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Illinois Waterfowl Surveys and Investigations W-43-R-65-B

Annual Progress Report FY2018

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ANNUAL REPORT – FY2018
Illinois Waterfowl Surveys and Investigations
Federal Aid in Wildlife Restoration
W-43-R-65-B

EXECUTIVE SUMMARY

Objectives

1) Investigate movements and home range size of ≥10 Canada geese during winter in and near the Greater Chicago Metropolitan Area (GCMA) of Illinois,
2) Inventory abundance and distribution of shorebird guilds during spring (April–May) and autumn (July–August) migration at ≥20 sites along and nearby the central Illinois River Valley and other areas in central Illinois,
3) Distribute results and findings to site managers and biologists of the IDNR and other state agencies, the Mississippi Flyway Technical Section, the UMRGLR Joint Venture, the USFWS, other scientists and collaborators as requested, and the general public through oral presentations, popular articles, technical reports, and peer-reviewed publications; make recommendations for future wetland management practices and research needs based on results and related research; and contribute to regional wetland and waterbird conservation planning efforts during the project period as appropriate and requested.

Methods

We deployed transmitters (n = 10, in 2014–2015; n = 31, in 2015–2016; n = 31, in 2017–2018) late autumn and throughout winter to account for temporal variation and across seven different capture locations to account for spatial variation. Transmitters recovered from hunters (n = 3) were redeployed during the late February 2018. Transmitters included solar-powered GPS units from Cellular Tracking Technologies in Somerset, Pennsylvania, USA, and operated on the Global System for Mobile communications network and were configured to acquire a GPS location once per hour. Transmitters were < 2% of the body mass of Canada geese ($\bar{x}$ = 4,713 grams, SE =10.6)

We completed four aerial, shorebird inventories of the central Illinois River Valley (IRV) during August 2016. We completed 10 shorebird flights of the Illinois River Valley during August 2017 (n = 5) and spring 2018 (n = 5). We inventoried shorebirds at 60 locations from near DePue to Naples, IL during August 2016. Locations were subdivided in autumn 2017 and spring 2018 into 96 unique areas with defined ownership categories and varying degrees of levee protection from the mainstem river.

Major Accomplishments and Findings

We monitored cellular-collared Canada geese in the Greater Chicago Metropolitan Area, specifically their use of space near Midway International Airport (MWD). Extensions of runways 13 and 31 were intersected more frequently (13.26% of transitional movements, x = 225) than extensions of runways 4 and 22 (2.52% of transitional movements, x = 76). We recorded 18 instances of movements intersecting airspace over runways at MDW (0.60% of transitional movements). The majority of transmittered Canada geese bred within the range of the temperate-nesting, Mississippi Flyway Giant Population with the exception of one male that appeared to be part of the subarctic-nesting, Mississippi Valley Population based on timing of migration and movement pattern indicating nesting. On average, 24.6% of transmittered geese underwent molt migrations during 2015–2017.

We monitored the chronology and distribution of shorebirds aerially in the IRV during autumn and spring migration. Total number of shorebirds peaked in the IRV during autumn 2017 at 18,120, and averaged 12,024 birds/flight. We noted a positive trend with shorebird abundance and mudflat availability as river levels decreased in the IRV during August 2017. We documented lower shorebird numbers during spring 2018 in the IRV with a peak of 3,320 birds and an average of 2,527 birds/flight. Fluctuating water levels during migration drastically reduced the availability of shorebird habitat in the IRV during spring. Aerial detection of shorebird flocks was 97% and aerial count bias was 89.1% (range 0–250%) for total shorebirds. Count bias averaged 101.1% for large shorebirds and 80.4% for small shorebirds.

NARRATIVE

STUDY 141: ECOLOGY OF CANADA GEESE WINTERING IN THE GREATER CHICAGO METROPOLITAN AREA

Objectives

1) Determine daily flight distance, winter home range size, and proportional habitat use of a minimum of 10 Canada geese in the GCMA during winter,
2) Determine factors affecting daily movements and habitat use of a minimum of 10 Canada geese in the GCMA during winter,
3) Identify movement patterns of a minimum of 10 Canada geese that pose risks for conflict with humans in target areas of the GCMA during winter,
4) Summarize and distribute these data to agency personnel, research collaborators, the scientific community, and the general public through popular articles, oral presentations, technical reports, peer-reviewed publications, and other means.

Introduction

Canada geese (*Branta canadensis*) are important ecologically and economically throughout Illinois and the midwestern United States. Canada goose population ecology is well studied in the U.S. and Canada, and this species is intensively managed to regulate sport harvest within and among goose subpopulations (Klimstra and Padding 2012). In the past several decades, the Mississippi Valley population of subarctic-breeding Canada geese, which breeds in the lowlands of Hudson Bay, Canada, has remained relatively stable in abundance but appears to have changed its wintering range and migration timing (Gates et al. 2001, AGJV 2013).

Anecdotal information suggests that subarctic-breeding geese winter farther north than historically and many previous assumptions regarding factors affecting their movements may be incorrect due to changing food and habitat availability on the landscape. Concurrently, temperate-breeding (i.e., “resident”) Canada goose populations have increased drastically across much of the Midwest (Nelson and Oetting 1998, Dolbeer et al. 2014). During winter, these populations’ ranges overlap creating large abundances of geese in some areas (Paine et al. 2003).

One such mixed congregation area is the Greater Chicago Metropolitan Area (GCMA) in northeastern Illinois which includes the city of Chicago and surrounding suburbs with a human population of greater than 9.4 million and a breeding goose population of >30,000 (Paine et al. 2003, U.S. Census Bureau 2013). In northern wintering regions, geese may congregate in mixed, high-density flocks near electric generation cooling lakes, open river channels, navigation waterways, and other isolated areas of open water (Havera 1999). During mild winters, the GCMA may be the terminal wintering latitude for many temperate breeding geese may remain throughout winter mixing with migrating subarctic-breeding and temperate-breeding geese from Wisconsin and Ontario. Geese are likely attracted to the GCMA because of reduced risk from natural predators and little to no hunting; open water throughout winter at aerated ponds, warm-water out-flows into waterways, and electrical generation cooling lakes; and presumably ample food sources due to extensive agriculture and waste grain within the region. Goose abundances may reach significant numbers during winter offering opportunities for wildlife recreation (e.g., viewing, hunting), but may also create challenges and conflicts that range from inconvenient (e.g., noise, droppings) to extremely dangerous (e.g., aircraft strikes).

The risk of Canada geese to air operations at Midway International Airport (MDW) during winter is immense. Anecdotal observations suggest winter abundances of Canada geese in urban habitats near MDW likely number in the tens-of-thousands. Bird strikes with aircraft are well documented in terms of numbers, species, and economic loss (Dolbeer 2006, Dolbeer and Wright 2009, FAA 2016), but very limited information exists on factors influence movements of geese in the vicinity of airports. Wildlife managers use habitat management, lethal removal to reduce population sizes, and/or harassment on and near airports to reduce the risk of bird strikes.

Management of nuisance goose abundances through lethal means via hunting and euthanasia are the most effective techniques to reduce goose abundances in a region at meaningful time scales but are not possible or popular in urban areas. However, geese that remain in the safety of urban areas throughout winter may be exposed to harvest during molt migrations. Molt migration by temperate-nesting Canada geese is the northward movement to the Arctic and Subarctic by failed- and non-breeders following the nesting period. Molt migration is common in Canada geese nesting in the Upper Midwest (Coluccy 2001, Luukkonen et al. 2008) and has been documented previously in Illinois (Zicus 1981). Exposure to harvest during southward molt migration may influence demographic rates. However, the factors influencing propensity to undergo molt migration are still poorly understood.

We will investigate wintering ecology, movements in relation to Midway International Airport, breeding origins, and migratory movements of Canada geese wintering in the GCMA. By understanding the movements of geese near airports, we can provide information on where and when geese might be in the patch of aircraft and better understand why geese cross commercial airspace. We will continue to quantify daily movement distances, distribution, and habitat use of urban and rural wintering Canada geese. We will determine breeding origins and nest sites of Canada geese that overwinter in the GCMA to improve understanding of where nuisance goose abundances in winter originate. Lastly, we will quantify the distribution and timing of geese wintering in the GCMA to improve our understanding of how hunting in more northern areas influences these abundances. Results of this research will provide a better understanding of factors influencing how geese use the GCMA, source populations of geese using areas of interest, and how wildlife and habitat managers can manage geese to increase wildlife related recreation or dissuade geese from using areas to avoid dangerous conflicts.

Methods

Study Area

Canada geese were captured in the Greater Chicago Metropolitan Area (GCMA; 915 km^2) located in northeastern Illinois, USA (Fig. 1) during late autumn and winter. The GCMA includes portions of three counties (Cook, Du Page, and Will). The GCMA is heavily urbanized but did have agricultural fields present within the GCMA boundaries (United States Department of Agriculture 2015). The GCMA averages 43 days annually below freezing, with 7 days below -18°C. November has an average high of 9°C and a low of 0°C, December has an average high temperature of 2°C with a low of -6°C, January has an average high of 0°C and a low of -9°C, and February has an average high of 2°C and low of -7°C (NOAA 2015*a*). Chicago averages approximately 93 cm of snowfall annually (NOAA 2015*a*). The GCMA has an estimated temperate-breeding Canada goose population exceeding 30,000 individuals (Paine et al. 2003) and a human population of 9.4 million, including the City of Chicago and surrounding suburbs (United States Census Bureau 2013).

Field Methods

We deployed transmitters in November of 2017 on wintering geese (n = 26) and in April of 2018 on nesting geese (n = 5). We focused capture efforts at sites nearby Midway International Airport (41º47'6.5"N, 87º45'6"W) such as large parks, cemeteries, and the Stickney Water Reclamation Plant because of their available habitat and increased risk of goose-aircraft collisions when Canada geese concentrated at these locations throughout the fall and winter months (Fig. 1). Standard waterfowl capture techniques (e.g., rocket nets and cannon nets) could not be used in most urban areas, so we used cast nets and small animal net guns (Wildlife Capture Services, Flagstaff, Arizona, USA) for most capture attempts. After a Canada goose was captured, we determined sex and age using cloacal inversion and feather characteristics and then obtained morphological measurements (i.e., mass, skull length, culmen length, tarsus length; Moser and Rolley 1990, Moser et al. 1991) as potential indicators of body condition. All length measurements were taken using a caliper (nearest 0.1 mm) and mass was obtained using a Rapala mini digital scale (nearest 0.01 kg). An aluminum tarsal band and a GPS transmitter affixed to a white plastic waterfowl neck collar with black alphanumeric codes was then placed on each goose prior to release (Castelli and Trost 1996, Coluccy et al. 2002, Caswell et al. 2012).

Transmitters (n = 10 in 2014–2015, n = 31 in 2015–2016, n = 31 in 2017–2018) were deployed at various times periods late fall and throughout winter to account for temporal variation and across seven different capture locations to account for spatial variation between 2014 2016. Additional transmitters were deployed in November of 2017 on wintering geese (n = 26) and in April 2018 on geese nesting near the lakefront (n = 5) using funding from USDA-Wildlife Services. Transmitters recovered from hunters (n = 3) were redeployed during the late February. Transmitters included solar-powered GPS units from Cellular Tracking Technologies in Somerset, Pennsylvania, USA, and operated on the Global System for Mobile communications network and were configured to acquire a GPS location once per hour. Transmitters were < 2% of the body mass of Canada geese ($\bar{x}$ = 4,713 grams, SE =10.6) and all Canada geese were captured and handled using the approved methods detailed by the University of Illinois Institutional Animal Care and Use Committee (Protocol #14155).

Data Analysis

We examined movements in relation to MDW by quantified intersections of transitional movements with focal air areas during winter from 1 November to 28 February 2016. We examined all instances of transitional movements that occurred within the GCMA. We removed movements that included a location with a speed value of > 15 km/h to exclude in-flight locations. In order to provide a description of flight altitudes of Canada geese, we described altitude frequency as meters above ground level for in-flight locations.

We classified transitional movements based on habitat types with the locations associated with each movement. Habitat types associated with start and end locations of movements were used to classify transitions. We classified habitats as green space, water, rooftop, railyard, or miscellaneous using available aerial imagery and ancillary information (Google Earth Pro, Google Inc., Mountain View, CA, USA). Green spaces were typically large parks, cemeteries, and other large areas of turf that contained a mixture of trees and shrubs, large sports fields, and golf courses within their boundaries. Three buffers were chosen to represent important air space based on FAA recommendations separation distance between habitats known to attract wildlife and airports (FAA Advisory Circular 150/5200-33A; Fig. 2). We analyzed intersection of movements with a 1.61 km and 3.05 km radius buffers, the recommended separation distance between wildlife attractants and airports serving piston-powered and turbine-powered aircraft, respectively (Cleary and Dolbeer 2005). We also analyzed intersections of goose movements with airport runways and lines on runway headings extending for 3.21 km (2 mi) from the ends of three runways 13/31 and runways 4/22 (hereafter runway extensions) as an approximation for aircraft approach paths for those runways (Fig. 2).

We used ANOVA to examine differences in habitat transitions and proportion of intersections by individuals and habitat types (AOV; Program R, R Foundation for Statistical Computing, Vienna, Austria). We modeled the intersection of movements using mixed effect, logistic regression modeling (GLMER) in Program R. We used a suite of biologically plausible predictor variables based on existing literature (Table 1) and individual goose ID as a random effect to account for subject-specific effects. We reported model outcomes as predicted probabilities or the influence of a specific variable on the probability of a movement intersection by holding all other variables at their means (Muller and MacLehose 2014).

Location data was used to visually assess nest attempts by identifying periods of reduced movement in March and April that could indicate nest attendance. We plan to improve our ability to identify nest in the near future by developing a machine learning algorithm that identifies patterns in movement indicating nesting or non-nesting movement behavior. Migratory distribution of geese undergoing molt migrations to the Subarctic will be estimated using dynamic Brownian Bridge Movement Models and timing of movements quantified based on geopolitical boundaries. We will describe departure from breeding regions as the last ground location prior to large scale relocation movements north, away from the breeding regions. Likewise, arrival to the molting areas in the Subarctic will be defined as first ground location following long distance relocation movements. The inverse will be true for southward migration.

Future research will model the propensity to molt migrate by using generalized linear models to examine the effects of degree of urbanization, data of nest failure, age, and landscape attributes around the nest site.

