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EFFECTS OF HABITAT AND INVERTEBRATE DENSITY ON ABUNDANCE AND FORAGING BEHAVIOR OF BROWN-HEADED COWBIRDS

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ABSTRACT.—We studied foraging Brown-headed Cowbirds (*Molothrus ater*) in central Missouri to determine the influence of habitat type and invertebrate biomass on cowbird abundance and behavior. We measured flock size, density, peck rate, foraging time, vigilance, aggression, and invertebrate abundance in five habitats. Seven sites contained short-grazed grass, short-ungrazed grass, tall-grazed grass, tall-ungrazed grass, and feedlot habitat treatments. Cowbird flock sizes were largest in short-grazed grass, but densities were highest in feedlots. Foraging time and aggression did not differ among habitats, but peck rates were highest in feedlots, and vigilance at foraging sites was highest in short-grass habitats. Females spent more time foraging than males, but peck rates did not vary significantly with sex. Males spent more time in vigilant and aggressive behaviors than did females. Invertebrate biomass and density were lowest in feedlots. Large flock sizes and high peck rates coincided with high invertebrate densities in short-grazed grass. Cowbird flock size was positively related to invertebrate density, but foraging time and peck rate were not related to invertebrate density. We conclude that cattle were an important component of the habitat that influenced cowbird foraging behavior. Cowbirds selected feedlots because of readily available grain and selected short-grazed grass because of the availability of invertebrate foods. Compared with grazing, grass height was of secondary importance to foraging cowbirds. *Received 12 March 1997, accepted 3 September 1997.*

ALTHOUGH BREEDING ECOLOGY, host interactions, and parasitism levels have been widely studied in Brown-headed Cowbirds (*Molothrus ater*), little is known about their feeding ecology (see Lowther 1993). Historically, Brown-headed Cowbirds may have been limited to the shortgrass plains because of their feeding requirements. The cowbird's life history likely evolved on the Great Plains with bison (*Bison bison*). Bison ate and trampled grass in a manner that may have provided suitable vegetative structure for foraging cowbirds, exposed foods such as insects and seeds, and possibly increased the availability of insects to cowbirds (Friedmann 1929). Cowbirds commonly feed in shortgrass habitats such as pasture and other agricultural habitats such as feedlots, horse corrals, and croplands (Friedmann 1929, Mayfield 1965, Rothstein et al. 1980, 1984, Thompson 1994, Thompson and Dijak 1998).

Mechanisms underlying the association of feeding cowbirds with livestock and shortgrass habitats have not been determined. Cowbirds could benefit directly from the presence of cattle because cattle expose invertebrates and may serve as perches or protective cover. Cowbirds could benefit indirectly from cattle because grazing maintains shortgrass cover. Cowbirds might prefer shortgrass cover because of increased visibility to detect predators and conspecifics, or because of more efficient movement or foraging. Shortgrass habitats also might offer a high density food because grazed habitats often have high numbers of invertebrates (Coyner 1938, Holmes et al. 1979, Capinera and Sechrist 1982, Jepson-Innes and Bock 1989). Despite detailed observations on foraging cowbirds (Friedmann 1929, Mayfield 1965, Williams 1975), there has been little analysis of cowbird foraging behavior or feeding-habitat preference. Thompson and Dijak (1998) showed that feeding cowbirds preferred grassland and feedlots, but they did not differentiate between grazed and ungrazed or tallgrass and shortgrass habitats.

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A better understanding of cowbird feeding-habitat requirements could benefit conservation efforts directed at cowbird hosts. During the breeding season, cowbirds typically spend the early morning in host-rich forested habitats and then commute in late morning to agricultural or developed areas to feed (Rothstein et al. 1984, Thompson 1994). The distribution of suitable feeding habitats appears to be an important limiting factor for cowbirds in many landscapes (Robinson et al. 1993, 1995, Donovan et al. 1998, Thompson et al. 1998).

