdeer	*Charadrius vociferus*
LISP	Lincoln Sparrow	*Melospiza lincolnii*
MALL	Mallard	*Anas platyrhynchos*
MODO	Mourning Dove	*Zenaida macroura*
MYWA	Myrtle Warbler	*Setophaga coronata coronata*
NAWA	Nashville Warbler	*Oreothlypis ruficapilla*
NOCA	Northern Cardinal	*Cardinalis cardinalis*
OSPR	Osprey	*Pandion haliaetus*
OVEN	Ovenbird	*Seiurus aurocapilla*
PAWA	Palm Warbler	*Setophaga palmarum*
RBWO	Red-bellied Woodpecker	*Melanerpes carolinus*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
REVI	Red-eyed Vireo	*Vireo olivaceus*

APPENDIX II [CONTD.]

Species code, common name, and scientific name for all bird species detected during variable circular plot (VCP) surveys and intensive searches at I-90.

Species Code	Common Name	Scientific Name
ROPI	Rock Pigeon	*Columba livia*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
SACR	Sandhill Crane	*Grus canadensis*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
SSHA	Sharp-shinned Hawk	*Accipiter striatus*
SOSP	Song Sparrow	*Melospiza melodia*
SWTH	Swainson's Thrush	*Catharus ustulatus*
TUVU	Turkey Vulture	*Cathartes aura*
WBNU	White-breasted Nuthatch	*Sitta carolinensis*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
WODU	Wood Duck	*Aix sponsa*
WTSP	White-throated Sparrow	*Zonotrichia albicollis*
YBSA	Yellow-bellied Sapsucker	*Sphyrapicus varius*
YSFL	Yellow-shafted Flicker	*Colaptes a. auratus*

APPENDIX III

Species encountered during variable circular plot (VCP) surveys and intensive searches at each I-90 study site.

Study Site	Species Encountered
Baumann Park	AMCO, AMCR, AMGO, AMRO, BEKI, BLJA, CANG, CEDW, EAWP, GRHE, GWTE, KILL, MALL, OSPR, RTHA, SSHA, WODU, YSFL
Ipsen Road Conservation Area	AMCR, AMGO, AMRO, BCCH, BEKI, BHCO, BLJA, BRCR, BRTH, CANG, CEDW, CHSW, COHA, COYE, DEJU, DOWO, EAPH, FISP, GBHE, GCKI, GRCA, HAWO, HOWR, KILL, MALL, MYWA, NAWA, NOCA, PAWA, RBWO, RCKI, ROPI, RWBL, SACR, SSHA, SOSP, SWTH, TUVU, WBNU, WCSP, WTSP, YSFL
Lib Conservation Area	AMCR, AMGO, AMRO, BCCH, BEKI, BLJA, BRCR, CANG, CARW, CEDW, CHSW, COGR, COHA, COYE, DEJU, DOWO, EABL, EAPH, EATO, EAWP, EUST, FOSP, GCKI, GRCA, HAWO, HOWR, LISP, MALL, MODO, MYWA, NAWA, NOCA, OSPR, OVEN, RBWO, RCKI, REVI, RHWO, RWBL, SAVS, SSHA, SOSP, SWTH, TUVU, WBNU, WTSP, YBSA, YSFL
Swanson Park	AMGO, BCCH, BLJA, CANG, GBHE, MALL, MODO, NOCA, OSPR, OVEN, TUVU, WODU