

Arrow Lethality Study Update - 2005

Part III

By

Dr. Ed Ashby

Broadhead Performance Update

A number of broadheads await completion of testing, but some laudable performers have completed testing. Several performed well enough for inclusion as "best quality broadheads" for heavy game/heavy bone; with some being potential contenders for the "best of the best" category. For now, by virtue of their long unblemished record of performance, the 190 grain Grizzly, Modified Grizzly and Deadhead remain alone in that class.

In each broadhead test series the 190 grain Grizzly, Modified Grizzly (a 190 grain Grizzly narrowed to a 1" cut, with a resultant 170 grain weight), and the Deadhead are re-tested as 'controls'. Each represent "benchmark performance" on heavy game/heavy bone; the Grizzly/Modified Grizzly representing 'long and narrow' broadheads; the Deadhead, 'wide cut' broadheads. No multiblade "benchmark" broadhead has yet been found for heavy game/heavy bone.

From the array of Grizzly broadheads available, only the 190 grain, or its modified versions, had previously been tested. The full selection was tested this year. As with the 190 grain, the edge bevel angle was changed to 25 degrees, and the Tanto tip modified to a full COI prior to testing. On heavy bone impact, especially at adverse angles, bending was a frequent occurrence with the lighter weight; lesser blade thickness; models. The 160 grain has been successfully used on heavy game by a number of hunters, and good performance was anticipated.

For testing, the 160 grain Grizzly was mounted on tapered hickory shafts; average total mass 839 grains; average impact momentum (Mo.) 0.47 slug-ft./second. On the first two "punishment shots", from broadside into the scapular flat of an average size adult male buffalo, the broadheads were damaged. One bent at the point where the ferrule fades into the blade. On the second broadhead, the bone 'swaged down' the blade, from tip to near the ferrule fade-out. Neither penetrated the scapula. (See photo.)

This was far from the 160 grain Grizzly's anticipated outcome. To put it in prospective, the new study's buffalo data contains 14 broadside scapular flat impacts *on comparable sized, or larger, animals* with the 190 grain Grizzly and

Modified Grizzly. They show a scapular-flat penetration rate of 100%. Of those, 78.6% also penetrated the underlying rib(s) to enter the thorax. These arrows show an average mass of 825.5 grain, but range from one Extreme FOC arrow weighing 572 grains to one 1115 grain double shafted arrow. Their range of impact momentum is from 0.41 to 0.59 slug-ft./second.

Having equal blade thickness, the only variables between the 160 and 190 grain Grizzly were the differing mechanical advantage and/or a potential metallurgic difference. Mechanical advantage affects the resistance *impulse* encountered.

Rockwell testing of the two bent 160 grain broadheads shows a hardness of R50. A sampling of the other, lighter weight, models damaged show hardness from R48 to R49. The manufacturing specification is for R50 hardness. Several randomly selected samples of the 190 grain Grizzly, all of current production at the new study's outset, were previously tested for hardness, independently, by two different testers. All showed R52 to R53.

The 190 grain Grizzly has been subjected to random sample hardness testing many times during the decades of the broadhead study. Besides those currently produced (and exclusively used in the new study's testing) this includes those manufactured by Harry Elburg and by Jim Able. None have ever tested below R52; none above R55.

Generally, I have found excellent durability in broadheads between R49 and R55 hardness. Most broadheads, however, do not have the laminated blade construction of the Grizzly. Could this be a factor requiring slightly greater metal hardness in the Grizzly's blade steel? Does the very thin, 25 degree, edge bevel I add to the Grizzly require the higher hardness shown by the 190 grain models? I do not yet know.

The 190 grain's higher mechanical advantage means resistance forces are spread over a longer time period, reducing the peak level of resistance. The 160 grain Grizzly 'swaged' by bone is, however, *suggestive* that differing metal hardness is the more likely culprit.

The 190 grain Grizzly and its modified version are the most tested broadheads in the study. They have been subjected to far more punishing impacts than those which damaged the 160 grain models. No 190 grain Grizzly has been damaged in any manner, by any impact, with any tissues of any animal. They remain the benchmark broadheads; those against which the performance of all others must be judged - including their siblings.

Author's Note: All lighter weight test samples of the Grizzly were purchased, direct from the manufacturer, just prior to the 2005 testing, and secured on very short notice. This may well mean that much of the problem is of my own creation, and does not reflect any manufacturing problem. Waiting so late to order a large and diverse number of samples may have required rushed manufacturing to meet the departure deadline for testing. Still, there are the damaged 160 grain models, which were R50 hardness.

