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DENSITY, ABUNDANCE, AND HABITAT ASSOCIATIONS OF THE INLAND SWAMP SPARROW (*MELOSPIZA GEORGIANA GEORGIANA*) IN IOWA

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ABSTRACT.—Wetlands continue to decline throughout North America and the Prairie Pothole Region, thus emphasizing the importance of understanding population trends and habitat associations of wetland species to ensure effective conservation and habitat management of those species. We estimated density and abundance and evaluated habitat associations of the Inland Swamp Sparrow (*Melospiza georgiana georgiana*) in Iowa. We conducted standardized distance sampling surveys for Swamp Sparrows and measured habitat characteristics at 307 wetlands in two regions of Iowa in 2009 and 2010. We used Program Distance to model detection probability and estimate region-specific breeding densities of Swamp Sparrows at Iowa wetlands. We then extrapolated density estimates to the total area of wetlands in each region to obtain estimates of breeding abundance. We correlated Swamp Sparrow counts to nine habitat variables using Poisson regression in Program R. Swamp Sparrow counts were positively correlated with percent cover of cattail (*Typha* spp.) and water depth (cm) and negatively correlated with percent cover of woody vegetation, vegetation size (m), and wetland size (ha). We estimated breeding densities of Swamp Sparrows to be 1.488 birds/ha (95% CI = 1.308 − 1.692) in region 1 (Des Moines Lobe landform) and 0.041 birds/ha (95% CI = 0.006 − 0.275) in region 2 (remainder of the state). Our results, in comparison to those of other studies, indicate that Swamp Sparrows associate with a variety of wetland characteristics depending upon what is available. Swamp Sparrows are relatively uncommon breeders in Iowa, and our work confirms that most occur in the Des Moines Lobe landform in north-central and northwestern Iowa. Biologists and land managers should incorporate our findings on this species' habitat associations into management activities to ensure that Swamp Sparrow populations persist into the future. *Received 5 January 2015. Accepted 30 April 2015.*

Key words: density, habitat association, marsh bird, Prairie Pothole Region, Program Distance, Swamp Sparrow, wetland.

The Inland Swamp Sparrow (*Melospiza georgiana georgiana*; hereafter Swamp Sparrow) breeds in freshwater marshes east of a line from eastern South Dakota south to eastern Nebraska and extending east to eastern Pennsylvania and West Virginia (Mowbray 1997). In Iowa, the Swamp Sparrow breeds in a variety of marsh habitats ranging from temporary marshes dominated by reed canary grass (*Phalaris arundinacea*) and cattail (*Typha* spp.) to semi-permanent and permanent wetlands dominated by cattail, bulrush (*Scirpus* spp.), sedges (*Carex* spp.) and other woody vegetation (TMH, pers. obs.). It is one of three subspecies of Swamp Sparrow (the others are Southern Swamp Sparrow [*M. georgiana ericrypta*] and Coastal Plain Swamp Sparrow [*M. georgiana nigrescens*]), all of which differ in the extent of their breeding range (Greenberg and Droege 1990, Mowbray 1997), breeding season habitat requirements (Greenberg and Droege 1990, Mowbray 1997, Beadell et al. 2003), plumage (Greenberg et al. 1998), and song (Liu et al. 2008). Despite a slightly increasing population trend according to the North American Breeding Bird Survey (BBS; Sauer et al. 2014), the Swamp Sparrow is still listed as a species in need of long-term conservation and planning by Partners in Flight (Rich et al. 2004).

Few studies have estimated density or abundance and evaluated habitat associations of the Swamp Sparrow (Fairbairn and Dinsmore 2001, Riffell et al. 2001). Wetland losses appear to be slowing across much of the U.S. (Dahl 2011), but the Prairie Pothole Region (PPR) is still experiencing substantial loss of prairie wetlands primarily due to agricultural development (Dahl 2014). Several wetland dependent species are experiencing population declines and are of conservation concern as a result of this loss of wetland habitats on the landscape (Quesnelle et al. 2013). In addition, there is still some uncertainty as to how an increasingly changing climate will affect wetlands across the PPR. Models predict that wetlands in the western portion of the PPR will experience reduced water levels or complete drying, whereas wetlands in the eastern portion of the PPR will experience

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TABLE 1. Number of wetlands surveyed for Swamp Sparrows in each size class in Iowa, 2009–2010.

