What Goes into Picking the Right Bullet

The Misconceptions with Lead Core Bullets (Cup and Core)

Starting out, I'll give an example scenario: let's say a skeptical hunter has been on the internet looking at others' experiences hunting and has seen many folks talk about their successes using match style "target" bullets on their hunts. He decides to give it a go himself and buys a box of Hornady ELDMs or Sierra TMKs (just as an example), works up a good load, and is ready to go out on a hunt. He has this beautiful buck come walking out at 280 yards, it's quartering heavily towards him, yet he aims in his usual spot (just behind the shoulder). He takes the shot, the buck leaps, then makes an attempt at running, gets about 5-10 yards, and then piles up. Upon getting to the animal, he discovers there's no exit wound. This has already raised a flag for him, as he has been raised to desire an exit to create a blood trail if tracking is required, which typically it has been in the past with the bullets he's used to using. So now he's already thinking this bullet hasn't really performed as he'd hoped or thought it should. Now he begins to field dress the buck, and during the process has discovered the bullet did a good number on the rear lobe of the left lung. He then sees multiple lacerations on the liver, then sees bits of rumen and evidence the bullet traveled into the guts. He's now even more convinced this bullet didn't perform well due to the mess he's seeing. He's found bits of jacket and bits of lead here and there in the cavity and tissues as well. He's concluded the bullet completely came apart and has deemed it failed as a result. He's just made the conclusion that he was right, these bullets have no place in hunting as they just "blow up" and don't even produce an exit wound so you can properly track it.

So let's stop and take a closer look at that example. Let's clear our minds and any bias based on what you might have been previously taught. In that particular scenario, a tougher constructed bullet, such as the highly popular Remington Core Lokts, Nosler Accubonds or Partitions, Hornady ELDX or SST, etc, etc might have actually performed much worse with that particular shot. They typically wouldn't have come apart quite as much and while the animal likely would still have died at some point, it also most likely would have been a much slower death and very likely would have run a long way before succumbing to its wounds and/or asphyxiation. Yes, an exit would have, could have, proved useful in that scenario. It's very possible any of those bullets would have simply gone through the rear of the lung and punched out between the liver, and in that scenario, a lot of times death doesn't occur for a long time.

Bullets such as Sierra TMKs, Hornady ELDMs or A-Tips, Bergers of the hybrid design, etc are actually very forgiving to less than ideal shot placements like in that example because they do indeed come apart and they'll inflict much more damage, create much wider wounding, and cause a much faster death. The softer/frangible bullets still tend to shed enough material outwards that they'll still hit liver and/or lung when shot placements aren't ideal and are in that "no man's land", and will typically still cause enough blood loss to find and recover the animal not far from where it was shot.

What a lot of people see when using bullets like the TMKs, Bergers, ELDMs, etc is what looks like the bullet came apart and didn't exit, and to them it seems like poor performance, but what they fail to realize and comprehend is what's right in front of them. They actually DO have the animal and they're actually able to cut it open to see those results, rather than still out there trying to find the animal.

When a bullet actually fails, you don't have an animal to examine, typically, so it's easy to make that misconception. The animals that get hit with shots like that and with bullets like Core Lokts, etc, and the animal simply takes off never to be found, is when most people think they simply missed. In reality, most times they do hit the animal, but the bullet did not transfer enough energy to drop it, nor create sufficient blood loss in a timely manner to cause a quick enough death to even see the animal ever drop.

A lot of hunters tend to only look at the deer/animals recovered and create a bias on the perceived results based solely on those instances. They don't factor in the ones that got away because they either figure they missed, or they simply never see the results to even know what really happened inside the animal and with that particular bullet. In my example, they see a bullet that came apart and want to assume that it's poor performance, even if the animal dropped on the spot or only went a few feet or yards. They tend to focus on things they've heard or have been told and only focus on the small picture rather than the big picture and what's right in front of them.

Many people want to conclude that a bullet that didn't exit failed. Honestly, if it truly failed, you wouldn't have the animal to even see that it didn't exit. More times than not, the true failures are the times the animal was never recovered because the bullet simply didn't inflict sufficient trauma to cause a quick enough death, or death at all. Bullets that create exits that allow for a blood trail, and a blood trail that's actually needed to track it, are also, in my opinion and experience, to be considered not ideal performance since needing to track it via a blood trail is a sign that death did not occur as fast as it could or should have. That said, no bullet is going to work 100% of the time, every time. There are always going to be anomalies with both the bullet, and the particular animal. Some animals are dead on their feet and can defy all odds and logic and still manage to run without having any of its vital organs still intact. It's truly remarkable sometimes. These situations shouldn't be cause for rejection either.

