What's Wrong With .30 Caliber?

By: Bryan Litz

Introduction

In recent years, long range shooting has evolved in many ways. One of the major trends is towards smaller calibers. Calibers as small as 6mm, and even .224" are commonly being used in 600 and 1000 yard prone and Benchrest competition. In spite of the once common knowledge that 'bigger is better' for long range shooting, the 'benchmark' has shrunk from the big .30 cal magnums to the more moderate 6.5mm. Long range championships are being won with the tiny 6mmBR once thought underpowered for all but short range Benchrest competition. Why is this? Why is the once venerated .30 caliber loosing so much ground to the smaller calibers for long range shooting? Recoil, of course, plays a major role, but that's not all there is to it.

Applications and Assumptions

This analysis will focus on the external ballistic performance of small arms bullets, specifically for long range prone and benchrest target shooting as well as long range hunting and tactical applications[1]. In these applications, one of the most important measures of ballistic performance is wind drift. Therefore, the relative quality of bullet performance will be judged based on how resistant the round is to wind deflection.

In this article, the terms 'scale' and 'scaling' are used to in the context of 'scaling the size', not 'weighing on a scale'.

Bullet Weight and Scaling

The May 2007 Issue of Precision Shooting **[Ref1]** featured part one of a series authored by yours truly that focused on the effects of scaling bullets. The mass, Ballistic Coefficient (BC), stability, velocity, recoil and other effects were described. For this discussion, I would like to focus on bullet mass, and how it's affected by scaling between calibers.

It's a generally accepted fact that the heaviest bullet in a given caliber is the best bullet to use for long range target shooting. There are several credible studies on this topic, **[Ref2] [Ref3]** and it is one of the fundamental truths of long range ballistic performance. Assuming constant form factors (drag profiles) heavy bullets will have higher BC's than lighter bullets of the same caliber. Heavier bullets will also have lower muzzle velocities than lighter bullets, but *when loaded to the same pressure, the higher BC of the heavier bullet is more valuable than the higher muzzle velocity in terms of retained velocity and wind deflection at long range.* German Salazar put it aptly: "Muzzle velocity is a depreciating asset, not unlike a new car, but BC, like diamonds, is forever." For this reason, the present discussion focuses on the heaviest bullets available in each caliber.

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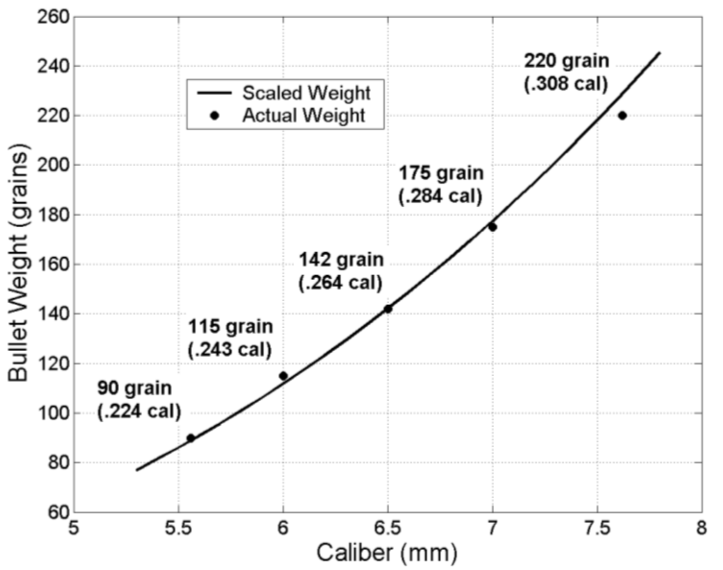
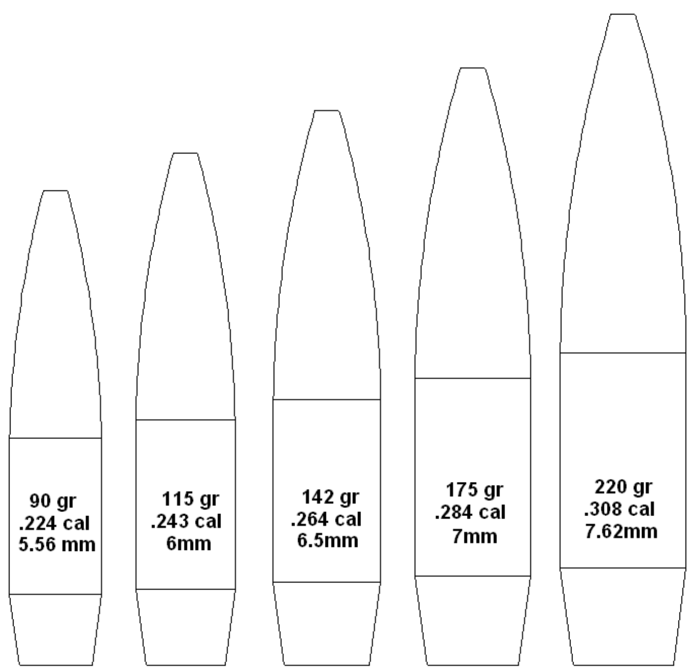
[1] Not all bullets used in the examples are recommended for hunting, but the trends apply to hunting bullets as well.

