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The extent of damage to pistachios by some birds that knock nuts to the ground, where they hull, shell, and eat them, can be measured. Losses to birds that pluck nuts from the tree and fly off to eat them elsewhere can only be estimated.

Bird damage to pistachios

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Crows are the primary culprits followed by ravens and jays

Various bird species are pests to a number of California crops. Nut crops such as pistachios, almonds, and walnuts are particularly hard hit, although information on actual losses is limited. Most damage occurs when birds feed on nuts or knock them to the ground when landing in trees.

Between 1975 and 1984, the acreage of bearing pistachios in California increased from about 600 to 31,900 acres, with a corresponding increase in reported bird damage. We are conducting a study to identify the bird problem, evaluate current control methods, and, to a limited degree, propose and test new damage control methods. A survey was mailed to commercial pistachio growers as the first

step in defining the problem and evaluating current bird control methods.

The major focus of the survey was to identify the bird species involved, the extent and degree of damage, control methods used, and their effectiveness. The California Pistachio Commission mailed the survey to all 458 commercial pistachio growers in the state shortly after the 1984 harvest. Ten days later, a follow-up reminder was mailed to survey recipients. We analyzed data using the SAS System on a VAX computer at the University of California, Davis.

For reporting purposes we grouped counties into the three districts used by the California Pistachio Commission. District I (Southern) is Tulare County and all

counties to the south. District II (Central) is Merced, Madera, Fresno, and Kings counties. District III (Northern) is Monterey, San Benito, Inyo, and all counties to the north of Merced County.

Scope of the problem

We received 105 responses (23 percent) from the 458 surveys mailed. Thirteen (12.7 percent) were excluded from analysis, because the orchards represented were not in production, were outside California, or were managed by another person. The remaining 92 indicated they had pistachio losses due to one or more bird species.

Bird damage was widespread throughout the state, as indicated by surveys returned from 18 counties. These 18 counties represent 98 percent of the bearing pistachio acreage in California. The information we report here is based on the survey returns and does not account for bird damage and control that undoubtedly occur but were not reported. Our estimates should therefore be considered conservative.

The survey included questions about six potential pest bird species with additional questions about birds unidentified or not listed. Bird damage was reported to occur in orchards representing 22,460 of the 31,900 bearing acres (fig. 1).

Growers reported the American crow (*Corvus brachyrhynchos*) as the most frequent pest bird of pistachios, followed by the Brewer's blackbird (*Euphagus cyanocephalus*) and European starling (*Sturnus vulgaris*), scrub jays (*Aphelocoma coerulescens*), common raven (*Corvus corax*), and yellow-billed magpie (*Pica nuttalli*).



Paul Gorenzel



Paul Gorenzel



Scrub jays (top), magpies (center), and blackbirds (lower) ranked below crows and ravens as the most serious bird pests in pistachio orchards. In total, birds caused \$1.8 million in damage in 1984.

Eleven growers indicated they had damage caused by unknown or unidentified birds. Some growers recognized bird damage, but were uncertain of the species responsible. Others listed birds such as house finch (*Carpodacus mexicanus*), sparrow (family Fringillidae), mourning dove (*Zenaida macroura*), domestic pigeon (*Columba livia*), and western meadowlark (*Sturnella neglecta*) as causing damage in their orchards.

From the results of the survey and our own field observations, it is clear that most of the pistachio crop damage caused by birds occurs during the six- to eight-week period between the maturation of the first nuts (hull-slip) and harvest.

To better assess the relative importance of pest birds to pistachio production, we estimated the dollar loss caused by each species using the equation given in the table 1 footnote.

Bird damage

Ravens were reported, with one exception, to damage pistachios only in the southern region, from Tulare County

south. One grower reported raven damage in Yolo County, which is within the bird's California range but appears to be an exceptional case of pistachio damage this far north. The raven normally knocks pistachios from the tree, then moves to the ground to hull, shell, and eat some of the pistachios that have fallen. Raven damage was calculated to cost just over \$900,000 (table 1). Most growers indicated that ravens were in the pistachio orchard during its most susceptible period, hull-slip to harvest.

