# Habitat Characteristics of Spring Blackbird Roosts in East-central South Dakota

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ABSTRACT -- In the northern Great Plains, blackbirds (Icteridae) roost almost exclusively in emergent-dominated wetlands. The physical characteristics of wetland roosts are not well understood. From 20 March to 20 April 1999, we studied 16 wetlands used as blackbird roosts in east-central South Dakota. Six wetlands had major roosts (range: 102,000-298,000 blackbirds); whereas, 10 wetlands had minor roosts (range: 2,010-34,000 blackbirds). Maximum roost size was correlated directly with emergent vegetation area ($P = 0.05$) and possibly with wetland basin area ($P \leq 0.10$). Water depths were greater at used sites within wetlands of major roosts (median = 44 cm) than at used sites of minor roosts (median = 25 cm). Palustrine wetlands with large expanses of emergents (> 100 ha) and water depths (> 40 cm) had an increased likelihood of developing into major spring roosts in east-central South Dakota.

**Key words:** blackbirds, cattail, emergents, roost-site selection, South Dakota, spring migration, wetlands.

High densities of large semipermanent wetlands and an abundance of waste corn (*Zea mays*) in stubble fields make east-central South Dakota an attractive stopover area for spring migrating blackbirds (Icteridae). Several million blackbirds

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might stage in this region for weeks. The main migration occurs between mid-March and late April (Homan et al. 2004). During peak migratory periods, over a million birds might roost in a single wetland (Knittle et al. 1987), and wetland roosts from 50,000 to 300,000 birds are common (Homan et al. 2004). The roosts in east-central South Dakota are dominated by the red-winged blackbird (*Agelaius phoeniceus*), often forming greater than 70% of a roost (Homan et al. 2004). Why some wetlands are used consistently as spring roosts and favored by large populations, while other similar wetlands are not, has perplexed biologists for many years (Meanley 1965, Weatherhead and Bider 1979).

Roost-site selection is a process involving habitat quality at decreasing spatial scales (Johnson 1980, Hutto 1985, Orians and Wittenberger 1991). As defined by Johnson's (1980) hierarchal order of selection, the staging grounds in east-central South Dakota (and in particular, the Prairie Coteau region) would be considered a second-order selection. Roost-site selection would be a subset of the next lower spatial scale, third-order habitat selection. This scale is defined by the spatial area within which routine activities are conducted. At the third-order level, blackbirds choose their roosting sites based wholly or in part on visual or behavioral cues. In the present case concerning roost-site selection by blackbirds, these would include physical aspects of wetlands such as basin size and the vegetation available as roosting substrate. Land uses within the range of daily excursions also might influence roost-site choice. Although these habitat cues are considered the proximate causes of roost-site choice, they are embedded in some ultimate causes, which affect fitness and survival because such choices ultimately regulate physical and biological costs and benefits (Hildén 1965). As a result of non-random habitat use, some wetlands will have higher probabilities of holding large roosts than others (Cody 1985). Once chosen, non-random use might occur within the wetland. This typifies fourth-order selection, also known as microhabitat selection (Hall et al. 1997).

In 1999, during spring migration, we investigated the effects of wetland characteristics on roost-site use in east-central South Dakota. Our study design incorporated elements of hierarchical spatial scales that potentially could be encountered by blackbirds selecting roost sites at traditional stopover areas. The objective was to evaluate predictability of roost development based on physical and vegetative features that could be recognized by biologists without making detailed environmental measurements.

## STUDY AREA

We conducted our research in a 15,710 km$^2$ area in east-central South Dakota comprising nine counties: Brookings, Clark, Codington, Deuel, Hamlin, Kingsbury, Lake, Miner, and Moody. There were over 60,000 seasonal wetlands and nearly

17,000 semipermanent wetlands in the study area. The wetland basins occupied 32,300 ha and 70,660 ha, respectively (Reynolds et al. 1997). The Prairie Coteau ecoregion, which makes up most of the study area, has high concentrations of semipermanent wetlands (Johnson and Higgins 1997, Bryce et al. 1998). The historical upland vegetation type was tallgrass prairie and mixed grass prairie, but very little of the native prairie grasses remain. Agricultural land use was intense. Rolling and hilly terrain was used for pastureland and hay. Flatter lands were planted mainly in corn and soybean (*Glycine max*); 290,000 ha of corn and 350,000 ha of soybeans were harvested in the study area in 1998. These two crops accounted for over 40% of land use in the study area (National Agricultural Statistics Service 2005). Annual precipitation averaged 55 cm; however, extended dry and wet cycles occurred.

