3-1-1988

EFFECT OF ULTRASONIC, VISUAL, AND SONIC DEVICES ON PIGEON NUMBERS IN A VACANT BUILDING

Paul P. Woronecki
USDA/APHIS/ADC, Denver Wildlife Research Center, Ohio Field Station, Sandusky,

EFFECT OF ULTRASONIC, VISUAL, AND SONIC DEVICES ON PIGEON NUMBERS IN A VACANT BUILDING

PAUL P. WORONECKI, USDA/APHIS/ADC, Denver Wildlife Research Center, Ohio Field Station, Sandusky, OH 44870.

ABSTRACT: Three bird scaring devices, ultrasonic, visual and sonic, were evaluated for repelling pigeons from inside a vacant building. After 10-30 days of treatment, none of the devices reduced the pigeon population from levels recorded in pre- and posttreatment periods. However, both the visual and sonic devices altered pigeon behavior during their 10-day treatment periods and temporarily reduced the pigeon population during the first 2 days of treatment. The ultrasonic device was completely ineffective; no change in pigeon activity was observed during a 20-day treatment period.

Proc. Vertebr. Pest Conf. (A.C. Crabb and R.E. Marsh, Eds.),
Printed at Univ. of Calif., Davis. 13:266-272, 1988

INTRODUCTION

Birds in and on structures can cause serious nuisance, health, safety and damage problems. Excluding, repelling and scaring birds are preferred nonlethal and nonchemical techniques for creating an environment unattractive to birds. Although physical barriers can permanently exclude birds from structures, they may not be economical or compatible with the purpose or design of the facility. Visual and acoustical devices to scare and repel birds in and around structures are often the methods of choice for managing bird problems. However, the efficacy of most of these devices has not been objectively field tested (Jackson 1983, Stewart 1984, Griffiths 1986). Devices with ultrasonic (i.e., >18,000 Hz, the upper frequency level heard by humans) output are the most appealing because they are not conspicuous or distracting and lack annoying sounds.

The utility of ultrasonic sounds for repelling birds has no apparent biological foundation because most birds do not hear higher frequencies than humans can hear (Frings and Frings 1967). Pest birds such as starlings (Sturnus vulgaris), house sparrows (Passer domesticus) and pigeons (Columba livia) have hearing ranges from 200 to 18,000 Hz (Brand and Kellogg 1939, Summers-Smith 1963). In addition, even if birds could detect ultrasonic sounds, birds generally habituate quickly to sounds and this would make the devices ineffective for long-term control (Murton and Wright 1968, Murton 1971, Boudreau 1975, Blokpoel 1976, Murton and Westwood 1976).

A review of the literature revealed only 6 studies which have attempted some type of objective evaluation of ultrasonics against birds (Theissen et al. 1957, Theissen and Shaw 1957, Meyhan 1978, Martin and Martin 1984, Kerns 1985, Griffiths 1986). Except for Meyhan (1978), whose device was below ultrasonic frequencies (16,776 Hz), these studies have not demonstrated effectiveness of ultrasonics in repelling birds. However, there arc continued testimonials and advertising claims that ultrasonics arc effective against birds (Dubco 1984, Duggcr 1984, Krzysik 1987). Krzysik (1987) mentions a typical testimonial in support of ultrasonics: "The Dukanc Corporation in the mid-1950's installed an Ionovac on Baltimore's City Hall to disperse the resident pigeon population. Nearly the entire bird population within a mile radius of the city hall, including pets, were (sic) exterminated."

My primary purpose was to objectively evaluate the efficacy of a currently available ultrasonic device in repelling pigeons from the inside of a building. For comparative purposes, I also evaluated a visual scare device (Deva-Spinning Eyes) and a sonic device (Deva- Megastress II). The goal was to provide scientifically based information to the public on the effectiveness of these devices.

METHODS

Ultrasonic Device

Ultrason UET-360 (UET-360) was evaluated because it was being advertised in pest control magazines with such claims as "ultrasonic sounds that birds fear but people can't hear." The UET-360 is powered by alternating current between 110-140 volts and can be selected to emit either continuous or pulsed output sounds with an electronic oscillator tuned between 18-23 kilohertz (KHz). The output of the oscillator is fed into a transducer which converts its electrical oscillations to ultrasonic sound waves. The device is mounted to a turntable that rotates 2 times per minute.

