How Good Are Copper Bullets, really???

by

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This project started with the purchase of a new rifle in 270 Winchester caliber. Since I had no ammunition in this caliber on hand, I decided to handload copper bullets to better familiarize myself with them.

I hesitate to admit that it has been only recently that I have educated myself with the published articles that clearly show that upland game are being impacted by the deposition of lead from hunter's cartridges and shells. I was embarrassed to admit, even to myself, that as a practicing wildlife biologist I let this part of my professional knowledge lapse. As the foremost stewards of the resource — and I believe that to be sport hunters — we ought to be doing better.

Recently, there has been a surge of activity regarding lead particles in game from hunter-shot animals and the consumption of that meat with resulting human health concerns. No, a direct correlation has not been made between game consumption and human lead poisoning, but the corollary facts are there, so who wants to take a chance!!

Thirty-eight years ago, about the time I was starting my career, lead poisoning in waterfowl was the issue of the day. I am proud that the Wisconsin Department of Natural Resources took a leadership position in outlawing lead shot use in waterfowl hunting. Yes there was resistance, but there also was active dialog and training conducted with hunters by the agency. The hunting community came around, as they always do, with what's best for the resource. This ethic is what makes Wisconsin sportspersons what they are. As public stewards, we did this even though the non-lead shot at the time was a pretty "crappy" choice.

It is now time to address the other hunting aspects that still employ lead. With shot shells it is easy; there are excellent substitutes for lead and many hunters are using non-lead exclusively. For rifles, there is a good choice, copper, and time will show it to be as good or better than all the various incantations of lead bullets.

So, with this paper I have enlightened myself about just how good copper bullets really are. Phil Lehman jumped on board to help me and we had lots of fun, but not without trials and tribulations, putting this together.

I hope this information is helpful to you.

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This investigation will evaluate accuracy and performance of non-lead centerfire rifle bullets in sporting and suppressed rifles. The WI DNR Savage rifles in 308 Winchester were used in this evaluation with commercial ammunition. Pre-testing of the methodology, and specialized handloads to simulate extreme situations were tested using a 270 Winchester Browning X-bolt and that data also will be presented.

A secondary component of this investigation will develop an easy hands on way for hunters to evaluate non-lead hunting ammunition performance and to compare it with centerfire lead ammunition.

The following commercial and handloaded ammunition was used in this study:

270 Winchester [with 22 inch sporter rifle barrel]

Hornady Guilding Metal eXpanding (GMX), 130 gr.
(handloaded) *Barnes* Tipped Triple Shock X bullets (TTSX), 130 gr.
(handloaded) *Barnes* Maximum Range eXpanding bullets (MRX), 130 gr.
(handloaded) *Hornady* Guilding Metal eXpanding bullets (GMX), 130 gr.

308 Winchester [with 18 inch bull target barrel, with and without suppressor]

Hornady Guilding Metal eXpanding (GMX) *Superformance*, 150 gr.
Barnes Triple Shot X bullet (TSX), 150 gr
CorBon using the *Barnes* Multi Purpose Green bullet (MPG), 140 gr.
Federal using *Nosler* Ballistic Tipped (lead) bullet, 150 gr.

Barnes has been making copper bullets for 20 years, thus they have worked out the technologies that others are just discovering. The Barnes TSX and TTSX bullets are 100% copper bullets that have a reputation with hunters as being an accurate, deeply penetrating, expanding round.

The Barnes MPG bullet is a fragible powdered metal copper-tin core inside a guilding metal jacket. This was developed for military purposes and references indicate that it would be a good round for urban animal control in that it will not ricochet or pass through a targeted animal.

Hornady GMX bullets are non-lead and made of guilding metal, which is a copper-zinc alloy (brass) that is about 90% copper. This is a new bullet available to hunters. Hornady has a consistent reputation with its products which is why it was added to this study.