Scaled Weight Compared to Actual Weight



Predicted Weight scaled from 142 gr bullet				
89 gr	112 gr	142 gr	177 gr	229 gr



Weight of actual bullets (gr)				
90 gr	115 gr	142 gr	175 gr	220 gr

Figure 1. The true 'heavyweights' for various calibers.

Figure 1 shows how bullet weight is affected when you scale the well known 'heavyweight' 6.5mm 142 grain Sierra MatchKing bullet up and down in diameter. You can see that a 'heavyweight' .224" bullet is ~89 grains. Makes sense, as 90 grains is the heaviest .224" bullet available. The heavy 6mm bullet is 112 grains. Ok, we know that 115 grains is about the practical upper limit for that caliber, and there are several fine offerings from Berger and DTAC in this weight range. The 142 grain 6.5mm that was chosen as the basis of comparison is in good company. In that weight class, you have the Berger 140VLD, 140BT and 140 Short BT, the Sierra 142 MK, the Hornady 140 Amax, the Lapua 139 Scenar, and the 140 grain JLK. That's 7 legitimate 'heavyweight' bullets in 6.5mm. Move up to 7mm where the 'heavyweight' is supposed to be 177 grains, and you have the Berger 180 VLD, the Sierra 175 MK, and the JLK 180 VLD.

Now move up to .308 caliber. According to the established trend, a real 'heavyweight' .30 caliber bullet should weigh 229 grains. How many .30 cal bullets are that heavy? You've got the Sierra 220 and 240 grain MatchKings. Next heaviest things are the Sierra 210, Berger 210, Hornady 208, etc. So there are only two bullets, the Sierra 220 and 240 grain MatchKings that are even in the neighborhood of what a 'heavyweight' .30 caliber bullet should be. Let's take a look at the 240 grain MatchKing. This 'mamba-jamba' freight train of a bullet shares the same tangent ogive nose design as all of the .30 caliber MatchKings down to 155 grains. The ogive looks short and blunt on such a long bullet which affects the aerodynamics which will be the topic of the next section. The long bullet has other common problems as well, in particular, the excessive copper fouling caused by the long bearing surface. Prolonged success with the 240 grain MatchKing is intermittent at best, and experiences vary among those who've tried them in competition. At 11 grains over the trendline, maybe it's just a little too long.

The 220 grain MatchKing is only 9 grains below the trendline, which isn't so bad. As far as legitimate 'heavyweight' .30 caliber bullets, this is probably the best option available, yet it doesn't seem to be very popular.

I think part of the reason these heavy .30 cal bullets get overlooked is because many shooters think that a 185-190 grain bullet is 'heavy' for .30 caliber. In fact, a 190 grain .30 caliber bullet is somewhat of a 'middleweight'. To put it in *technical* perspective, a .30 caliber 190 grain bullet is proportional to a 150 grain 7mm bullet, 120 grain 6.5mm bullet, or a 95 grain 6mm bullet. The 155 grain bullet used in Palma competition is very much a 'lightweight' for .30 caliber. 155 grain bullets are used for international Palma competition because the rules specifically require it, not because 155 grains is the best weight for a .30 cal bullet at long range. Recently, some 155 grain bullets made by Berger and Sierra are designed with different, more aerodynamic profiles that help to compensate for being so light. The reduced drag helps them make up some ground compared to their conventional heavier counterparts, and introduces the next section of this article: aerodynamics.

History also plays an important role in the perception of 'proper' bullet weights for .30 caliber. As pointed out by Dr. K. C. Erikson in 1995 **[Ref5]**, and more recently by German Salazar, .30 caliber shooters used ~173 grain bullets as their standard for many decades before long range shooting became popular and the modern push towards really heavy bullets came about.

Aerodynamics

Ballistic Coefficient is comprised of three components: mass, cross sectional area, and drag **[Ref1]**. Mass was discussed in the previous section. The cross sectional area is related to the caliber of the bullet. The drag of the bullet, measured by the form factor, is a big part of the problem with .30 caliber bullets.