The device's output was measured at the Denver Wildlife Research Center (DWRC) and the Ohio Field Station (OFS) to determine the electrical and sound characteristics before, during, and after the test. Measurements were taken with a B&K Precision Sound Level Meter in a vacant parking lot, in an enclosed metal building and at 22 unobstructed points within the test site. All measurements were taken while the meter was pointed straight into the device. Both impulse and peak sound levels were taken at DWRC but only peak sound levels were recorded at OFS. An impulse response is defined as the maximum RMS (root mean square) value of the pressure waves whereas the peak response is the maximum peak value.

Visual Device

Dcva-Spinning Eyes (Brakam Millar, Saltncy Engineering Limited), one of many eye devices on the market, consist of 2 (0.9 x 0.6 m) flags attached to a horizontal 1.9-m boom which when mounted to a vertical post or stake will rotate in the wind. The flags are made from yellow "crackly" nylon with an "enormous" (0.7 x 0.5 m) red eye and a "menacing" (0.2 m) black pupil on both sides. Sonic Device

The Deva-Megastress II (Brakam Millar, Saltney Engineering Limited) is an electronic sound generator with 1 speaker mounted on top, 2 speakers on 25-m leads and 1 speaker on a 50-m lead. The 4 speakers can be positioned in many layouts. The device operates from a 12-volt battery and has a photo-electric cell to switch it on and off. According to the distributor, the sound generator produces 56 different sound variations selected at random and the sequence of sounds commences from a different speaker each series. The distributor claims that the "sound system is designed to get rid of birds effectively and for as long a period of time as possible" because "birds cannot anticipate which sound is coming and when."

Before the Deva-Megastress II was installed, sound level measurements were taken with a B&K Precision Sound Level Meter at distances of 1.0 to 4.6 m in an enclosed metal building while the meter was pointed straight into the device. Only peak sound levels were recorded.

The devices were evaluated in a vacant power house building (PH-1) occupied by more than 70 pigeons at NASA, Plum Brook Station, near Sandusky, Ohio. The building floor space was 704 m^2 (approximately 22 x 32 m) with an 18 m high ceiling. The UET-360 advertisement claims that the total spatial coverage should exceed 8,000 ft^2 (744 m^2) prime coverage plus secondary coverage dependant on surroundings. An open network of concrete pillars, catwalks, platforms, stairs, and railings existed in the building at 4 levels with an interior wall partially separating the upper level. Pigeon activity within PH-1 was concentrated in the upper 4.6 m of the building; birds nested on the ledge of the interior wall and roosted on the ledges, railings, conduits and light fixtures. Most pigeons exited and entered the building through broken windows in the SW corner. This made censusing the pigeons simple and accurate.

The UET-360 was suspended by chains and a cable 4.6 m from the ceiling at the same level as the ledge used for nesting. The device was 7.3 m from the ledge and 11.9, 7.3 and 18.6 m from the walls.

Two sets of spinning eyes were suspended from the ceiling at the same level as the ultrasonic device. One set was attached to the UET-360 turntable to permit constant rotation during the test. The second set was suspended by a cord (allowing movement) 13.4 m from the first set, also 7.3 m from the nesting ledge and 18.6, 7.6 and 11.9 m from the walls.

The 4 Deva-Megastress II speakers were positioned at 10-m intervals on the upper level of the building facing the nesting ledge. Three were 10.4 m from the ledge (center and 2 corners of the upper level) and the fourth was placed near the northwest corner. Test Procedure

The ultrasonic device was evaluated from 8 October to 26 November 1986. The spinning eyes were evaluated from 27 November 1986 to 3 January 1987, followed by the sonic device from 31 December 1986 to 2 March 1987 (these periods include pre- and posttreatment observation periods).

The number of pigeons residing in PH-1, used to evaluate the effectiveness of the frightening devices, was determined by counting the birds leaving and remaining within the building when a person entered the building. The birds were counted by 1 person stationed 46 m from the southwest corner of the building. The person entering the building counted the pigeons remaining and noted any nesting activity. These counts were normally done between 0730 and 1000 at least 3 times per week. Supplemental observations of pigeon behavior and numbers were conducted at times other than scheduled counts to note any changes in behavior or activity resulting from the treatment.