The Meat Saver

Moving on, another common misconception and misunderstood subject involves meat loss/damage and meat saving shots.

The amount of meat damage with certain shots will always depend on bullet construction/composition, impact velocity and amount of resistance, and things like angle of the shot, muscle tension and density upon impact. A relaxed shoulder will typically result in a different amount of wounding versus a contracted shoulder. Even the bullet's RPMs has a big influence on wound channel size as well, in regard to centrifugal forces causing the bullet to come apart more or less.

Besides headshots and gut shots, it's near impossible to get reliable and repeatable results- killing quickly and humanely (not talking ethics here)- without losing at least some meat. It's just the nature of the beast. Proper bullet selection is crucial. By placing your shot accordingly, based on that particular bullet and the impact velocity it'll be at when it hits the animal, and at the distance you engaged it, you can balance out the amount of expansion and penetration and achieve best results with minimal meat damage yet still achieve an emphatic death.

Hunters that desire a quick and clean kill with zero meat loss in a repeatable, consistent, and reliable manner are living in a fantasy world, sorry to say. Sure, you can get lucky, but getting lucky is not a repeatable, consistent, and reliable thing.

Blood loss is what kills most efficiently, reliably, and quickly. Hitting an animal in the body and inflicting enough blood loss to kill the animal quickly, but not lose any meat is just not something you can count on. You run more of a risk losing an animal with bullet performance like that than you do dropping them and killing them quickly. And honestly, if you use the right bullet, within the limits of that bullet, you're really not going to lose a lot of meat with a shoulder shot. Guys act like shoulder meat is the best meat on the animal and that they're going to lose so many pounds of meat placing their shot there. That's simply not true. Not unless you used the wrong bullet or placed it in the shoulder when it would be impacting well outside its limits, as in too high of an impact velocity and/or amount of resistance for the bullet type and weight you're using. That'll result in shallow penetration and over-expansion near the surface. That indeed will result in more meat lost, but that's not the bullet's fault or necessarily the shot placement's fault either. It's the hunter's/shooter's fault for not knowing that would be a poor shot placement under the circumstances for that particular bullet. That’s just the harsh reality of it. That's when a behind-the-should shot, or neck shot, or even head shot would actually be a better choice, if you’re in that scenario with not an ideal bullet combo.

Bullets that don't shed weight and that hold together do tend to reduce meat loss/damage, but that comes at a trade-off. Typically, the overall amount of wounding is less with that type of bullet. If it impacts below its ideal velocity, the amount of wounding will be even less. If you miss vitals, you may very well miss recovering the animal too. A well-constructed cup and core bullet, for example, that will indeed shed weight can be much more forgiving in that particular scenario since it would produce wider wounding and may still reach vitals and be the difference between recovering the animal or not.

Ultimately, there are multiple factors to consider, but in my experience and all the research and studying I've

done and with all the other info shared out there from others' hunts and experiences, I have concluded you simply cannot guarantee consistent, reliable, repeatable quick and clean kills with zero meat loss. It's always been worth it to me to pick the right bullet and place it accordingly and lose a little meat than it is to risk losing ALL the meat by potentially not recovering the animal.

You can't guarantee a particular presentation of the animal either to count on executing your favorite shot placement. You can, however, still place your shot in other ideal areas to give you desired results- that being a quick and clean kill and a recovered animal.

When a hunter starts talking about how they want a bullet that penetrates deep, doesn't damage meat, and gives them a big blood trail to follow, it immediately tells me they don't fully understand terminal ballistics and bullet construction/composition, and the anatomy of the animal they're hunting, along with the basics in effective killing of game animals. You do not NEED a blood trail if you truly know what you're doing, are using the best bullet for the job, and place it in the appropriate place according to the situation you're presented with. A lot of people like to use the phrase "if I do my part". Well, I say that means knowing all the things I just mentioned. Also, if you actually use the right bullet and can implement the high shoulder shot under your particular circumstances, you won't need a blood trail to track it.

