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EFFECTIVENESS OF SELECTED LEAD AND STEEL SHOT SHELLS FOR DISPATCHING CRIPPLED DUCKS

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ABSTRACT

The effectiveness of 7 different shot charges in 2¾-inch, 12-gauge shells in dispatching crippled ducks was evaluated in Illinois in 1978-1983. Hunters fired a total of 2,969 shells (mean distance 31 m) at 1,795 ducks. Dispatching rates for crippled ducks were 90-94% for steel #5, copper-coated lead #7½, and lead #8; 87% for lead #6 and steel #4; and 82-84% for lead #4 and steel #6. Collectively, the 3 steel shot loads were similar to the 4 lead shot loads in effectiveness for dispatching crippled ducks.

INTRODUCTION

Crippled birds — those hit with a charge of shot but not retrieved — are an undesirable aspect of waterfowl hunting, especially because relatively few recuperate in the wild (Bellrose 1953, Van Dyke 1981, Kirby et al. 1981). Crippling rates averaged 16.9% of all ducks knocked down (20.3 birds per 100 bagged) in the United States during the 1971-1984 hunting seasons (U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Admin. Rep. 1973-1985). Factors that influence crippling rates include species of waterfowl, type of habitat, use of a dog, competition among hunters, and the skill of the individual hunter (Bellrose 1953:338).

If hunters do not quickly dispatch (kill or incapacitate) crippled ducks that have been knocked down over aquatic habitats, cripples elude being reduced to possession by diving, hiding, and/or swimming away. In a survey of some 1,500 duck hunters in Illinois during the 1979 season (when lead shot accounted for 97% of the state's duck harvest), 79% used 2¾- or 3-inch, 12-gauge shells; 79% used unbuffered shot charges; and 97% used #6 or larger shot (49% used #4 and 26% used #6) (W. L. Anderson, unpublished data). However, 24% of all hunters surveyed used small shot (#9, #8, #7½) for dispatching cripples. These hunters believe that a charge of many small shot places more pellets in vital areas (head or neck) than conventional duck loads.

The mandatory use of nontoxic (steel) shot for waterfowl hunting on selected areas began in the Atlantic Flyway in 1976, in the Mississippi Flyway in 1977, and in the Central and Pacific flyways in 1978. Nontoxic shot will be required for all waterfowl hunting in the United States beginning in 1991 (U.S. Dep. Inter. 1986). Decisions regarding the seriousness of lead poisoning in waterfowl and whether to convert to nontoxic shot have not been made in Canada, Mexico, most of Europe, and elsewhere. Thus, this study was undertaken to evaluate the effectiveness of small shot sizes relative to large shot sizes and of steel shot relative to lead shot in dispatching crippled ducks in aquatic habitats. The ultimate goal is to reduce crippling losses associated with duck hunting.

METHODS AND MATERIALS

Twelve-gauge, 2¾-inch shotgun shells loaded with 7 different shot charges were used: 1⅛-oz lead #8 (Remington ShurShot), 1¼-oz copper-coated lead #7½ (Federal Premium), 1¼-oz lead #6 (Remington Express), 1¼-oz lead #4 (Winchester Super-X), 1⅛-oz steel #6 (Federal Hi-Power), 1⅛-oz steel #5 (Federal Hi-Power), and 1⅛-oz steel #4 (Remington Waterfowl). None of the shells was buffered. The copper-coated lead #7½, lead #6, and lead #4 shells were purchased from local retail dealers; the other shells were purchased directly from the manufacturers. Ballistic characteristics and patterning performances of these shells are summarized in Table 1.

For the most part, each of the 7 types of shells was tested during 2 consecutive years during the 6-year period, 1978-1983. Testing was conducted on public and private areas throughout Illinois by duck hunters from the Illinois Department of Conservation, the Illinois Natural History Survey, and private citizens. A diversity of habitats that varied from open "big" water to vegetation-choked marshes were represented.

Potential participants were contacted in September of each year to determine (1) whether they were willing to use the test shells (provided free) and to record data while duck hunting and (2) how many shells of each type they could reasonably use in 1 season. Participants were subsequently sent 10-25 shotgun shells of each type they had specified (78% were issued ≥2 types), standardized forms on which to record data, and printed instructions. The instructions stipulated that the test shells were to be used in the same manner as other shotgun shells for dispatching crippled ducks. Data were recorded by the hunters (a separate form for each bird) for species, number of shells fired, estimated distance (in yards) for each shell, and whether the ducks were successfully dispatched. The criteria for comparing the effectiveness of shells were (1) percentage dispatched of crippled ducks shot at and (2) number of ducks dispatched per 100 shells of each type fired.

The data were analyzed with computer facilities at the University of Illinois, Champaign. Differences among the shell types were tested for significance using the arcsine test (Sokal and Rohlf 1969:607).

