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TIMING OF AUTUMN MIGRATION OF SORA (*PORZANA CAROLINA*) IN MISSOURI

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ABSTRACT.—Monitoring and conserving waterbirds, including Sora (*Porzana carolina*), in Missouri, is constrained by the lack of information on migration phenology. We performed nocturnal distance sampling surveys by ATV across 11 state and federal managed wetlands in Missouri, USA from 2012–2015 to compare the timing of Sora' autumn migration among years. Migration of Sora in Missouri began in the first week of August, on average it peaked on 25 September, and continued through the last week of October. We detected migration of Sora earlier in autumn than did previous work. We found the start and end of migration did not vary annually in 3 of 4 years. With our results, wetland managers should be able to better time their management for rails in Missouri. *Received 7 July 2016. Accepted 4 February 2017.*

Key words: autumn migration, Missouri, moist soil management, Rallidae, Sora, wetlands.

Understanding the timing of a species' migration is as important as knowing the species' habitat needs and stopover ecology (Sheehy et al. 2011, Albanese and Davis 2015, Hostetler et al. 2015). Awareness regarding the time of year that habitat is needed is vital to inform habitat management, especially in highly ephemeral habitats such as palustrine emergent wetlands. Public wetlands across the central United States, including Missouri, are typically managed as migratory bird stopover habitat, with a focus on waterfowl; other wetland-dependent birds, including Sora (*Porzana carolina*), also use these habitats although the timing of their need is less well known (Melvin and Gibbs 1994, 2012; Andersson et al. 2015). The timing of autumn migration varies annually in many species and may be related to habitat availability, weather, and other variables (Richardson 1978, 1990; Krementz et al. 2012; Aagaard et al. 2015). While there is evidence that the timing of waterfowl and passerine migration has changed in response to climate change, there is no information available for Sora migration timing, which makes it difficult to predict how, or if, climate change will affect Sora or when habitat is needed to support multi-species management (Sokolov et al. 1999, Lehikoinen and Jaatinen 2012).

Several small-scale studies have been conducted on Sora migration timing, but no projects have looked specifically at the timing of migration across multiple sites and years in the Mississippi Flyway. Missouri is centrally located in the Mississippi Flyway and is an important midway point of stopover habitat for migratory waterbirds (Case and McCool 2009, Soulliere et al. 2013). Previous small-scale studies indicate migration of Sora peaks in Missouri in the last 2 weeks of September and ranges from the last week of August to the last week of October (Rundle and Fredrickson 1981, Clark-Schubert 2009). While observations of Sora reported in eBird (Sullivan et al. 2009) ranged from the first week of August through the last week of October in Missouri, these data may not be reliable to examine variation in migration phenology because of the low detection probability of Sora and the lack of consistent observer effort (Sullivan et al. 2009, Conway 2011, Conway and Gibbs 2011). Our objective was to document autumn migration phenology of Sora in Missouri using a standardized method and compare migration phenology differences among years.

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METHODS

Study Area.—We selected 11 publicly managed wetland properties across Missouri because of their historical importance for migrating waterbirds (Fig. 1). At each property, we surveyed moist soil wetland impoundments (wetlands surrounded