## METHODS

During October 1998 all wetland basins greater than or equal to 40 ha and containing greater than or equal to 20 ha of emergent vegetation were located while flying aerial transects (~9.8 km wide). Additionally, we included any wetlands that were known to have held large roosts during previous spring migrations (Knittle et al. 1996). Lastly, any active roosts found while conducting mobile searches throughout the study area were included. Sixteen wetlands fit our selection criteria. We visited the wetlands one to three times per week between 20 March and 20 April 1999. We recorded the number of blackbirds either during morning departure or evening return by using the block-count method (Meanley 1965, Arbib 1972). Morning counts were started 30 min before sunrise; evening counts started 60 min (minor roosts) to 90 min (major roosts) before sunset. If there was measurable precipitation or visibilities less than 1 km, no counts were done. The size of roosting populations at the monitored wetlands were often dynamic; however, at least one count of greater than or equal to 50,000 birds was needed to characterize a wetland as a major roost site.

We used a Geographic Information System (GIS) to estimate proportions of five agricultural land-use categories within a 16 km radius of the 16 wetlands. Agricultural land use was classified as follows: 1) soybean, 2) corn, 3) fallow, 4) pasture/hay, and 5) other crop. The classifications were obtained from 1998 Landsat Thematic Mapper images analyzed by the National Agricultural Statistics Service Spatial Analysis Research Section. Wetland basin sizes and areal coverages of emergent vegetation and open water were obtained from vertical aerial photography conducted during April 1999. This was low altitude, large-scaled photography with a ground resolution of approximately 1 $m^2$. Digitized images of the color photographs were imported into GIS, and the basin areas and wetland features were then quantified. Proportions of emergents and open water were obtained by dividing areal coverages of these variables by basin size. Prior to the wetland feature analyses, each digitized image was geo-referenced and rectified by using control points collected by a differential Global Positioning System receiver (SATLOC Inc., Scottsdale, Arizona). The GIS classifications were error checked against ground-truthed points (Congalton 1991). Classification accuracy of the open-water and emergent vegetation features averaged 90% among the 16 wetland basins.

In the specific areas used by the roosting blackbirds, we ran three 45 m transects. Each transect was spaced 25 m apart and ran parallel to the long axis of the roosting site. Water depth (m), emergent plant density (stems/$m^2$), and average vegetation height (m) were measured at 10 regularly distributed points along each transect. An equal number of points were taken at randomly selected unused areas within the same wetland. Data were collected along transects run in major and minor roosts.

We used Spearman rank correlation analysis to investigate the relationship between maximum roost counts at the 16 wetlands and 1) basin area, 2) areal coverages of emergent vegetation and open water, and 3) proportions of emergent cover and open water. Wilcoxon two-sample tests were used to examine null hypotheses of no difference ($P = 0.05$) between water depth, vegetation height, and stem density between 1) used and unused areas of major roosts, and 2) used areas of major and minor roosts. Wilcoxon two-sample tests were also used to compare agricultural land-use proportions within 16 km radii of major and minor roosts.

## RESULTS

Sixteen wetlands had roosting populations ranging in maximum size from 2,000 to 298,000 (Table 1). Six wetlands contained major roosts (>102,000 birds). Five of the major roosts were in wetlands with a history of harboring large numbers of blackbirds during previous spring migrations or were in wetlands less than 6 km from previously reported major roosts.

