EXPERIMENTAL USE OF ACETYLENE EXPLODERS TO CONTROL DUCK DAMAGE

by

W.J.D. Stephen

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W.J.D. Stephen, Canadian Wildlife Service, Saskatoon

Each harvest season flocks of ducks cause losses estimated in millions of dollars to barley, oats, and wheat crops on the Canadian prairies (Elkins 1957: 1). In the Prairie Provinces hunting season dates and bag limits are influenced by the threat of grain-eating species of waterfowl. In a further effort to reduce crop damage, many ducks are shot under authorization of Sections 32 and 33 of Canadian Migratory Bird Regulations. Successful control of duck damage on individual fields through the use of firearms and scarecrows has been reported by Hochbaum *et al.*, (1954: 181) and Bossenmaier and Marshall, (1958: 28). However, the latter suggest (*op. cit.*:28) that in unfavourable years harassment would simply shift ducks from one vulnerable field to another. If the interests of scientific waterfowl management are to be less in conflict with those of agriculture, it is essential that a method of controlling duck damage be developed which may be universally applied by farmers.

In 1958 following a discussion by the Waterfowl Advisory Committee it was proposed that Canadian and United States agencies co-operate in an attempt to assess and alleviate problems caused by ducks damaging grain in Canada. Research reported here is a direct result of that proposal. In August and September of 1958, personnel loaned from seven Canadian and United States agencies began exploratory work on the Canadian prairies. It was decided in 1959 that co-operators investigating duck damage alleviation should test both known and new methods for preventing depredations. Results obtained that year indicated that automatic acetylene exploders held most promise as a practical means of damage control. Acetylene exploders are machines which create an explosion by igniting a small amount of acetylene gas. In some models, the noise of the explosion is amplified to a decibel level similar to that of a shotgun blast.

Objective of the 1960 experiment was to test use of exploders as a means of controlling duck damage in a large district.

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Description of study area

The study area of Meadow Lake was selected for two reasons. First of all, it has a history of being subject to severe duck depredation. Secondly, it is in a large agricultural district (2,000 ± square miles) which is a clearly defined ecological unit since it is separated from other grain-growing areas of Saskatchewan by a band of mixed-wood forest about 40 miles wide. The 2,000 square mile area is made up of smaller blocks (200± square miles) of cultivated land which are also separated from each other by mixed-wood forest. One of those smaller blocks, in the vicinity of the town of Meadow Lake, was chosen as an experimental area. Duck damage was then compared in treated and untreated areas which were ecologically similar.

An outline of the 209.5 square mile experimental area used in 1960 is shown in Figure 1. As an agricultural district the Meadow Lake area includes some of the most fertile soils in the province (Mitchell et al. 1950: 85). Since a short frost-free period tends to limit productivity of the area, barley and other short-season crops are grown predominantly. Topography of the area is smooth. As in typical parkland, cultivated areas are interspersed with trees (aspen and associated understory), often at the edges of fields and usually around water areas and farm buildings.

1960 Harvest phenology in study area

Damage to wheat, barley and oat crops occurs most frequently while they are in a swathed condition. Although swathing allows more uniform drying and therefore an earlier harvest, it increases vulnerability of grain crops to duck damage. In general, severity of damage is related to the length of time that crops are swathed and the number of field-feeding ducks in the area. Normally, small-grain crops mature at approximately the time - late July or early August - that flocks of young-of-the-year and post-breeding adult ducks begin to congregate. Twenty to thirty days are usually required to harvest mature grain in a district using the swathing method. In the Meadow Lake experimental area in 1960, swathing was delayed a week to ten days by a wet spring, and harvesting was prolonged over a period of 62 days because of frequent rain (see Figure 2).

A comparison of numbers of waterfowl available and progress of harvesting is given in Figures 2 and 3. Mallards (*Anas platyrhynchos*) and pintails (*Anas acuta*) were the most abundant species, while green-winged teal (*Anas carolinensis*), blue-winged teal (*Anas discors*), and baldpate (*Anas americana*) made up 5 to 10% of the waterfowl counted. Fluctuations in waterfowl numbers, apparent in Figure 3, are considered normal.