The devices were installed according to manufacturer or distributor recommendations. However, physical barriers were not placed in any openings that birds used for ingress and egress (i.e., broken windows, doors, and vents). All nests (including eggs, nestlings, and non-flying young) were removed on the day the ultrasonic device was installed.

The operation of the UET-360 began 11 days after installation. It was operated continuously for 20 days (October 20 through November 7), 10 days in the continuous output mode followed by 10 days in pulsed output mode. The device was then turned off and pigeon numbers observed for 10 days. Before the device was turned off, sound output was measured.

The spinning eye flags, installed 30 days after the UET-360 was turned off, were left in the building for 8 days (December 16 through December 24). After the 8-day treatment period the flags were removed; counts continued for 10 additional days.

The Deva-Megastress II was installed 16 days after the flags were removed. Between 9 January and 19 February 3 different treatments (time schedules) were tested (Table 1). Each treatment lasted 10 days with a 10-day nontest period between the second and third treatments. The treatments were designed to be compatible with human activity in an occupied building (off period coinciding with daytime working hours).

RESULTS

Test I-Ultrasonic Device

The continuous output was a 19.2 KHz frequency signal with a slight amplitude modulation at 120 Hz. The peak to peak voltage driving the speaker was a maximum of 25 volts. The device was found to emit 79 pulses per minute during the pulsed output at a frequency from 26

Table 1. Operating periods for the 3 treatments used for the evaluation of the Deva-Megastress II on pigeons, Sandusky, Ohio, January and February 1987.

Treatment no.	Operating periods	Start		End		No. of hrs/day
		Date	Time	Date	Time	
I	1630-1730 0930-1030	9 Jan.	1630	19 Jan	1730	2
II	0030-0230 0630-0830 1630-1830	21 Jan.	0030	30 Jan.	0830	6
III	1730-1830 1930-2030 2130-2230 2330-0030 0130-0230 0330-0430 0530-0630 0730-0830	9 Feb.	1730	19 Feb.	0830	8

Table 2. Sound level responses from an Ultrason-UET 360 taken with a B&K Precision Sound Level Meter at 3 m before, during, and after an evaluation conducted in Sandusky, Ohio, October and November 1986.

Location	Sound level (decibels)[a]			
	Continuous		Pulsed	
	Impulse	Peak	Impulse	Peak
DWRC (parking lot)	95	101	96	101
Sandusky (metal building)		100		101
Sandusky (Power House-1)[b]		96		98

[a]Manufacturer's rating was 132 decibels at 0.92 m.
[b]Building where pigeons were roosting.

KHZ to about 20 KHz.

Sound level measurements taken at 3 m before, during and after the evaluation were quite comparable even though they were taken under different conditions (Table 2). Peak sound level measurements taken at incremental distances from 1.5 m to 4.6 m at DWRC and Sandusky ranged from 105 to 97 dB and 105 to 96 dB, respectively, in the continuous output and 105 to 98 dB and 105 to 97 dB, respectively, in the pulsed output. The impulse sound levels were approximately 5 dB lower.

The peak sound level measurements taken at 3 to 28 m at 22 locations in PH-1 ranged from 73-98 dB for both continuous and pulsed output. Measurements taken at the same level as the device and in the area of pigeon roosting and nesting activity ranged from 84-98 dB for the pulsed output and 84-96 dB for the continuous output. Measurements taken at several locations in the building where the device was not visible showed only background levels of 70-73 dB without any peak responses. Our sound pressure wave measurements in the building showed that the ultrasonic

Table 3. Mean number of pigeons leaving Power House-1 during morning counts for the period when Ultrason UET-360 was evaluated, Sandusky, Ohio, 1986.

Dates	Treatment period	No. pigeons			No. of observations
		$\bar{x}$	SD	Range	
8-17 Oct.	Pretreatment[a]	64	8.2	52-73	5
18-28 Oct.[b]	Pretreatment	66	21.0	31-89	7
29 Oct.-7 Nov.	Ultrasonic-Continuous	75	15.1	48-92	6
8-17 Nov.	Ultrasonic-Pulsed	73	15.3	55-93	5
18-26 Nov.	Posttreatment	71	16.7	51-93	7

[a]During the preceding month the pigeons in Power House-1 were counted on 8 occasions, averaging 62 ± 14.3 birds/count.
[b]The ultrasonic device was installed and all nests (including eggs, nestlings, and non-flying young) were removed on 17 Oct.

signals are easily shadowed by objects and that there were areas in PH-1 where the pigeons could escape from the sound being produced by the UET-360.