The aerodynamic drag which acts to slow a bullet down is related to how streamlined its profile is. Just like a Corvette has less wind resistance than a VW Bug, so a long sleek VLD with a boat-tail has less aerodynamic drag than a short, fat, flat based bullet. If two bullets have the same mass and diameter (same sectional density), the one with less drag will have the higher BC. The 'drag' part of the BC equation is quantified by the form factor. The form factor simply relates the drag of the bullet to the drag of some standard bullet. For this discussion, I'll refer to the G7 standard because it's more appropriate for long range bullets than the classic G1 standard **[Ref4]**. A bullet with a G7 form factor of 1.000 has exactly the same drag as the G7 standard projectile. A G7 form factor less than 1.000 means the bullet has *less drag* than the G7 standard, and a form factor greater than 1.0 means the bullet has *more drag* than the G7 standard. A bullets BC is simply its sectional density divided by its form factor.

Let’s take a look at some of the ‘heavyweight’ bullets in various calibers and see what their form factors are. Figure 2 shows the profiles of some popular heavyweights in 6mm, 6.5mm and 7mm along with their G7 form factors, sectional density, and G7 BC. The BC data presented in Figrure 2 was measured using a technique of proven accuracy and repeatability. The details of the BC testing are not important, it’s just important to note that these numbers were all measured in the same way, and were not obtained from the manufacturers **[Ref4]**.

So what do the numbers tell us? Well, the G7 form factors of the 6mm bullets are right around 1.0, which is pretty good. The form factors of the heavy 6.5mm and 7mm bullets are on average less than 0.95 which indicates extremely low drag. The G7 form factors of the more blunt .30 cal heavyweights are ~1.08 average. That’s about 13% higher drag than the 6.5mm and 7mm bullets. 13% more drag is a huge deal. It would mean 13% lower BC if the bullets had the same sectional density, but the heavy .30 caliber bullets have about 9% to 13% higher sectional density than the 7mm and 6.5mm bullets, respectively. The result is that the heavy, blunt .30 cal bullets have a BC that’s only marginally greater than the 6.5mm bullets, and about equal to the heavy 7mm bullets.

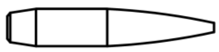
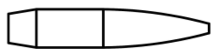
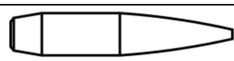
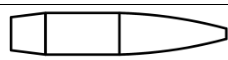
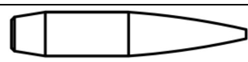
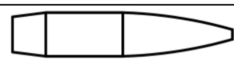
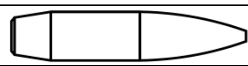
6mm		**i7**	**Sd** (lb/in^2)	**G7 BC** (lb/in^2)
115 VLD		**0.987**	0.278	0.282
115 DTAC		**1.007**	0.278	0.276
6.5mm				
140 VLD		**0.944**	0.287	0.304
142 SMK		**0.968**	0.291	0.301
7mm				
180 VLD		**0.946**	0.319	0.337
175 SMK		**0.948**	0.310	0.327
.308 Caliber				
220 SMK		**1.068**	0.331	0.310
240 SMK		**1.092**	0.361	0.332

Figure 2. Notice how blunt the heavy .30 cal bullets are compared to their smaller caliber ‘heavyweights’. The relative bluntness of the .30 cal bullets produces more drag, and hurts the BC.

One more thing to consider about aerodynamics is the effects of aftermarket bullet modifications, specifically, pointing. *Bullet pointing reduces drag more for smaller caliber bullets than for larger caliber bullets*. The reason is because nominal meplat diameters are *proportionally* larger on smaller bullets, so reducing them helps more. For example; a 0.065” diameter meplat is only 21% of .308 caliber, but it’s 27% of the 6mm caliber. Squeezing the meplat down to 0.040” makes it 13% of .308 caliber and 16% for 6mm caliber. The difference doesn’t seem like much, but there are two things to remember. First of all, the *area* of the tip is what’s important, and the area scales with the square of the diameter (meaning the smaller caliber has even more of an advantage than indicated by the above numbers). Second of all, the smaller bullets tend to operate at higher average speeds than the larger bullets. The reduction in wave (supersonic shock) drag is more significant for the smaller bullets traveling faster. Effects of bullet pointing are brought up because it's another variable in favor of smaller calibers. However, the rest of the discussion will go back to considering unmodified bullets.

A Closer Look at Recoil

I've mentioned recoil as a negative effect of the larger calibers, but the subject warrants a little more discussion. The following discussion is about recoil in general, and is not specific to the .30 caliber.

