Terminal ballistics evaluation of the muzzleloading bullet vs modern hunting ammunition

There are many beliefs, disinformation surrounding the effect of the bullets fired by during the last centuries. There are many trying to guess how effective they may have been compared to today's modern hunting rifles. Every hunter has an opinion, but only a few have real experiences. We all know that, under 100 m, muzzleloading hunting rifles are capable of the same accuracy as modern rifles, and we know that any game can be taken with these arms. It's not a question for debate - our ancestors used these arms with great success for centuries.

I have been working on the legislation of muzzleloading hunting in my country for ten years now, and I have to say that only a very few hunters are against the project. I strongly believe that the values of this old hunting method are necessary to save the rich tradition of the real hunters. We received many questions about this project, and a great number of requests to demonstrate the wound ballistic effect of the heavy weight lead projectile of the muzzleloading era. I wanted to answer these questions in the easiest possible way, by comparing the effect of the blackpowder bullet to the effect of a well known modern hunting caliber, the 8x57 JRS:

How to use the data received from a ballistic gelatin test?

(Testing with ballistic gelatin allows many things to be examined). You can measure the penetration, the diameter of the impact wound and the cavity, the size of the temporary cavity (with high speed camera), the form of the permanent cavity, the deformity of the bullet, the straightness of the

8x57 JRS Norma
Alaska
.54 Plains
.535 roundball

patch of the bullet in the media and the infections entering the wound. There are professional recipes to simulate the density of animal flesh, but if you are not prepared to spend your life in the kitchen cooking stinking gelatin, there is an easier way. You can compare the result of a shot in gelatin to another different bullet effect. You will not get exact numbers from an experiment like this, but to determinate the effectiveness of a muzzleloading bullet the easiest way is to compare it to a modern hunting bullet, that we know from everyday use.

The recipe I used for the test does not simulate the substance of the flesh completely, so you cannot say that, if the bullet penetrated 50 cm in the gelatin, it will do the same in the body of the game. This is why we need a reference. I know that the 8x57 JRS penetrates both sides of all the big game (deer, roe deer, wild boar, mouflon) of my country within 100 m, and I know that it has more than enough killing power to take the game causing as little suffering as possible. To have a representative comparison it is not enough to shoot one with

Two 60 x15 x 15 cm gelatin blocks prepared for test shooting

the rifles, you need at least 3-5 shots to get an average you can use to evaluate the experiences.

The blocks used for both rifles must be of the same type of gelatin. The gelatin loses water when it is stored for a long time, so it is important that both blocks must be of the same age.

There is no need to test the bullet effect at point blank range. We have to simulate a real-life hunting distance, like 50-100 m, the true hunting range of the muzzleloaders.

The guns

For the comparison, I selected two well accepted rifles: a Krieghoff Hubertus 8x57 JRS single barrel hunting rifle, and a .54 caliber Pedersoli Flintlock Frontier rifle. Both guns are popular, common hunting rifles, nothing special about them, both can do the job they were designed for with excellence . The Frontier has a 990 mm barrel, with a 1:65” twist rate and 8 grooves. This rifling is basically designed for shooting roundballs, but it performs well with Maxi bullets and Plains bullets as well.

