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Electronic Repeller and Field Protocol for Control of Crows in Almonds in California

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ABSTRACT: Past studies have shown that the American crow, a major pest in almonds, can be effectively hazed out of almond orchards with broadcast distress calls. These studies, however, have not approached the matter from an integrated pest management standpoint. A large-scale field protocol was required to guide growers when using electronic broadcast units. A broadcast unit was designed for testing the field protocol with emphasis placed on preventing habituation and saving power. A selection of crow chick distress calls were recorded on the University of California-Davis campus for use in the broadcast unit. In addition, recordings of 2 dying adult crows were obtained from the United States Department of Agriculture National Wildlife Research Center in Fort Collins, CO. The calls proved effective in preliminary hazing tests and during the field study. The field protocol included broadcast unit deployment at the first sign of bird damage at a rate of one unit per 1.6 ha, distributed uniformly throughout the orchard, moved to a new tree every 2 weeks, and automatically switched to a different call every 3 to 4 days. Growers at each site were also supplied with pyrotechnics to supplement the distress calls and were encouraged to use other techniques such as shooting and gas cannons. The units ran until harvest. Six orchards, a pair from each of 3 different areas in California, were chosen to test the field protocol. The orchards were surveyed for damage over 2 growing seasons, and 1 orchard in each pair received treatment in the second year. Two of the 3 treated sites showed a decrease in damage due to the treatment of the broadcast units implemented with the field protocol. One site showed a damage reduction from 0.84 (6.0 kg/ha) to 0.25 (1.1 kg/ha). Another site showed a damage reduction from 1.54 (18.2 kg/ha) to 0.73 (4.8 kg/ha). The third site was not damaged in the first year, therefore damage reduction in the second year was not possible.

KEY WORDS: almonds, American crow, biosonics, bird control, bird damage, bird hazing, *Corvus brachyrhynchos*, crow, distress calls, warning calls

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INTRODUCTION

The American crow (*Corvus brachyrhynchos*) is the primary avian pest in almonds. A mail survey conducted in 1993 polled nut growers in Sutter and Yuba Counties of California and showed a 3 to 4% loss in production due to crows (Hasey and Salmon 1993). Growers taking part in the survey reported the American crow as the most frequent bird pest in almonds. Confirming these high damage rates, another California study recorded damage in some almond orchards ranging from $320 to $2,470 per ha (Salmon et al. 1999).

With such perceived and actual monetary losses, growers would usually employ some sort of management technique to keep crows out of their orchards. Techniques have included shooting, propane cannons, and visual and sonic scaring devices. There has been a renewed interest in the use of broadcast distress calls to scare birds from a large area. Broadcast distress calls have been shown to effectively haze crows out of almond orchards in past studies (Salmon et al. 1999, 2000). While the studies were successful, the technique was tested on a small scale. There is a need for a production-scale protocol that specifies the use and integration of broadcasting devices into current pest management programs.

Literature Review

Birds cause problems to humans and themselves in a number of settings other than agriculture: urban bird roosts, sewage plants, mining settling ponds, landfill sites, airports, and oil spills. Commercial bird problems are similar to agricultural problems, and knowledge can be drawn from research in any of these areas and applied to the agricultural industry

Management Strategies and Applications

Population reduction is commonly viewed as a short-term solution to a pest problem and has generally been used on a limited basis in agricultural, urban, and airfield bird problems. Crows usually have a high population density in an agriculture setting, and therefore require great efforts to reduce their population to acceptable numbers. Crows and magpies are difficult to trap and there have been few attempts to do so. While poisoning has been an effective killing method in the past, concerns with killing non-target species have made this method all but obsolete (Micke 1996).

While trapping, poisoning, and shooting are not viable methods for population reduction, shooting is still a useful scaring technique. Shooting can help reinforce other techniques, such as propane cannons or biosonics.

It is advisable to kill a limited number of birds to reinforce the scaring techniques being used in a given area (Littauer 1990, Micke 1996).

