SHOT PLACEMENT

A sharp broadhead drops game with amazing efficiency. The key to success is however a sharp broadhead and correct shot placement.

To effect a clean, humane kill, broadheads must be razor sharp!

The many hours of arduous effort, practice and planning have come to this - a decision which requires, at most, a few fleeting seconds - the moments of truth.

More bowhunters fail here more than at any other time during the chase. The decision is this - just when is the precise moment when the animal is in your effective bow range, has it's guard down and you stand the best chance of penetrating it's defences with an arrow into it's vitals which will cause a quick, humane death? If you fail now, there go your hopes. There is seldom the luxury of a second shot.

- Anatomy of the shot - how an arrow kills

A sharp broadhead kills by:

Disrupting the central nervous system (brain or spinal chord is hit).

Inducing massive bleeding (hemorrhage).

Slow death through infection (usually peritonitis).

Although the arrow penetration and diameter of wound channel is important, the sharpness of the broadhead is critical in that it must be able to cut through tissue (skin, bone, connective tissue, muscle,) to reach large blood vessels or organs with a rich blood supply (heart, lungs, spleen, liver). If massive blood loss is induced the animal is unconscious within seconds and dies very quickly.

Brain and spinal shots are mostly unintentional but are devastatingly effective resulting in immediate collapse. Most bowhunters prefer to place arrows in the heart / lung area which causes profuse and rapid blood loss, lung collapse and humane death. An animal will die if it loses approximately 30% of it's blood volume.

In most instances, an animal that has been hit by a sharp broadhead in the heart / lung vitals, will leave a blood trail fairly easy to follow. We will look at this in the section on "Follow up procedures".

- **Blood physiology and the blood clotting mechanism (coagulation).** (Figure 1)

Blood is the bodies transport system. It transports respiratory gasses (oxygen and carbon dioxide), food, antibodies to fight infection, and waste products.

Transporting oxygen to the tissues of the body is one of it's most vital functions. Blood picks up fresh oxygen in the alveoli of the lungs and transports it as oxyhaemoglobin to the body tissues. The blood being pumped out of the aorta and through the arteries in highly oxygenated and bright red in colour. At the tissue level, blood gives off oxygen and takes up carbon dioxide which is transported in the veins back to the lungs, via the heart. It is exhaled from the lungs. Because venous blood is low in oxygen content it is darker than arterial blood. Lung blood is bright red with a pinkish hue and is often frothy or bubbly in appearance.

Several mechanisms help to prevent blood loss from ruptured vessels:

• Severe blood loss leads to a decrease in blood pressure which reduces the flow of blood from the damaged area.

• Damaged blood vessels constrict and thereby decrease blood loss.

• The most important mechanism however, is the closing of blood vessels at the site of the injury by a plug consisting of coagulated protein and blood cells. Such a plug or clot, is important in the complete arrest of bleeding from minor injuries, but if major blood vessels have been ruptured it will not suffice.

To be effective a clotting mechanism must act rapidly, and yet, the animal must be assured that blood does not clot within the vascular system. Blood must therefore have the inherent ability to clot and the clotting mechanism should be ready to be turned on when needed; on the other hand it must not be set into motion inadvertently as this, in itself, could be fatal (intravascular clotting).

A blood clot consists of the protein fibrin, an insoluble fibrous protein which is formed from fibrinogen, a soluble protein present in normal plasma. The transformation of fibrinogen to fibrin is catalyzed by an enzyme called thrombin, and the reason that blood does not clot within the circulatory system is that thrombin is absent from the circulating blood. It's precursor, prothrombin, is however present in circulating plasma. Clotting is normally initiated when blood comes into contact with damaged tissues. When a blood vessel is cut, thrombinplastin is released from the vessel wall which initiates the clotting process. If the cut is ragged and made by a fairly blunt object (like a blunt broadhead), more thromboplastin is released, and there is stronger constriction of the vessel wall which will stop the bleeding sooner than if the vessel wall was cut with a sharp object (such as a sharp broadhead). A clean cut causes the blood vessels to constrict less vigorously and bleeding is prolonged.

What is necessary to initiate coagulation is the formation of thrombin from prothrombin. This is the final step in a complex sequence of biochemical events. See a diagram of a simplified clotting process on the next page (Figure 9.3).

When blood vessels are damaged a series of enzymatic steps is generated in which the enzyme formed in the first step serves as a catalyst or activator for the next step and so on. This series of steps forms an "enzyme cascade" which ends up with the final formation of the clot in which the soluble fibrinogen is changed into the insoluble fibrin.

As long as the animal is bleeding it will leave a blood trail to follow. The normal clotting time can differ from species to species. Some examples are shown in Table 9.6.

THE BLOOD CLOTTING PROCESS

The broadhead severs the blood vessel.