RESULTS

During the 6-year study, 173 individual hunters (mean of 64 per year) were issued 15,685 shotgun shells: 1,360 lead #8, 3,040 copper-coated lead #7½, 2,605 lead #6, 2,130 lead #4, 2,125 steel #6, 2,250 steel #5, and 2,175 steel #4. Of the hunters, 116 (67%) generated usable data by firing 2,969 shells at 1,795 ducks. Mean distance to the ducks, as estimated by the hunters, was 31.0 ± 0.3 (SE) m. The ducks were 49% mallards (*Anas platyrhynchos*) and black ducks (*A. rubripes*), 28% other dabbling ducks (*Anas* spp. and *Aix sponsa*), 21% diving ducks (primarily *Aythya* spp. and *Bucephala* spp.), and 2% unidentified.

The percentage dispatched of crippled ducks shot at was highest for steel #5, copper-coated lead #7½, and lead #8, intermediate for lead #6 and steel #4, and lowest for lead #4 and steel #6 (Table 2). Except for lead #8 versus lead #4 and steel #4, all differences between the 3 highest and the 3 lowest percentages were significant ($P < 0.05$).

For the number of ducks dispatched per 100 shells fired, the steel #5, copper-coated lead #7½, and lead #8 exhibited the highest values, lead #6 and steel #4 were intermediate, and steel #6 and lead #4 had the lowest values (Table 2). Except for lead #8 versus steel #4, all differences between the 3 highest and the 3 lowest values were significant ($P < 0.05$).

DISCUSSION

This study was designed to test the relative effectiveness of 7 different shot charges in 2¾-inch, 12-gauge shells in dispatching crippled ducks. We did not, however, take into consideration crippled birds that were not searched for or dispatching attempts in which no shells were fired. Thus, our findings are not representative of retrieval rates for all ducks knocked down in aquatic habitats.

In addition, we did not have rigid control over the collection of data, as was the case in recent field tests of steel versus lead shot for waterfowl hunting (Mikula et al. 1977, Anderson and Sanderson 1979, Humburg et al. 1982, Hebert et al. 1984). In those tests, evaluation of the effectiveness of shotgun shells was complicated by the fact that the targets were frequently multiple and always in flight. According to Humburg et al. (1982:124), who worked in Missouri, data recorded by duck hunters was, on average, within 14% of data recorded by trained observers. In this test, hunters' versus observers' estimates of distances to ducks were similar at 27-37 m, significantly greater at < 27 m, and significantly less at >37 m (Humburg et al. 1982:124). In comparison, the process was simplified in our study — i.e., hunters attempted to hit single birds that were stationary or moving slowly on water. The hunters recorded the number of shells fired per attempt (67% involved 1 or 2 shells), whether the duck was dispatched, and estimated distances to the duck, the mean of which was 31.0 ± 0.3 (SE) m. Although our methods were something less than scientifically perfect, we submit that they produced useful data for attempting to reduce crippling losses associated with duck hunting.

Of the 7 types of shells tested, steel #5, copper-coated lead #7½, and lead #8 were the most effective in terms of the percentage of crippled ducks dispatched (Table 2). In terms of ducks dispatched per 100 shells fired, the steel #5, copper-coated lead #7½, and lead #8 also exhibited the best performances.

In countries where lead shot is permitted for waterfowl hunting, duck hunters should be encouraged to use shotgun shells loaded with small-size shot such as lead #7½ and lead #8 for dispatching cripples. These loads of small shot were more effective than the common duck loads consisting of lead #4 or #6 shot (Table 2). Indeed, significant ($P < 0.05$) positive correlations existed between the dispatching rates for crippled ducks that were shot at and the number of pellets in the pattern (Table 1) for the 4 lead shot loads: $r = 0.98$ (df = 2) at 27.4 m and $r = 0.96$ (df = 2) at 36.6 m. Thus, the lead shot loads can be ranked in order of effectiveness for dispatching crippled ducks: copper-coated lead #7½, lead #8, lead #6, and lead #4.

In countries where nontoxic shot is required, steel #5 shot is recommended for dispatching crippled ducks. This load was more effective than either the steel #6 or steel #4 shells (Table 2). Unlike the lead loads, no relationship was found between the number of pellets in the pattern and the effectiveness of the 3 steel shot shells for dispatching cripples. Compared with the 2 other steel shot loads, the steel #6 placed the most pellets in the 30-inch circle (Table 1) but was least effective for dispatching crippled ducks (Table 2). Because we cannot explain this apparent "anomaly" in the performance of the 3 steel shot shells, additional testing of various sizes of steel shot may be warranted. In the interim, the steel shot loads are ranked in order of effectiveness as follows: steel #5, steel #4, and steel #6.

For purposes of comparing lead versus steel shot for dispatching crippled ducks, data for the 4 lead shot loads may be combined in 1 group and data for the 3 steel shot loads in another. Dispatching rates for crippled ducks were 88.7% for lead loads and 88.0% for steel loads. Similarly, the number of cripples dispatched per 100 shells fired was 52.8 for the lead loads and 54.1 for the steel loads. These small differences between the lead and steel loads were not significant ($P > 0.05$), and we conclude that taken collectively effectiveness of the 3 steel shot loads was similar to that of the 4 lead shot loads.