Results

During 16 November 2015 – 28 February 2016, 3,008 transitional movements were recorded from 24 transmittered Canada geese with 125.33 ± 15.62 movements per goose. The number of transitional movements reflected the number of transmittered birds in the GCMA during each month. The majority of transitional movements were recorded during January (44.8%, x = 1,346, n = 23), followed by February (38.3%, x = 1,151, n = 23), December (14.7%, x = 442, n = 15), and November (2.3%, x = 69, n = 5). Of 3,008 transitional movements recorded, 2,767 (92%) were identified as intersecting one or more focal air operation area of MDW (Table 2). Of focal area buffers, the 8.05 km buffer was most frequently intersected (91.3% of transitional movements, x = 2,745) followed by the 3.05 km buffer (27.3% of transitional movements, x = 821), and the 1.61 km buffer (7.5% of transitional movements, x = 225). Extensions of runways 13 and 31 were intersected more frequently (13.3% of transitional movements, x = 225) than extensions of runways 4 and 22 (2.5% of transitional movements, x = 76). We recorded 18 instances of movements intersecting airspace over runways at MDW (0.6% of transitional movements).

Greater than 75% of intersections stemmed from movements associated with greenspace habitats. Transitional movements from greenspace to water habitats had the most intersections with focal airspace operations areas (n = 23, x = 879 intersecting of 1061 movements), followed by railyard to greenspace habitats (n = 14, x = 540 intersecting of 540 movements), and green space to miscellaneous habits (n = 23, x = 401 intersecting of 415 movements; Table 2). The runway 13 and 31 extensions were intersected more (x = 399) than runway 4 and 22 extensions (x = 76; Table 2). For runway 13 and 31 extensions, greenspace and railyards contributed the highest percentage of the intersecting movements (46.9%, x = 187), followed by rooftop and greenspace (28.8%, x = 115; Table 2).

No correlation was detected between parameters thus all parameters were included in model fit (Pearson, $P < 0.15$). Several habitat types, particularly those to and from rooftop and railway habitats, had positive effect on intersections with focal airport operations areas while most other fixed effects had little or negative effect on intersections (Fig. 3). The probability of intersection of runway headings 13 and 31 was greatest for movements between greenspace and railway and greenspace and rooftop habitats across all months (Fig. 4). Movements between railway and miscellaneous followed by greenspace and rooftop, water and rooftop, and greenspace and railway habitats had the highest predicted probabilities for intersection of movements with a 3.05 km buffer around MDW (Fig. 5).

The majority of transmittered Canada geese bred in areas considered part of the temperate-nesting, Mississippi Flyway Giant Population with the exception of one male that appeared to be part of the subarctic-nesting, Mississippi Valley Population based on timing of migration and movement pattern indicating nesting (Fig. 6). On average, 24.6% of transmittered geese underwent molt migrations during 2015–2017. Canada geese from nesting areas in the GCMA, southeast Wisconsin, and Thunder Bay all departed around the same time at the end of May and beginning of June on molt migration, arriving in the Hudson Bay region of the Subarctic around a week later (Table 3).

Discussion

We documented a substantial number of potential intersections between Canada geese and flight paths around MDW highlighting the risk to human safety and need for management of Canada goose in areas outside of the airport boundaries. Managing wildlife outside of the airport should be a focus of managers responsible for mitigating bird strike as Canada geese pose risks outside airport boundaries (Dolbeer 2011, Rutledge et al. 2015). Our use of GPS-GSM transmitters in relation to focal areas highlight the risk overwintering Canada geese pose to air traffic as they move between near-airport habitats. This approach produced detailed information on factors influencing movements intersecting air operation and guide efforts to reduce the risk of bird strikes.

Previous studies have utilized transmitters to examine avian movements in relation to air operations with Canada geese (Rutledge et al. 2015) and vultures (Avery et al. 2011, Walter et al. 2012), but habitat use and movements likely differ greatly by species and region. The use of transmitter identified specific sites increasing the risk of Canada goose involve bird strikes with air traffic from MDW. Studies examining the effectiveness of harassment on urban Canada geese have been mixed (Smith et al. 1999, Sherman and Barras 2004, Seamans and Goss 2016). Several papers have suggested the large-scale management of Canada geese within an 8 km buffer of airports would be required for effective reduction of bird strike risk (Seamans et al.

2009, Rutledge et al. 2015). However, the abundance of suitable habitats for geese near MDW makes management at such a large scale difficult. However, the risk Canada geese pose to air operations is great and harassment efforts to reduce goose abundances near airports justified (Seamans et al. 2009) and few studies have examined the effects of harassment during winter months (Dorak et al. 2017). Rooftop and railyard habitats may provide thermal benefits and act as refuge from harassment efforts near airports (Dorak et al. 2017). We suggest harassment of Canada geese at these sites, known to intersect with air operations during winter has the greatest potential to reduce the risk of catastrophic bird strikes.

We advocate for the use of GPS-equipped transmitters to examine risks of avifauna to human health and safety. Fine-scale movement data derived from transmitters has a myriad of applications for guiding wildlife managers. For instance, we found movements to and from the Belt Way Clearing Yard (i.e., railyard) and nearby rooftops, only 1.5 km from MDW, to greenspaces account for > 75% of transitional movements that intersected runway 13/31 extensions. We believe geese used this rail yard for foraging on waste and spilt grain while the use of rooftops was likely related to the lack of disturbance there. Further research should be used to examine responses to harassment activities (Rutledge et al. 2015) and exam airspace distribution of avifauna in relation to air traffic distribution to better examine bird strike risks (Avery et al. 2011). Additional research is needed to better understand response of Canada geese to harassment in urban areas and understand thermoregulatory balance in these areas.

Future Direction

We have deployed 74 transmitters and currently have > 20 transmitters functioning with birds located from Chicago to parts of Hudson Bay. We have an additional 39 transmitters to deploy in autumn 2018 with money from Illinois DNR and USDA-Wildlife Services. Accelerometer data has been collected, organized, and analyzed in preparation for future work using sensors to quantify differences in behaviors and movement between urban and rural wintering geese. We will examine questions dealing with movements throughout the annual cycle, response of transmitter-marked geese to targeted disturbance, behavior specific habitat use, and other aspects of Canada goose ecology that may inform management decisions. We will begin examining effects of harassment on movement and behavior in collaboration with USDA-Wildlife Services this winter.

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Table 1. Variables used in mixed effect, logistic regression models of Canada goose (*Branta canadensis*) movements intersecting with focal air operations areas at Midway International Airport in Chicago, Illinois, USA during 16 November 2015 – 28 February 2016.

Variable	Levels	Shorthand
Fixed Effect		
Categorical		
Month of year	4	month
Habitat types	8	type
Continuous		
Daily low temperature (c°)		tmp.c.
Average daily wind speed (km)		wind.spd.
Snow depth (cm)		snow.cm.
Time of day		hr.day.strt
Random Effect		
Categorical		
Transitter ID	24	ID

Table 2. Percentage of intersecting movements of focal air operations areas at Midway International Airport, Chicago, IL, USA by Canada goose (*Branta canadensis*) flights from transitional habitats recorded 16 November 2015 – 28 February 2016.

			Intersecting			Movements
Habitat type	1.61 km	3.05 km	8.05 km	Runway 13/31	Runways 4/22	Total
Green/Misc (*n* = 24)	8.9%	11.1%	14.6%	6%	27.6%	415
Green/Rail (*n* = 22)	32%	30.1%	19.7%	46.9%	9.2%	540
Green/Roof (*n* = 21)	34.7%	22.3%	12.1%	28.8%	14.5%	336
Green/Water (*n* = 24)	7.1%	7.6%	32%	3.8%	23.7%	1061
Rail/Misc (*n* = 17)	8.9%	11.8%	4.4%	3.8%	3.9%	120
Rail/Water (*n* = 17)	2.2%	5.2%	4.9%	3.5%	6.6%	135
Roof/Water (*n* = 20)	4%	5.2%	3.1%	3.5%	7.9%	90
Water/Misc (*n* = 23)	2.2%	6.7%	9.3%	3.8%	6.6%	311
Total (*n* = 24)	225	821	2745	399	76	3008

Table 3. Mean departure and arrival of Mississippi Flyway Giant Population Canada geese (*Branta canadensis*) molt migrating to the Subarctic, Hudson Bay, Canada during 2015–2018.

	Northward		Southward	
Year	Departure (± SD)	Arrival (± SD)	Departure (± SD)	Arrival (± SD)
2015 (*n* = 2)	05/27/2015 ± 2.12	06/08/2015 ± 4.24	09/05/2015 ± 7.78	09/27/2015 ± 20.51
2016 (*n* = 10)	05/25/2016 ± 6.46	06/05/2016 ± 9.33	09/06/2016 ± 4.56	09/16/2016 ± 14.69
2017 (*n* = 6)	06/01/2017 ± 1.98	06/09/2017 ± 3.86	09/04/2017 ± 5.56	09/17/2017 ± 11.57
2018 (*n* = 10*)	06/02/2018 ± 6.46	06/01/2018 ± 2.65	**	**

* sample indicates number presumed to have departed on molt migration but not confirmed due to lack of connections-

** not calculated due to not all individuals having returned at the time of this report

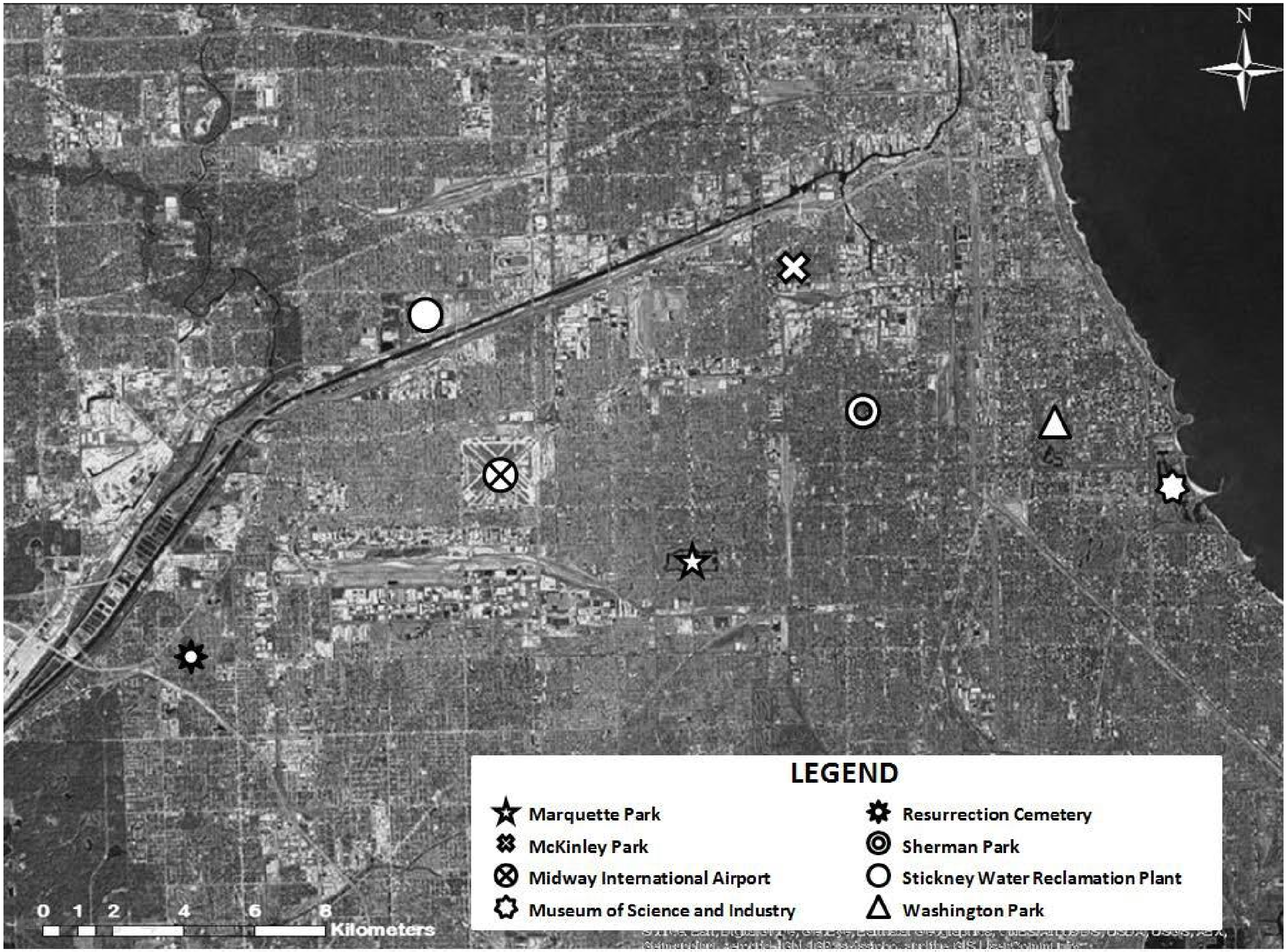

Figure 1. Capture locations ($n = 7$) of Canada geese (*Branta canadensis*) in relation to Midway International Airport in the Greater Chicago Metropolitan Area, Illinois, USA.

