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DIURNAL AND SEASONAL ABUNDANCE PATTERNS OF BIRDS IN VINEYARDS

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ABSTRACT

Diurnal abundance patterns of birds were examined in two northern California wine grape vineyards in 1981 and in three other vineyards in 1982. Birds entering the vineyards were counted during day-long censuses conducted one day per week throughout the period of damage susceptibility; grape maturity, ambient air temperature, wind speed, and precipitation also were estimated. Overall, the number of birds of all species entering the vineyards did not vary significantly among six time periods of the day. However, American robins (*Turdus migratorius*) were clearly most abundant daily before 0930 h, and their numbers generally declined afterwards. House finches (*Carpodacus mexicanus*) also peaked daily in abundance before 0930 h, but they also reappeared in a second peak during 1730-1830 h.

Birds initially were attracted to the vineyards when berry maturity, as determined by sugar content, reached about 11-13^0 Brix; but overall bird abundance did not appear to be related to grape maturity, air temperature, or wind speed. However, abundance did increase in response to rainfall. A general model predicting diurnal abundance patterns for all species of grape-depredating birds at all vineyards is not possible, but the abundance patterns of some species probably can be predicted at specific vineyards. Growers should monitor bird abundance in their vineyards to determine if and when damage measures are most needed.

INTRODUCTION

Many species of birds damage ripening grapes in the United States (Jubb and Cunningham, 1976; Hothem et al., 1981), but few studies have investigated the factors influencing their presence and abundance in vineyards. Most bird censuses in grape vineyards have been adjuncts to other studies of bird depredations and generally have been conducted during limited periods early in the morning (Jubb and Cunningham, 1976; Hothem et al., 1981; Hothem and DeHaven, 1982). Thus, these censuses may have over-estimated the importance of species most active early in the morning while underestimating those active at other times of day.

Bird abundance and activity in vineyards may vary widely during the day and throughout the growing season, and a better understanding of these patterns could facilitate more cost-effective use of damage control measures. For example, growers could concentrate their damage control efforts at those times of day when the most serious grape depredators are present in the vineyards. This could both reduce the costs of controlling damage and also delay habituation to various visual and/or auditory bird-frightening devices, such as raptor-mimicking kites, automatic propane exploders, and biosonics.

During the 1981 and 1982 grape growing seasons, we monitored bird activity in several vineyards in California. Our objectives were to (1) determine whether diurnal variations of bird abundance in vineyards were predictable, (2) determine whether these patterns were widespread and common to many vineyards or were specific to certain locations and years, and (3) identify the environmental variables most closely associated with these patterns. The results of these studies are reported here.

METHODS

Study Sites

We censused birds at five different wine grape vineyards in northern California during 1981 and 1982, two vineyards during 1981 and three vineyards during 1982 (Table 1). Two of the vineyards were in Napa County, two were in Sonoma County, and one was in San Joaquin County. All of the vineyards were selected because they had relatively large numbers of birds and high levels ($>$5%) of bird damage during recent years. At Kiser, bird abundance was recorded for the entire vineyard, while only portions of the other larger vineyards were censused.

TABLE 1. Period of study and level of grape maturity (°Brix) during first census at each of five wine grape vineyards censused during 1981 - 82 in California.

Vineyard	Period of study	°Brix
Three Palms	20 July - 3 Aug 1981	15.4
Cortopassi	31 July - 4 Sept 1981	11.4
Clegg	26 Aug - 8 Oct 1982	13.1
Kiser	17 Aug - 29 Sept 1982	12.8
Rasmussen	12 Aug - 23 Sept 1982	10.8

Bird Censuses

We evaluated diurnal patterns of bird abundance by conducting a series of day-long censuses at each vineyard. In 1981 we conducted the first census at each vineyard within seven days after $>$ 10 birds were seen in the vineyard during one hour of observation. In 1982 the first census was conducted within three days after damage was noted on 10% of 300 randomly selected bunches of grapes. During both years, after the first census at each vineyard, we conducted additional day-long censuses at seven-day intervals until harvest.