Much to their credit, the manufacturer made no attempt to make excuses for the 160's failures (or any of the other, lighter weight models), saying simply, "It should not happen, ever. Let us know what you find and just tell it like it is. It all helps us find and correct any problems". This I find refreshing, and a most admirable attitude, from folks who are, as we use to say in Africa, "The right sort". Pretty well sums it up.

Following their own retesting of the hardness, with like results, some 'test samples' of the lighter weight models of the Grizzly are being hardened to R52-R53. These will be tested this year to ascertain the outcome.

I'm told by the makers that they are looking into changing the Grizzly's single bevel to a 25 degree edge. The folks at Grizzly; and some of other broadhead makers, too; are paying attention, and trying very hard to produce the best possible product. For that we can all be glad.

G5's Shkote received initial testing this year. The small secondary blades proved tedious to sharpen, but it appears they may facilitate bone penetration. The Shkote's tip suffered a 100% bend/break rate on rib impacts, with one incident of the main blade's edge rolling severely, with a chip breaking from the blade. The Shkote's performance warrants further testing (with a modified tip profile), especially the potential effect the small secondary blades may have upon bone penetration.

Several broadheads tested can be recommended for heavy game and/or heavy bone impact, though all require tip modification to prevent tips breakage or, worse yet, tips curling on bone impact. A curled tip frequently prevents bone penetration.

Tip bends substantially affect outcome penetration, even when the bone is penetrated. Comparison of bone-breeching rib impact shots on which the broadhead's tip curled (with the main blade remaining unbent) against the same broadhead/shaft

combination when the tip did not curl indicates that even very tiny tip-curly cause an average penetration loss of 14%; and this is *after* the bone has been breached!

Among broadheads tested and making the "best broadheads" class (after tip modification) are: STOS 160 grain; BlackStump 125 grain; and Wolverine 160 grain. Tip testing is *strongly suggestive* that round COI tips or COI Tanto profiles are the most effective. All modified tip testing of the above broadheads was conducted with COI Tanto tips. It is worth mentioning that the Wolverine never suffered a tip curl, with the unmodified tip breaking rather than bending, and they require addition of a *wide* Tanto tip to prevent breakage.

It is tempting to add the Magnus 125 grain (also with modified tip) to the above list. Initial performance has been on a par with the above broadheads, but they have not yet been through the punishment phase of testing; something all broadheads must pass to enter the "best broadheads" category.

In addition to those above, there are others making the "best broadheads" list that are deserving of special mention. In one way or another, their performance has been "a cut above".

First is the 125 grain Abowyer Custom. The Custom has a flat chisel tip, which chipped at the corners on almost every bone impact. After the tip was modified to a COI Tanto design no damage occurred during testing. Being a left hand, 25 degree, single bevel edge, the Custom was tested on left-fletched hickory shafts.

The Custom is of very high quality materials and construction, exceedingly effective at splitting bone, and gave excellent penetration. All shots into the scapular flat penetrated, sticking firmly into the on-side rib. All rib impact shots penetrated and, more impressively, *all* stuck solidly into the off-side rib, excepting one which penetrated the off-side rib. Testing on the new 190 grain version of the Custom is planned for 2006. If it performs as well as its smaller cousin, it may well be a rival to the Deadhead as a wide cut 'benchmark'.

Special mention also goes to a prototype broadhead from Ribtek, called the Pro Big Game. The ferrule is solid rather than the open ring design innate to the Ribtek, and fades extremely nicely into the blade. It has a tip profile similar to that of the Ribtek. The double bevel edges are sharpened at 14 degrees, for a total edge angle of 28 degrees.

The Pro Big Game's low angle double-bevel edge is difficult to sharpen by hand, as the ferrule prevents filing or honing across the broadhead's face. Sharpening can easily be

accomplished with a belt grinder or (low speed) horizontally mounted grinding stone. Col Graham, maker of the Ribtek, uses a pair of files mounted on a block at the proper angle, and finishes the edge on a leather strop.

Only the 174 grain, 189 grain and 258 grain versions of the Pro Big Game have been tested. There were several incidents of *partial* edge rolling; from just back of the tip to where the triple thick anterior blade section stops, but no edge roll was noted along the rearward portion of the blades.

I would prefer a smoother metal finish on the broadhead's face, to lower the coefficient of friction, and a higher Rockwell hardness, which should reduce the edge-roll tendency but, even without these 'wish list' changes, the Pro Big Game is an excellent performer. It appears that Col is on-track to develop a world-class broadhead, and in weights very useful for developing Extreme FOC arrows too! As I understand it, plans are to offer the Pro Big Game only as a special order item.

