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BREEDING BIOLOGY OF THE BLACK-BACKED LESSER GOLDFINCH IN PONDEROSA PINE FORESTS ON THE COLORADO FRONT RANGE

JOHN W. PRATHER,[1,2,3] LISA M. MUNGER,[1] AND ALEXANDER CRUZ[1]

ABSTRACT.—We present information on nest site characteristics and breeding biology of the black-backed race of the Lesser Goldfinch (*Carduelis psaltria psaltria*) in montane ponderosa pine (*Pinus ponderosa*) woodland in the foothills of Boulder County, Colorado. We located 62 nests during summer, 1999–2001. There appeared to be strong microhabitat preferences for nest sites. Nests generally were placed toward tips of long branches in the middle of ponderosa pines. Most nests were well concealed in needle clusters in trees near forest edges and openings. Mean canopy cover at nest sites was 49%. Nests usually were oriented toward the south or east, and orientation was correlated with the aspect of the surrounding terrain. More than 70% of nests were located in small, loose colonies. Nesting success was fairly high; at least 21 nests fledged young while only 10 failed due to predation. Mayfield nest success was 73% during 2000 and 52% during 2001. Most predation events occurred after the eggs had hatched. We found only one instance of brood parasitism by the Brown-headed Cowbird (*Molothrus ater*). Compared to the green-backed race (*C. p. hesperophila*), Black-backed Lesser Goldfinches appear to breed later in the season and have smaller clutch sizes. *Received 13 November 2001, accepted 28 June 2002.*

Two races of the Lesser Goldfinch (*Carduelis psaltria*) occur in North America. The green-backed race (*C. p. hesperophila*) is primarily resident from southwestern Washington to Baja California and eastward through Utah, central Arizona, and Sonora (Watt and Willoughby 1999). It is a widespread breeder in California and Baja California, and occasionally farther north on the West Coast (Watt and Willoughby 1999). The black-backed race (*C. p. psaltria*) ranges from Colorado and western Oklahoma southward through Mexico to Guerrero, Oaxaca, and central Veracruz (Gross 1968, Watt and Willoughby 1999). In Colorado, it is a fairly common breeder in foothills, mesas, and plains of both the eastern and western slopes (Andrews and Righter 1992, Levad 1998). Unlike the green-backed race, this subspecies is partially migratory, withdrawing during winter from Colorado, Utah, and northern New Mexico (Watt and Willoughby 1999). However, winter sightings recently have increased in the intermountain west (Versaw 2000).

Due in part to the difficulty in locating and monitoring Lesser Goldfinch nests, little information exists on the breeding biology of this species. The few extensive studies of Lesser Goldfinch breeding biology were conducted in California, where the green-backed race is prevalent (Coutlee 1968a, 1968b; Linsdale 1968). Almost all data on the black-backed race is anecdotal (see Watt and Willoughby 1999). These subspecies differ considerably in their migratory behavior, timing of breeding, and molting pattern (Watt and Willoughby 1999), so comparative studies of other aspects of their breeding biology are of interest. During the summers of 1999, 2000, and 2001, we located and monitored nests of Black-backed Lesser Goldfinches on open space properties in and around Boulder, Colorado. We provide here information on the breeding biology and nest site selection on this relatively poorly studied subspecies.

STUDY SITES AND METHODS

Our study sites were located on city- and county-maintained open space properties in the foothills around Boulder, Colorado (40° 00′ N, 105° 16′ W; elevation 1,600–1,900 m). We located and monitored nests in 10 plots ranging from 4–6 ha in size. These plots were dominated by ponderosa pine (*Pinus ponderosa*) woodland and savannah with a mixture of Douglas fir (*Pseudotsuga menziesii*) at higher elevations. We did not search for nests in residential or riparian areas, although such areas bordered some plots. All of our plots were within a few kilometers of the

[1] Dept. of Environmental, Population, and Organismic Biology, Univ. of Colorado, Boulder, CO 80309-0334, USA.

[2] Current address: Center for Environmental Sciences and Education, Northern Arizona Univ., Flagstaff, AZ 86011-5694, USA.