1. Bleeding starts.

2. Thromboplastin is released from the damaged wall of the blood vessel into the circulating blood plasma.

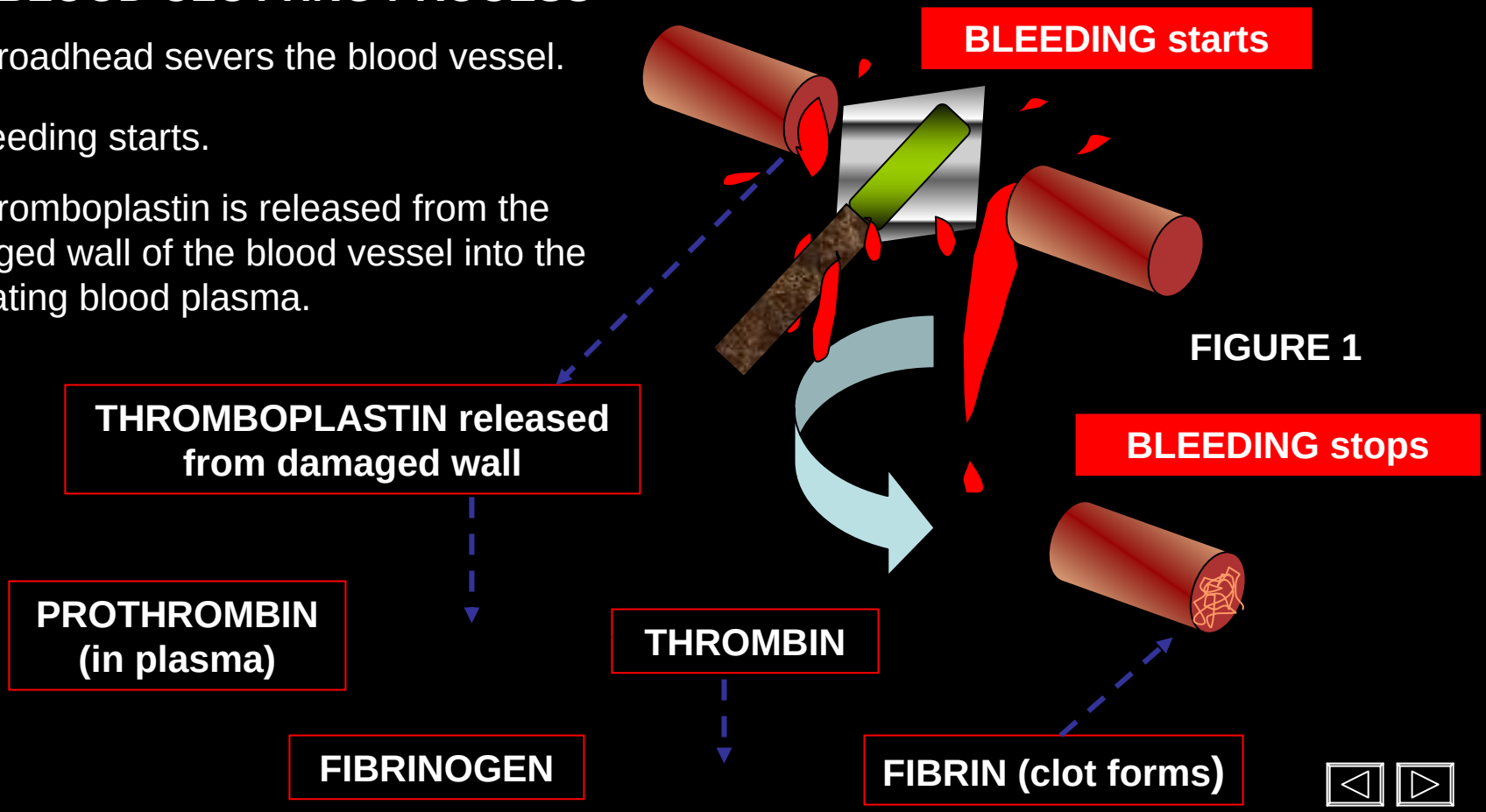


FIGURE 1

3. The thromboplastin acts as a catalyst to convert prothrombin in into thrombin.

4. The thrombin in turn enables fibrinogen to change into fibrin threads which trap blood cells, form a clot at the damage site and, reduce or stop bleeding. This is aided by the constriction of the muscular wall of the blood vessel.

If blood has not yet clotted you will have a good indication of how recently the animal has passed that way. For example: if you are following an impala and find fresh blood that has just begun to clot, you will know that the animal was there about two and a half minutes ago.

FIGURE 9.6

Animal group	Average clotting time (minutes)
Horse family (e.g. zebra)	$11^1/_2$
Dog family (e.g. jackal, hyaena)	$2^1/_2$
Pig family (e.g. warthog, bushpig)	$3^1/_2$
Antelope family (e.g. impala, kudu, duiker)	$2^1/_2$

When you arrive at your moment of truth where should you aim to get the quickest and most humane kill?

Let us look at a typical example. An impala adult ram weighs approximately 55 kg (about 120 pounds) and has a blood volume of approximately 3,9 liters. An animal will die when it loses about 30% of it's blood volume which in the case of the impala is about 1,2 liters.

When a large artery such as the aorta is severed this volume of blood will be lost within 10 - 15 seconds. We will look closely at the anatomy of a zebra on the next page as an example. The shot which will kill almost instantaneously is one which enters the brain or severs the spinal chord.

Although an arrow shot from a compound bow is capable of penetrating the spine or skull these areas represent a small and difficult target easily missed and resulting in a wounded animal. A sharp broadhead cuts very cleanly and it has been well documented that arrow wounds that have not hit internal organs heal well, often without any adverse effects on the animal. Bullets in contrast strike and expand with tremendous force (soft points), pulverizing bone and flesh to create major damage to tissue which invariably results in infection and slow death in a bullet wounded animal. A broadhead relies on streamlined, low friction cutting action to do it's job. Bullets are able to penetrate fairly heavy bone but broadheads must be directed to soft body areas where vital organs exist. The ideal target zone is therefore the heart / lung area. An arrow into this area will penetrate well and will cause a quick and relatively humane kill. Areas to avoid are the head, neck, paunch and rump. Although some of these areas are well supplied with large blood vessels which can result in a kill, they are difficult to locate externally. There are two basic reasons why a bowhunter will take an unwarranted shot: (1) Ignorance - they may simply not know any better. (2) The hunter may allow temptation to get the better of him and attempt a shot which is risky or marginal.

NINE SHOTS TO CONSIDER:

1. The broadside shot. (Figure 2 and 3)

The ideal organ to hit to cause profuse bleeding is the heart, but the heart lies very low in the thorax between the front legs and is afforded partial protection by the upper leg bones, the brisket, and thick muscle. When aiming for a safe shot in the broadside presentation aim for a region just above the heart - a point at the top of the crease at the back of the front leg.

The broadside shot is one of the most effective. There is a wide margin of error around the aiming point resulting in a large killing zone. The scapula has been removed for clarity as well as most of the ribs.

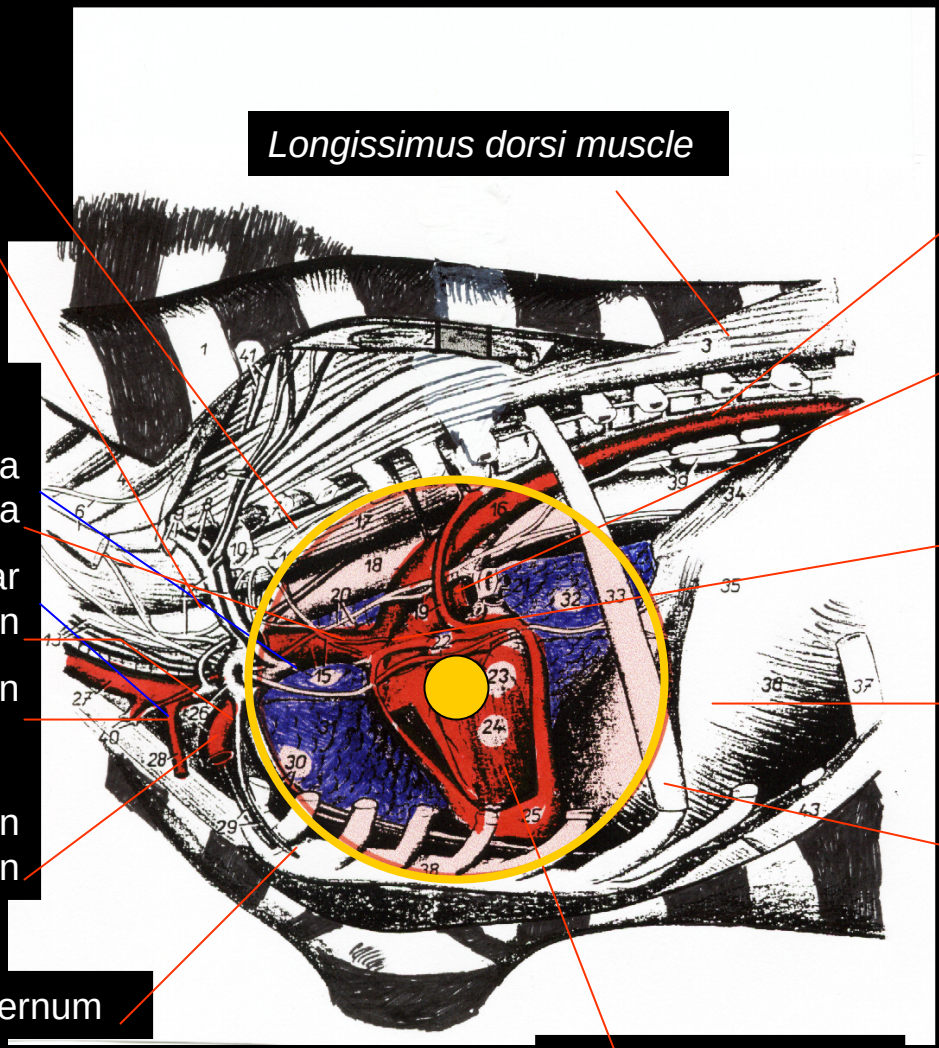
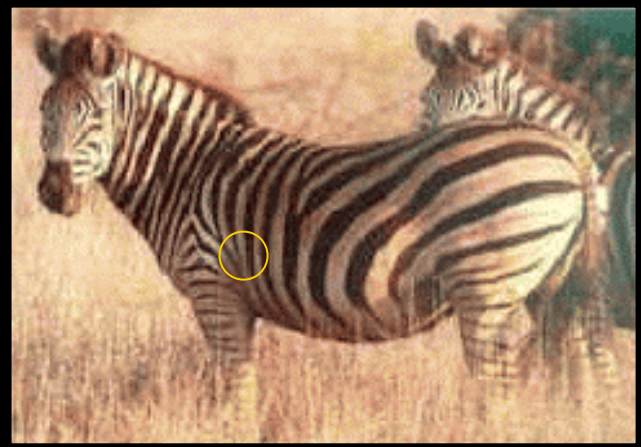


