Feeding Habitats of Spring-Migrating Blackbirds in East-central South Dakota

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ABSTRACT -- Between 27 March and 21 April 1998, we monitored blackbird (Icteridae) activity and habitat selection at a migratory staging area in east-central South Dakota. We used fixed-area observation points located within 201-km^2 circular plots centered on four wetland basins that were used as night roosts. Each roost was surveyed four times, with the surveys spread evenly throughout the blackbird migration. We recorded the number of blackbird flocks, flock size and composition, habitat used, and behavior (e.g., loafing and feeding). Fifty percent (n = 242) of the 482 flocks recorded in the quadrats was observed loafing in trees of woodlots and shelterbelts. Feeding flocks preferred habitats classified as Corn (e.g., disked, plowed, and stubble corn fields) over two other foraging habitat categories (Cultivated and Grassland). A comparison of proportional availability of Cultivated habitat (soybean [*Lathyrus odoratus*] and wheat [*Triticum aestivum*] stubble, inclusive) against proportional use by feeding flocks indicated that this habitat was avoided. Grassland habitat (hayfields, CRP, and pasture) was used according to its availability. Intensity of Grassland use depended on time of survey (AM and PM), with use greater during the PM survey. A two-factor model (habitat, time, and the interaction term) provided the best parsimonious fit of 15 *a priori* models tested with Akaike's information criterion (AIC_C). Selection of foraging habitats by blackbirds might reflect comparable strategies used by other early migrating granivores. This knowledge could help wildlife managers maximize the placement of corn field food plots for optimum benefit to wildlife species.

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Key words: agriculture, blackbirds, corn fields, feeding sites, habitat selection, shelter belt, South Dakota, spring migration.

East-central South Dakota is used by many species of birds as a migratory stopover area (Linz et al. 1995, Linz et al. 2002, Linz et al. 2004). Birds on migration will pause here for several days and acquire additional energy reserves needed to continue northward (Schaub and Jenni 2001). Several species of granivorous passerines migrate through South Dakota, either singly or in small groups, and thus are difficult to observe; however, blackbirds (Icteridae) are highly visible during migration and among the earliest of the passerines to move into east-central South Dakota (Linz et al. 2003, Homan et al. 2004). Early migration at northern latitudes can be hazardous because of low or sporadic food availability and periods of severe weather (Whitmore et al. 1977). The foraging strategies employed by blackbirds while staging here might have implications that extend beyond this specific group of birds because similar foraging strategies might be used by more cryptic granivores, some of which are species in decline in the northern Great Plains.

In a small, preliminary study conducted during early spring in east-central South Dakota, route surveys indicated that use of harvested fields of corn (*Zea mays*), soybean (*Lathyrus odoratus*), and small grains was similar among the three field types for 20 species of birds (excluding blackbirds), including upland gamebirds, waterfowl, and nongame birds (Linz et al. 1995); however, for blackbird species, use of corn fields occurred at greater frequencies than expected (Linz et al. 1995). More detailed research was conducted in stubble soybean and corn to assess rates of use by blackbirds (Linz et al. 2003) and other granivorous bird species (Linz et al. 2004). Blackbirds used corn fields at much greater rates than soybean fields; whereas, other granivorous bird species used corn and soybean fields at statistically equal rates (Linz et al. 2004). Although results from these three studies were comparable, none of them accounted for habitat availabilities across the study area. We reported in our paper on habitat selection by blackbirds (primarily, red-winged blackbirds [*Agelaius phoeniceus*]) in respect to habitat availabilities occurring over much larger areas than were considered in the other studies. The incorporation of a larger geographical area into the analysis of habitat selection might provide more realistic perspectives on the selection process used by blackbirds during spring migration in east-central South Dakota.

Spring migration is a critical time, when migrating bird populations are at their lowest levels of the year and populations might be limited by food conditions at the staging area (Hutto 1998, Petit 2000, Schaub and Jenni 2001, Smith and Moore 2005). Our objectives were to (1) document the daytime activities of migrating blackbirds and (2) describe the selection of foraging habitats within a common radius of daily travel from the spring roosts.

