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USE OF SUPPLEMENTAL NORTHERN BOBWHITE (*Colinus virginianus*) FOOD BY NON-TARGET SPECIES

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Abstract.—Several studies have investigated the use of supplemental feeders by Northern Bobwhites (*Colinus virginianus*) and non-target species, but none have previously examined the use of food spread along fields. We used motion-sensing cameras to assess use of supplemental quail food spread along the edges of fields. A total of 3,233 camera hours resulted in 591 animal pictures associated with 328 animal visits. Rodents were the most common visitors (66.2% of pictures, 46.3% of visits), followed by songbirds (19% of pictures, 35% of visits). Eastern cottontails (*Sylvilagus floridanus*), Mourning Doves (*Zenaidura macroura*), Common Ground-Doves (*Columbina passerina*), white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), nine-banded armadillos (*Dasypus novemcinctus*), and bobcats (*Lynx rufus*) were infrequent visitors, making up fewer than 13% of pictures or 16% of visits combined. Northern Bobwhites were not captured in any pictures, but this is likely an artifact of camera placement.

Supplemental feeding is a common practice for the management of Northern Bobwhites (*Colinus virginianus*, hereafter quail) throughout the Southeast (Robel and Kemp 1997, Townsend et al. 1999, Sisson et al. 2000, Guthery et al. 2004). Objectives of feeding include increasing or maintaining populations by increasing survival through winter or during periods of unfavorable conditions. Methods of delivering supplemental food include maintaining fixed feeders and spreading feed along roads, in forested plots, or along field and food plot edges (Frye 1954, Godbois et al. 2003, Haines et al. 2004). Whatever the method of delivery, it is certain that a portion of feed is consumed by species other than quail. Several studies have investigated non-target consumption of feed at fixed quail feeders (Frye 1954, Collins 1956, Haugen 1957, Kane 1988, Boyer 1989, Guthery et al. 2004, Henson 2006). These studies suggest that quail only consume between 1 and 5% of supplemental food (Collins 1956, Haugen 1957) and make between 0 and 11% of total visits to feeders (Kane 1988, Guthery et al. 2004, Henson 2006). Common visitors to feeders include songbirds, rodents, and raccoons (*Procyon lotor*). Deer and doves have also been noted as regular visitors. We know of no studies that have examined non-target use of feed

supplied by other methods, such as spreading feed along field and food plot edges. The less concentrated nature of feeding in this manner may attract a different set of foragers or present fewer potential side effects of feeding from fixed feeders such as food spoilage or attraction of predators. Examination of crops of quail harvested on site shows that quail do use the provided supplemental food (J. Stober, J. W. Jones Ecological Research Center, Newton, GA, unpubl. data); however, the use of supplemental food by non-target species has not been examined. Therefore, our objective was to fill this gap in knowledge by assessing the use of supplemental food spread along field and food plot edges by species other than quail.

METHODS

Study site.—This study was carried out at the Joseph W. Jones Ecological Research Center at Ichauway in Baker County, Georgia. Ichauway is a 12,000 ha property consisting primarily of longleaf pine (*Pinus palustris*) and wiregrass (*Aristida beyrichiana*) ecosystem. Longleaf pine ecosystems have a low-density overstory, a diverse, herbaceous groundcover, and an open, park-like mid-story with limited occurrence of hardwood tree species (Van Lear et al. 2005). Management at Ichauway focuses on maintaining and restoring longleaf pine stands and maintaining populations of quail and white-tailed deer (*Odocoileus virginianus*) (Atkinson et al. 1996). Management practices include frequent application of prescribed fire, predator removal, discing fields to provide habitat and food for quail, planting food plots throughout the site, and spreading supplemental food along field edges and in forested plots (Atkinson 1996, Godbois et al. 2003). Food plots are planted with a variety of agricultural crops including grain sorghum (*Sorghum* spp.), pearl millet (*Pennisetum glaucum*), cowpea (*Vigna* spp.), corn (*Zea mays*), winter wheat (*Triticum aestivum*), sunflower (*Helianthus* spp.), soybeans (*Glycine* spp.), and chufa (*Cyperus esculentus*). Supplemental food includes a mixture of grain sorghum, soybeans, and corn (except during deer season) and is spread at two-week intervals from October through June.