Size class (ha)	Number of wetlands visited	
	2009	2010
≤5	20	30
>5 and ≤10	21	35
>10 and ≤20	28	39
>20 and ≤30	20	28
>30 and ≤40	11	11
>40	30	34
Total	130	177

deeper water and increased persistence on the landscape (Johnson et al. 2005). Given the population declines of other wetland dependent birds and the uncertain future of prairie wetlands throughout the Midwest, it is important to increase our knowledge of populations and habitat associations of the Swamp Sparrow in this region of the U.S. to better inform long-term conservation and planning efforts for this species.

The objective of our study was twofold: 1) to estimate density and abundance of the Swamp Sparrow at wetlands in Iowa, and 2) evaluate habitat associations of the Swamp Sparrow in Iowa.

METHODS

Wetland Selection and Point Placement.—We surveyed for breeding Swamp Sparrows at wetlands across Iowa during two breeding seasons as part of a larger study of secretive marsh birds. Wetlands to be surveyed were selected from the National Wetlands Inventory database (NWI; USFWS 2009). We considered all wetlands in the Aquatic Bed (AB), Emergent (EM), and Unconsolidated Bottom (UB) classes of the Palustrine system (n = 15,046) for selection because these classes included approximately 95% of the wetlands in Iowa and many contained potential habitat for Swamp Sparrows (Cowardin et al. 1979). We first stratified wetlands into six different classes by size (ha) to allow for equal representation of wetlands of all sizes. Those size classes included: ≤5 ha, >5 and ≤10 ha, >10 and ≤20 ha, >20 and ≤30 ha, >30 and ≤40 ha, and >40 ha. We used Hawth's Analysis Tools (Beyer 2004) in ArcGIS (v. 9.3; ESRI 2008) to randomly select an equal number of wetlands within each size class (Table 1). Wetland size ranged from 0.1 ha to 156 ha. We selected both natural and constructed wetlands and only considered wetlands on public land for ease of access. Surveyed wetlands had a mean water depth of 30 cm (±1 cm) and supported vegetation communities that consisted of cattail (*Typha* spp.), sedge (*Carex* spp.), bulrush (*Scirpus* spp.), and reed canary grass (*Phalaris arundinacea*). We surveyed primarily permanent or semi-permanent wetlands, but some temporary and seasonal wetlands were also surveyed (Stewart and Kantrud 1971).

After wetland selection, we randomly assigned a fixed number of survey points to each wetland by size class. We assigned 1 point to all wetlands in the ≤5 ha and >5 and ≤10 ha size classes, 2 points to all wetlands in the >10 and ≤20 ha size class, 3 points to all wetlands in the >20 and ≤30 ha size class, 4 points to all wetlands in the >30 and ≤40 ha size class, and 5 points to all wetlands in the >40 ha size class. To obtain adequate coverage of all wetlands and to avoid double counting birds, we placed points ≥400 m apart (Conway 2011). Survey points in smaller wetlands (<10 ha) were placed primarily near the wetland edge due to the decreased amount of wetland interior. Survey points were placed both along the wetland edge and in the wetland interior in larger wetlands. We accessed survey points primarily by foot, but some points were accessed by canoe in the larger, deeper wetlands.

Habitat Measurements.—Immediately prior to conducting bird surveys we measured habitat variables at both the survey point and within 50 m of the survey point depending upon the variable being measured (Conway 2011). We measured water depth (cm) and maximum vegetation height immediately at the survey point (within 1 m). We measured maximum vegetation height from the surface, which was either ground or the water surface, and assigned the measurement to one of three size classes (1 = 0.0–0.5 m, 2 = 0.5–1.0 m, and 3 = >1.0 m). We visually estimated percent cover of the major vegetation types (cattail, bulrush, sedge, reed canary grass, and woody) in 5% increments within a 50 m radius of the survey point. We also estimated the percent cover of open water within a 50 m radius of the survey point.