Visual frightening techniques include any methods that rely on predator recognition or visual startling due to movement, including Mylar tape, scarecrows, balloons, and predator models. Gorenzel et al. (2003) reported that while Mylar tape is effective when first deployed, birds habituate in just a few days. Marsh et al. (1992) reported mixed results from predator models. Models incorporating movement or sound produced the best results, but the birds eventually habituate to the methods.

Biosonics have been studied since the 1960s and have been shown to repel a number of different animal species from a range of environments (Bomford and O'Brien 1990). A biosonic device contains recordings of the target species' warning or distress calls, which are broadcast through a loudspeaker in the general area where the birds are a problem.

Pyrotechnics include several firework devices for scaring wildlife. Bird bangers, screamer sirens, shell crackers, and propane cannons emit loud noises that emulate a shotgun blast or loud whistle. When used in conjunction with shooting, these techniques can be very effective (Bomford and O'Brien 1990).

Broadcasting Bird Warning Calls

Littauer et al. (1997) note that scaring programs should begin early, when birds first arrive, to keep them from establishing feeding habits. Pyrotechnics or live ammunition fired from a vehicle is considered aggressive harassment and will yield the best results. Once aggressive scaring methods have reduced the bird presence, supplemental methods can be used to keep birds away without constant attention. Recorded warning calls, scarecrows, and propane cannons will help to supplement aggressive scaring methods. The supplemental methods should be moved every few days to help prevent habituation. When these scaring methods become ineffective, it is recommended that growers kill a limited number of birds to reinforce the aggressive and supplemental scaring techniques.

Naef-Daenzer (1983) performed a study on the scaring of carrion crows (*Corvus corone*) with distress calls and suspended bodies of dead crows. The broadcast apparatus consisted of a waterproof tape recorder and two loudspeakers. It played from dawn until dusk, each call was 20 - 30 seconds, and each silent period was 25 minutes. The fields treated with distress calls had significantly less damage than the fields treated with the dead crows and the untreated fields. There was no habituation to the calls at the reported calling rate.

Bird Response to Warning Calls

Bridgman (1980) reported that resting and feeding gulls react to broadcasts of distress calls of their own or closely related species by getting up and approaching the sound source. They then circle overhead for a while before drifting away in various directions to some other favored site. Rarely do they attempt to resettle on or near the original location. Crows react in a similar manner, as noted by Salmon et al. (2000). It is important that a grower using broadcast warning calls understand this. From the sight of flocking crows, some may believe they have been called in and will remain in the area and cause damage, but this is not the case. The call is actually doing exactly what is intended.

Effectiveness of Control

Baxter (2000) performed a study using distress calls to deter birds from two domestic waste sites located near an airfield. Calls were manually played during landfill operating hours at a frequency of not more than one 90-second call during each half hour. The deterrence was successful in stopping birds from loafing and feeding on the site during the initial period, but after 4 to 6 weeks, habituation began to occur. The number of birds returned to pre-trial levels after 10 weeks of playing the calls at both sites. There were no supplemental frightening techniques employed during the study.

Brough (1968) performed a 12-month study scaring gulls, corvids, lapwings, and starlings from Royal Air Force airfields. Broadcast warning calls and shell crackers were used to scare birds from the airfields. When shell crackers were used alone, they were successful on 88 of 120 occasions (73%). When broadcast calls were used alone, they were successful on 476 of 573 occasions (83%). Finally, when broadcast calls and shell crackers were used in combination, they were successful on 285 of 306 occasions (93%). This research showed the effectiveness of broadcast warning calls as well as the increased effectiveness of calls used in conjunction with a secondary scaring method.

Lehoux and Belanger (1995) tested the effectiveness of a floating playback device that broadcasts loud noises to keep seabirds away from an oil spill site. The noises used consisted of 1 predator sound and 5 artificial sounds including explosions, synthetic noise, helicopters, sirens, and other similar noises. The sounds were broadcast at intervals ranging between 4 and 12 minutes and sound length varied from 15 to 90 seconds. During one test, the device decreased the number of birds within a 700-m radius by 85%, and by 59% in a 6-km-long area in a second test. The maximum period in which the bird scarer was deployed was 64 hours, and no habituation was noted.