We determined the effects of habitat type and invertebrate biomass and density on the abundance, density, and behavior of female and male Brown-headed Cowbirds. We censused cowbirds in five habitats to determine feeding-habitat preferences and examined differences in foraging behavior among habitats. We measured invertebrate biomass and density to determine if habitat preferences and foraging success were related to food availability. If the main values of shortgrass habitats are increased visibility or ease of movement and foraging, then cowbirds should prefer these habitats irrespective of grazing. Cowbirds should prefer grazed habitats irrespective of habitat structure (grass height) if the main benefits from livestock are protective cover for cowbirds or increased food availability because cattle disturb and expose insects. Cowbirds also might choose foraging habitats based solely on food availability, in which case we would expect them to forage in habitats that have the highest abundance of invertebrates.

METHODS

Study area and design.—We studied cowbirds on private farms in Boone and Callaway counties southeast of Columbia, Missouri. The study area consisted mostly of cropland (corn, soybeans, winter wheat) and pastures (*Festuca* spp., *Dactylis glomerata, Phleum pratense,* and *Panicum virgatum*). Approximately 24 to 30% of the landscape was oak-hickory (*Quercus* spp. and *Carya* spp.) forest (Geissman et al. 1986). Cowbirds are abundant in the area, and host parasitism levels are comparatively high (Robinson et al. 1995, Thompson et al. 1998).

We collected data on numbers of cowbirds, foraging behavior, and invertebrate biomass and density in five habitat types replicated on seven study sites. Our study sites were seven small cattle farms, each of which consisted of these five habitats either in adjacent or nearby fields. Study sites had an average size of 52.7 ha and were more than 2 km apart, which is greater than the average distance traveled by cowbirds between breeding and feeding areas in this landscape (Thompson 1994); therefore, we assumed that there was little or no movement by cowbirds among study sites. Habitat types were: (1) short-grazed grass (grass grazed by cattle to 2 to 20 cm), (2) short-ungrazed grass (mowed lawns or hayfields with grass heights of 2 to 10 cm), (3) tall-grazed grass (grass grazed by cattle to 5 to 30 cm), (4) tall-ungrazed grass (unmowed hayfields with grass heights >30 cm), and (5) feedlots (permanent areas lacking grass where cattle were fed processed feed or grain). Unlike Rothstein et al. (1984), we rarely observed cowbirds in other habitats such as campgrounds, picnic areas, or at bird feeders because these habitats were uncommon in the study area (and thus would not have been available to include in the study site replications). Cattle were not always present in feedlots during observation periods, but feed always was available. Grass heights were based on measurements of the shortest and tallest patches of grass because grazing results in a variety of grass heights. Because of lighter grazing intensity in tall-grazed pastures, patches of short grass generally were smaller and scarcer than in short-grazed pastures. Habitat treatments ranged in size from 0.04 to 40 ha, and size tended to differ among habitats. Mean patch sizes were 0.21, 16.64, 9.04, 25.52, and 15.12 ha for feedlots, short-grazed, short-ungrazed, tall-grazed, and tall-ungrazed habitats, respectively. Insecticides were not used on study sites prior to or during the study.

Cowbird abundance.—We censused feeding cowbirds from 15 May to 11 July 1995. Censuses were distributed evenly throughout the day between 1100 and 1900 CDT. Most habitat patches were sampled at least six times. Some ungrazed habitats were sampled fewer than six times because of mowing schedules adhered to by landowners.

During each census, we observed the entire field from one vantage point or walked the entire field in a zigzag pattern and used playbacks of the male cowbird song and flight whistle (Rothstein et al. 1988). The playbacks caused birds to flush so that they could be detected even in tall grass. We recorded the total flock size per field; the number of females, males, and juveniles per flock; date; and time of day for each sighting.

Foraging observations.—We conducted 30-s focal-animal samples (Altmann 1974) in all habitats between 1100 and 1900 from 15 May to 14 July 1995 using a spotting scope or binoculars. When we located a flock in a particular field, we systematically observed individuals from the left to the right side of the flock. Usually, one researcher remained alert for newly arriving birds and pointed those birds out for observation. Observations were terminated if a flock or part of a flock departed. We recorded behaviors

on a microcassette recorder. Behaviors were classified as foraging, pecking, head raised, bill tilt, bow (Lowther 1993), preening, flying, landing, chasing or being chased, or avoiding other birds on the ground. We also recorded flock size, time of day, date, and type of food eaten (when possible) during each sample. Other species, such as European Starlings (*Sturnus vulgaris*) and Red-winged Blackbirds (*Agelaius phoeniceus*), fed in the same habitats but were not included in estimates of flock size.