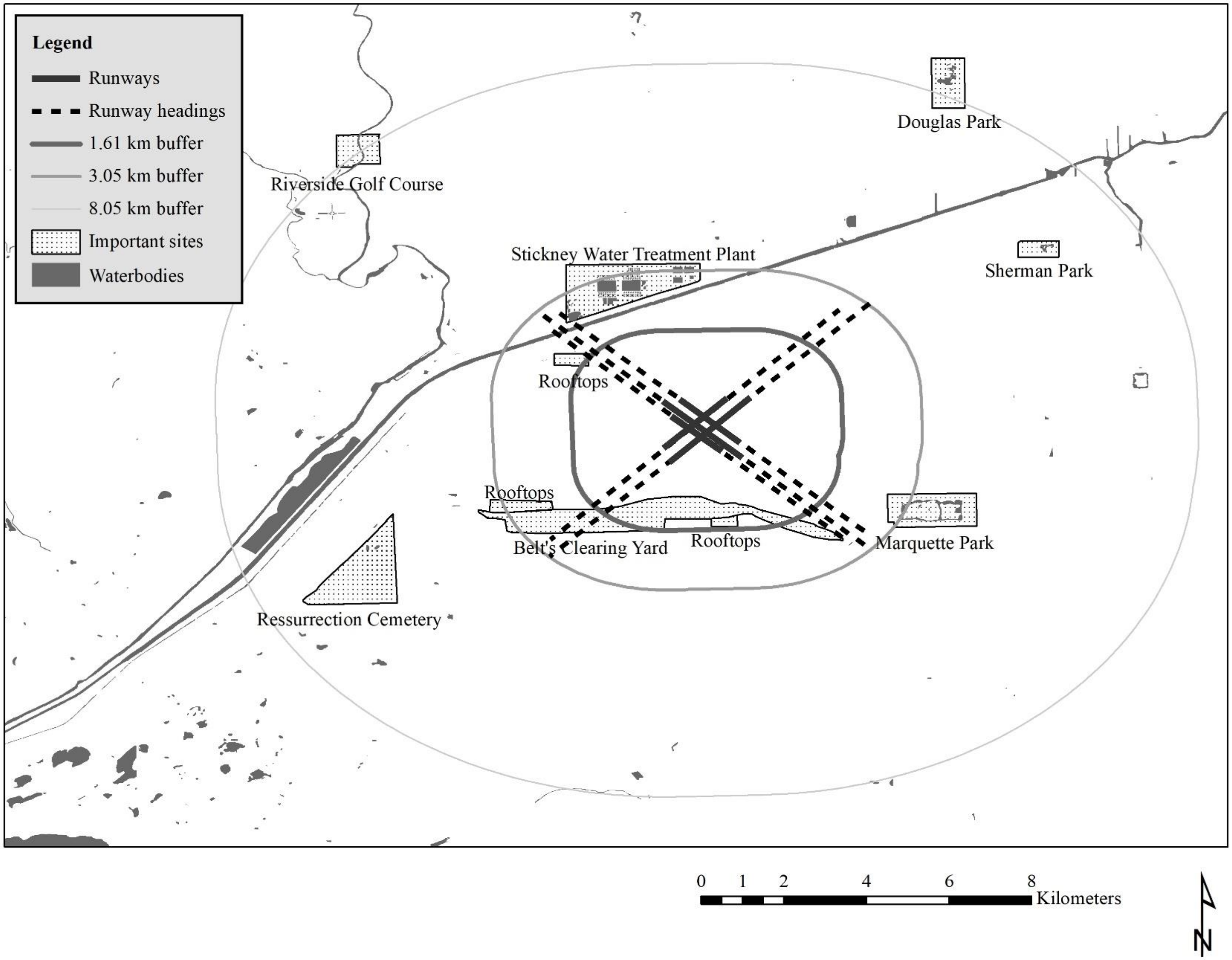

Figure 2. Map of focal air operations areas of Midway International Airport in Chicago, Illinois, USA in relation to sites of Canada goose (*Branta canadensis*) abundances.

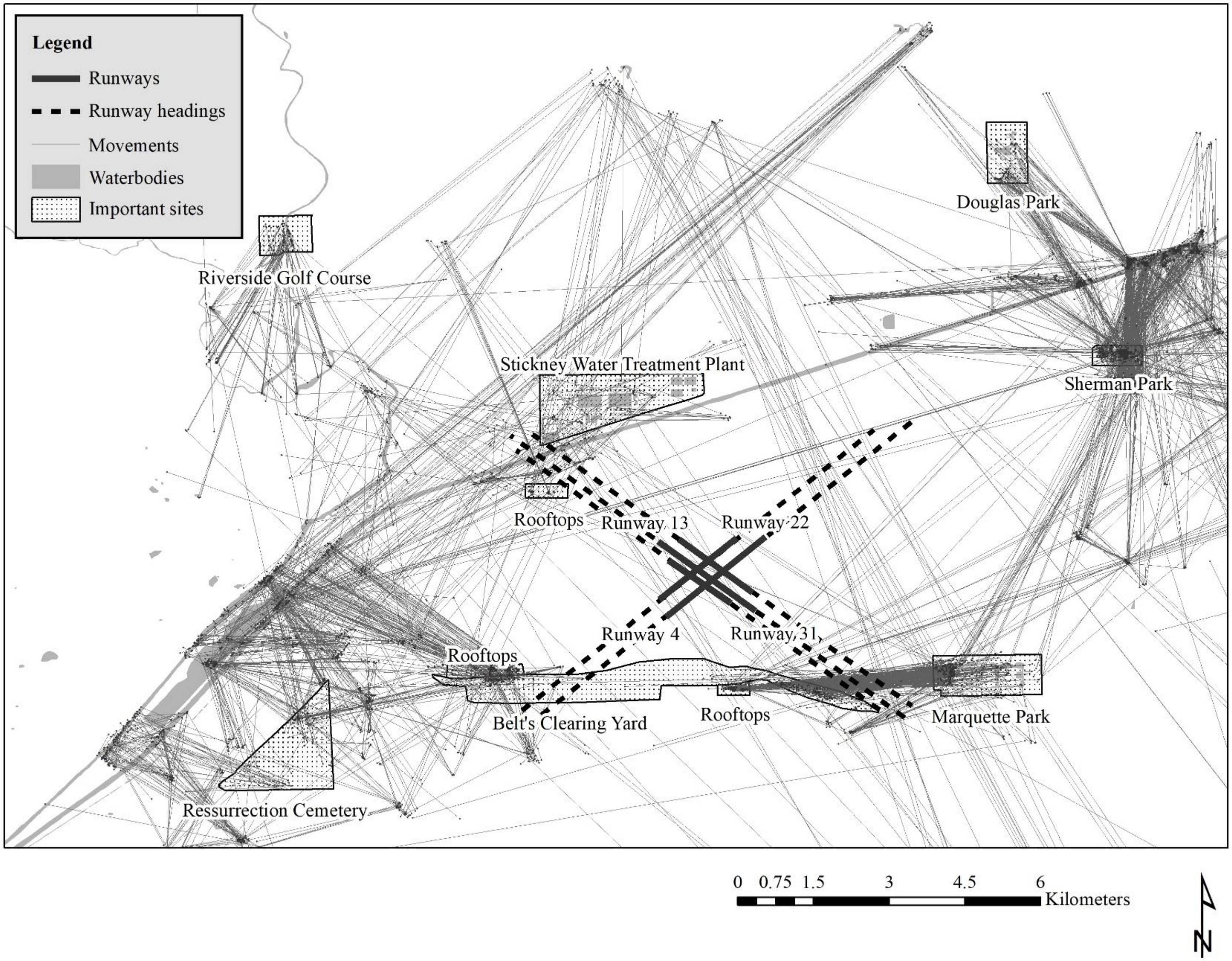

Figure 3. Map of transitional movements of Canada geese (*Branta canadensis*) in relation to Midway International Airport and runway headings in Chicago, Illinois, USA during November 2015 – February 2016.

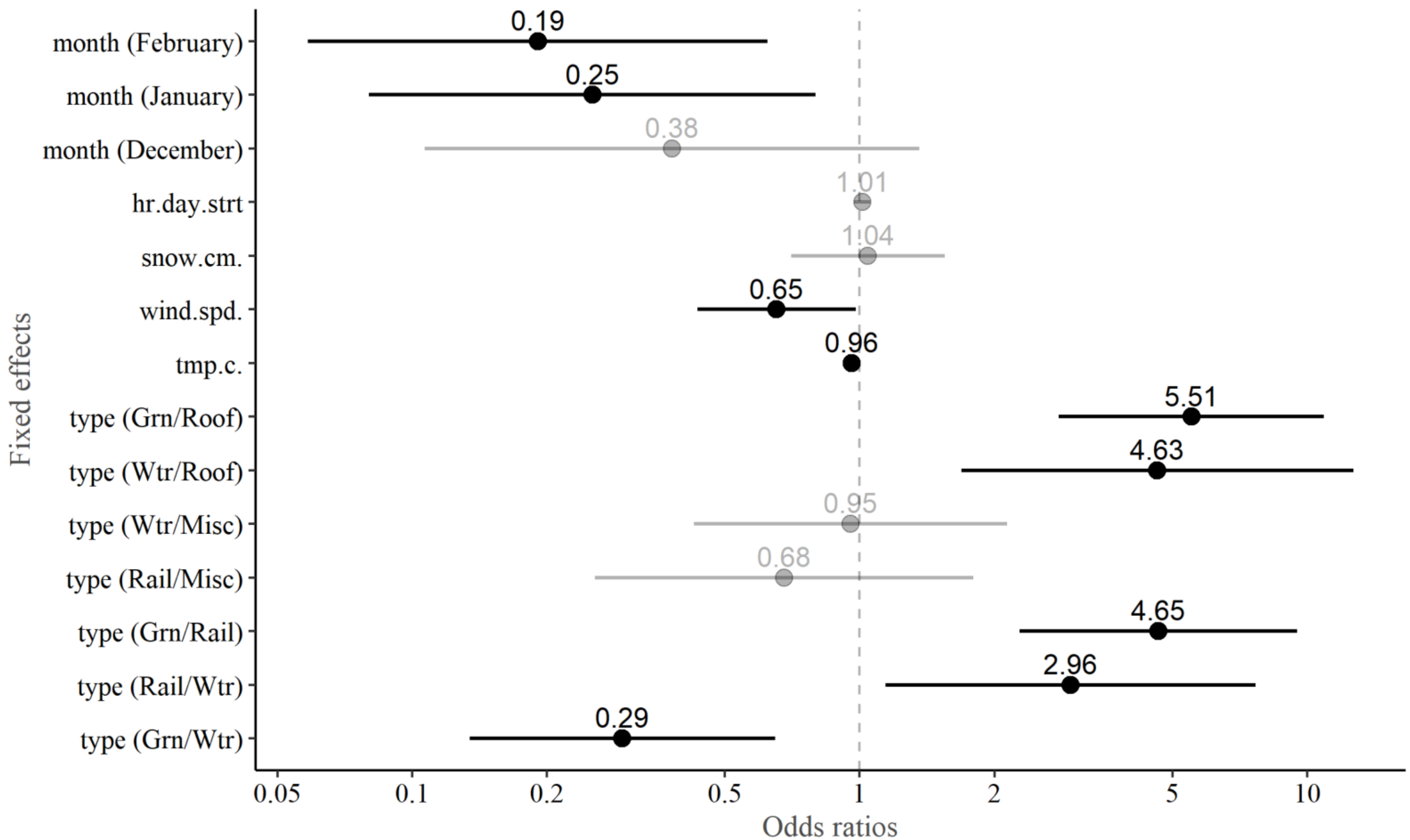

Figure 4. Best linear unbiased predictor values for fixed effects in logistic regression mixed effects models of Canada goose (*Branta canadensis*) movements intersecting 3.05 km extensions of runway headings 13/31 at Midway International Airport in Chicago, IL, USA during November 2015 – February 2016.

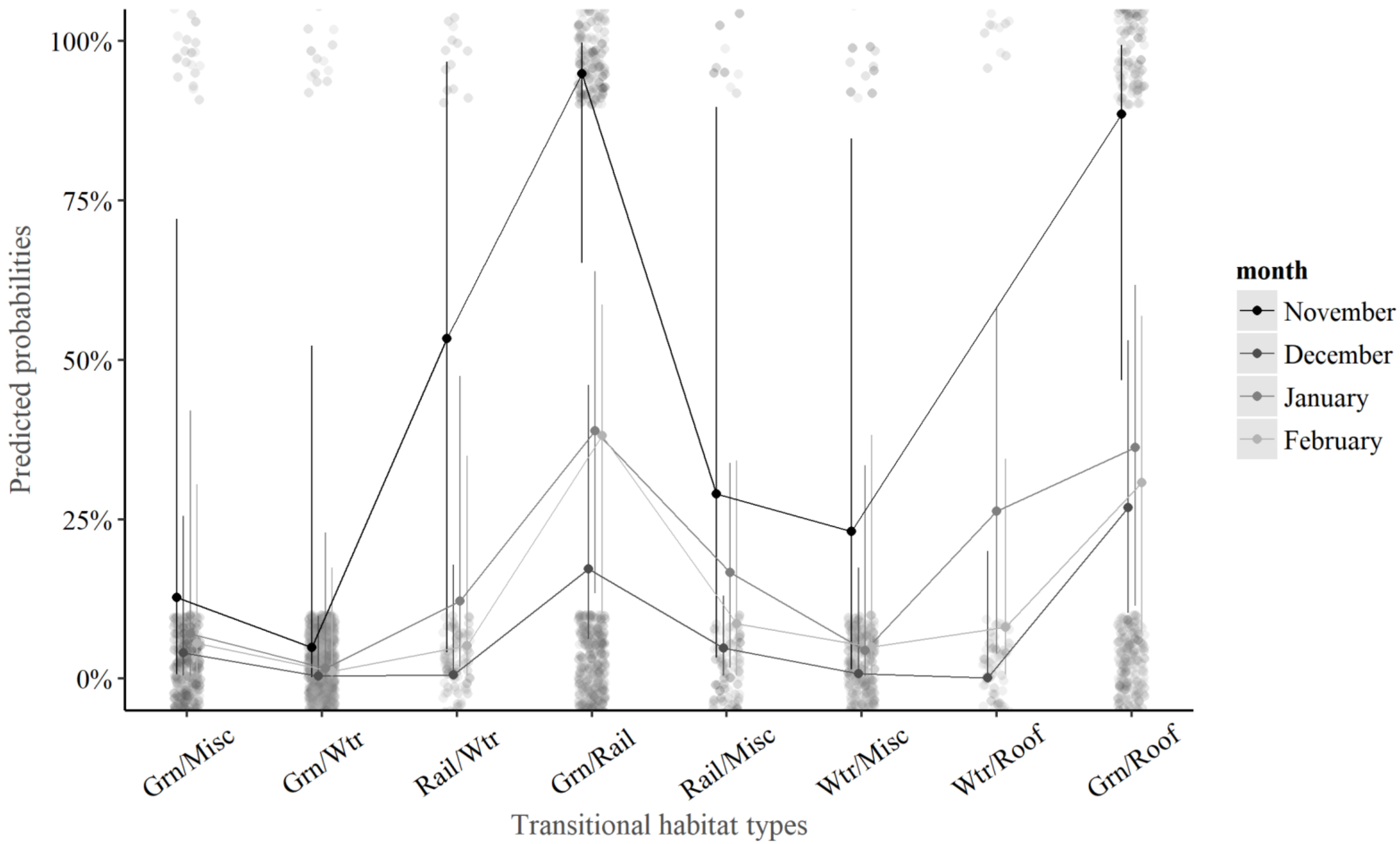

Figure 5. Predicted probabilities with 95% confidence intervals of mixed effects logistic regression model of Canada goose (*Branta canadensis*) movements intersecting 3.05 km extensions of runway headings 13/31of Midway International Airport in Chicago, IL, USA during winter of 2015–2016.