At the manufacturer's request, the 150 and 180 grain SilverFlame broadheads were given an especially punishing work-out this year, with many perpendicular and angular shots into heavy bone; some into the skull from close range (where arrow paradox would increase the likelihood of broadhead failure). For testing they were mounted on Big 5 shafts; total mass: 770 - 807 grain; average impact Mo. was 0.49.

Durability of the SilverFlame's alloy ferrule had been a concern, but none were damaged. The SilverFlame has been thoroughly tested. Only two 'negatives' were noted: (1) during punishment testing the tip bent or broke on 50% of the adverse angle shots; a situation minor tip modification should alleviate, and (2) the ferrule profile does not fade gradually into the blade, requiring increased impact force to penetrate bone.

At the impact momentum test level, the SilverFlame's penetration on all scapular flat impacts halted at the ferrule's lead edge. On rib-only impact shots, broadside to 25 degrees quartering from the rear, the SilverFlame performed effectively, and no tip damage was noted.

With its extremely fine quality blade steel and overall durability the SilverFlame is the top choice of all 'dedicated screw mount' broadheads yet tested, and the only screw mount broadhead so far to make the "best broadheads" category. I would love to see a heavier, non-vented blade, glue mount version of the SilverFlame, with a smoothly tapered ferrule;

preferably of steel. I find myself thinking more and more in terms of those Extreme FOC arrows!

The Eclipse 145 grain earns special note among "best broadheads" not only for its excellent performance, but also for that of its Teflon finish. The finish has proven durable and effective. It not only prevented corrosion (except on sharpened edges) in the harsh, humid and salty environment of Australia's tropical north coast, it gives the Eclipse a measurable penetration advantage in soft and fibrous tissues over other good performing broadheads of similar profile and mechanical advantage. The Teflon finish is a strong plus-factor for the Eclipse; one of which other manufacturers would do well to take note.

The above broadheads have been thoroughly tested, and deserve serious consideration from anyone seeking a heavy game/heavy bone broadhead. On lighter big game, should one's shot not impact at the 'planned point', these high performance broadheads, coupled with the right shafts and impact force, should prove capable of reliably smashing through shoulder bones and underlying ribs to reach vital organs, with edges still sharp and broadhead undamaged. As the new study moves into testing on lighter built big game (which will probably be in 2007), that premise will be closely examined, along with an attempt to delineate the force levels required to do so on these lighter built animals.

The most-asked broadhead question has been, "How is the Wensel Woodsman doing in the test?" Overall, it is the best performing three blade broadhead yet tested, but exhibits heavy bone penetration problems, as noted with all other three blade broadheads thus far tested.

The Woodsman was tested on Forgewood, tapered hickory and Grizzly Stik Big 5 shafts. Three quartering-from-the-rear (at 25 degrees) shots were also taken with the modified-tip version mounted on double shaft arrows; average mass 967 grains; average impact Mo. 0.52 slug-ft./second. These three shots averaged 9.17" penetration, with the highest penetration being 11.375".

Of the sixteen broadside, rib impact shots eight (50%) penetrated adequately to enter the thorax. Four (25%) penetrated sufficiently to give a double lung hit; one of which totally traversed the thorax, reaching the off-side ribs.

Of these 16 shots with the Woodsman, 6 were with Extreme FOC arrows. All four (100%) of the double lung hits occurred with Extreme FOC arrows and a modified-tip Woodsman.

Broadhead bends, on impact with the entrance rib, accounted for the two, Woodsman tipped, Extreme FOC arrows not penetrating the thorax. These two shots were on a trophy size bull. Arrow mass weights were 884 and 886 grains. One shot (original tip) impacted 13" up from the chest line and 3" back of the shoulder crease, centering a rib. The tip curled and all blades were 'swaged down'; collapsed; by the impact. Penetration was 5.875 inches. The second, with modified tip, impacted 14" up from the chest line and on the shoulder crease, also centering the rib, bending and compressing one blade badly and one blade slightly. Penetration was 5.75 inches. (See photo.)

The blade 'collapse' noted above occurred, in both cases, immediately above the vent cutouts. Though the Snuffer has a marked problem penetrating heavy bone, none have ever shown blade collapse. Perhaps a heavier, non-vented version of the Woodsman would not show this tendency for blade collapse.

Only one scapular shot was taken with the Woodsman (modified-tip version): tapered hickory shaft; impact Mo. 0.47 slug-ft./second; broadside shot angle; on an average size adult buffalo cow. The shot impacted near the outer edge of the scapular flat, failing to penetrate the scapula.

