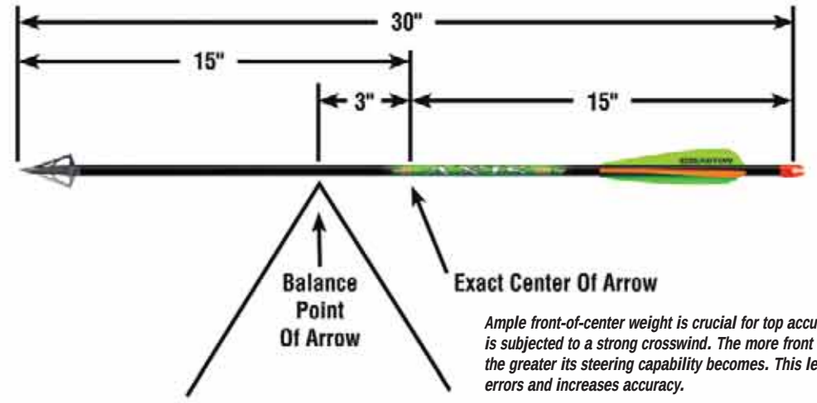
(Opposite) *Variables such as arrow diameter and fletching size play a huge role in downrange arrow performance.*
(Below) *Easton's AXIS arrows are a top choice for bowhunters looking to maximize wind drift and energy downrange since they are ultra-small in diameter and weigh about 9 to 10 grains per inch of shaft length. This allows for a total arrow weight well beyond 400 grains.*

Arrow Mechanics

Identifying certain factors that give hunting arrows improved performance in windy conditions and increased energy downrange.

By Joe Bell



Ample front-of-center weight is crucial for top accuracy when an arrow is subjected to a strong crosswind. The more front heavy the arrow is, the greater its steering capability becomes. This lessens point-aim errors and increases accuracy.

The crawl was one of the longest I've ever made on a big-game animal. For hours I had been laying and slithering around in the spongy tundra grass, doing my best to get inside bowrange of a nice woodland caribou. It was cold, windy, and my raingear was doing little good keeping me warm. Water seeped in from the cracks, staying inside my arm and chest cavities, chilling me to the bone.

In addition to the frigid conditions, the stalk was tricky. There were some dense spruce bushes to navigate through, and the bull had a long string of cows bedded beside him. I moved only when all eyes looked away, or when shielded by ground cover or a swell in the topography. I had to remove my hip quiver frequently as I tunneled my way through the tangle-foot spruce.

Eventually, I made it to 45 yards—as close as it was going to get. I felt confident making the shot. I nocked an arrow, came to my knees, and waited. Several of the cows soon got nervous and rose from their beds, and bailed over a small rise. I knew it was a matter of seconds before the bull followed suit. Meanwhile, a fierce wind whipped across the tundra, bending frozen grass like wet noodles. I wondered how the gusts would affect my arrow's flight and told myself to aim off a little, just to be safe.

As soon as the bull indicated getting up, I hit full draw, and eased the 40-yard pin ever so slowly just above his last rib. He was quartering, with his eyes looking straight away. When everything felt right, I subconsciously triggered the release. I saw a glint of arrow flight, followed by a patch of grayish fur leaving the caribou's side right where I had wanted the arrow to strike. I became ecstatic. The caribou ran over the rise and disappeared. My guide and I later found the bull lying stone dead in a patch of spruce.

While soaking in my success, I began to reflect, and quickly realized I had totally forgotten to compensate for the wind during the heat of the moment. Yet, somehow, my arrow struck spot on. How could this be? The wind was easily blowing 20 mph that day, if not more. I pondered things for a bit and quickly concluded that I must have just gotten lucky, or, my arrow was incredibly effective at bucking the wind.

After packing the caribou out, I decided to experiment a bit and took some shots near the hunting cabin. A strong wind was blowing as I homed in on a large leaf on a mud bank about 50 yards away. I watched as all three of my broadhead-tipped arrows

Many bowhunters have discovered that some shafts stabilize sufficiently well using smaller-style fletching, even those designed for target shooting. Using less fletching and weight reduces flight drag and wind drift, and gives arrows more front-of-center weight. This tends to make them faster and more accurate in windy conditions. Pictured are AAE Max 2.3 vanes (above).

landed only within 3 inches of the leaf! I was aiming dead on.

