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Evaluating Tradeoffs in the Response of Sora (*Porzana carolina*) and Waterfowl to the Timing of Early Autumn Wetland Inundation

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Abstract.—Wetland loss has increased the importance of multi-species management in remaining wetlands, which provide habitat for a multitude of wetland-dependent species. Many public wetlands across the mid-latitude United States are managed as moist soil impoundments with emphasis on migratory waterfowl. However, how the timing of these water management decisions affects rails is still uncertain. Wetland managers identified this as an area of uncertainty regarding timing of alternative water management strategies to benefit waterfowl and rails, which was addressed through a 3-year management experiment. Sora (*Porzana carolina*) and waterfowl were surveyed on 10 public wetland properties in Missouri, USA from 2014-2016, and their responses to early autumn inundation of managed palustrine wetlands were compared. A total of 558 Sora surveys detected 5,755 birds (20.6 birds/survey ± 30.8 SD), and 1,304 waterfowl surveys detected 1,411,779 birds (15,686.4 birds/survey ± 23,933.9 SD). Sora responded positively (birds/ha) to inundation of moist soil impoundments earlier in autumn migration (August). The top model for Sora included treatment, year and region of Missouri. There was no difference in waterfowl abundance between early or late inundation. Inundating wetlands earlier in autumn migration can provide habitat for migrating Sora without negative effects on waterfowl use of those wetlands, and wetland managers can incorporate this into their decision-making framework.

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Key words.—autumn migration, moist soil management, *Porzana carolina*, Sora, waterfowl, wetlands.

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Wetland loss has been widespread across North America since European arrival, putting additional pressure on remaining wetlands to provide a wide suite of ecosystem services including habitat for autumn migrating wetland birds (Tiner 1984). Wetlands are among the most productive and economically valuable habitats (Dahl 2011), and while restoration has helped recover wetlands, in many places restored wetlands do not fulfill all the ecological functions they had before the surrounding landscape was altered (Moreno-Mateos *et al.* 2012). In the central United States, landscape level changes, including landcover changes (primarily to agriculture), ditching and tilling of land to increase the speed at which water drains, and leveeing rivers to protect adjacent lands from flooding, disconnect wetlands from their natural hydrology and flood cycles and have changed the way wetlands are managed (Jones *et al.* 1997; Alper 1998).

Many public lands have been set aside to provide wildlife habitat, often for a specific suite of species such as migratory waterfowl, and for human needs such as hunting, birdwatching and nature appreciation (Gopal 1991; Jones *et al.* 1995). Initially, these wetlands were protected and managed with a focus on waterfowl (ducks, geese and swans), but over time, management focus shifted to providing habitat that meets the annual life cycle needs of a wide range of wetland dependent species (Taft *et al.* 2002; Gray *et* *al.* 2013). Migratory wetland birds often use palustrine wetlands (Cowardin *et al.* 1979), which were historically sustained in their early successional state by flooding and scouring events. Now, due to landscape scale hydrological alterations, these wetlands are often maintained under moist soil management regimes (Rundle and Fredrickson 1981). Moist soil management consists of manipulating water levels seasonally (dry in summer, inundated in autumn; Fig. 1), combined with disturbance management (e.g. disking, mowing, or burning), to promote a specific plant community that is rich in seed-producing wetland plants for migratory waterfowl (Fredrickson and Laubhan 1994; Newcomb *et al.* 2014; Nam *et al.* 2015). The management of moist soil wetlands requires frequent decisions in the face of uncertainty to meet multiple objectives valued differently by a suite of stakeholders. Despite the widespread use of moist soil management techniques, many questions remain as to how these practices influence wetland dependent species other than waterfowl (Rundle and Fredrickson 1981; Fredrickson and Taylor 1982; Wilson *et al.* 2018).

Many rails (members of the family Rallidae), including Sora (*Porzana carolina*), rely on moist soil wetlands throughout their annual cycle, including autumn migration (Fournier *et al.* 2018; Wilson *et al.* 2018). Due to the elusive behavior of rails, little is known about how rails are affected by moist-soil management (Melvin and Gibbs 2012).

