Sound Levels of Broadcast Calls and Responses by American Crows

W. Paul Gorenzel, Terrell P. Salmon, A. Britt Pearson, and **Sean R. Ryan**
Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, California

Abstract: Bird control often entails the use of sound to disperse birds from croplands or other sites. Little information is available concerning the sound levels produced by noise-making devices or the effective area of coverage. In 1998 and 1999 we measured the sound levels of American crow (*Corvus brachyrhynchos*) distress calls produced by 2 models of a commercially available broadcast unit. With the units set up at different heights (0.9 to 4.9 m) in an open area or in an almond orchard, we used a sound meter to measure sound levels at distances of 1 m and 15 m, and then at 15-m intervals out to a distance of 90 m from the speakers. Sound levels decreased from about 102 dB at 1 m down to or nearly to background noise levels at a distance of 90 m. Sound levels from a unit set up to broadcast at a 4.9-m height through the orchard canopy were lower than for a unit set up at a 0.9-m height broadcasting under the canopy. Sound levels from a unit set at the 0.9-m height in the open were greater than those from the 0.9-m setup under the canopy only at a distance of 90 m. We set up a broadcast unit at various roadside locations in Yolo County, California, to determine the distance over which crows heard and reacted to the broadcast calls. Upon activation of the unit, we scanned the surrounding area for any crows flying from their perches. When crows reacted to the call we recorded the distance to the site of origin with a laser rangefinder and the number of crows. We also recorded the distance and number as above for any 2nd or 3rd flocks responding. We broadcast the calls on 11 days and on 27 occasions crows responded, typically by flying up from their perches, sometimes flying overhead, and then flying away. The average distance for the 1st flocks was 142 m $\pm$ 73 SD (range 22 - 275 m). On 7 occasions 2nd flocks responded from an average distance of 174 m $\pm$ 110 SD (range 71 - 312 m). On all but one occasion the 2nd flocks originated from a more distant location than the associated primary responders. We observed one instance of a 3rd flock responding. Fourteen (51.8%) of the 27 primary responses were from distances >122 m, about the distance at which the sound levels from the broadcast unit drop to background levels. These data indicate crows detected sounds from the broadcast units at distances greater than suggested by the sound meter. Using the average distance of 142 m for the 1st flocks responding, we calculated crows in a 6.3 ha open area could hear the broadcast calls. Using the maximum distances we observed of 275 m for 1st flocks and 312 m for 2nd flocks, we suggest that under some conditions crows within open areas of nearly 24.3 ha and 30.4 ha, respectively, heard the calls or responded to other crows hearing the calls.

Key Words: American crow, *Corvus brachyrhynchos*, biosonics, bird control, Bird Gard, broadcast call, sound levels

Proc. 20th Vertebr. Pest Conf. (R. M. Timm and R. H. Schmidt, Eds.)
Published at Univ. of Calif., Davis. 2002. Pp. 103-109.

INTRODUCTION

American crows (*Corvus brachyrhynchos*) damage a number of crops in California and are particularly damaging to almond and pistachio crops (Clark 1994, Hasey and Salmon 1993, Salmon et al. 1986). From 1997 to 1999 we evaluated the efficacy of broadcast crow calls to control damage by American crows in almonds (Salmon et al. 1997, 1999, 2000). We used commercially available units to broadcast the calls and followed the manufacturer's recommendations concerning placement (e.g., 1 broadcast unit every 3.2 - 4 ha). However, there was no supporting data for the manufacturer's recommendations nor any information in the literature concerning the sound levels produced or the effective area of coverage for noise-making devices. Our objectives were to measure the sound levels produced by Bird Gard broadcast units and to determine the range of distances over which crows responded to broadcast calls.

STUDY AREAS

We recorded sound levels at 2 locations, in an orchard and at an open area. In 1998 we used the Wada-Bailey orchard near Yuba City, in Sutter County, California. The 2.7 ha orchard consisted of 690 17-yr-old almond trees. The trees averaged 6.7 m ±0.3 SE in height, were planted with a 6.1-m spacing between trees and rows, and were fully leafed. In 1998 and 1999 we used an open area located in croplands approximately 8 km northwest of Davis, in Yolo County, California. The recording site was at the 4-way intersection of 2 little-used county roads. The site was surrounded by fallow fields and rice paddies. No buildings or trees were present.