The Nosler Ballistic Tipped bullet has been the choice of the agency for deer herd culling. It is accurate with an aggressive mushroom cavity. It quickly puts deer down. Unfortunately it is a lead core bullet and fragments in the wound channel abound.

ACCURACY

The current ammunition for the Department 308 Winchester rifles is the Federal Premium 150 grain round with the *Nosler* Ballistic Tip bullet. This has been an accurate round and it has proven itself in anchoring deer in culling activities. The Barnes TSX, TTSX and Hornady GMX rounds that we tested were every bit as accurate, both with and without a suppressor. They hold together in mushrooming, retaining all their weight, unlike lead core rounds. Five-round groups shot from a bench and utilizing a *"lead sled"* shooting platform easily gave groups of 1½" groups at 100 yards for both Barnes and Hornady loads.

308 Win TSX and GMX 5-shot groups, with & without the suppressor, at 100 yards!!

It surprised us that suppressed barrels had nearly the same velocities as unsuppressed barrels, and both were very accurate; Barnes TSX measured 2,688 fps, and the Hornady GMX 2806 fps, measured 10 feet in front of the muzzle. With both brands of ammunition, suppressed rounds always printed at 100 yards, 4-6" lower and slightly to the right. We hypothesize that the weight of the suppressor upsets the harmonics of the barrel at ignition causing the bullets to print lower. This was very consistent.

Hornady *superformance* ammunition with their recent 'rocket-science' powder development have their rounds achieving 100-200 fps faster with lower internal pressures than other brands. However, we could not detect a significant difference in accuracy, penetration, or expansion performance with these faster cartridges.

The 270 Winchester rounds tested were handloads using 130 gr Barnes TTSX or Hornady GMX bullets at about 3,100 fps.

Penetration and Expansion

We tested penetration and expansion in several media. Some tests were a real Torture for the bullet. It was our desire to examine performance at extreme conditions to judge just how good these non-lead bullets were. We used compressed phone books, water & phone books, water alone, *The Bullet Test Tube* ballistics media, and ballistics media & sheet aluminum to see if these non-lead bullets hold together, penetrate and expand.

Compacted phone books have long been used as a medium to test how well a bullet will penetrate and hold together.

To make this test even more drastic, a plastic gallon jug of water was placed in front of the phonebooks resulting in rapid expansion followed by tough penetration. Penetration would be much less, since the bullets rapidly mushroomed on the water and there now was more frontal resistance. If a bullet was going to rupture into fragments, it would do so with this test.

These TSX and GMX bullets held together, had similar penetration depths and mushrooming diameters at both 25 yards (where velocities were higher) and at 100 yards (where velocities were lower). Remarkable. Although lead bullets were not tested side-by-side in this study, the authors have done previous evaluations with conventional and bonded lead core bullets and on average none have performed as well as the TSX and GMX bullets.

Ballistics Media

The Bullet Test Tube

Ballistic media will show us the wound channel, depth of penetration and expansion. We intended to measure the volume of the cavity from each round. Because the Barnes and Hornady bullets penetrated so deeply, passing through 2 tubes of media with their expansion cavities it became impractical to gather this data. The exit holes were so large we could not practically plug them to get a volumetric measurement with the equipment we had on hand. Lead core bullets usually only have an expansion cavity in one tube of media, although they may penetrate into the second tube, which is much easier to measure.

Using ballistic media is labor intensive, but it has merit in visually showing more aspects of bullet performance.

