1. They may PORPOISE in flight.
2. They may FISHTAIL in flight.
3. They may not CLEAR the bow properly as the arrow leaves the bowstring.
4. They may MINNOW in flight (a specific type of clearance problem).

Porpoising

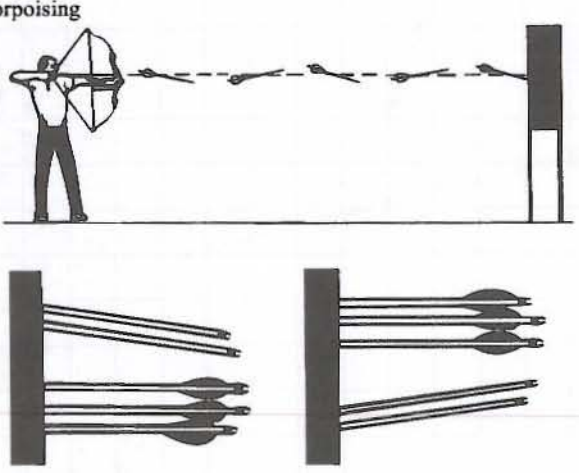
It is important to correct for Porpoising first. If the arrow leaves the bowstring with the nock too high or too low, a motion known as Porpoising occurs. Porpoising is caused by an incorrect nocking point location. Use the Bare Shaft Planing Test to find the correct nocking point location. Shoot at least three fletched shafts at a distance of 15 to 20 yards (or meters). Then shoot two identically-aimed unfletched shafts. Once you get the bare shafts to impact close to the fletched arrows at 20 yards (or meters), you may want to try shooting 25-30 yards (or meters) for a finer tuning indication.

If the unfletched shafts impact above the identically-aimed fletched shafts, move the nocking point up on the bowstring until both fletched and unfletched shafts strike at the same elevation. See Fig. 10.

If the unfletched shafts impact below the identically-aimed fletched shafts, move the nocking point down on the bowstring until the unfletched shafts hit at the same elevation or slightly lower than the fletched shafts.*

To assure you have eliminated Porpoising, repeat the test, shooting first the fletched, then the unfletched shafts, and make adjustments to the nocking point until both fletched and unfletched shafts impact at the same elevation.

Fig. 10
Porpoising



Nocking point too low* Nocking point too high*

* It is sometimes desirable to have the bare shaft impact just slightly below the identically-aimed fletched shafts. Bare shafts that impact above identically-aimed fletched shafts indicate a low nocking point. If the nocking point is too low, it may force the arrow fletching down into the arrow rest, creating Clearance problems.

Fishtailing

If the arrow leaves the bow with the nock end leaning to one side or the other, Fishtailing occurs. The nock end of the arrow will appear to move from side to side as the arrow follows its flight path. See Fig. 11.

Use the Bare Shaft Planing Test to correct Fishtailing. Shoot three fletched shafts at a distance of 15 to 20 yards (meters), then shoot two identically-aimed, unfletched shafts.

If the unfletched shafts impact left (stiff) of the identically-aimed, fletched shafts, as seen in Fig. 11 (for a right-handed archer), either decrease the spring tension on the cushion plunger, increase bow weight slightly (if your bow weight is adjustable), or increase arrow point weight.

If the unfletched shafts impact right (weak) of the identically-aimed, fletched shafts, as seen in Fig. 11 (for a right-handed archer), increase the spring tension on the cushion plunger, decrease bow weight slightly (if your bow weight is adjustable), or decrease arrow point weight.

Your equipment is basically tuned when the bare shafts and fletched shafts impact at the same or very near the same location. Once you have completed the finer tuning methods listed for Fine Tuning and Micro Tuning on pages 12-14, do not be surprised if the bare shaft impact changes. It is common on a well-tuned bow to have the bare shaft impact a little low and slightly stiff (to the left of the fletched shafts for a right-handed archer). Occasionally, a good tune may be achieved with the bare shaft impacting slightly weak (to the right of the fletched shafts for right-handed archers), but this is less common.

