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PHAINOPEPLA UTILIZATION OF HONEY MESQUITE FORESTS IN THE COLORADO RIVER VALLEY

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Phainopeplas (*Phainopepla nitens*) arrive in the lower Colorado River Valley in the fall and remain through the winter and spring. During the winter they eat the fruit of mistletoe (*Phoradendron californicum*; Rand and Rand 1943, Walsberg 1975, 1977), which primarily parasitizes honey mesquite trees (*Prosopis velutina*). Phainopeplas breed in the valley in spring and then unlike most winter residents, leave the area during the hot summer months.

This report summarizes Phainopepla population data gathered in the lower Colorado River Valley and presents data on the temporally dynamic nature of the Phainopepla niche within the honey mesquite community. We studied the birds' responses to vegetation volume at various levels, the density of honey mesquite trees and of wolfberry shrubs (*Lycium pallidum*), and the amount of mistletoe per unit area. These parameters are important to the Phainopepla niche because mistletoe is the predominant winter food and wolfberry fruits are an important postnesting food. Mistletoe clumps are used as nest sites and as shelter from weather and predators.

Extensive stands of honey mesquite formerly were abundant in the lower Colorado River Valley (Grinnell 1914). The last large stand now occurs on the east side of the river in an area about 80 km long between Ehrenberg and Parker, Yuma Co., Arizona. In the past 10 years much of the land supporting this forest has been converted to agricultural uses; much of the remainder is scheduled to be cleared in the next few years. Elsewhere in the valley, honey mesquite occurs only in mixed-species communities. The remaining honey mesquite forest may be one of the last places to study a large Phainopepla population in the lower portions of the Valley. It is certainly one of the most important areas for wintering and breeding Phainopeplas.

METHODS

We established 20 transects 1,600 m long in relatively homogeneous stands of honey mesquite (95% or more of the vegetation 2 m or taller was honey mesquite). Seven of these were established in late December 1973, nine were established in June and July 1974, and four were added in early January 1975. We felt that 20 transects adequately reflected the structural variations found in the 6,000-ha forest being studied. Emlen's (1971) transect census method was used to estimate population sizes. The monthly population of Phainopeplas per transect was determined by taking the average of three censuses each month. Censusing for this study extended from January 1974 through November 1976. Censuses were taken during the first two hours after sunrise, when the birds are most active (Anderson and Ohmart 1977). Estimates are expressed as the mean number of birds per 40 ha. In January 1975, each transect was marked at 150-m intervals. The side of the transect (left or right) and the 150-m interval in which a bird was detected was recorded. This was important for developing vegetation profiles for the portion of the forest used most frequently by Phainopeplas at different times of the year.

Vegetation profiles were developed for each transect in two ways: honey mesquite trees and wolfberry shrubs within 15 m lateral to the transect were counted within each 150-m interval for the entire length of each transect; volume indices to foliage were obtained using the board technique (MacArthur and MacArthur 1961). Tree and shrub counts were extrapolated to 40 ha. Relative foliage volume estimates were obtained at six levels (0.2, 0.6, 1.5, 3.0, 4.5, and 6.0 m) within each 150-m interval on each side of the transect. The average number of trees and average relative volume of vegetation in each layer in the 150-m intervals in which at least one Phainopepla occurred within 15 m lateral to the transect center line (0.2-ha plots) was used to characterize the preferred vegetation of the birds at various times of the year.

The distribution of the Phainopeplas among the 20 transects of somewhat different structure was calculated using $H' = -\sum p_i \ln p_i$, where p_i is the proportion of the total number of Phainopeplas which occurred in each 40-ha area. J, the proportion of maximum possible H', equals $(H')/(H'_{max})$. H'_{max} was derived from the natural logarithm of the total number of 40-ha areas; significance of H' was tested following Zar's (1974) method of testing diversity indices.

Relationships between variables were tested using Pearson product-moment correlations. Differences between means were tested using a two-tailed t-test for small samples ($n < 30$) and a two-tailed z-test for large samples ($n \geq 30$). The level of statistical significance accepted in this report was $P < 0.05$.

