Lead-Steel Questions

Bob Smith

Interviewer: Mike Smith

June 1977

Summary: Mike Smith from the Public Affairs Office in D.C. is talking to and asking questions to Bob Smith with Migratory Bird Management about lead shot verses steel shot. They talk about misconceptions of both, lead poisoning, costs, accuracy, manufacturing, and testing methods.

Keywords: Flyways, lead/steel shot, waterfowl, hunting, Patuxent, Bellrose study of 1959

Mike Smith:
I'm Mike Smith of the Public Affairs Office in Washington, and with me is Bob Smith of the Office of Migratory Bird Management. This is an informal tape, as you can see, and what we're going to be talking about here are types of questions that have been raised by sportsmen, by hunting groups regarding the steel shot question and implementation of steel shot in many areas along the Atlantic and this year in the Mississippi Flyway. Bob has been working on this project full-time since last fall, has been going out meeting with different conservation groups and sportsmen organizations, state agencies, and the like and fielding a wide variety of questions on lead shot and steel shot, and what he's prepared for me is a sample of some of the types of questions that have been most frequently asked, and Bob, you have some suggested answers for these. Now these answers that Bob is going to provide are suggested answers that you may want to use in dealing with various organizations. I don't think we can say that these are absolutely the last word in the answers to all these questions, but they're going to be, I think, very helpful recommendations.

Bob, the first question here, I'll be taking sort of the role of the questioner or the advocate or adversary or whatever, as the case may be. The first question, I thought steel shot zones would occur only in those areas where lead poisoning die-offs have been recorded. The zones described in this year's regulation include areas with no history of die-offs on a large scale. Why were these areas identified?

Bob Smith:
Well, there's a misconception here, I think, in the beginning that this problem only exists where it is visible or very conspicuous. The problem exists, as far as we can tell, everywhere that the hunters deposit lead pellets in waterfowl feeding areas. We have taken samples of gizzards, or various people have taken samples of gizzards, perhaps 50 to 60,000 gizzards have been opened and examined from hundreds of locations throughout the United States, including Alaska, and shot is being eaten in all of these locations. We've

never found a sample in which a portion of the birds did not have lead shot in their gizzards. So the problem is general and wide spread, the problem of eating lead pellets.

What we have done, in an effort to reduce this problem is focus on so-called hot spots or areas where lead ingestion rates are very high or the deposit of lead shot in feeding areas is very high, either or both. These two things are closely related of course. So if you rely solely on the concept that you have to have a die-off, I think you really miss the point of the problem of lead poisoning. It is widespread. Die-offs generally occur, incidentally, in one spot. I mean, visible die-offs occur where birds are subjected to some other kind of stress, such as starvation or even other diseases, and this is where the large concentration of birds in one spot occurs. Typically a lead poisoned bird will be quite different from a bird with a bacterial disease or viral disease. It won't be a bird that dies in a large group of birds that are dying. It will wander away. It's a kind of a chronic condition, and it takes quite a few days. The bird will gradually become paralyzed in the wings but still be able to swim, and almost invariably, it will isolate himself and die in heavy cover, which is quite different from fowl <unclear> or botulism, that type of disease.

Mike Smith:
Another question that's been asked quite a lot is regarding estimates that have been, the numerical estimates placed in the number of lead poisoned birds each year, and I think a sample question would run like this. There are two million deaths each year due to lead poisoning. How accurate is this estimate? Didn't Bellrose who made the estimate indicate that this was not justification for conversion to non-toxic shot?

Bob Smith:
In 1959 when Bellrose published that study, which was by far the most intensive study of the problem, it lasted for about five or six years, he did conclude that the losses were; and the magnitude of four to five percent of the mallard population in the Mississippi Flyaway was dying each year and two to three percent of the entire duck population in the United States would be

dying of lead poisoning each year, and this, at that time, that did not seem to him to warrant a major shift to another type of ammunition. Of course, you have to realize at that time, there was not another type of ammunition available. The initial tests of steel had taken place at that time, but it had caused quite a bit of marrow damage. So there really wasn't a viable option to lead at that point. So it was quite natural that he would conclude that since you didn't have an alternative that you would have to continue with lead. Since that time, of course, the development of steel shot as a viable alternative has come quite a ways over about a 20 year development period, and Bellrose, in 1975, I believe, made the statement that there should be a change at this point. It was obvious that the time had come.