Each census consisted of six one-hour counts conducted at various times throughout the day. During 1981 the six counts began at the following times: (1) 0.5 h before sunrise, (2) 0830 h, (3) 1130 h, (4) 1430 h, (5) 1730 h, and (6) 1.5 h before sunset. During 1982 we randomly selected the starting time for the first one-hour count of each census so that it would begin between 0.5 h before sunrise and 0730 h, and subsequent counts then began at 2.5-hour intervals after the start of the first count.

Each one-hour count was divided into two 30-min segments during which we recorded all birds entering the plot across selected borders of the vineyard. We observed either one or two borders of the study plot during one of the 30-min segments, and then observed an alternative border or borders during the other 30- min segment. During each one-hour count, we randomly decided the sequence in which we observed the borders.

Other Measurements

Before each one-hour count, we used a dry-bulb thermometer and a hand-held anemometer to measure the ambient air temperature (°C) in the shade and the average wind speed (km/hr), respectively, at 1.5 m above the ground. We estimated the average grape maturity at each vineyard weekly, on the same day as the census, by estimating the average sugar content of sampled berries collected from 5-10% of the vines in the study area. We randomly selected one berry from the middle of a randomly selected bunch on each sample vine and then combined and crushed all berries in a large piece of cheesecloth. The juice was collected and thoroughly mixed, and three or four readings were taken with a hand-held refractometer. We used data from U.S. Department of Commerce climatological reports (1981 a,b,c, and 1982 a,b,c) to estimate daily precipitation at each of the study sites.

Data Analyses

To determine whether the overall abundance of all species at all the vineyards varied regularly throughout the day, we conducted a three-way analysis of variance (ANOVA) with vineyard, census (week), and count period (time of day) as independent variables. The square root of the total number of birds of all species entering the study sites was the dependent variable. We also analyzed variations in the abundance of American robins and house finches separately for two vineyards each. The square root of the number of birds of each of these species entering the vineyard was the dependent variable, and week and time of day were two independent variables. We used Duncan's new multiple-range test (Steel and Torrie, 1960, p. 107) to compare count periods.

Step-wise multiple regression (Ryan et al., 1981) was used to determine whether air temperature, wind speed, or grape maturity affected the total number of birds of all species entering each site during each day-long census. The average of the six temperature and wind speed readings for each census and the average refractometer reading from the sampled grape berries were three independent variables.

RESULTS AND DISCUSSION

Diurnal Patterns of Abundance

All vineyards and species combined — We conducted seven consecutive weekly censuses at Cortopassi during 1981 and at Clegg, Kiser, and Rasmussen during 1982. These four vineyards were included in the following analysis. Three Palms Vineyard was excluded from this overall analysis because only three census could be completed before it was harvested.

We recorded a total of 28 species during the two-year study (Table 2). At the Clegg and Cortopassi vineyards, birds were most abundant during the first and second counts, respectively, and at Cortopassi there was also a second, lower peak of abundance late in the afternoon (Fig. 1). Birds also exhibited a bimodal daily pattern of abundance at Kiser, with nearly equal peaks during the first and fifth count periods. At Rasmussen, there were no consistent differences among the six counts.

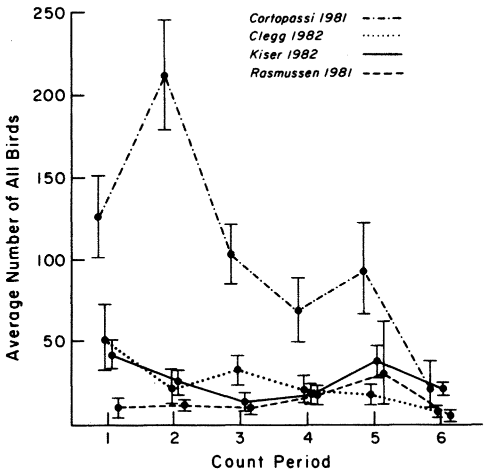

FIGURE 1. Average number of birds of all species (± standard error of the mean) recorded during each of six one-hour count periods throughout the day at each of four wine grape vineyards in California.