We used a computer program to time and record behaviors while playing tapes recorded in the field. Individual birds observed for <30 s were eliminated from analysis. Some behaviors were grouped for analysis: aggression (bows, bill tilts, and chasing other birds), avoidance (avoiding and being chased), and flying (flying and landing). Mean times spent flying or avoiding other birds were negligible and were not included in the analysis. Birds standing still with their heads raised were assumed to be vigilant for predators, intruders, or conspecifics. Foraging included time spent pecking, because cowbirds searched for seeds and insects by pecking and probing on the ground. Birds pecking at the ground, gleaning, or probing into soil were considered to be pecking. We used peck rate as a measure of foraging effort (attempt per second) and calculated it by dividing the number of pecks by foraging time in a 30-s observation. We dropped two of the seven sites from the analysis because cowbirds at those sites were only present in one habitat type (i.e. we could not get estimates of foraging behavior in the other habitats). Cowbirds were uncommon in tall-ungrazed grass, and it was difficult to observe them foraging in this habitat; thus, we dropped tall-ungrazed habitat from the foraging analysis.

Invertebrate biomass and density.—We collected invertebrates with a hand-held suction collector (modified from Wilson et al. 1993). Each field was sampled twice at intervals of at least two weeks between 7 June and 14 July 1995. We took samples in three 2-m^2 plots that were located randomly along a diagonal transect in each habitat patch. Samples were collected by sweeping the suction collector over the plot twice 1 to 3 cm above the ground. In tall-grass plots, we swept the collector over the tallest height of the grass, at mid-height, and near the ground. Invertebrates were vacuumed into a nylon bag and placed on ice to slow their movements and predatory activities. Samples were stored at 0°C until we separated them from litter and debris. We dried the samples for 24 h at 70°C and counted and weighed (±0.001 g) each individual. We identified invertebrates to order and analyzed only the following orders known to occur in the cowbird's diet: Acarina, Araneida, Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, and Orthoptera (Williams 1975, Williams and Jackson 1981). We excluded invertebrates from the orders Thysanoptera and Collembola because these are minuscule and live in leaf/grass litter where they probably are not available to cowbirds. We assumed that habitat treatment and invertebrate availability were uniform within each field because foraging cattle and cowbirds used the entire fields.

Statistical analyses.—Data were analyzed with SAS statistical procedures (SAS Institute 1988). We calculated means for dependent variables (i.e. density, flock size, peck rate, etc.) from the multiple observations or visits for each habitat-by-site combination. We used two-way ANOVA to determine the effect of habitat and sex on flock size; we log-transformed flock size to correct for heterogeneous variances (Neter et al. 1990). We also used two-way ANOVA to determine the effect of habitat and sex on cowbird density. Density for each habitat patch was calculated by dividing mean flock size by patch size. Comparisons of cowbird densities provide insight into habitat selection because densities essentially are standardized by habitat patch size, which is a measure of habitat availability. We used a rank-transformation to correct heterogeneous variances in cowbird density.

We also used two-way ANOVA to determine the effects of habitat and sex on peck rate, foraging time, vigilance, and aggression. The data had heterogeneous variances that were proportional to the means, so we used a square-root transformation (Neter et al. 1990). We used one-way ANOVA on log-transformed data to determine if there was a habitat effect on invertebrate biomass and density. We also used linear regression to test for relationships between invertebrate biomass and density and foraging success, cowbird density, flock size, and date. For these regressions, we could use only data on invertebrate biomass and density from fields in which we observed cowbirds foraging ($n = 10$). We did not include data from feedlots because foraging success was high but, as we discuss below, invertebrates were not the primary food in feedlots. Cowbird density and flock-size variables were log-transformed when necessary to correct for nonlinear relationships with the invertebrate variables. We used Tukey's mean separation procedure to identify differences among treatments (Neter et al. 1990). Results were considered significant at $P \leq 0.05$. All alpha levels reported are for individual tests; we did not adjust alpha levels to control for experiment-wide error rates.