Bird Surveys.—We conducted 10-min point counts for Swamp Sparrows from 16 May to 15 July 2009 and from 20 April to 10 July 2010 using an unlimited detection radius. We conducted surveys both in the morning (30 min before sunrise to 3 hrs after sunrise) and evening (3 hrs before sunset to 30 min after sunset). Because we detected 47% of Swamp Sparrows during evening surveys, we assumed there was no difference in detection probably between morning and evening surveys and used observations from both survey periods for our analysis. We conducted surveys at a total of 307 wetlands in both 2009 and 2010 (Table 1); 56 wetlands were surveyed four times in 2010 as part of a different study evaluating temporal variation in detection probability of marsh birds (see Harms and Dinsmore 2014) and the remaining 251 wetlands were surveyed once in either 2009 or 2010. For the 56 wetlands surveyed four times, we considered only visits that were >1 week apart for analysis to ensure independence between visits. We selected wetlands with replacement, so wetlands surveyed in 2009 may have been surveyed again in 2010. We assumed that visits to the same wetland in different years were independent because the population at any given wetland is not closed between years (i.e., Swamp Sparrows emigrate in fall). We also assumed points within wetlands were independent because they were placed $\geq$400 m apart (Conway 2011). Those 56 wetlands that were surveyed four times were randomly selected using the same procedure described above but limited to the Des Moines Lobe of Iowa (Prior 1991) for logistical reasons. These wetlands were likely representative of most ($>$95%) of the wetlands found in Iowa. We recorded all detections (visual and auditory) of Swamp Sparrows and measured the linear distance (m) to each detection using a Nikon ProStaff 550 laser rangefinder (Nikon Corp., Tokyo, Japan). To satisfy the assumption of distance sampling, we recorded a bird only once when it was first detected and did not record subsequent detections of the same bird at the same point or at subsequent points. Prior to each point count, we measured temperature (°C) and wind speed (bft) using a Weather Kestrel 4,000 handheld weather recording device (KestrelMeters.com, Birmingham, MI, USA) and visually estimated percent cloud cover. We did not conduct bird surveys during rain events or during periods of strong winds ($\geq$3 bft; Conway 2011).

Data Analyses.—We used Program Distance (ver. 6.2; Thomas et al. 2010) to estimate density and detection probability of Swamp Sparrows at wetlands across Iowa. Program Distance models detection probability as a function of linear distance between the observer and the detected bird using an inverse relationship between detection probability and distance (Thomas et al. 2010). We evaluated the distribution of raw distances and categorized those distances into two bins

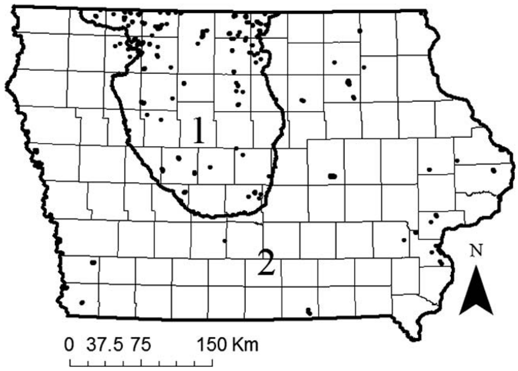

FIG. 1. Locations of wetlands surveyed for Swamp Sparrow within each of two regions in Iowa, 2009–2010.

(0–50 m and 50–100 m) to minimize error in recorded distances (Buckland et al. 2001). We truncated all distances above 100 m because they did not contribute additional information to the model. Previous studies have shown that factors such as wind speed and observer can affect detection probability of wetland birds (Conway and Gibbs 2001). Therefore, we individually modeled wind speed, temperature, cloud cover, and observer on detection probability. For models without covariates, we modeled the detection function using the conventional distance sampling (CDS) engine and considered four models best suited for detection functions (Buckland et al. 2001, Thomas et al. 2010): 1) uniform key function with a cosine expansion, 2) uniform key function with a simple polynomial expansion, 3) half-normal key function with a Hermite polynomial expansion, and 4) hazard-rate key function with a cosine expansion. For models with covariates, we modeled the detection function using the multiple covariate distance sampling (MCDS) engine and considered only the half-normal key function with cosine expansion (Marques and Buckland 2003). We selected the best-supported model using Akaike's Information Criterion (AIC; Akaike 1973). Because of the small number of detections in 2009, we pooled data from both years for analysis. We truncated the data to observations after 15 May to include only breeding birds and no migrants. Because the breeding range of the Swamp Sparrow extends mainly into the Des Moines Lobe landform of Iowa (Mowbray 1997), we post-stratified wetlands into two groups: the Des Moines Lobe landform (region 1) and the remainder of the state (region 2;

TABLE 2. Summary of habitat variables (mean ± SD) by year at surveyed wetlands in Iowa, 2009–2010.

Variable	2009	2010
Percent cover of water	21.05 (± 13.82)	26.76 (± 18.07)
Percent cover of bulrush	31.58 (± 21.73)	30.97 (± 24.71)
Percent cover of cattail	50.71 (± 25.47)	57.97 (± 25.53)
Percent cover of sedge	25.87 (± 13.82)	21.86 (± 16.25)
Percent cover of reed canary grass	24.78 (± 15.82)	28.34 (± 22.95)
Percent cover of woody vegetation	12.81 (± 7.88)	18.52 (± 12.28)
Water depth (cm)	30.12 (± 26.51)	34.56 (± 28.00)
Vegetation size (categorical 1, 2, or 3)	2.65 (± 0.59)	2.85 (± 0.42)

Fig. 1). We then estimated density separately for each region using the global detection function.