Since our statistical analysis did not account for count period as a repeated measure, and since the covariance matrix of the set of six times of day was not the same for all the vineyards, we used a conservative test to evaluate differences among the count periods. We divided the degrees of freedom associated with the F-test by r-1 (r = 6, the number of counts) and found no significant overall variation among times of day ($F = 2.21$, d.f. = 1,5, $p > 0.10$).

The vineyards in this study differed in surrounding habitat, variety and age of grape vines, and species of birds. To determine if bird abundance patterns were specific to particular vineyards and species, we examined the data for the two species present in sufficient numbers to permit separate analysis.

American robins — At Cortopassi, the vineyard with the most robins (Table 2), average differences in robin abundance during the various times of day ($F = 11.47$, d.f. = 5.30, $p < 0.001$). In particular, the second count showed significantly ($p < 0.05$) more birds than any other count except the first. The first count had significantly ($p < 0.05$) more birds than either of the last two counts, and the last count was significantly ($p < 0.05$) lower than each of the earlier counts, except the fifth (Fig. 2). These results clearly show that robin abundance peaked in the morning at this site and then declined gradually throughout the remainder of the day.

The average number of robins entering the Clegg site also varied significantly throughout the day ($F = 5.73$, d.f. = 5,30, $p < 0.001$). More birds were recorded during the first count than at any other time of day ($p < 0.05$), and then numbers declined sharply and remained low throughout the remainder of the day (Fig. 2).

For these two vineyards, the results suggest that the most cost-effective damage-control strategies might result from concentrating efforts, at least those aimed against robins, during the morning hours.

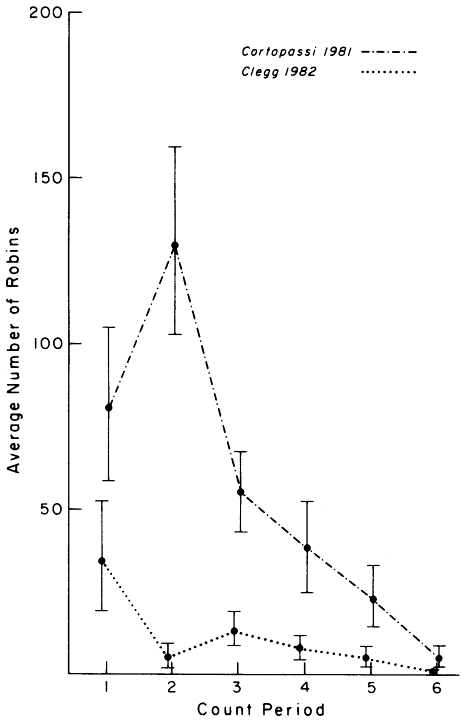

FIGURE 2. Average number of American robins (± standard error of the mean) recorded during each of six one-hour count periods throughout the day at each of two wine grape vineyards in California.

House finches — House finches were most abundant during 1981 and at Cortopassi and Three Palms, where they exhibited bimodal patterns of activity, with peaks of abundance early in the morning and late in the afternoon (Fig. 3). Average numbers varied significantly among the times of day at both Cortopassi ($F = 7.77$, d.f. = 5,30, $p < 0.001$) and Three Palms ($F = 4.23$, d.f. = 5,10, $p < 0.05$). Significantly more finches were counted at Cortopassi during the second count than during any other count except the fifth ($p < 0.05$). The smallest number of finches was recorded during the fourth count, which was significantly lower than all except the sixth count ($p < 0.05$). The difference between the number of birds counted during the fifth and sixth counts was also significant ($p < 0.05$). At Three Palms, bird numbers were also greatest in the morning, with significantly more finches recorded during counts 1 and 2 than during either counts 3, 4, or 6 ($p < 0.05$). There was a resurgence of house finch abundance at Three Palms during count 5, for which more birds were recorded than during either count 4 or 6 ($p < 0.05$).