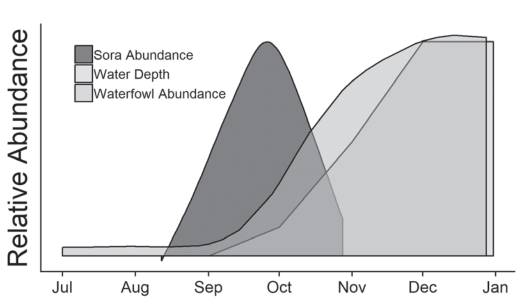

Figure 1. Conceptual figure showing the change in relative water depth in impounded moist soil wetlands in Missouri, USA compared to relative waterfowl abundance and relative Sora (*Porzana carolina*) abundance throughout the latter half of the year. Sora abundance data from Fournier *et al.* 2017.

Sora, the most abundant rail during autumn migration, migrate earlier in the autumn than many species of waterfowl (except early migrating teal; Fournier *et al.* 2017), which suggests water level management in moist-soil impoundments may require staggered timing to accommodate both Sora and waterfowl. This is important since a mismatch in timing of habitat availability and need can negatively affect wildlife (Jones and Cresswell 2010; Fournier *et al.* 2015). Sora select shallow water depths when those conditions are available but are also able to swim and dive in deeper water (Fournier and Krementz 2018). Moist-soil impoundments in the central United States serve as habitat for Sora only during migration, but are migratory and wintering habitat for many species of waterfowl. These impoundments typically have little water available early in autumn migration (late July through early September). The lack of flooded moist soil wetlands early in autumn is partly due to infrastructure limitations (i.e., pumping budget and water availability) and management decisions to delay inundation of wetlands until later in migration to ensure habitat is available for waterfowl, since inundation earlier could reduce habitat quality later (Fig. 1). The mismatch in the timing of wetland management and the migration of Sora raises questions about the effect that limited inundated wetland habitat available early in migration might have on Sora density during autumn migration stopover, and if this change could be made without negatively affecting waterfowl use of these impoundments due to increased vegetation senescence.

There are several sources of uncertainty that affect decision making in moist soil wetland management, including environmental variation in space and time, uncertainty around the underlying biological mechanisms that drive a desired plant response, and the degree to which management actions deviate from desired outcomes in intensity, timing and spatial extent (Williams 1997, 2001). Initiating wetland inundation in early August could benefit Sora, but it could also result in lower waterfowl use of wetland impoundments since moist-soil seeds will begin decomposing once inundated and/or be consumed by other species, or otherwise be depleted before autumn migration of waterfowl is complete. Early inundation during autumn migration would also result in stable water levels sooner, which is less desired by waterfowl (Weller 1988). Waterfowl respond strongly to newly flooded wetlands during migration and winter seasons (Weller 1988), and energetics models have indicated that sites flooded early can be depleted of seeds (Brouder and Hill 1995; Heitmeyer and Sheaffer 2006; Greer *et al.* 2007; Petrie *et al.* 2016). Previous research has also shown early flooded habitat has less use by Mallards (*Anas platyrhynchos*) and Northern Pintails (*Anas acuta*) (Rundle and Fredrickson 1981).

Wetland management decisions often involve tradeoffs that weigh the consequences of one management outcome versus another, these tradeoffs can be difficult to assess without sufficient data. One data gap that currently limits decision making (Sutherland *et al.* 2004) are the tradeoffs involved with wetland impoundments inundated early during autumn migration and whether this would limit habitat availability later in the season. Here we evaluate potential tradeoffs associated with early autumn wetland inundation and its effect on migratory rails and waterfowl through experimental manipulation of wetland impoundment inundation.