Ground observations of species composition of field-feeding flocks suggest that disappearance of pintails, which normally migrate early, accounted for the reduction of waterfowl numbers during the first week of September. Although it is difficult to compare the magnitude of depredation problems from year to year and between areas, it may be concluded, on the basis of the length of the harvest period and the numbers of ducks available to do damage, that duck depredation was potentially a serious problem in the study area in 1960.

Method

A daily patrol of the study area was made to observe waterfowl flights and field-feeding, and to service exploders. During the peak depredation period, from August 22 to September 20, eight to ten men patrolled the 209.5 square mile study area. Each observer was assigned to a segment varying in size from 15 to 36 square miles, depending on field-feeding activity. During the rest of the study period, from August 2 to August 21 and September 21 to October 7, one to four observers made daily patrols. Daily observations were made at two periods, the first beginning approximately one-half hour before sunrise and ending four or five hours later, the second beginning four or five hours before sunset and ending at dark. Observations were also made during the mid-day period when field-feeding occurred then.

In this experiment an exploder was set in a field after ducks were observed landing there and permission of the crop owner had been obtained. Additional exploders were installed if needed until ducks were discouraged from landing in that field. Small flocks (less than 25 ducks) landing in susceptible fields were dispersed with exploding shotgun shells; if they persistently attempted to land in the same site, an exploder was installed. It was not considered practical to install an additional exploder if only one or two ducks were observed landing.

Periodic counts were made of the number of unharvested fields of barley, wheat, and oats in the study area. Numbers of dabbling ducks were counted by aerial census on water areas from which field-feeding flights in the study area originated. Rainfall records were obtained from the Saskatchewan Department of Natural Resources Regional Office at Meadow Lake. Data on Wildlife Insurance in the experimental and surrounding areas were obtained through the courtesy of Mr. A.O. Smith, Chief Farm Underwriter, Saskatchewan Government Insurance Office, Regina. Mallard and pintail ducks were bait-trapped and banded in the period August 11 to September 5 on water areas within the study block in an attempt to measure population turnover, which might be related to harassing activities.

Distribution of exploders

Within the study area in 1960 there were a total of 922 fields under cultivation. Of those, 530 were sown to wheat, barley, and oats (not including those grain crops grown for forage). The distribution of sites in which exploders were used is shown in Figure 1. A total of 201 exploders were put in 141 fields. In the remaining 389 fields either ducks were not observed landing or the owner did not wish to have an exploder installed. There were five fields in the study area on which Wildlife Insurance claims were paid which did not have exploders installed in them. Fields with exploders in them ranged in size from 20 acres to 220 acres with a mean of 73.2±3.5 acres. Only 43 of the 141 protected fields (30.5%) required more than one exploder. The mean acreage of the 98 fields protected with one exploder was 67.3±3.9 acres. The mean acreage of 30 fields requiring two exploders was 83.8±7.7 acres. The mean acreage of 11 fields requiring three exploders was 86.3±17. acres. Those data indicate that the number of exploders required to protect a field from duck damage is not directly proportional to field size.

Differences in susceptibility to duck damage on particular sites have been reported by Hochbaum et al. (1954: 181). In the 1960 study particular attention was paid to field-feeding flights originating from the complex of loafing areas afforded by Cole and Murray Lakes. During most of the aerial censuses the largest proportion of ducks counted were concentrated there. Ground observations made throughout the study indicated that field-feeding flights of ducks originating there attempted to land within one or two miles. Observations of such feeding-flight patterns were recorded for that one segment only. The mean acres of fields protected by exploders within 1.5 miles of the loafing areas was 44.6±6.0 acres per exploder compared to 60.4±3.4 acres per exploder for protected fields in the rest of the study area. That difference is significant at the 90% confidence level indicating an increased susceptibility within 1.5 miles of the loafing areas mentioned. It is not known whether that increased susceptibility was due to attractiveness of those particular sites or related to a larger number of ducks available to do damage. It is of interest to note, however, that not all grain fields within the 1.5 mile radius were damaged by ducks.