STUDY AREA

The study was conducted in the Prairie Coteau ecoregion of east-central South Dakota. As a result of Pleistocene glaciation, most of the area lacks a well-developed drainage network and contains high densities of wetlands (Johnson and Higgins 1997). The vegetation in this region is classified as Northern Mixed-Grass Prairie (Johnson and Larson 1999). However, most of the prairie grasses had been replaced by agriculture; 70% of the lands in the study area (15,700 km^2) was devoted to agriculture. Soybean and corn were the dominate uses of agricultural land (40 and 33%, respectively), with pasture and hay land (15%) and wheat (9%) comprising the remaining bulk of agricultural use (National Agricultural Statistics Service 2006). Average daily temperature (6°C) and total precipitation (4 cm) during the March to April study period were similar to 30-yr averages (South Dakota Climate and Weather Statistics 2006). Spring planting did not begin until May and the cultivated lands were in either a stubble or disked condition.

METHODS

We identified four major roosts with maximum populations ranging from 66,000 to 217,000 birds. The Arlington (44.3°N, 97.0°W), DeSmet (44.4°N, 97.5°W), and Ramona (44.0°N, 97.3°W) roosts were located during previous studies (Linz et al. 1995, Linz et al. 2004). The Colman (43.9°N, 99.9°W) roost was located in March 1998. The roosts were in large wetland basins (120 to 300 ha) dominated by cattail (*Typha* spp.) or common reedgrass (*Phragmites australis*). Each roost was surveyed approximately once per week between 27 March and 21 April 1998. The surveys were spread evenly across this period, which covered the major part of the early blackbird migration (Knittle et al. 1987, Linz et al. 2003, Homan et al. 2004). The study plot boundaries were based on 8-km radii (201 km^2) extending from the center of the wetland basins. One roost was done per day, with the surveys divided into two 3-hr time periods. The morning survey (AM) was 1 to 4 hr after local sunrise and the afternoon survey (PM) was 4 to 1 hr before local sunset. Observation points were located at intersections of Public Land Survey System (PLSS) section lines. All flocks greater than or equal to 50 birds within a fixed-area quadrat (0.8 km x 0.8 km) centered on the PLSS intersection were tabulated. A team of two observers was used, with an observer monitoring either the northern or southern half of the quadrat. It took about 90 seconds to complete a point. If PLSS intersections were not reachable by four-wheel drive vehicle, they were not used. The number of survey points per plot ranged from 76 to 78. Flocks observed moving from an adjacent, previously surveyed point were not tabulated. We recorded the following data: flock size, species composition, flock activity (e.g., feeding and loafing), and habitat in which the activity was occurring. We used the following five habitat categories: 1) Grassland, which included hayfields, pastures, and Conservation Reserve Program (CRP) lands; 2) Corn, which included disked, plowed, and stubble fields; 3) Cultivated, which consisted of disked and stubble fields of soybean (two-thirds of the category) and small grains (wheat, one-third of the category); 4) Trees, which included shelterbelts, woodlots, and riparian forests; and 5) Miscellaneous, which was dominated by wetlands, but also included farmsteads, roadways, developed areas, lakes, ponds, rivers, standing water, and other unidentified areas. Of the five habitat categories, only three (Grassland, Corn, and Cultivated) were considered foraging habitats. We did not conduct observations during periods of measurable precipitation or when visibilities were less than 1 km.

Each flock was considered an independent observation of a habitat-use decision. Flocks of less than 50 birds were not recorded to avoid potential bias associated with not detecting smaller flocks equally in different habitats (Thomas and Taylor 1990). For several reasons, encountering a large number of migrating birds was unlikely more than once at the observation points. The surveys were conducted about a week apart, during which time, turnover at the roost (i.e., change in the composition of individuals) would be considerable; Otis et al. (1986) estimated that the daily turnover rate for spring blackbird roosts in east-central South Dakota was approximately 10%. Moreover, the probability for encountering a flock at an observation point during the survey was small. We made nearly 2,500 counts at the observations points over the study period and recorded less than 500 flocks.