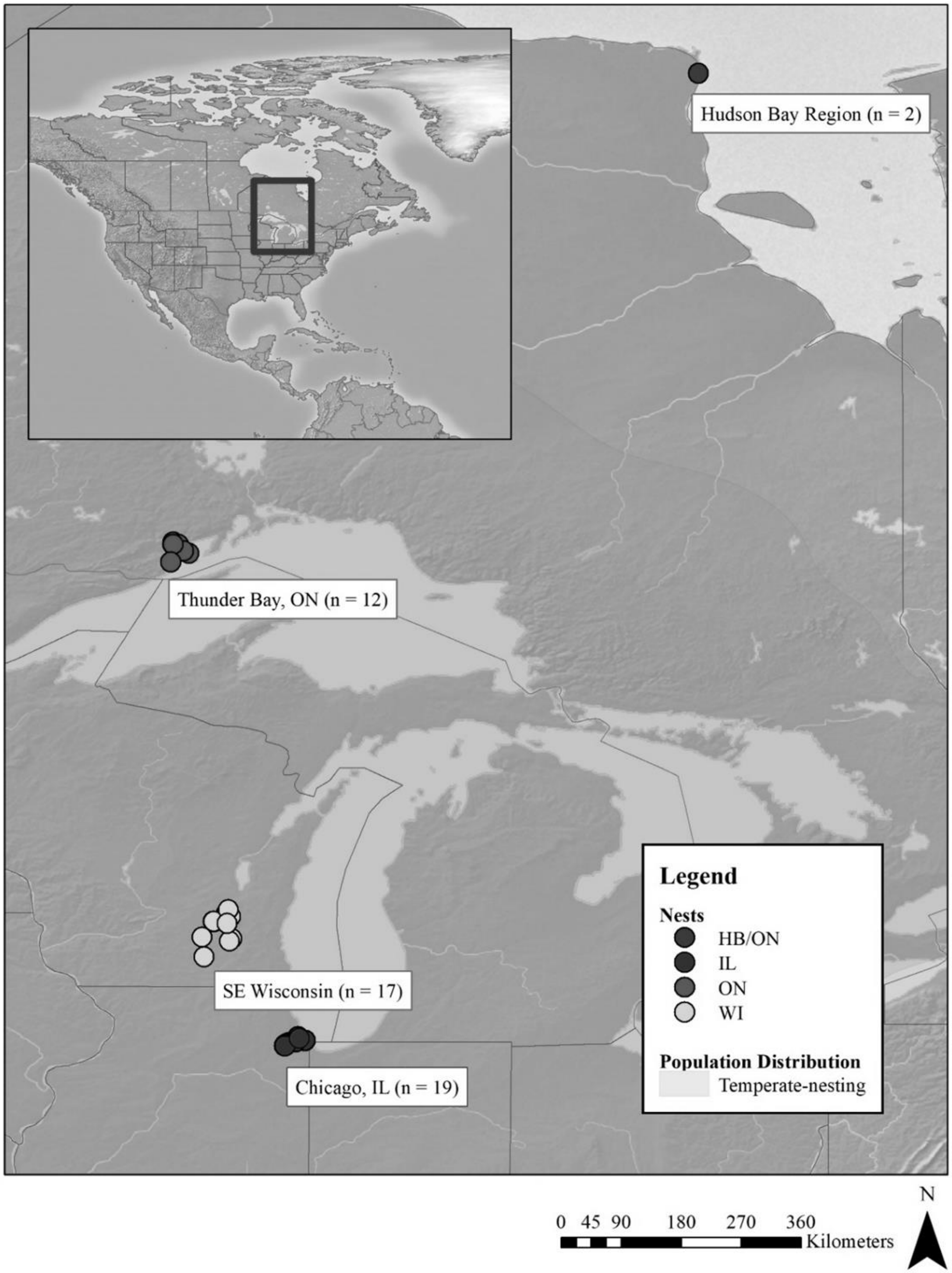

Figure 6. Presumed nest locations of Canada geese (*Branta canadensis*) transmittered in Chicago, Illinois, USA during winters of 2014–2018. The majority of transmittered geese were considered temperate-nesting Canada geese; the breeding distribution of that population is represented in the inset box (USFWS 2017).

STUDY 142: ABUNDANCE AND DISTRIBUTION OF MIGRATING SHOREBIRDS IN CENTRAL ILLINOIS

Objectives: At major shorebird migration stopovers within and nearby the Illinois River Valley and other locations in central Illinois within BCR 22 of Illinois and the UMRGLR Joint Venture, we propose to:

1) Document abundance and distribution of shorebirds using a minimum of 10 aerial surveys in and near the central Illinois River Valley during spring (n = 5 surveys) and autumn (n = 5 surveys) migration,
2) Estimate detection probability, count bias, and visibility bias during aerial surveys at a minimum of 5 locations/survey in and near the central Illinois River Valley during spring and autumn migration,
3) Estimate and compare shorebird densities on public and private land, lands managed for dabbling ducks (e.g., moist soil, emergent marsh), and floodplain wetlands connected and disconnected from river flooding, in and near the central Illinois River Valley during spring and autumn migration,
4) Develop predictive models of habitat availability and quality for shorebirds using river stage, precipitation, or other data in and near the central Illinois River Valley during spring and autumn migration, and
5) Summarize and distribute these data to agency personnel, research collaborators, the scientific community, and the general public through popular articles, oral presentations, technical reports, peer-reviewed publications, and other means.

Introduction

Shorebird populations are declining at certain stopover sites across North America, but recent research has indicated that shorebirds may be redistributing themselves on the landscape in response to anthropogenic activity (Thomas et al. 2006, Bart et al. 2007). Many studies have documented shorebird aversion to disturbance and anthropogenic activity (Burger 1986, Burger and Gochfeld 1991, Yasue 2006), but few have documented their response to habitat restoration and wetland management (Weber and Haig 1996, Twedt et al. 1998). Shorebirds are considered an indicator of wetland health on a global scale (Lanctot 2006, Thomas et al. 2006) and are a priority bird group used to direct conservation planning for the Joint Venture and State of Illinois (IDNR 2005, Potter et al. 2007, Schultheis and Eichholz 2013). Research has demonstrated that landscape structure influences shorebird movements (Farmer and Parent 1997, Yasue 2006), but also that wetland quality may be a significant determinant of use (Colwell and Landrum 1993, Taft and Haig 2006). Wetland restoration, enhancement, and protection may have improved and increased habitats for shorebirds in recent decades. However, relatively few studies have assessed habitat for migratory birds provided by these and other programs on private land or identified tradeoffs of restoration and management on guilds of migratory birds (O'Neal et al. 2008). However, specific restoration and management practices undoubtedly influence use by bird communities, and conservation planners should assess bird response by conducting monitoring or modeling habitat factors that determine site use (Skagen et al. 1999, 2005; Stralberg et al. 2009).

Private lands may provide extensive habitat for shorebirds, but are seldom monitored or included in habitat carrying capacity models (Shuford et al. 1998, Potter et al. 2007, Smith et al. 2012). Shorebird habitat deficits in the region may be inflated (Potter et al. 2007) if management on private lands increases habitat availability or is unaccounted for in use-day estimates (Smith et al. 2012). Currently, the Joint Venture assumes that food availability and habitat may be limiting for shorebirds during migration, but estimates of food and habitat availability may include bias if monitoring surveys are not conducted periodically (Potter et al. 2007, Smith et al. 2012). Large-scale population monitoring is needed to evaluate Joint Venture assumptions and determine the amount of habitat available on public and private lands, how water levels and wetland management practices affect availability, and if conservation efforts in the Joint Venture region are positively influencing shorebirds. To date, shorebird monitoring is largely dependent on volunteers using widely recognized and accessible viewing areas (e.g., Western Shorebird Reserve Network sites), and few monitoring efforts concurrently estimate abundances on public and private lands with regular and repeatable methodology (IDNR 2005).

A significant reason for lack of monitoring on private lands is difficulty in gaining access to these areas for counts, and variability in habitat among years (Shuford et al. 1998, 2007; Potter et al. 2007, Reiter et al. 2011). Several researchers have used aerial surveys to estimate shorebird abundances on private and public lands (*see* Bishop et al. 2000, Brown et al. 2005), which have significant advantages over ground surveys, including rapidity, elimination of private land access issues, and lower costs. Although several researchers have identified potential biases associated with aerial surveys of shorebirds, to our knowledge no previous published literature describes the relationship between ground and aerial counts of shorebirds in different wetland types in the interior United States. Carefully designed and statistically valid surveys are necessary to provide unbiased population estimates relative to specific locations and regions. Accurate estimates of shorebird abundance at migration stopover locations provides resource managers with quantitative documentation on bird responses to management actions and conservation planners with evidence of conservation program outcomes (Thomas et al. 2006).

Farmer and Parent (1997) recognized that habitats outside of recognized state and federal shorebird stopover sites may be necessary to meet population needs, especially in floodplains that often include private lands. Lands outside of typical shorebird stopover sites in the interior United States may be important to shorebird populations, and may explain differences in population declines from other regions (Bart et al. 2007). Smith et al. (2012) observed large concentrations of shorebirds using private lands managed for waterfowl in Illinois, but they did not quantify shorebird use on public and private lands, in response to changing water levels, or to corresponding management practices. A key assumption of Upper Mississippi Valley / Great Lakes Shorebird Conservation Plan is shorebird habitat and population objectives could be accomplished by fulfilling waterfowl habitat objectives (de Szalay et al. 2000). However, few researchers have examined the relationship between wetlands managed for waterfowl and the provision of shorebird habitat. In other regions, wetland management for waterfowl may create conditions avoided by shorebirds (Twedt et al. 1998). Moreover, we identified no published studies that examined the relationship between shorebird use of wetlands within the unrestricted floodplain of a dynamic river (e.g., the Illinois River) and wetlands in the floodplain separated from overland flow by levees. While loss of river connectivity with floodplain wetlands may be detrimental to some species (e.g., fishes), it may benefit others (e.g., shorebirds, waterfowl) because atypical seasonal flooding and high-water associated with anthropogenic modifications of the river systems (e.g., locks and dams, channelization, levees) eliminates habitat during key migration periods. Thus, leveed wetlands in floodplains with highly altered hydrology may benefit shorebirds, but their value is likely dependent on vegetation and water-level management.

There is an explicit need for improved and refined population estimates of shorebirds in Illinois (Potter et al. 2007:34). Methods determining population sizes should be thoroughly evaluated and tested before wide-scale implementation to prevent inconsistencies in data, and ultimately inefficient use of monitoring funds (McCaffery and Ruthrauff 2004, Thomas et al. 2006). Potter et al. (2007) identified a need for and a goal of developing a conservation lands database identifying public land ownership in the UMRGLR Joint Venture region to assist with estimating habitat needs. However, such a database would not include private lands, private or public lands not managed for shorebirds, or lands under local or non-profit conservation easements that may be contributing significantly to shorebird habitat in the region. Moreover, land ownership or "protection" status may not correlate with shorebird habitat needs, especially given difficulties in timing resource (i.e., mudflat) allocation during migration. Lands under private control and managed for other wildlife (e.g., dabbling ducks) may provide excellent shorebird habitat, but quantification and comparison on a landscape scale has not been previously completed (IDNR 2005:25,48; Smith et al. 2012). In fact, the Illinois State Wildlife Action Plan explicitly describes the difficulty in developing rigorous monitoring designs for shorebirds and indicates a need for coordinated and larger scale monitoring (IDNR 2005:103–105). It is widely assumed that conservation programs, especially those administered by the United States Department of Agriculture Natural Resources Conservation Service and Farm Services Agency, benefit shorebirds, but we are not aware of current research documenting large-scale responses of shorebirds to water and vegetation conditions on restored, protected, or waterfowl-managed lands in the interior United States (O'Neal et al. 2008).

Cost-effective and efficacious large-scale surveys of migrating shorebirds may only be possible using aerial survey techniques. And, preliminary results from aerial monitoring of shorebirds in the IRV was promising (detection rates ~0.29–0.46). Therefore, we investigated the abundance and distribution of shorebirds, detection rates, and wetland habitat associations in and near the central IRV using aerial surveys during spring and autumn.

Methods

We conducted 10 low-altitude, inventory-style aerial surveys for shorebirds weekly through August 2017 (n = 5) and late April through May 2018 (n = 5) to determine abundance and distribution of migratory shorebirds in the IRV (Table 4, Appendix 1). We surveyed 96 sites (i.e., shallow lakes, wetlands, and impoundments) within the 100-year floodplain of the Illinois River from Hennepin to Meredosia, IL, that typically comprise the majority of available mudflat area within the region. Shorebirds were categorized into "large" and "small" categories based on size. We considered large shorebirds to be anything the size of a Killdeer (*Charadrius vociferous*) and larger, while small shorebirds were considered anything the size of a Pectoral Sandpiper (*Calidris melanotos*) and smaller. We also recorded weekly habitat characteristics at each site during each survey, such as proportion of surface water, mud, and emergent vegetation.

Surveys were conducted from a single-engine, fixed-wing aircraft flying at approximately 150 mph and 200 ft above ground level. A pilot plus one observer circled each site until a count was achieved (Farmer and Durbian 2006) and habitat variables were collected by visual estimation. Sites were classified based on connectivity to the Illinois River (i.e., connected, partially connected, and disconnected; Lemke et al. 2018). The Illinois River stage was recorded at each gauge within the study area on the days of the surveys to evaluate river level changes on shorebird habitat availability.

A minimum of 5 ground counts were conducted concurrent with each aerial survey to determine the accuracy of aerial shorebird counts. Ground surveys took place on distinct portions of aerial survey sites due to the large size of many sites. We selected ground survey areas to enable observers to conduct a complete count and assume close to a 100% accurate ground count. Natural landmarks and other boundaries (e.g., shorelines, levees, vegetation, roads) were used to define discrete count areas. If no boundaries were present, we used boundary markers (e.g., brightly painted duck decoys) to define the survey location. Specific ground locations were designated *a priori* in order for the aerial and ground observers to census the same discrete areas.