We measured crow-response distances at various locations along roadsides in Yolo County. The sites were selected on the basis of the presence of crows observed in the distance or suitable habitat (e.g., trees in a riparian zone or bordering an alfalfa field) used by crows.

METHODS

Broadcast Units

We used two Bird Gard (BG) models to broadcast the crow calls, the "Bird Gard Super ABC Electronic Bird Repeller" and the "Programmable Bird Gard RDA Random Bird Repeller" (Weitech, Inc., 251 W. Barclay Dr., Sisters, OR 97759). Each BG unit was powered by a 12-volt, 95-amp, deep-cycle marine battery. The ABC model had a 4-speaker box separate from the control box, with a speaker facing in each of the 4 quadrants. The RDA model had 1 speaker integral with the control box and 1 remote speaker. Weitech custom-coded the microchips in both BG models with the same segments of crow calls from the "Common Crow Distress Call" cassette tape (Signal Education Aids, 2314 Broadway, Denver, CO 80205-2115).

Sound Measurements

We used a Sper Scientific Digital Sound Meter to measure sound levels in decibels (dB) on the A scale at fixed distances of 1 m, 15 m, and then 15 m intervals out to a distance of 90 m from the speakers. The speakers were aligned according to the cardinal points (e.g., north, south, east, west), and sound level measurements of both the broadcast calls and background noise were taken along the 4 transects extending to the cardinal points. We selected relatively calm days for measurements. We terminated measurements if wind levels were ≥16.1 kph.

In 1998 we recorded sound levels from the ABC model in the open area with the speakers at the 0.9-m height, and in the Wada-Bailey orchard with the speakers at the 0.9-m and 4.9-m heights. The sound meter was held at approximately waist height for the 0.9-m setup. Sound levels for the 4.9-m setup were recorded from atop a 3.0-m ladder, with the sound meter held at approximately a 3.7-m height. We calculated average sound levels using all the readings taken at each given distance from all the transects.

In 1999 we measured the sound levels in an open area from the RDA model setup in 1- and 2-speaker configurations. In the 1-speaker configuration the control-unit speaker was mounted at a 1.5-m height was aligned to the north. In the 2-speaker configuration the extension speaker was added, mounted at a 4.6-m height facing south. Sound levels of the broadcast calls and background noise were measured with the sound meter at waist height along transects as described above. We calculated average sound levels for each of the 4 directions from the RDA unit.

Crow Response Distance Measurements

At roadside locations we set up a BG ABC unit at the 0.9-m height. We selected locations where we saw crows in the distance perched in trees or on the ground, or locations where no crows were apparent but where the habitat appeared suitable (such as known foraging or loafing areas). One of the speakers was oriented towards the crows, if any were observed. When the BG unit was activated, we scanned the surrounding area for any crows flying from their perches. (The initial reaction of most crows was to fly towards the source of the broadcast.) For each observation when crows reacted, we recorded the compass direction, the distance to the site of origin, the number of crows, and the wind speed. We used a Bushnell Yardage Pro laser range finder to measure distances. In some instances, the calls of the 1st responding crows or the broadcasts prompted crows in another location to react. We recorded the direction and distance as above for any 2nd or 3rd flocks responding, and labeled them as secondary or tertiary crow responses.

RESULTS

Sound Measurements

We recorded sound levels in the Wada-Bailey orchard on 4 days and 3 days with the BG speakers at the 0.9-m and 4.9-m heights, respectively. We recorded sound levels in an open area on 1 day only with the speakers at a 0.9-m height. Wind speed during the sound measurements averaged 2.1 kph ± 0.2 SE (range 1.1 - 2.7 kph). We considered the impact of the wind to be minimal. Background sound levels for the 0.9-m and 4.9-m setups in the orchard averaged 43.6 dB ± 0.1 SE (range 40.2 - 50.0 dB) and 43.2 dB ± 0.1 SE (range 39.7 - 47.7 dB), respectively. Background noise levels were slightly greater and more variable at the open area, averaging 46.6 dB ± 0.6 SE (range 39.4 - 52.2 dB).

Sound levels decreased with distance (Table 1). At a 1-m distance from the speakers the highest level recorded was about 102 dB. Sound levels decreased to or nearly to background levels at the 90-m distance. There was no statistical difference in sound levels with the units set at the 0.9-m height in the orchard or in the open area, except at a distance of 90 m. The 4.9-m setup had statistically lower sound levels than the 0.9-m setups at all distances except at 90 m. We found sound levels decreased at similar rates over distance for all 3 setups (Figure 1). The difference in sound levels between the 0.9-m and 4.9-m units in the orchard decreased with distance, from a high of 12.9 dB at 1 m to a low of 0.9 dB at 90 m.