METHODS

Study area

We surveyed 10 state and federal properties in Missouri, USA, 4 associated with the Missouri River and its tributaries and 6 associated with the Mississippi River (Table 1; Fig. 2). All sites are within regions identified as continentally significant for waterfowl (Kushlan *et al.* 2002; North American Waterfowl Management Plan, Plan Committee 2012). At each property, we surveyed, on average, 2 moist soil wetland impoundments (wetland surrounded by a levee, with manual water level manipulation) for a total of 33 impoundments (Table 1). We selected the impoundment as the unit of interest because this is the scale at which property managers make wetland management decisions.

Missouri's moist soil wetlands are dominated by smartweeds (*Polygonum* sp.) and millets (*Echinochloa* sp.), which are used extensively by Sora and waterfowl during autumn migration (Fredrickson and Reed 1988; Fournier *et al.* 2018; Wilson *et al.* 2018). These moist soil impoundments are in a region of the United States with some of the highest wetland loss in the country (Tiner 1984; Dahl 2011; Homer *et al.* 2015). They are embedded within altered floodplains largely disconnected from their natural flood cycles where few wetlands are still connected with their original hydrology (Fredrickson and Laubhan 1994). Many of these moist soil impoundments are surrounded by agriculture (primarily corn and soybeans), others by wetlands, and a few by forested land.

Experimental design

A general assumption of current wetland management is that the timing of Sora migration is similar to early migrating waterfowl, e.g., blue-winged teal (*Anas discors*). However, Fournier *et al.* (2017) found that Sora migrate earlier than teal in the autumn. While some moist soil impoundments are flooded in time for the arrival of teal (mid-September) this wetland management timing does not match the earliest arrival of Sora and so may not meet the needs of Sora early in their autumn migration (Fig. 1; Fournier *et al.* 2017). Based on our initial results we engaged a workshop of state and federal wetland managers and scientists to solicit input into an experimental design to quantify the tradeoffs between two different water management actions and their effect on autumn migrating Sora and waterfowl wetland impoundment use.

Our original intent was to assign 33 wetland impoundments (size range 4.5-300 ha, mean size = 26.5 ha) at 10 state and federal properties to one of two inundation treatments, such that each property had at least one impoundment in each treatment. Our two treatments were early inundation in autumn migration (e.g., 1 August initiation date), timed to coincide with the earliest arrival of Sora, and late inundation in autumn migration (e.g., 20 September initiation date), in line with more typical water level management for migrating waterfowl. The plan was that treatments would be flipped in the second year and held constant in the third. As with many ecological systems, we faced issues of partial controllability, where in the prescribed treatment is not done according to prescription for a variety of reasons (Lyons *et al.* 2008; Martin *et al.* 2009). In our case, several treatments could not be applied across all three years, and almost every property, because of several over-bank flooding and extreme rain events.

After the fact, we created a rule for assignment of impoundments to treatments. Early inundation treatments were defined as having a mean water depth of ≥ 7 cm by the end of August and a maintained mean water depth of ≥ 7 cm from the end of August through the end of October. Late inundation treatments were defined as having a mean water depth of < 7 cm until after September 20th and the mean water depth of at least 7 cm maintained through the end of October. Impoundments that experienced extreme water depths (> 40 cm mean depth), because of overbank flooding from associated waterways or runoff during heavy precipitation, were not used that

Table 1. Moist soil wetland impoundments surveyed for Sora (*Porzana carolina*) and waterfowl in autumns of 2014-2016 on state and federal properties in Missouri, USA (latitude and longitude of the impoundment center in parentheses).