Salmon et al. (1999) tested broadcast warning calls to reduce crow damage in almonds. The playback device was specifically built to play bird calls and was commercially available under the brand name Bird Gard (Bird Gard, LLC, Sisters, OR). The commercial units were set to play at full volume every 5 minutes, and the calls lasted 24 seconds. To help prevent habituation, they were moved to a new location within each orchard twice a week. Growers were encouraged to use propane cannons and shooting to supplement the warning calls. Damage decreased at all sites compared to the first year. Losses ranged from \$54/ha to \$341/ha in the second year, compared to \$114/ha to \$2,508/ha in the first year.

Salmon et al. (2000) attempted to integrate broadcast warning calls into a pest control program. In this study, the growers deployed the units at the first sign of damage as well as moved and maintained the units while the research team took bird counts and estimated damage in the orchard. The commercial units from Salmon et al. (1999) were employed with the same settings, one 24-second call every 5 minutes. Each grower received enough units to cover 2-3.5 ha per unit. In one orchard, bird presence was reduced by 61%. In other orchards, crows completely vacated the area for the duration of the growing season. However, habituation was seen 4 to 5 weeks after deployment in some of the orchards.

While these studies were successful in using broadcast warning calls to haze crows and other birds, there was very little discussion on the proper way to deploy the broadcast units. If the broadcast units are not properly used, habituation could occur earlier than normal. Also, the majority of the studies lacked a properly designed experiment with replications. Therefore, a statistical comparison of treatment effects could not be made.

OBJECTIVES

The objectives of this study were to 1) design a simple broadcast unit, 2) develop a field protocol for controlling American crows in almonds, and 3) evaluate the effectiveness of the field protocol.

MATERIALS AND METHODS

Warning Calls

Some of the calls tested in past studies were commercially available (Salmon et al. 2000), but most of these commercially-available calls were copyrighted, impeding free distribution. Therefore, calls were recorded for the project or taken from public sources. In spring 2002 at the beginning of the nesting season, active nests were scouted in orchards on the University of California-Davis (UCD) campus. When the nesting season was far enough along for the fledglings to vocalize, recordings were made of the birds in distress. The chicks were picked up out of the nest and held upside down while being gently shaken and prodded. A microphone and tape recorder recorded the call. The chicks were then placed back in the nest. Four separate nests were visited over a 2-week period. The USDA National Wildlife Research Center (NWRC), located in Fort Collins, Colorado, had a number of public recordings, including crow warning calls. The NWRC calls were two separate calls of adult crows, one male and one female; each had been dosed with poison and recorded while they died. A number of other calls were located and selected as possible candidates for recording onto the units.

To test the effectiveness of the candidate calls, they were played locally. The most desirable reaction was for the entire flock to fly toward the sound while calling, and then vacate the area. When a flock of crows was spotted, one of the calls was broadcast in the direction of the flock. The reaction was noted as "desirable" or "other." This was done for 6 different candidate calls, with 15 to 20 repetitions per call. As shown in Figure 1, the UCD and NWRC calls elicited the desirable response 75% and 50% of the time, respectively.

From the results of the preliminary test, the NWRC calls and the UCD calls were selected due to the high percentage of the desirable reaction. Two segments were digitized from the NWRC calls and two from the UCD calls. Each segment was edited to 25 seconds, and long silences were removed with sound editing software (Goldwave v. 5, St John's, Newfoundland, Canada). The result was 4 calls labeled "UC1," "NWRC male," "UC2," and "NWRC female"; they were recorded onto the sound chip of the broadcast unit in this order.

