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Nesting ecology of Mourning Doves in a cold desert ecosystem.—Mourning Doves (*Zenaida macroura*) are distributed widely across the shrub deserts and grasslands of the western United States (McClure 1950), even where there are few or no trees. Doves are adaptable nesters, and a number of studies have dealt with, or mentioned, ground nesting by Mourning Doves (Cowan 1952, Hon 1956, Downing 1959). Fichter (1959) studied Mourning Dove production in four Idaho orchards, and Dahlgren (1955) studied tree-nesting doves in the intermountain region of Utah. However, there have been no published studies relating specifically to ground-nesting Mourning Doves in intermountain shrub deserts. Herein, we provide estimates of Mourning Dove nesting success and identify the vegetative cover variables associated with nest-site selection in ground nesting Mourning Doves in such an ecosystem.

Study area and methods.—Nesting Mourning Doves were studied on the Idaho National Engineering Laboratory (INEL) from 1983 to 1985. The INEL is located 80 km west of Idaho Falls on the upper Snake River Plain in southeastern Idaho and is administered by the U.S. Department of Energy. It encompasses about 231,600 ha at the northern extent of the Great Basin desert and receives 18–20 cm of precipitation annually (Anderson et al. 1978). The major vegetation types of the INEL were reported by McBride et al. (1978). Dominant shrubs on the INEL include big sagebrush (*Artemisia tridentata*) and Douglas rabbitbrush (*Chrysothamnus viscidiflorus*); common grasses include squirrel tail (*Sitanion hystrix*), Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread grass (*Stipa comata*), and wheatgrasses (*Agropyron* spp.). Common forbs on the INEL include prickly pear cactus

(*Opuntia polyacantha*), Hood's phlox (*Phlox hoodii*), longleaf phlox (*P. longifolia*), and milkvetches (*Astragalus* spp.).

Nests were found by locating radio-tagged (Howe and Flake 1988) doves on their nests, by chance flushes by ourselves or other personnel, and by systematically searching 4-ha plots. Plots were located at random within the major plant communities on the INEL (McBride et al. 1978), with 15 plots searched twice (mid-June and late July) in 1983 and once (late July) in 1984. Plots were searched by pulling a rope drag between two or three persons on foot. The rope drag was 7.5 m long with 1 m long weighted trailers fixed at 30-cm intervals. Even though Mourning Doves flushed readily from nests during rope dragging, extremely low densities of nests and the need to reduce manpower costs led to our dropping this technique in 1985.

Ages of nestlings were estimated from their appearance and size. Ages of eggs were determined by candling (Hanson and Kossack 1957, Muller et al. 1984). Apparent nesting success (Klett et al. 1986) overestimates nesting success but was calculated for comparison with earlier studies. Daily survival of nests was determined from the period the clutch/brood was exposed to risk and under our observation; these rates were used to estimate actual nesting success (Mayfield 1975, Miller and Johnson 1978). Nests were visited within one or two days after predicted hatch and on day 12 of fledging. We visited the nests at these infrequent intervals to reduce the risk of human-induced abandonment (Swank 1952) or other human-induced impacts on nesting success (Westmoreland and Best 1985). The ages of trapped or collected hatching year (HY) doves were estimated by primary molt progression (Swank 1955) to provide an estimate of the length of the nesting season and of peak nesting activity. On our study area, HY doves had not completed primary replacement through P7 prior to early September and could be separated from adult birds based on the characteristics of the remaining primaries (Haas and Amend 1979, Cannell 1984). HY Mourning Dove wings (N = 33) were obtained from the few hunters that conservation officers (Idaho Fish and Game Department) observed within 65 km of the INEL in early September. HY doves were live-trapped (N = 61) throughout the summer at the Test Reactor Area, Naval Research Facilities, and Auxiliary Reactors Area ponds on the INEL; 30 doves were also collected by shotgun at the Test Reactor Area and Argonne National Laboratory ponds in July and September for use in this study and for a separate food habits analysis.

Random sites were chosen within 50 m of each nest site for paired comparisons of all nest cover measurements. Horizontal nesting cover was measured with a point-frame (Floyd and Anderson 1987) in the 1 m^2 (microhabitat) centered on dove nests and at random sites. Percent cover was recorded by plant species and by cover type, i.e., shrub, grass, forb, and bare ground. The line-intercept method (Stoddart et al. 1975) was used to determine the major vegetation components and general cover composition within 5 m of each nest site and at random sites. Coverage (cm) was recorded for shrubs, grasses, forbs, and bare ground found along a 5-m transect in each cardinal direction; dominant plant species along the line-intercept also were recorded.