RESULTS

Cowbird abundance.—Flock sizes varied among habitats ($F = 37.49$, df = 4 and 56, $P = 0.0001$) and were largest in short-grazed grass. Mean flock sizes ranged from 6.6 in short-grazed grass to 0.03 in tall-ungrazed grass.

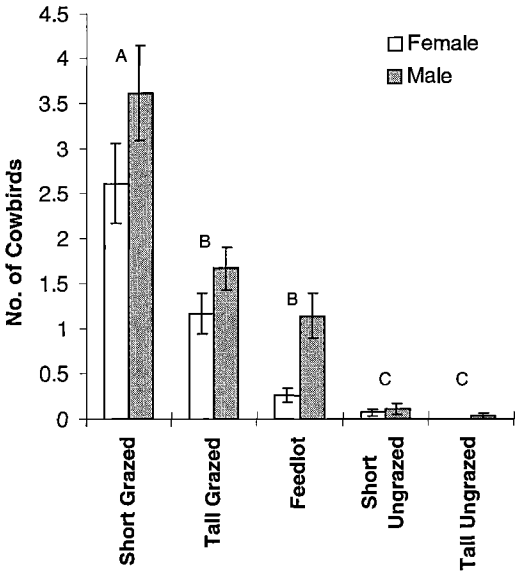

FIG. 1. Differences in mean number of cowbirds in four habitats in central Missouri. Habitats sharing the same letter do not differ significantly; bars indicate standard errors.

Flock sizes did not differ between tall-grazed grass and feedlots nor between the two ungrazed habitats (Fig. 1). Males outnumbered females in all habitats ($F = 4.49$, df = 1 and 56, $P = 0.04$), but there was no interaction between habitat and sex ($F = 0.85$, df = 4 and 56, $P = 0.49$), suggesting that the sexes used habitats in the same way.

Cowbird densities varied among habitats ($F = 59.03$, df = 4 and 56, $P = 0.0001$) and were highest in feedlots. Density in short-grazed grass was higher than in tall-grazed grass, and density in tall-grazed grass was higher than in the two ungrazed habitats. Patterns in numbers and densities of cowbirds were similar except for the elevated importance of feedlots. This difference may have been due largely to the small size of feedlots. Therefore, we limit further results and discussion to data based on numbers of cowbirds.

Foraging behavior.—Cowbirds foraged in all habitats, although their numbers varied greatly among habitats. Food items were difficult to identify because of their small size. Of 356 observations of focal animals, we identified 4 males eating grain and 16 females and 8 males pecking at or eating invertebrates (worms, grubs, or flying insects). On several occasions we observed females running after small beetles or chasing flying insects in short-grazed grass. In grazed habitats cowbirds followed cattle as they moved and usually fed within 1 m of a cow.

Peck rates were highest in feedlots but did not differ between grazed and ungrazed habitats ($F = 5.67$, df = 3 and 26, $P = 0.004$; Fig. 2A). Foraging time did not differ among habitats ($F = 0.69$, df = 3 and 26, $P = 0.57$; Fig. 2B); birds spent a mean of 24 s foraging per 30-s observation period. Vigilance varied among habitats ($F = 3.69$, df = 3 and 26, $P = 0.02$), with birds spending more time vigilant in short-ungrazed grass than in tall-grazed grass or feedlots (Fig. 2C). Habitat had no effect on aggressive behavior ($F = 0.55$, df = 3 and 26, $P = 0.65$; Fig. 2D).

Peck rates did not differ between the sexes ($F = 1.27$, df = 1 and 26, $P = 0.27$; Fig. 2A), but on average, females foraged for 5 more seconds per 30-s sample than did males ($F = 6.55$, df = 1 and 26, $P = 0.01$; Fig. 2B). Vigilance did not differ between males and females ($F = 2.88$, df = 1 and 26, $P = 0.10$; Fig. 2C), but males spent more time in aggressive behaviors than did females ($F = 4.44$, df = 1 and 26, $P = 0.04$; Fig. 2D). Interactions between habitat and sex were nonsignificant for all foraging behaviors ($P > 0.45$ for all comparisons).