Using the total wetland area from which we drew our sample of surveyed wetlands and the density estimate from the best supported model, we extrapolated breeding abundance of Swamp Sparrows in Iowa. We extrapolated breeding abundance of Swamp Sparrows for each region separately. We calculated total wetland area (ha) for each region in ArcGIS (ver. 9.3; ESRI 2008) using the NWI database from which we drew our sample of surveyed wetlands. The NWI database from which we drew our sample contained all wetlands in Iowa through 2002. We have no information on whether or not wetlands identified in the NWI still exist on the landscape. However, each wetland we selected to visit was still present. We report abundance (95% CI) as birds per hectare.

We evaluated habitat associations of Swamp Sparrows by relating Swamp Sparrow counts at each point to habitat variables at each point using Poisson regression (Vincent and Haworth 1983). We constructed a global model that included the nine above-mentioned habitat variables we wished to evaluate based on our knowledge of this species in Iowa and on a review of the literature. We also constructed models to evaluate each habitat variable individually resulting in a total of 10 candidate models in the model set. We evaluated models using Akaike's Information Criterion (AIC; Akaike 1973) adjusted for small sample sizes (AIC_c) and considered models with $\Delta AIC_c \leq 2$ to have strong support (Burnham and Anderson 2002). Prior to constructing models, we assessed correlation among habitat variables by constructing a correlation matrix. We fit models using the generalized linear model (GLM) function in Program R (R Core Team 2014). Again, we truncated the data to observations after 15 May to include only breeding birds.

RESULTS

We surveyed 247 wetlands in region 1 and 60 wetlands in region 2. We detected Swamp Sparrows at 37 total wetlands (28%) in 2009 and 102 total wetlands (58%) in 2010, which included detections at 65 points in 2009 and 221 points in 2010. We detected a total of 910 Swamp Sparrows at wetlands across Iowa in 2009 and 2010 with the most (n = 286) at wetlands in the >10 and ≤20 ha size class (n = 51) and the fewest (n = 38) at wetlands in the ≤5 ha size class (n = 28). Of the 910 total Swamp Sparrows, 885 were detected at wetlands in region 1 and only 25 at wetlands in region 2. On average, we detected 0.66 birds/ha at surveyed wetlands in 2009 and 2010. The total area of wetlands from which we drew our sample in region 1 was 8,913 ha with a mean of 1.75 ha (SD = 7.77 ha, n = 5,079) and in region 2 was 21,035 ha with a mean of 2.16 ha (SD = 16.01 ha, n = 9,744).

The best-supported habitat model was the global model that included all nine habitat variables. No other models were supported. Swamp Sparrow counts were positively correlated with percent cover of cattail (β = 0.034, SE = 0.007, $P <$ 0.001) and water depth (β = 0.031, SE = 0.007, $P < 0.001$). Swamp Sparrow counts were negatively correlated with percent cover of woody vegetation (β = −0.022, SE = 0.008, P = 0.010), vegetation size (β = −2.71, SE = 0.758, $P < 0.001$), and wetland size (β = −0.013, SE = 0.003, $P < 0.001$). Measurements of habitat variables are summarized by year and illustrate that the variables did not differ between the years (Table 2).

The best-supported density model for Swamp Sparrow was the half-normal key function with cosine expansion and included the covariates wind and observer on detection probability. Global detection probability of Swamp Sparrows was estimated to be 0.25 (±0.009). Detection probability was not affected by wind but differed significantly across observers. Density of Swamp Sparrows was estimated to be 1.488 birds/ha (95% CI = 1.308 – 1.692) in region 1 (Des Moines Lobe) and 0.041

birds/ha (95% CI = 0.006 – 0.275) in region 2 (the remainder of the state). We estimated breeding abundance of Swamp Sparrows in region 1 to be 13,262 birds (95% CI = 11,658–15,081) and in region 2 to be 862 birds (95% CI = 126 – 5,784).