Touching on Energy

This leads me to yet another misconception often discussed and touted as a crucial factor and something used as a minimum factor for a particular load/ammunition they're using, and that's energy. Personally, I stopped even looking at energy numbers several years ago now. It's just not even a concern of mine if I know the minimum impact velocity limitation of the particular bullet I'm using, and if I'll be within/above it. Impact velocity, sectional density (bullet mass), and shot placement are the main factors I worry about, and the things that influence those things. Energy is great, don't get me wrong, but it's only a potential and the bullet has to transfer that energy for it to really work in your favor.

Ultimately, you still need to inflict sufficient blood loss along with transferring any energy. That's what's most important. So, an extra 100-300fps or 200-400ft-lbs, for example, isn't really going to matter much. What really should be the focus is impact velocity as a threshold number, not energy. Energy, in regard to bullets and terminal ballistics, is only a potential, and if the bullet doesn't expand properly, it won't dump all the energy into the animal anyways. How a bullet performs terminally is dependent upon impact VELOCITY, the amount of resistance it encounters upon impact, and of course the construction/composition of the particular bullet used.

Most of the minimum energy figures you see stated and recommended out there are not good information and are made by those that either don't fully understand, or don't understand at all, terminal ballistics. It's unfortunately given many others a false sense of what is important too. When you see bullet manufacturers, conservation agencies, big names in the industry, etc. talk about minimum energy needed, it's easy to trust them and believe it's a figure you need to look at, but it's just not. If the bullet doesn't expand properly, it won't transfer that energy at the right time, or at all. What ultimately kills is blood loss. Transferring/dumping a ton of energy is beneficial only to shut down the central nervous system (CNS). That'll drop the animal, putting it into a temporary coma, allowing it to bleed out where it lies.

So ideally, yes you do want sufficient energy, but if you're not using the right bullet and not placing it in the right area, it won't matter. You could have 2000 ft-lbs of energy in a bullet at the time of impact, but if the bullet punches or pencils right through, most all that energy just exits with the bullet and the animal typically gets away. So, what did all that energy do for you? Nothing.

My figures with ideal impact velocity ranges come from tons of personal research and experience, not from advertisements from manufacturers. Once you get a really good grasp on terminal ballistics and bullet construction/composition, and know how certain types of bullets perform terminally, you can look at a particular bullet that you haven't used personally and you can already form a really good idea and presumption of how that bullet will perform based on that prior experience.

The thing that's helped hunters using magnum cartridges (or any cartridge pushing typical high velocities) is the

velocity they achieve, not so much the energy they produce. The impact velocity tends to be more than sufficient at typical ranges they're used. With those cartridges though, and using softer constructed bullets below .260 sectional density, and on larger/tougher game, especially with shot placements where resistance upon impact is high, you can experience shallow penetration and over-expansion.

That said, there's actually plenty of vitals behind the shoulder, and if the animal is quartering to, pretty much all the vitals will be through the shoulder. So, with the right bullet, used where it would still be within its limits (sufficient mass, impact velocity, etc), that's a great placement even though resistance will typically be high. The lungs hold the most blood and a double lung shot will allow an animal to bleed out quicker than a heart shot, especially if the heart is still pumping. The biggest parts of the front lobes of the lungs are behind the shoulder of most animals. There's an autonomic plexus (nerve bundle) behind the shoulder too- the brachial. Hitting it with enough shock will shut down the CNS, dropping the animal, and with sufficient hydraulic force (bullet expansion and wound channel size) the animal will bleed out before it can recover. It's an ideal shot placement. It's not ideal though if your particular bullet won't handle the amount of resistance it'll encounter though. That'll be dependent upon the construction type, sectional density (mass), and impact velocity though, as I've also mentioned.

Looking at Some Bullet Examples and Things to be Aware of

First off, in my experience, there's a big difference between "expansion" and "adequate expansion". For example, I have yet to see what I consider reliable and adequate expansion on Barnes, or similar mushrooming mono, below an impact velocity of 2000fps, although the LRX in particular is better than the TSX or TTSX.

Regarding differences in bullet lines such as the ELDM vs the ELDX:

The ELDX has a significantly thicker jacket than the ELDM, plus it has the interlock ring, but overall the ELDX is still a relatively soft bullet- in that it's not actually bonded and the jackets taper in thickness. The ELDM, on the other hand, does not taper in jacket thickness.

With too high of an impact velocity, the ELDX can still suffer from poor penetration and over-expansion. Where they differ the most from the ELDM is on the lower end of impact velocity. The thicker jacket and interlock ring will really start holding the bullet together more so than the ELDM at impact velocities dipping below like 1800fps, especially with lower resistance upon impact as well. So, the ELDM shines the most if you need a bullet that performs very well still at impact velocities around 2000fps and less.