Field methods.—We used Cuddeback Capture digital cameras (Non Typical, Inc., Park Falls, Wisconsin) to assess use of supplemental food. Five cameras were set out over supplemental food immediately after it was spread along field edges on 10 March 2009. These cameras were left out for 10 days and checked periodically to ensure adequate battery power and presence of supplemental food. A second set of 10 cameras was set out on 23 March 2009 and left out for nine days with the exception of one camera which was pulled on the sixth day following flooding from heavy rains. The minimum distance between the two sets of cameras was 1,930 m and the mean minimum distance between individual cameras was 268 m (± 19 m, SE). To detect small mammals (e.g., rats and mice) and to avoid flash glare on vegetation in night pictures, cameras were set in areas with relatively little cover in front of the camera, although good cover occurred to either side.

Animal images were classified by species (when possible) and group (e.g., songbird, rodent). Because individuals of some species (especially mice) had a tendency to spend longer periods of time in front of the camera than others, we distinguished between pictures and visits. Pictures of a single animal (or animals of the same species that could not be positively identified as a separate individual) occurring within 60 minutes of each other were grouped as a single visit. If multiple animals of the same species or group appeared in a single picture, that was counted as one picture for that species or group but as a separate visit for each individual.

RESULTS

Cameras were set for a total of 3,233.2 hours spread over 15 different locations. Five hundred and ninety-one pictures of animals were taken, with 328 separate visits (Table 1). Rodents including cotton mice (*Peromyscus gossypinus*), oldfield mice (*P. polionotus*), house mice (*Mus musculus*), cotton rats (*Sigmodon hispidus*), an eastern fox squirrel (*Sciurus niger*), and mice and rats that could not be identified to species, were the most common visitors accounting for 66.2% of total pictures and 46.3% of total visits. Songbirds including Chipping Sparrows (*Spizella passerina*), Brown-headed Cowbirds (*Molothrus ater*), Northern Cardinals (*Cardinalis cardinalis*), White-throated Sparrows (*Zonotrichia albicollis*), Red-winged Blackbirds (*Agelaius phoeniceus*), and other songbirds that could not be identified to species were the second most common visitors with 18.6% of pictures and 34.5% of visits.

Quail did not appear in any pictures, but another game bird, Mourning Doves (*Zenaida macroura*), appeared in 1.5% of pictures and made 2.4% of visits. Doves as a group, including Mourning Doves and Common Ground-Doves (*Columbina passerina*), accounted for 2.4% of pictures and 4.3% of visits. Mammalian predators including raccoons, a bobcat (*Lynx rufus*), and a nine-banded armadillo (*Dasypus novemcinctus*) were observed in only 1.1% of all pictures, making only 1.2% of visits. Other mammals including eastern cottontails (*Sylvilagus floridanus*, 5.4% of pictures and 6.4% of visits), deer (3.4% of pictures and 3.7% of visits) and feral hogs (*Sus scrofa*, 0.3% of pictures and 0.3% of visits) also made limited visits to camera locations. Species/groups unable to be identified due

Table 1. Non-target use of supplemental quail food in Baker County, Georgia, during March and April 2009.

	Pictures		Visits	
	N	%	N	%
Rodents ^A	391	66.159	152	46.341
Songbirds ^B	110	18.613	113	34.451
Rabbits	32	5.415	21	6.402
Deer	20	3.384	12	3.659
Doves ^C	16	2.707	14	4.268
Mammalian predators ^D	7	1.184	4	1.220
Hogs	2	0.338	1	0.305
Unknown	13	2.200	11	3.354
Totals	591	100	328	100

^AIncludes mice, rats, squirrels.

^BIncludes Chipping Sparrows, Northern Cardinals, Brown-headed Cowbirds, White-throated Sparrows, Red-winged Blackbirds, and birds identified only as passerines.

^CIncludes Mourning Doves and Common Ground-Doves.

^DIncludes raccoons, bobcats, and armadillos.

to overexposure of pictures taken at night with a flash accounted for 2.2% of pictures and 3.4% of visits. Species considered to be exotic or invasive (house mice, Brown-headed Cowbirds, hogs, and armadillos) were observed in 10% of all pictures and made 13% of visits.