POPULATION DENSITIES

January and February population levels for each year were combined because they were nearly identical. Phainopepla numbers increased steadily in September and October 1974 (Fig. 1) and peaked in November. Numbers

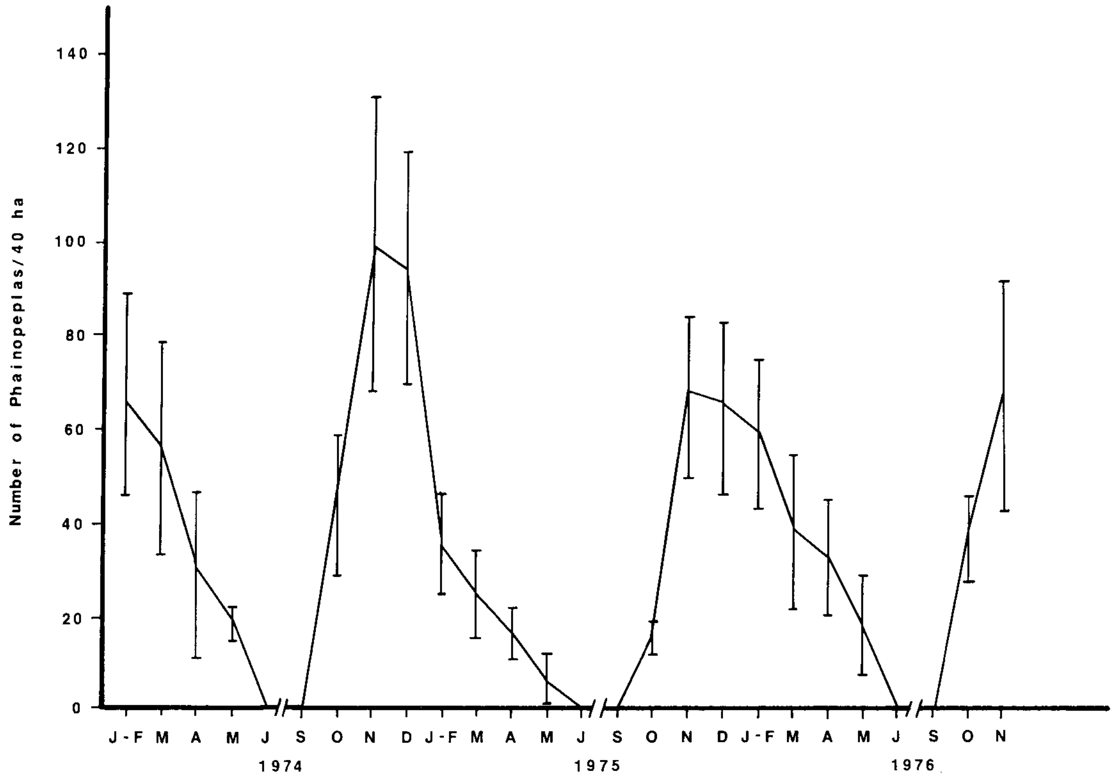

FIGURE 1. Numbers of Phainopeplas per 40 ha at various times of the year in the lower Colorado River Valley. Means are connected by lines and 2 S.E. are represented by vertical lines.

dropped slightly during December 1974, and in January–February 1975 the population decreased to about half the December level. Abundance continued to decrease through May. Few Phainopeplas remained in the Valley after May. Between December 1974 and January 1975 the population dropped precipitously (Fig. 1). In other years the population decreased only slightly from December to February. In all years the March population was significantly smaller than the peak for that year. The decrease continued until the end of May. Apparently many of the wintering birds do not remain to breed in the Colorado River Valley, but leave in February and March. These birds may breed in areas such as the Santa Monica Mountains in southern California, where Walsberg (1977) reported an upsurge in the population in April.