There are basically two different ways in which recoil is bad for accuracy and precision. The first is the effect it has on the mental state of the shooter, and their ability to deliver well executed shots. Many shooters develop a 'flinch' from anticipating the heavy recoil. This is a problem that affects shooters to various degrees, depending on mental discipline, physical size, etc. Heavy recoil also has a way of 'loosening up' a position, requiring the shooter to re-adjust periodically thru a string of fire. This seemingly minor inconvenience can prevent a shooter from shooting as fast as they would like. Speed can very often be of the essence, especially in Benchrest shooting where you don't have to wait for pit service.

The second aspect of heavy recoil is the effect it has on the rifle itself. The high pressure and heavy masses moving around tend to set the rifle in motion early (before the bullet exits the muzzle) more so than a smaller caliber shooting lighter faster bullets. German Salazar describes this as '*barrel movement during barrel time*'. It reasons that when shooting such heavy recoiling rifles with slow heavy bullets, that accuracy is much more sensitive to the quality of the shooters hold, trigger squeeze, and most importantly Natural Point of Aim (NPA).

To sum up: heavy recoiling rifles are harder to shoot accurately. Even if a shooter overcomes the mental aspect of heavy recoil, the 'system' is more sensitive to minor imperfections in shot execution. This may be another reason that drives .30 cal shooters down to the 'middleweight' 190 grain class bullets instead of the proportionally heavy 220-240 grain bullets.

Note; the above discussion on recoil is most pertinent to prone target shooting where the rifle has to be supported by the shooter. Benchrest shooters who use heavier rifles, supported by steady rests are not as subject to the '*barrel movement during barrel time'* gremlin as prone shooters, and may be why .30 caliber hasn't fallen out of favor for Benchrest as much as prone shooting in recent years.

Conclusions

The heaviest 7mm and .30 cal bullets have practically the same BC*, which means that given equal muzzle velocities, both will be deflected an equal amount in a given crosswind.*

However, consider the statement: "assuming equal muzzle velocities…". Even a moderate 7mm chambering is capable of delivering 2800 to 3000 fps with the heavy 7mm bullets, much faster with magnums. The heaviest .30 cal bullet requires a big magnum just to get to 2800 fps. So the first problem is: *you can't get the heavy .30 cal bullets going as fast as the heavy 7mm bullets!* Even if you could get the *same* muzzle velocities from the heavy .30 cal bullets, it would take much more powder to do it, barrel life would suffer, and you've only achieved parity with the 7mm. The various negative effects of the incredible recoil is really just the 'nail in the coffin' for the heavy .30 caliber bullets. If the available heavy .30 caliber bullets had lower drag profiles, they would have higher BC's, and wouldn't require equal muzzle velocities. Remember, when loaded to the same pressure, a bullet with a higher BC will have less wind deflection even though it starts at a lower muzzle velocity. But the truth of the currently available heavy .30 caliber bullets is; they don't have higher BC's than the heavy bullets in smaller calibers.

To answer the question posed by the title: What's wrong with .30 caliber? I offer the following explanations:

- Lack of legitimate 'heavyweight' (~230 grain class) .30 caliber bullets.
- The bullets that are in the 'heavyweight' class for .30 caliber have higher drag profiles than the heavy bullets in smaller calibers.
- Most .30 caliber long range shooters use 190 – 210 grain bullets, thinking that's 'heavy enough', when that's actually a 'middleweight' bullet for .30 caliber. These 'middleweight' bullets, even from .30 cal magnums, will tend to suffer more wind deflection (if only slightly) when compared to the 'heavyweight' 6.5mm and 7mm offerings.
- The energy (powder) required to propel a truly 'heavy' .30 caliber bullet to reasonable speeds produces recoil that's considered prohibitive for most applications, except maybe unlimited class Benchrest where rifles have no weight restriction.

Many people do very well with .30 caliber rifles at long range. I have to ask: are they doing well because of the caliber, or in spite of it?

Acknowledgment

I would like to thank German Salazar for his contributions to this article. In particular, the resources and advice provided on the historical perspective of .30 caliber match bullet development are critical to the understanding of this caliber today. Furthermore, an explanation of the recoil affects by someone who's shot a lot of 240 grain .30 cal bullets downrange was a valuable contribution.

References

[Ref1] Bryan Litz, "Understanding Long Range Bullets Part 1: The Nature of Scale" *Precision Shooting,* May 2007.

[Ref2] Geoffrey Kolbe, "Comments on Long Range Ballistics" *NRA Journal*, Spring 1996.

[Ref3] German Salazar, "A Long Range Shooter Looks at Heavy Bullets" www.6mmbr.com

[Ref4] Bryan Litz, "Ballistic Coefficient Testing of the Berger .308 155 Grain VLD" *Precision Shooting,* March 2008

[Ref5] Dr. K. C. Erikson, "The Evolution of the Match Bullet" *Precision Shooting Special 3 Vol. 1,* 1995