Mike Smith:
Bob, could we get back to the very first part of that question regarding the two million deaths each year. Possible question is, is this just ducks or does that include geese as well? Is that a high estimate, a low estimate? Is it possible that, let's say, in any given year, like a severe winter like '77, the total number might approach three million?

Bob Smith:
Well, that was a duck estimate. Of course, at that time, I don't think Bellrose would have predicted the losses of geese from lead poisoning. He had no knowledge that this was a problem, and perhaps it wasn't a problem at that time. I think it has developed as a problem in recent years as the number of goose hunters has increased in certain locations. I'm not sure I follow your question.

Mike Smith:
I guess what I'm asking here is what I think might be a common question in a sportsmen's group meeting would be, how do you arrive at this 1.6 to 2.4 million number, and how accurate is it now?

Bob Smith:

I see. Well of course this is based on examination of, I believe about 36,000 gizzards by Bellrose and other cooperators at that time, and it was also based on about 90 dosing experiments that he conducted there at the Illinois Natural History Survey, which he varied the number of shot pellets and the diets of birds and that sort of thing to determine the toxicity of one pellet, two pellets, and so forth, and he did this primarily with mallards, but he used other species as well. Then in addition to that, he captured several thousand, it seems to me about 4,000 wild mallards, dosed half of them with lead pellets and released the others undosed and compared their recovery rates. The bad recovery rates of these birds, and this combination of all of these experiments and the gizzard analysis and the dosing experiments with wild birds and captive birds, he arrived at this estimate of two million. The estimate, my review of this situation is that his estimate was on the conservative side due to the fact that whenever he had a choice, whenever there was a choice of taking a conservative position or a more liberal position on the extent of the lead poisoning, he invariably took the conservative position. So the impression I have is that it is probably a minimal estimate.

Mike Smith:
I see. Moving on to another question which you've encountered rather frequently: Lead shot is only one source of lead in our environment. Auto exhaust places many tons of lead in the environment each year. How do we know that lead shot is the cause of lead poisoning in waterfowl?

Bob Smith:
Well, we've looked at that several different ways, experimentally, in the last few years. First, exploration of that subject probably occurred in 1972 and '73 when we examined lead in the wing bones of mostly immature mallards from about 25 states scattered throughout the United States, and we measured the amount of lead deposited in the wing bones of these birds. These were random samples from the kill in the state, and then we correlated those lead deposits in the bone with the amount of shot that was found in the gizzards in those states, and there was a significant correlation. In other

words, if the state had a record of fairly high levels of shots in their gizzards of their ducks, they also had a high level of lead in the bones. Now that study has been misinterpreted in many ways by people opposed to steel shot. They have tried to argue that we have used that to determine what the mortality to waterfowl has been due to the lead in the bones. Lead in the bone only measures the exposure to lead. It doesn't measure how many birds have died or are going to die or anything like that. In the study of that lead in the wing bones, it was clear that there was probably a background level of lead in these bones that was not related to shot, eating shot, so we tried experimentally to explore how much background lead you can feed to duck, you know, other than a shoot, a pellet, and build the lead levels in the bones, and this was done at Laurel, at Patuxent, and they fed diets of 25 parts per million just mixed in the food daily and 5 parts per million, and I believe there was one other, but in that range. These would be low level doses of lead just fed to the bird daily.

Mike Smith:
Things comparable they might would say lead in the atmosphere near an urban area.

Bob Smith:
Right, and they were unable to build the lead in the bones to anything like what we found in the wild duck population itself, which, we think, is strong evidence that the bird has to eat lead in large quantities to build the amount of lead that is in the bones of wild ducks. Also you realize that we used immature ducks for this work. In other words, the ducks we were measuring lead in the wing bone were not more than six or eight months old, any of those birds. So we're not dealing with birds that have had years to accumulate small doses each day. We were dealing with a rather brief life period.