The decrease in numbers of Phainopeplas from December 1974 through January 1975 was due to a rapid loss of mistletoe berries at that time. Since the four transects added in January 1975 had as many birds as the average for the other transects, apparent decreases in the population could not be attributed to the addition of transects. December 1974 and January 1975 were colder than normal, with freezing temperatures occurring on 10 days between late December and early January (weather data from U.S. Bureau of Reclamation, Blythe, California). During this period much of the mistletoe crop froze and rapidly desiccated. Many Phainopeplas were suddenly confronted with a drastically reduced food supply at a time when energy demands were higher than in other years because of the colder, windier weather.

That the population in November 1975 was significantly smaller than in the same period the preceding year suggests that the loss of berries resulted in a reduction in the breeding population. The fruit supply is critical for breeding in Phainopeplas, as has been demonstrated by the birds' failure to breed over a large portion of the Colorado Desert in 1975 (Walsberg 1977). October and November populations in 1976 were larger, perhaps reflecting a more successful breeding effort in spring 1976.

CORRELATIONS BETWEEN NUMBER OF PHAINOPEPLAS AND VEGETATIVE PARAMETERS

Figure 2 shows correlations of Phainopepla numbers with various characteristics of the

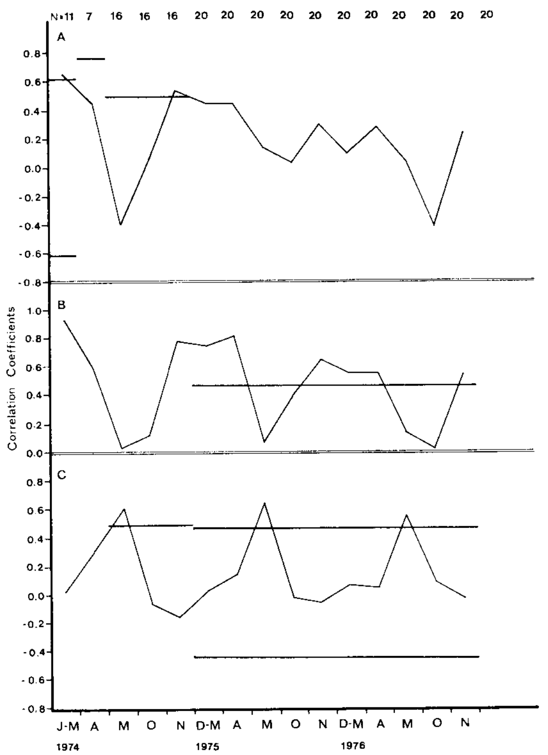

FIGURE 2. Correlations between the number of Phainopeplas and the number of trees and shrubs per 40 ha at various times of the year in the lower Colorado River Valley. Correlations are connected by lines; horizontal lines indicate the 0.05 confidence limit. N = the number of 40-ha plots in the analysis. Since the birds were territorial and remained in the same areas throughout the winter, these months were combined on the graphs. A = Number of Phainopeplas with number of honey mesquite trees per 40 ha. B = Number of Phainopeplas with number of honey mesquite trees with mistletoe per 40 ha. C = Number of Phainopeplas with number of wolfberry shrubs per 40 ha.

honey mesquite communities on the 40-ha plots. Birds arriving in October occupied areas with significantly fewer trees than areas inhabited later in the fall and winter (Fig. 2A). However, total tree density was generally unrelated to bird abundance (Fig. 2A). Phainopeplas concentrated in areas with mistletoe berries in the fall, winter, and early spring (Fig. 2B), and then moved to areas with many wolfberry shrubs in May (Fig. 2C) before leaving for the summer.

Although the mistletoe was largely unripened in October, 12 Phainopeplas collected then contained only the unripened fruit in their digestive tracts. Apparently insects are not a major item in the diet of fall birds. Because Phainopepla numbers in October were small and because mistletoe was present to some degree in all 20 stands, relatively even population distribution would mask a correlation of Phainopepla numbers and mistletoe abundance. The digestive tracts of 46 birds collected between 31 October and 8 February contained only mistletoe berries. Among 10 specimens collected in March, one contained insect remains and all contained mistletoe berries. As insects are scarce and Phainopeplas eat mainly mistletoe berries in winter, the consistent correlation between population densities and the presence of mistletoe was not surprising. Four of five specimens collected in May contained insects (41% by volume), three contained wolfberries (51% by volume), and one contained mistletoe. By May, much of the mistletoe crop had been depleted and wolfberry shrubs had begun to bear fruit.