For close range shots, what you need is a sufficient amount of mass, quantified best by sectional density, which is the amount of mass behind the frontal area of the bullet. How much you need will depend on the bullet construction and your expected impact velocity. An ELDX will still do better with more mass for close range (high impact velocity) shots due to how thin the jackets are at the ogive. If there's not enough mass behind the ogives, there might not be enough bullet left to do the job after the front starts coming apart on impact.

A bullet with thick jackets, but without tapering, would actually be better with **LESS** mass. You'd want less mass in order to lower the amount of over-penetration so that you can still achieve sufficient expansion. The Sierra TGK is a good example. The cores on those are also made of a harder lead alloy, which lowers the rate of expansion as well. That type of bullet will come apart at a slower rate having the same thickness at the ogive as at the bearing surface area. With too much mass, it'll just punch right through before it has a chance to fully expand. Lowering the mass (a lower SD) will lower the rate of penetration and balance out the expansion versus penetration. The same goes for actual bonded bullets too. If you go with a version with too much weight (mass/SD) you'll end up with more penetration than expansion. Lowering the weight helps balance the two. Same concept with mushrooming copper bullets too, but high impact velocity is even more crucial with those. You want relatively low mass/SD and a high impact velocity for best results with those. It’s a bit different with the petal-shedding copper bullets, but I’ll talk more about them later.

So, Do I Prefer Explosive Bullet Performance, and What Type of Shots do I Prefer?

I wouldn't say I prefer "explosive" performance, but wide wounding and a good deal of hydraulic force created. I don't want the bullet coming apart completely, before its job is done. That's why it's crucial to have sufficient mass with softer/frangible lead core bullets if impact velocity and/or impact resistance would be high.

As far as shot placements I prefer, I do tend to prefer shoulder shots, and I take them when able. That means only when the bullet wouldn't encounter too much resistance at too high of an impact velocity. I avoid direct shoulder shots if the bullet would impact above 2600fps, as my personal rule of thumb. I will place my shot just ahead or just behind the shoulder, depending on animal presentation and what my impact velocity would be and the particular bullet I'm using. The short answer is, with sufficient bullet mass, the bullet tends not to deflect so much and penetrates through. Steep quartering shots always tend to come with a lot of risk of deflection, in general. Just visualize the path of the bullet and where the vitals are with a particular shot placement and the anatomy the bullet must deal with. Place your shot where it makes the most sense.

Texas heart shots are always messy, and I would only take one if I really felt I had to. You're asking a lot of any bullet, plus risking spoiling meat by contaminating it with gut material. That said, I've seen many softer/frangible bullets actually perform very well with that shot and drop them dead on the spot.

There are many considerations that need to take place with the bullet you choose, how it inherently behaves terminally, and how to place your shot as required for the best possible end result. Understanding the limitations of the different bullet types and how to select the right one for your needs is the main hurdle.

Why Not Demand an Exit Wound?

Does an animal live longer and maintain blood pressure longer without an exit wound? Blood pressure has to do with how much/hard the pump (heart) is pushing it and how much resistance there is from the blood vessels. An exit hole through hide would not directly affect blood pressure. Only ruptures to blood vessels, arteries, veins, organs, and the heart would directly affect blood pressure. A loss in blood will reduce pressure too. The lungs hold the most blood, so destroying lungs will destroy a ton of blood vessels and allow for a massive loss of blood, especially if the heart is still pumping it all out into the chest cavity. An exit would only allow that blood to spill out onto the ground. That said, and exit can create a sucking chest wound and make breathing much more difficult and dying from asphyxiation can occur faster.

A bullet that completely destroys vitals but doesn't exit will tend to do more internal damage overall than a bullet that exited, because the one that exited held together more, retaining enough mass to continue to penetrate and carry energy along with it. Overall wounding will be less, as a result. That doesn't mean it still won't kill, or even quickly. An exit is only truly needed when a blood trail is required because tracking is needed.

You can definitely use too light of a soft/frangible lead core bullet for a particular scenario and/or place it on a spot where resistance upon impact would be too high. Without sufficient mass, that bullet will experience shallow penetration and over-expansion. It won't exit and most of the damage will be shallow too, sometimes more so on the surface. All the energy will have gone into the animal though, just not where it needs to go to do the most good. So, it's still crucial that you select the right bullet and with sufficient sectional density (mass). That's a key factor and something many hunters get wrong and don't understand.