We recorded sound levels on 3 separate occasions each with the RDA unit set up with and without the extension speaker. Wind speed during the sound measurements with the single speaker in the control unit averaged 7.2 kph ± 0.7 SE (range 6.4 - 8.5 kph). Wind speed during the sound measurements with the added extension speaker were similar, averaging 5.3 kph ± 2.4 SE (range 3.9 - 8.0 kph). We considered the impact of the wind to be minimal. Background sound levels during the single speaker and the 2-speaker sessions averaged 47.2 dB ± 0.7 SE (range 39.8 - 53.1 dB) and 44.9 dB ± 0.2 SE (range 43.3 - 47.4 dB), respectively.

Sound levels decreased with distance and varied depending on direction from the speakers. With the 1-speaker control unit setup (Figure 2), sound levels were greatest in front of the speaker (101.7 dB maximum), lowest behind the speaker (79.5 dB maximum), and intermediate to either side of the speaker (about 88 db maximum). Sound levels decreased to or nearly to background levels at distances between 75 to 90 m, except in front of the speaker. With the addition of the extension speaker, sound levels increased behind the control unit and were similar to those in front of the control unit (Figure 3). However, with the 2-speaker setup the sound levels in front of the control unit decreased somewhat compared to the 1-speaker setup.

Table 1. **Bird Gard sound level measurements taken with the speakers set at a 0.9-m and 4.9-m height in the Wada-Bailey orchard, and at a 0.9-m height in an open area.**

Distance (m)	Speaker setup	Sound levels (dB) $\bar{x}$	SE	Range	Sound level rankings	F value	*P*
1	0.9-m open	96.6	0.7	94.6-97.8	0.9-m open = 0.9-m orchard		<0.0001
	0.9-m orchard	98.6	0.4	93.1-101.9	> 4.9-m orchard	356.1	
	4.9-m orchard	85.7	0.3	83.1-88.9			
15	0.9-m open	74.2	0.9	72.5-76.7	0.9-m open = 0.9-m orchard		<0.0001
	0.9-m orchard	74.2	0.4	68.5-78.7	> 4.9-m orchard	22.3	
	4.9-m orchard	69.5	0.6	62.4-73.7			
30	0.9-m open	66.5	1.5	63.4-69.6	0.9-m open = 0.9-m orchard		<0.0001
	0.9-m orchard	66.4	0.5	60.8-71.0	> 4.9-m orchard	21.2	
	4.9-m orchard	60.3	0.8	51.1-66.7			
45	0.9-m open	62.8	0.6	61.0-64.0	0.9-m open = 0.9-m orchard		<0.0001
	0.9-m orchard	61.2	0.5	56.1-67.3	> 4.9-m orchard	28.0	
	4.9-m orchard	54.6	0.8	47.3-61.6			
60	0.9-m open	57.2	0.4	56.2-57.9	0.9-m open = 0.9-m orchard		<0.0001
	0.9-m orchard	55.4	0.6	50.9-60.5	> 4.9-m orchard	19.1	
	4.9-m orchard	50.3	0.7	44.1-55.1			
75	0.9-m open	52.0	1.4	47.7-53.9	0.9-m open = 0.9-m orchard		0.0272
	0.9-m orchard	50.3	0.8	43.6-59.8	> 4.9-m orchard	3.9	
	4.9-m orchard	47.7	0.7	43.1-52.4			
90	0.9-m open	50.8	1.2	49.0-53.0	0.9-m open > 0.9-m orchard		0.0082
	0.9-m orchard	46.5	0.6	44.4-48.6	= 4.9-m orchard	6.7	
	4.9-m orchard	45.6	0.9	41.4-48.8			