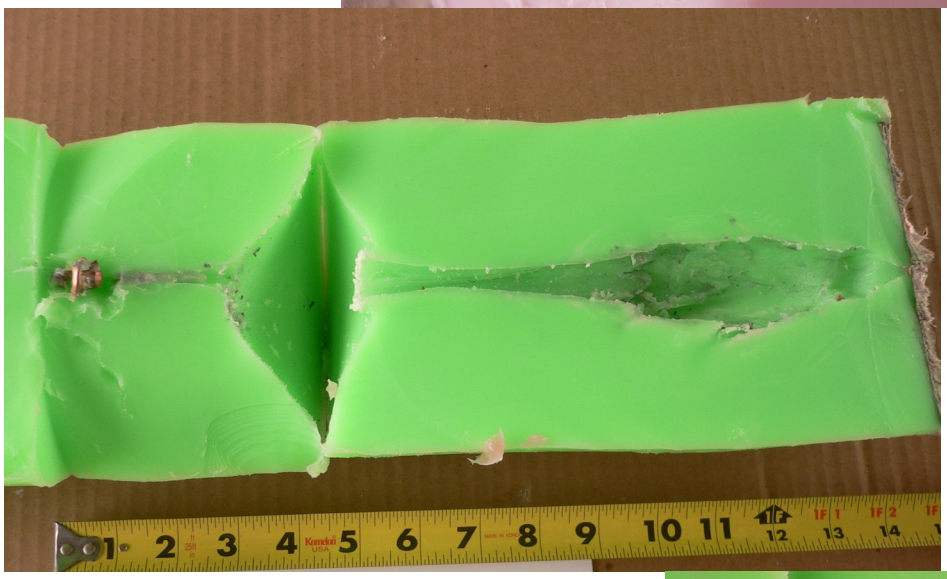
We did experience day-to-day variances in the performance of the ballistics media, probably due to the above average temperatures and humidity in July and August when this data was collected.

This is a 308 Win caliber Barnes 150 gr TSX bullet that penetrated 15” of the media.

This is a close up of the bullet, 100% weight retention and a perfect mushroom.

Hornady GMX 308 Win bullet, also with 15 inches of penetration.

Notice the 6 petals on the GMX bullet; there are 4 petals on the TSX bullets



150 gr Nosler Ballistic Tip in 308 Win. The dark shading in the cavity is lead particles and lead dust.

All that is left of the Ballistic Tip bullet is the copper jacket. The lead core has separated from the bullet and the remains are scattered in the wound cavity and beyond…..

This is the 308 Wincheste140 gr Barnes MPG bullet. At the time we collected this data we were concerned about the deep penetration of a fragible bullet. Thus we discontinued any further evaluation. This ammunition was expensive.

The 130 gr 270 Winchester GMX bullet cavity is on the top half of the picture and the TTSX bullet cavity is on the bottom. Bullet direction is right to left.

Take note the Barnes TTSX bullet appears to begin expansion immediately while the Hornady GMX penetrates some before expansion occurs. This was a consistent observation and will be examined further later in the paper.

Range was 25 yards and both bullets penetrated 14.5 inches. The flecks in the wound cavity are the plastic polycarbonate tips that help make the rounds more aerodynamic.

Velocity plays an important part in the mushrooming of the copper bullets. The higher the velocity the greater the expansion (mushrooming) of the bullet and the larger the wound cavity. We were able to demonstrate this by having the targets closer (higher velocity) and further away (lower velocity).

308 Win Bullets, 150 gr. Barnes TSX on the left were recovered from phonebooks at 100 yards and at 25 yards. Hornady GMX, 150 gr on the right were recovered at 100 yards and at 25 yards.

The shorter shanks and wider mushrooms at 25 yards are a result of higher velocities

The demonstrated ability of the copper bullets to have broad wound cavities and still hold their weight for deep penetration is why one often hears the manufacturers suggesting hunters pick "light-for-caliber" bullets in their big game cartridges. For example, the typical White-tailed deer load for the 270 Winchester is 130 grains when using the lead core bullets which slough their weight, including lead, when hitting the animal. With copper, there is no loss of weight, and even wider wound cavities with increased velocities, so a comparable choice is to use 110 gr bullets. The benefit to the shooter will be lighter recoil and thus more accurate shots.

With the 308 Winchester, the popular lead core bullet is 150 grains or larger. One can get better on-target performance by choosing a 130 or 110 grain copper bullet. An added benefit will be noticeable less recoil for the shooter.

Melting and recasting ballistics media is labor intensive and it makes a mess.