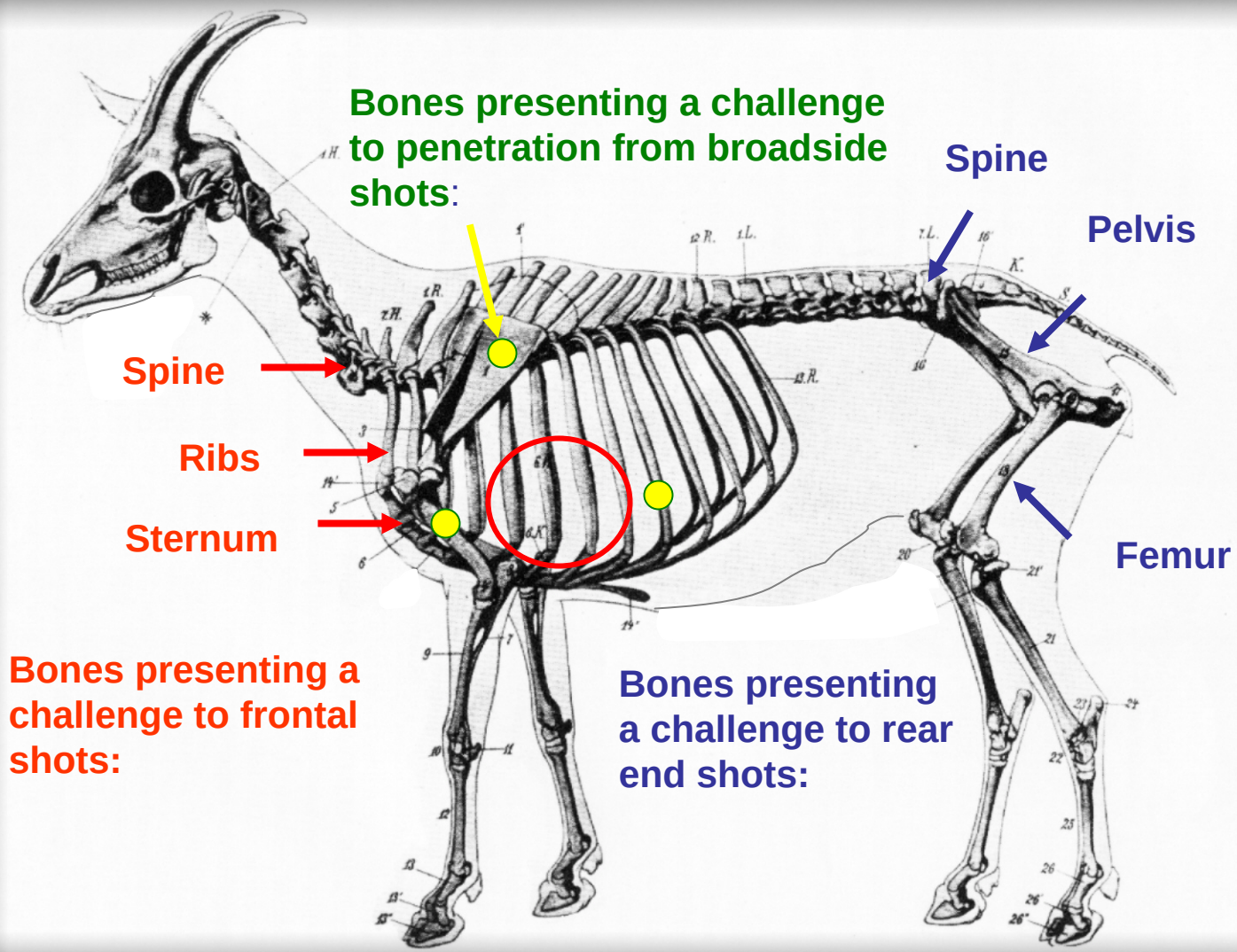
FIGURE 2

Aiming at this point allows you the greatest margin of possible error. Slightly forward and your arrow will still hit major blood vessels (external jugular, superior vena cava), anterior lobes of the lung (s), and nerve trunks. A shot slightly high will hit major blood vessels exiting the heart (aorta, pulmonary veins and artery etc.), and the top lobes of the lungs. A shot even higher than this can even hit the spine. A shot slightly back of the aiming point can hit anterior lobes of the lungs or liver. Slightly low and you will hit the bottom of the heart and lower lobes of the lungs. Hitting too far forward or back can create problems as we will see on the next page.

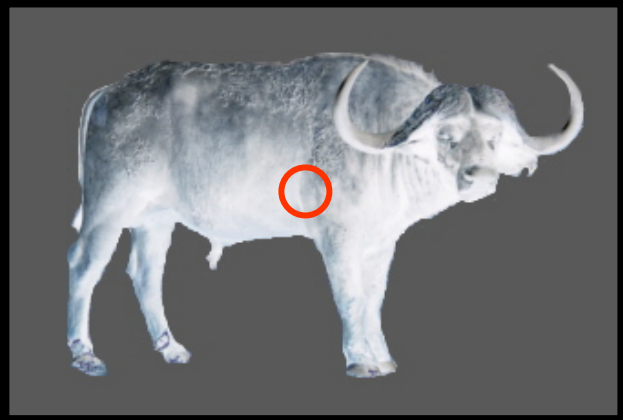


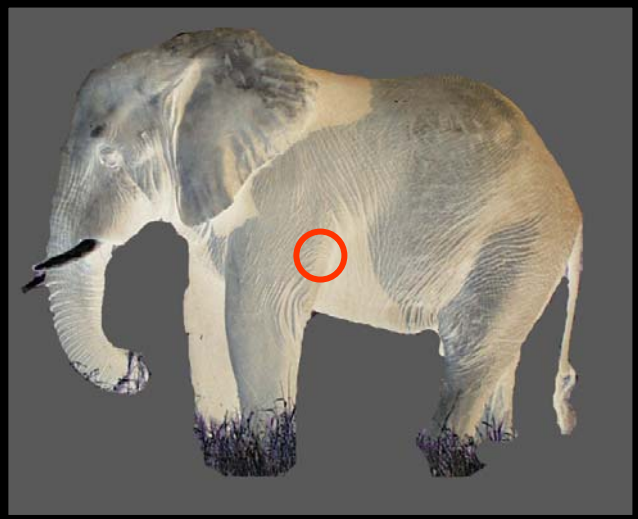
The broadside shot is suitable for almost all bird and mammal species.