Invertebrate biomass and density.—Invertebrate biomass ($F = 5.08$, df = 4 and 24, $P = 0.004$) and density ($F = 16.05$, df = 4 and 24, $P = 0.0001$) varied among habitats. Biomass and density were higher in grass habitats than in feedlots, but there were no significant differences between tall-grass and short-grass habitats or grazed and ungrazed grass (Fig. 3). Neither invertebrate biomass ($r^2 = 0.05$, $P = 0.41$) nor density ($r^2 = 0.002$, $P = 0.70$) varied over the sampling period.

Cowbird flock size and the number of female cowbirds were positively related to invertebrate density ($r^2 = 0.21$, $P = 0.03$ and $r^2 = 0.27$, $P = 0.01$, respectively; Fig. 4). The number of males within flocks was not related to invertebrate density ($r^2 = 0.11$, $P = 0.12$). Flock size ($r^2 = 0.002$, $P = 0.85$), number of females ($r^2 = 0.001$, $P = 0.89$), and number of males ($r^2 = 0.00$, $P = 0.99$) were not related to invertebrate biomass.

There was no relationship between invertebrate biomass and pecking rates ($r^2 = 0.11$, $P = 0.35$) or foraging time ($r^2 = 0.02$, $P = 0.69$), or

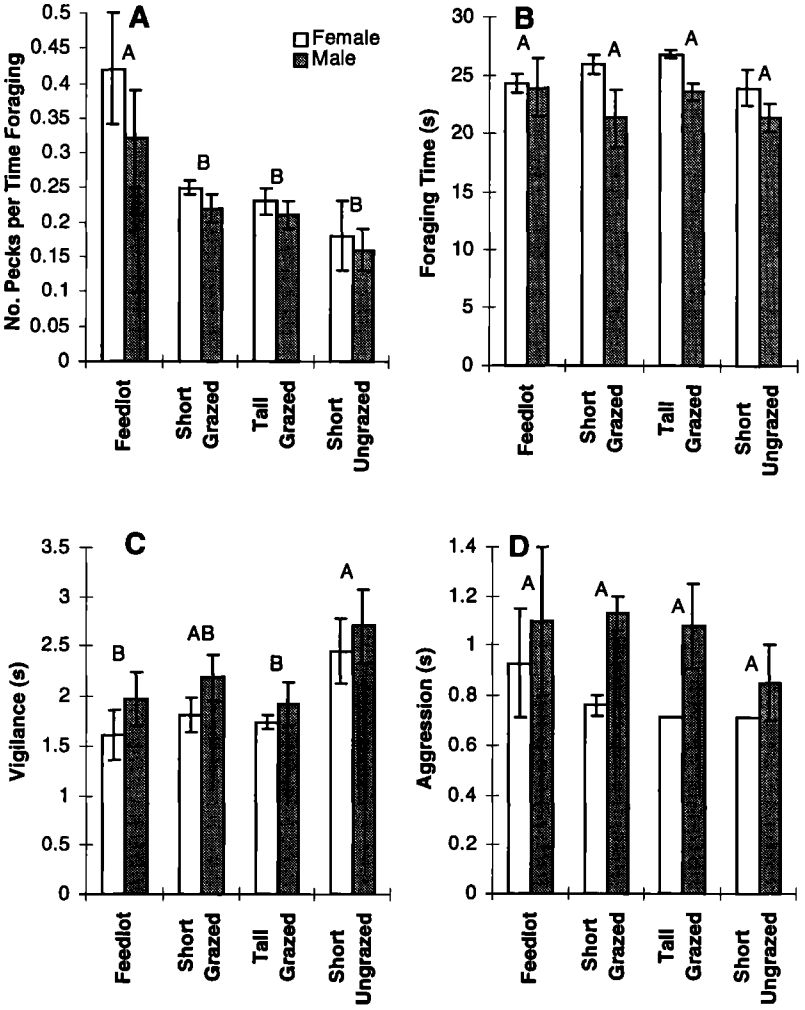

FIG. 2. Differences in Brown-headed Cowbird (A) peck rates, (B) foraging time, (C) vigilance, and (D) aggression between sexes and among four habitats. Habitats sharing the same letter do not differ significantly; bars indicate standard errors.

between invertebrate density and pecking rates ($r^2 = 0.03$, $P = 0.65$) or foraging time ($r^2 = 0.21$, $P = 0.18$).