Will Copper Bullets Mushroom On White-tailed Deer Sized Game?

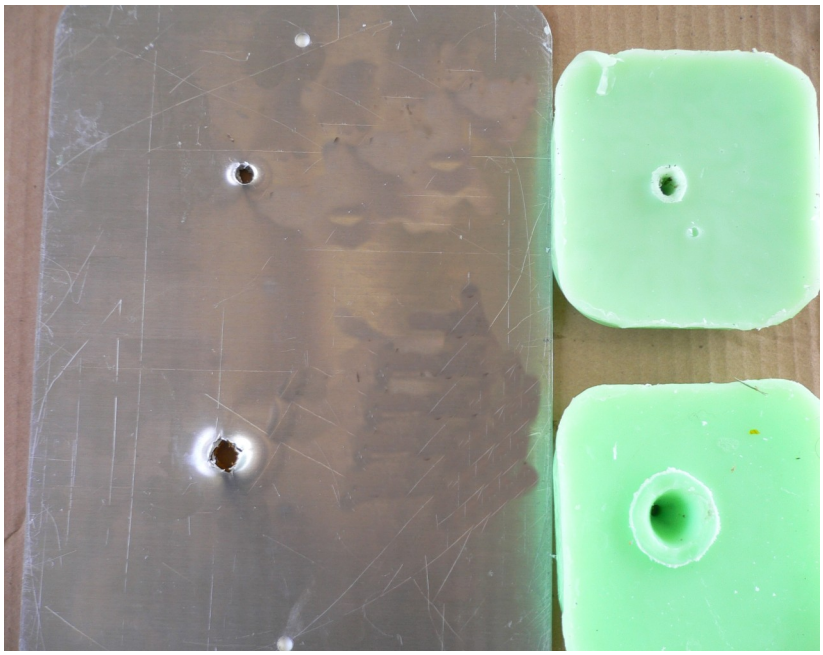
We witnessed the strong construction and deep penetrating aspects of these non-lead bullets. But will they deliver all that energy in thin skinned White-tailed deer sized animals?

Using very high-speed photography, the Barnes Bullets website shows their hunting bullets exiting an apple or tomato target and amazingly the bullets have already mushroomed. In our ballistics media, at 100 yards and 25 yards, we found the Hornady GMX bullets did not expand until they penetrated a short distance, where it appeared the Barnes bullets expanded immediately.

This led us to further test copper bullets to see how quickly they mushroomed. We shot low velocity rounds at about 1,800 fps through 1.5 inches of ballistics media and into a rigid barrier of 3/8" or 1/4" aluminum. The exit hole on the backside of the media and the aluminum should show the diameter of the passing bullet.

Attaching the ballistics media to the front side of the aluminum barrier.

Phil taking careful aim.



270 Winchester, 130 gr @ 1800 fps (reduced load) 1 1/2" media + **1/8" aluminum**

Top bullet is Hornady GMX. Bottom bullet is Barnes TTSX. Note the much larger exit holes with the TTSX which shows this bullet expands quickly, even at low velocities.

270 Winchester, 130 gr @ 1,800 fps (reduced load) 1 1/2" media + **1/4" aluminum**

Barnes TTSX is the top bullet. Note increased diameter of the hole, both in the media and the aluminum. Hornady GMX is the bottom bullet hole.

Water
as a
Bullet Collector

In discussing some of our methodology with the Barnes Bullet Company, we learned they often use water as the media to test bullet expansion. We started experimenting and discovered that 5 plastic milk jugs filled with water will capture a 308 or 270 bullet just fine at 25 yards. Eureka!! Compared to phone books and ballistics media, this was a godsend to this labor-poor investigative team.

308 Win 150 gr Barnes TSX (L) and 270 Win 130 gr Barnes TTSX (R) collected @ 25 yards. Bullets were recovered in the 5th milk jug.

