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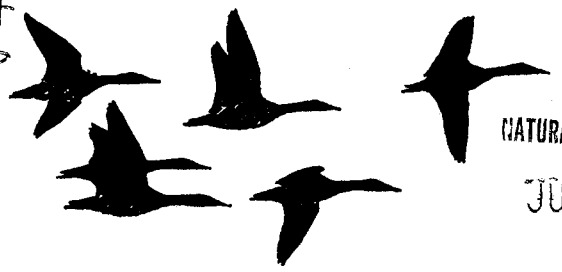

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EFFECTIVENESS OF STEEL SHOT FOR HUNTING INTERIOR CANADA GEESE

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Abstract: The relative effectiveness of steel shot and lead shot for hunting interior Canada geese (Branta canadensis interior) was tested on the Union County Public Hunting Area in southern Illinois during the 1977-78 season. All test shells were 2 3/4-inch 12 gauge that were loaded with 1 1/8 oz #1 steel, 1 1/8 oz BB steel, 1 1/2 oz #2 lead, or 1 1/2 oz BB lead. Numbers of geese knocked down per 100 shells discharged, as recorded by observers, were 18.7 for #1 steel, 16.2 for BB steel, 17.7 for #2 lead, and 18.3 for BB lead. Frequencies at which shot-at geese were knocked down were 44, 35, 37 and 37 percent, respectively. Crippling losses, expressed as percentages of all geese hit, were 46 for #1 steel, 37 for BB steel, 48 for #2 lead, and 44 for BB lead. The #1 steel was used at 9-10 percent shorter range, on the average, than the two lead loads. However, these differences and the others listed above for steel versus lead were not satistically significant ($P>0.05$). Additional tests with hunters not accompanied by observers were also conducted.

INTRODUCTION

Steel shot has been thoroughly tested for its effectiveness for hunting ducks (Andrews and Longcore 1969, Kozicky and Madson 1973, Kimball 1974 and 1975, Nicklaus 1976, Mikula et al. 1977) and was used experimentally on large numbers of small and medium-sized geese at Tule Lake, California during the 1977 season (Tom Roster, Oregon Institute of Technology, Klamath Falls, personal communication). However, steel shot shells of modern vintage have not been adequately tested for their ability to kill the larger races of Canada geese. Thus, the purpose of the present study was to determine the relative effectiveness of steel shot for hunting Canada geese of the Mississippi Valley population that winters in southern Illinois. Mean weights of these geese in December range from 2,948 g for immature females to 4,069 g for adult males (Hanson 1962:40-49).

This study was conducted on the Union County Public Hunting Area, which is adjacent to the Union County Refuge and is located in the Mississippi River floodplain between Ware and Reynoldsville, Illinois. This 2,050-acre hunting area, owned and operated by the Illinois Department of Conservation, is well suited for testing steel shot because hunting success is generally high, steel shot is required (12 gauge only), and hunters are closely monitored by Department personnel. Hunters must report to a check station both before and after hunting, they are transported both to and from the blinds, and they are limited to 10 shotgun shells each. The area has 50 blinds, 2 hunters are assigned to each blind, and hunting is permitted

from sunrise to 12 noon. Hunters are admitted to the area by permit (limit, one per hunter per year), which they obtain several weeks in advance from the Department's Permit Office in Springfield. Permit holders not reporting to the check station by 5:00 A.M. are replaced, by lottery, from additional hunters who are present on standby. The goose season began in the southern Illinois quota zone (Alexander, Union, Williamson, and Jackson counties) on 21 November 1977 and continued through 3 January 1978, when the quota of 29,000 birds was attained. The daily limit was two Canada geese per hunter.

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METHODS AND MATERIALS

Four types of shotgun shells, all 2 3/4 inch 12 gauge, were tested during this experiment: 1 1/8 oz #1 steel, 1 1/8 oz BB steel, 1 1/2 oz #2 lead, and 1 1/2 oz BB lead. The steel shot shells were manufactured in August 1977 by Federal Cartridge, Minneapolis, Minnesota, to specifications set forth by Tom Roster. The lead shells, also assembled in August 1977, were standard-run Federal Hi-Power loads. Ballistic characteristics of the shells are summarized in Table 1. All shells were identical in outward appearance, except that each shell type was marked with an alphabetical code. The codes were removed with acetone and a stiff brush before the shells were used in the tests.