[3] Corresponding author; E-mail: john.prather@nau.edu

city of Boulder and were subject to varying degrees of human disturbance.

Our field seasons extended from late May through mid-August, 1999–2001. We monitored nests at intervals of 2–4 days (normally every 3 days) following standard nest monitoring protocols (Ralph et al. 1993) until they were no longer active. We tried to limit nest failure from factors associated with nest monitoring (Martin and Geupel 1993). We determined nest contents by direct observation or by using a mirror mounted on a 6-m pole whenever possible, but some nests were too high to detect contents. We included all nests that were confirmed as being active, either by monitoring the contents or by observing the adults sitting on and/or visiting the nest with food.

After nests were no longer active, we measured habitat characteristics at each site using standardized protocols (James and Shugart 1970, Martin and Roper 1988). At the nest, we measured nest tree height, nest tree diameter (dbh), canopy cover over the nest, distance of nest to trunk and to tip of supporting branch, and the height of the lowest living branch on the nest tree. We measured distances with a measuring tape whenever possible, but heights of tall trees and higher nests were measured with a Suunto PM-5/360 PC clinometer. We measured canopy cover by obtaining a mean of four measurements with a Lemmon model-A convex spherical densiometer at a distance of 1 m from the nest in the four cardinal directions (Lemmon 1957). We measured slope and aspect of the terrain around the nest site using a compass and clinometer. Finally, we documented the location of each nest using a Garmin GPS-12 global positioning system. This made it possible to determine the distance to the nearest adjacent active Lesser Goldfinch nest for nests on sites where more than one such nest was located.

We used data from 38 nests (16 in 2000, 22 in 2001) in which the contents were determined to calculate nest success. Seven of these nests had unknown fates, mostly because they were still active at the time our field crew was disbanded and they could not be checked regularly afterwards. To calculate nesting success we followed the method proposed by Mayfield (1975), with adjustments suggested by Manolis et al. (2000) for nests of unknown fate. We used a mean egg-laying/incubation period of 14 days and nestling periods of 13 days in the calculations based on a sample of our own nests for which we had accurate data (see below).

We performed Shapiro-Wilks *W*-tests to determine whether goldfinch nests were normally distributed in their placement in relation to canopy cover, tree height, and branch length. We used a Rayleigh test (Zar 1999) to determine if there was a significant directional component to nest orientation with relation to the trunk of the nest tree. We used a Spearman correlation to determine if there was a significant relationship between aspect and the orientation of the nests. In this case both measurements were in degrees and the minimum degree distance between the two measurements was considered the difference. Finally, we used the nonparametric Wilcoxon test to determine if clutch size differed between 2000 and 2001 or between our data and that reported by Watt and Willoughby (1999) for the green-backed race. Statistical significance was set at $\alpha < 0.05$. All tests except the Rayleigh test were performed using JMP Statistical Software (SAS Institute, Inc. 1995). Means and standard deviations are provided for all measurements included in the results.

TABLE 1. Distances between active nests of Lesser Goldfinches (*Carduelis psaltria*) in four colonies located in ponderosa pine habitat near Boulder, Colorado, 2000–2001.

Colony	Year	Number of nests	Mean (±SD) distance between active nests (m)	Range (m)
A	2000	9	77 ± 44	24–124
A	2001	15	60 ± 25	26–115
B	2001	7	85 ± 26	53–113
C	2001	10	50 ± 41	17–118
All colonies		41	65 ± 36	17–124

RESULTS

All but one of the 62 nests were placed in thick clusters of needles in ponderosa pine trees. The remaining nest was placed in a branch fork of a tall Douglas fir sapling. Mean nest height was 6.1 m ± 1.7 m, and ranged from 2.2–15.0 m. Nest tree height appeared to influence placement, as mean nest height was 56% of total tree height and the distribution of nests around this mean was normal ($W = 0.98$, $P = 0.82$). Nests almost always were placed well out on long branches, with 55 of 62 nests located ≥70% of the distance out along the branch in a strongly skewed distribution ($W = 0.76$, $P < 0.001$). Most nests were well concealed in needle clusters in trees near openings or edges in the forest. Canopy cover at nest sites was normally distributed around a mean of 49% ($W = 0.93$, $P = 0.73$).