The median basin area of wetlands with major roosts was 167 ha (range = 24-327). Median emergent and open water coverages were 120 ha (range = 17-203) and 42 ha (range = 7-192), respectively. The low ends of the ranges were due to a major roost (160,100) that developed in a small wetland (24 ha) less than 2 km from a more typical semipermanent wetland roost (133 ha basin with 73 ha of emergents) that had existed as a major roost from 1993 to 1998. Otherwise, the remaining five major roosts were in large wetlands with extensive stands of emergents greater than 110 ha. Basin sizes of minor roosts were much smaller (median = 108 ha, range = 38-162). Concomitantly, emergent coverage (median = 56 ha, range = 31-104) and open water coverage (median = 30 ha, range = 5-101) were smaller (Table 1).

Table 1. Features of 16 wetlands with blackbird roosts during spring migration in east-central South Dakota in 1999.

| Wetland | Basin Area (ha) | Open Water (ha) | % Coverage | Emergents (ha) | % Coverage | Highest Count (x 1,000) |
|---|---|---|---|---|---|---|
| A | 152 | 18 | 12 | 134 | 88 | 298 |
| B | 309 | 106 | 34 | 203 | 66 | 180 |
| C | 24 | 7 | 29 | 17 | 71 | 160 |
| D | 123 | 10 | 8 | 114 | 92 | 123 |
| E | 181 | 66 | 36 | 115 | 64 | 122 |
| F | 327 | 192 | 59 | 135 | 41 | 102 |
| G | 154 | 60 | 39 | 94 | 61 | 34 |
| H | 131 | 33 | 25 | 98 | 75 | 12 |
| I | 133 | 29 | 22 | 104 | 78 | 12 |
| J | 88 | 28 | 32 | 60 | 68 | 12 |
| K | 82 | 30 | 36 | 52 | 64 | 8 |
| L | 70 | 19 | 27 | 52 | 73 | 7 |
| M | 128 | 67 | 53 | 60 | 47 | 6 |
| N | 38 | 5 | 13 | 33 | 87 | 6 |
| O | 48 | 6 | 12 | 42 | 88 | 4 |
| P | 132 | 101 | 77 | 31 | 23 | 2 |

Maximum roost size was not significantly correlated with basin area ($r^2 = 0.18$, $n = 16$, $P = 0.10$), but was significantly correlated with emergent area ($r^2 = 0.43$, $n = 16$, $P < 0.01$). However, open water and emergent vegetation (primarily, cattail [*Typha* spp.]), converted to proportions of basin area, were not significantly correlated with maximum roost size ($r^2 = 0.02$, $n = 16$, $P = 0.57$). Median proportions for emergent vegetation between major and minor roosts were nearly equal at 0.68 (range = 38-92) and 0.71 (range = 23-88), respectively.

No differences were detected between used and unused sites within wetlands of major roosts for water depth (m), emergent density (stems/m$^2$), and emergent height (m) (z range = 0.56-1.20, P range = 0.26-0.59). However, the comparisons probably were weakened by the limited number of major roosts available; stem densities at used sites were notably greater (median = 16 stems/m$^2$, range = 7-18) than at unused sites (median = 10 stems/m$^2$, range = 6-13). Median values between used and unused sites (respectively) for water depth were 44 cm and 38 cm, and for emergent stem height, 79 cm and 66 cm.

A comparison between used areas in major and minor roosts showed that water depths were greater (median = 44 cm, range = 24-56) for major roosts than minor roosts (median = 25 cm, range = 2-50; z = 2.2, P = 0.04). No difference was detected between emergent stem heights at used sites of major roosts (median = 79 cm, range = 50-125, n = 6) and minor roosts (median = 67 cm, range = 14-81, n = 10; z = 1.46, P = 0.16), nor were emergent stem densities different between used sites of major roosts (median = 16 stems/m$^2$, range = 7-18) and minor roosts (median = 14 stems/m$^2$, range = 4-20; z = 0.16, P = 0.87).