I've seen match/target style bullets with plenty of mass punch right through on double shoulder shots. They're 100% capable of those shots and doing it reliably. You just need to understand how the particular one you're using is constructed and how much mass/SD is needed with that bullet for those shots, and what the limits are as far as impact velocity. If you take a double shoulder shot and it would impact outside its limits, you can't expect it to perform ideally. And just using any 'ole copper mono instead isn't going to automatically give you good performance with that shot either. Those bullets have limitations too and I've seen plenty of double shoulder shots with soft/frangible bullets that have outperformed many monos with the same shot.

If most of your hunting is done at closer ranges or you tend to use fast pushing cartridges that even medium distance shots impact at higher velocities, tougher constructed bullets will work well for you. If you take shots or have a good chance of taking shots where impact velocities would be 2000fps or lower, soft/frangible bullets will overall perform best for you. The best course of action is to simply use the heaviest for caliber version your

rifle shoots well and to sufficient speeds. If you're using a soft/frangible bullet with an SD of .280 or more, you can use that without issue of shallow penetration and over-expansion for closer range shots, but you still get excellent wounding and terminal performance well below 1800fps impact velocities too. Bonded and/or mushrooming monos just don't do that as well.

Does Lower Impact Velocity Equal Less Bullet Penetration?

In general, no. Typically, when it comes to bullets, slower impact velocity results in more penetration and less expansion. So just because impact velocity might be slow, as well as the kinetic energy low, it doesn't mean it doesn't have enough power to make it all the way through.

A 55gr VMAX, as an example, impacting at 3200fps is highly unlikely to exit. It has a very low amount of mass/SD and is constructed soft and to come apart. However, that same bullet impacting at say 1200fps has a really good chance of exiting due to it not expanding as much at that velocity. Obviously, it's still not likely to exit on wide bodied game, but that's not my point.

A higher impact velocity would not necessarily mean more of a chance that it'll have the power to punch through, but rather it'll have more of a likelihood of expanding to the point of meeting the resistance required to arrest its forward momentum and not exit. Again, that's not necessary a bad thing, if it did its job by destroying the vitals and creating sufficient blood loss for a quick and clean kill.

So again, this is why having adequate mass with soft/frangible lead core bullets is so important. It'll ensure proper terminal performance. Conversely, you **DO NOT** want a high mass/SD with tougher constructed bullets because then you'll experience the opposite regarding expansion versus penetration. You'll have more penetration than expansion and before the bullet can inflict a massive amount of internal damage, it'll have already exited.

Even large calibers (like .338 and up) with soft/frangible lead core bullets can have this problem due to the sheer mass alone. The bullet can't expand fast enough before it exits the animal. Lower impact velocities can help with those large calibers, but with those and others of the tougher construction, you also don't want to dip below an impact velocity of 1800fps because then there's not going to be enough opposing force to create adequate expansion from the bullet. The large caliber bullets tend to have a smaller window regarding ideal impact velocity range.

Impacting Bone

Bone, in general, will result in more resistance to the bullet than muscle or organs. Any bullet hitting bone will expand more, or at a quicker rate, than if it only hit tissue. However, just because it hit bone doesn't mean it can't overcome it and penetrate through it and still have sufficient material left to inflict adequate damage to vitals for a quick and clean kill.

Also, when I talk about shoulder shots, I mean high shoulder shots, into the blade, not the socket or humorous bone. You're trying to hit the brachial plexus and the lungs, ideally.

I've hit many shoulders with a 208gr AMAX/ELDM, 215gr Berger Hybrid, 200gr Berger Hybrid, etc from a 300wm and never had what I'd consider a bad experience. Same as with a 195gr TMK from both a 308 and 300wm. Same as a 160gr TMK from a 7mm REM Mag, 140gr and 147gr ELDM from a 6.5 Creedmoor and 6.5 SST. I mean the list goes on and on. My point is they work very well and without issue. In fact, I've found they work the best overall, especially at lower impact velocities for those longer shots. I've shot many bonded and other tougher constructed lead core bullets and monos too to compare results, with similar results.