Property	Wetland Impoundments
Nodaway Valley Conservation Area	Sanctuary (40° 5′ 35.052″ N, 95° 2’ 50.9244″ W), Ash Grove (40° 5′ 7.2384″ N, 95° 2′ 51.6156″ W), Rail Marsh (40° 6′ 3.3048″ N, -95° 3′ 8.2368″ E)
Loess Bluff National Wildlife Refuge	Snow Goose B (40° 5′ 25.5408″ N, 95° 15′ 56.7144″ W), & D (40° 4′ 54.4224″ N, 95° 15′ 51.9588″ W), MSU 2 (40° 6′ 17.154″ N, 95° 14′ 16.6344″ W) and 3 (40° 6′ 3.2832″ N, 95° 14′ 12.7032″ W)
Fountain Grove Conservation Area	Pool 2 (39° 42′ 5.112″ N, 93° 18′ 43.2648″ W), Pool 2 Walk-in (39° 41′ 31.3584″ N, 93° 18′ 49.0932″ W), Pool 3 Walk-in (39° 41′ 26.3292″ N, 93° 18′ 13.95″ W)
Swan Lake National Wildlife Refuge	M10 (39° 35′ 32.1072″ N, 93° 11′ 39.4044″ W), M11 (39° 35′ 31.2864″ N, 93° 11′ 23.262″ W), M13 (39° 35′ 0.4236″ N, 93° 11′ 43.7244″ W)
Ted Shanks Conservation Area	2a (39° 32′ 43.2996″ N, 91° 9′ 40.3128″ W), 4a (39° 32′ 29.2488″ N, 91° 9′ 44.8524″ W), 6a (39° 32′ 26.07″ N, 91° 9′ 19.4436″ W), 8a (39° 32′ 8.0304″ N, -91° 9′ 23.868″ W)
B.K. Leach Conservation Area	Kings Tract 2 (39° 8′ 41.9856″ N, 90° 43′ 43.2948″ W), 5 (39° 8′ 0.3372″ N, 90° 44′ 1.9644″ W), 6 (39° 8′ 2.454″ N, 90° 44′ 20.2092″ W), & 9 (39° 8′ 29.4576″ N, 90° 44′ 35.1096″ W)
Clarence Cannon National Wildlife Refuge	MSU 1 (39° 15′ 31.716″ N, 90° 47′ 2.1444″ W), 2 (39° 15′ 53.0388″ N, 90° 47′ 6.9108″ W) & 12 (39° 15′ 40.734″ N, 90° 46′ 34.3416″ W)
Duck Creek Conservation Area	Unit A 14 (37° 3′ 41.1948″ N, 90° 7′ 24.69″ W), 18 (37° 3′ 24.0732″ N, 90° 7′ 47.1144″ W), 20 (37° 3′ 38.0016″ N, 90° 7′ 44.0868″ W), 22 (37° 3′ 26.0064″ N, 90° 8′ 14.8524″ W)
Otter Slough Conservation Area	21 (36° 41’ 26.6784″ N, 90° 7’ 52.2048″ W), 23 (36° 41’ 46.6908″ N, 90° 7’ 48.2196″ W)
Ten Mile Pond Conservation Area	Pool C (36° 42′ 49.3164″ N, 89° 20′ 25.7604″ W), E (36° 42′ 23.022″ N, 89° 20′ 6.8604″ W) and I (36° 44′ 27.1068″ N, -89° 19′ 51.4992″ W)

year (sample size by year; Table 2). We selected 7 cm as the lower bound for mean water depth because, for the majority of our impoundments, that depth resulted in the majority of the surface area within a wetland impoundment being flooded. We chose 20 September because it represents the midpoint of Sora migration and is often the time of year that early inundation for migratory waterfowl begins (Fournier *et al.* 2017c).

We measured water depth at 20 points in each wetland impoundment the morning after bird surveys (Fournier *et al.* 2018). At each point, five water depth measurements were taken, at the point, and at 5 meters in each cardinal direction. The mean of these measurements was taken to determine the mean water depth for that point. Post-hoc assignment of impoundments to inundation treatments allowed us to use information about how the water level management actually took place to assign the treatment after the fact and helped remove some of the issues associated with partial controllability.

Bird Monitoring

We surveyed Sora in wetland impoundments by conducting spotlight surveys from All Terrain Vehicles (ATV) for three hours at night from August-October 2014-2016 under a distance sampling framework, which allowed us to estimate Sora density (Chandler *et al.* 2011; Fournier and Krementz 2017). Fournier and Krementz (2017) details the survey specifics; in brief, an ATV was slowly driven through a wetland impoundment for 1.5 hrs in parallel transects 30 m apart. All Sora detected (on the ground or flushing) within 5 m of the transect line were recorded, and their distance from the line was recorded. Fournier and Krementz (2017) demonstrate the very low chance of double counting of individual birds. We visited each property four times per year, with two surveys occurring during each visit, on the same night, by two different observers, one observer in the first 1.5 hrs after sunset followed by the second observer in the second 1.5 hrs after sunset.