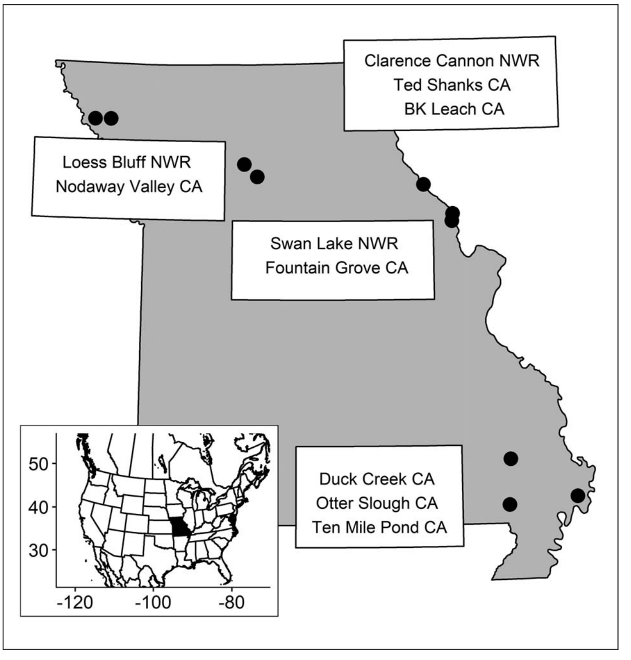

FIG. 1. Eleven study sites in Missouri USA where Sora (*Porzana carolina*) were surveyed during autumn migration in 2012–2015.

by levees with water control structures and dominated by smartweeds [*Polygonum* spp.] and millets [*Echinochola* spp.]; yearly sample size by region Table 1; further detail Supplementary Table S1). We made impoundments the survey unit, because this is the scale at which wetland management decisions are made. Wetland impoundments were usually managed on a multi-year rotation using water level manipulation and disturbance (discing, mowing, and burning) to hinder invasion by undesirable plants and set back succession (Rundle and Fredrickson 1981, Fredrickson and Taylor 1982). In 2012, Missouri experienced an extreme drought throughout the summer and autumn while weather conditions were more typical in 2013, 2014, and 2015 (U.S. Drought Monitor 2015).

Surveys.—Fournier and Krementz (2017) developed a method for surveying Sora outside of the breeding season, by driving transects at night on ATVs running parallel to a randomly chosen side of each impoundment and spaced 30 m apart in a systematic pattern. These surveys are done under a distance sampling framework where the perpendicular distance from the transect line to the point where each Sora was first detected is recorded, which allows for estimation of detection probability and density using hierarchical models (Fiske

TABLE 1. Survey start and end dates, visits per property type, and sample size of wetland impoundments surveyed by region for each year of autumn rail surveys in Missouri, USA.

				Visits per property		Number of impoundments surveyed by region				
Year	Observers	Start date	End date	State	Federal	NW	NC	NE	SE	Total
2012	4	17 Aug	7 Oct	3	3	5	7	11	17	40
2013	4	11 Aug	27 Oct	3	4	7	10	7	15	39
2014	2	12 Aug	22 Oct	4	4	7	6	11	9	33
2015	2	12 Aug	23 Oct	4	4	7	6	11	9	33

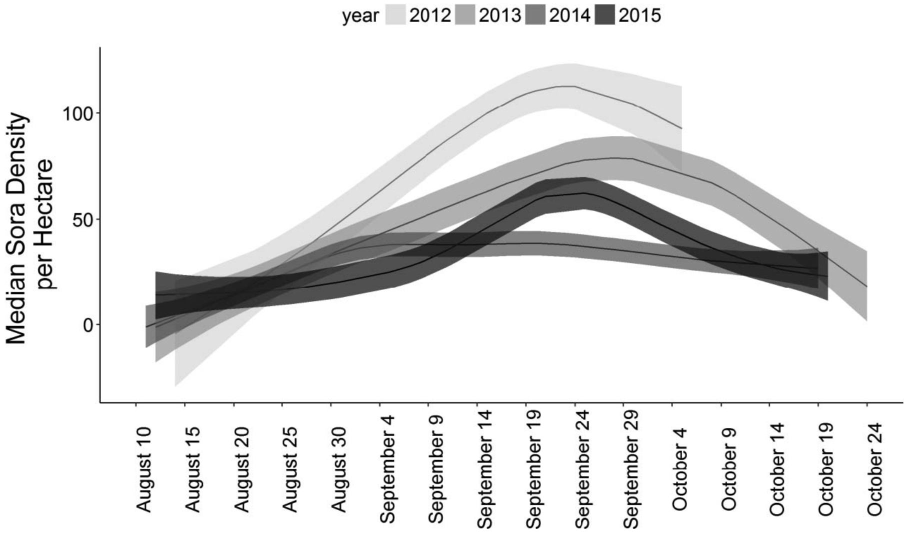

FIG. 2. Smoothed splines of density of Sora (*Porzana carolina*) from surveys across Missouri, USA from 2012–2015. Splines do not extrapolate beyond the survey periods, which differed among years.