How energy goes to work for us regarding bullets and terminal performance

So, starting out, ultimately knowing how the particular bullet you're wanting to use converts energy into force is what you should focus on and will be much more helpful than going with just a basic rule of thumb on minimum energy. There are many bullets out there that will produce excellent wounding with well under 1000ft-lbs of energy. That's because they're highly efficient at converting energy into force. Conversely, there are many bullets out there that are not efficient at converting energy into force or don't convert very much of it into force.

Many frangible lead core bullets are very efficient and effective at converting energy into force. Getting that proper balance though is crucial and achieved by having sufficient starting mass and not placing the shot in an area where the amount of impact resistance is too much for the impact velocity. An adequate amount of mass at the start can really help with that, as does adjusting shot placement for close range shots. A well-constructed and properly selected frangible mono can be very effective as well, to be fair. I'll go into more detail on that later.

Moving forward, energy goes to work by converting to force. Not all bullets turn their energy into force, or at least not a lot of force. Some are much better than others and need less energy to begin with to do so. How they convert energy to force is highly dependent upon their construction and the mechanics of how they behave terminally.

This is where the terms "energy dump" and "energy transfer" come in. As a bullet converts its energy into force, it rapidly loses momentum. If the bullet loses all its momentum from producing a huge amount of force, it typically doesn't exit. Typically, the higher the rate of momentum lost, the more force is produced, and more wounding occurs. That said, you still want to balance it all out so that it occurs within the chest cavity and does the most damage to the vitals. You don't want the bullet to lose all its momentum on or near the surface, for example.

Also, the more momentum the bullet still has, the more force it's still producing. If it produces a ton of force, but doesn't lose it all, and not at a rate higher than the speed its traveling, it'll still exit. We see this often with certain soft-constructed lead core bullets, in certain scenarios.

Touching on Certain Terms Coined as it Relates to Terminal Ballistics and More Specifically to Petal-shedding Monolithics

Slip planes: relate to plasticity, or more specifically plastic deformation and how the copper reacts, deforms, and breaks away after impacting an animal. This is material science. It has a lot to do with how and why the nose/ogive of monos like Hammer, Apex, Cutting Edge, etc. come apart and break away from the shank. Differences in alloys affect this as well, like if the petals fracture into many pieces, a few large pieces, if the shank looks as though the petals chipped off, or if it's more of a clean break, etc.

Shaped Charge, Pop, Detonation: In reference to the nose coming apart and petals separating rapidly. As in, the nose essentially explodes upon/after impact. Since there's no actual explosive in the nose of these bullets, it's not the same as an actual shaped charge and the force created as the petals expand, peel back, and separate is just instant massive hydraulic force, which pushes the fluid and tissues outward (both forwards and perpendicular), producing a ton of outward force and pressure in the process. This would cause the ribcage to expand and would produce what looks like a "bubble", as has been coined, formed in the chest cavity.

So, with that said, the flat surface area created and left behind on the shank of such a bullet produces far more outwards (perpendicular) force than a pointed or completely rounded shape. And less contact surface means less overall opposing force to decrease the forward momentum, and it also decreases drag.

That said, a lead core bullet that sheds weight can produce a similar transfer/conversion of energy into a rapid pressure increase and hydraulic force, and the mushrooming and wider contact surface, even if more rounded, produces a lot of perpendicular force as well. It just tends to produce more opposing force and drag and loses momentum at a higher rate, and its penetration potential CAN be less.

So, by ensuring said lead core bullet has enough mass at the start, and retains enough mass, and also retains enough velocity after the initial impact and shedding of weight, it can and will still penetrate deeply and this is when we see exits. Having a rounded front/edges also has the effect of reducing some drag and lowering some of the opposing forces. The amount of wounding produced is still massive as well.

We see similar internal damage with both types of bullets too, in the form of puréed organs, from the hydraulic force blowing them apart, and overall wide wounding. This still is dependent on other things though. It's not always guaranteed with either type of bullet.

Mass tends to be a bigger factor with soft constructed lead core bullets, and more specifically: retained momentum. Getting the right amount and balance is definitely achievable though and putting it all together produces excellent results that have been well documented.

Bubble: In my opinion, this is a term that seems to be misunderstood. From my summation, it's a made-up term for what the bullet does as it enters, initiates the petal-shedding event, and then travels through an animal. Ironically, the same people that say energy dump and energy transfer isn't real use this term, so I've seen.