Chart 5 gives a comparison between the Woodsman's performance and that of some single blade heads. The Chart has several features the reader should note.

(1) The Chart reflects all (and only) *broadside* shots striking a rib on entrance; for arrows having comparable shafting and total mass. Except for the six shots with the Woodsman with steel adaptors, and mounted on the Grizzly Stik Big 5 shafts (giving an FOC of 19.9%), Chart 5 *excludes* shots with extreme FOC arrows. As should be clear to all who have read Part 2 of the 2005 Updates, inclusion of single blade Extreme FOC arrows would make the outcome results even more lopsided in favor of the single blade broadheads.

(2) The Woodsman's penetration increases significantly with a modified tip. Chart 5 shows 3 broadside, rib impact, hits with the unmodified Woodsman. The tip bent on all. One penetrated the rib (33.3%), with the broadhead *barely* exiting the bone. Average penetration for the three shots was 5.08 inches.

There are 13 broadside, rib impact shots with the modified-tip Woodsman, nine of which penetrated the rib (69.2%). Average penetration was 11.2 inches. The Woodsman's factory tip is a decidedly weak point, curling on each of the first seven test

shots taken; five on buffalo and two (scapula impacts) on pig. The Woodsman is best used with a modified tip, even for lighter game.

(3) Many single blade broadheads shown in Chart 5 have modified tip configurations. All Grizzly and Abowyer Custom heads are modified to COI impact Tanto tips; approximately half the others have tips modified.

(4) Over 50% of the shots listed for the Grizzly and Modified Grizzly were with "Hill type" serrated edges which, as reported in last year's updates, is a significant hindrance to penetration on buffalo.

Author's Note: Penetrating a bone, as used in the study, refers to the passage of the entire broadhead through the bone. A portion of the broadhead extending from the off-side of a bone does not constitute "penetrating the bone". The arrow's forward progress was stopped by the bone.

"Penetration" is measured as the length of the wound channel through the tissues; from entrance wound to bottom of wound channel or exit wound. This effectively places a 'cap' on maximum measurable penetration. No "penetration measurement" can be a greater distance than the length of wound channel through tissues, from entrance wound to exit wound, even with complete arrow pass-through.

Chart 5
Wensel Woodsman Comparison Data
N_{Total} = 67

Excepting six shots with the Woodsman, Chart excludes Extreme FOC data. Includes all broadside rib impact shots with comparable shafting/mass.

			Avg.	Avg.		%	%	%
			Impact	Impact		Pen.	Reaching	Pen.
N=	Broadhead	Avg. Mass	KE	Mo.	Avg. Pen.	Entrance Rib	Exit Rib	Exit Rib
3	Wensel Woodsman	805	35.26	0.50	5.08	33.3%	0.0%	0.0%
13	Wensel Woodsman; Mod, Tip	856	35.08	0.52	11.02	69.2%	7.7%	0.0%
15	Grizzly 190 grain*	875	35.86	0.53	15.51	100.0%	53.3%	21.4%
10	Mod. Grizzly*	843	34.08	0.51	16.00	100.0%	80.0%	10.0%
3	Abowyer Custom 125 grain**	885	36.52	0.54	18.42	100.0%	100.0%	33.0%
13	Eclipse 145 grain***	843	34.40	0.51	16.57	92.3%	69.2%	7.1%
6	BlackStump 125 grain***	831	32.06	0.49	16.27	100.0%	100.0%	0.0%
4	Magnus 125 grain***	921	33.31	0.52	13.25	75.0%	50.0%	0.0%

* Grizzly and Mod. Grizzly with COI Tanto tips. Over 50% of Grizzly/Mod. Grizzly shots are with serrated edge sharpening. All other shots: honed and stropped edges.

** Modified to a COI Tanto tip.

*** Approximately 50% modified to COI Tanto tip.



The two bent 160 grain Grizzly broadheads



Not just heavy game. Broadhead damaged by adverse angle, heavy bone impact on a Whitetail doe. At 18 yards, on a 450 grain arrow, both broadhead and aluminum shaft gave way. Impacting with 68 ft. lbs of KE, and 0.53 slug-ft. of momentum, the penetration was 3 inches. (Courtesy of Wesley Mulkey)



Easily prevented by modifying tip profile, even minor tip bends, such as shown on this 145 grain Eclipse, cause an average tissue penetration loss of 14%.



Factory tips on Shkote 170 grain broadheads routinely bent on rib-impact shots. Note heavily rolled edge visible in left image.