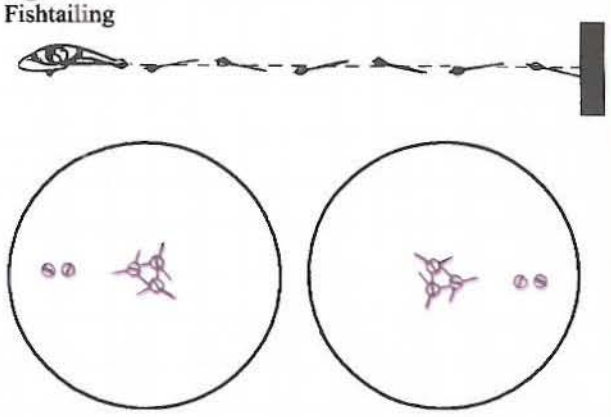
When correcting Fishtailing using the Bare Shaft Planing Test, you may have a problem adjusting the unfletched shaft's impact to that of the fletched shaft. Your arrows might be too weak (the unfletched shaft impacts to the right of the fletched shaft for right-handed archers) or too stiff (the unfletched shaft impacts to the left of the fletched shaft for right-handed archers). If, after completing this test, the bare shaft impact is more than 6 inches (15 cm) to the right (weak) or left (stiff) of the fletched shafts at 20 yards (18 m), you will need to make some modifications to the equipment to achieve a better tune. Follow the suggestions on how to better match the arrow to your bow in the "Adjustments Within the Bow and Arrow System" section on page 10.

Clearance

Proper clearance is absolutely essential for optimum grouping, consistency and accuracy. This is especially true with ultra-light weight arrows like the UltraLite aluminum, the A/C/E and A/C/C HyperSpeed shafts.

After you have performed the Bare Shaft Planing or Paper Tuning Arrow Test, it is a good idea to check for adequate clearance. To check for clearance, use dry powder foot spray, dry deodorant spray or similar product, applied to the last quarter of the arrow shaft, fletching, arrow rest assembly and sight window near the arrow rest. Do not disturb the powder sprayed on the arrow and

Fig. 11
Fishtailing



Stiff Arrow
Unfletched shafts impact left
(RH archer, opposite for LH)

Weak Arrow
Unfletched shafts impact right
(RH archer, opposite for LH)

Fig. 12
Minnowing

bow while preparing to shoot. The arrow should be shot into a firm target so that it will not penetrate to the fletching.

If you are not achieving good arrow clearance, and the arrow fletching and bow make contact, optimum grouping cannot be achieved. By examining the areas where the dry powder spray is scraped off, the nature of any interference can be determined, and the position of the fletching as the arrow leaves the bow can be identified.

Easton has introduced a new term indicating clearance problems called Minnowing. Like Fishtailing or Porpoising, Minnowing indicates a specific arrow flight disturbance. Minnowing will appear to look much like Fishtailing except that the tail of the arrow appears to move from side to side more quickly, and the amount of side swing is usually much less than in Fishtailing. (See Fig. 12.) Minnowing indicates inadequate clearance and is caused by the rear portion of the arrow (usually fletching) contacting the arrow rest assembly.

Correcting Clearance Problems

The following procedures can help you correct clearance problems that cause Minnowing:

1. If the arrow fletching is hitting the arrow rest, try rotating your arrow nock 1/32 of a turn. Continue rotating the nock in 1/32-turn increments until clearance is achieved.
2. Make sure your arrow rest support arm does not protrude past the outside of the arrow shaft when the arrow is resting on the support arm and is lying against the cushion plunger or side loading device. See Fig. 8.
3. Choose a lower profile fletching.
4. Follow the procedures for Tuning Adjustments within the Bow and Arrow System on page 10 for equipment modifications to achieve a better tune.
5. Move the cushion plunger or side loading device slightly out from the bow to help increase clearance if the other tuning modifications have no effect.

Paper Tuning Arrow Test

(Recurve or compound - RF, CF, CR)

Archers using mechanical release aids (CR) should review the following reminder notes before starting the Paper Tuning Test.

1. Align the arrow down the center of the bowstring with the tip of the arrow point correctly positioned as indicated in Fig. 7, page 3.
2. Initially position the sight pin over the centerline of the arrow.
3. When using a release aid the arrow normally bends more vertically than horizontally, so good clearance is essential. Usually, the entire arrow contacts the rest when it is shot and the fletching must be positioned to clear the rest.
   "Shoot-Through" Rests - It may be necessary to adjust the width of the arrow rest support arm(s) so the fletching will pass cleanly over or through.
   "Shoot-Around" Rests - Vane-to-nock indexing is very important and should be adjusted to achieve maximum clearance.