Ground crews identified and counted all shorebirds using optics (e.g., spotting scope, binoculars) in the delineated areas to species from an elevated location where visibility was unobstructed. If ground observers were unable to identify individuals to species, they were categorized as either "unknown large" or "unknown small." Three 5-minute ground counts, with a 5-minute break between each count, were conducted before the arrival of the airplane to investigate turnover at sites before the aerial count. The timing of the third ground count was coordinated so the 5-minute count concluded directly before the arrival of the airplane, and the aerial observer counted the total number of big and small shorebirds in the same area from the airplane. Timing of the airplane arrival was coordinated via cell phone, ideally so no birds entered or exited the count area between the ground and aerial counts. The ground observer counted the number of birds that flushed while the airplane was flying over the site to monitor the percentage of birds in the count area in flight, since shorebirds were more likely to be counted by the aerial observer when in flight (A. Yetter, Illinois Natural History Survey, *pers.comm*.). This provided ground to aerial count comparisons to determine the accuracy of aerial surveys to estimate migratory shorebird populations in the IRV. Ground observers recorded habitat variables for the discrete count area (e.g., proportion surface water, mud, emergent vegetation), along with weather data (e.g., temperature, wind, cloud cover), date and time of count on standardized datasheets. Future reports will contain results of mudflat availability and its relationship with shorebird abundance in the IRV. The total area of habitat available and population size can be incorporated into energetic carrying capacity models to determine if habitat deficits exist within the study area and the frequency at which habitat may be insufficient within the IRV to sustain migrating populations.

An assumption of our survey design was that approximately 100% of the individuals were detected and counted during the ground count (Pollock and Kendell 1987). However, error from detection probability and count bias can exist during ground counts (e.g., vegetation obstructing views, insufficient time to count all individuals, Heusmann 1990). In order to eliminate these issues during ground surveys, ground count locations were opportunistically selected to be open and well-defined mudflat areas. We have also begun conducting 5-minute double-observer counts from the ground to achieve a better estimate of detection rate, the results of which will be included in future reports.

Results

Total shorebird numbers during the August 2017 surveys ranged from 4,860-18,120, and averaged 12,024 birds per survey (Table 4, Fig. 7, and Appendix 1). Throughout this 5-wk survey period in fall 2017, the Illinois River stage (Havana, IL gauge) dropped from 13.3 to 6.3 ft, leading to increased mudflat availability and a positive trend with shorebird abundance. The total number of shorebirds in the April–May 2018 weekly surveys ranged from 1,705–3,320, with an average of 2,527 birds per survey. The Illinois River stage during the spring 2018 survey period fluctuated between 13.4 and 9.2 ft, changing and limiting the available mudflat habitat on a weekly basis. For generating aerial detection rate and aerial count bias, we conducted 68 ground counts simultaneous with aerial surveillance. The aerial observer detected shorebirds at 65 out of 67 sites (97%) where shorebirds were present, and did not detect any individuals at the one site where no shorebirds were present. Initial analysis has shown an average aerial count bias rate of 89.1% (range 0–250%) for total number of shorebirds present (Fig. 8). For large shorebirds, count bias averaged 101.1% (range 0% to 230%). For small shorebirds, count bias averaged 80.4% (range 0% to 400%).

Future Direction

We will investigate shorebird turnover rates at ground count locations both between days and within a 30-minute period prior to aerial surveys. We will employ double observer ground-counts to estimate detection rates for ground observers. Autumn surveys (2018) are scheduled to resume the first week of August.

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Date	Large	Small	Total
8/3/2016	5,885	9,255	15,140
8/11/2016	40,185	43,340	83,525
8/18/2016	22,130	11,375	34,065
8/25/2016	2,125	1,370	3,495
8/3/2017	1,425	3,235	4,660
8/10/2017	3,395	5,870	9,265
8/15/2017	6,275	11,845	18,120
8/24/2017	4,455	6,135	10,590
8/29/2017	11,975	5,310	17,285
4/25/2018	915	790	1,705
5/4/2018	1,370	640	2,010
5/7/2018	945	2,375	3,320
5/14/2018	495	2,565	3,060
5/18/2018	450	2,090	2,540

Table 4. Total number of shorebirds in the Illinois River Valley from autumn 2016, autumn 2017, and spring 2018.

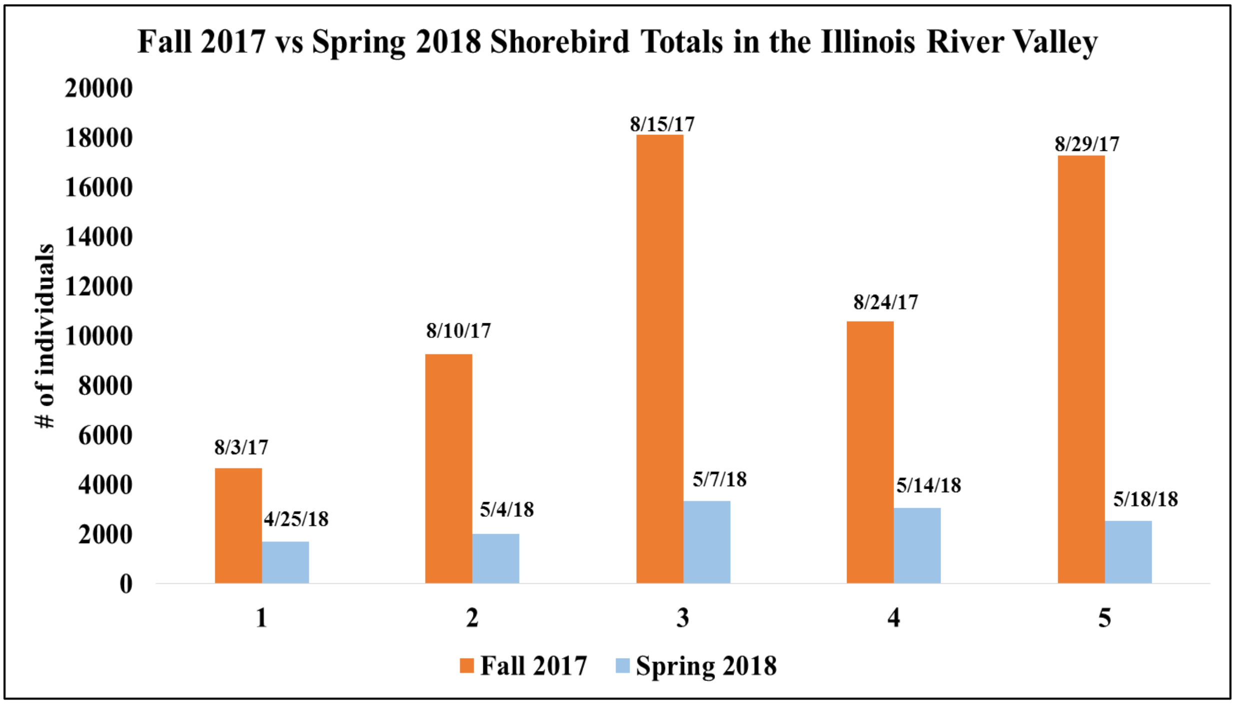

Figure 7. Total number of shorebirds counted in the Illinois River Valley during autumn 2017 and spring 2018 aerial surveys.

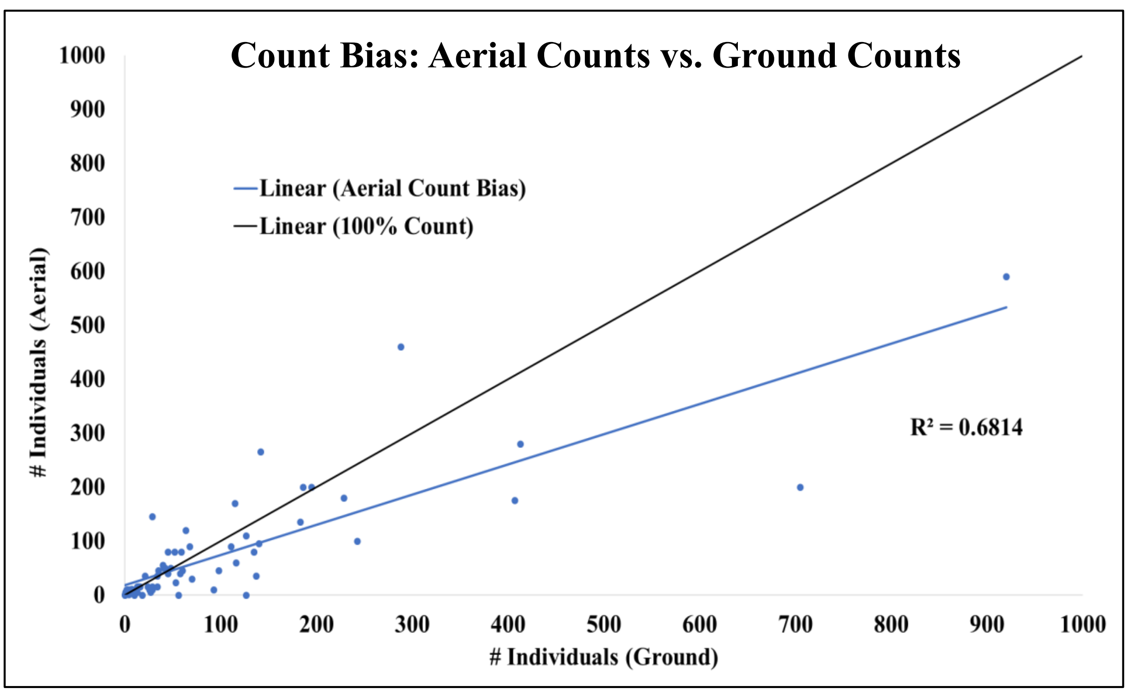

Figure 8. Aerial count bias of shorebirds relative to ground counts in the Illinois River Valley during autumn 2017 and spring 2018. Overall accuracy of aerial counts compared to ground counts averaged 89% (blue line).

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Disclaimer

Any opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of MWRD, CPD, CCFPD, DCFPD, TNC, USFWS, IDNR, or other organizations that supported this research.

Appendix 1. Shorebird Inventories of the Central Illinois River by Date and Location.

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 3, 2016		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Up)	Small (Pect's and under)	TOTAL
Turner Lake	95	20	0	20
Lake Depue	95	0	0	0
Coleman Lake	100	0	0	0
Bureau Ponds	10	0	0	0
Goose Lake	60	240	1,595	1,835
Senachwine Lake	95	180	340	520
Hennepin/Hopper	100	0	0	0
Swan Lake	50	100	740	840
Sawmill Lake	95	5	5	10
Billsbach Lake	90	10	55	65
Weis Lake	90	0	110	110
Sparland	95	0	0	0
Wightman Lake	95	0	0	0
Sawyer Slough	90	20	0	20
Hitchcock Slough	95	15	10	25
Babbs Slough	99	5	5	10
Meadow Lake	95	10	0	10
Douglas Lake	50	460	1,615	2,075
Goose Lake	90	460	670	1,130
Upper Peoria	99	0	15	15
Lower Peoria	99	0	35	35
Pekin Lake	100	0	5	5
Powerton Lake	100	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	5	0	0	0
Goose Lake	80	0	0	0
Rice Lake	90	10	0	10
Big Lake	80	75	360	435
Banner Marsh	100	0	5	5
Duck Creek	100	0	0	0
Clear Lake	95	75	5	80
North Pool	80	1,800	1,360	3,160
South Pool	90	1,270	830	2,100
Quiver Lake	80	30	0	30
Thompson/Flag Lake	99	135	700	835
North Globe	40	0	10	10
Dickson Mounds	100	0	5	5
South Globe	50	0	10	10
Wilder/Bellrose	10	0	0	0
Spoon River Btms	0	0	0	0
Matanza Lake	95	10	0	10
Bath Lake	90	0	0	0
Moscow Lake	90	0	0	0
Jack Lake	100	0	0	0
Grass Lake	95	0	0	0
Anderson Lake	90	0	5	5
Snicarte Slough	50	0	0	0
Ingram Lake	90	5	0	5
Chain Lake	100	0	0	0
Stewart Lake	100	0	0	0
Crane Lake	95	0	50	50
Cuba Island	50	250	220	470
Sanganois	60	515	180	695
Treadway Lake	99	0	50	50
Muscooten Bay	99	0	0	0
Big Prairie	30	160	195	355
Meredosia Lake	80	0	0	0
Smith Lake	95	25	20	45
Spunky Bottoms	10	0	50	50
TOTAL		5,885	9,255	15,140

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 11, 2016		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Up)	Small (Pectoral and under)	TOTAL
Turner Lake	90	655	30	685
Lake Depue	60	110	30	140
Coleman Lake	99	0	0	0
Bureau Ponds	1	50	0	50
Goose Lake	50	2,480	1,540	4,020
Senachwine Lake	90	960	300	1,260
Hennepin/Hopper	100	0	0	0
Swan Lake	50	700	700	1,400
Sawmill Lake	50	35	260	295
Billsbach Lake	70	0	0	0
Weis Lake	50	550	300	850
Sparland	90	100	100	200
Wightman Lake	90	200	300	500
Sawyer Slough	10	600	0	600
Hitchcock Slough	50	0	0	0
Babbs Slough	99	60	30	90
Meadow Lake	80	50	250	300
Douglas Lake	20	550	400	950
Goose Lake	80	2,400	3,310	5,710
Upper Peoria	99	220	0	220
Lower Peoria	99	10	30	40
Pekin Lake	10	240	220	460
Powerton Lake		0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	5	20	0	20
Goose Lake	80	210	25	235
Rice Lake	90	10	0	10
Big Lake	90	650	120	770
Banner Marsh	95	5	0	5
Duck Creek		0	0	0
Clear Lake	90	2,385	890	3,275
North Pool	80	10,200	7,900	18,100
South Pool	70	7,810	16,550	24,360
Quiver Lake	50	250	0	250
Thompson/Flag Lake	95	945	400	1,345
North Globe	30	260	200	460
Dickson Mounds	100	0	5	5
South Globe	30	35	50	85
Wilder/Bellrose	5	130	10	140
Spoon River Btms	0	0	0	0
Matanza Lake	90	175	55	230
Bath Lake	20	1,040	310	1,350
Moscow Lake	30	1,350	850	2,200
Jack Lake	99	10	20	30
Grass Lake	90	10	0	10
Anderson Lake	80	0	0	0
Snicarte Slough	50	320	500	820
Ingram Lake	90	330	140	470
Chain Lake	90	140	500	640
Stewart Lake	95	30	355	385
Crane Lake	95	0	0	0
Cuba Island	70	1,200	900	2,100
Sanganois	40	615	680	1,295
Treadway Lake	50	640	1,460	2,100
Muscooten Bay	80	0	0	0
Big Prairie	20	930	1,860	2,790
Meredosia Lake	60	155	510	665
Smith Lake	95	30	0	30
Spunky Bottoms	10	330	1,250	1,580
TOTAL		40,185	43,340	83,525

