EVALUATION OF A CANADA GOOSE CALL-ACTIVATED SWITCH FOR CROP DAMAGE ABATEMENT

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ABSTRACT

Damage and nuisance problems caused by Canada geese (Branta canadensis) are difficult to control with current abatement technology. We tested the efficacy of a goose call-activated switch as a modification for propane exploders (gas cannons), using recorded Canada goose calls and live goose trials. We recorded a 30 m range for the switch and found that it was activated by a range of non-target sounds. The development of this device and the technology involved are discussed. The call-activated switch is not a useful tool in reducing Canada goose damage in crop fields.

Canada geese frequently feed on agricultural crops (Craven and Hunt 1984) resulting in unacceptable levels of damage (Hunt 1984). Crop damage has been a major management concern near Horicon National Wildlife Refuge (HNWR) for 28 years (Hunt and Bell 1973) and available abatement techniques are often ineffective (Conover and Chasko 1985).

Propane exploders are a common abatement tool (Besser 1985). They ignite a measured amount of propane at 20-30 minute intervals. The resulting explosion is intended to frighten geese away from the field. About 1,000 exploders are deployed near HNWR each fall to protect crop fields.

Limitations on exploder efficacy and adverse public reaction to their noise led the Wisconsin Department of Natural Resources (WDNR) and the University of Wisconsin-Madison Department of Electrical and Chemical Engineering (UWECE) to examine possible improvements. One proposed modification was a call-activated switch that would use the vocalizations of Canada geese to activate the propane exploder. Such an exploder would be in operation only when it was needed, rather than on timed intervals.

A call-activated switch offers many conceptual advantages. An exploder that would fire only when geese are nearby would result in less opportunity for habituation. A call-activated exploder would also require less maintenance, consume less propane, and reduce "noise pollution." Alternatively, the switch could be connected to other abatement devices; e.g., it could pop-up a scare crow, release a balloon, or activate a recording of distress calls or applied to other species.

A functional call-activated switch would need to be highly sensitive to goose calls to offer a useful range (100 m). It must discriminate against other sounds present in the field to avoid frequent misfires and to be practical, the switch must be portable, inexpensive, and require little maintenance.

Two years of UWECE developmental work resulted in a prototype switch (Brown 1978). The device used a ceramic microphone to receive incoming sound. It stored the key frequency and duration features of a Canada goose call in Permanent Read Only Memory (PROM) and compared the incoming signal to that profile. When a match occurred, it fired the attached device by activating a solenoid.

The original prototype equipment was eventually turned over to the University of Wisconsin, Department of Wildlife Ecology (UWWE). We believed that this concept could be a solution to the complex problem of goose depredations in the Horicon area.

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However, there were no quantitative data on the physical limitations of the design and the behavioral responses of Canada geese to this new abatement technology. Our objectives were to establish the range of the call-activated switch, the frequency of successful activation when geese called within that range, the nature and frequency of non-target sounds that activated the switch, the reduction in cannon operating costs due to reduced maintenance and propane use, and the effectiveness of a call-activated cannon in reducing crop damage. Our intent was to bring this new technology into use, or demonstrate that it should be abandoned.

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STUDY AREA AND METHODS

We evaluated the call-activated switch near HNWR in east-central Wisconsin. Study sites were a level, 12 ha, upland field of newly mown alfalfa 2 km west of HNWR and a level, 8 ha area of mixed native grasses between impoundments, heavily used by Canada geese, in the northwest corner of HNWR. Census data (WDNR) indicated that there were about 150,000 Canada geese in the area during the study period.

Initial field tests of the original prototype of the call-activated switch showed that the device had severe range limitations. We felt that the switch might have physically deteriorated in storage and that new advances in electronics should be considered. We again took the device to UWECE. Burk O'Neil (Design Consultant, UWECE) examined the microphone unit and the discrimination circuitry and found both to be up to date. He rebuilt the pre-amp circuitry to increase sensitivity. The estimated commercial price for the improved prototype switch was $75 to $100 each. Staff of the UWECE assured us that no further technological improvement of the prototype switch was possible.

Tape Recorder Trials

Tape recorded Canada goose calls were obtained from the Cornell Library of Natural Sounds (Cornell University, Ithaca, NY) for use as the sound source. The original prototype and improved prototype were tested using these recorded goose calls, replayed at 3.2×10^{-4} W/m^2 peak intensity. We used a pair of 1 W, 8 ohm, speakers with a 275-14,000 Hz frequency response to allow a high fidelity to the original goose calls.

Using this method, we were able to precisely control the sound source volume and distance. The tape recorder tests were conducted in the upland study site, under favorable acoustic conditions. All buildings and trees were >80 m from the test site. All tests were under 6.5-19.2 km/hour winds.

The receiver microphone was always placed at a 3.0 m height. The tape recording was played at 1.0 m intervals from the microphone, at right angles to the wind direction. The recording was played a minimum of 3 times at each distance, and we noted whether the attached propane exploder was activated or not.

Live Goose Trials

During October of 1987, the improved prototype of the call-activated switch was tested at the HNWR study site, using Canada geese in flight as the sound source. The call-activated cannon was midway between, and 75 m from, open-water areas frequented by Canada geese. We limited the tests to 6.4-12.8 km/hour winds. Sound source distance was estimated using premeasured ground reference points.