Proportions of agricultural land use within a 16 km radius of wetland centers were similar between major and minor roosts (z range = 0.70-1.36, P range = 0.20-0.49). Soybean, corn, and pasture-hay comprised 68% of agricultural land use occurring within a 16 km radius of both roost types.

## DISCUSSION

Staging blackbirds often remain in east-central South Dakota for several weeks during spring migration. While staging, they encounter a wide variety of wetland configurations and sizes. Unlike the time commitment involved in choosing a nest site, the commitment to a roost site consists of only one night (Orians and Wittenberger 1991). When wetland conditions are not optimum for roosting, the birds can move on quickly and try another site. Over the study period, we should have observed unambiguous usage of wetlands having those characteristics favored by spring migrants. The difference between numbers of blackbirds at our largest minor roost (34,000) and our smallest major roost (102,000) indicated that indeed habitat selection was being practiced by the majority of migrants. However, this does not mean that the decision process used to select a roost site was necessarily being made on the variables we measured, and other factors (including behavioral factors such as philopatry) might have been used by the birds.

The nearly significant correlation between basin area and maximum roost size was probably an indirect finding, because five of the six major roosts occurred in very large stands of emergents (>110 ha). Variation in area of emergent coverage explained variation in maximum roost size better than variation in basin area. The ratio of open water areas to emergent vegetation, which sometimes can predict avian species use, was not usable for locating potential roosts (Linz et al. 1996a, 1996b; Linz and Blixt 1997). Thus, only two of the several wetland characteristics measured by us were indicative of major roosts. One of these was a third-order component involving selection at the wetland level (i.e., emergent area). The other was a fourth-order selection at the within-wetland level (i.e., water depth). Of these two, only emergent area would be suitable as a visually recognizable characteristic of major roosts. Although the presence of broad expanses of emergents suggested potential use as major roosts by blackbirds, it certainly was not definitive; 5 of 10 minor roosts had emergent coverages greater than 100 ha. Even so, such extensive blocks of emergents would be rare within the northern Great Plains landscape and using this characteristic should reduce rapidly the pool of potential wetlands of major roosts.

Although 5 of 10 minor roosts had emergent plant coverages greater than 100 ha, the quality of the stands themselves might have had some effect on roosting birds. Water depths at used sites of minor roosts were nearly 20 cm less than at used sites of major roosts. Stands in shallow waters were probably in poor condition because unstable water levels would probably interfere with optimal and long term emergent growth through occasional dry periods. At major roosts, taller and denser stands of emergents were characteristic of used sites; and despite the lack of a significant finding for stem density, we found that stem densities were much greater at used than unused sites. Beneficial growing conditions found in deeper portions of a wetland probably produce denser cattail stands of better quality (Weller 1994). Increased water depths could benefit roosting blackbirds in at least three ways. They could serve as 1) a barrier to predator incursions, 2) a reliable source of stored heat (water has a high heat-storage capacity), and 3) production of quality thermal vegetative cover. The latter two would be factors for thermal protection, particularly during frequent periods of below-freezing temperatures during spring migration (Meanley 1965, Lyon and Caccamise 1981, Eiserer 1984, Walshberg 1986, Glahn et al. 1994, Homan et al. 2000).

We found a 160,000 bird roost in a wetland containing only 17 ha of emergents. If this was a threshold minimum area capable of providing roosting substrate for greater than 100,000 birds, then use of large blocks of emergents (typical of those found at the other major roosts) would seem exorbitant. However, even within the vast stands of emergents, only small areas were used, and they were used repeatedly. Large expanses of emergents might be favored over smaller ones solely because larger areas of roosting substrate offer more chances (in the long term) of containing a preferred microhabitat.

The probability that an area will contain a blackbird roost can be thought of as a function of the physical characteristics of wetlands and the surrounding land use. The finding of no differences in agricultural land use between major and minor roosts should not imply that landscape was not a factor in roost-site selection. Agricultural landscapes in the Great Plains are by their natures fairly homogeneous and lacking in significant variation. This is compounded further by the fact that blackbirds might often fly far from their roosts while on daily excursions (Otis et al. 1986), and they feed in a wide variety of habitats (McNicol et al. 1982, Linz et al.