The shells were repackaged in lots of 20 of one type in standard-sized shotgun shell boxes of the kind used by hand loaders. The type of shell in each box was recorded and sealed in a 2¼- x 3½-inch I.D. envelope that was placed in the box with the shells. Should an envelope become lost, damaged, or otherwise unusable, the boxes were coded as to type of shell by cutting specified corners off the bottom flaps. The boxes were assembled in groups of four, with one box of each type of shell represented.

Hunters were screened for participation in the tests at the time they reported to the check station to draw for blinds. Each hunter was asked the gauge of shotgun he intended to use and, if 12 gauge, whether it had a 2 3/4- or 3-inch chamber. If both hunters in a party had 12 gauge guns, their willingness to take part in the testing was determined. Only occasionally was one hunter allowed to participate while the other was not.

Approximately eight parties, consisting of two hunters each, were selected each morning from among those hunters who drew the better blinds and agreed to take part in the test. Three or four of these parties--the ones in the most preferred blinds--were each assigned an observer, who was given a box of 20 shells at random, printed instructions, a form on which to record data, and a model 610 Ranging range

finder. The observer, a trained biologist with experience in goose hunting, accompanied the hunters in the blind; he removed the I.D. envelope from the box and retained it unopened until after the hunt. All pertinent data relative to the hunt (number of shells discharged, distance of geese, number of geese knocked down, etc.) were recorded by the observer. At the end of the hunt, the observer asked the hunters to evaluate the shells they had used and whether they thought they had shot steel or lead, after which the I.D. envelope was opened and the type of shell used was revealed. Whenever possible, the observers replaced hunters who shot their limits of geese with hunters from other blinds and continued with the testing.

The other four or five parties (those not accompanied by observers) were each given a box of 20 shells and printed instructions on how to use them. The shells were assigned to the hunting parties at random; at least one box of each type of shell was used most mornings. The I.D. envelopes were removed from each box, labeled as to the party (blind) to which the box was assigned, and retained at the check station. At the end of the hunt, the hunters had to account for all 20 shells by returning spent hulls and/or unfired shells, and fill out a questionnaire regarding their experience with the shells. The I.D. envelope was then opened and the hunters were informed as to the type of shell they had used.

Initially, observers were instructed to maintain a passive role in the hunt--i.e., they were not to offer advice on hunting techniques or otherwise aid the hunters. Unfortunately, goose hunting was poor and observers witnessed the knocking down of only 41 geese during the first 3 weeks of the season. After that, the observers made suggestions on placement of decoys, offered assistance in calling, and encouraged hunters to take advantage of all opportunities to shoot at geese. The last was the most instrumental in increasing hunting success.

Unless otherwise indicated, all corresponding data for the four types of shells were tested for significant differences ($P<0.05$); the test used was Student's t. Variance was calculated for percentage values and ratios with the formula pq/n (Cochran 1953:53).

RESULTS

Hunter Participation and Shotguns

A total of 1,843 hunters were screened during the 29 days that the shotgun shells were tested (the area was closed on Mondays and on December 24 and 25, and tests were not conducted on 6 other days). Hunters used 12 gauge shotguns with 2 3/4-inch chambers or 3-inch chambers more often than any other bore--39 and 30 percent, respectively. Another 15 percent used 10 gauges, 10 percent used 20 gauges, and 6 percent used 16 gauges.

Of 481 parties in which both hunters used 12 gauges, 80 percent agreed to participate in the testing. Parties that had two 12 gauges with 2 3/4-inch chambers were more willing to participate (92 percent, n = 200) than those that had one 12 gauge with 3-inch chamber (78 percent, n = 143) or two 12 gauges with 3-inch chambers (64 percent, n = 138).

There were 434 hunters, counting repeaters, who participated in the tests. One hundred eighty-six of these were accompanied by observers--85 used lead shot

shells and 101 used steel (Table 2). Of the remaining 248 hunters, which were not accompanied by observers, 129 used lead shot and 119 used steel. The average length of time that hunters accompanied by observers spent in the blinds engaged in goose hunting varied from 3.3 to 3.8 hours (Table 2).