Mike Smith:

Just out of curiosity, did they start exhibiting classic signs of, you know, field cases of lead poisoning and wasting of muscles and <unclear> and things like that.

Bob Smith:
When they're feeding low doses of lead?

Mike Smith:
Yeah, when they're fed the low doses.

Bob Smith:
No, the only thing they were able to detect was a change in the enzyme levels of one particular enzyme. Now this enzyme is related to hemoglobin production, and so it was obvious that they were tending to make these birds anemic by feeding them low doses, but during the course of the experiment, they did not build lead in their bodies to any extent and they maintained their weight and were healthy birds.

Mike Smith:
In other words, the field signs for lead poisoning would still be a pretty valid indicator then.

Bob Smith:
That a bird has eaten pellets, right.

Mike Smith:
Eaten pellets, yeah.

Bob Smith:
These birds are getting lead in quantities that requires that they eat in chunks, is the way I describe that.

Mike Smith:

Okay. This next question is one that, I'm sure, is probably one of the most common you've received. Steel has a specific gravity that is only about 70 percent that of lead. How can it compare with lead in killing waterfowl? Wouldn't it cripple more birds than lead? First of all, is that about the most common?

Bob Smith:
That's one of the very common statements that I receive. As a result of some rather distorted publicity they're getting from certain ammunition companies and other organizations. The number of tests, as I mentioned earlier, that steel shot was tested in the 1950's actually, it's not something new on the scene. It's been tested and tested and tested in almost every possible way that you can imagine to a shot shell, at least for its ballistic properties.

In summary, it's very difficult to summarize this in just a few words, but the ounce and a quarter of lead in the shot shell, the standard duck load is an ounce and a quarter and it occurs in number fours or number sixes and perhaps in number twos if you're shooting geese or even some people use twos for duck. The number four steel pellet has about the same down range energy as the number six lead pellet. The number two steel pellet has about the same down range energy, almost exactly the same down range energy as the number four lead pellet, and this is when you're comparing an ounce and an eighth load of steel with an ounce and a quarter load of lead. Now steel has some other advantages in addition to the fact that it could drop down one pellet size, increase pellet size one step, you get equivalent energy. There's more to it than that. The cushion that's in the rear of the lead shot shell, which is supposed to protect the lead from being deformed on setback, can be removed from the steel shell because the steel will not be deformed on setback, and so you gain space. So the number four steel pellet, there will be about 60 or 70 more of these in a steel shot shell than there would be in a number four lead shot shell, but there will be fewer than the number six lead.

So all this adds up to steel is almost but not quite, you see. It keeps coming out very close, but in addition to this, steel performs better when fired. It retains its spherical shape, which turned out to be a very important factor in shotgun ballistics. The steel delivers its energy more efficiently because of the fact that it's spherical. It maintains its patterns better, and it doesn't string out. It tends to maintain shorter shot strings. Shorter shot strings mean that you are more likely to miss a bird if it's crossing you than you would with lead, but it also means that if you hit it, you are very likely to kill it, whereas with lead, you can cripple. There are many compensating factors operating in this. It makes it, as I say, very difficult to explain in just a few sentences. Probably the simplest way to say this would be one of the very finest ballisticians that we have been able to locate, a man that worked for Winchester Western for years, his name is Ed Lowery, and he's recognized throughout the country as an expert in this matter, maybe the most outstanding expert, and he says that in his summary statements about this, that a person shooting an ounce and a quarter of lead and a person shooting an ounce and an eighth of steel will kill about the same number of ducks either way and they will cripple about the same number of ducks either way. If a person is a very good marksman, expert shot, he will kill more with steel. If he's a poor shot, he will miss more with steel because it has tighter patterns and shorter shot strings.