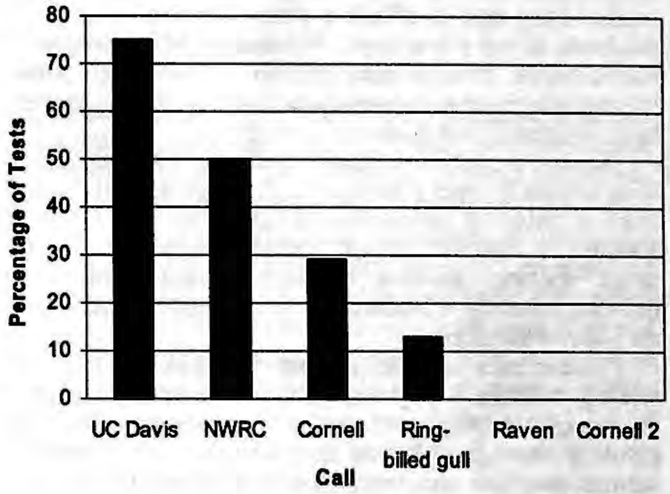

Figure 1. A bar chart of the percentage of desirable responses for the six different calls tested.

Broadcast Unit

The main design goals for the broadcast unit circuit board were to prevent habituation and save power. To save power, the unit went into a power save mode at night and automatically turned on just before sunrise each day. At the heart of the design was a sound chip that digitally saved and played back any sound recorded (Houk 2004). There were 4 different calls recorded on the sound chip, each 25 seconds long. When the circuit was on during the day, it waited approximately 12 minutes between calls. Every 3 to 4 days the circuit would automatically switch to a new call. After rotating through the fourth call, it would return to the first call and continued this cycle as long as the circuit was on. The circuit had a 5-W audio amplifier for connection to a loudspeaker.

The circuit drew approximately 0.70 mA during the day in standby mode, and 8 μA at night. The audio amplifier and speaker drew the majority of the current in play mode, about 200 mA. A sealed, deep-cycle battery with a 36-Ah rating (Model: UB12350, Universal Battery Co., China) was selected to power the circuit. This allowed the circuit to run the entire growing season without recharging. A weatherproof trumpet speaker (Speco Model SPC-8, 8Ω, 15W, Speco Technologies, Amityville, NY) was used for broadcasting the calls.

A circuit enclosure, speaker, and battery made up one unit. A stainless steel plate, from which a hook was bolted, held the circuit enclosure and speaker. The battery sat on the ground and a 2.5-m power cord connected the battery to the circuit. The hook had a large opening for hanging on tree branches up to 10 cm in diameter. The completed unit is shown in Figure 2.

Table 1. Almond orchard test sites.

Site	Location	Area (ha)	Varieties	Rodent Problem
1	Firebaugh, CA	20.6	Nonpareil, Carmel, Monterey	None
2		20.6	Nonpareil, Aldridge, Monterey	None
3	Kerman, CA	29.5	Nonpareil, Carmel	Light
4		22.3	Price, Nonpareil, Carmel	Light
5	Yuba City, CA	24.3	Peerless, Price, Nonpareil, Butte, Mission	Very Light
6		16.2	Peerless, Price, Sonora, Carmel	None

Figure 2. Assembled unit hanging in an almond tree.

Experimental Design

Site Selection and Experimental Plan

Orchard selection was constrained by several requirements. First, there must have been a crow population in or around the orchard. Second, due to the difficulty of distinguishing bird and rodent damage, the orchard could not have had California ground squirrels (*Spermophilus beecheyi*) present, as this would slow the surveys. Third, the orchard had to contain at least one variety of almonds with paper shells. Fourth, the orchards must have been far enough away from each other as to assume that crows repelled from one study orchard would not fly to another study orchard. It was also assumed the sounds at one test site could not be heard at any other test sites. Six such orchards were selected with the help of the local farm advisors. Table 1 shows the site characteristics of the orchards selected for the study.