In reality, what this is, and what is occurring, it is indeed energy transfer and hydraulic force. The confusion of these terms seems to also come in part by things like that "Shooting Holes in Wounding Theories" paper, which there's been much discussion on about its legitimacy and the background of the writer and that no one seems to really know who this person really is and their actual experience, nor have I seen anyone figure out how to contact this person. So a separate reality and terminology has been created and in my opinion, that doesn't lineup with actual reality and actual science, at least not completely and as stated.

The term "bubble" has been used to ultimately refer to the huge rise in pressure inside the chest cavity from the bullet expanding very abruptly, then coming apart, and the extreme velocity itself.

What that actually is though is energy transfer and hydraulic force being produced as a result. Hydraulic force will literally apply pressure against what it is being exerted upon, therefore the outward pressure within the chest cavity will increase and cause the whole ribcage to expand. We see the same sort of thing with gel, as the whole block expands and shape-shifts upon impact. High speed camera footage shows us the hydraulic force and energy transfer much clearer. This effect, specifically the amount of energy transferred, and hydraulic force produced, is highly dependent upon bullet construction and how the bullet behaves upon impact. Not all perform the same and produce the same results.

Regarding momentum in reference to terminal ballistics:

Let’s look at an example, comparing two relatively common bullets. One is a lead core bullet- the 215 grain Berger Hybrid, and the other is a mono- the 124gr Hammer Hunter.

So, comparing the 124gr Hammer to the 215gr Berger, mass-wise, we're talking a difference of .187 vs .324, in the form of sectional density. This helps us quantify and compare their mass more proportionally. We're also talking about a huge difference in construction and mechanics of how they work.

From what I've seen and experienced so far, bullets like Hammer varieties, Apex Outdoors Afterburners, LeHigh Defense Controlled Chaos, Cutting Edge varieties, etc. are all what I consider frangible in design. This is due to the fact they are purposely designed to shed weight and have the entire ogive section separate from the remaining shank upon/after impact- shedding away from the rest of the projectile.

So with that said, in theory they should also have a decent amount of starting mass since they're designed to shed a lot of weight, just like a soft/frangible lead core bullet. They need the retained mass in order to retain

momentum. That will ensure they still have the ability or potential to produce adequate hydraulic force as they continue penetrating. If they lose too much momentum, and/or not create a wide enough surface area at the front of the remaining shank, penciling can or will still occur because the amount of hydraulic force produced will be greatly reduced. On the other hand, a lower amount of surface area would tend to allow the shank to not lose a ton of forward momentum and most frequently exit. This is compared to a mushroomed lead core or a softer alloy petal-shedding mono that still mushrooms after shedding the petals and creates with a wider surface area.

A soft/frangible lead core bullet, such as a heavy for caliber Berger, with plenty of mass to start with, will still shed a lot of weight in most scenarios, but it'll also still end up more mushroomed overall (wider overall surface area) than those listed monos. So that helps still produce wide wounding from hydraulic force even if they lose a lot of momentum as a result. They expend a ton of energy into the animal- in the form of hydraulic force- which creates the puree we tend to see from the lungs being destroyed.

The following formulas and equations give a basic look at some numbers regarding momentum and using a common scenario with the 124gr Hammer at a muzzle velocity (MV) of 4200fps and the 215gr Berger at a MV of 3200fps. The figures on amount of mass lost and amount of velocity lost is an estimation based on typical or advertised results, but obviously isn't a guarantee since getting those actual numbers will be pretty impossible to obtain. So, take this for whatever it may be worth. Maybe it's worth nothing to you, and I'm fine with that. I feel it's a good representative though to the real world. Also, the percentage of mass lost and velocity lost is in reference to *after* impact and *after* the main shedding of weight has occurred. The mass lost is the same for the Hammer at close and longer range because it seems that amount stays pretty consistent as long as the petals all completely separate and the bullet performs as designed. The Berger will vary based on impact velocity and impact resistance and that's why it's different. It'll obviously lose more mass with higher impact velocities and more resistance, hence why the numbers are what they are. This is simply to illustrate the point and get you thinking.