FIGURE 3: SHOT PLACEMENT & SKELETAL STRUCTURES



It is possible in some large species to place an arrow precisely between the ribs. This can be done in elephant, giraffe, and rhino that have gaps between the ribs but is risky with buffalo that have overlapping ribs. This does however require a very accurate shot from close range. See below.





There are important considerations with broadside shot placement the most important being not to place the shot too far back. This will result in perforation of the stomach , rumen or intestines which will cause infection of the abdominal wall, referred to as peritonitis, and a slow, painful death for the animal.

Any shot behind the line of the diaphragm is likely to result in a gut shot animal

No ethical hunter wants this to happen. Shots too far forward can hit the upper leg bone (humerus) or shoulder blade (scapula) and impede penetration.

A further useful indicator for the broadside shot is that it must be at a level of about one third of the width of the body (as shown below).

The level of the broadside heart / lung shot must be at one about one third of the width of the body.

In concluding this section on broadside shot placement it can also be mentioned that one of the reasons that this shot is so effective is that, in most small and medium sized animal (up to the size of kudu and wildebeest), complete pass through of the arrow is not at all unusual, resulting in an entry and exit wound, and a good blood trail to follow (see below).

A good entry and exit wound will leave a clear blood trail to follow

2. Quartering away shot
(Figure 4, 5, 6 and 7)

This is one of the most effective, if not the easiest, shots you can take with almost any animal and especially with dangerous species such as buffalo, rhino, elephant and hippo. This shot can be a challenging one.

The aiming point uses the opposite foreleg as a reference point. If placed correctly the arrow should enter between the last rib and the pelvis and will penetrate liver, diaphragm, one or both lungs and heart, resulting in a quick kill. If placed in the correct position there is no hard tissue to impede penetration of the arrow. What makes the shot a challenging one is that the target “window” can be fairly narrow. The more oblique the position of the animal the narrower this window comes until a point is reached where the shot must be passed up.The hunter must position himself slightly to the rear of the animal. This is also a good position to escape observation.

FIGURE 4

The level of the shot is the same as that for a broadside shot - about $^{1}/_{3}$ up from the belly.

The following pages illustrate the anatomy, advantages and limitations of this shot.

Bones which can make a quartering away shot quite difficult are ribs, femur and pelvis. The area indicated by the light blue fill is devoid of any bone to impede the entry of an arrow.

The aiming point is the intersection shown by the blue vertical and horizontal lines.

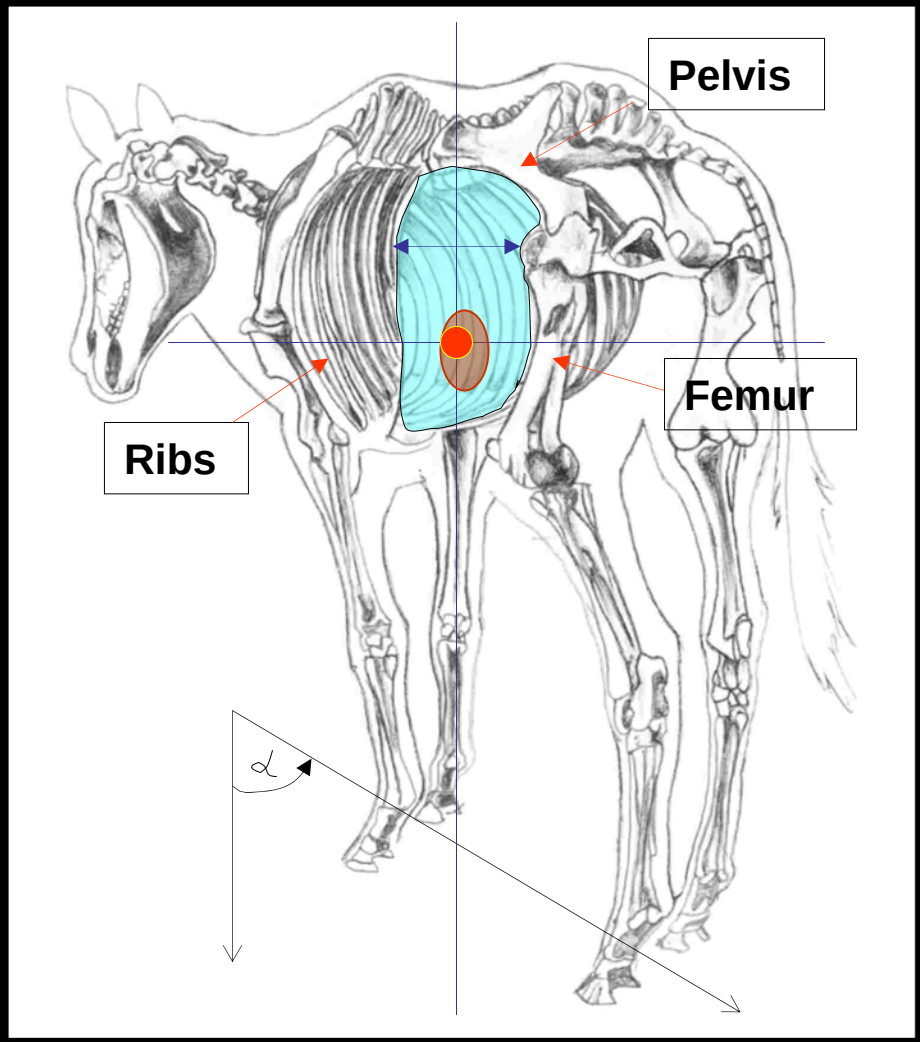


FIGURE 5

The aiming window shown by the blue arrow will depend on the angle at which the animal is standing in relation to the hunter. If this angle becomes too oblique the gap between the pelvis / femur and the ribs will become too small making it inadvisable to risk a shot. This is illustrated on the next page.