The mean length of time that exploders were used for protection of a field (from installation of first exploder until the field was harvested) was 15 days, with a range from one to 41 days. In some fields it was found that one exploder would prevent ducks from landing for a period of time, then additional exploders had to be installed.

In Table 1 a comparison is made of the per cent grain harvested, peak duck numbers, mean numbers of exploders per field, mean numbers of fields requiring protection, and numbers of fields in which additional exploders were required. It can be seen that the number of fields requiring protection increased with an increasing duck population as long as the ratio of unharvested fields to harvested fields remained 4:1 or more. However, the number of exploders per field increased steadily until the last week of September. In part, that was due to the procedure of leaving a maximum number of exploders in a field until it was harvested. For example, on August 14 ducks might have been observed landing in a field and one exploder installed. On August 29 further landings in the same field might have been observed, and two additional exploders installed. The three exploders were then operated until the field was harvested, whether or not ducks were ever observed attempting to land there again.

The addition of exploders to fields in which exploders were already operating reflects a change in susceptibility of those fields. The dates on which peak numbers of additional installations were made coincide with duck population peaks. The highest number of additional installations was made during the period when there were relatively few unharvested fields available to ducks for feeding.

TABLE 1: Mean number of fields requiring protection, mean number of exploders used, number of fields requiring additional exploders, peak duck numbers, and percent grain harvested by weekly periods, Meadow Lake, 1960.

Date	Mean No. fields	Mean No. exploders	No. exploders per field	No. fields requiring additional exploders	Peak duck numbers	Per cent grain harvested
Aug. 8-14	4.8	5.6	1.15	0	11,200*	0%
Aug. 15-21	19.3	22.7	1.18	2	15,600*	- **
Aug. 22-28	49.3	58.4	1.19	6	18,500*	- **
Aug. 29-Sept. 4	72.3	98.7	1.38	13	21,600	20%
Sept. 5-11	62.4	98.7	1.50	3	12,500	- **
Sept. 12-18	53.8	83.6	1.55	7	20,000	38%
Sept. 19-25	33.6	54.0	1.61	3	16,200*	- **
Sept. 26-Oct. 2	32.0	49.7	1.55	0	10,600	90%

* by interpolation
** no data for given period

Observations made in this study and also reported by Hochbaum et al. (1954: 181) suggest that wariness of field-feeding flocks increases with progression of the season. Hunting activity undoubtedly contributes to increased wariness of shotgun-like noises. There was no evidence collected during the study to indicate that the necessary increase in the number of exploders per field was a result of ducks becoming less wary of exploders as time went on.

The need for additional exploders on particular sites might be attributed to several factors. Some of them are as follows: (1) increased attractiveness of the field in relation to other fields, which may have been plowed or in which ducks are prevented from feeding by exploders or hunting disturbance; (2) increased numbers of ducks field-feeding; (3) new individuals in the field-feeding population. It is not possible to state categorically from the data presented in Table 1 which, if any, of those factors were of most influence. However, it may be suggested that it is to a farmer's advantage to maintain undisturbed feeding areas in the form of stubble fields in order to reduce the attractiveness of his unharvested crops.

Results

There was no evidence collected during the study to suggest that mallards and pintails stopped flying out to fields. Throughout the study, observations were made of ducks feeding in harvested fields adjacent to susceptible fields in which exploders were operating. Ducks would usually continue to use harvested fields until disturbed by hunters or the field was turned over with a mould-board plow. Tillage with a discer or cultivator does not make waste grain completely unavailable, so ducks would continue to use fields tilled in that manner.

The value of automatic acetylene exploders as a means of preventing damage in a large district may be assessed by comparing the number of claims made on Wildlife Insurance in the study area and the adjacent area. The adjacent area encompasses approximately 2,000 square miles. It includes agricultural areas which are usually referred to by town names such as: St. Cyr, Dorintosh, Rapid View, Makwa, Loon Lake, Goodsoil, Beacon Hill, and Pierceland. In the years 1956 to 1959, the study area consistently had a higher proportion of Wildlife Insurance claims. In 1960 in the adjacent area, claims were made on 48.0% of the policies issued (47 out of 98). In the study area, claims were made on 34.8% of the policies issued (8 out of 23) for fields protected by exploders. Claims were made on five additional policies issued for fields not protected by exploders. The owners of three of those five fields did not wish to have exploders installed. The other two claims were for $100 or less so that they might have been caused by small flocks which went undetected by daily patrols. The difference in proportion of claims between the study area and adjacent area in 1960 was tested for significance (Dixon and Massey, 1951: 191). It can be concluded that the probability is only 0.12 that such a difference would be exceeded by chance alone. If harassment had caused damage to be spread among more farmers in the study area, then an increase in the number of claims would have been expected.