These results suggest that damage control, at least in these two vineyards in 1981, probably could have been suspended during the middle of the afternoon without incurring additional significant damage from house finches.

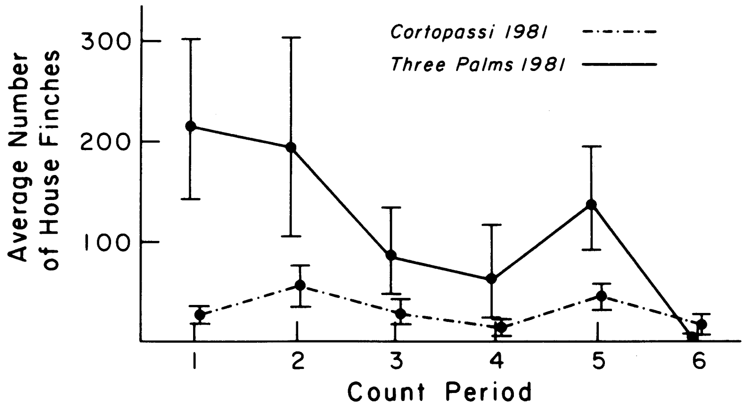

FIGURE 3. Average number house finches (± standard error of the mean) recorded during each of six one-hour count periods throughout the day at each of two wine grape vineyards in California.

Factors Affecting Bird Abundance

We ran a step-wise multiple regression for each of four vineyards: Cortopassi-1981, Kiser-1982, Rasmussen-1982, and Clegg-1982. However, none of the three independent variables (ambient air temperature, wind speed, and grape maturity) explained a significant amount of variation in bird numbers at any of the sites ($F < 6.61$, d.f. = 1,5, $p > 0.05$).

One might expect the palatability of grapes to increase as the sugar content of the berries increases. However, the lack of a significant regression between grape maturity and bird abundance indicates that this may not be the case. Other studies also have suggested that bird damage to grapes is not directly proportional to grape maturity (Stevenson and Virgo, 1971; Tobin, 1984).

Birds apparently began entering the vineyards after the fruit reached a certain threshold level of maturity, but developments past this threshold did not seem to influence bird abundance. Except for Three Palms, the grapes at all the study sites had reached similar levels of maturity, between 10.8 and 13.1° Brix (Table 1) by the first census. Even the birds at Three Palms may have begun causing damage before the grapes actually reached the 15.4° shown in Table 1. The grapes at this site matured faster than the grapes at the other vineyards, and they progressed from hard, green, and immature berries to soft, blue berries, with a corresponding increase in ° Brix from 11-15, during the week preceding the start of the first census.

One factor that appeared to be related to the abundance of birds in the study vineyards was precipitation. No precipitation was recorded during the study in 1981 (U.S. Dept. of Commerce, 1981 a,b,c), but it rained during six days of the study in 1982 (U.S. Dept. of Commerce, 1982 a,b,c). At Clegg, rain fell the day before and during the fourth census (2.0 cm) and during the fifth census (1.6 cm), the two censuses with the second and third most birds, respectively, of the seven censuses conducted at this site. At Kiser, it rained just before the sixth (1.3 cm) and seventh (1.7 cm) censuses, the censuses with the most and third-most birds, respectively. At Rasmussen, three times more birds were recorded during the sixth census, when 2.5 cm of rain fell, than during any other census at that site. Thus, it appears that birds increased in abundance during and just after rainfall. We do not know if the birds actually caused more damage to grapes during these times; but it is likely that they would, since their food consumption generally increases during inclement weather (Morton, 1967).

Bird numbers varied between 1981 and 1982. We initially included Three Palms, Kiser, and Rasmussen in both years of the study, but the data for one year at each of the sites had to be excluded because of insufficient birds visiting the vineyard. This points out the need for grape growers to monitor bird activity carefully in their vineyards each year so that control measures are applied only when they are actually needed.