A 10 and 11-day pretreatment period was used to evaluate the effect of removing nests and the presence of the UET-360 in PH-1. During the first pretreatment period the average number of pigeons per observation was 64 (Table 3). During the second pretreatment period, after disruption of nesting activity and installation of the device (not turned on) the average number of pigeons per observation was 66.

The evaluation of the UET-360 in the continuous output began at 0940 on 29 October. Before the outside switch was turned on 20 pigeons left the building. During the first 15 minutes after the device was turned on, only 10 pigeons vacated the building. After the building was entered, 57 more pigeons left the building and 2 remained. Within 10 minutes pigeons began returning to the building through the broken windows. During the 10-day continuous output treatment period, the average number of pigeons counted leaving the building was 75. On day 10 (7 November) the device was switched to pulsed output. A search of the building revealed that 4 nests had been reconstructed (7.3-20.4 m from the UET-360), indicating that these pigeons were not avoiding areas where ultrasonic pressure waves were the strongest. Before the observers left the building, pigeons began entering without any noticeable reaction to the changed output. The average number of pigeons using the building during the 10-day treatment period of pulsed output was 73.

Three days after the pulsed output began or 13 days after the ultrasonic sounds commenced, eggs were noted in the 4 nests. By the tenth and final day of the pulsed treatment, 8 eggs were visible in the nests and the pigeons were incubating.

The average number of pigeons observed during the 10-day posttreatment period was 71. At the end of this posttreatment period at least 2 eggs had hatched. No further information on nesting activity was documented during this study. Test II Visual Device

Preceding the installation of the "Deva-Spinning Eyes," the average number of pigeons per observation during the first and second pretreatment periods, was 54 and 69, respectively (Table 4). The spinning-eyes treatment began at 1000 on 16 December when the 2 sets of eyes were installed after the last pretreatment morning count and after all the pigeons had left the building. The initial response of the pigeons that reentered the building was different from that observed previously. Pigeons entered the building, exited rapidly, and left the area. The next observation of pigeon numbers was made at 0830 the following morning. Only 1 pigeon occupied the building at that time. The minimum count of pigeons leaving the building during the preceding 4 months had been 31 on 24 October and 3 December. However, the following morning (18 December) 82 pigeons left the building. During the treatment period, the average number of pigeons counted leaving the building was 62. The average number of pigeons observed during the posttreatment period was 81. Test III Sonic Device

The sound level measurements taken from 1.5 to 4.6 m ranged from 97 to 117 dB. Measurements at 3 m ranged from 102 to 108 dB. I found the device to output 6 to 17 sec of sound per burst with 10 to 19 sec between bursts, 8 to 9 bursts per sequence which lasted 3 to 4 min,

Table 4. Mean number of pigeons leaving Power House-1 during morning counts for the period when Deva-Spinning Eyes were evaluated, Sandusky, Ohio, 1986 and 1987.

Dates	Treatment period	No. pigeons x	SD	Range	No. of observations
27 Nov.-4 Dec.	Pretreatment	54	17.1	31-72	3
5-16 Dec.	Pretreatment	69	26.5	35-96	6
17-24 Dec.	Eye treatment	62	34.9	1-95	7
25 Dec.-3 Jan.	Posttreatment	81	13.5	69-104	4

and 4 to 7 min between sequences.

The average number of pigeons per observation during the pretreatment period was 81 (Table 5). Operation of the Deva-Megastress II followed the sequence shown in Table 1. Treatment I began at 1630 on 9 January and all 83 pigeons in PH-1 vacated during the first sequence of sounds. Approximately 36 pigeons continued to circle and perch on PH-1 until dark (1730). The number of pigeons that roosted in or on PH-1 that night was not determined. On 10 January no pigeon activity could be observed in PH-1 until the first sequence began and all 18 pigeons left the building. Four pigeons reentered PH-1 between sequences but left when the second sequence began. There were no pigeons in or around PH-1 when observations were discontinued at 1030. Observations began again at 1620 and, during the first 2 sequences, 81 pigeons left PH-1 but 80 reentered and remained in the building before the sound period ended.