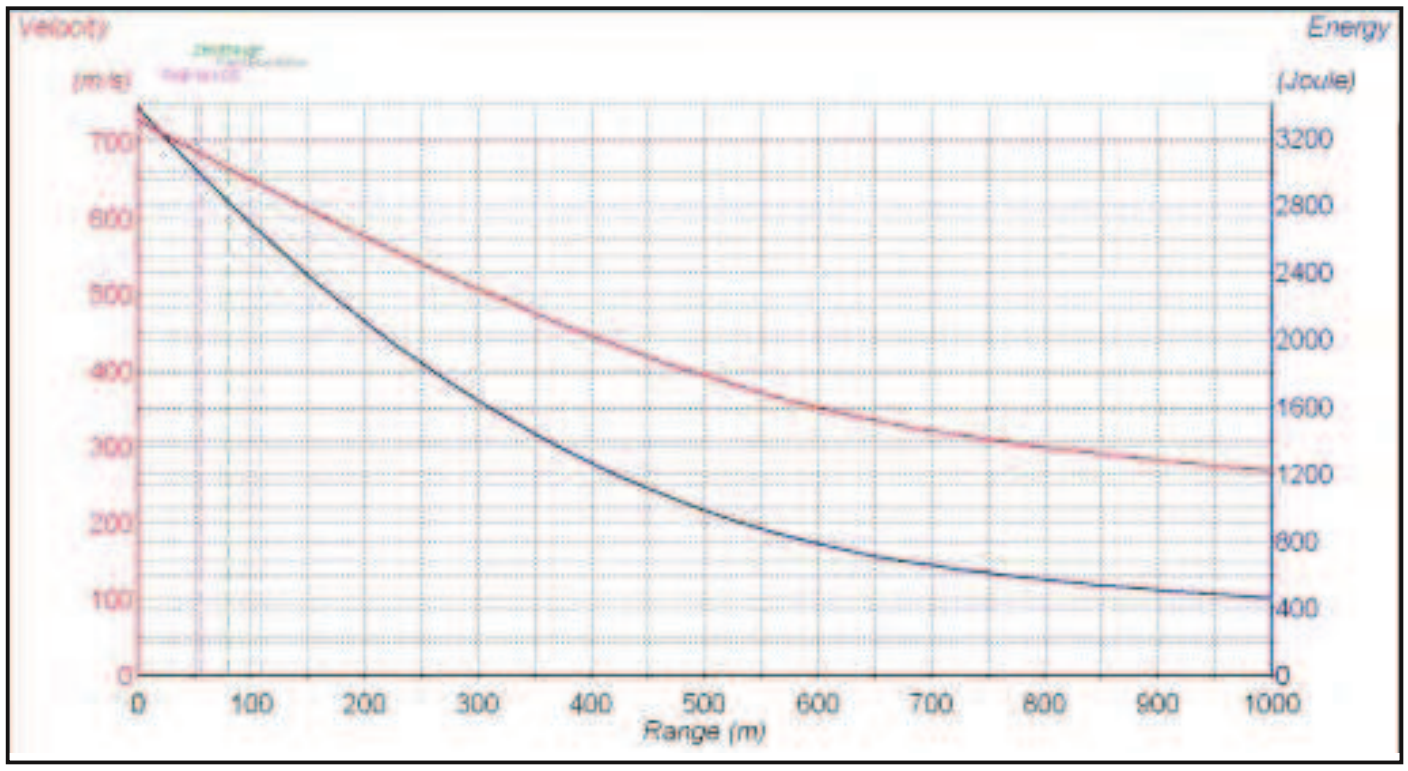
The bullets

I chose widely known and accepted bullets for the test. The ammo for the reference gun was a 8x57 JRS Alaska round from Norma. The bullet of this good quality cartridge is a traditional soft point bullet. Nothing special, but it does the job perfectly according to my experience. I took wild boar, roe deer, deer with this round, and no game escaped more than 20 m-s with a well placed shot. The muzzleloading rifle was fired with two bullets: a .535” roundball, and a modern hunting bullet, the .54 cal Lyman Plains bullet. I prefer this bullet because I find it more accurate in the Pedersoli barrels than the traditional Maxi Balls. However, it has one disadvantage compared to the Maxi: the grooves hold less lube, so fouling can be an issue if you shot more than five with your rifle, but this is not a problem if you use the gun for hunting.