DISCUSSION

Short-grazed grasslands were the primary habitats used by foraging cowbirds. We believe that food availability was the primary ultimate factor affecting selection of foraging habitat. Intermediate numbers of cowbirds used feedlots because of the readily available food there, but nutritional demands, especially for females, required them to seek invertebrate foods in other habitats (i.e. short- and tall-grazed grass). The fact that cowbird density was highest and flock sizes were intermediate in feedlots (Fig.1) demonstrates the importance of feedlots as a foraging habitat because availability of feedlots was considerably lower than that of the other habitats that we studied. We believe that cowbirds select short-grazed grass habitats primarily because of the high invertebrate densities there. Cowbird numbers were positively related to invertebrate densities, and invertebrate densities appeared to be higher in grazed habitats than in ungrazed habitats (although this difference was not significant). Grass

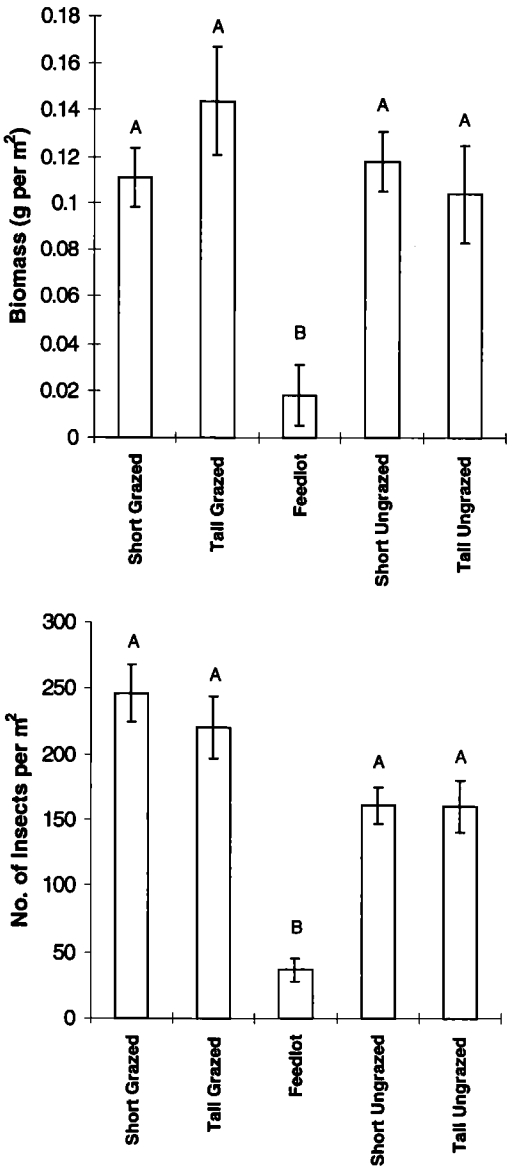

FIG. 3. Differences in mean (±SE) invertebrate biomass and invertebrate density among five habitats. Habitats sharing the same letter do not differ significantly.