For each orchard, another orchard from the same area was assigned as its pair. In the first year, all of the orchards were surveyed for crow damage without the broadcast units in place. In the second year, one orchard in each pair was selected for treatment and the remaining orchard was the control. Between any two pairs, it was assumed that in Year 2, the damage change due to a shift in the population density of crows at the control site would be the same damage change at the treated site.

Damage Assessment

A damage rating procedure from past studies was slightly modified to fit the larger orchards in this study. Data were used from two previous studies (Salmon et al. 1999, 2000) to calculate the number of damaged nuts in each damage rating category. The data consisted of the number of damaged nuts in half of a tree canopy. There were 4 damage categories: none (damage rating = 0), light (1), medium (2), and heavy (3), as shown in Table 2. The number of nuts in each category was chosen based on estimated economic loss.

The survey method was adapted for use with an all-terrain vehicle (ATV) to expedite the survey process. Ten percent of the trees of each variety were sampled by randomly selecting enough rows so that the number of trees in the selected rows was approximately 10% of the tree population. The ATV rider would drive along one side of each row, estimate the number of damaged nuts under the half canopy, and call out the damage rating into a tape recorder. After the survey was completed, the tapes were transcribed onto a spreadsheet.

Three surveys were conducted throughout the growing season (Salmon et al. 2000). The first survey was scheduled at the first sign of damage. The last survey was scheduled right before the estimated harvest date. The middle survey was scheduled approximately halfway between the first survey and the estimated harvest date.

Table 2. Damage ratings per tree.

Damage Category	Damage Rating	Damaged nuts/half tree
None	0	0
Light	1	1 - 13
Medium	2	14 - 43
Heavy	3	>44

Data Analysis

Each tree surveyed in the orchard was sorted into its respective damage rating category and variety. The data were averaged to provide a single mean damage rating for each survey in each orchard. These numbers were used to create bar charts showing the average seasonal damage at each site. The mean damage rating for the year could also be used to calculate a nut loss per hectare, or per tree, and depending on the price of almonds, a loss in dollars per hectare.

Field Protocol

Each component of the field protocol outlined below was derived from previous experience and the literature to help prevent habituation and increase effectiveness. At the first sign of bird damage, the units were deployed. This damage consisted of a few trees with shells opened by birds. From past studies, it was estimated that 1 unit should cover about 1.6 ha. Units were dispersed in a pattern that yielded uniform coverage. The units were moved to a new tree about every 2 weeks, maintaining the uniform distribution pattern. The speakers on the units were pointed toward the center of the orchard to keep the sound in the orchard. When the units were placed in the tree, they were hung at a height of 1 - 2 m. The units were set to switch to a different call every 3 to 4 days. When the units were deployed, the growers at each site were supplied with pyrotechnics to supplement the warning calls. They were also encouraged to use other techniques such as shooting and gas cannons. The units were run until harvest.

RESULTS AND DISCUSSION

Figure 3 displays the composite results from Year 1 for each untreated site. The damage level at site 4 and site 6 illustrate what was expected from an orchard with a crow problem: the damage increased as the season progressed. Sites 1 and 2 had little to no damage; this was indicative of an orchard with active control programs or without a crow population in the area. Sites 3 and 5 showed no large increases in the relatively low damage ratings. Figure 4 displays the composite results from Year 2 for control and treated sites. The average damage ratings for sites 4 and 6, both treated sites, were greatly reduced throughout the season compared to Year 1 (Figure 3). Although site 1 was treated in Year 2, it showed no change due to the lack of preventable damage in either year. Control sites 2, 3, and 5 showed similar damage levels between Years 1 and 2, indicating that the bird pressure remained about the same between years.

As shown by the average damage ratings, the implementation of the field protocol successfully reduced damage in commercial almond orchards. Two of the 3 treated orchards showed a decrease in damage due to the treatment of the broadcast units implemented with the field protocol. The site 4 average damage rating was reduced from 0.84 (6.0 kg/ha) to 0.25 (1.1 kg/ha). The site 6 average damage rating was reduced from 1.54 (18.2 kg/ha) to 0.73 (4.8 kg/ha). Site 1, the only site that showed no difference between years, had no damage to reduce in Year 1 and was not considered when recommending the field protocol.