Rain Barrel
Bullet Collector

When we were nearly complete conducting the data for this investigation, we happened upon the work of Jim Peterson and four other wildlife biologists in California and Arizona who developed a neat way to show hunters how lead core, including lead bonded bullets, scatter lead through out a carcass.

http://www.nps.gov/grca/naturescience/bullet_study.htm

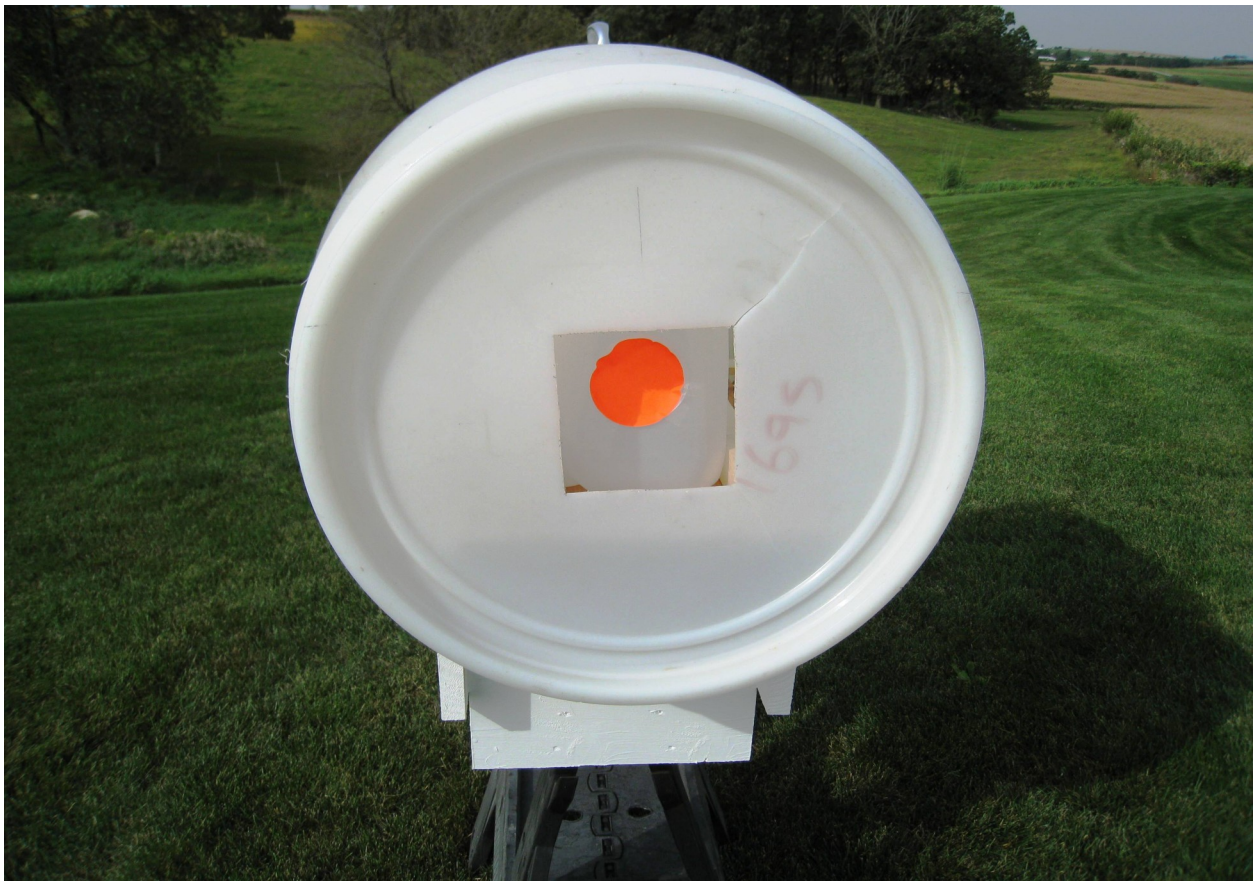
Their break through in practical and hands-on information transfer to hunters of lead versus copper bullets inspired us to develop "*a rain barrel recovery system*" too. We now have a practical tool to invite hunters to come shoot their ammo and see how it performs compared to copper bullets. The rain barrel quickly allows the users to collect the bullet fragments, including lead particles for comparison with copper bullets that they just shot.