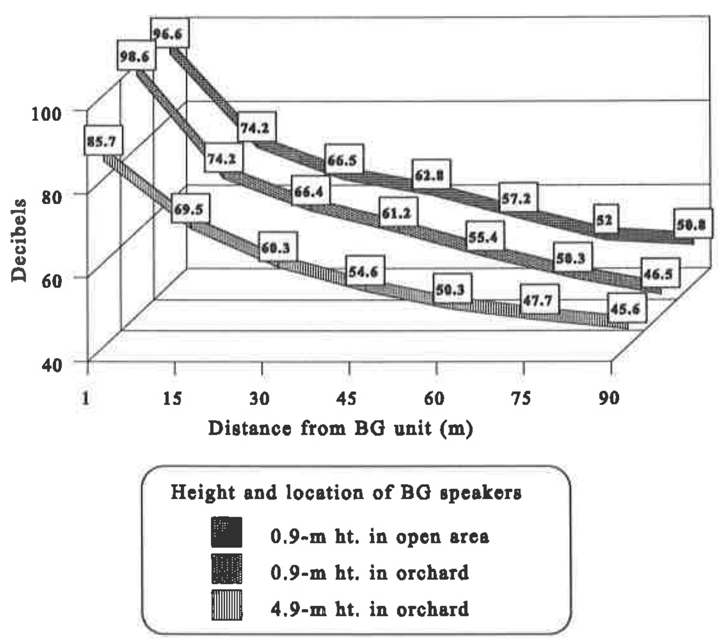

Figure 1. Average sound levels (dB) with increasing distance from a 4-speaker Bird Gard ABC unit at 0.9-m and 4.9-m heights in an almond orchard and in an open area with no obstructions.

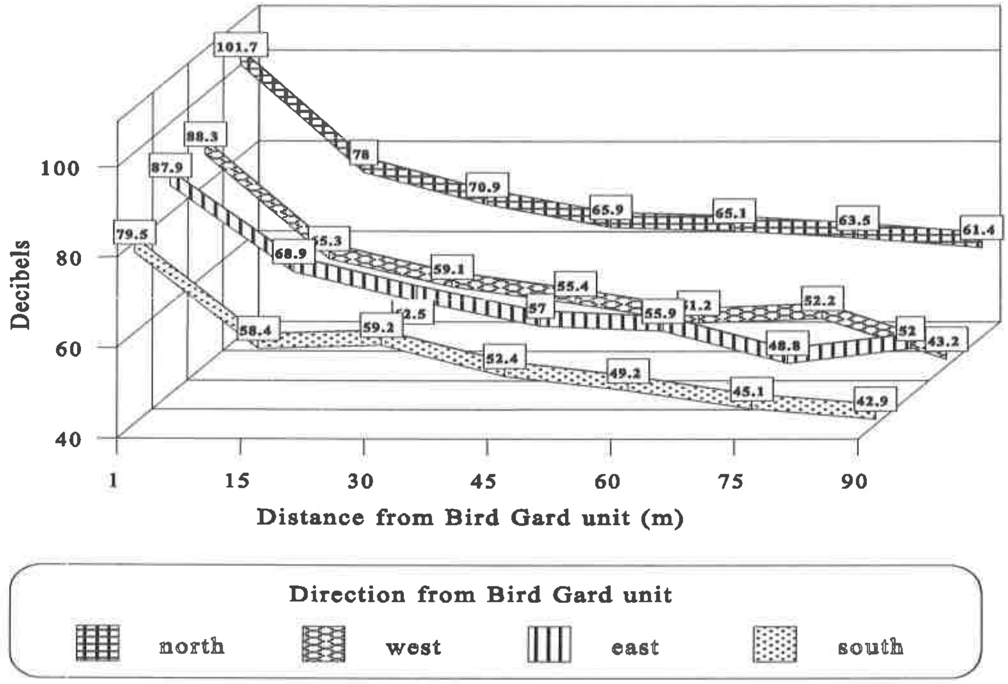

Figure 2. Decrease in average sound levels (dB) with increasing distance from a Bird Gard RDA unit without an extension speaker. The single speaker in the control unit was set up facing north at a 1.5-m height in an open area with no obstructions.