Efficiency of Shells

The number of geese knocked down per 100 shells discharged, as determined for hunters accompanied by observers, was 18.7 for #1 steel, 16.2 for BB steel, 17.7 for #2 lead, and 18.3 for BB lead (Table 2). Differences among these values were not statistically significant ($P>0.05$). Although the range at which geese were knocked down was about 5 percent less for #1 steel than for the other types of shot, the differences were not significant (Table 3). Considering all geese shot at, #1 steel was used at an average range of 44.0 yards, which is 9-10 percent less than the average distances at which #2 lead and BB lead were used; these differences approached significance ($F=2.55$, df = 3 and 445).

Hunters not accompanied by observers reported the following numbers of geese knocked down per 100 shells expended: 12.4 for #1 steel, 10.5 for BB steel, 11.6 for #2 lead, and 13.7 for BB lead (Table 2). Again, there were no significant differences. These hunters were possibly less efficient than hunters accompanied by observers because the latter had, on the average, the better blinds.

The frequencies at which shot-at geese were knocked down by the four types of shot at various ranges are summarized in Table 4. With one exception, there were no significant differences among any of the comparable values. When all geese shot at and all ranges were considered, the success rates for knocking down geese were 44 percent for #1 steel, 35 percent for BB steel, 37 percent for #2 lead, and 37 percent for BB lead. Corresponding values for all geese shot at beyond 40 yards were 33, 30, 26, and 22 percent, respectively.

The data comprising the lower half of Table 4 suggest that geese hit by the steel loads were knocked down at essentially the same frequency as geese hit by the lead loads. The success rates for all ranges were 64 percent for #1 steel, 67 percent for BB steel, 65 percent for #2 lead, and 64 percent for BB lead. Corresponding values for geese hit beyond 40 yards were 51, 61, 58, and 48 percent, respectively.

Crippling losses, expressed as percentages of all geese hit, for hunters accompanied by observers ranged from 37 percent for BB steel to 48 percent for #2 lead (Table 2). Paradoxically, BB steel had the highest crippling losses (63 percent) among hunters not accompanied by observers; #2 lead had the second highest losses (52 percent) among these hunters, and BB lead had the lowest (35 percent). The value for BB steel differed significantly from the values for BB lead and #1 steel. Crippling losses during the entire study--for hunters accompanied by observers and hunters not accompanied by observers combined--occurred at a rate that approached one goose (0.85) for every one retrieved. In this study, any goose hit (regardless of how lightly) and not retrieved was considered crippled. We have no knowledge of the percentage of these birds that eventually died or recovered.

Crippling losses among geese knocked down by hunters accompanied by observers were 8 percent for #1 steel, 2 percent for BB steel, 20 percent for #2 lead, and 6 percent for BB lead (Table 2). Corresponding data reported by hunters not accompanied by observers ranged from 4 percent for #1 steel to 12 percent for #2 lead.

Hunter Response to Shells

Hunters who participated in the testing were inclined, when questioned after hunting, to rate the lead shot shells as "good" and the steel shot shells as "average" (Table 5). They rated steel loads as "poor" more frequently than they did the lead loads. The majority of the hunters who expressed an opinion identified correctly the type of shot--steel or lead--they had used. The only noteworthy exception occurred among hunters who shot BB lead and were accompanied by observers--these hunters confused BB lead with steel shot.

DISCUSSION

The procedures used in testing the shot shells for effectiveness in hunting Canada geese had some obvious biases. We specifically point out that (1) better blinds were selected for the testing, (2) observers offered assistance to the hunters during the second half of the season, and (3) observers were reluctant to use the range finders because the hunters did not favor the presence and use of these optical instruments in the blinds. Although records were not kept, we judged that 25 percent of the range determinations were made with the range finders or by linear measurement (pacing) and that 75 percent were by ocular estimation.

Counter to these apparent shortcomings is the fact that more than 50 percent of the geese harvested in the four-county quota zone are shot from better-than-average blinds with the assistance of registered guides. Thus, the procedures we used in testing the shells, although not altogether typical of the public goose hunting area, are similar to the hunting techniques that prevail throughout the southern Illinois quota zone.