CONCLUSION

The units were deployed in almond orchards for two-and-a-half months. Some habituation by crows was noted after two months of deployment. As shown by the average damage ratings, the implementation of the field protocol successfully reduced damage in these commercial orchards. The units functioned effectively and did not require a battery charge during the trial.

FUTURE WORK

While the current circuit design is simple and inexpensive, the next logical step is to control the sound chip with a microcontroller. This would eliminate many of the components in the current circuit, helping to cut costs while making the circuit more versatile. By changing the program on the microcontroller chip, parameters such as calling time, call switching, on/off time could be changed to adapt to the application.

There will always be a certain degree of habituation when trying to haze wildlife from an area. Parameters designed into the broadcast unit to help prevent habituation were the order of calls, how quickly they were switched, and the time between calls. Studies to determine the optimum call order, switching time, and

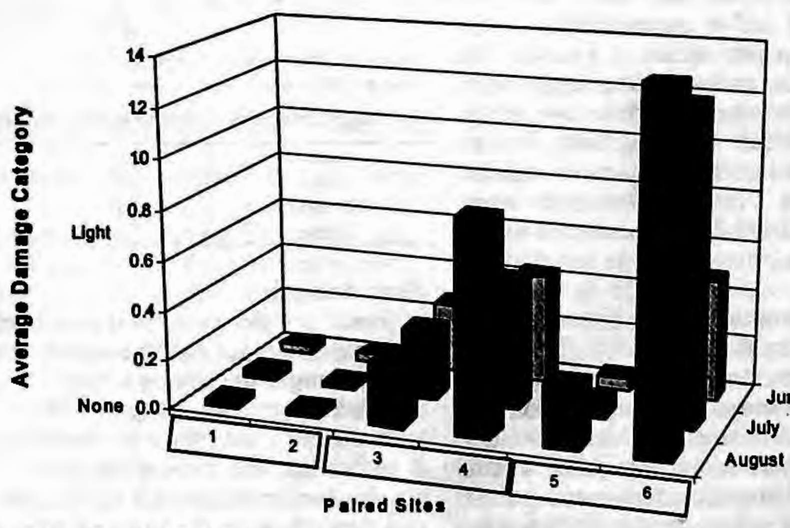

Figure 3. Average damage rating for each site and survey during Year 1.

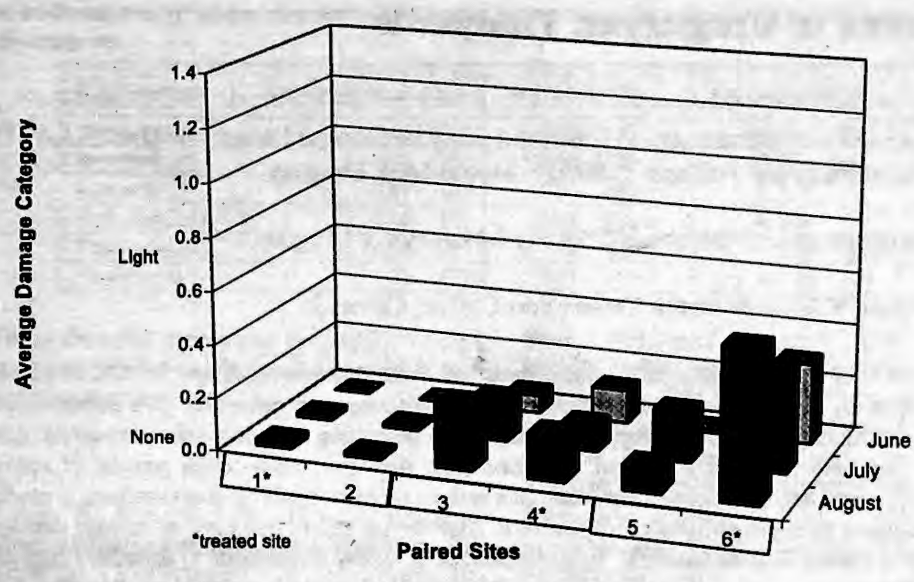

Figure 4. Average damage rating for each site and survey during Year 2.

time between calls to help minimize habituation would be useful.