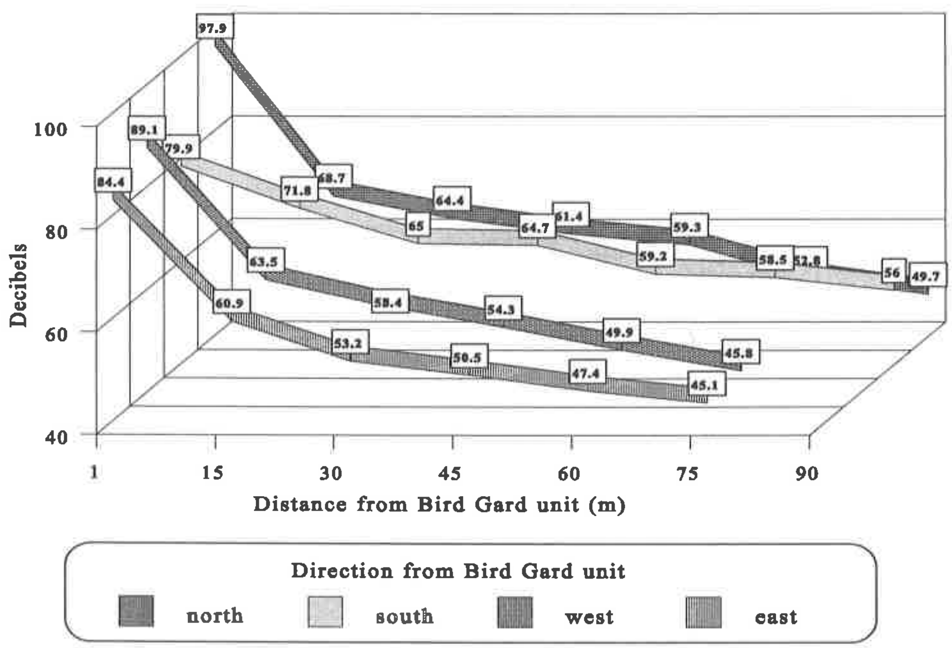

Figure 3. Decrease in average sound levels (dB) with increasing distance from a Bird Gard RDA unit with an extension speaker. The single speaker in the control unit was set up facing north at a 1.5-m height in an open area with no obstructions. The extension speaker was set up facing south at a 4.6-m height.

Table 2. Response by crows and distance of crows from broadcasts of crow distress calls from roadside locations in Yolo County, California, 1998. Bearing refers to the compass bearing from the observer to the crow(s).

Date	Wind bearing	Wind speed (kph)	Map no.[a]	No. crows	Bearing	Dist. (m)	Response
20 Jul	145°	1.6	1	20	312°	23	3 flew away, 17 no reaction
	145°	1.6	1b	10	305°	120	3 flew away, 7 no reaction
	145°	2.4	2	3	315°	97	Left perch, flew away
	145°	2.4	2b	1	312°	240	Left perch, flew away
21 Jul	122°	4.0	3	1	28°	194	Left perch, then relanded
	180°	2.1	4	20	175°	74	Left perch, flew away
22 Jul	90°	0.6	5	1	315°	25	Left perch, flew away
	90°	0.6	5b	4	160°	90	Left perch, flew away
	90°	0.6	5c	5	170°	250	Left perch, flew away
	295°	1.6	6	2	10°	144	Left perch, flew away
	295°	1.6	6b	4	50°	75	Left perch, 2 flew away, 2 relanded
27 Jul	315°	1.3	7	100	300°	100	60 left perch, flew away, 40 no reaction
4 Aug	0°	3.1	8	3	260°	83	Left perch, flew away
	0°	4.8	9	5	60°	102	Left perch, flew away
	0°	4.8	9b	15	20°	310	Left perch, flew away
	0°	3.9	10	1	0°	95	Cawed only
6 Aug	245°	1.6	11	10	198°	92	Left perch, flew away
	148°	4.5	12	6	305°	40	Left perch, flew away
	148°	4.5	12b	2	352°	71	Left perch, flew away
	0°	3.2	13	40	350°	40	Left perch, relanded
4 Sep	176°	12	14	8	310°	275	Flew away to north
	114°	19	15	1	70°	108	Flew away to north
8 Sep	230°	5.0	16	300+	46°	220	Left perch, flew away
	218°	6.0	17	45	26°	216	Flew overhead, circled
	200°	3.4	18	7	170°	116	Flew away
9 Sep	226°	4.5	19	26	190°	257	Flew away to east
	170°	4.6	20	2	0°	198	Flew from perch down to cover
14 Sep	350°	1.1	21	39	110°	200	26 left perch, then relanded, 13 no response
	10°	2.3	22	142	310°	190	42 circled overhead, 100 left perch then relanded
	10°	2.3	22b	16	90°	312	All left perch, flew overhead
	65°	1.3	23	116	105°	227	All left perch, 84 flew away, 30 circled overhead
	50°	2.5	24	17	150°	142	8 left perch, flew away, 9 no response
18 Sep	135°	5.9	25	13	90°	230	9 left perch, then relanded, 4 no response
	60°	4.6	26	500	90°	165	400 left perch, circled overhead, 100 no response
	47°	4.9	27	45	278°	183	33 left perch, relanded, 12 no response

[a]Refers to the corresponding number in Figure 4; "b" and "c" refer to secondary and tertiary responding flocks, respectively.