A regular 'ole rain barrel fitted to a carpenters horse works just fine.

Here is a closer look at the internal parts of the rain barrel. The platform is necessary to hold the 5 or 6 1-gallon water filled milk jugs. When a bullet penetrates the jugs fragments are caught in the jugs or they flow with the dissipating water into the bottom of the barrel where they are easily collected.

This is quite dramatic and gives the shooter a clear picture of the "lead splatter."

Just slip the gallon jugs into the barrel and attach the front. Phil is the handy man of the team.



The rain barrel is now ready to enlighten many hunters about the performance of their deer hunting loads.

What Did We Learn

- Copper ammunition is accurate.
- Copper ammunition does not foul barrels. Rifle barrels don't need any unusual cleaning beyond what is done now with lead core bullets.
- Copper bullets hold together well and are not prone to fragmenting or breaking apart.
- Copper bullets are known for their deep penetration in game, so the entry and exit wounds will give a blood trail which helps in locating the deer carcass.
- One can use lighter weight bullets which will have less recoil in any given rifle.
- Copper bullets will expand at low velocities and high velocities.
- Copper bullets will not contaminate other animals, the environment, or my deer carcass with lead.
- Copper bullets are fun…..

Bullet Performance Data

Phone Books @ 100 yards					
Caliber	Bullet	Unfired Bullet Weight	Retained Bullet Weight	Mushroom Bullet Diameter	Penetration
.308	TSX	150 gr	149.6 gr	0.4870″	12″
.308	GMX	150 gr	149.3 gr	0.5058″	12″
.277	TTSX	130 gr	129.5 gr	0.4992″	11.5″
.277	GMX	130 gr	128.9 gr	0.4912	12″

Water + Phone Books @ 100 yards					
Caliber	Bullet	Unfired Bullet Weight	Retained Bullet Weight	Mushroom Bullet Diameter	Penetration
.308	TSX	150 gr	150 gr	0.5819″	3.5″
.308	GMX	150 gr	149.5 gr	0.5260″	4.5″
.277	TTSX	130 gr	129.2 gr	0.5380″	5.5″
.277	GMX	130 gr	128.5 gr	0.5140″	5.0″

The Bullet Test Tube media @ 100 yards					
Caliber	Bullet	Unfired Bullet Weight	Retained Bullet Weight	Mushroom Bullet Diameter	Penetration
.277	TTSX	130 gr	129.5 gr	0.5450″	19″
.277	GMX	130 gr	127.0 gr	0.5310″	18″

The Bullet Test Tube media @ 25 yards					
Caliber	Bullet	Unfired Bullet Weight	Retained Bullet Weight	Mushroom Bullet Diameter	Penetration
.308	TSX	150 gr	150 gr	0.5940″	15″
.308	GMX	150 gr	150 gr	0.5710″	15″
.308	MPG	140 gr	0	0	14″
.308	Nosler Ballistic Tip	150 gr	73 gr	Lead core & jacket sepa-ration	12″
.277	TTSX	130 gr	129.6 gr	0.5630″	14.5″
.277	GMX	130 gr	127.1 gr	0.5300″	14.5″

Exit Hole Diameter, 1 ½″ ballistics media + 1/8″ aluminum, reduced velocity @ 1,800 fps			
Caliber	Bullet	Unfired Bullet Weight	Exit Diameter
.277	TTSX	130 gr	0.553″
.277	GMX	130 gr	0.295″

Exit Hole Diameter, 1 ½″ ballistics media + 1/4″ aluminum, reduced velocity @ 1,800 fps			
Caliber	Bullet	Unfired Bullet Weight	Exit Diameter
.277	TTSX	130 gr	0.445″
.277	GMX	130 gr	0.295″