and Chandler 2011, Denes et al. 2015). We conducted surveys beginning 30 min after sunset for 2 hrs each night in 2012 and for 3 hrs each night in 2013, 2014, and 2015 (Table 1).

We began surveys each year in the northwest region of Missouri and moved clockwise around the state (Fig. 1). Regions were visited 3–4 times a year, and each visit involved multiple surveys of the same impoundment by different observers. Effort varied by year because of changes in the number of observers, closure of some properties in preparation for hunting seasons and, in 2013, because of the U.S. federal government shutdown (Table 1).

Density.—We estimated density of Sora using the generalized distance sampling model of Chandler et al. (2011) in the R package 'unmarked' (version 0.11-0; Fiske and Chandler 2011, R Core Team 2016). Unmarked provides an approach to fit biological data collected through repeated measures techniques to hierarchical models that estimate density while accounting for imperfect detection (Royle et al. 2004). The repeated transects within each survey allowed us to better estimate detection probability (MacKenzie 2006, Chandler et al. 2011). We met the population closure assumption by estimating density for each impoundment during each visit separately. This resulted in 3–4 separate density estimates per impoundment each year. We truncated our observations to only include those within 5 m of the line, which encompassed 96% of the detections because the small number of detections in the larger distance bins would add "little information for the estimation of the detection function and could complicate model fitting" (Schmidt et al. 2012).

We used the intercept-only model to estimate density of Sora and detection for each impoundment at each survey. We treated each year's density estimates as a function of day of the year with a cubic smooth spline in R (smoothing parameter = 0.8; Fig. 2). We bootstrapped 95% confidence intervals around the density estimates. We estimated detection probability by comparing the expected value from 500 bootstrap simulations of the 'getP' function within the unmarked package. To compare the distribution of migration among years, we used a Kolmogorov-Smirnoff non-parametric test.

RESULTS

We detected 6,283 Sora during 868 hrs of surveying. Detection probability on the line was 17% (SE = 15–19). The earliest Sora we detected was 11 August 2015 (Fig. 2), and study area managers reported seeing Sora in 2012 and 2015 before our surveys began (C. Alger, pers. comm.;

TABLE 2. Distribution of densities of Sora by date in Missouri, USA. IQR is the Inner Quartile Range = the number of days between Quantile 1 and Quantile 3.

Year	Minimum	Quantile 1	Median	Quantile 3	Maximum	IQR
2012	17 Aug	13 Sept	22 Sept	27 Sept	7 Oct	14
2013	11 Aug	14 Sept	26 Sept	3 Oct	27 Oct	19
2014	12 Aug	5 Sept	23 Sept	5 Oct	22 Oct	30
2015	12 Aug	14 Sept	29 Sept	3 Oct	23 Oct	19

C. Crisler, pers. comm.). We found no significant differences among years in densities of Sora (Sora/hectare) before 31 August or after 19 October (2012 data collection ended 7 Oct, Fig. 2). Densities in all years except 2014 peaked in late September, followed by a slow decline thereafter, whereas 2014 had no clear peak and a greater interquartile range, indicating a wider spread of Sora across autumn 2014 than during other years (Table 2). The peak in densities of Sora in 2012 was higher than in any other year. The distribution of density was different between 2014 and 2013, and 2015 and 2013 (D = 0.22, and 0.23, $P \leq 0.001$, Fig. 3), but not between 2014 and 2015 (D = 0.04, $P = 0.96$, Fig. 3). The differences in the distributions were a result of higher densities of Sora in 2013 beginning around the end of August through the end of the first week in October as compared to the densities of Sora in either 2014 or 2015 (Fig. 3).