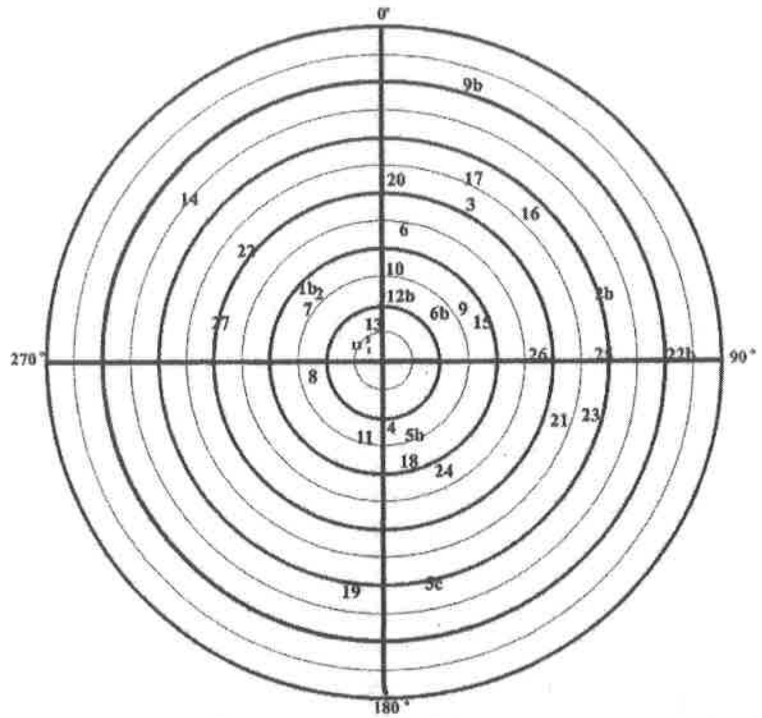

Figure 4. Distance and relative location of crows responding to distress calls from a Bird Gard broadcast unit located at the intersection of the horizontal and vertical axes. The circles emanating from the origin represent increments of 30.5 m. The numbers at the end of the axes are compass bearings, 0°, 90°, 180°, and 270°, represent north, east, south, and west, respectively. Numbers 1 - 27 in the figure correspond to the map numbers and their corresponding observations in Table 2. Plain numbers in black are primary responders, "b" and "c" after the numbers are secondary and tertiary responders, respectively.

Sound levels to either side of the speakers were lower with 2 speakers compared to 1 speaker and reached background levels at 75 m distance. There was no increase in the sound level at 1 m in front of the extension speaker compared to no extension speaker. Mounted at a height of 4.6 m, the extension speaker broadcast was only partially measured by the sound meter held at waist level.

Crow - Distance Measurements

On 11 days we broadcast the crow distress calls at various locations in Yolo County. On 27 occasions crows responded to the broadcast, typically by flying up from their perch, sometimes flying overhead, and then flying away (Table 2). On 8 instances a portion of the flock members did not respond by flying up, but rather remained in their original location and gave no other indication, such as cawing, of any response to the broadcast call. The average distance for the primary responders was 142 m ± 73 SD (range 23 - 275 m). We recorded secondary responders on 7 occasions at an average distance of 174 m ± 110 SD (range 71 - 312 m). On all but one occasion the secondary responders originated from a more distant location than the associated primary responders (Figure 4). We observed one instance of a tertiary response at a distance of 250 m.

Fourteen (51.8%) of the 27 primary responses were from distances >122 m, distances at which the sound levels from the BG unit had already decreased to background levels. These data indicate crows can detect sounds from the BG units at distances greater than would be suggested by the sound meter. Using the average distance of 142 m for primary responders from the BG unit, we calculate that crows in a 6.3 ha open area could hear the BG broadcasts. Using the maximum distance we observed of 275 m for a primary response, we suggest that under some conditions crows within an open area of nearly 24.3 ha could hear the calls. Using the maximum distance of 312 m for secondary responders, we calculate under some conditions crows within an open area of about 30.4 ha could either hear or respond to other crows hearing the BG broadcasts.