The Paper Tuning Arrow Test is the most commonly used bow tuning test for archers using compound bows with release aids. This test also works well for finger release:

1. Firmly attach a sheet of paper to a picture frame type rack approximately 24" X 24" (60 x 60 cm).
2. Position the center of the paper about shoulder height with a target mat about six feet behind the paper to stop the arrows.
3. Stand approximately 4 to 6 feet (7.8-1.5 m) from the paper.
4. Shoot a fletched arrow through the center of the paper with the arrow at shoulder height (parallel to the floor).
5. Observe how the paper is torn.

This tear indicates good arrow flight. The point and fletching enter the same hole.

This tear indicates a low nocking point. To correct, raise the nocking point 1/16" (1.6 mm) at a time and repeat the procedure until the low vertical tear is eliminated.

This tear indicates a high nocking point, clearance problem, or a very weak arrow if you are using a release aid. To correct, lower the nocking point 1/16" (1.6 mm) at a time until the high tear is eliminated. If, after moving the nocking point a few times, the problem is unchanged, the disturbance is most likely caused by a lack of clearance or by an arrow which is too weak (if using a release aid). To identify a clearance problem, check to see if the arrow fletching is hitting the arrow rest. (See "Clearance" on page 5.)

CR - If no clearance problem exists and you are using a mechanical release, try:

1. A more flexible arrow rest blade if using a launcher type rest or reduce downward spring tension on adjustable tension launcher rests.
2. Decreasing peak bow weight if there is an indication the arrow spine is too weak.
3. Reducing the amount the shaft overhangs the contact point on the arrow rest.
4. Choosing a stiffer arrow shaft.

This tear indicates a stiff arrow reaction for right-handed archers using finger release (RF, CF). Left-handed finger release archers will have an opposite pattern. This is an uncommon tear for right-handed compound archers using a mechanical release (CR). However, it can occur and generally indicates that the arrow rest position is too far to the right or that there is possible vane contact on the inside of the launcher rest.

Finger Release (RF, CF) To correct:

1. Increase bow weight/peak bow weight.
2. Use a heavier arrow point and/or insert combination.
3. Use a lighter bowstring (less strands or lighter material, like Fast Flight®).
4. Use a weaker spine arrow.
5. Decrease cushion plunger tension or use a weaker spring on "shoot around" rests.
6. CF only - Move the arrow rest slightly in toward the bow.

Mechanical Release Aid (CR) To correct:

1. Move the arrow rest to the left. Continue moving the rest to the left in small increments until the right tear is eliminated.
2. Make sure the arrow has adequate clearance past the cable guard and cables.
3. Make sure the bow hand is well relaxed to eliminate excessive bow hand torque.

This tear indicates a weak arrow reaction or clearance problem for right-handed finger release (RF, CF) archers. Left-handed finger release archers will have the opposite pattern. For right-handed compound archers using mechanical releases (CR), the left tear is common and usually indicates a weak arrow reaction and/or clearance problem. If a high-left tear exists, (see next tear illustration) make sure you correct the nocking point first before proceeding further.

Finger Release (RF, CF) To correct:

1. Check for Clearance (See page 5).
2. Decrease bow weight/peak bow weight.
3. Use a lighter arrow point and/or insert combination.
4. Use a heavier bowstring (more strands or heavier material).
5. Use a stiffer spine arrow.
6. Increase cushion plunger tension or use a stiffer spring on "shoot around" rests.
7. CF only - Move the arrow rest slightly out, away from the bow.

Mechanical Release Aid (CR) To correct:

1. Move the arrow rest to the right. Continue to move the rest to the right in small increments until the left tear is eliminated.
2. Make sure the bow hand is well relaxed to eliminate excessive bow hand torque.
3. Decrease peak bow weight.
4. Choose a stiffer spine arrow.

This tear shows a combination of more than one flight disturbance. Use the procedures that apply to the tear pattern for your style of shooting, and combine the recommendations, correcting the vertical pattern (nocking point) first, then the horizontal. If you experience a tuning problem (especially with the nocking point location) and are unable to correct a high/low tear in the paper, have your local pro shop check the "timing" (roll-over) of your eccentric wheels or cams.

For archers using release aids, it may, in some cases, be necessary to apply adjustments opposite from those described. The type of arrow rest and release aid combination used can alter the dynamic flex of the arrow to produce tear patterns contrary to those indicated (although it is uncommon).