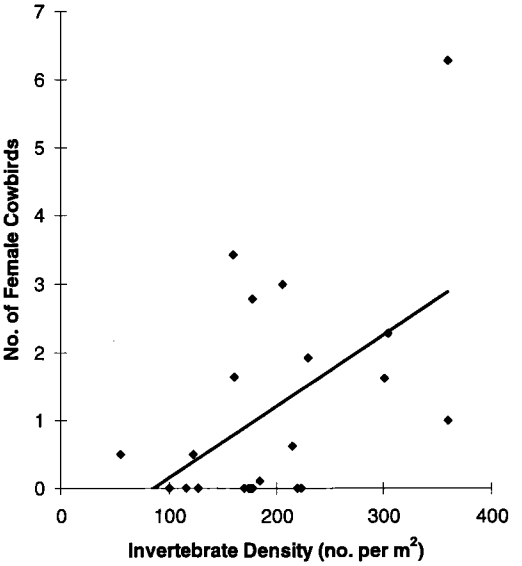

FIG. 4. Relationship between the number of female cowbirds and invertebrate density. The number of female cowbirds = −0.908 + 0.011 (invertebrate density).

height may have been secondarily important because short-grazed grass was used more than tall-grazed grass; however, tall-grazed grass was used more than short-ungrazed grass. Although not quantified in this study, the presence and/or movements of livestock also may have been of secondary importance for disturbing insects because foraging cowbirds continuously followed and remained close to livestock (usually within 1 m).

Cowbird abundance.—Cattle were an important component of cowbird foraging habitat. Flock sizes were noticeably larger in short- and tall-grazed grass and in feedlots than in short-ungrazed and tall-ungrazed grass. Grass height was less important than grazing, but within grazed habitats, short grass was preferred over tall grass. These results are consistent with the observed importance of feedlots, corrals, and grasslands in other studies (Verner and Ritter 1983, Rothstein et al. 1984, Thompson 1994, Thompson and Dijak 1998).

Cowbirds might have foraged in larger flocks in short-grazed grass for increased protection from predators in this open habitat (Powell 1974, Caraco 1979). Flock sizes, however, were small in short-ungrazed grass. Given that flock size and invertebrate density (Fig. 4) were positively related, it is more likely that cowbird flock size was high in short-grazed grass because of high densities of invertebrate foods and perhaps the increased availability of food due to the presence of livestock.

Interestingly, tall-grazed grass was the most common habitat in the study area and had high invertebrate densities but lower flock sizes than

short-grazed grass. Flock sizes may have been lower in tall-grazed grass because the tall vegetation impaired the birds' maneuverability and detection of food. Because birds may be less able to detect predators in tall grass, they may perceive tall grass as both a source of cover and a source of attack from predators (Lima 1987).

Males outnumbered females in all habitat types, which is consistent with observations in other populations of cowbirds (Darley 1971, Rothstein et al. 1980, Verner and Ritter 1983, Thompson 1994).

Foraging behavior.—We detected significant habitat effects on peck rates and vigilance, but not on foraging time and aggression. Peck rates were highest in feedlots, perhaps because hayseed and grain were readily available in feedlots, unlike invertebrate prey in grass habitats. The other habitat effect on behavior was increased vigilance in short-grass habitats, particularly short-ungrazed grass. The lack of vegetative cover and cattle in short-ungrazed grass may have influenced perceived predation risk and resulted in increased vigilance. Furthermore, small flock sizes in short-ungrazed grass may have contributed to longer vigilance times and shorter foraging times.

Given the available food source in feedlots, the high use of grazed habitats suggests that these habitats also provide important foods. The quality of nutrition that cowbirds receive in feedlots may not be sufficient for reproductive needs, especially for females (King 1973). Typically, weed seeds and grains make up 94% of the cowbird's diet in winter and 48% by volume in summer (Friedmann 1929, Martin et al. 1951, Meanley 1971, Williams 1975, Robertson et al. 1978, Williams and Jackson 1981). A decrease in the seed component of the diet during the breeding season is accompanied by an increase in the invertebrate component, especially for females (Ankney and Scott 1980). Female cowbirds obtain all of their protein, most of their fat, and some of their calcium for egg production directly from their diet (Ankney and Scott 1980). We believe the need for a high intake of invertebrates is one of the main reasons that female cowbirds foraged in grazed-grass habitats during the breeding season.

Potential differences in nutritional demands of females and males also were consistent with the sex effects that we observed. Females spent more time foraging than did males, possibly because they must search for and pursue high-protein invertebrates. Male activities such as mate guarding and traveling require mostly high-energy food. Therefore, males can feed on more convenient foods such as weed seeds and grain that are lower in protein but high in energy. Males were much more abundant than females in feedlots, which may reflect their tendency to feed more on grains. Ankney and Scott (1980) found that males also increase their intake of invertebrates during the egg-laying period, but they concluded that this was because males and females feed together, and invertebrates generally are more available during this period.