Public land property managers conducted waterfowl surveys weekly on Mondays beginning the first Monday of October and continuing through the end of January. Property managers counted waterfowl in each impoundment from the same vantage point(s) each Monday at the same time of day, typically in the afternoon. All waterfowl species were combined in our analyses.

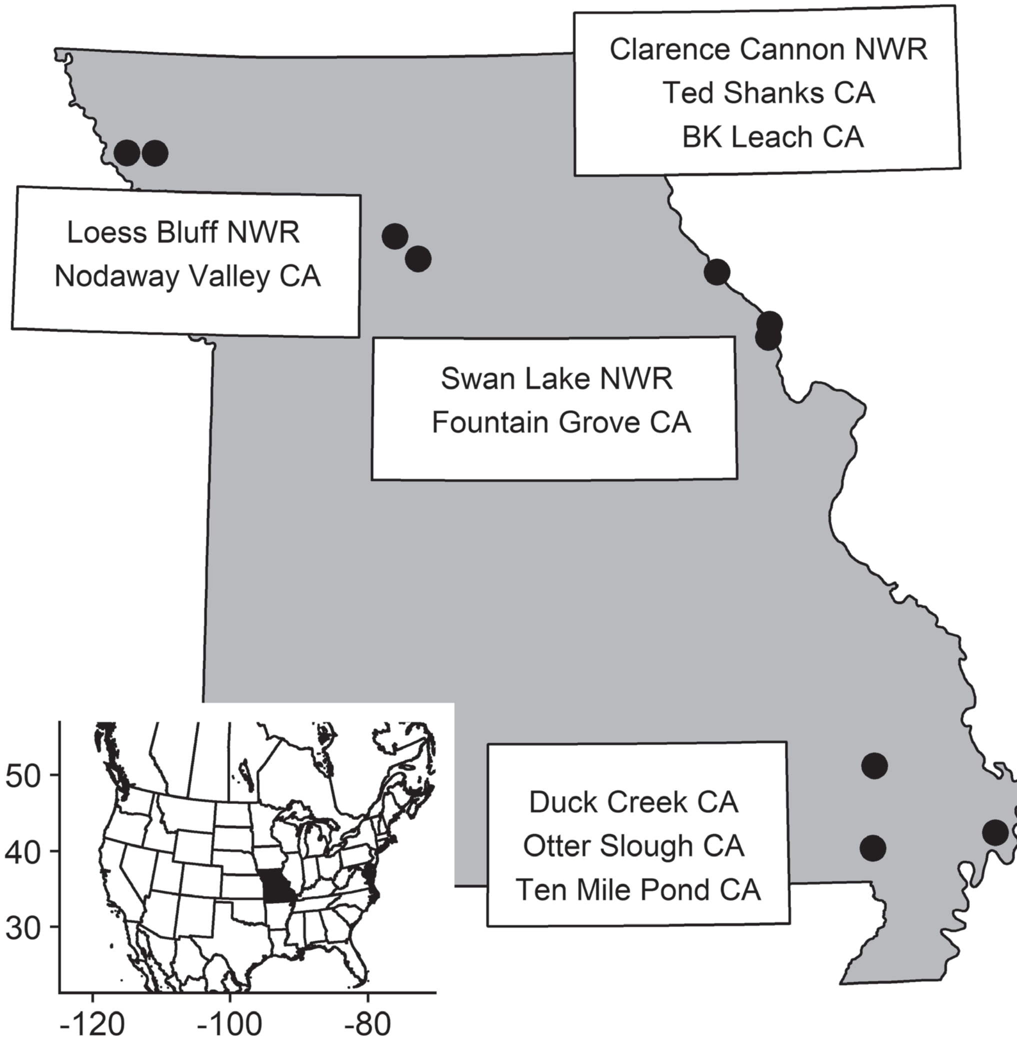

Figure 2. Ten study sites in Missouri, USA where Sora (*Porzana carolina*) were surveyed during autumn migration in 2014-2016 (NWR = National Wildlife Refuge, CA = Conservation Area).