POPULATION DISTRIBUTION AMONG STUDY PLOTS

The monthly evenness of distribution among transects (J) fell into three periods (Fig. 3): October through February, March and April, and May. In general, J was the same within each period but was significantly different from other periods. Phainopeplas were relatively evenly distributed (J approaching 1.0) throughout the honey mesquite community from October through February. Their distribution was more restricted in March and April, and most restricted in May.

The fact that J did not change during the first period might be interpreted as meaning that the occupied portion of the honey mesquite forest was the same at this time. We have seen that this was not true. Similar evenness can be obtained among the transects even though the birds were attracted to different portions of the mesquite community. In October the birds were relatively evenly distributed over the study area, but within the whole mesquite forest they were found in the more open portions (Fig. 4). The slight unevenness in distribution resulted from a slightly disproportionate number of Phainopeplas in 40-ha areas with fewer mesquite trees and less mistletoe (i.e. the more open 40-ha plots). From November through February the birds were still fairly evenly distributed over the study area, but tended to be concentrated in those places with the most mistletoe (Fig. 2B) and greatest foliage volume at 3 to 5 m (Fig. 4). In March, however, even though the birds occupied areas whose vegetation seemed nearly the same as before, their distribution was significantly less uniform (Fig. 3). This happened because, although the population decreased all over the valley, it decreased faster in 40-ha plots which con-

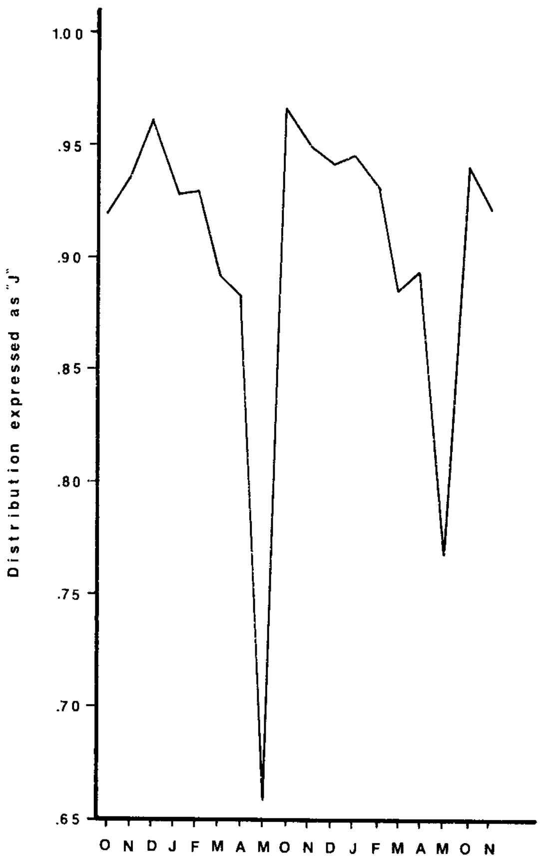

FIGURE 3. Niche breadth of Phainopeplas expressed as J (proportion of maximum NB) for 19 months (October–May) in the lower Colorado River Valley.