Momentum Formula:

- P = MV
- Momentum = mass X velocity

Hammer Hunter 124gr:

- 8.03 X 1280.16
- Momentum = 10,280 Kilogram meters per second **(Kgm/s)**

Berger Hybrid 215gr:

- 13.93 X 975.36
- Momentum = 12,611Kgm/s

**Note grains has been converted to grams and feet per second has been converted to meters per second.*

Close Range Shot (MV):

Hammer:

- Loses 40% mass = 4.82
- 50% velocity loss = 640.08
- Momentum after weight shed and velocity loss = 4.82 X 640 = **3,085.19Kgm/s**

Berger:

- Loses 50% mass = 6.97
- 40% velocity loss = 585.22
- Momentum after weight loss and velocity loss = 6.97 X 585.22 = **4,078.98Kgm/s**

Longer Range Shot (600 yard adjusted impact velocity):

Hammer:

- Loses 40% mass = 4.82
- 70% velocity loss (2522fps or 786.7m/s starting) = 236.01
- Momentum lost after weight shed and velocity loss = 4.82 X 236.01 = **1,137.57Kgm/s**

Berger:

- Loses 30% mass = 9.75
- 60% velocity loss (2450fps or 747.76m/s starting) = 299.1
- Momentum after weight shed and velocity loss = 9.75 X 299.1 = **2,916.23Kgm/s**

So, if you look at simple cause and effect, and action/reaction, certain selling points with certain petal-shedding monos can be contradictory.

How can a bullet with less momentum and less mass penetrate completely, yet also produce the same or more hydraulic force (amount of wounding)? A huge amount of hydraulic force will create an opposing force to forward momentum. This is why even with more momentum a bullet like a Berger often doesn't exit. It sheds weight, but also still continues to mushroom. The fact that it still has more momentum but doesn't exit, yet retains a lot of mass, shows us it produced a ton of hydraulic force and that arrested the forward momentum rapidly.

Regarding Large Magnum Cartridges and/or Large Calibers vs Short Action and/or Smaller Caliber:

First off, I do use large magnums and will continue to do so because there are practical reasons to do so. I'm not too naive though to think you must use a magnum, 30cal minimum, and like a 200gr or heavier bullet with around 1500 or so foot pounds of energy, minimum, in order to be most successful. I use a lot of smaller cartridges and smaller calibers too, with the same success rate. Ultimately, the bullet is the hero, not the cartridge or even caliber size.

What cartridge is needed really depends. With certain bullets, certain distances needed, and certain game, sure a big magnum or large caliber might be what you want. But when you start tweaking things like exactly what bullet you're using (and in the right direction), you can still achieve desired results with much smaller cartridges, less powder, lighter bullets, lower recoil, etc. That's because you can create proper wounding and trauma still by using the right bullet. You can still do what is needed with less kinetic energy in the bullet because you're still untimely getting the actual amount of needed energy from the bullet and transferred directly into the wounding. That's what it's all about.

That's why shedding weight with bullets after impact works so well. There just needs to be enough starting mass so that there's also enough retained mass to keep the wounding going all the way through the vitals.

And thanks to the huge demand for high BC bullets nowadays, we have smaller caliber bullets, constructed with thin jackets and no bonding, that have plenty of mass (to get the increase in BC), plus cartridges coming out to get the most out of them with great efficiency.

The only people still having issues are those that do not understand bullet construction and terminal ballistics and are still picking the wrong bullet for the job or wrong combination with a particular cartridge and then placing it in a poor location on the animal for the particular scenario presented.

Now in regards to monos specifically, many have known for some time now, myself included, that the way to go

is to actually have them shed weight, and not simply mushroom and retain as much weight as possible. We've known this since companies like Lehigh Defense and others first introduced their own copper bullets that shed weight (petals). We/they found that to truly get the best results in the form of productive energy transfer and hydraulic shock production, shedding weight is what needs to occur. Those initial designs and products though still weren't perfect and had other hurdles to get over to really get the most from them and to achieve the best results. Companies like Apex Outdoors, Hammer, Cutting Edge, etc. are evolutions of those initial designs.

That basic principle design was, or is, indeed good. The design to shed weight and still have a surface left that produces hydraulic force is crucial for best results. It allows for a rapid transfer of energy during the petal-shedding event, and without losing too much momentum as it still produces hydraulic forces and wide wounding.

What hurdles still remain though for this design and these companies are staying competitive with long range capabilities (low impact velocity performance and ability to retain as much velocity as possible), reliable and consistent expansion and full shedding of the petals without issues caused by necking over, tumbling, or not expanding at all, as well cost. We've seen certain companies do well, and others not so much. More companies pop up all the time too. Some are making great strides in those hurdles.

So, as these types of monos continue to evolve and improve, using them with large cartridges and calibers will be, and already is in many scenarios, unnecessary as well.