On 11 January, no pigeon activity was observed until 0931 when all 9 pigeons left PH-1 and the immediate vicinity at the second burst of sounds. At 1640, 59 pigeons left the building at the second sequence of sounds. However, before the sound period ended, 23 had reentered and 2 minutes after the sounds ended an additional 39 pigeons entered the building.

On 12 January pigeon activity was observed in PH-1 at 0800 and by 0904, 46 pigeons had left the building. The first sequence began at 0906 (because sunlight activated the device early), and the remaining 55 pigeons left PH-1. Fourteen pigeons entered PH-1 between sequences but exited as another sequence began. At 1620 up to 35 pigeons were observed flying and perching on PH-1 and, after the sounds began, 58 pigeons left the building. During the sound period, 77 pigeons reentered the building and 25 entered after the sound period ended. Similar behavior and pigeon numbers were recorded until 20 January; however, pigeons exited later each morning and entered earlier each evening. The average number of pigeons observed during the Treatment I period was 78.

Treatment II began at 0030 on 20 January (Table 1). This schedule added another sound period at midnight and increased the sound periods in the morning and afternoon. The first observation was made at 1630 and no birds left PH-1 during the first 2 sequences of sounds. An observer entered PH-1 and 94 pigeons were counted leaving the building. One hour before this sound period was over 94 pigeons had reentered PH-1. On 21 January no birds left PH-1 until 0759 and by the end of the sound period 65 pigeons left the building. An additional 38 left after the building was entered. Afternoon observations were discontinued to eliminate any additional stress on the pigeons. No changes in pigeon behavior or numbers were noted until 30 January when the device was shut off. The average number of pigeons observed during the Treatment II period was 101.

During the following 10 days without sounds the average number of pigeons per morning observation was 85. Treatment III (Table 1) began at 1730 on 9 February and continued until 0830 on 19 February. The average number of pigeons per observation was 90, and no changes in behavior or pigeon numbers was noted. The average number of pigeons observed during the posttreatment period was 72 (Table 5).

DISCUSSION

There was no obvious reduction in the number of pigeons residing in PH-1 during the 60 days of treatment by the 3 devices when compared with the nontreatment periods (Tables 3, 4, and 5). Despite the inability of any of the devices to reduce the overall number of pigeons using PH-1 during the treatment periods, it was obvious the Deva-Spinning Eyes and the Deva-Megastress II did cause at least an initial reduction in pigeon numbers and a temporary change in behavior. The spinning eyes reduced pigeon numbers for 1 day while the Deva- Megastress II reduced the number of pigeons observed leaving PH-1 during the first a days and altered their behavior during the first 10-day treatment period. The Ultrason UET-360 elic-

Table 5. Mean number of pigeons leaving Power House-1 during morning counts for the period when Deva-Megastress II was evaluated, Sandusky, Ohio, 1987. See Table 1 for explanation of treatment periods.

Dates	Treatment period	No. pigeons			No. of observations
		x	SD	Range	
31Dec.-9Jan*	Pretreatment	81	12.0	64-104	7
10-20 Jan.	Treatment I	78	38.0	9-107	8
21-30 Jan.	Treatment II	101	4.0	92-106	8
31 Jan-9Feb.	No treatment	85	13.4	60-97	6
10-19 Feb.	Treatment III	90	4.8	81-97	7
20 Feb-2 Mar.	Posttreatment	72	10.6	54-82	4

[a]The last 2 counts from posttreatment evaluation of the spinning-eyes were used as the first 2 counts of the pretreatment evaluation of the Megastress.

ited neither an initial fright response nor any reduction in pigeon numbers during the 2, 10-day treatment periods. Pigeons constructed nests, laid eggs and incubated eggs 7.3 - 20.4 m from the Ultrason UET-360.

Before any treatment and during the evaluation of UET-360 and spinning eyes most pigeons would only leave the building after it was entered by a person. During the first 10-day treatment period evaluating Deva-Megastress II, most pigeons would leave PH-1 before the sequence began or shortly after the first bursts of sound and would only reenter the building when the device was not operating. By the second and third Deva-Megastress II treatment periods, pigeons were remaining in PH-1 and would not hesitate to enter the building while it was operating.