The loads of the muzzleloading rifle

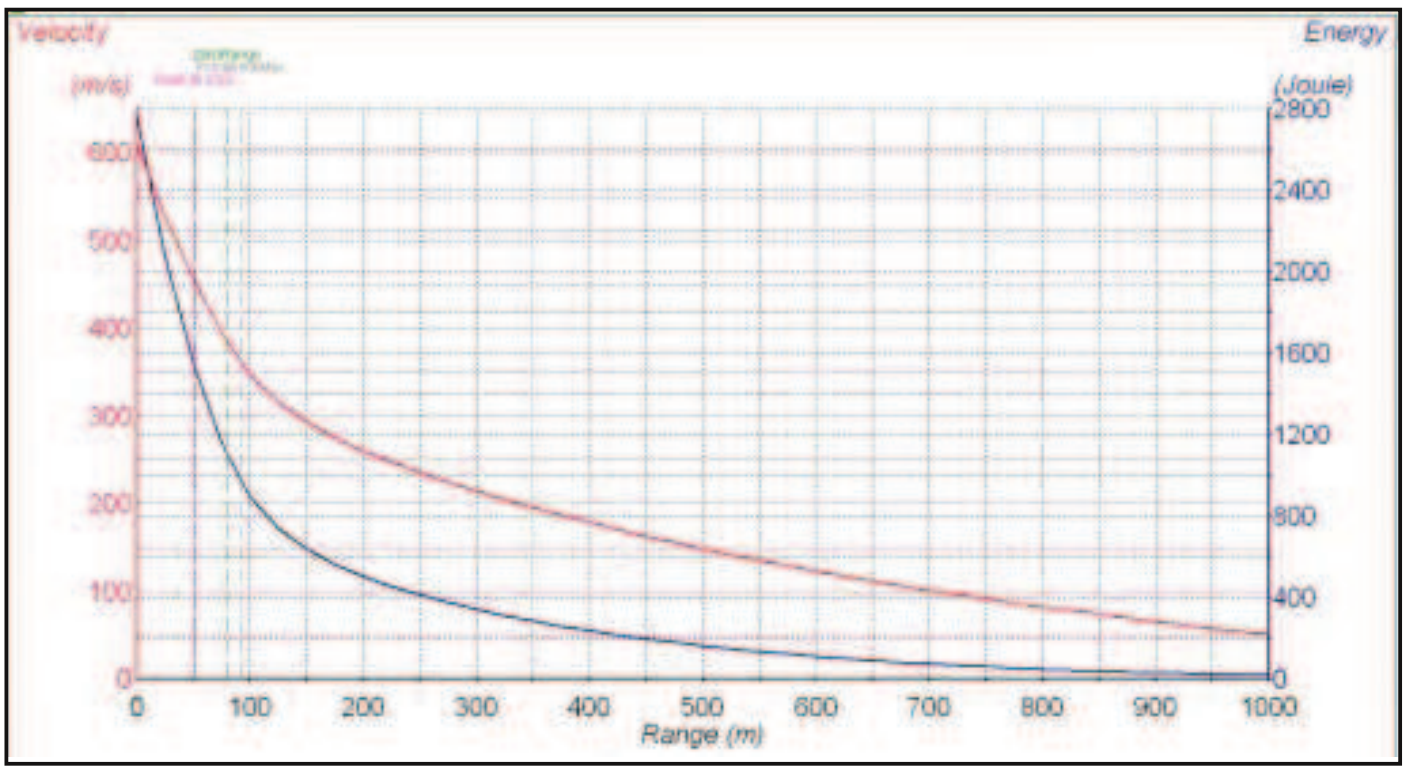
Hungarian hunting regulations determine the minimum muzzle energy for the game types. For roe deer the bullet must have a minimum of 1000 J, for deer and mouflon the bullet must have minimum 2500 J. We don't have energy regulations for the wild boar, but in my opinion it's better to be closer to the 2500 than the 1000 J. These energies are more than enough for a heavy weight muzzleloading bullet, but rules are rules, so I set the roundball load and the