It might be reasoned that the decrease observed in the number of claims on the study area was effected by a movement of ducks into adjacent areas. Re-traps and recoveries of mallards and pintails banded during the study suggest that such a shift did not take place. Of 73 pintails banded, 17 were re-trapped on the study area at periods varying from 1 to 12 days after banding. Of 72 mallards banded, 10 were re-trapped from 1 to 9 days after banding; four were recovered on the study area 10, 17+, 18 and 36 days after banding; a fifth was recovered approximately five miles from the study area 23 days after banding; and a sixth was recovered approximately 150 air miles from the study area 27 days after banding. All bandings, re-traps, and recoveries were made within the period that exploders were used on the study area. Those data suggest that exposure to harassment did not drive ducks out of the district.

All species of ducks were not discouraged from feeding in fields with equal ease. It was more difficult to prevent green-winged teal from landing in a field than either mallards or pintails. To my knowledge field-feeding activity by green-wings has not been reported previously. Fortunately, their abundance at Meadow Lake, and on the prairies generally, in relation to mallards and pintails, makes their economic value as crop destroyers rather small. Green-wings were observed feeding in only three susceptible fields on the study area. In those fields they appeared to act as decoys so that more exploders had to be installed than might have been needed for mallards or pintails alone.

There seemed to be different responses of ducks to exploders in relation to flock size. Very small groups of field-feeding ducks (single's, two's, and three's) were often flushed from fields or were seen to land in fields at very short distances from exploders. It was difficult to make accurate measurement of those distances.

Small flocks (10 to 100) took less time to enter a field than a large flock (100 or more). As a result, it was found necessary to operate exploders at a rate of approximately one explosion per minute so that small flocks would not land between explosions. Once on the ground, ducks seemed harder to scare that while in flight.

Evidence is presented to show that there was a reduction in the number of insurance claims in this study area and that ducks did not move out of the district. It follows that automatic acetylene exploders, operating at a rate of approximately one explosion per minute in all fields requiring protection can be used to reduce duck damage without simply spreading the losses among other farmers in the same or adjacent districts. It is probable that duck damage losses could be made negligible by systematic, prolonged harassment in unharvested fields if ducks were allowed to feed undisturbed in stubble or light] cultivated fields nearby.

Exploder operation and defects

Exploders used for this experiment were the "Zon" model M 60 as shown in Figure 4. Both "Zon" and "Scare-away" brands of automatic acetylene exploders were tested in 1959. The "Zon" was chosen for 1960 experiments because it appeared to be sturdier, with cast iron and welded construction compared to the stamped and rivetted construction of the other exploder.

In exploders of which "Zon" and "Scare-away" are examples, mixtures of acetylene and air are ignited in an explosion chamber situated behind a megaphone so that sound made by combustion is amplified. Energy derived from the flow of acetylene gas actuates the ignition and explosion interval-control system. Flow of gas is regualted either by the rate of generation when operated from a carbide and water acetylene generator, or by a throttle valve when operated from bottled gas. Flowing gas expands a diaphragm which is mechanically linked so that it cocks a flint-and-wheel ignition system. When an appropriate amount of acetylene is accumulated, a lever is tripped which releases the gas through a check valve into the explosion chamber and allows a spark to be struck. A small but loud explosion results.

Operating costs vary with the rate of explosion. If an exploder were operating around the clock at a rate of one explosion per minute, bottled acetylene, worth about four dollars, would last about a week. The daily operating cost would then be approximately 57 cents. The seasonal cost of operation of exploders for a 15 day mean period, as at Meadow Lake in 1960, would be about \$8.50. That cost could be reduced even more if a suitable timing device were used which would shut the exploder off at night.