CONCLUSIONS

The devices evaluated in this study failed to reduce the pigeon population residing in a vacant building. The ultrasonic device tested did not alter pigeon activity or numbers during the 20-day treatment period and pigeons resumed nesting activity within 7.3 m of the device. A visual device altered pigeon activity and reduced the number of pigeons occupying the building for the initial 24-hour period. However, pigeon numbers then returned to pretreatment levels. A sonic device altered pigeon behavior for more than 10 days but only reduced the number of pigeons for 2 days.

This study indicates that devices with ultrasonic output are ineffective in solving pigeon problems and that other scaring devices offer only temporary relief from pigeons even if they can change bird behavior. Pigeons inure to strange sights and sounds quite rapidly.

ACKNOWLEDGMENTS

I acknowledge personnel from NASA/Plum Brook Station and Teledyne Isotopes for use of facilities and technical assistance. Special thanks to my colleagues R. A. Dolbeer and A. L. Kolz for their help in experimental design, technical assistance, data collection and review of this manuscript. Acknowledgment goes to R. E. Griffiths for his review and comments on the manuscript. I recognize the input of USDA employees, J. A. Kelley, M. A. Link, M. Restani, T. W. Seamans, and B. J. Bly.

LITERATURE CITED

BLOKPOEL, H. 1976. Bird hazards to aircraft: problems and prevention of bird/aircraft collisions. Clarke, Irwin & Co. Ltd., Canada. 235 pp.

BOUDREAU, G. W. 1975. How to win the war with pest birds. Wildl. Technology. 174 pp.

BRAND, A. R. and P. P. KELLOGG. 1939. Auditory responses of starlings, English sparrows and domestic pigeons. Wilson Bull. 51(1):38-41.

DUBCO, T. Shriek devices test tough courthouse pigeons. The Miami News. Nov. 12,1984.

DUGGER, C. W. Noise routs courthouse pigeons. The Miami Herald. Nov. 15, 1984.

FRINGS, H. and M. FRINGS. 1967. Behavior Manipulation (Visual, mechanical, and acoustical. In: W. W. Kilgore and R. L. Doutt (eds.), Pest Control: Biological, Physical, and Selected Chemical Methods, Academic Press, New York, pp. 387-454.

GRIFFITHS, R. E. 1988. Efficacy testing of ultrasonic bird repellers. Pages 56-63 In: R. W. Bullard and S. A. Shumake (eds.), Vertebrate pest control and management materials: 5th Vol., ASTM STP 974. American

Society for Testing and Materials, Philadelphia, PA.
JACKSON, W. B. 1983. Opening comments. Proc. Bird Control Seminar. 9:1-3.
KERNS, J. D. 1985. Evaluation of the effectiveness of the "Ultrason ET" ultrasonic device as a means of cliff swallow control. Natural Resources Report No. 85-2. Fort Wainwright, Alaska.
KRZYSIK, A. J. 1987. A review of bird pests and their management (unclassified). Technical Report REMR-EM-1. 145 pp.
LUND, M. 1984. Ultrasound disputed. Pest Control. 52(12): 16.
MARTIN, L. R. and P. C. MARTIN. 1984. Research indicates propane cannons can move birds. Pest Control 52(10):52.
MEEHAN, A, P. 1976. Attempts to influence the feeding behaviour of brown rats using ultrasonic noise generators. International Pest Control. 18(4): 12-15.
MEYHAN, A. 1978. Granivorous birds in sunflower crops. Proc. Vert. Pest Conf. 8:73-77.
MURTON, R. K. and E. N. WRIGHT. 1968. The problems of birds as pests. Proc. Symposia of the Institute of Biology. No. 17.254 pp.
______ .1971. Man and birds. The New Naturalist. 364 pp.
____ and N. J. WESTWOOD. 1976. Birds as pests. In: T. H. Coaker (ed.), Applied biology, Academic Press, London, pp. 89-181.
SUMMERS-SMITH, D. 1963. The house sparrow. Collins, London. 251 pp.
STEWART, J. L. 1984. Acoustics in pest control. Av-Alarm Corporation, Eugene, Oregon.
THEISSEN, G. J., E. A. G. SHAW, R. D. HARRIS, J. B. GOLLOP and H. R. WEBSTER. 1957. Acoustic irritation threshold of Peking ducks and other domestic and wildfowls. J. Acoust. Soc. Am. 29:1301.
________ , and E. R. G. SHAW. 1957. Acoustic irritation threshold of ringbilled gulls. J. Acoust. Soc. Am. 29:1307