Crows were reported as pests of pistachios by 79 percent of the survey respondents. We estimated that crows caused slightly less than \$800,000 damage to pistachios statewide. Crows feed on the nuts either in the tree or on the ground after knocking them from the tree. In areas where disturbance is likely, a crow will remove the nut from the tree and fly out of the orchard to feed in a less disturbed location. Crows were most common in the orchard from hull-slip to harvest, but many remained after harvest. Some people suggest crows are beneficial after

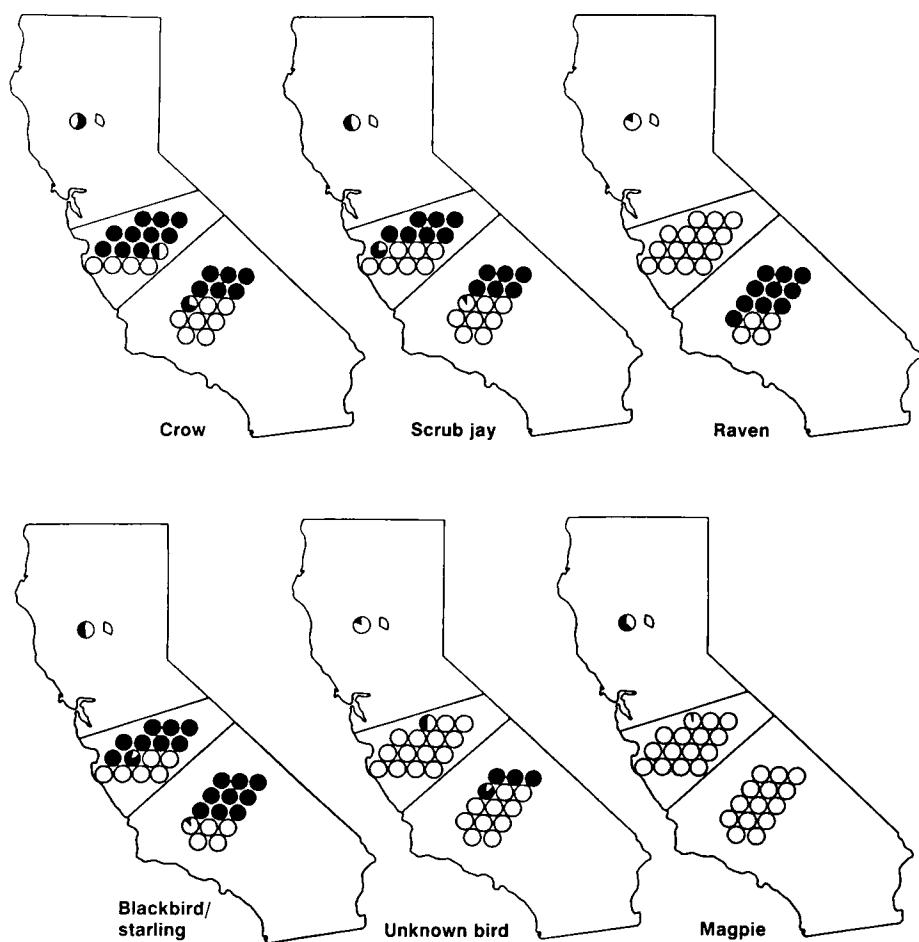


Fig. 1. Distribution of pistachio production and bird damage by district. Each circle represents 1,000 bearing acres. Blacked-out circles represent acreage of the orchards with some level of bird damage.

harvest, because they remove mummy nuts, a practice important in controlling naval orangeworm if present in the area. After-harvest feeding may further condition the birds to use pistachios as food, however, creating a greater dependence on the orchard and crop the following year.

Scrub jay damage to pistachios was reported by 53 percent of the growers. Scrub jays either hull, shell, and eat pistachio nuts in the tree or remove them from the cluster and carry them from the orchard to either eat or cache in another location. More than 14,000 acres of pistachios were affected, and we estimate that scrub jays caused just over \$48,000 damage. While scrub jays occur in orchards throughout the year, their numbers increase sharply from hull-slip to harvest.

Magpies were reported to cause over \$28,000 damage to pistachios. Reports of these losses came from only eight counties, all north of Madera County, fitting well with the bird's known geographical distribution. Much like crows in their feeding behavior, magpies feed on nuts in the tree or knock them to the ground to feed on them. Occasionally magpies cache pistachio nuts.