Once you have achieved a good tune at 4 to 6 feet (1.2-1.8 m), move back 6 feet (1.8 m) more and continue to shoot through the paper. This ensures that the tune is correct and that the arrow was not just in a recovery position when it passed through the paper at the first distance.

SHORT DISTANCE TUNING

(Recurve and compound - RF, CF, CR)

Many times it is not possible to shoot long distances when your equipment needs to be tuned. The following method results in a very good equipment tune at short distances. Use this tuning method after you have completed one of the basic bow-tuning methods—either the Bare Shaft Planing or Paper Tuning Arrow Test.

Start at approximately 12 to 15 yards (meters) from the target. Use a 40 cm or 60 cm target face and place it with the face side in so you are shooting at a plain white target.

Up-Down Impact

Using fletched arrows only, shoot approximately 6 to 8 arrows along the top edge of the target face. This step determines if your nocking point is correct. See Fig. 13.

Normally, small tuning problems show up at close range, because the arrow has its maximum vibration at short distance. This test assists you in identifying these arrow flight problems and makes it possible to make finer adjustments than with the previous tuning procedures.

If you are unable to consistently hit the top edge of the target face, there is probably a small tuning disturbance in the equipment. To correct, make a 1/32" (.8 mm) nocking point adjustment either up or down and shoot again. Continue making nocking point adjustments in 1/32" (.8 mm) increments (no more than 1/32" (.8 mm) at a time).

If your arrows are hitting the top edge of the paper more consistently and you are achieving a straight, horizontal line of arrows across the top of the paper, you are correcting the disturbance. If the horizontal line of arrow impact is widening, go back to your original nocking point position and start making 1/32" (.8 mm) nocking point adjustments in the opposite direction. This will provide you with the correct nocking point position.

Left-Right Impact

Once you have achieved the straightest horizontal line of arrows that your ability will allow, you are ready to tune for left/right arrow impact. Shoot 6 to 8 arrows at the left edge of the paper in a vertical line. See Fig. 14.

To improve the left/right impact for CR and CF archers, move the in/out position of your arrow rest. This is done to compensate for the effect of the eccentric wheel. The offset of the eccentric wheel on compound bows does not always compensate for the degree of natural torque generated in the bow. The wheel often torques or leans over slightly as it reaches the full draw position. This is common and is nothing to be concerned about. At full draw, the "limb center" you started with in the preliminary setup may not really be the true balanced center. Therefore, through some trial and error, you must locate the best in/out position for the arrow to obtain maximum accuracy.

Make a 1/32" (.8 mm) adjustment either in or out and shoot again. Continue making 1/32" (.8 mm) adjustments until you achieve the best possible vertical impact line of arrows. If the vertical line widens, go back to your original arrow rest position and move it 1/32" (.8 mm) in the opposite direction. If the vertical line narrows, continue 1/32" (.8 mm) adjustments in that direction until you achieve the straightest line possible.

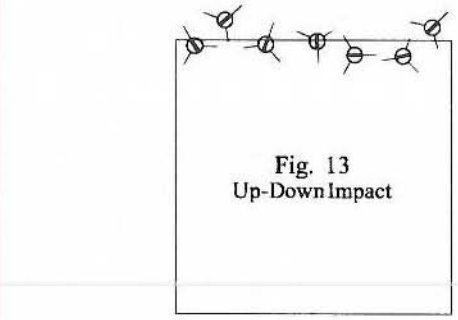


Fig. 13
Up-Down Impact

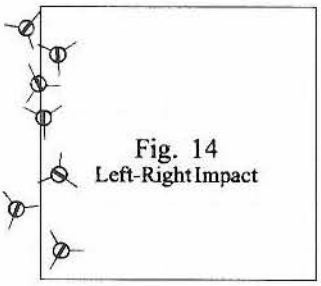


Fig. 14
Left-Right Impact

CF archers using cushion plungers should make the necessary arrow rest adjustments and then try a second tuning adjustment, the cushion plunger spring tension. Increase or decrease spring tension 1/8 of a turn at a time. Again, if the vertical line becomes wider, return to the original spring tension setting and make 1/8 turn adjustments in the opposite direction until you achieve a narrow vertical impact line.

RF archers should make cushion plunger spring tension adjustments only, increasing or decreasing the spring tension 1/8-turn at a time. If the vertical line becomes wider, return to the original spring tension setting and make 1/8-turn adjustments in the opposite direction until you achieve a narrow vertical impact line. Do not move the in/out position of your arrow! The in/out position of your arrow to the centerline of the bow has already been established in the preliminary equipment setup.