Data Analysis

We used the generalized distance sampling model of Chandler *et al.* (2011) in the R package '*unmarked*' (R version 3.4.0, unmarked version 0.11-0) to compare Sora density between the two treatments (Fiske and Chandler 2011; R Core Team 2019). R package '*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). We met the population closure assumption by modeling each visit to an impoundment separately. We truncated our observations to only include those detections that occurred within 5 meters of the survey line 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). These truncated observations encompassed 96% of the detections. We ran 3 Poisson models with a hazard key function: a model with treatment, region and year; a model with treatment and re-

Table 2. Number of moist soil wetland impoundments per inundation treatment and year surveyed for Sora (*Porzana carolina*) and waterfowl in autumns from 2014-2016 in Missouri, USA.

Year	Early Inundation Treatment	Late Inundation Treatment
2014	6	5
2015	7	7
2016	12	2

gion; and a model with treatment and year as covariates. We included region of Missouri and year because we expected that Sora density would vary among years and regions because of influences beyond the control of our study. We compared models with Akaike's Information Criterion (AIC) and tested the top model's fit using a Freeman Tukey test.

We analyzed the waterfowl data with a generalized repeated measures negative binomial mixed model with a link function to compare the two inundation treatments in the '*lme4*' (Version 1.1-13) package in R (Bates *et al.* 2015). We chose a negative binomial because our count data were zero heavy. We used maximum count of waterfowl in an impoundment over two-week periods as the response variable. We chose to use the maximum count of the two surveys in a two-week period to help reduce the lack of independence among counts.

Inundation treatment was a fixed variable. We included two-week period as the repeated measure since we do not believe waterfowl counts to be independent among two-week periods. We included region of Missouri and year as random effects because we expected that waterfowl abundance would vary among years and regions because of influences beyond the control of our study. We compared models with AIC_c and we used Nakagawa Shinichi *et al.*'s (2012) method for obtaining an R^2 from a generalized linear mixed effects model on our top model using the '*MuMIn*' package in R (Barton 2018).

Results

We completed 558 surveys for Sora, (2014 = 184; 2015 = 178; 2016 = 196), detecting 5,755 Sora (2014 = 1,219; 2015 = 1,022; 2016 = 3,514). On average, 20.6 Sora were detected per survey, with high variation (SD = 30.8 Sora). We completed 1,304 waterfowl surveys (2014-2015 = 401; 2015-2016 = 415; 2016-2017 = 488), detecting 1,411,779 individuals (2014-2015 = 489,422; 2015-2016 = 529,806; 2016-2017 = 392,511). On average 15,686.4 individuals were detected, with high variation (SD = 23,933.9).

The top model for Sora included treatment, year and region of Missouri and it fit the data (t = 3003, SD = 38, P = 0.962; Table 3). We found a positive effect of early treatment on Sora density (Fig. 3, Table 4) and significant differences among regions and years (Table 4). Sora density increased each year, and was highest in the southeast region and lowest in the north-central region (Fig. 3, Table 4).

The top model for waterfowl fit the data with a marginal R^2 = 0.04 (variation explained by fixed variables), and a conditional R^2 = 0.15 (variation explained by the fixed and random variables, Table 5). We found no difference in waterfowl abundance between the two (early and late) inundation treatments (β = -0.36, SE = 0.40, P = 0.37; Table 6).