CONCLUSIONS

Although it is not possible to construct a general model that accurately predicts diurnal patterns of abundance for all species of birds at all vineyards, it may be possible to construct specific models that predict the abundance patterns of some individual species at specific vineyards. Growers should monitor bird activity and apply control measures when the major depredating species at their specific vineyards are most abundant. Bird populations should especially be monitored during and just after periods of rainfall. In general, grapes seem to first become palatable to the birds when the fruit matures to about 11-13° Brix. Relationships between bird number and stage of grape maturity, ambient air temperature, or wind speed were not found and are probably of little value in predicting damage vulnerability..

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DISCUSSION

Question: Do you have estimates of annual losses?

Tobin: The last good study (about 10 years ago) was 4.4 million nationwide. Since then grape acreages have gone up dramatically, but I haven't seen any recent figures. Damage is probably much higher.

Question: Are there any insect pests that the birds might feed on?

Tobin: Insect mites, and birds might well play a role in limiting their numbers; but I've seen no data or cost/benefit estimates. During the time of year, when grapes are maturing, the vineyard is an easy food source for birds. We see mostly immatures, and they feed on insects as well as grapes. I don't think the birds are under stress from hunger.

Question: What about damage levels for an individual grower?

Tobin: It can be 100%. We've seen situations where the bird damage was so great that the grower didn't even attempt any harvest. Overall, on a statewide level, the damage is relatively low in California. But it is the individual farmer, typically in an isolated situation with good surrounding bird habitat, who may suffer heavy damage.

TABLE 2. Bird species recorded during censuses in California grape vineyards during 1981 and 1982.

		Number of Birds				
Species	Scientific Name	Cortopassi (1981)	Three Palms (1981)	Clegg (1982)	Kiser (1982)	Rasmussen (1982)
house finch	Carpodacus mexicanus	1556	2129	5	98	486
American robin	Turdus migratorius	2599	17	623	1	4
northern mockingbird	Mimus polyglottos	29	—	2	358	20
western tanager	Piranga ludoviciana	1	—	244	34	—
California quail	Callipepla californica	—	—	21	219	—
house sparrow	Passer domesticus	—	—	—	—	229
European starling	Sturnus vulgaris	141	—	2	149	8
brown towhee	Pipilo fuscus	—	—	17	75	20
rufous-sided towhee	Pipilo erythrophthalmus	—	—	31	8	—
western bluebird	Sialia mexicana	3	25	8	14	46
Stellar's jay	Cyanocitta stelleri	—	—	52	—	—
scrub jay	Aphelocoma coerulescens	52	—	13	24	8
dark-eyed junco	Junco hyemalis	—	—	41	8	1
acorn woodpecker	Melanerpes formicivorus	—	4	42	—	—
Nuttall's woodpecker	Picoides nuttallii	1	1	—	—	—
northern flicker	Colaptes auratus	2	—	25	3	1
pileated woodpecker	Dryocopus pileatus	—	—	4	—	—
black phoebe	Sayornis nigricans	—	—	—	11	18
goldfinch	Carduelis spp.	—	11	1	13	5
cedar waxwing	Bombycilla cedrorum	—	—	15	—	—
black-headed grosbeak	Pheucticus melanocephalus	—	—	8	—	—
evening grosbeak	Coccothraustes vespertinus	—	—	—	7	—
yellow warbler	Dendroica petechia	—	—	—	—	5
song sparrow	Melospiza melodia	—	—	—	5	—
vesper sparrow	Pooecetes gramineus	—	—	—	2	—
white-crowned sparrow	Zonotrichia leucophrys	—	—	—	35	—
yellow-billed magpie	Pica nuttalli	4	—	—	—	—
lazuli bunting	Passerina amoena	—	1	—	—	—
	Total	4388	2188	1154	1064	851