SilverFlame tips suffered damage only during adverse angle bone impact, an easily corrected detail. Thus far, it is the only screw-mount, or alloy ferruled, broadhead to make the "best broadhead's" list.



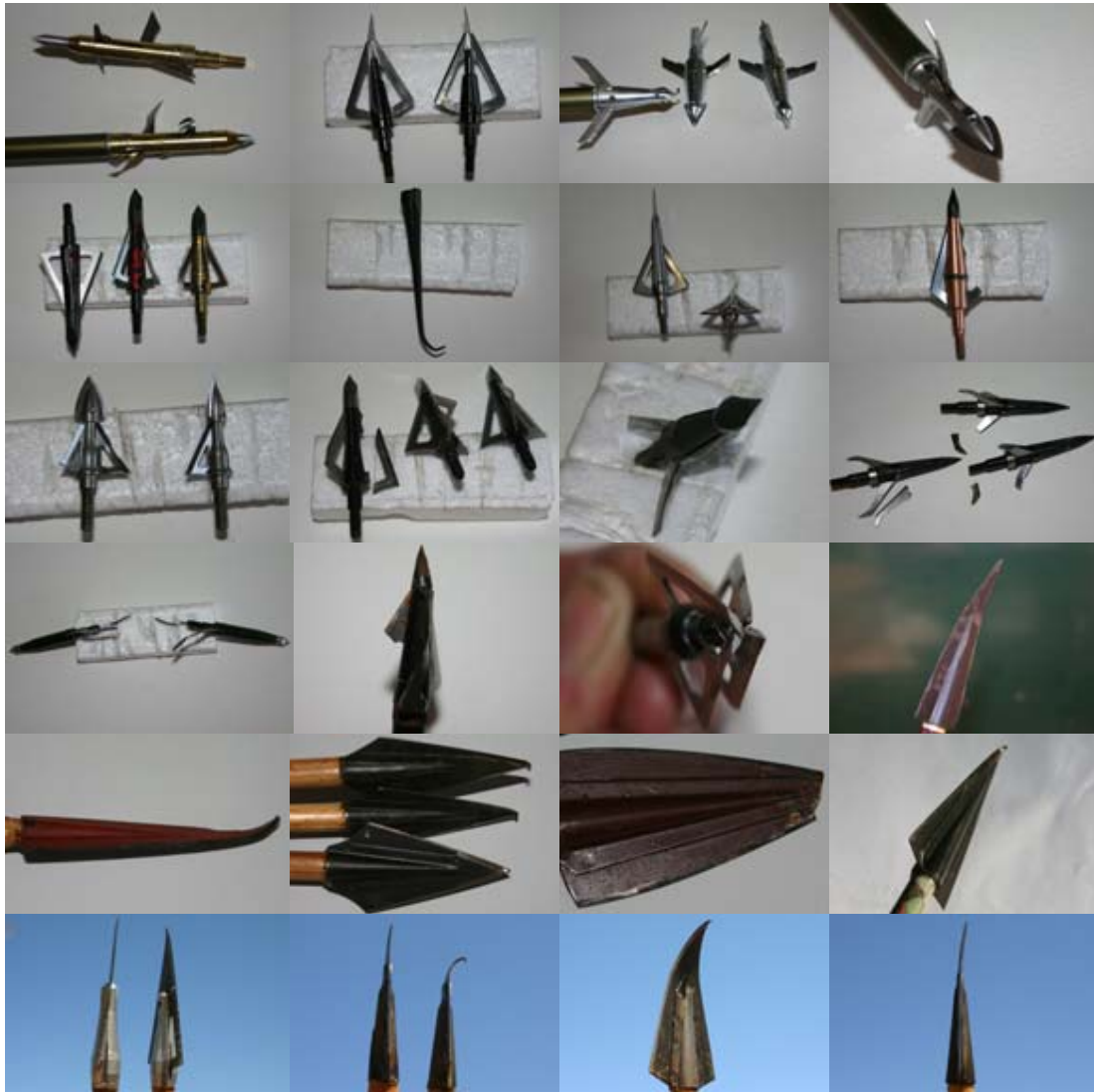
These Wensel Woodsman broadheads were damaged on right-angle rib impact, halting their penetration. Note differing tip design; factory tip (R) curled on every shot while modified tip (L) remained undamaged on all shots.



The 258 grain Pro Big Game (Lower) dwarfs even the 190 grain Grizzly (Upper).



Some of the broadheads damaged during 2005 testing.



A closer look at a few damaged broadheads from this year's testing.

All Material © 2006, Dr. Ed Ashby