Discussion

Our objective was to evaluate the tradeoffs between wetland inundation during autumn migration for Sora and waterfowl. We did this by comparing the response of Sora and waterfowl to two wetland inundation treatments, one of which was early in autumn migration, and one of which was more in line with typical management, where inundation occurs later in the autumn. In line with previous observations of Sora congregating around inundated wetlands early in migration, (Griese *et al.* 1980; Rundle and Fredrickson 1981), we found higher Sora density in moist soil impoundments inundated earlier in autumn migration. Intentional inundation of wetlands early in migration makes habitat available and supports Sora during these important migratory stopover periods.

Public land managers initially expressed concern that early inundation would reduce habitat for later migrating waterfowl species because vegetation would senesce and fall below the water. We found no effect of

Table 3. Akaike's Information Criterion (AIC) table of hierarchical distance sampling models of wetland inundation treatment on Sora (*Porzana Carolina*) density in Missouri, USA in autumns from 2014-2016.

	K	AIC_c	ΔAIC	AIC_c Weight
Treatment + Region + Year	9	-10510.18	0.00	1
Treatment + Region	7	-10392.89	117.29	0
Treatment + Year	6	-10350.15	160.04	0
Intercept Only	3	-10106.57	403.61	0

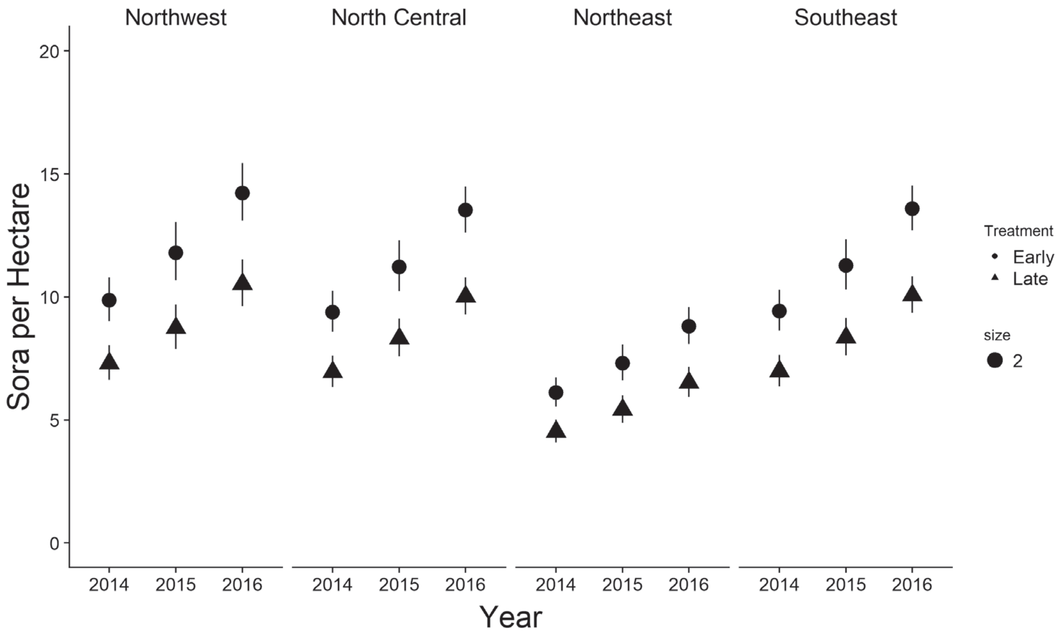

Figure 3. Comparison of Sora (*Porzana carolina*) density (Sora per hectare) by year and region between the early and late inundation wetland treatments in Missouri, USA in autumns from 2014-2016. Vertical line represents the 95% confidence interval around the estimate.

early inundation treatment as measured by the number of waterfowl using an impoundment over time, allowing an individual wetland to provide for the life history needs of Sora and waterfowl during autumn migration in the same wetland impoundment. However, our project did not evaluate food availability and quantity, nor did we count individual waterfowl species. We counted and analyzed waterfowl as one group, which could have obscured any species-specific effects. Rundle and Fredrickson (1981) found Mallard and Northern Pintail use was lower in impoundments flooded early in autumn migration. Future work should investigate species-specific waterfowl response to our wetland management schemes.