Difficulties were experienced in operating "Zon" automatic acetylene exploders. The exploder will only operate for a period of four to six hours at a rate of approximately one explosion per minute from the amounts of carbide and water recommended for use with the generator supplied. A farmer would have to replenish both carbide and water twice a day in order to ensure suitable operation during peak depredation periods. As a comparison, bottled acetylene supplies would last about one week. However, when operated from bottled gas, the valve on a tank of acetylene, and available acetylene throttle valves, such as "Linde 19 x 39", are too coarse to allow easy adjustment of flow. The range from zero explosions to a three-explosion-per-minute maximum (determined by the mixing rate of acetylene and air) is regulated by approximately one-eighth to one-sixteenth of a turn of either the acetylene tank valve or the throttle valve. That range makes the interval of explosion hard to adjust. Once the valves were adjusted the interval of explosion was also affected by changes in atmospheric pressure and temperature because of their affect on flow rate.

Maintenance of exploders in operating condition was also a problem. Almost every machine that was installed required at least minor maintenance during its period of use. Minor maintenance was that done while the machine was still in the field. Most frequently, repairs of that type were made to the lighter assembly. Examples of causes of trouble are as follows: (1) relaxed tension on spring holding flint against wheel; (2) clogging of flint wheel with flint dust; (3) uneven wear on flint so that it no longer faced the wheel; (4) loosening of nut holding flint-cocking mechanism to diaphragm linkage. Any of those defects would result in no explosion, and the possibility of ducks landing in the field concerned. Major maintenance involved replacement of parts. Such replacement was made necessary by fractures of welds or castings, and excessive wear on moving parts. Forty-six per cent of the 150 machines available required major maintenance in the first season of operation.

Discussion

The usefulness of harvested fields as alternate feeding areas could not be fully evaluated during the Meadow Lake study. No effort was made by the experimenters to discourage hunting on stubble fields nor to discourage farmers from tilling stubble. Despite those limitations, it was obvious throughout the study that ducks were using harvested fields as substitute feeding areas when driven from susceptible fields.

In many parts of the prairies where wind erosion is a problem and there is relatively little straw to be decomposed, spring cultivation of stubble, as recommended by the Federal Department of Agriculture, is the rule. In order to prevent duck damage in those areas, it may only be necessary to harass ducks on susceptible fields and to enforce legislation designed to ensure that ducks are not disturbed on harvested fields by hunters until threat of depredation in the vicinity is past.

In many northern areas of the prairies, including the Meadow Lake district, there is a short growing season and little threat of wind erosion; it would therefore seem to be to the farmer's advantage to cultivate stubble in the fall although this would encourage duck depredation in unharvested fields. In those areas there may be times and places where alternate feeding sites are in short supply, and the cost of preventing duck damage by exploders alone may be more than an individual farmer is willing to pay for protection from a "publicly owned" hazard. In areas of the prairies where fall cultivation is the rule, it seems advisable to investigate the need for provision of alternate feeding sites to be used in conjunction with harassment for duck damage control. Information on adequate type, optimum size, location and number of feeding areas is needed.

If abatement of conflicts with agriculture is to be part of a continental program of scientific waterfowl management, it is my opinion that the first step in such a program is to develop a dependable exploder. I believe that the next step will be to pinpoint the areas which are susceptible to duck damage and establish priorities for action. A flexible program can then be designed to cope with problems which are related to land use, farmer's attitudes, and waterfowl resources.

Summary and Conclusions

1. Under conditions in which crops were susceptible to duck damage for about twice the normal period of time, automatic acetylene exploders were used to reduce depredations without spreading the damage among more farmers or affecting the distribution of ducks in a manner deleterious to hunting. In 98 of 141 susceptible fields (69.5%), only one exploder per field was required. More than two exploders per field were needed in only 9.2% of the susceptible fields.

2. The difficulty experienced in regulating the interval of explosion and maintenance necessary to ensure continued operation are thought to be serious limitations to the usefulness of the model of acetylene exploder tested.

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