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LITERATURE CITED

Anderson, W.L., and G.C. Sanderson. 1979. Effectiveness of steel shot in 3-inch, 12-gauge shells for hunting Canada geese. Wildl. Soc. Bull. 7:213-220.

Bellrose, F.C. 1953. A preliminary evaluation of cripple losses in waterfowl. Trans. N. Am. Wildl. Conf. 18:337-360.

Hebert, C.E., V.L. Wright, P.J. Zwank, J.D. Newsom, and R.L. Kasul. 1984. Hunter performance using steel and lead loads for hunting ducks in coastal Louisiana. J. Wildl. Manage. 48:388-398.

Humburg, D.D., S.L. Sheriff, P.H. Geissler, and T. Roster. 1982. Shotshell and shooter effectiveness: lead vs. steel shot for duck hunting. Wildl. Soc. Bull. 10:121-126.

Kirby, R.E., J.H. Riechman, and T.W. Schoenfelder. 1981. Recuperation from crippling in ducks. Wildl. Soc. Bull. 9:150-153.

Mikula, E.J., G.F. Martz, and L.A. Lyel. 1977. A comparison of lead and steel shot for waterfowl hunting. Wildl. Soc. Bull. 5:3-8.

Sokal, R.R., and F.S. Rohlf. 1969. Biometry: the principles and practice of statistics in biological research. W.H. Freeman and Co., San Francisco, Calif. 776 pp.

U.S. Department of the Interior. 1986. Final supplemental environmental impact statement; use of lead shot for hunting migratory birds in the United States. U.S. Fish and Wildl. Serv., Off. Mig. Bird Manage., Washington, D.C. 549 pp.

Van Dyke, F. 1981. Mortality in crippled mallards. J. Wildl. Manage. 45:444-453.

Table 1. Ballistic characteristics and patterning performance of 2¾-inch, 12-gauge shells tested for effectiveness in dispatching crippled ducks in aquatic habitats in Illinois, 1978-1983 hunting seasons.

Type and Size of Shot	Nominal Shot Charge (oz)	Pellets per Shell[b]	Nominal Velocity (fps)[c]	Number of Pellets in Pattern[a]	
				27.4 m (30 yards)	36.6 m (40 yards)
Lead #8(.090)[d]	1⅛	449	1,255	390 (86.9)[e]	241 (53.8)[e]
Lead #7½[f] (.095)	1¼	451	1,220	422 (93.6)	339 (75.2)
Lead #6 (.110)	1¼	286	1,330	234 (81.8)	159 (55.6)
Lead #4 (.130)	1¼	168	1,330	154 (91.7)	113 (67.3)
Steel #6 (.110)	1⅛	354	1,365	327 (92.4)	275 (77.7)
Steel #5 (.120)	1⅛	259	1,365	250 (96.5)	205 (79.2)
Steel #4 (.130)	1⅛	215	1,365	189 (87.9)	145 (67.4)

[a]Patterns were determined by firing 10 shells of each type at each distance and counting the number of pellets registering in a circle 30-inches in diameter drawn around the densest portion of the pattern. Pattern testing was conducted at Champaign, Illinois, in mean temperature of 22 C, at an elevation of 213 m, under no-wind conditions, and through a 30-inch full-choke barrel.

[b]Mean for 10 shells.

[c]Mean velocity (n=10) of each test shell was within current SAAMI (Sporting Arms and Ammunition Manufacturers' Institute) specifications, as tested by H.P. White Laboratory, Inc., Street, MD.

[d]Diameter in inches.

[e]Numbers within parentheses are percentages calculated by using the mean number of pellets registering inside the 30-inch circle divided by the mean number of pellets found in 10 shells of the type being tested.

[f]Copper-coated.

Table 2. Effectiveness of selected 2¾-inch, 12-gauge shells in dispatching crippled ducks in aquatic habitats in Illinois, 1978-1983 hunting seasons. Values followed by the same capital letters in the same column differ significantly ($P<0.05$).

Type and Size of Shot	Number of Shells Fired[a]	Crippled Ducks		
		Number Shot At	Percentage Dispatched	Number Dispatched per 100 Shells
Lead #8	253	160	90.0 A	56.9 AB
Lead #7½[b]	557	352	91.8 BCD	58.0 CDE
Lead #6	393	234	87.2 E	51.9 FG
Lead #4	379	197	83.8 BF	43.5 ACFHI
Steel #6	451	262	82.8 ACG	48.1 BDJ
Steel #5	440	289	93.8 EFGH	61.6 GHJK
Steel #4	496	301	87.0 DH	51.8 EIK

[a]Mean distance to the crippled ducks was 31.0 ±0.3 (SE) m (n = 2,329), as estimated by hunters who participated in the test.
[b]Copper-coated.