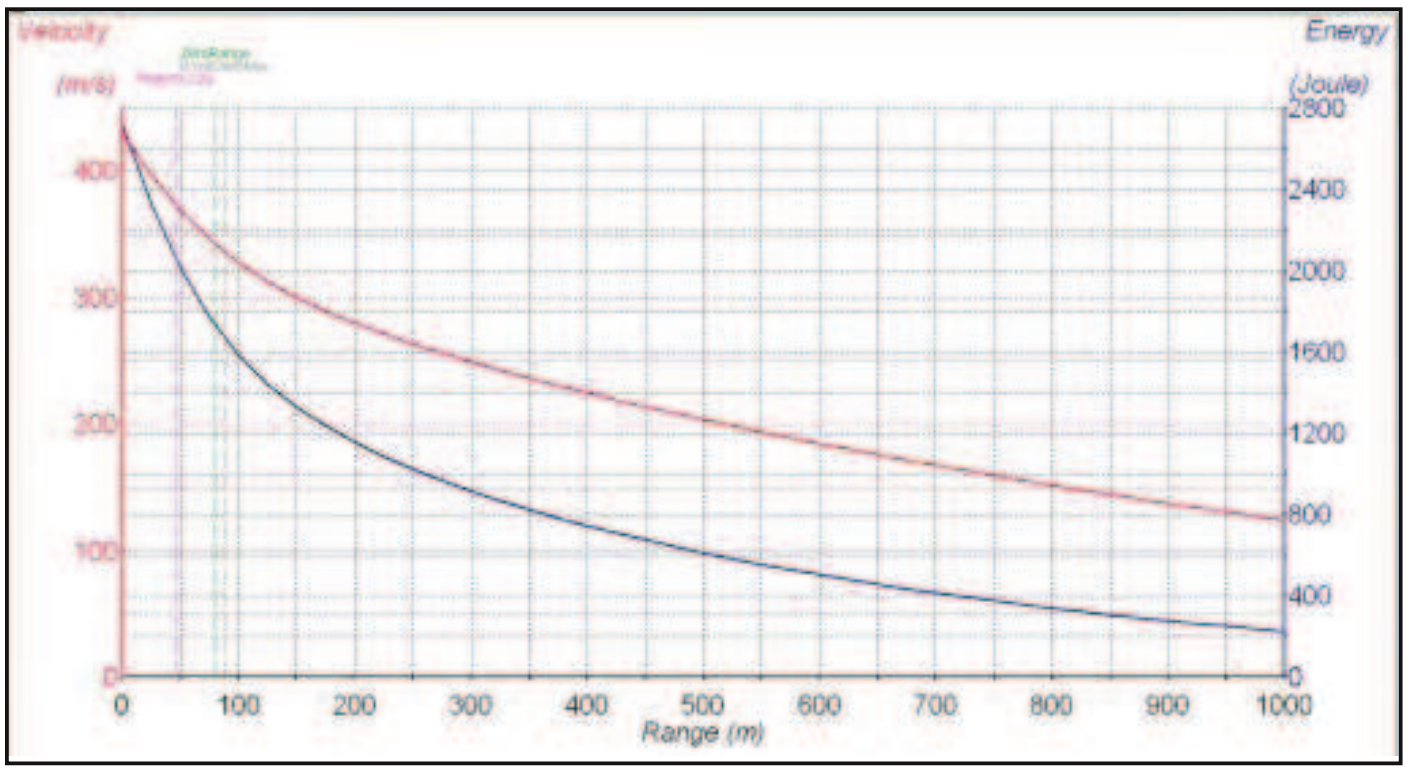
Bullets removed from the gelatin



Energy and velocity table of the Norma Alaska round

Energy and velocity table of the roundball

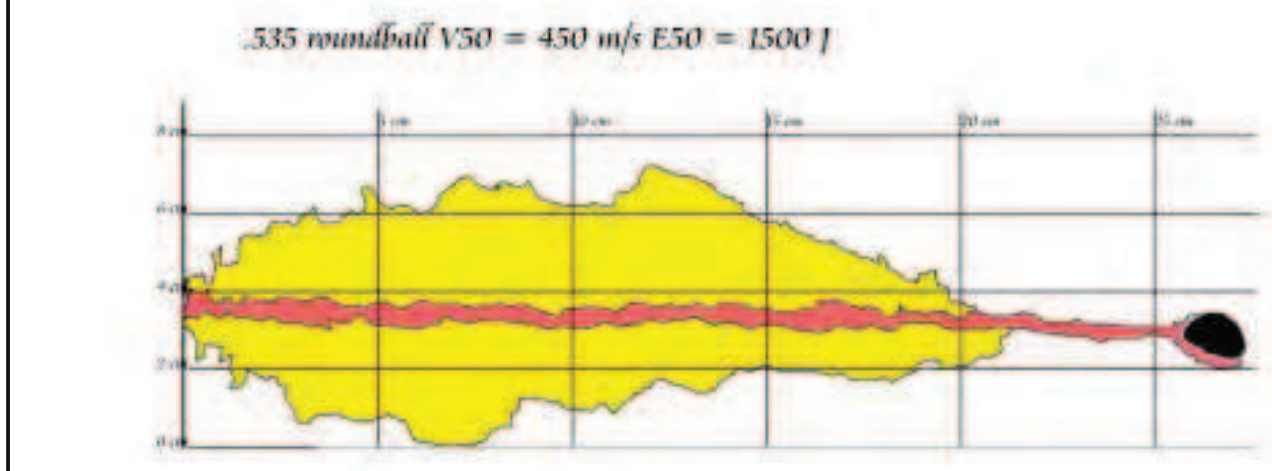


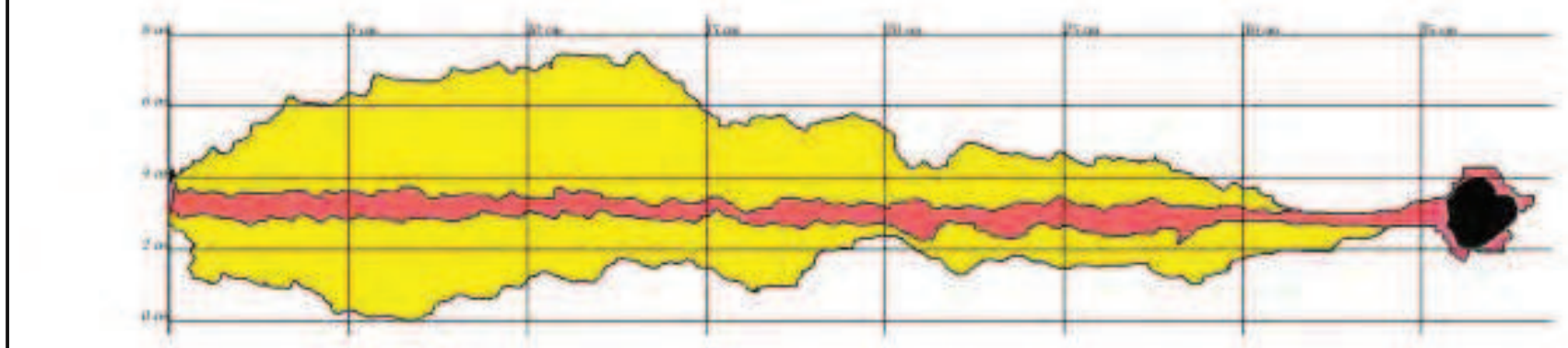


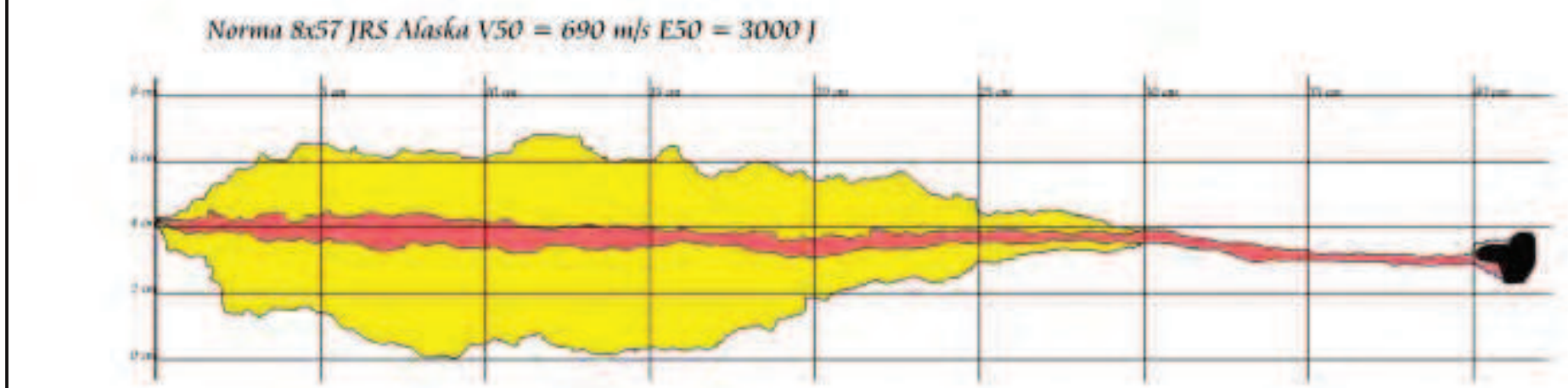
Energy and velocity table of the Plains bullet

conical bullet load to 2700 J, to securely go above the regulation level. I used 3Fg Swiss powder for the experiments, and Sellier & Bellot 4 mm caps.

Extracted bullets showed heavy expansion







The penetration

This part is the easiest to measure. The round ball passed average 27 cm into the media and became the bronze medalist of this game. Surprisingly the penetration of the Plains bullet and the 8x57 JRS was nearly the same. The Plains bullet passed 38 cm, while the Alaska bullet did only 4 cm more, 42 cm. The velocity of the Plains bullet at the point of impact was 370 m/s with 2000 J energy at 50 m, while it was 3000 J and

Clik the image for the video documentary:

690 m/s for the Alaska round. So with 50 % more energy it penetrated only 10 % deeper. This is surprising only if you skipped the physics classes of elementary school: the higher the speed of the bullet is, the stronger the effect of resistance will be when entering the media.

The damage to the surrounding tissue

The permanent cavity of the bullet shows two different effects in the media: first of all the bullet cuts a straight path as it goes through the gelatin (red area). Second, it damages the tissue as it transfers its energy to the surrounding flash (yellow area). This effect follows the the central wound like a wave. The size and density of this wave shows us the powder of the bullets.