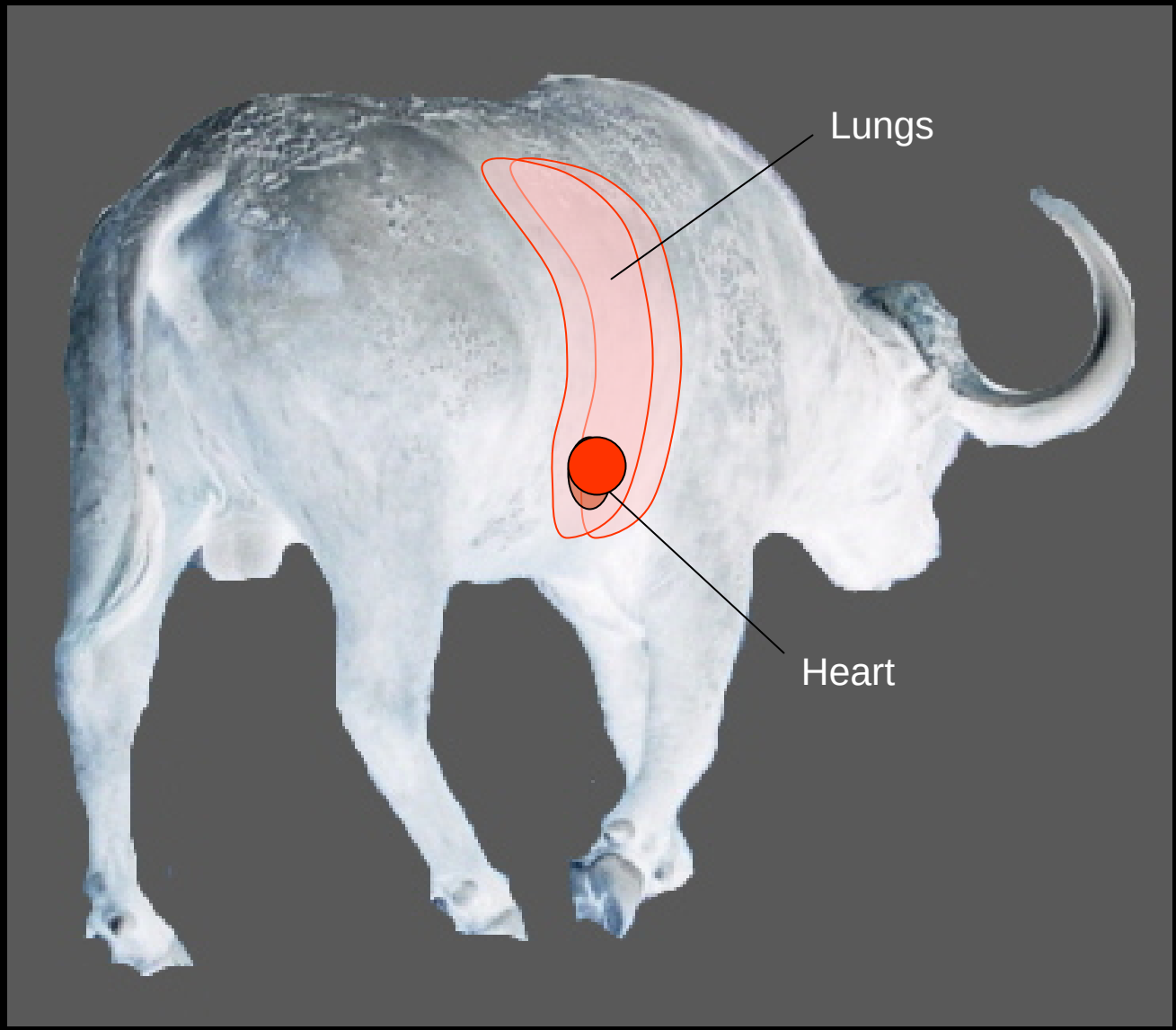
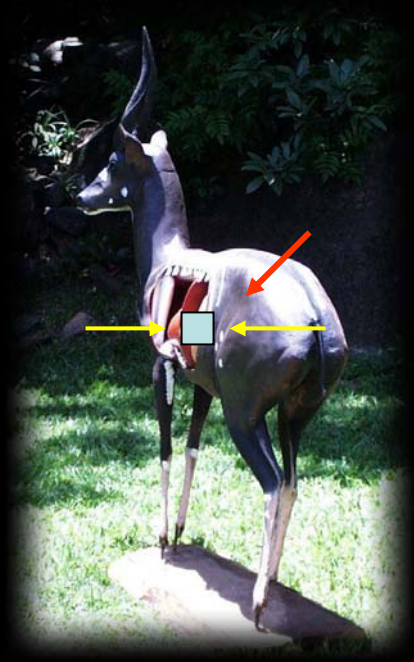


FIGURE 6: This quartering away position offers the bowhunter a good shot into the heart / lung vitals.

FIGURE 7:THE EFFECT OF ANGLE ON QUARTERING AWAY SHOTS

The perfect quartering away shot. An arrow in the green square is likely to hit the heart or major blood vessels exiting the heart and cause single or double lung puncture. The arrow should penetrate the ribs. The femur (yellow arrow) and pelvis (red arrow) are well out of the way.

Another excellent position for a quartering away shot. The target area is however shrinking, the femur and pelvis moving closer, and the rib angle becoming more oblique. Could hit lung(s), heart, liver and diaphragm



The limit for the quartering away shot. The target window has become small with no room for error. Slightly right and you will hit the pelvis or femur. Slightly left and the arrow will deflect off the ribs. Double lung puncture is unlikely.

No shot - the target window is unacceptably small. The angle is too oblique with no room for error. Arrows ever so slightly off target will be deflected off the ribs, femur or pelvis. Aiming point almost obscured by the femur.

3. Quartering on shots. (Figure 8)

This is similar to the facing on shot and is not advised. Quartering on shots are marginal at best because the vital target area is reduced by the scapula (shoulder blade), sternum (brisket) and humerus (upper foreleg bone). In large species there is also a bulk of heavy pectoral muscle. In an animal the size of a bushbuck the target window is reduced in size to about 3” (75mm) in front of the closer shoulder, (see below). A misdirected arrow is either going to impact with bone or end up in the gut - neither of which is desirable.

FIGURE 8

4. Facing on or head on shots. (Figure 9)

Most bowhunters will at some time find themselves at full draw, staring face to face at an animal that has detected their presence and turned to face them. This is a poor shot to take (except for perhaps small species and birds) because it is impossible to hit both lungs and the heart is protected by the brisket, and shoulder bones. The target area is small and the head and neck always moving. Good penetration in large animals will also be a problem because of the distance from point of entry to vital organs (see two pages ahead). Some of the larger species such as hippo and rhino hold their heads low and a frontal shot into the heart lung area with archery equipment is almost impossible. The skulls of species such as rhino, buffalo, hippo, and elephant are very thick and an arrow will not penetrate them. In animals that hold their heads up it might be possible to effect a kill by hitting vital structures in the neck such as the carotid arteries, jugular veins, vagus nerves or spine - this however cannot be done with any degree of predictable accuracy and would be purely by chance. The fact that you are in full view of the animal and that it is likely to run at the first sign of movement (or charge!), and is also very likely to jump the string makes, this shot a high risk one and should not be attempted. Be patient. If you are well camouflaged and have the wind in your favour an animal will, after staring at you for a few minutes (it might feel like hours), often turn side on affording you the opportunity for a broadside shot.

On the following page you will se what we should not attempt frontal shots with archery equipment.

WHY SHOULD WE NOT ATTEMPT FRONTAL SHOTS WITH ARCHERY EQUIPMENT ?

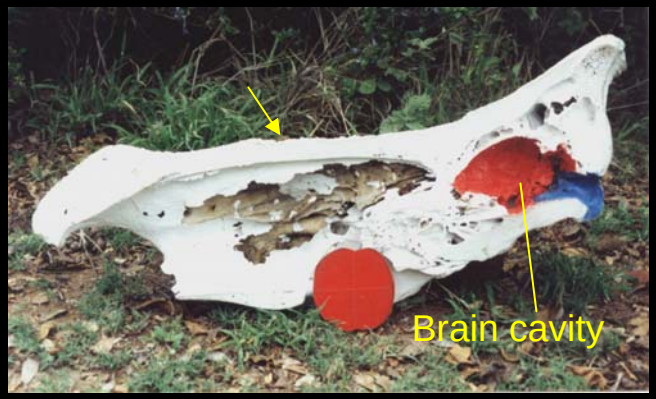
The head and neck are in almost constant motion (i.e. a moving target) and the animal will be looking at you.