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 18, 2016		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Up)	Small (Pectoral and under)	TOTAL
Turner Lake	90	30	10	40
Lake Depue	100	0	0	0
Coleman Lake	100	0	0	0
Bureau Ponds	10	0	0	0
Goose Lake	90	520	70	590
Senachwine Lake	95	0	0	0
Hennepin/Hopper	100	0	0	0
Swan Lake	50	1,180	125	1,305
Sawmill Lake	90	0	0	0
Billsbach Lake	100	0	0	0
Weis Lake	100	0	0	0
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Sawyer Slough	100	0	0	0
Hitchcock Slough	100	0	0	0
Babbs Slough	100	0	0	0
Meadow Lake	100	0	0	0
Douglas Lake	30	2,400	600	3,000
Goose Lake	100	0	0	0
Upper Peoria	100	105	0	105
Lower Peoria	100	0	0	0
Pekin Lake	80	850	250	1,100
Powerton Lake				0
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	5	0	5
Goose Lake	80	320	145	465
Rice Lake	90	0	0	0
Big Lake	80	100	50	150
Banner Marsh	95	0	0	0
Duck Creek				0
Clear Lake	90	475	195	670
North Pool	80	7,650	5,200	12,850
South Pool	70	4,060	920	4,980
Quiver Lake	70	60	65	125
Thompson/Flag Lake	95	450	45	495
North Globe	30	110	205	315
Dickson Mounds	100	0	0	0
South Globe	30	295	425	720
Wilder/Bellrose	10	5	0	5
Spoon River Btms	0	0	0	0
Matanza Lake	95	30	15	45
Bath Lake	70	300	400	700
Moscow Lake	70	190	785	975
Jack Lake	100	10	0	10
Grass Lake	100	0	0	0
Anderson Lake	80	105	80	185
Snicarte Slough	80	110	60	170
Ingram Lake	90	510	350	860
Chain Lake	95	75	0	75
Stewart Lake	100	0	0	0
Crane Lake	80	25	0	25
Cuba Island	50	900	400	1,300
Sanganois	60	170	5	175
Treadway Lake	60	210	300	510
Muscooten Bay		0	0	0
Big Prairie	30	710	255	965
Meredosia Lake	70	80	575	655
Smith Lake	90	0	0	0
Spunky Bottoms	10	290	205	495
TOTAL		22,330	11,735	34,065

August 11, 2016		40,185	43,340	83,525
August 3, 2016		5,885	9,255	15,140

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 25, 2016		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Up)	Small (Pectoral and under)	TOTAL
Turner Lake	100	0	0	0
Lake Depue	100	0	0	0
Coleman Lake	100	0	0	0
Bureau Ponds	10	0	0	0
Goose Lake	95	0	0	0
Senachwine Lake	95	0	0	0
Hennepin/Hopper	100	0	0	0
Swan Lake	60	230	100	330
Sawmill Lake	90	5	0	5
Billsbach Lake	100	0	0	0
Weis Lake	100	0	0	0
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Sawyer Slough	100	0	0	0
Hitchcock Slough	100	0	0	0
Babbs Slough	100	0	0	0
Meadow Lake	100	0	0	0
Douglas Lake	70	0	100	100
Goose Lake	100	0	0	0
Upper Peoria	100	5	0	5
Lower Peoria	100	0	0	0
Pekin Lake	100	0	0	0
Powerton Lake				
Spring Lake	100	5	0	5
Spring Lake Bottoms	10	5	0	5
Goose Lake	80	0	0	0
Rice Lake	90	0	0	0
Big Lake	90	10	0	10
Banner Marsh	90	0	0	0
Duck Creek				
Clear Lake	95	0	0	0
North Pool	80	860	90	950
South Pool	70	410	680	1,090
Quiver Lake	100	0	0	0
Thompson/Flag Lake	95	145	60	205
North Globe	20	5	0	5
Dickson Mounds	100	0	0	0
South Globe	30	0	0	0
Wilder/Bellrose	30	0	0	0
Spoon River Btms	0	0	0	0
Matanza Lake	95	0	0	0
Bath Lake	90	0	0	0
Moscow Lake	95	25	130	155
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	90	0	0	0
Snicarte Slough	100	0	0	0
Ingram Lake	100	0	0	0
Chain Lake	100	0	0	0
Stewart Lake	100	0	0	0
Crane Lake	70	0	0	0
Cuba Island	70	0	0	0
Sanganois	70	0	0	0
Treadway Lake	80	60	0	60
Muscooten Bay				
Big Prairie	30	275	80	355
Meredosia Lake	70	10	30	40
Smith Lake	80	75	100	175
Spunky Bottoms	40	0	0	0
TOTAL		2,125	1,370	3,495

August 18, 2016		22,130	11,375	34,065
August 11, 2016		40,185	43,340	83,525
August 3, 2016		5,885	9,255	15,140

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 3, 2017		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	60	0	100	100
Lake Depue	100	0	0	0
Coleman Lake	100	0	0	0
Bureau Ponds	20	10	100	110
Goose Lake	90	110	70	180
Senachwine Lake	90	500	210	710
Hennepin/Hopper	100	5	0	5
Swan Lake	70	0	0	0
Sawmill Lake	90	0	50	50
Billsbach Lake	100	0	0	0
Weis Lake	100	0	0	0
Sparland	100	0	0	0
Wightman Lake	90	0	0	0
Sawyer Slough	100	0	0	0
Hitchcock Slough	90	0	0	0
Babbs Slough	90	0	50	50
Meadow Lake	100	0	0	0
Douglas Lake	90	0	0	0
Goose Lake	100	10	0	10
Upper Peoria	100	0	0	0
Lower Peoria	100	0	0	0
Pekin Lake	100	0	0	0
Powerton Lake	100	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	10	0	10
Goose Lake	100	10	10	20
Rice Lake	90	0	0	0
Big Lake	100	0	0	0
Banner Marsh	90	10	15	25
Duck Creek	100	5	0	5
Clear Lake	90	0	0	0
North Pool	100	0	5	5
South Pool	90	50	90	140
Quiver Lake	100	5	0	5
Thompson/Flag Lake	100	100	35	135
North Globe	70	0	0	0
Dickson Mounds	100	0	0	0
South Globe	60	0	0	0
Wilder/Bellrose	10	10	45	55
Spoon River Btms	0	0	0	0
Matanza Lake	90	5	10	15
Bath Lake	100	0	5	5
Moscow Lake	100	0	0	0
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	80	25	420	445
Snicarte Slough	60	5	0	5
Ingram Lake	100	0	0	0
Chain Lake	100	0	0	0
Stewart Lake	100	0	0	0
Crane Lake	90	15	10	25
Cuba Island	40	140	1,000	1,140
Sanganois	40	110	440	550
Treadway Lake	90	0	0	0
Muscooten Bay	100	0	0	0
Big Prairie	30	275	570	845
Meredosia Lake	80	0	0	0
Smith Lake	90	5	0	5
Spunky Bottoms	70	10	0	10
TOTAL		1,425	3,235	4,660

August 3, 2016	Averaged 80 percent	5,885	9,255	15,140

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 10, 2017		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	70	40	0	40
Lake Depue	80	80	10	90
Lake Depue Impoundments	10	30	0	30
Coleman Lake	100	0	0	0
Coleman Impoundment	10	0	0	0
Bureau Ponds	40	30	30	60
Goose Lake	80	140	0	140
Goose Impoundments	70	395	0	395
Senachwine Lake	90	150	150	300
Senachwine Lake Impoundments	50	200	165	365
Hennepin/Hopper	100	0	0	0
Swan Lake	70	65	25	90
Swan Lake Impoundments	0	0	0	0
Sawmill Lake	90	10	5	15
Sawmill Lake Impoundments	10	0	40	40
Billsbach Lake	80	20	15	35
Weis Lake	80	110	10	120
Sparland	90	0	10	10
Wightman Lake	90	5	0	5
Wightman Lake Impoundments	10	0	0	0
Sawyer Slough	70	0	0	0
Hitchcock Slough	80	5	25	30
Hitchcock Impoundment	70	0	0	0
Babbs Slough	80	130	0	130
Atchison Impoundment	10	110	20	130
Meadow Lake	90	10	10	20
Douglas Lake	60	30	120	150
Oberhelman Impoundment West	90	5	0	5
Rice Pond Impoundments East	90	0	0	0
Goose Lake	80	75	170	245
Upper Peoria	90	35	60	95
Lower Peoria	90	5	0	5
Pekin/Worley Lake	90	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	5	0	5
Goose Lake	100	0	0	0
Goose Lake Impoundments	90	100	200	300
Rice Lake	90	0	0	0
Ridge Field	10	0	30	30
Barton Field	10	0	0	0
Big Lake	100	10	5	15
Big Lake Impoundments	100	0	0	0
Banner Marsh	90	10	15	25
Banner Marsh Impoundments	0	0	0	0
Clear Lake	90	0	30	30
Clear Lake Impoundments	80	80	420	500
North Pool	90	85	20	105
South Pool	90	5	70	75
Quiver Lake	90	5	0	5
Quiver Lake Impoundments	70	20	25	45
Thompson/Flag Lake	90	25	10	35
North Globe	70	0	5	5
Dickson Mounds	100	0	0	0
South Globe	60	70	1,045	1,115
Wilder/Bellrose	10	10	0	10

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY

Date: August 10, 2017		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Spoon River Btms	0	0	0	0
Matanzas Lake	90	0	0	0
Matanzas Lake Impoundments	10	25	55	80
Bath Lake	80	30	70	100
Moscow Bay	90	10	60	70
Moscow Bay Impoundments	50	0	0	0
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	60	50	350	400
West Point	0	0	0	0
Snicarte Slough	40	0	0	0
Ingram Lake	100	0	0	0
Lower 40 Impoundments	70	10	5	15
Chain Lake	90	5	0	5
Stewart Lake	90	10	0	10
Bur Oak Island	50	20	60	80
Crane Lake	100	0	0	0
Rainbow/Crane Impoundments	10	25	0	25
IRC Impoundments	10	0	60	60
Otter Lake	90	30	10	40
Mound Lake Impoundments	10	45	200	245
Staley Impoundment	20	50	60	110
Barkhausen Impoundments	10	50	310	360
Oklahoma Impoundments	0	0	0	0
Sanganois Impoundments	0	0	0	0
Sanganois	40	10	25	35
Line Blinds	60	50	150	200
Wiener Swale	10	20	0	20
Treadway Lake	70	130	700	830
Curry Lake	100	0	0	0
Big Prairie	40	140	190	330
Flynn Club	10	70	30	100
Gust Club	30	60	30	90
Meredosia Lake	100	0	0	0
Meredosia Club Impoundments	30	105	65	170
Meredosia FWS Impoundments	30	85	10	95
Upper Smith Lake	90	10	0	10
Lower Smith Lake	90	10	0	10
Spunky Bottoms	40	240	690	930
TOTAL		3,395	5,870	9,265

August 3, 2017		1,425	3,235	4,660

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: August 15, 2017		Observer: Aaron Yetter & Luke Malanchuk		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	80	20	5	25
Lake Depue	70	55	50	105
Lake Depue Impoundments	10	0	0	0
Coleman Lake	100	0	0	0
Coleman Impoundment	60	0	0	0
Bureau Ponds	50	0	0	0
Goose Lake	60	45	10	55
Goose Impoundments	50	140	100	240
Senachwine Lake	90	25	10	35
Senachwine Lake Impoundments	30	290	10	300
Hennepin/Hopper	100	0	0	0
Swan Lake	70	365	40	405
Swan Lake Impoundments	0	0	0	0
Sawmill Lake	90	70	70	140
Sawmill Lake Impoundments	10	20	5	25
Billsbach Lake	80	15	5	20
Weis Lake	80	200	100	300
Sparland	80	25	10	35
Wightman Lake	90	50	20	70
Wightman Lake Impoundments	10	0	0	0
Sawyer Slough	50	210	0	210
Hitchcock Slough	60	5	0	5
Hitchcock Impoundment	70	0	0	0
Babbs Slough	90	0	15	15
Atchison Impoundment	10	5	0	5
Meadow Lake	90	0	10	10
Douglas Lake	50	0	0	0
Oberhelman Impoundment West	20	800	300	1,100
Rice Pond Impoundments East	90	10	0	10
Goose Lake	90	140	40	180
Upper Peoria	90	75	0	75
Lower Peoria	90	0	0	0
Pekin/Worley Lake	30	60	20	80
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	20	0	20
Goose Lake	90	0	5	5
Hate Levee Impoundment	50	140	450	590
Woodyard Impoundments	40	235	650	885
Rice Lake	90	0	0	0
Ridge Field	10	0	0	0
Barton Field	10	0	0	0
Big Lake	90	15	10	25
Big Lake Impoundments	90	50	200	250
Banner Marsh	90	20	0	20
Banner Marsh Impoundments	0	5	0	5
Clear Lake	90	65	160	225
Clear Lake Impoundments	20	50	325	375
North Pool	90	190	200	390
South Pool	90	230	120	350
Quiver Lake	80	50	0	50
Quiver Lake Impoundments	70	200	30	230
Thompson/Flag Lake	90	50	60	110
North Globe	40	95	150	245
Dickson Mounds	100	0	5	5
South Globe	40	190	500	690
Wilder/Bellrose	10	10	0	10
Spoon River Btms	0	0	0	0

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: August 15, 2017		Observer: Aaron Yetter & Luke Malanchuk		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Matanzas Lake	90	110	100	210
Matanzas Lake Impoundments	10	40	0	40
Bath Lake	20	180	600	780
Moscow Bay	90	0	0	0
Moscow Bay Impoundments	10	40	600	640
Jack Lake	100	0	0	0
Grass Lake	90	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	40	35	400	435
West Point	0	0	0	0
Snicarte Slough	40	30	200	230
Ingram Lake	90	90	170	260
Lower 40 Impoundments	10	0	10	10
Chain Lake	90	120	420	540
Stewart Lake	90	30	310	340
Bur Oak Island	20	0	0	0
Crane Lake	90	0	10	10
Rainbow/Crane Impoundments	40	20	20	40
IRC Impoundments	10	10	0	10
Otter Lake	80	100	900	1,000
Mound Lake Impoundments	10	30	400	430
Staley Impoundment	10	50	700	750
Barkhausen Impoundments	10	80	170	250
Oklahoma Impoundments	0	0	0	0
Sanganois Impoundments	10	10	70	80
Sanganois	50	50	200	250
Line Blinds	50	50	150	200
Wiener Swale	10	140	50	190
Treadway Lake	80	250	1,900	2,150
Curry Lake	100	0	0	0
Big Prairie	30	340	450	790
Flynn Club	10	0	0	0
Gust Club	40	15	10	25
Meredosia Lake	90	40	200	240
Meredosia Club Impoundments	10	150	100	250
Meredosia FWS Impoundments	10	10	0	10
Upper Smith Lake	90	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	10	15	20	35
TOTAL		6,275	11,845	18,120
August 10,2017		3,395	5,870	9,265
August 3, 2017		1,425	3,235	4,660