Log-linear models were constructed to describe the observed counts of feeding flocks in relation to habitat type (H), roost (R), time of day (D), and week of migration (W). A saturated model, including all terms and interactions, would describe the data perfectly (Agresti 1996), but probably would be unnecessarily complex and difficult to interpret. Instead, we considered 15 *a priori* models and used a modified Akaike's information criterion (AICc) for making inferences. Relative AICc values and Akaike weights were used to rank the models and determine the strength of evidence for each model. Model averaging techniques were used to incorporate model selection uncertainty and calculate estimates of the proportion of blackbird flocks in each foraging habitat (Burnham and Anderson 1998, Anderson et al. 2000).

The habitat term (H) was included in all of the *a priori* models because our primary interest was in assessing levels of use among different foraging habitats (Linz et al. 1995). The roost term (R) might be needed in the models if habitat selection differed from roost to roost. This seemed possible, but not certain, since the habitats surrounding the roosts were similar in configuration. Therefore, we considered a number of models with and without the R term.

Time of day (D) might be incorporated if habitat selection differed between morning and evening surveys. Thus, we tested models with and without D. Finally, flock species composition could change as the migration season progressed (Barras 1996, Homan et al. 2004), and this might result in temporal differences in habitat selection patterns. Therefore, models with and without the W term were considered. We tried to limit this effect by timing our study period to the peak period of red-winged blackbird migration, before the influx of other late-migrating blackbird species, such as the yellow-headed blackbird (*Xanthocephalus xanthocephalus*). In addition to main effect models, we considered a number of models with two-way interactions. Three-way interactions seemed less likely, and their difficult interpretation prompted us to exclude them from the analyses (Table 1).

Habitat availabilities in each of the four study plots surrounding the roosts were calculated by using a nonmapping technique (Marcum and Loftsgaarden 1980). At each observation point in the study plot, we randomly selected 16 squares from a 100 by 100 square grid placed over high resolution images (National Aerial Photography Program) of the 0.8 km by 0.8 km quadrats (approximately 1200 random samples of habitat per study plot). A habitat category was assigned to each square. The classification of the squares was verified during the 1998 field season. The proportional availabilities of the five habitat categories in the study plots were estimated from habitat proportions generated from the randomly selected squares.

RESULTS

The red-winged blackbird was the most numerous species making up 78% (144,784) of the total 186,350 flock members tallied. The common grackle (*Quiscalus quiscula*) was the second most abundant with 21% (38,374). The largest number of common grackle occurred during 4 to 9 April, the second of the four survey periods. The small remainder of blackbird species included the brown-headed cowbird (*Molothrus ater*), rusty blackbird (*Euphagus carolinus*), yellow-headed blackbird, and Brewer's blackbird (*Euphagus cyanocephalus*). Within the habitats, the flocks were generally mixed-species flocks. Although some flocks were of extraordinary size (maximum of 10,000 birds), the vast majority of the 482 flocks we counted ranged between 300 and 450 birds.

Of the 482 flocks, 242 (50%) were perched in shelterbelts and woodlands. Only one flock was observed feeding in trees. The Miscellaneous category had 59 flocks; no feeding activity was recorded for flocks observed in this habitat category. The remaining 181 flocks were observed actively feeding in Corn, Grassland, and Cultivated habitats. We used these three categories for subsequent analyses of foraging habitat selection.

Table 1. Fifteen potential *a priori* log-linear models describing the observed counts of feeding blackbird flocks around spring roosts in east-central South Dakota.

Possible Effects	*a Priori* Models	
Main Effects	Main Effect Models	
Habitat (H)[a]	H	HDR
Roost (R)[b]	HR	HWD
Week (W)[c]	HW	HWR
Time of Day (D)[d]	HD	HWDR
Two-way Interactions	Two-way Interaction Models	
H x R	H|R	H|W|D
H x W	H|W	H|W|R
H x D	H|D	H|D|R
	H|W|D|R	

[a]1) Harvested corn fields, 2) stubble and disked soybean and wheat, and 3) CRP, pasture, and hayfields.
[b]4 roosts: Arlington, Coleman, DeSmet, and Ramona.
[c]4 1-week periods from 27 March - 21 April.
[d]2 3-hr survey periods: 1 to 4 hr after sunrise and 4 to 1 hr before sunset.