The neck has vital structures such as carotid arteries, jugular veins, vagus nerves and spine but is a narrow and constantly moving target.

DON'T ATTEMPT FRONTAL SHOTS

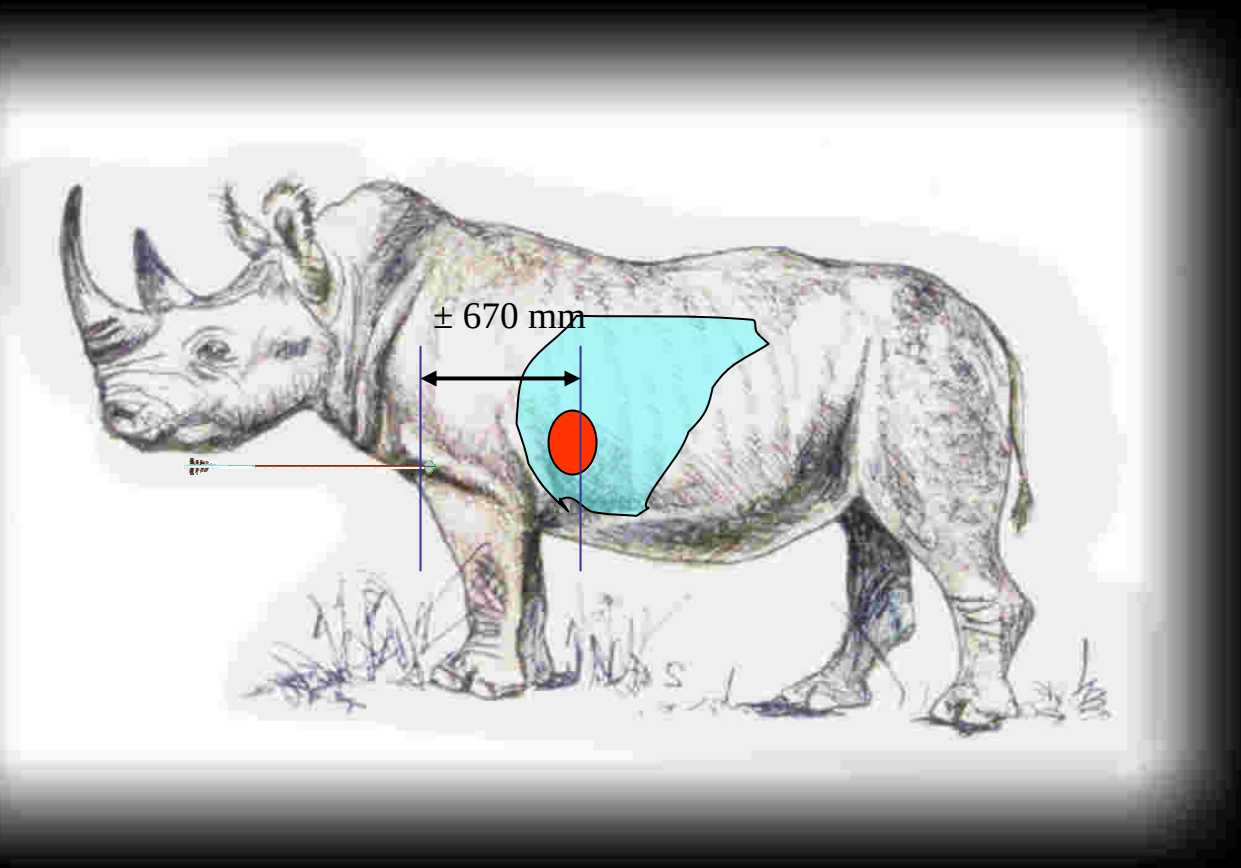
The target area (red circles) is very small and protected by shoulder bones, and brisket (red arrows).

FIGURE 9



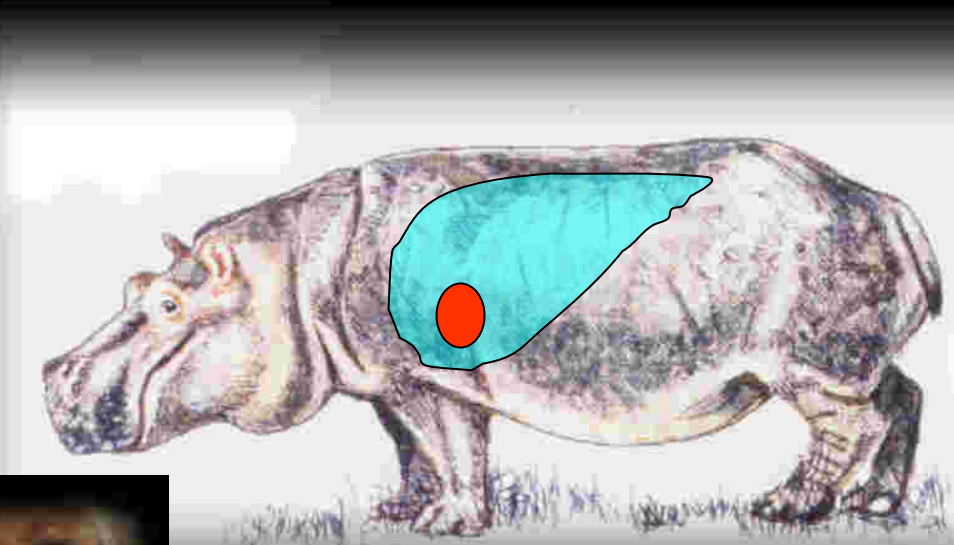
Attempting frontal shots at large animals is not advisable. Not only is there a very real danger of hitting large bone structures but the arrow also has a long way to penetrate before reaching vital organs. Animals like hippo and rhino also tend to keep their heads low and attempting to put an arrow through the thick skulls of these animals is futile.

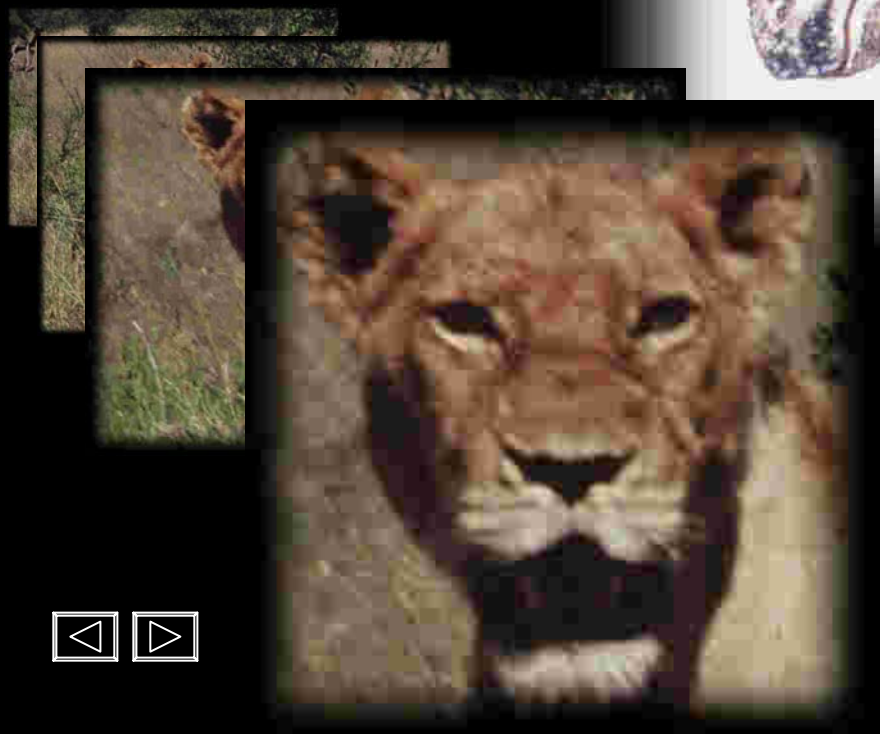
Top left shows the skull of a white rhino - about 30mm thick (arrows). Brain diameter about 14cm.