Luckily, for this hunt, I switched to a heavier-than-normal arrow (about 475 grains), mainly for deeper penetration on moose, another species I was pursuing on the trip. It was also small in diameter and constructed of both carbon and aluminum. It measured 27 inches from nock throat to insert and boasted a 125-grain low-profile fixed-blade broadhead and lightweight 3 3/4-inch plastic vanes—a combo with a front-of-center weight beyond 12 percent. All in all, it was the ultimate setup for the conditions at hand.

After years of bowhunting big game, I realize how crucial it is to go afield with the right shooting setup. Accuracy on game is really a matter of inches—miss one way or the other, and you'll quickly find yourself eating tag soup. To avoid this, you must be diligent in equipment selection. Arrow choice is one of the most important elements, as I found out that day hunting caribou.

In this article I'll discuss five key components that give arrows improved performance downrange in windy conditions. Western bowhunters, especially, will benefit from this information, as will any tree-stand hunter who occasionally shoots at deer across large windswept fields or food plots.

BENEFITS OF SMALLER ARROW DIAMETER

A few weeks ago, while attending a major outdoor 3-D shooting event, I had the opportunity to watch several of the nation's top shooters challenge themselves against tough shooting conditions. It rained the majority of the time during the three-day shoot, with wind blowing occasionally. Yet these gifted bow shots continued to lace the small orange "kill" spots on the targets nearly every time. I looked closely at their equipment, and at the end of each shooting day, the top scorers had one thing in common: they were using the smallest, skinniest arrow shafts you could buy—similar in size to coffee straws!

For the same reason outdoor target archers use small-diameter arrows to enhance shooting accuracy, so should hunters. The reason, of course, is purely mathematical. The cross-sectional area of a skinny shaft versus a medium-width shaft may not seem like much up close, but when you take into consideration the entire length of the shaft, the difference is substantial. With inches less of side-surface area, the wind has less mass to blow against. This lessens the affects of wind drift and takes the guesswork out of where to aim.

Of course, today's premium outdoor target shafts are not suitable for using broadheads—the shank is too small to accept a threaded broadhead-headbody. However, there are some pretty skinny bowhunting shafts now available. One of my all-time favorites is the Easton Axis Carbon and Axis Full Metal Jacket series. Such shafts reduce surface area values by up to 15 percent or so compared to normal-size carbon shafts, and up to 20 or 25 percent compared to large-diameter all-aluminum shafts. This kind of arrow can reduce the wind planing effect and result in more hits afield.

Another benefit to using smaller-diameter arrows is the reduction of fletching drag needed to properly stabilize the shaft. This is due to less side-surface area and a faster axis of rotation.

Arrow performance is a concern even for treestand hunters, as shots on occasion do require pinpoint accuracy across an open field or food plot.

For example, let's take three different shaft diameters. A large 2315 aluminum (measures about 11/32-inch wide), a typical internal-component carbon (about 5/16-inch wide), and a super-narrow Easton Axis Series (about 17/64-inch wide).

Now, if we were to outfit each of these arrows with vanes mounted at a 5-degree helical, the spin rates would vary for each shaft. For every one full rotation, the 2315 would have to travel forward 8.8 inches, the 5/16-inch carbon 7.99 inches, and the skinny 17/64-inch carbon 6.8 inches! (Due to variables such as wind and drag, these are not actual numbers, but relative.)

This spinning and air drag is known as centrifugal force. Basically, think of a simple tabletop. When you slowly spin it, it tends to wobble. But if you spin it faster, it builds up air resistance or drag and becomes stable, no longer wobbling. An arrow functions similarly; it must spin fast enough so that fletching creates the right amount of air drag to make it stable in flight.

In the end, this means smaller-diameter arrows not only give improved flight trajectory downrange (due to less surface area and drag) but they give the ability to use smaller vanes or less vane helical without theoretically sacrificing loss of arrow stability or control.

ARROW WEIGHT AND FOC

Any time you increase an object's weight, you increase the amount of inertia or force that is required to move it in one direction or another. This is why heavier bullets and arrows are better for bucking the wind—it takes more resistance to create sideways drift.