Other rails, such as Virginia (*Rallus limicola*) and Yellow Rail (*Coturnicops noveboracensis*), may also be considered in wetland management decisions, though their later migratory timings compared to Sora may lessen the need for specialized management since current waterfowl management matches their timing more closely (Rundle and Fredrickson 1981; Reid 1989; Conway

Table 4. Predicted values from Poisson hierarchical models comparing Sora (*Porzana Carolina*) density between two wetland inundation treatments in Missouri, USA in autumns of 2014-2016.

Covariate	Predicted Densities (Sora/ha)	Standard Error	*P*-value
Early Treatment	7.30	0.37	<0.001
Late Treatment	5.40	0.28	<0.001
Region NW	11.80	0.60	<0.001
Region NC	11.22	0.52	<0.001
Region NE	7.30	0.37	<0.001
Region SE	11.27	0.51	<0.001
Year 2014	6.10	0.30	<0.001
Year 2015	7.30	0.37	<0.001
Year 2016	8.80	0.38	<0.001

Table 5. Akaike's Information Criterion (AIC) table of negative binomial mixed effects models of wetland inundation treatment on waterfowl abundance in Missouri, USA in autumns from 2014-2016.

	K	AIC_c	Delta AIC	AIC_c Weight
Fixed = Treatment, Random = Region + Year	6	3507.94	0.00	0.71
Fixed = Treatment, Random = Region	5	3510.16	2.22	0.23
Fixed = Treatment, Random = Year	5	3513.07	5.12	0.05
Intercept	4	3515.56	7.62	0.02

1995; Leston and Bookhout 2015). Sora, Virginia and Yellow Rail use the same wetlands, though they select different areas within those wetlands (Fournier *et al.* 2017b, 2018). The three rail species have overlapping migratory timing, though each species migrating through Missouri is coming from a different part of the breeding range (Fournier *et al.* 2017a, b, d). This disparate distribution highlights the importance of Missouri wetlands toward the full life cycle conservation of migratory wetland birds.

Our experiment identified a relationship between the timing of inundation and Sora response but did not identify the specific mechanism behind the response. Lyons *et al.* (2008) looked at multiple aspects of the environment to better examine the mechanism by incorporating counts of birds, plant communities, and invertebrates. Future research should also include ecosystem variables to better understand the mechanism behind bird response to managed inundation of impoundments. In addition, other organisms also need to be considered under multi-species management, including invertebrates (Fredrickson and Reed 1988; Batzer and Resh 1992; Alford 2014), and amphibians (Mengel 2010; Kross and Richter 2016; Tozer *et al.* 2018). Consideration should also be given to larger ecosystem functions, such as nutrient cycling (Mayer 2005) and flood control (Costanza *et al.* 1989; Maltby 1991; Ton *et al.* 1998).

Table 6. Predicted values from a negative binomial mixed models comparing maximum waterfowl counts between two wetland inundation treatments in Missouri, USA in autumns from 2014-2016.

Fixed Effect Variable	Predicted Value	Standard Error
Early inundation treatment	6.86	0.56
Late inundation treatment	6.49	0.64

Widespread wetland loss has placed a great burden on publicly managed wetlands to serve a wide variety of needs (La Peyre *et al.* 2001). The positive response of Sora to early inundation and the lack of difference in waterfowl response suggests that water management strategies are possible that will benefit Sora and waterfowl. The positive response of Sora and waterfowl to early inundation of moist soil impoundments suggests that flexibility, in terms of time and space, can be built into water management strategies such that, while specific locations may change dependent on the year and climatic conditions, available habitat can be provided that covers the entire migratory period. Multi-species management is necessary to ensure that habitat is available on the landscape to meet the needs of a diverse wetland community, especially as the landscapes around these wetlands become more altered (Fredrickson and Laubhan 1994; Winter *et al.* 2001; Euliss *et al.* 2008). Inundating wetlands early in migration successfully provides habitat for Sora and waterfowl, allowing for evidence-based multi-species management of these important palustrine wetland habitats.

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