Of the nests we located, 68% (42 of 62) were oriented between 90° and 210° in a nonuniform and nonrandom distribution (mean angle = 143°, Rayleigh's $R = 2.94$, $Z = 8.49$, $P < 0.001$). Nest orientation also was significantly positively correlated with the aspect of the terrain around the nest site ($r_s = 0.30$, $P = 0.018$). In at least four cases, several goldfinch nests were located in an area of <12 ha, with nests as close as 17 m to their nearest active neighbor (Table 1). Goldfinches in these colonies regularly were seen feeding and moving together in small flocks.

Nest building and egg laying occurred from the first week of June through at least the first week of August. Using nests with known dates of laying and fledging, and those for which dates could be extrapolated from available data, we determined that the breeding season extended from 2 June through 19 August, 2000, and from 1 June through 5 September, 2001. The peak of the breeding season (≥50% of nests active) occurred between 16 June and 13 July 2000, and between 26 June and 22 July 2001. Several late nests may have been second nesting attempts following previous failures. On two occasions in late July 2001, we found female Lesser Goldfinches building nests while also feeding fledglings, indicating second broods. In both cases the new nests remained empty for several days before the first egg was laid.

Egg laying dates were from 9 June through 5 August. Females laid one egg per day for a total of 3–5 eggs. Mean clutch size was 3.55 ± 0.52 ($n = 11$) during 2000 and 3.93 ± 0.70 ($n = 15$) during 2001. Clutch sizes did not differ significantly between years ($Z = 1.39$, $P = 0.16$), though larger sample sizes might have revealed differences. Our overall mean clutch size (3.77 ± 0.65, $n = 26$) was significantly lower than that reported by Watt and Willoughby (1999) for the green-backed race (4.15 ± 0.46, $n = 20$; $Z = 2.18$, $P = 0.021$). Incubation began soon after the first egg was laid, and lasted 12–15 days (mean of 13.8 ± 1.1 days, $n = 14$). Consequently, young hatched sequentially, usually over a period of 2–3 days. Nestlings remained in the nest another 11–15 days after the initial egg hatched (mean of 13.3 ± 1.5 days, $n = 13$), fledging as a group.

During the period when a nest held eggs or younger nestlings, nest attentiveness by female goldfinches was very high. On nests with known contents, we found females on their nest during 112 of 121 (93%) checks during incubation and 31 of 46 (67%) checks during the first 6 days of the nestling period. Male goldfinches regularly fed the female and/or the nestlings during these periods. After day 6 of the brooding period, females were found on the nest during only 9 of 45 (20%) checks, and both adults regularly were seen feeding the nestlings.

At least 21 Lesser Goldfinch nests successfully fledged young, while only 10 nests definitely failed due to predation. Assuming a nesting cycle of 27 days (14 days incubation plus 13 days brooding), we determined Mayfield nest success to be 73.6% during 1999/2000 and 52.1% during 2001. Mean number of fledglings produced per successful nest was 2.93 ± 0.70 ($n = 21$). Eight of the ten nests that failed due to predation were lost after the eggs had hatched. Only one nest was parasitized by a Brown-headed Cowbird (*Molothrus ater*).

DISCUSSION

Lesser Goldfinches nest sites in our study area were significantly correlated with some measured microhabitat characteristics. Nests usually were placed well toward the tips of branches in the midportion of ponderosa pines. Nests were well concealed in needle clusters with mean canopy cover almost 50% at the nest site. Lesser Goldfinches tended to select sites oriented to the south and east of the main trunk of the nesting tree and orientation was positively correlated with aspect at the nest site. The direction of orientation may, therefore, be related to temperature or incident sunlight. We suggest that the above characteristics may be important with respect to nest placement, at least in coniferous woodlands. Further study of the thermal characteristics of the nest and nest site selection in Lesser Goldfinches is warranted.