DISCUSSION

Migration of Sora began the week of August 10th in all years, with 2013's shape being different from 2014 and 2015. The shape of migration among years suggests weather can play a role in shifting the distribution of migration, while at the same time processes like photoperiod are consistently triggering its initiation (Bellrose 1980). We did not compare 2012 with the other years because 2012 surveys ended 2 weeks earlier; however, we do note that in 2012 we had our highest peak densities of Sora which may have been because of an exceptional drought in the state that reduced the number of flooded wetlands (U.S. Drought Monitor 2015).

Knowing when a species migrates has implications for habitat management, monitoring, and research since the population's needs may not be met during migration or they could be missed during monitoring if those surveys are timed incorrectly. Previous research in the Mississippi Flyway missed the initiation of Sora migration by several weeks, which is not surprising since the difficulty of detecting rails can lead to incorrect determination of migration initiation (Fournier et al. 2015). Our work consistently shows migration beginning in early August, which is in line with eBird (Sullivan et al. 2009). This is especially important to consider when making wetland management decisions during autumn migration, because habitat management will need to be timed with migration. Extreme weather events, such as flooding and drought are predicted to increase across Missouri with climate change. The increase in extreme weather will make active wetland management more challenging and the understanding of needed timing of wetland habitat even more important.

The latest date we detected Sora coincided with the end of migration in Missouri observed by Clark-Schubert (2009), whereas eBird records from Missouri continued into November. We were unable to extend our surveys beyond the end of October because of the initiation of waterfowl hunting seasons, and we chose not to initiate them earlier in August to prevent disrupting late nesting species. As a result, we failed to capture the true initiation and end of migration, but our data encompass the majority of Sora migration and should be sufficient to inform future research and monitoring.

When attempting to manage for a suite of wetland species, consideration should be given to potential mismatches that may occur between the timing of species' needs and resource availability. Early autumn could be the most limited time of year for flooded wetlands on the landscape in Missouri in part because of late summer draw-

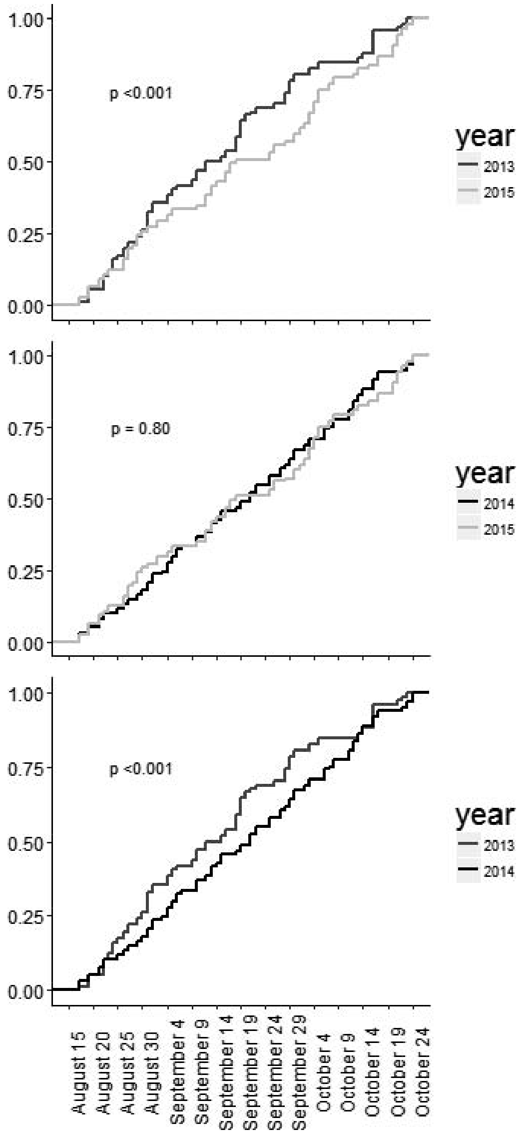

FIG. 3. Comparison of cumulative distributions of density of Sora (*Porzana carolina*) between years. The first year, 2012, was not compared to other years, because the survey period that year ended earlier than in the other years.