DISCUSSION

Supplemental feeding is a common management tool for a variety of game species including quail, deer, and Wild Turkey (*Meleagris gallopavo*) (Frye 1954, Pattee and Beasom 1979, Lambert and Demarais 2001). Goals of providing supplemental food for game species include providing resources to the target species during times when natural food resources are limited and increasing body size, survival, or reproduction of individuals in a population (Dunkley and Cattet 2003). For a feeding program with these goals to be successful, several assumptions must be met: 1) the natural food resources are limiting, 2) no other habitat parameter limits population growth when food is provided, 3) the target species uses the supplemental food, and 4) the food does in fact enhance survival and reproduction when used by the target species (DeMaso et al. 2002). Given that non-target species also commonly use supplemental food, populations of these non-target species meeting the assumptions above may also be influenced in a variety of ways. In small mammals and birds, these effects may include increases in abundance and litter or clutch size, earlier reproduction, increased body size and growth rates, and decreased home range sizes (Boutin 1990). A previous study at this site showed that supplemental feeding increased cotton rat populations by 5.5 times (L. M. Conner, J. W. Jones Ecological Research Center, Newton, GA, unpubl. data).

On our study site, supplemental food is spread along field edges for quail. We found that the most frequent visitors to the supplemental food were rodents and songbirds. Deer, rabbits, doves, mammalian predators, and hogs were less frequent visitors. These results are consistent with studies of non-target use of fixed feeders (for quail and other species) in that non-target species were by far the most common visitors. However, most of these studies noted songbirds as the primary visitors (Frye 1954, Haugen 1957, Kane 1987, Lambert and Demarais 2001, Guthery et al. 2004) although rodents were also observed as significant visitors in every case. Broadcast feeding may be more conducive to use by small mammals than fixed feeders. Given that small mammals have small home ranges, fixed feeders are likely to provide food resources to a limited number of small mammals, especially in comparison to birds, which are more mobile. The more dispersed nature of broadcast feeding seems to enable access to supplemental feed by a greater proportion of small mammals than fixed feeders.

Quail, the target species, were not captured in any of the images. Although it is possible that quail did not use supplemental food during our study, previous research on Ichauway suggests that this is unlikely. Crops removed from quail harvested between 1995 and 2006 showed heavy use of supplemental food such that between 66.2 and 90.1% ($78.3\% \pm 8.5\%$, mean \pm SE) of crop volume consisted of supplemental food (J. Stober, J. W. Jones Ecological Research Center, Newton, GA, unpubl. data). The apparent lack of quail use of supplemental food in this study is probably best explained by camera placement. Cameras were placed overlooking relatively open areas along field edges, although good cover existed to either side. Although this placement was intentional to allow detection of small animals such as mice and to avoid flash glare against vegetation in night pictures, this placement may have effectively prevented sampling of quail. This is supported by the relatively few pictures of cotton rats (10), a species that has been shown occur in great numbers in areas where supplemental feeding occurs (Doonan and Slade 1995). Like quail, cotton rats have heavy cover requirements (Goertz 1964) and are unlikely to forage in open areas. In addition to being biased against species with heavy cover requirements, it is likely that our sampling was biased against uncommon species and very small species such as insects which were beyond the ability of our cameras to detect.

Because of these complications due to camera placement, it is impossible for us to say whether feeding methods that involve spreading feed over large areas are more effective at delivering food to quail and other species than fixed feeders. However, compared to fixed feeder studies, we found fewer visits by mammalian predators which may be attracted to feeding areas by increased small mammal populations. Guthery et al. (2004) attributed 9.3% of visits to mammalian predators. Henson (2006) observed that 43% of total feeder visits were made by raccoons alone. Our finding that only 1.2% of visits were by mammalian predators was somewhat surprising given the high proportions of predators detected in these fixed feeder studies and because previous research on site has found that predators are attracted to areas where supplemental food is spread. However, these results may also be an artifact of our sampling design which may underestimate use of feed trails by less common species as well as species that avoid open areas. We know that bobcats were found to occur 10 times closer to feeding areas than expected (Godbois et al. 2004) and that Red-tailed Hawks (*Buteo jamaicensis*) were found to occur three times closer to feeding sites than expected (Turner et al. 2008). If other predators respond similarly, this suggests our sampling method may not have been sensitive to these relationships.

In conclusion, the supplemental food was used by a variety of bird and mammal species. Rodents and songbirds composed $\geq 80\%$ of total visits and pictures. Although quail were not captured in any images, this was likely an artifact of camera placement. Future research should investigate use of supplemental food spread along field edges and food plots by including areas with greater cover. This study was conducted over a period of less than one month, from late March to early April. Extending similar research over a greater length of time would help to detect seasonal patterns of feed use by both target and non-target species of wildlife (Frye 1954, Haugen 1957, Henson 2006).

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