The results of this study indicate that, for the shot shells tested and the conditions that existed on the Union County Area during the 1977-78 season, the #1 steel and BB steel were as effective as the #2 lead and BB lead in knocking down Canada geese (Tables 2 and 4). It is particularly noteworthy that the two steel shot loads were as effective beyond 40 yards as the two lead shot loads. However, these conclusions are somewhat qualified because the #1 steel was used at shorter ranges, on the average, than the other types of shot, especially the lead loads (Table 3).

The relative numbers of geese that were hit but not retrieved, as determined for hunters accompanied by observers, were similar for the four types of shot tested (Table 2). However, hunters not accompanied by observers reported crippling losses that were significantly higher for BB steel than for #1 steel and BB lead. Although this high crippling loss cannot be ignored, we have more confidence in the crippling data obtained by the biologically trained observers than that reported by the hunters. The hunters were, for the most part, inexperienced goose hunters and, consequently, had observed few geese being hit by either lead or steel shot. We tentatively conclude that, for the shells tested, the #1 steel--and probably the BB steel--crippled geese at essentially the same rates as the two lead shot loads.

Although we detected no appreciable differences in the performance of the four types of shot shells tested, hunters who used the shells tended to give the lead loads higher ratings than the steel loads (Table 5). They also tended to determine correctly the shot they had used--steel or lead. We believe that these two factors

are interrelated, and that the long-standing tradition of using lead shot for hunting influenced their judgment in evaluating the test shells. Stated another way, the hunters had confidence in lead shot and lacked confidence in steel shot.

We recommend that the four types of shot shells used during this study be tested again during the 1978-79 goose hunting season, and that 3-inch shells--probably loaded with 1 7/8 oz #2 lead and 1 3/8 oz BB steel--be added to the tests. It would also be desirable to test 2 3/4-inch shells loaded with 1 1/2 oz #2 hard lead that is cushioned with granulated plastic and 2 3/4-inch shells loaded with 1 1/4 oz #1 or BB steel, provided the latter has a muzzle velocity in excess of 1,300 fps. High-quality 2 3/4- and 3-inch 12 gauge loads are the most common shot shells used for goose hunting in southern Illinois. The procedures to be used in 1978-79 should remain the same as those adopted during the second half of the 1977-78 season, except that techniques should be developed--whether with range finders or by some other means--to determine objectively the range of the geese.

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Table 1. Ballistic characteristics of shotgun shells tested for effectiveness for hunting Canada geese, 22 November 1977 to 3 January 1978, Union County Public Hunting Area, Illinois. The data in this table were provided by Bill Horn and Bill Stevens, Federal Cartridge, Minneapolis, Minnesota.

	Ounces of Shot	Number of Pellets	Three-foot Coil Velocity	Pattern Efficiency[a]
Lead #2	1 1/2	131	1,260 fps	68%
Lead BB	1 1/2	75	1,260 fps	68%
Steel #1	1 1/8	116	1,375 fps	78%
Steel BB	1 1/8	80	1,375 fps	78%

[a] Percentage of pellets in 30-inch circle at 40 yards, using full choke shotgun.

Table 2. Hunting effort, flight characteristics, efficiency of shot shells, and crippling losses during testing of steel and lead shot for hunting Canada geese, 22 November 1977 to 3 January 1978, Union County Public Hunting Area, Illinois. Data categories that were tested for statistically significant differences among the various types of shot are indicated by an asterisk.

Category	#2 Lead	BB Lead	#1 Steel	BB Steel
TESTS WITH OBSERVERS				
Hunter trips	42	43	55	46
Mean number of hours per hunt	3.8	3.5	3.3	3.3
Flights shot at	108	120	102	97
Mean number of geese per flight[a]	8.6	8.8	5.7	6.0
Shot shells discharged	232	257	257	216
Geese knocked down	41	47	48	35
*Geese knocked down per 100 shells	17.7	18.3	18.7	16.2
Geese hit but remained airborne	22	26	26	17
Geese retrieved	33	41	40	33
Percent crippling loss				
*For geese knocked down	20	6	8	2
*For all geese hit	48	44	46	37
TESTS WITHOUT OBSERVERS[b]				
Hunter trips	64	65	49	70
Shot shells discharged	294	263	194	200
Geese knocked down	34	36	24	21
*Geese knocked down per 100 shells	11.6	13.7	12.4	10.5[c]
Geese hit but remained airborne	29	13	15	30[c]
Geese retrieved	30	32	23	19
Percent crippling loss				
*For geese knocked down	12	11[d]	4[d]	10[d]
*For all geese hit	52	35[d]	41[d]	63[d]

[a] One or two geese comprised 61 percent of the flights.