This study showed the effectiveness of deploying the units at 1 site within a given geographical area. If such a program became popular with growers, there would surely be adjacent orchards, or entire farms, trying to use the broadcast units. The dynamics of hazing crows from a 200-ha almond farm would likely be different than hazing crows from a 20-ha orchard.

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REFERENCES

BAXTER, A. 2000. Use of distress calls to deter birds from landfill sites near airports. Pp. 401-409 *in*: Proc. Int. Bird Strike Committee, IBSC25/WP-AV9, 17-21 April 2000, Amsterdam, The Netherlands.

BOMFORD, M. AND P. H. O'BRIEN. 1990. Sonic deterrents in animal damage control: a review of device test and effectiveness. Wildl. Soc. Bull. 18:411-422.

BRIDGMAN, C. J. 1980. Bio-acoustic bird scaring in Britain. Pp. 383-387 *in*: D. N. Johnson (Ed.), Proc. IV Pan-Afr. Ornithol. Congr.

BROUGH, T. 1968. Recent developments in bird scaring on airfields. Pp. 29-38 in: R. K. Murton and E. N. Wright (Eds.), The Problems of Birds as Pests. Academic Press, London.

GORENZEL, W. P., D. A. WHISSON, AND P. R. KELLY. 2003. Bird hazing techniques applicable to oil spill response: and annotated bibliography. Final Report to the California Department of Fish and Game, Office of Spill Prevention and Response. University of California, Davis. 54 pp.

HASEY, J., AND T. P. SALMON. 1993. Crow damage to almonds increasing; no foolproof solution in sight. California Agriculture 47(5):21-23.

HOUK, A. P. 2004. Electronic system and field protocol for control of crows in almond orchards with broadcast distress calls. M.S. thesis, University of California, Davis. 83 pp.

LEHOUX, D., AND L. BELANGER. 1995. Evaluation of the effectiveness of the Breco bird scarer in dispersing aquatic birds away from oil spills. Environment Canada, Canadian Wildlife Service. October 1995.

LITTAUER, G. A. 1990. Avian predators, frightening techniques for reducing bird damage at aquaculture facilities. Publication No. 401, Southern Regional Aquaculture Center, Stoneville, MS. 4 pp.

LITTAUER, G. A., J. F. GLAHN, D. S. REINHOLD, AND M. W. BRUNSON. 1997. Control of Bird Predation at Aquaculture Facilities: Strategies and Cost Estimates. Publication No. 402 (revised), Southern Regional Aquaculture Center, Stoneville, MS. 4 pp.

MARSH, R. E., W. A. ERICKSON, AND T. P. SALMON. 1992. Scarecrow and predator models for frightening birds from specific areas. Proc. Vertebr. Pest Conf. 15:112-114.

MICKE, W. C. (Editor). 1996. Almond Production Manual. Publication 3364, Division of Agriculture and Natural Resources, University of California. 289 pp.

NAEF-DAENZER, L. 1983. Scaring of carrion crows by species-specific distress calls and suspended bodies of dead crows. Proc. Bird Control Seminar 9:91-95.

SALMON, T. P., W. P. GORENZEL, AND A. B. PEARSON. 2000. An operational crow control program using broadcast calls. Final report to California Department of Food and Agriculture, May 4, 2000. Univ. of California, Davis

SALMON, T. P., W. P. GORENZEL, A. B. PEARSON, AND S. R. RYAN. 1999. A test of broadcast calls to reduce crow damage in almonds. Final report to California Department of Food and Agriculture, March 9, 1999. Univ. of California, Davis.