A goodness of fit test indicated that the data fit well ($G = 57.17$, d.f. = 57, $P = 0.47$) with the most parameterized model (H|W|D|R) for interpreting the observations of feeding flocks. Additionally, there was no indication that the data were overdispersed ($\hat{c} = 1.003$). A parsimonious model that adequately described the data included habitat category, time of day (AM or PM), and the interaction between these two factors (Model H|D, Table 2). Model H|D earned 67% of the support (Akaike weight, $w_i = 0.67$), while models HWD and HD earned 14% and 10% of the support, respectively (Table 2). Other models received considerably less support ($w_i = 0.03 - 0.00$). Because model H|D had almost five times as much support as the next closest model and dominated the unconditional parameter estimates, we used its structure for our interpretation.

Approximately equal amounts of the three foraging habitats were available to the birds (Table 3). Feeding flocks were observed in Corn more often than expected based on availability, with 56% of the flocks observed in this habitat. Grassland habitat was used according to its availability. Grassland habitat was used more often in the evening than the morning. Cultivated habitat, which included soybean and wheat fields, was used less than expected based on availability (Table 3).

Table 2. Summary of the evidence supporting 15 *a priori* log-linear models considered to describe the observed counts of feeding blackbird flocks around spring roosts in east-central South Dakota.

Model[a]	LogLikelihood	AICc	Delta AICc (Δ_i)	Akaike Weight (w_i)
H|D	1663.24	1674.79	0.00	0.67
HWD	1664.54	1677.95	3.15	0.14
HD	1670.87	1678.66	3.87	0.10
HWDR	1662.49	1681.32	6.53	0.03
HW	1670.33	1681.89	7.09	0.02
HDR	1668.82	1682.23	7.43	0.02
H	1676.67	1682.54	7.75	0.01
H|W|D	1651.92	1684.30	9.50	0.01
H|R|D	1651.33	1683.71	8.91	0.01
HR	1674.61	1686.17	11.37	0.00
HWR	1668.28	1685.33	10.53	0.00
H|W	1668.67	1691.02	16.22	0.00
H|R	1669.75	1692.10	17.31	0.00
H|W|R	1644.57	1694.73	19.93	0.00
H|W|R|D	1623.45	1684.94	10.15	0.00

[a]Refer to Table 1 for model descriptions and naming conventions.

Table 3. Proportion of spring-migrating blackbird flocks (n = 181) feeding in three habitats during morning and afternoon observations in east-central South Dakota.

Foraging Habitat	Proportion Available (%)	Proportion Used (%) AM	Proportion Used (%) PM
Grassland	35.6[a] (34.4, 36.8)[b]	8.7 (4.8, 12.6)	19.9 (14.0, 25.8)
Corn	29.8 (28.7, 31.0)	25.5 (18.9, 32.1)	30.6 (23.2, 37.9)
Cultivated	34.6 (33.4, 35.9)	7.1 (3.6, 10.6)	8.2 (4.3, 12.2)

[a]Mean
[b]95% C.I.

DISCUSSION

East-central South Dakota has been used as a major stopover site consistently for decades by millions of blackbirds on their annual spring migration. Thus, substantial quantities of food must be available to support the energetic demands placed on the environment by this sizable migratory population. Although studies on the food habits of spring-migrating populations of granivores are rare in the literature (Hutto 1998), two studies have reported on foods eaten by the red-winged blackbird during early spring at northern latitudes, McNicol et al. (1982) in Ontario, Canada, and Mott et al. (1972) in Brown County, South Dakota. The authors found that waste grains, including corn, small grains (e.g., wheat, oats, and millet), and weed seeds (primarily, foxtail [*Setaria* spp.] and smartweed [*Polygonum* spp.]) comprised the main portion of the diet in March and early April. McNicol et al. (1982) found that 71% of the diet was waste corn in areas of intense cultivation; whereas, in non-agricultural areas, weed seeds (mainly, foxtail) formed the greater part of the diet. Mott et al. (1972), in their intensely cultivated study area in South Dakota (70% cultivated, with corn the major crop at greater than 20% of land area), found that foxtail predominated in the diet, although waste corn and wheat were also present.