The wave of the roundball was only 20 cm long, so it transferred its energy in a short path. The last 6-7 cm of the path of the ball was only a thin cut. The wave of the damage of the surrounding tissue causes 3-4 cm deep cracks starting from the central cavity. At the peak of the wave, there are 5-6 cracks like this. The effect of the Plains and Alaska bullet showed many similarities. Both the length of the wave (30-32 cm), the number and size of the cracks (8-10 3-4 cm deep cracks) were nearly identical.

The tests showed that the round ball transfers its energy faster than the conical bullets, but the penetration was much less, and the damage to the surrounding tissues was much less also. The deepness of the cracks was the same as with the Alaska and Plains bullets, but the number of cracks was significantly lower. The length of the damage wave of the Plains bullet was slightly greater than the Alaska bullet, but its penetration was shorter with a few centimeters. The two bullets are head to head in the competition, while the roundball is clearly the loser of the game.

However there is a factor that is not shown in these tests: the size of the temporary cavity. It is clear that this effect is stronger with the high speed Alaska bullet, but to check the exact difference, we need a high speed camera. I hope to test this later also.

The size of the impact wound

The size of the entrance wound was much bigger with the muzzleloading bullet, than with the modern Alaska bullet. The diameter of the roundball and Plains bullet was nearly identical (2-2,5 cm), while it was only 3-4 mm with the modern bullet. This is not surprising, as the nose of the muzzleloading bullets is more flat than the soft point bullet, and their diameter is much bigger also. Thanks to this effect, the bleeding at the impact caused by the muzzleloading bullet is much stronger.

Bullet deformity

In the case of deformity, soft lead bullets have a clear advantage: bigger diameter and softer material means better expanding capabilities. All three bullets showed good deformity during the tests. The Alaska bullet, with an original diameter of 8,2 mm became a nice mushroom, with a diameter of 16,8 mm. After the impact, it retained 93 % of its original weight. The 13,5 mm diameter round ball became 16,1 mm, while the 13,8 mm Plains became a 23,5 mm diameter nice big mushroom. The soft lead bullets did not use any of the original weight. These saltine tests however do not simulate the bullet hitting a bone.

The impact energies

The muzzleloading bullets lose their velocity and energy faster during their flight because of the unfavorable form compared to modern hunting bullets. The external ballistics of the roundball are inferior compared to any conical bullets. The .535 roundball starting with 2700 J of muzzle energy loses 1200 J when it reaches the target at 50 m, keeping only 1500 J of the original energy. This is the same value as the Alaska bullet, which hit the target at a distance of 330 m. The Plains bullet retains 2000 J at 50 m from the initial 2700, like the Alaska bullet at 220 m. The 220 m for the Alaska bullet is not a great distance, as this is the second point where the trajectory crosses the line of sight if the rifle is set to the 180 m GEE (Günstigste EnschießEntfernung) - and we all know that the 8x57 is capable of taking any European big game at this distance.

Summary

Muzzleloading bullets were used for hunting for centuries, and they are capable of taking any big European game today as well. But to use a muzzleloader effectively on the hunting fields, we must know the possibilities and limits of our loads. We have many choices like the caliber of the gun, weight and form of the projectile, type of powder, lubrication, etc.. so the responsibility is high. I suggest you keep some important rules to respect the ethics of hunting, and to minimalize the possibility of injury to the game and causing unnecessary suffering. First of all, do not use your muzzleloader above 100 m distances. The GEE distance of our bullets is much less than that of modern hunting bullets, as the muzzle velocity of our projectiles is lower, while they have inadequate ballistic form and a higher weight. In many hunting situations, you don't have time to adjust your sight to a higher distance. Our projectiles lose kinetic energy faster the modern bullets, but they certainly have enough killing power under 100 m. A .535” roundball starting with 2700 J energy has „only” 900 at 100 m. The flight time of our bullets is also longer because of the low velocities. So the game has more time to step into the shot. And we definitely don't want to injure the game, but to kill without causing suffering. The heavy weight conical bullet's terminal ballistic effect is comparable to the 8x57 JRS bullet's effect, so we can be sure that it is effective.

So pay attention to the distance. Know your rifle, know your load and make yourself an expert in shooting from the instinct, stalking, and judging distances. If you do so, you will realize that the slow reloading time and shorter distance is not really a disadvantage, it helps your hunting experiences.

NB

Plains vs 8x57JRS Alaska quick comparison

Advantages:	Bigger diameter impact wound
	There is no weight loss
Similarities:	Nearly identical penetration
	Nearly identical damage to the surrounding tissue
	Same diameter central cavity
	Similar expansion capabilities
Disadvantages:	Limits in shooting distance because of the curved trajectory
	Slow reloading