downs. This combined with the increase in extreme weather events, particularly droughts, predicted in climate change scenarios, could further decrease the amount of flooded wetlands during this important time for Sora. Future work should look to inform decisions that incorporate the needs of Sora into the wetland management process.

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LITERATURE CITED

Aagaard, K., S. M. Crimmins, W. E. Thogmartin, B. G. Tavernia, and J. E. Lyons. 2015. Evaluating predictors of local dabbling duck abundance during migration: managing the spectrum of conditions faced by migrants. Wildfowl 65:100–120.

Albanese, G. and C. A. Davis. 2015. Characteristics within and around stopover wetlands used by migratory shorebirds: is the neighborhood important? Condor: Ornithological Applications 117:328–340. doi:10.1650/CONDOR-14-166.1

Andersson, K., C. A. Davis, G. Harris, and D. A. Haukos. 2015. An assessment of non-breeding waterfowl surveys on national wildlife refuges in the Central Flyway. Wildlife Society Bulletin 39:79–86. doi:10.1002/wsb.500

Bellrose, F. C. 1980. Ducks, geese and swans of North America. Stackpole, Mechanicsburg, Pennsylvania, USA.

Case, D. J. and D. D. McCool (Editors). 2009. Priority information needs for rails and snipe: a funding strategy. Association of Fish and Wildlife Agencies, Migratory Shore and Upland Game Bird Support Task Force, Washington, D.C., USA. www.fws.gov/migratorybirds/pdf/surveys-and-data/Info-Needs-Rails-Snipe.pdf (accessed 30 Aug 2012).

Chandler, R. B., J. A. Royle, and D. I. King. 2011. Inference about density and temporary emigration in unmarked populations. Ecology 92:1429–1435. doi:10.1890/10-2433.1

Clark-Schubert, N. D. 2009. Fall migration ecology of the Sora (*Porzana carolina*) at Four Rivers Conservation Area in Missouri. Thesis. University of Arkansas, Fayetteville, USA.

Conway, C. J. 2011. Standardized North American marsh bird monitoring protocol. Waterbirds 34:319–346. doi:10.1675/063.034.0307

Conway, C. J. and J. P. Gibbs. 2011. Summary of intrinsic and extrinsic factors affecting detection probability of marsh birds. Wetlands 31:403–411. doi:10.1007/s13157-011-0155-x

Denes, F. V., L. F. Silviera, and S. R. Beissinger. 2015. Estimating abundance of unmarked animal populations: accounting for imperfect detection and other sources of zero inflation. Methods in Ecology and Evolution 6:543–556. doi:10.1111/2041-210X.12333

Fiske, I. J. and R. B. Chandler. 2011. unmarked: an R package for fitting hierarchical models of wildlife occurrence and abundance. Journal of Statistical Software 43:10. doi:10.18637/jss.v043.i10

Fournier, A. M. V. and D. G. Krementz. 2017. Nocturnal distance sampling all-terrain vehicle surveys for nonbreeding rails. Wildlife Society Bulletin 41:151–156. doi:10.1002/wsb.745

Fournier, A. M. V., M. C. Shieldcastle, T. Kashmer, and K. A. Mylecraine. 2015. Comparison of arrival dates of rail migration in the southwest Lake Erie marshes, Ohio, USA. Waterbirds 38:312–314. doi:10.1675/063.038.0313