TROUBLE-SHOOTING ARROW GROUPS

You may have heard people say, "If your arrows group well at 20 yards, they will group at any distance," or, "If your arrows group at long distances, they will group at short distances." In some cases, neither statement is true. There may be a minute disturbance in the equipment

Fig. 15
Good grouping patterns show progressively increasing grouping sizes as shooting distances increase.

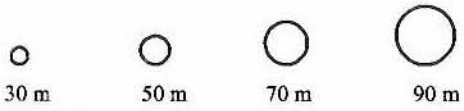


Fig. 16
Excessive Drag

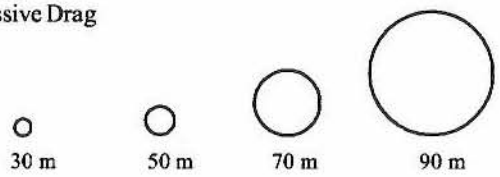


Fig. 17
Insufficient Clearance

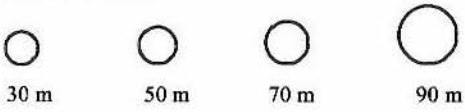
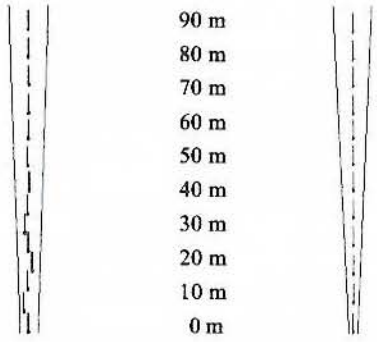


Fig. 18
Poor close range grouping
Acceptable long range grouping

Fig. 19
Path without disturbance



that affects the equipment's potential for superior accuracy and causes poor arrow grouping. What follows here is information that will help you perform the fine tuning adjustments necessary to eliminate most or all of the minute tuning problems.

Many archers have experienced one or all of the following arrow grouping/arrow flight combinations:

Poor arrow flight and good grouping - This is commonly the result of a stiff arrow. The arrow yaws slightly as it leaves the bow, but usually recovers quickly and often produces very acceptable grouping.

Good arrow flight and poor grouping - Although this seems contradictory, the phenomenon is somewhat common and relates to the tuning method you use. Having a perfect bullet hole through paper using the Paper Tuning Arrow Test, or having the bare shafts impact exactly with the fletched shafts using the Bare Shaft Planing Test, does not always mean your arrows will group well; it only indicates you have good arrow flight. For this reason, Easton has developed the Fine Tuning and Micro Tuning methods, to assist you in obtaining optimal grouping from your equipment.

Poor arrow flight and poor grouping - This is most often a problem of mismatched arrow spine or untuned equipment. The information and tuning procedures in this bulletin should help you correct this problem.

Good arrow flight and good grouping - This should be the end result of your efforts!

Arrow grouping patterns often reveal probable arrow flight problems. Two of the most common grouping indicators for determining arrow flight problems are described below. The examples provided are shown in FITA distances, although they easily correlate to any long- and short-distance shooting. Fig. 15 illustrates good grouping patterns at the distances indicated.

Excessive Drag

The grouping examples in Fig. 16 show a large pattern at long distances (90 m) but the grouping is within acceptable limits at closer distances. This pattern implies the arrow has too much drag. Excessive drag will cause the arrow to become unstable due to the rapid decay of its forward velocity. When forward velocity drops too quickly, instability occurs. This unstable flight causes poor grouping at long distances and extreme vulnerability to wind drift. On light weight arrows, it is very important to reduce drag to a minimum to maintain maximum downrange velocity. This can be done by reducing the size (height and/or length) of the fletching or by reducing the angle of the fletching, or both.

Insufficient Clearance

The grouping patterns in Fig. 17 show acceptable grouping at the two long distances. However, the shorter distance groups are not reduced in size proportionately to the longer distance groups. (Compare to Fig. 15). This usually indicates a clearance problem or micro distur-

bance within the bow and arrow system. To correct, see the section on Clearance on page 5 or the Fine Tuning and Micro Tuning sections on pages 12-14.