Visual obstruction of the nest site by vegetation was measured with a 30-cm wide vegetation profile board (Nudds 1977) divided into 0.5-m intervals. Obstruction of the board by vegetation (0%, 1–20%, 21–40%, 41–60%, 61–80%, and 81–100%) in the first meter above nest and random sites was estimated from 5, 10, 15, 20, and 25 m in the cardinal directions and one non-overlapping random direction. Visual obstruction above 1 m was negligible on the INEL. Analysis of variance was used to test for differences between nest sites and random sites for both point-frame and line-intercept data. Visual obstruction data were subjected to chi-square analysis to identify differences between nest and random sites.

Results.—Dove nests in the cold desert were dispersed widely and difficult to find. Density of nests during the two searches of 4-ha plots in 1983 and one search in 1984 averaged only

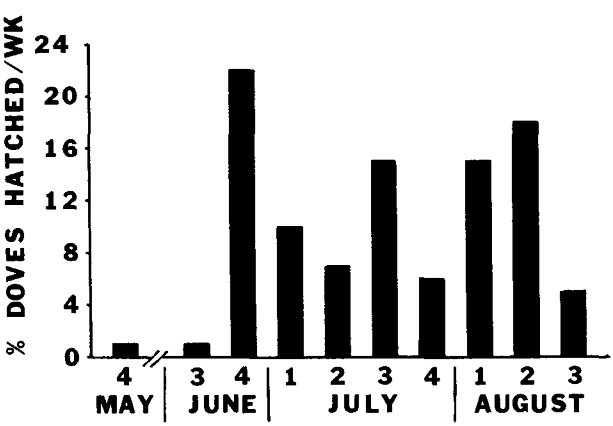

FIG. 1. Hatching chronology for Mourning Doves on the Idaho National Engineering Laboratory as estimated from live-trapped (N = 61) and collected (N = 63) HY doves from 1983–1985.

0.02 nest/ha. During three years of study 28 nests were found, but four of these apparently were abandoned due to our initial disturbance and were dropped from estimates of nesting success. Of 28 nests, three were located by systematic search of plots, 11 by radiotelemetry, and 14 by chance flushes. All nests were on the ground. Of the 24 nests, 18 (75%) fledged young; only one of 10 clutches found during laying or incubation was destroyed before hatching. Even with four abandoned nests included, 63% (apparent success) of the clutches produced fledged young. Yearly successful nest/total nests and fledglings/successful nest were: 1983 (5/6, 1.8), 1984 (7/10, 2.0), and 1985 (6/8, 1.7). In our estimates, we classified 12-day-old young as fledglings to avoid forced fledging of young on days 13 and 14 when they more readily abandoned the nest site. Actual survival (Mayfield 1975, Miller and Johnson 1978) from the beginning of incubation to fledging (26 days) for the 24 nests was 0.50 (daily rate = 0.974). Nine nests found during laying or incubation had a survival rate to hatching of 0.82 (daily rate = 0.986). Nests reaching the hatching stage and nests found during the nestling stage had a survival rate to fledging of 0.68 (N = 23, daily rate = 0.968). The difference in survival rates between incubation and nesting stages indicates the assumption of constant survival was not met in estimating overall survival from the beginning of incubation to fledging. When a nest was found destroyed, we assumed the loss occurred half way between the date found and the date last checked in calculating daily survival rates, as suggested by Mayfield (1975). All nests were active when initially found.

Data from collected wings (N = 63) and live-trapped juveniles (N = 61) indicated that peak hatching occurred the fourth week of June, the third week of July, and the first and second weeks of August (Fig. 1). Wings collected in late July or early August and live-trapped juveniles taken prior to August bias the August peak downward; nevertheless, the third peak in hatching is still clear. Other possible biases include those due to possible early departure of older HY doves and potential ingress of HY doves to the study area. Data from collected wings indicated that the nesting season on INEL began around mid-May and ended in early September.

Analysis of variance revealed differences in the percentage of bare ground ($P = 0.02$) and grass cover ($P = 0.02$) between nest and random site microhabitats (1 m^2). Nest sites

TABLE 1

AVERAGE VEGETATION COVERAGE (±SE), BY COVER TYPE, AT MOURNING DOVE NEST SITES AND PAIRED RANDOM SITES ON THE IDAHO NATIONAL ENGINEERING LABORATORY

	N	Shrub	Bare	Grass	Forb
Microhabitat[a]					
Nest	28	44.0 (3.32)	43.9 (2.82)[c]	10.0 (1.39)[c]	6.6 (1.38)
Random	26	37.8 (3.44)	53.9 (2.93)	5.4 (1.44)	5.0 (1.43)
5-m area[b]					
Nest	28	30.5 (1.70)	57.4 (1.71)	7.6 (1.00)	4.6 (0.60)
Random	26	29.5 (1.70)	57.5 (1.71)	8.6 (1.00)	4.4 (0.60)

[a] Cover measured with a 9 × 9 point frame in the 1 m^2 centered on the nest or a random point.