1984, Linz et al. 2002). Possibly, major roosts can only be found in areas of intense agricultural use, or conversely, intense agricultural use in the northern Great Plains occurs only in landscapes with wetland configurations preferred by migrating blackbirds.

## MANAGEMENT IMPLICATIONS

A thorough knowledge of roost-site preferences by blackbirds might help in reducing conflicts that often occur between agricultural producers in the Great Plains and concentrated flocks of blackbirds (Linz et al. 1995). The traditional method for finding roosts involves mobile searches for evening and morning flight lines. This method has two drawbacks. Search time is limited, and long flight lines, those that would be easiest to detect, do not occur until after a site has already developed into a major roost. Historical use of wetlands could help focus search efforts for roosts, but additional information on preferred wetland characteristics would further expedite the process. National Wetlands Inventory data could be used to rank wetlands according to size and type of aquatic bed; whereas, digital orthoquad images could be used to ascertain if wetlands previously had contained emergent vegetation.

Three of the six major roosts had open water: emergent cover ratios greater than 66%. Typically, resource managers prefer a 50:50 ratio of open water to emergent cover (Weller 1994). This ratio maximizes habitat heterogeneity in wetlands and is thought to increase biodiversity, which wildlife managers seek. With the invasion of hybrid cattail (*T. glauca*) into the northern Great Plains starting in the 1950's, wetlands have lost their habitat mosaics because hybrid cattail creates dense monotypic stands leaving little or no areas of open water (Kantrud et al. 1989). This not only decreases avian biodiversity but also degrades ecological functions (Weller and Fredrickson 1974, Weller 1994, Linz et al. 1996a, 1996b). The presence of a major blackbird roost could indicate that a wetland has started to lose its spatial heterogeneity.

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## LITERATURE CITED

Arbib, R. 1972. On the art of estimating numbers. American Birds 26:706-712, 814.

Bryce, S., J. M. Omernik, D. E. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S. H. Azevedo. 1998. Ecoregions of North Dakota and South Dakota. Northern Prairie Wildlife Research Center, Jamestown, North Dakota. Online: http://www.npwrc.usgs.gov/resource/1998/ndsdeco/ndsdeco.htm (Version 30NOV98).

Cody, M. L. 1985. Habitat selection in grassland and open-country birds. Pp. 191-226 *in* Habitat selection in birds (M. L. Cody, editor). Academic Press, Orlando, Florida.

Congalton, R. G. 1991. A review of assessing the accuracy of classifications of remotely sensed data. Remote Sensing of the Environment 37:35-46.

Eiserer, L. A. 1984. Communal roosting in birds. Bird Behaviour 5:61-80.

Glahn, J. F, R. D. Flynt, and E. P. Hill. 1994. Historical use of bamboo/cane as blackbird and starling roosting habitat: implications for roost management. Journal of Field Ornithology 65:237-246.

Hall, L. S., P. R. Krausman, and M. L. Morrison. 1997. The habitat concept and a plea for standard terminology. Wildlife Society Bulletin 25:173-182.

Hildén, O. 1965. Habitat selection in birds. Annales Zoologici Fennici 2:53-75.

Homan, H. J., G. M. Linz, and W. J. Bleier. 2000. Winter habitat use and survival of female ring-necked pheasants (*Phasianus colchicus*) in southeastern North Dakota. American Midland Naturalist 143:463-480.

Homan, H. J., G. M. Linz, R. M. Engeman, and L. B. Penry. 2004. Spring dispersal patterns of Red-winged Blackbirds, Agelaius phoeniceus, staging in eastern South Dakota. Canadian Field-Naturalist 118:201-209.

Hutto, R. L. 1985. Habitat selection by nonbreeding, migratory land birds. Pp. 455-476 *in* Habitat selection in birds (M. L. Cody, editor). Academic Press, Orlando, Florida.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65-71.

Johnson, R. R., and K. F. Higgins. 1997. Wetland resources of eastern South Dakota. South Dakota State University, Brookings, South Dakota.

