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Comparing the performance of lead and steel target shotgun loads

By Phil Bourjaily
and the Max McGraw Wildlife Foundation

Federal Premium supplied shotshells loaded to the same ballistic specifications. Half contained steel shot (left) and half contained lead, and each material required its own specific shot cup. The steel loads held about 80 pellets more than the lead loads due to steel's lower density.

Introduction

Several gun clubs in the United States require nontoxic ammunition for clay target shooting. Such requirements are likely to spread due to ongoing efforts to remove all forms of lead deposition from the environment. And despite a lack of conclusive evidence, some localities have used the specter of lead contamination as a reason to close gun clubs.

Thus, the availability of affordable, effective nontoxic target ammunition may prove soon important to the survival of clay target shooting in the United States. For proof, US shooters have only to look across the Atlantic to Great Britain, which in 2026 announced that lead shot would be banned for all shooting including hunting and clay targets effective April 1, 2029, and to countries such as Germany, where lead was banned long ago. For many reasons, steel pellets have been the most common replacement for lead shot.

Many shooters resist the idea of switching to nontoxic ammunition, with a few contending they would quit the sport if forced to shoot steel. They argue that steel shells cost more, provide sub-optimal performance and potentially could damage their gun barrels.

To address such concerns, the Max McGraw Wildlife Foundation of Dundee, Illinois, designed a study to test the effectiveness of steel target loads against lead. Although steel is not the only nontoxic pellet material, it is the only one comparable to lead in terms of cost, an important consideration for target shooters who fire thousands of rounds in a year.

The goal was not solely about performance. The study also was designed to see whether seasoned clay target competitors could determine any difference between the lead and steel shells.

Gun clubs across the United States increasingly are facing pressure to use nontoxic ammunition for clay target shooting, while in Europe several countries already either prohibit lead shot or are planning to do so.

The test

In September 2025 five volunteers participated in a five-station, 30-target blind test at Northbrook Sports Club in Hainesville, Illinois. Four of the shooters had achieved Master Class, the highest ranking bestowed by the National Sporting Clays Association, and the fifth was an experienced A Class competitor. Each shooter shot three pairs of targets at each of the five stations. The stations had been set at a tournament level of difficulty so Northbrook's members could practice for the upcoming NSCA nationals.

The test subject's guns were loaded for them, so they never knew whether they were shooting a lead or a steel load. The lead and steel loads were provided by Federal Premium. Both contained 1 1/8 oz. of shot with a velocity of 1,145 fps. The identical payload and speed ensured that the shells' recoil characteristics were as similar as possible. The shooters used their personal 12-gauge target over/under shotguns, choked as if they were entering a competition using lead.

The resulting scores showed that steel and lead performed almost identically. Even at longer distances, none of the shooters discerned a difference in the forward allowance required to break targets, nor in the admittedly subjective quality of their breaks. The recoil sensation was essentially identical, even though the lead load used a cushioned wad while the steel load contained a simple shot cup. The lone difference, according to one member of the test team, is that the burned powder smelled different. The steel loads did leave barrels slightly dirtier.

The targets were presented at ranges of 15 to 50 yards. While steel loads broke more targets than lead—66 hits to 61 overall—it should not be inferred that steel is superior to lead. In terms of pure ballistics, it is not.

But at normal ranges on challenging targets, steel shot was no handicap to any of the shooters. Nor did any of them have to change their shooting style, since they never knew which load they were shooting,

After shooting the five sporting clays stations, the shooters compared steel and lead loads on Northbrook's "practice grid," a series of traps set in the open, including

one perched 30 yards in the air on a cherry picker. On the grid, test-team members could step back and shoot at longer ranges than would be typically set in sporting competition. After several shots with both loads, the group reached a consensus that steel required more forward allowance than lead at ranges exceeding 60 yards, although they did break multiple targets with steel at those ranges.

For all practical purposes, there was no difference in performance between lead and steel at ranges up to 50 yards. Many of the test shooters said they would have no problems using steel if nontoxic shot were mandated for clay targets.

Additional testing

Test team member Tristan Stubbs returned to the practice grid armed with 1-ounce, 1,290 fps Kent loads of steel 7 shot. He broke clays at a laser-ranged 90 yards, although with lead he broke even longer targets.

The Kent loads' extra velocity compared to the Federal shells used in the blind test may have helped by shortening perceived leads and increasing target-breaking energy. Regardless, 90 yards far exceeds the distance of any target likely to be thrown in formal competition.