Generally speaking, choose arrows that provide about 5.5 to 6 grains per pound of bow pull weight. This means, for example, an arrow that weighs no less than 385 grains for a 70-pound bow.

For the same reason, the forward-weight of the arrow becomes critical too. As an arrow flies in the wind, it will fishtail or wag in the direction of the crosswind, wanting to follow the path of least resistance. However, the heavy part of the arrow (the front end) keeps the shaft from completely somersaulting and tracking true, despite the force.

Western big game, especially pronghorn antelope, usually require longer shots across expansive, windswept country. Arrows equipped with aerodynamic components will fly more true and on target.

A heavier, smaller broadhead, such as the New Archery 125-grain Nitron, offer a great combination, since it will tune easily and fly more true in the wind.

With physics in mind, the higher the front-of-center weight, the less leverage effect the wind has on fish-tailing or "planing" the arrow. This lessens the degree of point-aim errors.

"Heavier shafts drift less in the wind, and more front of center will improve your group size," says Darin Cooper, a brilliant engineer and pro-level archer with many tournament wins and bowhunting trophies on his wall. "For this reason, I have worked hard to up my broadhead-point weight to 160 grains or so." To achieve this, Cooper uses a 125-grain fixed broadhead and heavier inserts.

For best results, choose arrow setups that yield a 10 percent or more forward-of-center weight, with 15 percent being a maximum.

The author believes heavier, smaller-diameter arrows are best for bucking the wind and maximizing energy downrange. This fact really hit home during a woodland caribou hunt many years ago, when he used a first-of-its-kind small-diameter, heavy aluminum/carbon arrow weighing about 475 grains. He made an accurate shot at 45 yards, despite a relatively strong crosswind.

FLETCHING SIZE

I was recently out at the local archery range, shooting with a group of guys. We shot from various distances, out to 80 yards. The wind was howling—so much so, that we all felt like calling it a day. But we rode it out and kept shooting in the 25- to 35-mph gusts.

Three of us in particular were shooting similar setups, only our arrows were different. I was shooting my usual arrow setup: Easton Full Metal Jacket shafts (300 grains, shaft only), 100-grain stainless steel bullet points, and 2-inch Arizona Archery Max Hunter vanes. Another archer was using Easton ACCs with low-profile 2-inch target-style vanes, and the other was using "fat" carbon shafts with four-fletched target vanes. We were all shooting about the same speed, 275 fps, only my arrows were the shortest.

While shooting at the 80-yard target, I was aiming off center by nearly a foot in order to hit the center of the 90-meter FITA target. The archer using ACCs and target vanes told me he was aiming off about half that. We continued to compare notes on the 60- and 50-yard targets with similar results. It became obvious; fletching size can have a drastic effect on an arrow's performance in the wind. Similar to arrow-shaft size, the larger the fletching, the more side surface area there is and the more the wind has to pull against.

Through much experimentation and testing, pro bowhunter Randy Ulmer has found 2-inch, low-profile target-style vanes the ultimate setup in the wind when using a mechanical broadhead. (He prefers AAE Max vanes in conjunction with a Rage two-blade broadhead.)

With such small vanes, Ulmer recommends using a high degree of helical offset in order to get the arrow spinning as soon as it leaves the bow, stabilizing it better. However, he does warn against the use of target-style vanes for hunting if you have a "rough" release. If this is the case, larger vanes, either 3- or 4-inch conventional styles, or tall, compact vanes, such as AAE Max Hunters, will prove to be much more forgiving and accurate.

I guess the key here is to use just enough fletching, and no more. How much all depends on the style of broadhead you use, the quality of your arrow shafts, and how well tuned your bow is.

The only way to come up with the optimum combination is to fletch up some arrows with different vanes, then shoot and compare group sizes. Start with standard 4-inch vanes and work your way down. I suggest at least a moderate helical, no matter what kind of broadhead or vanes you're using.

BROADHEAD CHOICE

In theory, one would consider a mechanical broadhead the best for windy-day shooting. With less surface area, they are less affected by the wind and therefore more accurate. However, when wind wags the arrow, it will strike the target fishtailed. In this case, it must penetrate properly despite an angled impact. In my tests, most mechanicals have proven not to do this well.