Males spent more time in aggressive and vigilant behaviors than did females. This difference may not have been due entirely to predator avoidance, but rather to the time that males spent guarding their mates and watching for other males. Sex ratios may influence the prevalence of male competition for females and subsequent mate-guarding activities associated with monogamous populations (Teather and Robertson 1986). Overall, mean aggression times were very low (0.8 s), which is similar to the observations of Dufty (1982) and Rothstein et al. (1986). Males were involved in mate-guarding activities (see Laskey 1950, Darley 1982) that entailed remaining alert for approaching males and keeping a defensive position between a mate and any approaching males. It is noteworthy that we saw little aggression by females. The most common form of aggression by females was bill tilting and/or lunging toward other females when their immediate feeding area was approached.

The fact that females spent more time foraging than males and fed where invertebrate densities were high, and that males spent more time in aggressive behaviors, suggests that the presence of males in these habitats was due to mate competition or mate guarding rather than a preference for feeding habitats. Most likely, females (which have a higher nutrient demand than males) selected invertebrate-rich feeding habitats, and males merely accompanied them and fed wherever they did.

Invertebrate biomass and density among habitats.—Invertebrate biomass and density were lowest in feedlots, which lacked the vegetative structure required by grassland insects. Low

statistical power may have prevented us from detecting a significant difference among grazed and ungrazed habitats. Mean invertebrate densities appeared to be higher in grazed habitats than in ungrazed and feedlot habitats (Fig. 3). Alternatively, invertebrate densities also may have been affected by other unmeasured factors. Other studies have reported that some insects, especially grasshoppers, are more abundant in moderately to heavily grazed pastures (Coyner 1938, Holmes et al. 1979, Capinera and Sechrist 1982, Jepson-Innes and Bock 1989). Parker (1930) found that grasshoppers prefer less ground cover for oviposition. Coyner (1938) also found that invertebrates, specifically leafhoppers, thrived in heavily grazed pastures because they preferred to feed on succulent new growth near the ground. Smith (1940) found that insect abundance increased with increasing grazing intensity but declined with severe overgrazing, whereas species diversity declined with increasing grazing intensity. Light grazing provides a variety of grass heights that are used by different species of invertebrates (Watts et al. 1982, Tscharntke and Greiler 1995).

Invertebrate density in relation to cowbird abundance and foraging behavior.—Flock size and the number of female cowbirds were significantly related to invertebrate density. This is strong evidence that cowbirds, particularly females, selected foraging habitats based on the availability of invertebrate foods. If cowbirds were feeding primarily on grass seeds, they should have foraged in small areas without spending the extra energy to keep up with grazing cattle. The lack of a significant relationship between male cowbird numbers and invertebrate abundance is consistent with the sex effects discussed previously. The effect of invertebrate density on peck rates and foraging times was inconclusive; considering the small sample (n = 10) and unbalanced design, these results warrant further investigation.

In conclusion, cowbirds selected short-grazed habitats over other grassland habitats, and the number of female cowbirds was positively related to invertebrate density. The primary importance of grazing appears to be its effect on invertebrates. Specifically, invertebrate density appeared to be higher in grazed habitats, and cowbirds preferred to feed in the immediate vicinity of cattle regardless of grass height.

Management Implications

Our results have conservation implications for host species of cowbirds. Several studies have suggested that cowbirds are limited by the availability of suitable feeding areas (Robinson et al. 1995, Donovan et al. 1998, Thompson et al. 1998). Efforts to reduce feeding areas in midwestern landscapes should be directed at grazed habitats and feedlots. Such efforts do not have to involve eradication of feeding sites, but could be less drastic, such as eliminating grazing or maintaining grass at taller heights. Through pasture rotation and decreased grazing intensity, landowners may provide more forage for livestock and reduce the need to supplement livestock with hay and grain in feedlots during the breeding season.

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