Anthony I. Matarese Jr., a two-time sporting clays world champion, agreed to shoot some of the 1-ounce, 1,290 fps 7 shot loads at M&M Hunting and Sporting Clays, his home course in Pennsville, New Jersey. Matarese, who shoots a similar lead shell in competition, said he perceived almost no difference between steel and lead out to 45 yards. At 50 to 55 yards, he did see the need for additional forward allowance. Subjectively, he thought the lead loads broke the clays more definitively.

The math would bear this out. A shooter firing No. 7½ lead at 1,300 fps would need 13 feet of forward allowance to break a 50 mph clay target crossing at 50 yards An equivalent steel shell with No. 7 shot would require 16 feet of lead. However, going up to No. 6 steel shot at the same speed would shrink the needed forward allowance by about a foot while also increasing striking energy at the target. Therefore, No. 6 shot may be a better choice for longer targets.

Specifications: Lead vs. steel

Steel and lead pellets have differing ballistics. Here is a comparison of one steel and one lead target load of identical payload and velocity.

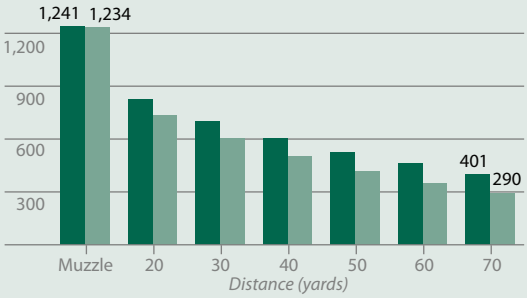
No. 7½ lead
1⅛ ounces
394 pellets

No. 7½ steel
1⅛ ounces
475 pellets

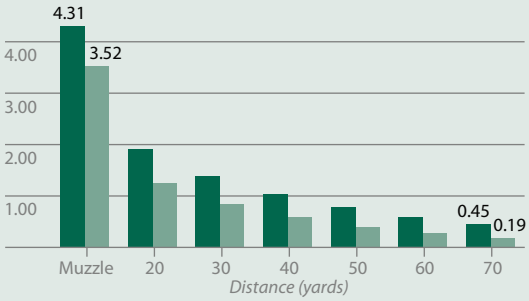
Recoil energy (foot-pounds, 8-lb. shotgun)

Recoil velocity (feet per second, 8-lb. shotgun)

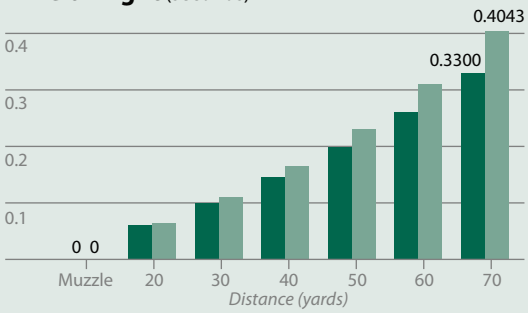
Pellet velocity (feet per second)



Average pellet energy (foot-pounds)



Time of flight (seconds)



Test team member Tristan Stubbs was able to break targets at a laser-measured 90 yards with an ounce of No. 7 steel shot.

Again, the takeaway from additional testing is that there is very little perceptible difference between steel and lead at practical ranges.

Barrel damage

The belief persists that steel shot ruins shotgun barrels. Steel, being much harder than lead, can score shotgun barrels. Hard steel shot also doesn't compress and "flow" through tight chokes as softer lead does, and it can damage the constricted portion of a gun barrel.

The ammunition industry long ago developed tougher shot cups to protect barrels. Almost every shotgun made since the 1980s has screw-in choke tubes designed with steel in mind, and practically all modern shotgun barrels are made of steel that can withstand the use of any currently manufactured shot.

Guns are most at risk for barrel damage if they have chokes tighter than Modified, and if the shells contain the large sizes of steel shot typically used for waterfowl hunting. Clay target loads containing 6 or 7 steel shot present much lower potential to harm a gun. If a gun has a Modified or more open choke, chances are good it can shoot steel without any problem. It is also possible to have guns retrofitted with steel-rated choke tubes, and there are steel-rated sub-gauge carrier sets available as well. Some very old guns, such as older double guns of the type used in "Vintager" shoots, may not be suitable for steel shot.

Implications for target setting

Steel presents challenges for target setters accustomed to setting courses for lead shot. Because steel has less energy at longer ranges and it relies on multiple hits to break a clay, targets from 45 to 60 yards should be set to show plenty of belly or dome to present a larger area for pellet strikes.

Second, because steel pellets are extremely hard, they present a greater danger of ricochets. Target setters must be careful to remove exposed rocks where rabbit targets are set to roll along the ground. Steel shot can bounce off trees as well, so setters should ensure there are no trees in the line of fire inside of about 30 yards.