Not surprisingly, waste grains and weed seeds are major diet items in early spring for blackbirds (and probably other granivores as well). For example, seed production of foxtail species common to the northern Great Plains (e.g., *S. viridis*, and *S. glauca*) is prolific. For *S. viridis* growing in corn and soybean and not treated with post-emergent herbicide, seed production was approximately 4,000 seeds/m^2 (Forcella et al. 2000). Seed density declined to approximately 400/m^2 when post-emergent herbicide was applied early in the growing season. Foxtail seeds are extremely valuable to a diverse set of granivorous species encompassing a broad range of body sizes. In some cases, foxtail will account for greater than 50% of the diet of upland game, (e.g., gray partridge [*Perdix perdix*]) waterfowl (e.g., blue-winged teal [*Anas discors*]), and ground-feeding songbirds (e.g., American tree sparrow [*Spizella arborea*]) (West 1967, Sedivec and Barker 1998). One of the other major dietary staples in early spring, waste corn, also is abundantly available in most harvested corn fields. In fields sampled in Kansas in February, average kernel density was 70 kernels/m^2 (Salter et al. 2005). This value was comparable to an estimate made by Frederick and Klass (1984) for waste corn in recently harvested fields in Nebraska (88 kernels/m^2). Dolbeer et al. (1978) measured waste corn at 69 kernels/m^2 in corn stubble during November near a winter blackbird roost in western Tennessee; however, by February, it had dropped to less than 3 kernels/m^2, presumably due to a wintering population of 5 to 10 million blackbirds feeding in the fields. Waste corn in eastern South Dakota unlikely received the kind of feeding pressure under which Dolbeer et al. (1978) recorded the severe decline of waste corn. Indeed, blackbirds in our study area apparently spent a very large portion of their time loafing in trees and wetlands, perhaps indicating that the amount of time spent foraging was relatively minor.

Heavy and consistent use of this rather confined geographic region in east-central South Dakota by large populations of blackbirds might indicate that the area attracted and supported other granivorous passerines in March and April. We have identified 20 different granivorous bird species (excluding blackbirds) in our field plots since our research began in this region (Linz et al. 1995, Smith 1999, Linz et al. 2002, Linz et al. 2004). East-central South Dakota could be a major stopover area for these granivorous species and others, but to our knowledge no estimate of migrating population sizes, besides blackbirds, is known in this region. Many of the bird species residing in the northern Great Plains have been in population decline for several years, and many of these species are granivores (Brennan and Kuvlesky 2005).

We did not sample the fields for densities of weed seeds and waste corn, instead using flock activity as our indicator of presence of food. Obviously, leftover cereal grains and weeds seeds are major food sources for granivorous birds on migration, and we recommend that more research be conducted to assess the amounts of foods available in the three foraging habitats we defined. Moreover, additional field studies aimed at documenting the optimal size, placement, configuration, and density of food patches for granivorous birds also should be considered in light of the recent population declines of several prairie grassland bird species. Managers interested in providing food plots for migrating wildlife should consider planting corn or other row crops, such as sunflower (*Helianthus* spp.), near wetlands and shelterbelts to enhance the quality and safety of critical stopover habitat (Johnson and Beck 1988). Harvested fields of row crops will be used by residents, winter migrants, and spring migrants when the ground is free of snow (Galle et al. 2004). Leaving some standing crop will provide another source of cover and food during periods of snow cover. The strategic placement of food plots at critical stopover sites should help enhance the body condition and survivability of birds at reproductive sites in the northern Great Plains (Smith and Moore 2005).

ACKNOWLEDGMENTS

We thank M. Klich, R. Kostecke, M. Lutman, and R. Wimberly for assistance with data collection. Funding was provided jointly by the National Wildlife Research Center, a unit within the Wildlife Services program of the United States Department of Agriculture, Animal and Plant Health Inspection Service, and by the Department of Biological Sciences at North Dakota State University.

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Received: 27 July 2005 *Accepted: 31 August 2006*

Associate Editor for Ornithology: Gregory A. Smith