"There's no question that mechanical broadheads have the indisputable advantage when you consider wind drift," said Cooper. "However, every mechanical broadhead robs some portion of the arrow's penetration to open the blades. They also have a tendency to kick the arrow on angled shots. That kick can substantially reduce penetration. This can make them less ethical to use."

For the same reason Cooper claims, I tend to favor today's smaller compact heads for high-wind shooting. I've found many of these heads to group only slightly less consistently compared to mechanicals—an accuracy tradeoff I consider worthwhile. Some of my favorite heads in this class use 1- to 1 1/8-inch cutting diameters, which include the Rocky Mountain Blitz, G5 Striker, Slick Trick, Innerloc Stainless Extreme, Wasp Boss Bullet, American Broadhead Sonic 125, Rocket Ultimate Steel 125, Steelforce Phathead, or Muzzy 100-grain 4-Blade, to name a few.

I will say that on occasion I will use the Snyper mechanical broadhead. This broadhead's unique cam-opening, front-facing blades have proven to negate the need for straight-line entry. It's a deadly penetrator, regardless of the conditions.

ENERGY RATINGS: LIGHT VS. MID-WEIGHT ARROW

LIGHT ARROWS SHED ENERGY MORE QUICKLY DOWNRANGE COMPARED TO HEAVIER ARROWS

	Speed (point blank)/Energy	Speed (40 yds.)/Energy
Light Arrow (343 grains):	279 fps/59.30 foot-pounds	265 fps/53.49 foot-pounds
Mid-Weight Arrow (426 grains):	256 fps/62 foot-pounds	245 fps/56.79 foot-pounds
Speed/Energy Difference:	23 fps/2.7 foot-pounds (4.55 %)	20 fps/3.3 foot-pounds (6.17%)

Note: All values calculated using the formula for Kinetic Energy: Velocity (squared) x Arrow Weight divided by 450,240 = Kinetic Energy in foot-pounds. Speed is in feet per second.

Elk are tough and require stopping power. This is where arrow weight becomes a critical concern. By upping arrow weight by 50 to 75 grains, you gain about 6 percent more kinetic energy at 40 yards. Jeff Anderson shot this bull well beyond the 40-yard mark and was thankful for excess arrow energy.

ARROW SPEED & ENERGY CONSIDERATIONS

Arrow speed is important when shooting downrange, not only when shooting at unknown distances, but for lessening the margin for the occasional vertical aiming error. Such speed is especially handy on windy days as well—the faster the arrow arrives, the less time there is for the wind to blow on it.

But not all speed is equal. A slightly slower setup using a 400-grain arrow traveling at 265 fps is better than a lighter 350-grain arrow at 280 fps, given the front of center weights are equal. In other words, heavy, small-diameter arrows are a better choice over faster, lightweight arrows due to stability factors.

Balance seems to be the key here—you want to select a fairly fast rig and a fairly heavy arrow. For most archers, this speed range seems to be 270 to 280 feet per second, with arrow weights ranging from 390 to 450 grains.

Short-draw users will benefit from some of today's super-accurate low-brace-height bows. Good examples would include the Hoyt Katera and Mathews Reezen. Such setups offer 26- or 27-inch draw lengths the power to shoot arrows weighing around 400 grains out to 280 fps or so.

Beyond shooting accuracy, heavier arrows also offer increased energy retention downrange, especially when shooting beyond 40 yards. This is another key reason why expert archers like Cooper and Ulmer believe in using heavier arrows for tackling big animals like elk and large mule deer. Cooper and Ulmer typically shoot arrows in the 420- to 460-grain range.

Cooper flatly states that 50 grains more of arrow weight is actually equivalent to shooting a 10-pound heavier bow. "I've done some engineering calculations that indicate how critical mass is to maximizing penetration," said Cooper. "My calculations show that a 500-grain arrow shot from a 60-pound bow will achieve roughly the same penetration as a 70-pound bow with a 450-grain arrow. The key is momentum and not kinetic energy." The formula for calculating this factor is: Momentum = (mass x velocity) ÷ 225,218.

Choosing the right arrow setup can offer great dividends in challenging bowhunting conditions. In doing so, consider the rules of physics, which indicate that a heavier, smaller-diameter arrow with aerodynamic components is the best defense against shooting in a strong crosswind, and creates the ultimate choice for obtaining maximum energy downrange.