Now a confusing factor in all this is the magnum load of lead, which was tested at <unclear> by Winchester Western, and the magnum load is not a particularly popular load because it's a very expensive load. I don't know what percentage of the hunters use a magnum, but it would be less than 25 percent, maybe 10 or 15 percent, and the magnum lead load at an ounce and a quarter out-performed the ounce and a eighth of steel in the <unclear> test, and it will. It always will. It is a more lethal shotgun load than the ounce and an eighth of steel. There are other things you can say about that. For example, magnum loads are made of harder lead than standard loads, and they damage some chokes of shotguns. This has been documented. As I mentioned earlier, they're expensive. They cost almost the same as steel per box. Yes, it is possible to make a lead load that is more lethal than a

steel load, but your standard lead load and your standard steel load, their performance is so similar that we have trouble measuring the difference. Some tests, steel will out-perform lead and some tests, lead will out-perform steel, but they're always very close.

Mike Smith:
Okay, I guess this would be another fairly common question. Since steel is harder than lead, it will cause damage to shotgun barrels and even stress to the metal of the barrel, causing barrels to burst. What do we know about this?

Bob Smith:
Well, there's no doubt that we have the information from tests conducted by munition companies that certain shotguns, the choke is going to be opened up by steel shot. You can perhaps categorize three types of choke movement here. Well of course, the three types of shotguns, we'll say, when using steel shot. There are some shotguns that are not affected at all by steel shot. Of course, we're talking about the full choke barrel, here. We're really not talking about modified and improved cylinders. This is a problem that the full choke barrel has in certain guns. There are some shotguns that you can fire thousands of rounds through them, a full choke barrel, there'll be no choke movement at all. The Remington 870 was tested this way, and there was no movement, no measurable movement. There are other shotguns, probably the bulk of the shotguns being made in the last 15, 20 years will experience some choke movement in a full choke barrel, but it won't be detectable to the eye, and it won't affect the performance or the life of the gun in any way. Then there are other shotguns, most likely double barrel guns, because double barrel guns have thinner barrels, and then some of the older doubles have softer steel barrels, too, I think, and for some strange reason, doubles tend to be old. I don't know why that is, but some of the old guns and some of the doubles with thin barrels, you'll get choke expansion that's visible, and even in this case, it's sort of interesting, the tests indicate that you haven't necessarily changed the patterning performance of that gun all through its life, and this was really a surprise to me, because I think if you have visible

expansion of the choke, you would expect the pattern to fall apart. There are even some guns in those tests that patterned tighter after the choke was opened than they did before the choke was opened.

Mike Smith:
They get to a point where they start being more consistent. They're changed but consistent.

Bob Smith:
I think that, of course, you can also, you have to end up on this with a punch line that steel shot performs very well with modified chokes. It's a tight patterning pellet anyway. You really don't need a full choke barrel. This leaves you with several options. You can go to an adjustable choke or you could have your gun changed to a modified choke or buy another barrel. The only guns that I would really be seriously concerned about would be older guns that have some value, some monetary value, that begin to have, oh I guess you'd say an investment value, something like that. It'd be serious questions. If I had one of those guns, I would not use steel shot, I don't think, in that gun. But not because of safety problems. There's been no evidence and this was discussed at great length during the court case last fall, there's really no evidence that this is going to cause barrels to burst or be a safety problem to hunters or anything like that. The copies tell us there are about a thousand barrel bursts each year throughout the United States, and almost all cases, these are due to obstructions in the barrels, and this is with lead shot.

Mike Smith:
I was going to say, I know some hunters who just automatically have the mental image that if they use steel, they're going to have a burst, and you know, sort of a tree shaped blunder bust type barrel. I mean, that's, you know, that's a popular image that's going to have to be confronted, I think, with some people.

Bob Smith:

Most of them will not even detect a choke movement. If it occurs, it will not be visible, and as far as it being a safety hazard, there's just no evidence. We've had some barrel bursts with steel shot, but you've got to realize, we've fired about three million rounds of steel shot now, and these barrel bursts, as best we can tell, are all related to obstructed barrels, and they would be no different from the barrel bursts that occur with lead shot.

Mike Smith:
Good point. Another question, I have been told that steel is not the only substitute for lead shot. Is it true that other types of non-toxic shot have been developed?