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: August 24, 2017		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	80	0	0	0
Lake Depue	60	135	135	270
Lake Depue Impoundments	10	0	0	0
Coleman Lake	100	0	0	0
Coleman Impoundment	70	0	0	0
Bureau Ponds	50	30	30	60
Goose Lake	70	0	0	0
Goose Impoundments	30	0	0	0
Senachwine Lake	90	35	30	65
Senachwine Lake Impoundments	10	510	5	515
Hennepin/Hopper	100	0	0	0
Swan Lake	40	265	30	295
Swan Lake Impoundments	0	0	0	0
Sawmill Lake	90	0	5	5
Sawmill Lake Impoundments	10	0	0	0
Billsbach Lake	80	0	300	300
Weis Lake	80	0	50	50
Sparland	90	10	100	110
Wightman Lake	90	0	0	0
Wightman Lake Impoundments	10	0	0	0
Sawyer Slough	70	50	150	200
Hitchcock Slough	70	410	50	460
Hitchcock Impoundment	80	0	0	0
Babbs Slough	90	15	0	15
Atchison Impoundment	10	0	0	0
Meadow Lake	90	5	0	5
Douglas Lake	60	5	0	5
Oberhelman Impoundment West	10	5	0	5
Rice Pond Impoundments East	70	0	0	0
Goose Lake	90	10	10	20
Upper Peoria	90	15	0	15
Lower Peoria	90	0	0	0
Pekin/Worley Lake	20	65	0	65
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	0	0	0
Goose Lake	90	10	0	10
Hate Levee Impoundment	20	10	0	10
Woodyard Impoundments	10	10	0	10
Rice Lake	90	0	0	0
Ridge Field	10	0	0	0
Barton Field	10	0	0	0
Big Lake	90	0	15	15
Big Lake Impoundments	30	50	50	100
Banner Marsh	90	0	0	0
Banner Marsh Impoundments	0	0	0	0
Clear Lake	80	125	130	255
Clear Lake Impoundments	30	10	0	10
North Pool	60	215	130	345
South Pool	70	485	975	1,460
Quiver Lake	70	10	150	160
Quiver Lake Impoundments	50	20	5	25
Thompson/Flag Lake	80	200	40	240
North Globe	30	40	20	60
Dickson Mounds	100	0	0	0
South Globe	30	30	40	70
Wilder/Bellrose	10	0	0	0
Spoon River Btms	10	0	0	0
Matanzas Lake	90	15	35	50
Matanzas Lake Impoundments	10	0	0	0
Bath Lake	20	30	50	80
Moscow Bay	40	120	700	820
Moscow Bay Impoundments	10	0	0	0
Jack Lake	90	0	0	0
Grass Lake	90	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	40	40	50	90
West Point	0	0	0	0
Snicarte Slough	40	70	20	90
Ingram Lake	90	15	40	55
Lower 40 Impoundments	10	10	0	10
Chain Lake	90	30	200	230
Stewart Lake	90	390	1195	1,585
Bur Oak Island	20	10	0	10
Crane Lake	100	0	0	0
Rainbow/Crane Impoundments	20	0	0	0
IRC Impoundments	10	0	0	0
Otter Lake	90	0	100	100
Mound Lake Impoundments	10	20	0	20
Staley Impoundment	10	10	0	10
Barkhausen Impoundments	10	150	10	160
Oklahoma Impoundments	10	10	0	10
Sanganois Impoundments	10	0	0	0
Sanganois	30	10	0	10
Line Blinds	60	10	200	210
Wiener Swale	20	0	0	0
Treadway Lake	50	240	700	940
Curry Lake	90	0	0	0
Big Prairie	30	240	170	410
Flynn Club	10	5	0	5
Gust Club	30	10	0	10
Meredosia Lake	80	165	180	345
Meredosia Club Impoundments	10	30	35	65
Meredosia FWS Impoundments	10	20	0	20
Upper Smith Lake	80	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	10	25	0	25
TOTAL		4,455	6,135	10,590
August 15, 2017		6,275	11,845	18,120
August 10,2017		3,395	5,870	9,265
August 3, 2017		1,425	3,235	4,660

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: August 29, 2017		Observer: Aaron Yetter & Luke Malanchuk		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	80	10	5	15
Lake Depue	60	155	30	185
Lake Depue Impoundments	10	0	0	0
Coleman Lake	100	0	0	0
Coleman Impoundment	70	0	0	0
Bureau Ponds	40	100	0	100
Goose Lake	60	650	110	760
Goose Impoundments	40	90	0	90
Senachwine Lake	90	1,725	650	2,375
Senachwine Lake Impoundments	40	100	20	120
Hennepin/Hopper	100	0	0	0
Swan Lake	50	20	0	20
Swan Lake Impoundments	0	0	0	0
Sawmill Lake	90	300	0	300
Sawmill Lake Impoundments	10	0	0	0
Billsbach Lake	70	5	0	5
Weis Lake	60	450	100	550
Sparland	80	20	5	25
Wightman Lake	90	55	0	55
Wightman Lake Impoundments	10	0	0	0
Sawyer Slough	50	0	40	40
Hitchcock Slough	60	0	0	0
Hitchcock Impoundment	80	0	0	0
Babbs Slough	90	35	0	35
Atchison Impoundment	10	0	0	0
Meadow Lake	90	85	5	90
Douglas Lake	40	15	0	15
Oberhelman Impoundment West	10	0	0	0
Rice Pond Impoundments East	60	0	0	0
Goose Lake	90	415	300	715
Upper Peoria	90	175	0	175
Lower Peoria	100	0	0	0
Pekin/Worley Lake	30	35	0	35
Spring Lake	100	0	0	0
Spring Lake Bottoms	10	0	0	0
Goose Lake	90	70	155	225
Hate Levee Impoundment	20	70	0	70
Woodyard Impoundments	10	35	0	35
Rice Lake	90	5	5	10
Ridge Field	0	0	0	0
Barton Field	10	0	0	0
Big Lake	90	75	85	160
Big Lake Impoundments	10	5	0	5
Banner Marsh	90	15	0	15
Banner Marsh Impoundments	10	0	0	0
Clear Lake	80	270	140	410
Clear Lake Impoundments	30	25	20	45
North Pool	50	250	750	1,000
South Pool	50	1,975	830	2,805
Quiver Lake	70	35	5	40
Quiver Lake Impoundments	50	5	0	5
Thompson/Flag Lake	80	1,035	490	1,525
North Globe	30	95	55	150
Dickson Mounds	100	0	5	5
South Globe	20	345	205	550
Wilder/Bellrose	10	10	0	10
Spoon River Btms	10	0	0	0
Matanzas Lake	90	40	0	40
Matanzas Lake Impoundments	10	0	0	0
Bath Lake	40	350	350	700
Moscow Bay	40	1,275	225	1,500
Moscow Bay Impoundments	10	125	10	135
Jack Lake	90	10	0	10
Grass Lake	90	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	30	200	80	280
West Point	0	0	0	0
Snicarte Slough	50	70	0	70
Ingram Lake	90	5	30	35
Lower 40 Impoundments	0	0	0	0
Chain Lake	80	10	60	70
Stewart Lake	90	135	20	155
Bur Oak Island	10	35	155	190
Crane Lake	90	0	0	0
Rainbow/Crane Impoundments	30	0	10	10
IRC Impoundments	0	0	0	0
Otter Lake	80	180	10	190
Mound Lake Impoundments	10	60	0	60
Staley Impoundment	20	0	10	10
Barkhausen Impoundments	10	40	0	40
Oklahoma Impoundments	10	0	0	0
Sanganois Impoundments	10	0	0	0
Sanganois	30	0	0	0
Line Blinds	60	0	0	0
Wiener Swale	10	0	0	0
Treadway Lake	70	275	110	385
Curry Lake	90	0	0	0
Big Prairie	30	185	165	350
Flynn Club	10	0	0	0
Gust Club	10	30	0	30
Meredosia Lake	90	110	35	145
Meredosia Club Impoundments	10	0	0	0
Meredosia FWS Impoundments	20	20	30	50
Upper Smith Lake	90	15	0	15
Lower Smith Lake	100	0	0	0
Spunky Bottoms	10	45	0	45
TOTAL		11,975	5,310	17,285
August 24, 2017		4,455	6,135	10,590
August 15, 2017		6,275	11,845	18,120
August 10,2017		3,395	5,870	9,265
August 3, 2017		1,425	3,235	4,660

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: April 25, 2018		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	70	5	0	5
Lake Depue	90	0	0	0
Lake Depue Impoundments	20	5	10	15
Coleman Lake	100	0	0	0
Coleman Impoundment	40	40	0	40
Bureau Ponds	40	20	0	20
Goose Lake	80	15	0	15
Goose Impoundments	70	0	0	0
Senachwine Lake	100	0	0	0
Senachwine Lake Impoundments	60	40	100	140
Hennepin/Hopper	90	15	0	15
Swan Lake	70	0	0	0
Swan Lake Impoundments	60	50	100	150
Sawmill Lake	100	0	0	0
Sawmill Lake Impoundments	40	10	5	15
Billsbach Lake	90	0	0	0
Weis Lake	100	5	0	5
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Wightman Lake Impoundments	20	10	0	10
Sawyer Slough	100	0	0	0
Hitchcock Slough	100	0	0	0
Hitchcock Impoundment	30	15	5	20
Babbs Slough	100	0	0	0
Atchison Impoundment	20	20	200	220
Meadow Lake	100	0	0	0
Douglas Lake	100	0	0	0
Oberhelman Impoundment West	100	0	0	0
Rice Pond Impoundments East	100	5	10	15
Goose Lake	100	0	0	0
Upper Peoria	100	0	0	0
Lower Peoria	100	0	0	0
Pekin/Worley Lake	100	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	70	75	0	75
Goose Lake	100	0	0	0
Hate Levee Impoundment	100	0	0	0
Woodyard Impoundments	100	0	0	0
Rice Lake	100	0	0	0
Ridge Field	20	30	0	30
Barton Field	10	0	5	5
Big Lake	100	10	5	15
Big Lake Impoundments	100	0	0	0
Banner Marsh	80	5	0	5
Banner Marsh Impoundments	0	0	0	0
Clear Lake	100	5	0	5
Clear Lake Impoundments	90	10	0	10
North Pool	100	5	0	5
South Pool	100	0	0	0
Quiver Lake	100	0	0	0
Quiver Lake Impoundments	100	0	0	0
Thompson/Flag Lake	80	65	5	70
North Globe	60	10	0	10
Dickson Mounds	100	0	0	0
South Globe	70	5	0	5
Wilder/Bellrose	30	5	5	10
Spoon River Btms	10	15	0	15
Matanzas Lake	100	0	0	0
Matanzas Lake Impoundments	60	5	0	5
Bath Lake	90	0	0	0
Moscow Bay	100	0	0	0
Moscow Bay Impoundments	90	0	5	5
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	100	0	0	0
West Point	10	20	0	20
Snicarte Slough	100	0	0	0
Ingram Lake	100	0	0	0
Lower 40 Impoundments	70	0	0	0
Chain Lake	100	0	0	0
Stewart Lake	100	0	0	0
Bur Oak Island	80	0	30	30
Crane Lake	100	0	0	0
Rainbow/Crane Impoundments	90	0	10	10
IRC Impoundments	30	10	0	10
Otter Lake	100	0	0	0
Mound Lake Impoundments	100	0	0	0
Staley Impoundment	100	0	0	0
Barkhausen Impoundments	90	50	0	50
Oklahoma Impoundments	100	0	0	0
Sanganois Impoundments	10	10	130	140
Sanganois	70	170	5	175
Line Blinds	100	0	0	0
Wiener Swale	100	0	0	0
Treadway Lake	90	0	0	0
Curry Lake	100	0	0	0
Big Prairie	60	75	125	200
Flynn Club	80	0	20	20
Gust Club	90	5	0	5
Meredosia Lake	100	5	0	5
Meredosia Club Impoundments	90	55	0	55
Meredosia FWS Impoundments	90	5	15	20
Upper Smith Lake	100	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	70	10	0	10
TOTAL		915	790	1,705