Blackbirds and starlings were grouped together, because it is difficult to distinguish between them in mixed flocks. Blackbirds/starlings were the second most frequent bird reported to cause damage to pistachios, and they affected more acres than any other bird. In observations in pistachio orchards, we have found blackbirds to be much more common than starlings. Both species spend most of their time foraging for insects on the orchard floor but occasionally feed on pistachios that have fallen to the ground. Only rarely do blackbirds remove pistachio nuts from the tree. The dollar loss calculated for blackbirds/starlings ranks fifth behind the ravens, crows, scrub jays, and magpies.

The "unknown bird" category was used by growers who had bird problems not listed on the survey questionnaire, or who were aware of the damage but never saw the birds involved or could not identify the species. Only 12 percent of those reporting some type of bird damage to pistachios indicated that unknown birds caused damage, affecting 4,118 acres with an estimated dollar loss of \$566.

Future bird problems

Growers were asked to indicate whether their losses to birds were increasing, decreasing, or remaining the same. Eleven of the growers reporting damage by ravens said that the problem was becoming more severe, because raven populations were increasing and the pistachio trees were maturing. Most growers with

crow damage reported an increasing problem in their pistachio orchards, which they felt was due to higher numbers of crows in the general area. A majority of those indicating losses to scrub jays also reported them as a growing problem because of increasing populations. It was not clear from the survey responses whether magpies were becoming a more serious problem, but none of the growers with losses to these birds indicated that they were decreasing. The seriousness of the blackbird/starling problem, overall, did not appear to be changing.

Control methods used

The growers were asked to specify and rate the methods used, if any, to control each bird species. All of the commonly used control measures attempted to frighten or disperse birds from the orchard. Shooting was the most common, followed by gas cannons (propane exploder), Av-Alarm (electronic noise maker).

and hawk kites (kites that look like predatory birds). The observed effectiveness of a control method varied with the bird species.

For ravens, over half of the growers using shooting rated it moderate to excellent (table 2). Av-Alarm and hawk kites were reported so infrequently that conclusions about their effectiveness are difficult to draw.

For crows, shooting was most frequently used, and almost half of those using this method reported a moderate level of control. Most growers using gas cannons reported slight to moderate control. Most growers considered Av-Alarm and hawk kites to be ineffective for crow control.

Shooting was most effective in dispersing scrub jays. Gas cannons, Av-Alarm, or hawk kites offered slight or no control.

Shooting and gas cannons were the only techniques used by more than one grower for controlling magpies. Most re-

TABLE 1. Damage by different bird species to pistachios reported by growers on the statewide survey, 1984

District	Surveys returned	Growers reporting damage	Area affected	Average reported loss	Average estimated loss*
RAVEN					
Northern	19	5	200	12.19	2,439
Central	34	0	0	0	0
Southern	39	33	9,848	92.34	909,364
TOTAL		15	10,048	90.74	911,803
CROW					
Northern	19	79	578	6.42	3,711
Central	34	91	10,401	1.82	18,921
Southern	39	69	6,689	115.61	773,320
TOTAL		79	17,668	45.05	795,952
SCRUB JAYS					
Northern	19	79	361	1.15	415
Central	34	44	7,743	2.37	18,351
Southern	39	49	6,159	4.84	29,814
TOTAL		53	14,263	3.41	48,580
MAGPIE					
Northern	19	74	599	47.44	28,417
Central	34	6	62	0.56	35
Southern	39	0	0	0	0
TOTAL		17	661	43.04	28,452
BLACKBIRD/STARLING					
Northern	19	63	547	2.21	1,209
Central	34	65	8,819	1.28	11,288
Southern	39	51	9,123	0.96	8,758
TOTAL		59	18,489	1.15	21,255
UNKNOWN BIRD					
Northern	19	21	203	1.42	288
Central	34	15	50	1.71	85
Southern	39	5	3,865	0.05	193
TOTAL		12	4,118	0.14	566

* Estimated by equation: $L_b = \left(\sum \left(\frac{Y_b P}{100} \right) a_b \right) D$

L_b = total dollar loss to all growers reporting damage from bird species b

Y_b = individual grower estimate of percent yield loss per acre for part of the orchard damaged by species b

P = statewide average pistachio production (1,944 pounds per acre)

a_b = individual grower estimate of acres damaged by species b

D = statewide average price paid to the growers (98 cents per pound)



Gas cannons are employed by some growers to frighten birds away from pistachio orchards. The effectiveness of the cannon and other control methods in dispersing birds varies with the species.

ported slight to moderate control with these methods.