[b] Cover measured with a 5-m line intercept tape. The number of cm of each cover type was combined across the four cardinal directions at each site and divided by the total number of cm measured.

[c] Nest site differs significantly from random site ($P < 0.05$).

contained less bare ground and more grass than random sites. Shrub cover ($P = 0.20$) and forb cover ($P = 0.43$) were similar at random and nest sites (Table 1). Twenty-three of 28 ground nests were under big sagebrush; the remaining nests were under rubber rabbitbrush (*Chrysothamnus nauseosus*) and Douglas rabbitbrush. The average percentage of big sagebrush cover in the 1 m^2 around each nest was slightly higher (35% vs 26%) than that at random sites but the difference was not quite significant ($P = 0.06$). Within a 4 × 4 decimeter quadrat directly over nest sites and random sites, 100% and 81%, respectively, contained shrub cover, mostly living. Line-intercept data from the 5-m radius area immediately around the nest and random sites indicated no differences (ANOVA) in shrub ($P = 0.67$), bare ground ($P = 0.96$), grass ($P = 0.45$), or forb ($P = 0.86$) cover (Table 1).

The variation in visual obstruction of the vegetative profile board at the nest site was greatest when measured from 15 m, thus all obstruction measurements used in analysis were taken from that distance. Visual obstruction was not different between the nest sites and random sites at either the 0.0–0.5 m ($P = 0.32$) height or the 0.5–1.0 m ($P = 0.51$) height. Most of the samples at 0.0–0.5 m indicated 41–100% obstruction, but most of the 0.5–1.0 m samples indicated 0–20% obstruction.

Discussion.—The apparent nesting success rates for ground nesting Mourning Doves in this study were somewhat higher than those observed in other studies in the intermountain region. Fichter (1959) reported a nesting success of 66.5% and 1.21 fledglings produced per nest attempt for Mourning Doves nesting in orchards in southeastern Idaho. Dahlgren (1955) reported 58% nesting success and 1.8 Mourning Doves fledged per successful nest, averaged over a 2-year period, in orchards and canal bank vegetation in Utah. The success rates in our study are partly influenced by our recognition of observer-caused abandonment of four nests. Daily survival rates (Mayfield 1975, Miller and Johnson 1978) provide more realistic estimates of nesting success but are not directly comparable with most earlier studies.

Other studies of ground nesting Mourning Doves reported lower nesting success and slightly higher nesting densities than our study. Downing (1959), in northwestern Oklahoma, reported 29% nesting success and 0.06 nests/ha, and Hon (1956) reported 33% nesting success with 0.08 nests/ha for Mourning Doves on the coastal islands of North Carolina. Hon's estimate included high abandonment, at least 50% of which was due to human interference. Reynolds and Trost (1981), when using a rope dragging procedure similar to ours, found Mourning Dove nesting densities on the INEL identical to those reported in our study. Fichter (1959) recorded peak nesting activity in the latter two-thirds of July in southern Idaho, whereas Dahlgren (1955), in northern Utah, reported the greatest nesting activity in mid-June and late July. Our observations from nests, live captures, and collected doves confirmed peaks in nesting activity in June and July but also noted a substantial peak from early to mid-August.

Downing (1959) stated that overhead cover did not appear to be essential to ground nesting Mourning Doves in Oklahoma while Hon (1956) found that 93% of the ground nests on his study site in North Carolina had at least partial overhead cover. All of the nests found in our study were located under shrubs, primarily big sage. We strongly suspect that shading and overhead cover, especially from big sage, were important to nesting doves on the INEL even though the association with shrubs was not statistically significant. A larger sample size of nests is needed to evaluate this relationship. Reynolds and Trost (1981) also noted that Mourning Doves (N = 6) on the INEL nested under shrubs. We suggest that land use practices that maintain substantial shrub cover intermixed with grasses should provide excellent nesting cover for Mourning Doves in the cold desert.

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Nest sites of the Micronesian Kingfisher on Guam.—The Guam subspecies of the Micronesian Kingfisher (*Halcyon cinnamomina cinnamomina*) is one of the casualties of the recent extinction of Guam's avifauna. Predation by the introduced brown tree snake (*Boiga irregularis*) is thought to be the prime factor (Savidge 1986, 1987). The Micronesian Kingfisher was formerly widespread and common throughout the forested regions of Guam (Marshall 1949, Baker 1951) and was one of the last bird species, along with the Mariana Crow (*Corvus kubaryi*) and Guam Rail (*Rallus owstoni*), to decline to critical population levels (Savidge 1987).

The present study, conducted from March to July 1985, was part of a joint effort by the Guam Division of Aquatic and Wildlife Resources, Wildlife Conservation International, and the American Association of Zoological Parks and Aquariums. I censused the remaining kingfishers and studied nest sites in order to assess habitat requirements for conservation and captive breeding.