A hippo skull on the left. Note too the long distance an arrow would have to reach the vitals from a frontal shot and the position of the head - making this almost impossible.

Attempting a frontal shot at a big or dangerous animal is pushing your luck and might just result in this….





And you don’t want to be on the receiving end with just a bow and arrow to defend yourself with !

Shown below are cross sections of the skull of an elephant, buffalo and lion to compare with those of the hippo and rhino shown on the previous two pages. The red part of the skull shows the extent of the brain cavity and the round disc the frontal cross section showing the diameter of the brain. Targets organs meant only for high powered rifles and not for arrows.

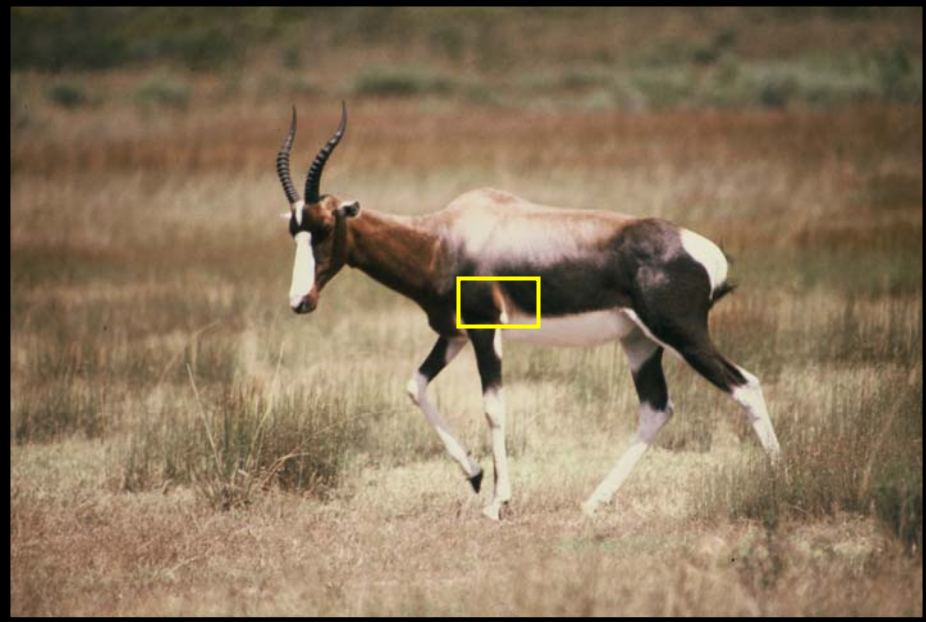
Elephant (top), buffalo (top right) and lion (right).

To summarize thus far: We do not attempt frontal shots with archery equipment !

5. The walking shot. (Figure 10)

Experienced bowhunters are comfortable with taking walking shots. When an animal is broadside or quartering away, little, if any leading is required. The big mistake most bowhunters make is to be impatient. An animal will often stand after walking a few paces to survey it's surroundings, affording you the opportunity of a stationary target.

Novice bowhunters should not attempt this shot. Release of the arrow should be timed with leg movement.



The shot should not be taken whilst the animal is walking. Rather pass up the shot or wait for the animal to stand. The rewards are worth the patience.

FIGURE 10

The faster the animal moves the riskier the shot becomes. The front leg nearest to you should be forward when you shoot. If it is back the arrow may hit it and prevent it from reaching the vitals.

USE DISCRETION WHEN ATTEMPTING WALKING SHOTS

6. The running shot. (Figure 11, and Table 1)

The answer to this one is easy. No ethical bowhunter should attempt a shot at a fast walking, trotting,or running animal ! Expert bowhunters are capable of taking running shots but as a general rule it is irresponsible and unethical. There are so many variables involved that a running shot, especially with bow and arrow, **SHOULD NOT BE ATTEMPTED**.

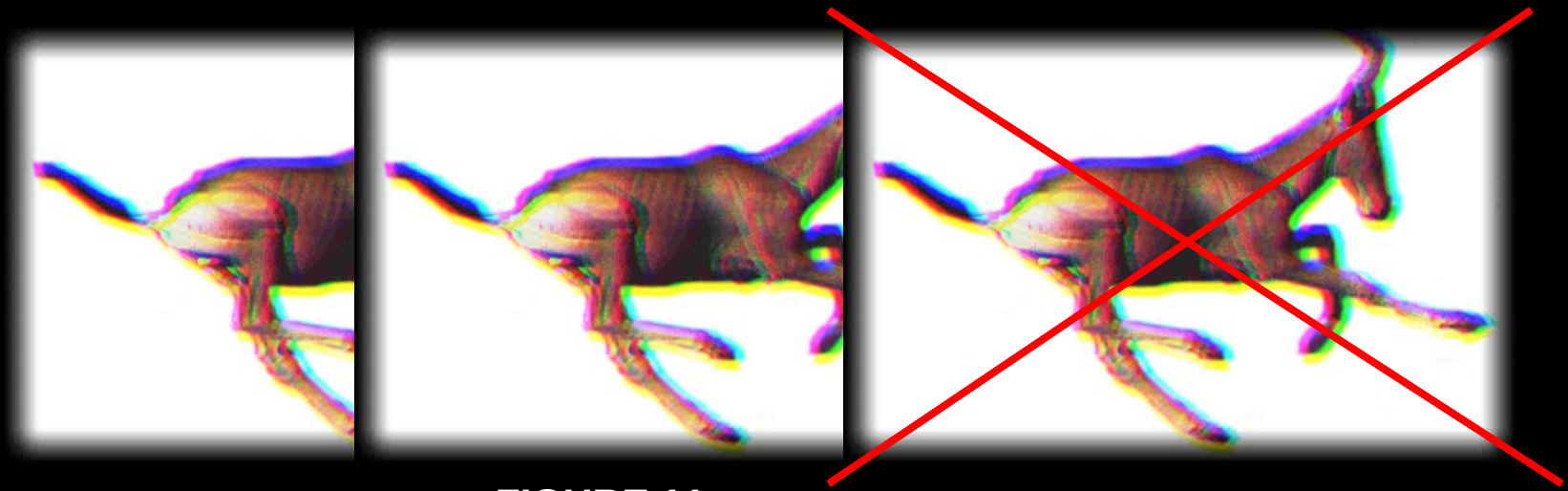


FIGURE 11

NO ! NO ! NO ! IF YOU ARE AN ETHICAL BOWHUNTER DON'T EVEN CONSIDER A RUNNING SHOT !