Similar results were reported for shooting and gas cannons to control blackbirds/starlings. Av-Alarm and hawk kites were reported to give slight to no control of these types of birds.

Despite reporting losses due to birds, many pistachio growers used no control measures. As an example, 28 percent reporting losses to crows took no action to reduce their losses. One reason for this may be that growers feel available techniques are not cost-effective.

Conclusions

Bird damage was reported in 22,460 acres, or 70 percent of California's commercially producing pistachio orchards. The total dollar loss in 1984 to growers responding to the survey was estimated to be \$1.8 million for all birds combined, representing 4 percent of the gross income for those growers. More importantly, the per-acre losses reported by growers averaged \$27.68, ranging from 5 cents to \$1,086. In our own assessments of orchards with bird damage, losses ranged from about \$40 to over \$200 per acre (based on 98 cents per pound). Clearly, birds affect some orchards (and growers) much more severely than others.

Based on the large number of growers affected and the estimated dollar loss, we feel crows are the primary bird pest of pistachios. Estimates of losses due to ravens were the highest at over \$900,000. Fortunately, the availability of a moder-

ately effective control method and the raven's limited geographic range make this species somewhat easier to deal with.

Although the survey estimated losses of only \$48,167 caused by scrub jays, this probably under-represents the problem. Scrub jays are still an important bird pest of pistachios because of their statewide distribution, their potentially serious impact on some growers, and the difficulty growers have in controlling them.

Our own assessments of scrub jay damage to pistachios indicated that the range of damage was considerably greater than the average estimated from the survey returns. We suspect the grower estimates of damage by scrub jays may be low. First, in four pistachio orchards at harvest, we found over 90 percent of the bearing trees had some scrub jay damage, most at relatively low levels. This level of damage distributed over the entire orchard may be more difficult for the grower to quantify than heavy damage occurring in a few trees. Second, we found that nearly two-thirds of the nut loss caused by scrub jays occurred when the jays carried pistachios from the orchard, leaving no evidence of damage.

Magpies did over \$28,000 damage to the 1984 pistachio crop. Fifth in economic importance were the blackbirds and starlings. Damage by blackbirds/starlings may be overestimated, since we found that most nuts eaten were already on the ground. Finally, those birds not listed on the survey or unidentified caused only \$566 damage. We feel these estimates are conservative, since they were obtained from only those growers who returned the survey.

The most frequently used control technique was shooting to frighten or disperse the birds, followed by gas cannons, Av-Alarm, and hawk kites. Growers generally felt that shooting gave the highest level of control. They rated hawk kites the lowest regardless of the pest species. None of the available techniques seems to have provided a consistent level of control for all those using it, and it seldom gave what the growers considered excellent control.

Bird damage represents a destabilizing factor in the pistachio production of individual growers, and improved control methods are needed.

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TABLE 2. Growers indicating the perceived effectiveness of control methods they used for each bird species damaging pistachios, 1984

Technique	Number	Level of control			
		None	Slight	Moderate	Excellent
RAVEN					
Shooting	8	12	25	25	38
Gas cannon	7	14	57	0	29
Av-Alarm	3	67	0	0	33
Hawk kites	1	100	0	0	0
CROW					
Shooting	47	11	36	47	6
Gas cannon	25	16	28	40	16
Av-Alarm	7	57	0	14	29
Hawk kites	5	80	20	0	0
SCRUB JAY					
Shooting	29	0	58	41	1
Gas cannon	14	36	36	28	0
Av-Alarm	7	43	43	14	0
Hawk kites	5	80	20	0	0
MAGPIE					
Shooting	9	11	45	33	11
Gas cannon	4	25	25	50	0
Av-Alarm	1	0	0	100	0
BLACKBIRD/STARLING					
Shooting	18	6	55	33	6
Gas cannon	10	10	50	30	10
Av-Alarm	4	50	50	0	0
Hawk kites	4	75	25	0	0