Bob Smith:
Well, because the period from about beginning in 1960's, many, many types of shot were tested. Tin, lead alloys, disintegrating shot that would disintegrate in water, copper coatings, lead coated with nickel, nickel coated with lead, that sort of thing, steel coated with lead was tried. Most of the problems with some of these were related to their toxicity but also the cost. Copper is both slightly toxic, and in fact it's much more toxic than you think. It doesn't take much copper to become toxic, but probably the most serious problem with copper is its cost. It's become like a semi-precious metal.

Mike Smith:
Almost like gold, which would have a very good weight.

Bob Smith:
But a few years ago, the Canadians began to explore mixing a shot, a mixture of lead and steel, and there's been some tests run on this for toxicity, and if the lead content of these pellets does not exceed about 35, 40 percent, it greatly reduces the toxicity of the pellet. In fact, you would expect a pellet that's 40 percent lead to be 40 percent as toxic as a lead pellet. It's not like that. It's much less toxic than that. They still show some toxicity, but it's very promising in terms of toxicity.

Mike Smith:
And the likelihood of a bird being able to pass it through its system unharmed would be increased?

Bob Smith:
Greatly increased, but the problem with that shot is that it's apparently, well we don't know, because we have left the door wide open for any company that wants to apply for a non-toxic shot, and we have explained in the regulations how they do that, and we have never received an application for any other shot. I think the problem with the mixture shot, for example, is not in its toxicity. It's in its cost of production and method of production. The shot that we tested for toxicity varied in the amount of lead contained in each pellet all over the place, which means they really haven't, at that time they had not perfected a way to control the mixture in the manufacture of it. This would mean that pellets would not have the same specific gravity. In other words, individual pellets in the load would vary considerably in their weight, which would have all sorts of ballistics problems. So you've got cost problems, ballistics problems, but toxicity is very promising.

Mike Smith:
Okay, the price of steel shot shells runs two to three dollars a box more than standard lead loads. Is this price difference going to continue?

Bob Smith:
Well, I wish I knew. I wish I had a good crystal ball on that one. It's apparent that the cost of lead shot shells is increasing. I'm told by one company that the cost of raw lead increased quite a bit between last year and this year's production of lead shot shells. It would seem almost inevitable as the volume of a particular shot shell increases, its price goes down. This is just a law of supply and production.

Mike Smith:
The basic material is so-called soft steel, is not that much more expensive.

Bob Smith:
No, the basic material would probably run, per box of shells, maybe a dollar and a quarter more. We're talking about differences of two and three dollars now. The difference in that is probably due to production, initial production costs and volume. As I mentioned, for example, the magnum lead load is quite expensive because it's a low volume item, you see. So you have two things happening here. One is the price of lead shot shells probably will gradually creep up toward the price of steel shot, whereas the price of steel shot should go down a little. They'll get closer together. I'm not sure how much cheaper steel shot will actually be, you know, in the final result of that.

Mike Smith:
Okay. Today steel shot is available only in factory loads of 12 gauge. When will I be able to buy steel shot in other gauges and purchase components for hand loading steel shot?

Bob Smith:
Well, again this is out of the control of the Fish and Wildlife Service. We have no authority to dictate what gauges will be produced and distributed. We can regulate what hunters most use, but if you're not careful, we can regulate something that won't happen, and then the hunter is caught in a bind, so this is a very difficult thing to kind of do it year by year, but there's no theoretical reason that other gauges cannot be produced. There is no theoretical reason that I'm aware of that other gauges can't be produced, at least, and I have seen results of tests which would support that, that they are just as capable of killing ducks, relative to their lead counterpart, you know, as 12 gauge. I think that companies are reluctant to go into the production of these less popular gauges until you've gone far enough with the steel shot program to create a real demand. In other words, a production demand. That's part of the problem.

Now as far as the hand loading is concerned, there is obviously no reason that if you can factory load a shell, then you can hand load it. That seems self-evident. If you have the powders and the wads and the pellets to factory

load, then you can hand load. This seems to be simply a matter of the companies making this decision to package these components and make them available to the hunters. We have requested that they do this. We have requested that they make 20 and 16 gauge available. They have been reluctant to do that.

Mike Smith:
Perhaps somewhere down the road, marketing pressures will make it lucrative to them to do so.