[b] Data reported by hunters.

[c] One hunting party (two hunters) reported that they discharged 20 shells and hit 10 geese, all of which remained airborne.

[d] Differs significantly ($P<0.05$) from comparable values with the same superscript.

Table 3. Mean range ± SE, in yards, at which Canada geese were shot at during testing of steel and lead shot shells, 22 November 1977 to 3 January 1978, Union County Public Hunting Area, Illinois. Sample sizes are in parentheses.

Fate of Geese	#2 Lead	BB Lead	#1 Steel	BB Steel	F
Knocked down	41.9±1.74 (41)	40.6±1.70 (47)	38.3±1.92 (48)	41.3±1.99 (35)	0.78 ns
Hit but remained airborne	49.5±2.75 (22)	49.5±1.69 (26)	45.2±2.12 (26)	52.9±4.05 (17)	1.48 ns
Not hit	53.6±2.37 (49)	55.5±1.70 (55)	51.2±3.42 (34)	48.4±2.05 (49)	1.96 ns
All of above	48.5±1.41 (112)	48.8±1.18 (128)	44.0±1.55 (108)	46.2±1.44 (101)	2.55 ns

Table 4. Frequency at which shot-at geese were knocked down during testing of steel and lead shot shells, 22 November 1977 to 3 January 1978, Union County Public Hunting Area, Illinois. Sample sizes are in parentheses.

Range (yards)	Percent Knocked Down			
	#2 Lead	BB Lead	#1 Steel	BB Steel
	FOR ALL GEESE SHOT AT			
≤30	64(14)	75(16)	64(22)	47(17)
31-40	47[a](30)	79[a](19)	52[a](31)	38[a](21)
41-50	32(31)	27(45)	45(29)	52(27)
≥51	22(37)	17(48)	19(26)	14(36)
All ranges	37(112)	37(128)	44(108)	35(101)
	FOR GEESE HIT			
≤30	90(10)	86(14)	78(18)	89(9)
31-40	64(22)	88(17)	76(21)	67(12)
41-50	63(16)	50(24)	54(24)	70(20)
≥51	53(15)	44(18)	45(11)	45(11)
All ranges	65(63)	64(73)	65(74)	67(52)

[a]The value for BB lead differed significantly ($P<0.05$) from the values for #1 steel, BB steel, and #2 lead.

Table 5. Evaluation of shot shells by hunters who took part in testing of steel and lead shot for hunting Canada geese, 22 November 1977 to 3 January 1978, Union County Public Hunting Area, Illinois. Sample sizes are in parentheses.

Response of Hunters	Tests With Observers				Tests Without Observers			
	#2 Lead	BB Lead	#1 Steel	BB Steel	#2 Lead	BB Lead	#1 Steel	BB Steel
Percent who rated shells as:								
Good	48	46	38	43	30	48[a,b]	18[a]	20[b]
Average	39	46	41	49	57	41[a]	64[a]	52
Poor	13	8	21	8	13	11[a]	18	28[a]
	(31)	(41)	(42)	(35)	(47)	(46)	(38)	(40)
Percent who thought they had used:								
Lead shot	47[a,b,c]	26[a]	17[b]	11[c]	31[a]	45[b,c]	16[b]	10[a,c]
Steel shot	19[a,b,c]	43[a]	50[b]	46[c]	22[a,b]	21[c,d]	53[a,c]	65[b,d]
Didn't know	34	31	33	43	47[a]	34	31	25[a]
	(32)	(42)	(42)	(37)	(51)	(47)	(38)	(40)

[a]Differs significantly ($P<0.05$) from comparable values with the same superscript.

[b]Differs significantly ($P<0.05$) from comparable values with the same superscript.

[c]Differs significantly ($P<0.05$) from comparable values with the same superscript.

[d]Differs significantly ($P<0.05$) from comparable values with the same superscript.