DISCUSSION

We detected Swamp Sparrows at wetlands with a variety of habitat characteristics across Iowa. We found that counts of Swamp Sparrows were positively influenced by the percent cover of cattail. Thus, it is no surprise that Swamp Sparrows are commonly found throughout the PPR of Iowa because most of this region's seasonal, permanent, and semi-permanent wetlands contain at least a small component of cattail cover (TMH, pers. obs.). Several studies have found that Swamp Sparrows associate with wetlands with robust stands of emergent vegetation (Greenberg 1988, Fairbairn and Dinsmore 2001, Riffell et al. 2001). Swamp Sparrows will often use emergent vegetation as a substrate for nests (Mowbray 1997), thus demonstrating the importance of emergent vegetation cover for Swamp Sparrows in Iowa.

Contrary to other studies, we found Swamp Sparrow counts to be significantly lower at wetlands with increased percent cover of woody vegetation. Riffell et al. (2001) found that Swamp Sparrow abundance was positively correlated with the amount of deciduous stems and frequency of woody vegetation species. Beadell et al. (2003) found that counts of the Coastal Plain Swamp Sparrow increased with increasing shrub density in the Chesapeake and Delaware Bays. During the winter season, Swamp Sparrows again associate with areas of dense shrubs and near dense edges (Watts 1996, Baldwin et al. 2007). One possible explanation for this difference is the structure of woody vegetation along coasts compared to the structure of woody vegetation in interior wetlands. Beadell et al. (2003) observed Coastal Plains Swamp Sparrows most frequently using marsh-elder (*Iva frutescens*) and saltbush (*Baccharis halimifolia*) among others, both of which grow to an average of 6 ft (USDA NRCS 2015). Woody vegetation in Iowa wetlands typically consists of both black willow (*Salix nigra*) and sandbar willow (*Salix interior*) and eastern cottonwood (*Populus deltoides*), all of which grow to an average of 20 ft but can reach heights of up to 60 ft (USDA NRCS 2015). It is possible Inland Swamp Sparrows avoid woody vegetation in Iowa wetlands due to the height of these plants relative to other surrounding herbaceous vegetation. In addition, many of Iowa's wetlands are currently being managed to reduce the amount of shrubs and other woody vegetation (TMH, pers. obs.), and it's likely that many of Iowa's prairie wetlands were largely devoid of many shrubs. In other words, coastal wetlands likely possess a higher amount of shrub cover than inland wetlands, particularly prairie pothole wetlands found throughout most of Iowa. Therefore, our results suggest that although Swamp Sparrows frequently utilize shrubs along coasts during the breeding season where shrubs are more abundant, they use other habitat characteristics in wetlands with no or different shrub cover present.

Wetland size negatively influenced Swamp Sparrow counts at Iowa wetlands suggesting that Swamp Sparrows avoid larger wetlands. We detected the most Swamp Sparrows at wetlands in the ≥10 and <20 ha size class, which was the median size class of surveyed wetlands. Riffell et al. (2001) found Swamp Sparrows to be positively associated with wetland size but negatively associated with perimeter-area ratio, a function of wetland size. In another study conducted in Iowa, perimeter-area ratio positively influenced Swamp Sparrow densities but wetland size did not influence Swamp Sparrow densities (Fairbairn and Dinsmore 2001). Although we did not measure perimeter-area ratio of wetlands for this study, we know that perimeter-area ratio increases with the number of small marshes added to a complex and with increased irregularity of marsh edges (Fairbairn and Dinsmore 2001). It is also likely that small- to intermediate-sized wetlands contain habitat characteristics such as shorter vegetation that are preferred by Swamp Sparrows. Therefore, land managers should strive to increase the number of small- to intermediate-sized wetlands on the landscape, particularly in wetland complexes.

Several studies have suggested Swamp Sparrows utilize water as a primary habitat cue and we found no different result in our study (Reinert and Golet 1979; Greenberg 1988, 1992; Greenberg and Droege 1990). Swamp Sparrow counts were positively influenced by water depth and we commonly found Swamp Sparrows at wetlands with water depths >24 cm. The difference in the number of Swamp Sparrows detected between 2009 and 2010 was likely due to the amount of precipitation received each year during the breeding season. In 2009, average precipitation in Iowa ranged from 10.01 cm (±3.76 cm) in May to

11.81 cm (±4.93 cm) in June (Iowa Environmental Mesonet 2015). In 2010, average precipitation in Iowa ranged from 10.62 cm (±4.95 cm) in May to 23.67 cm (±6.27 cm) in June (Iowa Environmental Mesonet 2015). The increased precipitation in 2010 likely led to more potential Swamp Sparrow habitat, which increased counts of breeding Swamp Sparrows that year. Swamp Sparrows feed primarily on insect larvae, adult dragonflies and damselflies, beetles, and other aquatic invertebrates. Therefore, water serves as a primary source of food for Swamp Sparrows during the breeding season (Reinert and Golet 1979). In addition, Swamp Sparrows often build nests in emergent vegetation over water, which may help reduce nest predation by land predators.