Fig. 18 illustrates why you may have problems with close distance grouping while long-distance groups are good. When an arrow is shot, it is at its maximum bending as it leaves the bow. As the arrow travels further, the amount of flexing reduces (dampens). If the flexing reduces, then so does the magnitude of any original disturbance. The example shows that the arrow has some disturbance and close range grouping is poor, although the arrow stabilizes at longer range and provides acceptable groups. Micro disturbances and clearance problems usually cause these disturbances.

Fig. 19 shows the path of the arrow when it leaves the bow without any disturbance. This is the path you are trying to achieve in the Fine Tuning and Micro Tuning processes.

ADJUSTMENTS WITHIN THE BOW AND ARROW SYSTEM

If you are having problems tuning your bow, you will need to make some modifications to your equipment to achieve a better tune. Here are some suggestions:

Bow Weight Adjustment

Virtually all compound bows, as well as some recurve bows, have an adjustable draw weight. If your arrow reaction is too stiff, increase the draw weight. If your arrow reaction is too weak, decrease the draw weight.

Bowstring

Bowstring "weight" can have a significant effect on arrow spine. Increasing or decreasing the number of strands in the bowstring can influence the arrow's dynamic spine enough to require a shaft size change of one full size weaker or stiffer. If your arrow reaction is too stiff, decrease the number of strands in your bowstring. If your arrow reaction is too weak, increase the number of strands. Serving weight (center serving) can also produce the same effect. For example, monofilament center serving will cause the arrow to react stiffer than lighter weight nylon center serving. Simply changing from a metal nocking point to a "tie-on" nocking point can have a noticeable effect on arrow spine, due to the weight difference between the two styles of nocking points.

The bowstring is a critical part of your technical equipment. If you have a very difficult time tuning your bow, the problem could be the bowstring. An incorrectly made bowstring can produce a tension imbalance in the strands of the string causing some strands to be looser than others. This imbalance forces the string to load and stretch at different rates, creating an inconsistent arrow launch which greatly decreases accuracy. If a problem exists, and tuning procedures don't seem to be working, try changing the string and retuning.

Point and Insert Weight

X10, A/C/E and A/C/C, & Beman ICS arrows can be tuned by using various point and/or insert weight combinations. External component systems use weight combinations of point plus outsert. Aluminum arrows can be point-weight-tuned by using 7%, 8% or 9% F.O.C. NIBB points. If your arrow is too weak, go to a lighter insert/point. If your arrow is too stiff, try a heavier insert/point. Continue to change insert and/or point weight within the acceptable balance point range (7-16% F.O.C.).

Brace Height

For recurve bows, another way of altering arrow spine is with the brace height. By increasing or decreasing the distance from the bowstring to the pivot point of the grip, the dynamic spine of the arrow can be made slightly weaker or stiffer. Increasing brace height will make the arrow shoot weaker, and decreasing brace height will make the arrow shoot stiffer.

Brace height affects arrow spine by increasing or decreasing the amount of energy delivered to the arrow at the moment of release. Raising the brace height (shortening the bowstring) compresses the limbs, increasing stress (prestress or preload) in the limb material. The more preloading of the limbs, the greater the actual bow poundage at full draw. The reverse is true when lowering brace height. A lower brace height (lengthening the bowstring) reduces the prestress in the limbs and reduces bow weight at full draw.

RECURVE BOW LENGTH	MAXIMUM BRACE HEIGHT RANGE	
64"	7 3/4" - 9"	(19.7 cm to 22.9 cm)
66"	8" - 9 1/4"	(20.3 cm to 23.5 cm)
68"	8 1/4" - 9 1/2"	(21.0 cm to 24.1 cm)
70"	8 1/2" - 9 3/4"	(21.6 cm to 24.8 cm)

However, raising brace height produces some small loss in arrow velocity as the slight increase in draw weight does not equally compensate for the reduction in the bow's "power stroke." When the power stroke is reduced, the amount of time the arrow stays on the bowstring is also reduced, in turn, decreasing the length of time the arrow has to absorb the bow's energy.

Although you may note a small loss in velocity when increasing brace height, do not let speed be the deciding factor when selecting the best brace height for your bow. As is often said, "Better to have a slow bull's eye than a fast miss."

Adjusting the brace height on a compound bow is often overlooked as a tuning adjustment. This is because the changes in brace height will change the draw length and draw weight possibly requiring additional adjustments. Nevertheless, finding the correct brace height for your compound (usually higher than the manufacturer's setting)