Fredrickson, L. H. and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. Resource Publication 148. USDI, Fish and Wildlife Service, Washington, D.C., USA. doi:10.3996/012014-JFWM-009.S2

Hostetler, J. A., T. S. Sillett, and P. P. Marra. 2015. Full-annual-cycle population models for migratory birds. Auk: Ornithological Advances 132:433–449. doi:10.1642/AUK-14-211.1

Krementz, D. G., K. Asante, and L. W. Naylor. 2012. Autumn migration of Mississippi Flyway Mallards as determined by satellite telemetry. Journal of Fish and Wildlife Management 3:238–251. doi:10.3996/022012-JFWM-019

Lehikoinen, A. and K. Jaatinen. 2012. Delayed autumn migration in northern European waterfowl. Journal of Ornithology 153:563–570. doi:10.1007/s10336-011-0777-z

MacKenzie, D. I. 2006. Modeling the probability of resource use: the effect of, and dealing with, detecting a species imperfectly. Journal of Wildlife Management 70:367–374. doi:10.2193/0022-541X(2006)70[367:MTPORU]2.0.CO;2

Melvin, S. M. and J. P. Gibbs. 1994. Sora. Pages 209–217 *in* Migratory shore and upland game bird management in North America (T. C. Tacha and C. E. Braun, Editors). International Association of Fish and Wildlife Agencies, Washington, D.C., USA.

Melvin, S. M. and J. P. Gibbs. 2012. Sora (*Porzana carolina*). The birds of North America online. Number 250. doi:10.2173/bna.250

R Core Team. 2016. R: a language and environment for statistical computing. Version 3.2.4. R Foundation for Statistical Computing, Vienna, Austria. www.r-project.org

Richardson, W. J. 1978. Timing and amount of bird migration in relation to weather: a review. Oikos 30:224–272.

Richardson, W. J. 1990. Timing of bird migration in relation to weather: updated review. Pages 78–101 *in* Bird migration: physiology and ecophysiology (E. Gwinner, Editor). Springer-Verlag, Berlin, Germany.

Royle, J. A., D. K. Dawson, and S. Bates. 2004. Modeling abundance effects in distance sampling. Ecology 85:1591–1597. doi:10.1890/03-3127

Rundle, W. D. and L. H. Fredrickson. 1981. Managing seasonally flooded impoundments for migrant rails and shorebirds. Wildlife Society Bulletin 9:80–87.

Schmidt, J. H., K. L. Rattenbury, J. P. Lawler, and M. C. MacCluskie. 2012. Using distance sampling and hierarchical models to improve estimates of Dall's sheep abundance. Journal of Wildlife Management 76:317–327. doi:10.1002/jwmg.216

Sheehy, J., C. M. Taylor, and D. R. Norris. 2011. The importance of stopover habitat for developing effective conservation strategies for migratory animals. Journal of Ornithology 152:S161–S168. doi:10.1007/s10336-011-0682-5

Sokolov, L. V., M. Y. Markovets, and Y. G. Morozov. 1999. Long-term dynamics of the mean date of autumn migration in passerines on the Courish Spit of the Baltic Sea. Avian Ecology and Behaviour 2:1–18.

Soulliere, G. J., B. W. Loges, E. M. Dunton, D. R. Luukkonen, M. W. Eichholz, and K. E. Koch. 2013. Monitoring waterfowl in the Midwest during the non-breeding period: challenges, priorities, and recommendations. Journal of Fish and Wildlife Management 4:395–405 doi:10.3996/062012-JFWM-054

Sullivan, B. L., C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142:2282–2292. doi:10.1016/j.biocon.2009.05.006

U.S. Drought Monitor. 2015. United States Drought Monitor Compare Two Weeks Maps. National Drought Mitigation Center, U.S. Department of Agriculture, and the National Oceanic and Atmospheric Administration. droughtmonitor.unl.edu (accessed 1 Oct 2015).