RESULTS

Tape Recorder Trials

Both versions of the call-activated switch triggered the propane exploder in response to the tape recording. However, the original prototype switch failed at ≥10 m (n = 30). We judged this performance unsatisfactory and returned the switch to UWECE for the improvements noted above. All further references to the call-activated switch refer to the improved prototype.

The improved prototype did extend the effective range. In every trial (n = 48) where the sound source was ≤28 m from the microphone, the tape recording activated the switch. The switch functioned at 29 m only if wind speeds remained ≤17.6 km/hour (n = 4). At 30 m the switch activated only in ≤8.0 km/hour winds (n = 11) and at 31 m the switch would not function, even under calm conditions (n = 8).

The switch did discriminate against most non-goose sounds. The foam covering of the microphone and a self-dampening gain built into the recognition circuitry screened out wind sounds ≤19.2 km/hour. A 90-second time delay feature built into the circuitry screened out the blast from the propane exploder it activated. However, the "goose-activated" switch was activated by several other sound sources. Human voices at conversational volume could activate the device from up to 4 m away if a word or phrase with acoustic similarity to a goose call was spoken clearly toward the microphone (e.g., "five," n = 18). Tire noise from a nearby highway triggered the switch until the device was moved to >85 m from the road. Explosions also triggered the switch: a shotgun blast at ≤15 m (12 gauge, muzzle pointed away from the microphone) or an exploder fired at ≤75 m from the microphone.

Live Goose Trials

The improved prototype of the call-activated switch was evaluated for 7 hours near the roost ponds. Groups of ≤15 Canada geese flying 20-30 m from the microphone activated the switch 11 times during the test period, with no failures. Two activations occurred with larger groups of 80-100 geese, flying at 50 m distances. Six groups of <15 geese called at distances of 30-50 m, but none of these triggered the switch. Thus, the effective range of the call-activated switch was only 30 m, identical to that determined in the tape recorder trials.

Other sound sources also activated the switch during the live goose test period. Highway noises from a road located 80 m from the test site caused 15 misfires. The switch activated an additional 15 times during the testing period due to unknown causes. It also triggered twice due to jet aircraft.

DISCUSSION AND MANAGEMENT IMPLICATIONS

Range Limitation

Both trials suggest a maximum effective range of 30 m for the call-activated switch. Although large flocks could trigger the device from a greater distance, geese do not commonly arrive at a feeding site in groups of >100 (Zicus 1976). The switch could have its full potential effect only if a critical number of geese vocalized within range during their initial approach, otherwise that moment of vulnerability would pass. Thus, a single call-activated exploder could be relied on to protect an area of only 0.2 a. The standard recommended density for traditional propane exploders is 1/8 ha.

As noted, the activation of other exploders will trigger the switch. If each exploder was equipped with a call-activated switch and placed within 75 m of the next, a staccato chain reaction would occur in a field when the first call-activated exploder fired. Used in this manner, the call-activated exploders could each protect 1.5 ha. A minimum of 5 call-activated exploders would be required to protect an 8 ha field.

The range limitation of the call-activated switch is dictated by basic acoustics. In the laboratory, the switch can be activated by a goose call of 3.8 X 10^{-11} W/m^2 intensity, at the point of reception. A single goose, emitting a 3.2 X 10^{-4} W/m^2 intensity call, could trigger the switch from 50 m, in an environment with no absorption or disruption of sound waves (Inverse square law). Outdoors, with sound absorption and wind effecting the performance, it took 80-100 birds calling at that distance to trigger the device.

To double the range of the switch would require that the sound source volume or the sensitivity be increased $\geq$4 times because the intensity of the sound wave (assuming no absorption) diminishes proportional to the inverse square of the distance from the source (Inverse square law). We cannot influence the source volume, we can only seek to increase the sensitivity. Assuming that increase, we would also need a similar increase in the capability of the device to sort that sound from normal outdoor background sounds, including wind. The present design achieves that separation by self-dampening the gain as ambient noise levels increase, which decreases sensitivity (range). This approach is counter-productive in the HNWR setting, where wind and other background noise are common. Current technology offers no solution to this impasse.

Discrimination Limitations

The call-activated switch discriminates "goose calls" by accepting sounds in the 600-850 Hz frequency band that have the amplitude and duration typical of Canada goose calls (Brown 1978). During 7 hours of testing at the HNWR site the switch triggered 45 times: 13 times due to geese, and 32 times in response to other sounds. A mean of 10 minutes elapsed between activations. Timed exploders are usually set to go off once every 20-30 minutes. One proposed use for the call-activated switch was the protection of agricultural crops near hospitals, schools, and other noise-sensitive locations. However, the broad band of frequencies emitted by tires (Brown 1978) at those sites could trigger the call-activated switch as soon as it resets. Therefore, use of the switch within 85 m of a highway would increase the level of disturbance compared to a simple timed abatement device. Also, under those circumstances there would be no reduction in maintenance, propane use, or opportunity for habituation.

Management implications

The original WDNR project and our study demonstrated that a call-activated switch can be designed and constructed. However, test data suggest no current application of this technology in Canada goose damage abatement. In another context, a species specific acoustic switch could be useful to locate, count, or manage species with distinct and frequent vocalizations, especially in remote areas.

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