DISCUSSION

Sound Level Comparisons

The sound levels in front (north) and to the rear (south) of the control unit for the 2-speaker RDA model (Figure 3) compare favorably with the average sound levels for the 4-speaker ABC model (Figure 1) in an open area. With a speaker facing each quadrant, the sound levels for the ABC unit were equal to all 4 sides.

Although the sound levels to the sides (east and west in Figure 3) of the RDA unit were less than for the ABC unit, the practical effect may be minimal or none at all. We did not detect any difference in crows' behavior as they flew over or around the 2-speaker vs. 4-speaker units when they were broadcasting.

We suggest the RDA model may be as effective as the ABC model. Use of the RDA model at $149 each rather than the more expensive ABC model at $449 each would reduce control costs. Reduced costs would be important in low value crops and low to moderate damage situations. Reduced costs could contribute to favorable benefit:cost ratios.

Area of Coverage

Marketing literature from BG in 1998 indicated effectiveness for a single ABC unit over 3.2 to 4.0 ha. For a circular area of 3.2 ha, the radius would be 102 m. Our sound meter measurements indicate that the BG sound levels reached background noise levels at distances between 90 to 120 m, which would roughly equate to an area in the 3.2- to 4.0-ha range. Our crow response measurements indicate crows can hear the broadcasts from considerably greater distances of up to 275 m, which equates to an area of about 24 ha. However, simply hearing the broadcast does not necessarily equate to effective control. Testing is needed to determine if 1 BG unit is effective at distances >122 m or areas >4.0 ha.

The question of how many BG units are required per unit of area remains unanswered and perhaps depends on local conditions and the bird species in question. We suggest that the effectiveness of the BG units and hence the number of units required per unit of area may in part be related to the presence of alternate feeding sites and the intensity of other control methods (e.g., shooting). As an example, BG deployment in 5 orchards by Salmon et al. (1999) ranged from 1 unit/1.4 ha to 1 unit/3.2 ha. Wada-Bailey, the orchard with the highest density of BG units at 1 unit/1.4 ha, had the highest damage at $341/ha. The local vicinity around Wada-Bailey lacked alternate feeding sites. There were no other almond orchards, alfalfa or hay fields within a 13 km^2 area of Wada-Bailey. Also, shooting was only infrequently employed at Wada-Bailey. Conversely, Stiles, the orchard with the lowest density of BG units, had low damage at $77/ha. Alternate feeding sites within 13 km^2 of Stiles included 4 almond orchards and 9 alfalfa or hay fields. In orchards with light to moderate crow pressure, such as Stiles, 1 unit for every 3.2 ha was effective. For orchards with heavy crow pressure, such as Wada-Bailey, an increase over the recommended number of units may be necessary.

ACKNOWLEDGEMENTS

We thank Ken and Gary Wada for access to their orchard. We thank William S. Pierson of Signal Education Aids for permission to use the Signal Crow Distress Call in the Bird Gard units. We appreciate the support and funding provided by the Vertebrate Pest Control Research Advisory Committee, California Department of Food and Agriculture, contract No. 96-0486.

LITERATURE CITED

CLARK, J. P. 1994. Vertebrate Pest Control Handbook, 4th Ed. California Department of Food and Agriculture, Sacramento, CA.

HASEY, J., and T. P. SALMON. 1993. Crow damage to almonds increasing: no foolproof solution in sight. Calif. Agric. 47:21-23.

SALMON, T. P., A. C. CRABB, and R. E. MARSH. 1986. Bird damage to pistachios. Calif. Agric. 40:5-8.

SALMON, T. P., W. P. GORENZEL, and W. K. FORD. 1997. Test of a taped alarm call to reduce crow damage in almonds. Final Report, California Department of Food and Agriculture, Contract No. 96-0486, Sacramento, CA. 37 pp.

SALMON, T. P., and A. B. PEARSON. 2000. An operational crow control program using broadcast calls. Final Report, California Department of Food and Agriculture, Contract No. 96-0486-III, Sacramento, CA. 30 pp.

SALMON, T. P., A. B. PEARSON, and S. R. RYAN. 1999. A test of broadcast calls to reduce crow damage in almonds. Final Report, California Department of Food and Agriculture, Contract No. 96-0486-II, Sacramento, CA. 31 pp.