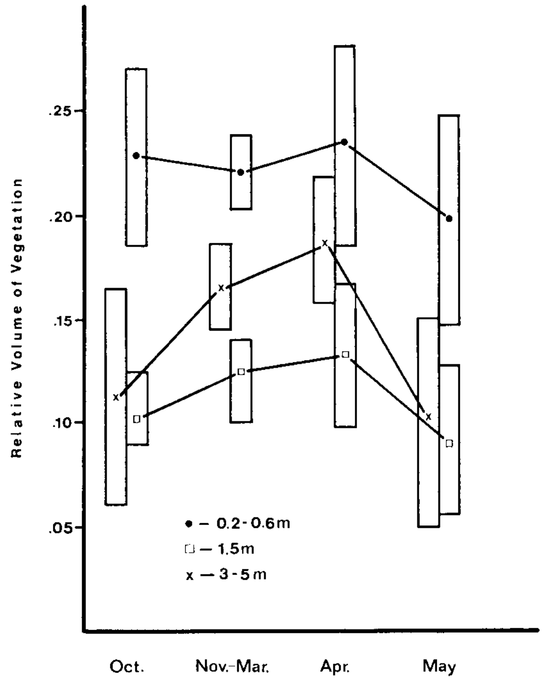

FIGURE 4. Relative density of the vegetation at three levels at different times of the year in 0.2-ha strips in which Phainopeplas occurred at least once. The data from different years for each period have been pooled. Means are connected by lines and the rectangles represent 2 S.E.

tained less mistletoe. The populations in plots with fewer dense patches of mesquite trees decreased faster than those in plots with more dense patches.

Although J was nearly the same in April as in March, the birds used more patches with a higher density of trees (Fig. 2A), containing more foliage, particularly above 3 m (Fig. 4). Some of these differences were statistically significant and biological significance was suggested by the fact that Phainopeplas occurred in denser patches in April during all three years of the study. The population decrease in April was probably due to the departure of nonbreeders. The breeding birds remained in the same proportions as in March in the 40-ha plots, but their occurrence in the vegetatively denser 0.2-ha patches probably was related to the need for more cover for nest protection.

The distribution of Phainopeplas among the transects in May differed in almost every respect from that at other times of the year. The distribution was less even because the birds were concentrated in areas with wolfberry shrubs; this was confirmed by the subplot analysis (Fig. 2C). Since wolfberry abundance was not significantly correlated with large numbers of trees with mistletoe, the significant correlation between Phainopepla abundance and mistletoe was lost. The fact that there was less foliage volume at all levels (Fig. 4) reflects the fact that wolfberry bushes occur in relatively open areas.

SUMMARY

Phainopeplas annually overwinter, breed, and then leave the Colorado River Valley in May. Their distribution among 20 40-ha plots of slightly different vegetative structure was fundamentally dissimilar for the time periods of October through February, March through April, and May. During each period distributions were similar. Although the evenness of distribution of Phainopeplas among the transects did not change from October through February, the portion of the overall vegetation actually occupied in October was different than at other times. In October, Phainopeplas occupied areas with fewer total trees than in winter or early spring. In winter they occupied areas with the greatest volume of

mistletoe (a major food) and in spring (March and April) they were associated with denser vegetation (important for nesting). In late spring (May) they occupied relatively sparse areas that supported wolfberry bushes, and their diet consisted primarily of insects and wolfberries.

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LITERATURE CITED

ANDERSON, B. W., AND R. D. OHMART. 1977. Climatological and physical characteristics affecting avian population estimates in southwestern riparian communities using transect counts, pp. 193–200. U.S. For. Serv. Gen. Tech. Rep. RM-43.

EMLEN, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323–341.

GRINNELL, J. 1914. An account of the mammals and birds of the lower Colorado River Valley. Univ. Calif. Publ. Zool. 12:51–294.

MACARTHUR, R. H., AND J. W. MACARTHUR. 1961. On bird species diversity. Ecology 42:594–598.

RAND, A. L., AND R. M. RAND. 1943. Breeding notes on the Phainopepla. Auk 60:333–341.

WALSBERG, G. E. 1975. Digestive adaptations of *Phainopepla nitens* associated with the eating of mistletoe berries. Condor 77:169–174.

WALSBERG, G. E. 1977. Ecology and energetics of contrasting social systems in *Phainopepla nitens* (Aves: Ptilogonatidae). Univ. Calif. Publ. Zool. 108:1–63.

ZAR, J. H. 1974. Biostatistical analysis. Prentice Hall, Engelwood Cliffs, New Jersey.

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