Overall, we observed most Swamp Sparrows in the transition zones of wetland to upland habitats, areas that are more heterogeneous in regards to habitat characteristics. Most singing males were observed using cattails (both dead and live) as perches, whereas the few females observed were skulking amongst shorter vegetation such as sedges and shorter cattails. These observations support our results that Swamp Sparrows in Iowa associate with shorter vegetation and increased cover of cattail as well as small- to intermediate-sized wetlands which tend to have a more pronounced transition zone with diverse habitat characteristics.

We estimated the breeding density of Swamp Sparrows to be 1.488 birds/ha in the Des Moines Lobe landform of Iowa, which is about average when compared to other studies. Baldwin et al. (2007) estimated density of overwintering Swamp Sparrows to be 4.04 birds/ha at a coastal prairie in Texas. Conversely, Beadell et al. (2003) estimated breeding densities of Coastal Plain Swamp Sparrows ranging from 16 birds/km^2 (0.16 birds/ha) to 37 birds/km^2 (0.37 birds/ha) along the Delaware Bay. To our knowledge, no study has directly estimated breeding density and abundance of the Inland Swamp Sparrow in the Midwest or other regions not cited above. We estimated the total number of breeding Swamp Sparrows in Iowa to be 14,124 birds. Assuming that most birds detected were singing males, this suggests that there are 14,124 breeding pairs of Swamp Sparrows in Iowa, 94% of which are in the Des Moines Lobe of Iowa. Although we surveyed only wetlands on public lands, we assumed wetlands on both public and private lands had similar basic characteristics (e.g., emergent vegetation, hydrology) because we selected both from the same classes within the Palustrine system (Cowardin et al. 1979). Public and private wetlands may differ in regards to management regimes (i.e., private wetlands are most likely not actively managed whereas public wetlands may be managed for hydrology or vegetation communities). However, most public wetlands are not actively managed in Iowa due to their natural state or due to lack of infrastructure (e.g., water control structures) to do so. Therefore, we assumed that both public and private wetlands share many of the same characteristics and estimated abundance based on both public and private wetlands.

In Iowa, Swamp Sparrows associate more with emergent vegetation and water depth and not with woody vegetation cover, contrary to Swamp Sparrows along Great Lakes coasts that prefer deciduous woody cover nearby (Riffell et al. 2001). In addition, our study aids in illustrating the difference in habitat associations among the three subspecies of Swamp Sparrows. Coastal Plain Swamp Sparrows prefer wetlands with dense shrub cover and little open water (Beadell et al. 2003). In Pennsylvania and Rhode Island, Swamp Sparrows associate with shallow water and emergent vegetation cover (Reinert and Golet 1979, Greenberg 1988). These studies were presumably conducted on the Southern Swamp Sparrow although neither specified the subspecies studied. Understanding differences in habitat associations among the three subspecies increases our overall biological knowledge of the species as a whole as well as allows for subspecies-specific habitat restoration and management dependent on geographic location.

Wetlands continue to decline throughout the U. S. (Dahl 2011) and PPR (Dahl 2014), and Johnson et al. (2005) illustrated that wetlands throughout the PPR will experience changes in habitat conditions in response to climate change. Wetlands in the eastern portion of the PPR will experience increased water levels and persistence on the landscape in the face of climate change (Johnson et al. 2005), two characteristics that should benefit Swamp Sparrows based on our results. However, decreased water levels in and drying of wetlands in the western portion of the PPR will likely result in reduced habitat for Swamp Sparrows (Johnson et al. 2005). Therefore, continued monitoring of Swamp Sparrow populations and suitable habitat throughout its range will be important for long-term conservation planning, and further research on habitat associations of Swamp Sparrows in other portions of its range could provide additional information on habitat restoration and management for Swamp Sparrows in the face of climate change. We recommend that land managers in Iowa preserve intermediate-sized wetlands and maintain deeper water and robust emergent vegetation communities as such wetlands. Although the Swamp Sparrow is not currently a species of concern in Iowa, biologists and land should incorporate our findings into wetland restoration and management plans to minimize the risk Swamp Sparrows becoming a species of concern in the future.

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