We found mean clutch size for Black-backed Lesser Goldfinches to be lower than that reported for the green-backed race by Watt and Willoughby (1999). However, samples sizes from both studies are small and each was taken largely from a single location and a limited number of breeding seasons. Thus, there may be considerable undocumented temporal or geographical variation in clutch size due to climate, habitat, or territory quality (Cody 1965, Ricklefs 1980, Hogstedt 1985, Kulesza 1990). Indeed, in our study we found 5-egg clutches only during 2001, when mean clutch size was higher.

Our results suggest that Lesser Goldfinch reproductive success is high, with a mean Mayfield nest success rate of 62.3% over the 3 years of the study. These values were higher than any other species on our sites for which we have a large sample size (e.g., Western

Tanager, *Piranga ludoviciana*, Fischer et al. in press; Plumbeous Vireo, *Vireo plumbeus*, Chace and Cruz 1999). This may be because Lesser Goldfinches show relatively high levels of nest attentiveness. Lesser Goldfinch females remain on the nest almost continuously from the start of incubation until after the young have hatched, apparently being fed primarily by the male during this period (Watt and Willoughby 1999; JWP and LMM pers. obs.). Most of the nests that failed were lost after this period of high nest attentiveness, supporting this conclusion. Furthermore, the well-concealed nests may deter predation. We had difficulty observing some nests, even when we knew their location.

We located only one Lesser Goldfinch nest that had been subject to brood parasitism, and few records apparently exist in the literature (Woods 1930, Chace and Cruz 1996). Lesser Goldfinches, like other small finches, probably are poor host species for cowbirds since the main portion of their diet appears to be seeds and grains (Linsdale 1957, Watt and Willoughby 1999). Middleton (1977) found 22 of 234 (9.4%) American Goldfinch (*Carduelis tristis*) nests parasitized by cowbirds in Wisconsin, but found that very few cowbird eggs hatched and no cowbird young fledged from these nests, further suggesting that goldfinches are poor hosts for cowbird parasitism. Finally, the nest attentiveness described above may serve as a deterrent to cowbird parasitism.

The Lesser Goldfinch is reported to be highly gregarious during the nonbreeding season, but less so while nesting (Watt and Willoughby 1999), despite previous reports of multiple pairs nesting in small areas (Jensen 1923, Gross 1968). While we found some individual nests, at least 41 of the pairs we studied during 2000 and 2001 were nesting in colonies (Table 1), a behavior also noted in the green-backed race (Coutlee 1968a, Watt and Willoughby 1999). The closest active nests were located ≤30 m of each other in these colonies, although mean distance between nests was about 65 m (Table 1). There was a great deal of interaction among pairs within a colony, particularly during the nest-building period and after the young fledged. While chasing and other aggressive encounters did occur, Lesser Goldfinches were seen moving and foraging together in small groups throughout the breeding period. We did not find any evidence to suggest the clustering of nests was related to dependence on water and their resulting occupation of similar habitat near one another as suggested by Gross (1968). In fact, our largest study site, which contained 9 nests during 2000 and 15 during 2001, was >2 km from any permanent water source, and the only water present in any of our sites was in the form of small intermittent streams and pools.

The timing of the breeding season, as well as the molting pattern, differs between the races of the Lesser Goldfinch (Watt and Willoughby 1999). Green-backed Lesser Goldfinches breed from April through early July in California, with a peak between mid-May and mid-June (Coutlee 1968a, Watt and Willoughby 1999). Our data, and that of the Colorado Breeding Bird Atlas (Levad 1998), suggest that Black-backed Lesser Goldfinches in Colorado begin breeding almost 2 months later, and the peak of the breeding season extends from mid-June through mid-July. As suggested by Watt and Willoughby (1999), the molting patterns of these two races probably differ due to this difference in timing of breeding. The black-backed race has time to undergo a complete prealternate molt during spring before breeding begins, while the early breeding green-backed race has no more than a limited partial molt during spring.

The results of our study reveal interesting patterns in the breeding biology of the Black-backed Lesser Goldfinch. The breeding biology of this subspecies differs in several ways from the better-studied green-backed race, which might help explain other differences between them, such as the timing of molt. Our data on nest site selection, nest attentiveness, and coloniality suggest that additional studies focused on these subjects might yield additional interesting results.

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