Kantrud, H. A., G. L. Krapu, and G. A. Swanson. 1989. Prairie basin wetlands of the Dakotas: a community profile. United States Fish and Wildlife Service, Biological Report 85.

Knittle, C. E., G. M. Linz, J. L. Cummings, J. E. Davis, Jr., B. E. Johns, and J. F. Besser. 1996. Spring migration patterns of male red-winged blackbirds (*Agelaius phoeniceus*) from two migratory roosts in South Dakota and Minnesota. American Midland Naturalist 136:134-142.

Knittle, C. E., G. M. Linz, B. E. Johns, J. L. Cummings, J. E. Davis, Jr., and M. M. Jaeger. 1987. Dispersal of male red-winged blackbirds from two spring roosts in central North America. Journal of Field Ornithology 58:490-498.

Linz, G. M., D. L. Bergman, H. J. Homan, and W. J. Bleier. 1995. Effects of herbicide-induced habitat alterations on blackbird damage to sunflower. Crop Protection 14:625-629.

Linz, G. M., and D. C. Blixt. 1997. Black terns benefit from cattail management in the northern Great Plains. Colonial Waterbirds 20:617-621.

Linz, G. M., D. C. Blixt, D. L. Bergman, and W. J. Bleier. 1996a. Response of ducks to glyphosate-induced habitat alterations in wetlands. Wetlands 16:38-44.

Linz G. M., D. C. Blixt, D. L. Bergman, and W. J. Bleier. 1996b. Responses of red-winged blackbirds, yellow-headed blackbirds and marsh wrens to glyphosate-induced alterations in cattail density. Journal of Field Ornithology 67:167-176.

Linz, G. M., M. J. Kenyon, H. J. Homan, and W. J. Bleier. 2002. Avian use of rice-baited corn stubble in east-central South Dakota. International Biodeterioration and Biodegradation 49:179-184.

Linz, G. M., D. L. Vakoch, J. F. Cassel, and R. B. Carlson. 1984. Food of red winged blackbirds (*Agelaius phoeniceus*) in sunflower fields and corn fields. Canadian Field-Naturalist 98:38 44.

Lyon, L. A., and D. F. Caccamise. 1981. Habitat selection by roosting blackbirds and starlings: management implications. Journal of Wildlife Management 45:435-443.

McNicol, D. K., R. J. Robertson, and P. J. Weatherhead. 1982. Seasonal, habitat, and sex-specific food habits of red-winged blackbirds: implications for agriculture. Canadian Journal of Zoology 60:3282-3289.

Meanley, B. 1965. The roosting behavior of the red-winged blackbird in the southern United States. Wilson Bulletin 77:217-228.

National Agricultural Statistics Service. 2005. Agricultural statistics database. Online: http://www.nass.usda.gov/quickstats/.

Orians, G. H., and J. E. Wittenberger. 1991. Spatial and temporal scales in habitat selection. American Naturalist 137:29-49.

Otis, D. L., C. E. Knittle, and G. M. Linz. 1986. A method for estimating turnover in spring blackbird roosts. Journal of Wildlife Management 50:567-571.

Reynolds, R. E., D. R. Cohan, and C. R. Loesch. 1997. Wetlands of North and South Dakota. Northern Prairie Wildlife Research Center, Jamestown, North Dakota. Online: http://www.npwrc.usgs.gov/resource/wetlands/wetstats/wetstats.htm (Version 01OCT1997).

Walshberg, G. E. 1986. Thermal consequences of roost-site selection: the relative importance of three modes of conservation. Auk 103:1-7.

Weatherhead, P. J., and J. R. Bider. 1979. Management options for blackbird problems in agriculture. Phytoprotection 60:145-155.

Weller, M. W. 1994. Freshwater marshes — ecology and wildlife management. Third edition. University of Minnesota Press, Minneapolis, Minnesota.

Weller, M. W., and L. H. Fredrickson. 1974. Avian ecology of a managed glacial marsh. Living Bird 12:269-291.

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