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: May 4, 2018		Observer: Aaron Yetter		
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	70	0	0	0
Lake Depue	70	10	5	15
Lake Depue Impoundments	20	10	0	10
Coleman Lake	90	0	10	10
Coleman Impoundment	20	0	0	0
Bureau Ponds	10	0	10	10
Goose Lake	80	10	0	10
Goose Impoundments	70	70	55	125
Senachwine Lake	100	0	0	0
Senachwine Lake Impoundments	10	5	20	25
Hennepin/Hopper	100	15	10	25
Swan Lake	70	10	30	40
Swan Lake Impoundments	10	0	5	5
Sawmill Lake	100	0	0	0
Sawmill Lake Impoundments	20	0	5	5
Billsbach Lake	90	15	10	25
Weis Lake	100	5	5	10
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Wightman Lake Impoundments	20	0	5	5
Sawyer Slough	80	0	0	0
Hitchcock Slough	90	0	0	0
Hitchcock Impoundment	80	0	0	0
Babbs Slough	100	5	0	5
Atchison Impoundment	20	0	0	0
Meadow Lake	100	20	0	20
Douglas Lake	80	10	20	30
Oberhelman Impoundment West	100	0	0	0
Rice Pond Impoundments East	100	10	0	10
Goose Lake	90	10	25	35
Upper Peoria	100	0	5	5
Lower Peoria	100	0	0	0
Pekin/Worley Lake	70	5	0	5
Spring Lake	100	0	5	5
Spring Lake Bottoms	70	55	0	55
Goose Lake	90	0	10	10
Hate Levee Impoundment	80	5	0	5
Woodyard Impoundments	80	105	5	110
Rice Lake	100	5	0	5
Ridge Field	20	0	0	0
Barton Field	10	0	0	0
Big Lake	90	10	0	10
Big Lake Impoundments	100	0	0	0
Banner Marsh	90	0	0	0
Banner Marsh Impoundments	0	0	0	0
Clear Lake	80	80	25	105
Clear Lake Impoundments	60	360	50	410
North Pool	80	80	25	105
South Pool	90	25	25	50
Quiver Lake	90	0	0	0
Quiver Lake Impoundments	70	5	10	15
Thompson/Flag Lake	70	45	45	90
North Globe	60	20	5	25
Dickson Mounds	100	0	0	0
South Globe	60	5	20	25
Wilder/Bellrose	20	15	10	25
Spoon River Btms	0	0	0	0
Matanzas Lake	90	0	0	0
Matanzas Lake Impoundments	20	30	0	30
Bath Lake	80	20	15	35
Moscow Bay	100	0	0	0
Moscow Bay Impoundments	90	5	0	5
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	80	25	60	85
West Point	10	0	0	0
Snicarte Slough	70	5	0	5
Ingram Lake	100	0	0	0
Lower 40 Impoundments	50	50	0	50
Chain Lake	90	5	45	50
Stewart Lake	90	0	0	0
Bur Oak Island	80	0	0	0
Crane Lake	90	5	0	5
Rainbow/Crane Impoundments	80	5	0	5
IRC Impoundments	20	10	0	10
Otter Lake	100	5	0	5
Mound Lake Impoundments	90	5	0	5
Staley Impoundment	80	0	0	0
Barkhausen Impoundments	90	0	0	0
Oklahoma Impoundments	100	0	0	0
Sanganois Impoundments	20	0	0	0
Sanganois	70	60	5	65
Line Blinds	100	0	0	0
Wiener Swale	90	10	0	10
Treadway Lake	70	70	10	80
Curry Lake	100	0	0	0
Big Prairie	60	10	25	35
Flynn Club	90	0	0	0
Gust Club	80	0	0	0
Meredosia Lake	90	5	15	20
Meredosia Club Impoundments	70	5	0	5
Meredosia FWS Impoundments	80	10	10	20
Upper Smith Lake	100	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	20	5	0	5
TOTAL		1,370	640	2,010

4/25/2018		915	790	1,705

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: May 7, 2018		Observer: Aaron Yetter, Luke Malanchuk		Havana River Gauge 11.13 ft
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	70	5	5	10
Lake Depue	80	15	5	20
Lake Depue Impoundments	10	0	20	20
Coleman Lake	100	0	0	0
Coleman Impoundment	20	0	10	10
Bureau Ponds	10	0	5	5
Goose Lake	80	15	0	15
Goose Impoundments	70	55	30	85
Senachwine Lake	100	0	20	20
Senachwine Lake Impoundments	20	5	0	5
Hennepin/Hopper	100	0	0	0
Swan Lake	80	5	5	10
Swan Lake Impoundments	20	0	0	0
Sawmill Lake	100	5	0	5
Sawmill Lake Impoundments	60	10	0	10
Billsbach Lake	90	0	0	0
Weis Lake	100	5	0	5
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Wightman Lake Impoundments	20	0	0	0
Sawyer Slough	90	5	0	5
Hitchcock Slough	90	0	0	0
Hitchcock Impoundment	70	0	0	0
Babbs Slough	90	10	15	25
Atchison Impoundment	10	0	0	0
Meadow Lake	90	5	0	5
Douglas Lake	80	35	5	40
Oberhelman Impoundment West	100	0	0	0
Rice Pond Impoundments East	100	5	10	15
Goose Lake	90	10	10	20
Upper Peoria	100	15	0	15
Lower Peoria	100	5	0	5
Pekin/Worley Lake	100	0	0	0
Spring Lake	100	0	5	5
Spring Lake Bottoms	70	35	20	55
Goose Lake	90	0	25	25
Hate Levee Impoundment	90	5	50	55
Woodyard Impoundments	70	10	80	90
Rice Lake	100	0	0	0
Ridge Field	10	10	5	15
Barton Field	10	0	0	0
Big Lake	90	10	10	20
Big Lake Impoundments	70	20	40	60
Banner Marsh	100	0	5	5
Banner Marsh Impoundments	10	10	0	10
Clear Lake	80	55	35	90
Clear Lake Impoundments	60	55	400	455
North Pool	90	25	145	170
South Pool	90	60	85	145
Quiver Lake	100	0	0	0
Quiver Lake Impoundments	70	0	5	5
Thompson/Flag Lake	70	80	130	210
North Globe	30	10	20	30
Dickson Mounds	100	0	0	0
South Globe	40	25	245	270
Wilder/Bellrose	10	30	70	100
Spoon River Btms	0	0	0	0
Matanzas Lake	100	0	0	0
Matanzas Lake Impoundments	30	0	5	5
Bath Lake	70	30	80	110
Moscow Bay	100	0	0	0
Moscow Bay Impoundments	80	5	5	10
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	70	30	115	145
West Point	0	0	0	0
Snicarte Slough	90	0	45	45
Ingram Lake	100	0	0	0
Lower 40 Impoundments	50	40	90	130
Chain Lake	90	0	5	5
Stewart Lake	100	0	0	0
Bur Oak Island	70	15	150	165
Crane Lake	90	0	0	0
Rainbow/Crane Impoundments	80	0	30	30
IRC Impoundments	20	5	10	15
Otter Lake	100	0	0	0
Mound Lake Impoundments	90	10	30	40
Staley Impoundment	90	10	0	10
Barkhausen Impoundments	90	0	0	0
Oklahoma Impoundments	100	0	0	0
Sanganois Impoundments	10	10	100	110
Sanganois	70	15	30	45
Line Blinds	100	0	0	0
Wiener Swale	90	0	0	0
Treadway Lake	80	15	10	25
Curry Lake	100	0	0	0
Big Prairie	60	35	5	40
Flynn Club	80	5	0	5
Gust Club	70	10	5	15
Meredosia Lake	80	10	50	60
Meredosia Club Impoundments	60	0	0	0
Meredosia FWS Impoundments	60	40	55	95
Upper Smith Lake	100	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	50	10	40	50
TOTAL		945	2,375	3,320

4/25/2018		915	790	1,705
5/4/2018		1,370	640	2,010

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: May 14, 2018		Observer: Aaron Yetter	Havana River Gauge 9.17 ft	
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	70	0	0	0
Lake Depue	80	0	0	0
Lake Depue Impoundments	10	0	0	0
Coleman Lake	100	0	0	0
Coleman Impoundment	20	10	0	10
Bureau Ponds	10	0	0	0
Goose Lake	90	0	20	20
Goose Impoundments	50	20	30	50
Senachwine Lake	100	0	0	0
Senachwine Lake Impoundments	10	5	10	15
Hennepin/Hopper	100	0	5	5
Swan Lake	70	0	5	5
Swan Lake Impoundments	10	0	0	0
Sawmill Lake	90	0	5	5
Sawmill Lake Impoundments	30	0	5	5
Billsbach Lake	90	5	10	15
Weis Lake	90	0	0	0
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Wightman Lake Impoundments	10	0	0	0
Sawyer Slough	90	0	0	0
Hitchcock Slough	90	0	0	0
Hitchcock Impoundment	70	0	0	0
Babbs Slough	100	0	10	10
Atchison Impoundment	10	0	0	0
Meadow Lake	100	0	0	0
Douglas Lake	80	10	10	20
Oberhelman Impoundment West	100	0	0	0
Rice Pond Impoundments East	100	5	0	5
Goose Lake	90	0	0	0
Upper Peoria	100	0	5	5
Lower Peoria	100	0	0	0
Pekin/Worley Lake	70	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	50	0	200	200
Goose Lake	90	0	5	5
Hate Levee Impoundment	40	0	15	15
Woodyard Impoundments	20	20	0	20
Rice Lake	100	0	0	0
Ridge Field	10	0	0	0
Barton Field	10	0	0	0
Big Lake	90	0	0	0
Big Lake Impoundments	50	0	0	0
Banner Marsh	100	0	0	0
Banner Marsh Impoundments	10	0	0	0
Clear Lake	90	5	185	190
Clear Lake Impoundments	60	5	60	65
North Pool	90	25	85	110
South Pool	90	10	120	130
Quiver Lake	90	0	0	0
Quiver Lake Impoundments	60	0	10	10
Thompson/Flag Lake	70	90	155	245
North Globe	30	50	800	850
Dickson Mounds	100	0	0	0
South Globe	30	10	130	140
Wilder/Bellrose	10	5	10	15
Spoon River Btms	0	0	0	0
Matanzas Lake	90	0	0	0
Matanzas Lake Impoundments	10	0	0	0
Bath Lake	60	5	50	55
Moscow Bay	100	0	5	5
Moscow Bay Impoundments	90	0	40	40
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	40	10	30	40
West Point	0	0	0	0
Snicarte Slough	90	10	5	15
Ingram Lake	90	30	10	40
Lower 40 Impoundments	50	30	105	135
Chain Lake	90	0	5	5
Stewart Lake	100	0	0	0
Bur Oak Island	70	0	0	0
Crane Lake	100	0	0	0
Rainbow/Crane Impoundments	30	10	50	60
IRC Impoundments	10	5	0	5
Otter Lake	100	0	0	0
Mound Lake Impoundments	90	0	105	105
Staley Impoundment	90	0	0	0
Barkhausen Impoundments	80	0	0	0
Oklahoma Impoundments	100	0	0	0
Sanganois Impoundments	10	0	0	0
Sanganois	80	0	5	5
Line Blinds	90	0	0	0
Wiener Swale	90	5	0	5
Treadway Lake	70	15	5	20
Curry Lake	100	0	0	0
Big Prairie	60	60	130	190
Flynn Club	80	20	50	70
Gust Club	70	0	0	0
Meredosia Lake	80	0	0	0
Meredosia Club Impoundments	60	10	20	30
Meredosia FWS Impoundments	30	0	0	0
Upper Smith Lake	100	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	10	10	60	70
TOTAL		495	2,565	3,060

4/25/2018		915	790	1,705
5/4/2018		1,370	640	2,010
5/7/2018		945	2,375	3,320

ILLINOIS NATURAL HISTORY SURVEY WATERFOWL - AERIAL SHOREBIRD SURVEY				
Date: May 18, 2018		Observer: Aaron Yetter	Havana River Gauge 11.45 ft	
LOCATION	% Wet	Big (Killdeer and Larger)	Small (Pectoral and Smaller)	TOTAL
Turner Lake	80	0	0	0
Lake Depue	100	0	0	0
Lake Depue Impoundments	10	0	5	5
Coleman Lake	100	0	0	0
Coleman Impoundment	20	0	0	0
Bureau Ponds	30	0	30	30
Goose Lake	90	10	20	30
Goose Impoundments	60	5	230	235
Senachwine Lake	100	0	0	0
Senachwine Lake Impoundments	60	0	5	5
Hennepin/Hopper	100	5	0	5
Swan Lake	90	0	0	0
Swan Lake Impoundments	10	0	0	0
Sawmill Lake	100	0	0	0
Sawmill Lake Impoundments	30	0	0	0
Billsbach Lake	100	0	0	0
Weis Lake	100	0	0	0
Sparland	100	0	0	0
Wightman Lake	100	0	0	0
Wightman Lake Impoundments	20	5	0	5
Sawyer Slough	100	0	5	5
Hitchcock Slough	100	0	0	0
Hitchcock Impoundment	70	5	0	5
Babbs Slough	100	0	0	0
Atchison Impoundment	20	5	0	5
Meadow Lake	100	0	0	0
Douglas Lake	90	0	5	5
Oberhelman Impoundment West	100	0	0	0
Rice Pond Impoundments East	100	0	5	5
Goose Lake	90	15	5	20
Upper Peoria	100	5	5	10
Lower Peoria	100	0	0	0
Pekin/Worley Lake	100	0	0	0
Spring Lake	100	0	0	0
Spring Lake Bottoms	50	35	60	95
Goose Lake	90	0	10	10
Hate Levee Impoundment	60	15	0	15
Woodyard Impoundments	50	5	5	10
Rice Lake	100	0	10	10
Ridge Field	0	0	0	0
Barton Field	10	0	0	0
Big Lake	90	5	0	5
Big Lake Impoundments	40	10	0	10
Banner Marsh	100	10	0	10
Banner Marsh Impoundments	10	0	0	0
Clear Lake	100	5	0	5
Clear Lake Impoundments	30	0	205	205
North Pool	90	5	0	5
South Pool	90	30	0	30
Quiver Lake	100	0	0	0
Quiver Lake Impoundments	80	0	15	15
Thompson/Flag Lake	70	115	80	195
North Globe	30	40	960	1,000
Dickson Mounds	100	0	0	0
South Globe	30	10	85	95
Wilder/Bellrose	10	20	35	55
Spoon River Btms	0	0	0	0
Matanzas Lake	100	0	0	0
Matanzas Lake Impoundments	10	0	10	10
Bath Lake	60	20	50	70
Moscow Bay	100	0	0	0
Moscow Bay Impoundments	90	0	0	0
Jack Lake	100	0	0	0
Grass Lake	100	0	0	0
Anderson Lake	100	0	0	0
Carlson Unit	30	0	50	50
West Point	0	0	0	0
Snicarte Slough	90	0	50	50
Ingram Lake	100	0	0	0
Lower 40 Impoundments	30	20	0	20
Chain Lake	100	0	0	0
Stewart Lake	100	0	0	0
Bur Oak Island	60	0	40	40
Crane Lake	90	5	10	15
Rainbow/Crane Impoundments	30	10	0	10
IRC Impoundments	10	5	0	5
Otter Lake	100	0	0	0
Mound Lake Impoundments	90	0	40	40
Staley Impoundment	90	0	0	0
Barkhausen Impoundments	90	0	0	0
Oklahoma Impoundments	100	0	0	0
Sanganois Impoundments	10	0	5	5
Sanganois	80	0	0	0
Line Blinds	100	0	0	0
Wiener Swale	90	0	20	20
Treadway Lake	90	0	0	0
Curry Lake	100	0	0	0
Big Prairie	50	5	10	15
Flynn Club	70	0	5	5
Gust Club	80	0	0	0
Meredosia Lake	90	10	0	10
Meredosia Club Impoundments	60	0	20	20
Meredosia FWS Impoundments	40	0	0	0
Upper Smith Lake	100	0	0	0
Lower Smith Lake	100	0	0	0
Spunky Bottoms	60	15	0	15
TOTAL		450	2,090	2,540

4/25/2018		915	790	1,705
5/4/2018		1,370	640	2,010
5/7/2018		945	2,375	3,320
5/14/2018		495	2,565	3,060

Submitted by:

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Illinois Natural History Survey

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