Ballistics

Steel and lead shot behave differently due to differences in the materials. Lead shot, weighing 11.2 grams per cubic centimeter, is much denser than steel shot at 7.8 g/cc. Denser lead pellets retain velocity and energy better than steel pellets.

On the other hand, steel patterns efficiently because it is harder and unlike lead, does not deform under the stress of firing. Since steel shot is lighter than lead, there are more pellets of a given size in an ounce of steel than in an ounce of lead pellets.

Comparing the two Federal loads used in the McGraw test, the lead load of 1 1/8 ounces of 7 1/2 shot contained 394 pellets, compared to 475 pellets in the 1 1/8 loads of slightly larger steel 7 shot. In pattern testing, the steel loads patterned 10 percent tighter than the lead loads at distances between 20 and 40 yards. The denser patterns

Test team members (from left): John Butler, Tristan Stubbs, Thomas Lotus, Cody Jesse and Clifford Seibert.

of steel, combined with the higher number of pellets, suggest that in many cases steel loads put more pellets on target than lead, somewhat offsetting lead's higher retained energy.

At 40 yards, a lead 7½ pellet launched at 1,145 fps retains 1.03 foot/pounds of energy. At the same distance, the much lighter steel 7 pellet with the same muzzle velocity retains .58 ft/lbs. As for velocity, a lead 7½ launched at 1,145 fps travels 40 yards in 0.1460 seconds, while the steel 7 at the same initial velocity covers 40 yards in 0.1649 seconds.

The longer time of flight means that on a 50-mph crossing target at 40 yards, a shooter switching from lead to steel ammunition would have to increase forward allowance by 1.3 feet. In the testing, however, none of the shooters noticed any difference in forward allowance, perhaps because the shot pattern at that distance provides a wide margin for error.

Comparing pellet counts

	1 ounce	1⅛ oz
Lead 8	410	461
Lead 7½	350	394
Steel 7	422	475
Steel 6	315	354

In pattern testing, the steel loads patterned 10 percent tighter than the lead loads at all distances between 20 and 40 yards.

Another way to compensate for steel's lesser energy and velocity at longer ranges is to use larger pellets. The ammunition in the long-range individual comparisons conducted by Stubbs and Matarese contained one ounce of steel 7 shot driven at 1,290 fps. As previously

If steel shot becomes mandatory, targets should be thrown with more dome or belly facing the shooter, particularly at longer ranges.

noted, No. 6 steel shot—the largest currently allowed in clay target shooting—performs more like lead 7½ shot and may well prove more effective at longer distances. Shooters will have to pattern their guns with different chokes as they would with any load, but they should be able to find a steel equivalent to their chosen lead load.

The tests also suggest that steel shot loaded to moderate speeds is entirely adequate for targets and that the high-velocity steel loads sold by some manufacturers are unnecessary. Loading shells to speeds under 1,300 fps would mitigate long-held (and accurate) contentions that many steel target shells recoil too much for comfort, particularly in over/under shotguns.

Price

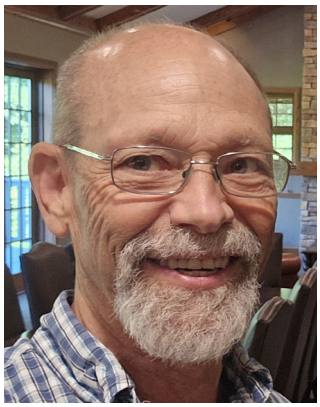
Opponents of steel shot have long cited the added price of ammunition as an argument against switching away from lead. In fact, there is often little or no difference in price between lead and steel. As of this writing in January of 2026, the online retailer Brownell's offered 12-gauge Winchester Super Target load of lead and steel at the identical price of $9.99 per box. The premium Winchester AA target loads in lead and steel sold for $12.99 per box.

Going forward

As of this writing in early 2026, ammunition manufacturers were experimenting with biodegradable shot cups and wads. As the technology improves, it is likely that more manufacturers will produce non-toxic loads with such wads. These hold the potential for eliminating or mitigating environmental concerns.

As demand for non-toxic loads increases, manufacturers would be well advised to develop more steel shells with moderate velocities and loaded with No. 6 shot as well as No. 7. Such a load may also prove useful for dove and quail hunters.

While most target shooters will likely shoot lead as long as possible, the results of this test should provide assurance that nontoxic shot requirements are not the death knell of shooting. If a club's options are to either shoot steel or shut down, they should rest assured that steel performs adequately for clay target games.



About the author

Phil Bourjaily is one of the nation's most respected authorities on shotguns and shooting. He serves as shotguns editor for *Field & Stream* and *Ducks Unlimited* magazines and shoots clays and hunts birds of all kinds as much as possible. He lives in eastern Iowa with his wife and a German shorthaired pointer.

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