See the next page for why.

When shooting at a moving target most hunters think only in terms of horizontal lead. For angling shots however, both horizontal and vertical leads are involved. While the horizontal lead decreases with increasing angle, vertical lead comes rapidly into play (see right). In Table 1 below it also becomes evident that there are too many variables involved in attempting running shots.

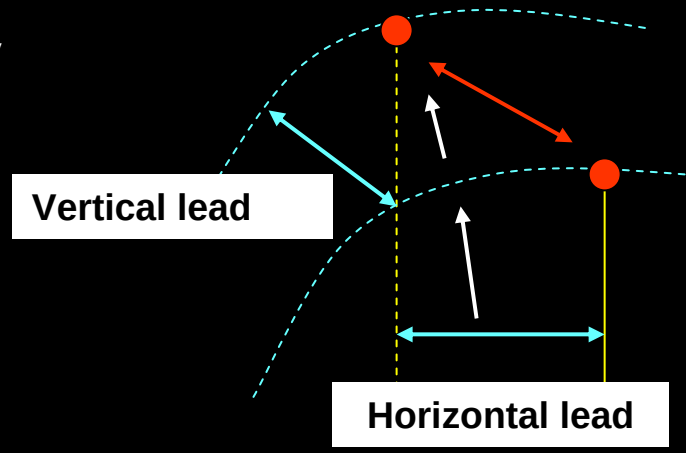


TABLE 1

HORIZONTAL LEAD FOR A BROADSIDE SHOT AT VARIOUS TARGET SPEEDS, ARROW SPEEDS AND SHOT DISTANCES.

Arrow speed	Shot distance	Ambling walk	Fast walk	Trotting	Running
(fps)	(yards)	2 mph	5 mph	15 mph	35 mph
150	10	0,6	1,5	4,4	10,9
	20	1,2	2,9	8,9	21,9
	30	1,8	4,4	13,3	32,,8
225	10	0,4	1,0	2,9	7,0
	20	0,8	2,0	5,9	14,1
	30	1,2	2,9	8.8	21,1
300	10	0,3	0,7	2,2	5,2
	20	0,6	1,5	4,4	10,4
	30	0,9	2,2	6,6	15,6

7. Shooting through obstructions. (Figure 12)

The deflected arrow is probably the oldest excuse in bowhunting. Nonetheless it is one of the most common causes of missed shots. Often poor light prevent us from seeing small branches or leaves. There are times when we might elect to shoot through foliage. The consequences of the shot then depend on what contact is made and how big the deflection is. Light foliage close to the animal is less likely to cause deflection as opposed to obstructions close to the hunter. As far as possible avoid attempting to shoot through foliage.

RATHER PASS UP A SHOT THAT REQUIRES YOU TO SHOOT THROUGH OBSTRUCTIONS.

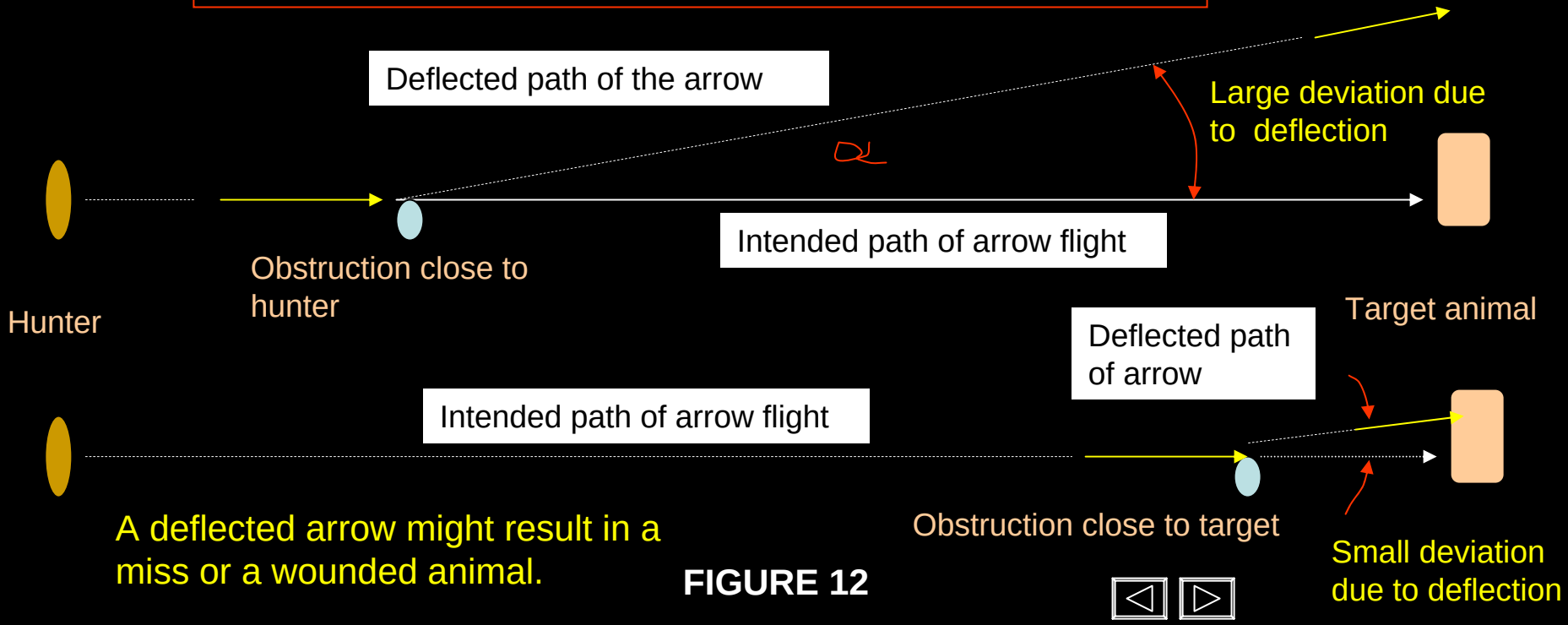


FIGURE 12

8. Shooting straight down. (Figure 13)

Treestand hunters and hunters shooting from elevated hides often find themselves shooting at an animal below them. This is an acceptable shot for many species but there are some factors to consider. When shooting down at a target there is a tendency to shoot high - you must compensate for this by aiming slightly lower than if you were shooting on the level. The angle and distance to the target will determine how much you must compensate and this can be determined for your own personal equipment by careful experimentation in preparation for the hunt. The trick when shooting from above is not to visualize side view vital organ locations - they are different when viewed from above. The shot must be angled forward towards the vital organs and you must visualize where you want your arrow to end up. Depending on your position relative to the animal you will have to put the arrow in further back for shallow angles and almost directly down into the vital organs if the animal is immediately below you. This is illustrated on the next page. A shot directed at the spine is an option on small to medium sized animals. If you miss the spine and the arrow is still directed towards the vitals it can still produce a lethal shot. The effect of a spinal shot will also be immediate and the animal will collapse on the spot if the spinal chord is severed. This shot should however not be attempted on large or heavy boned animals.

It is advisable to practice shooting from elevated positions before the actual hunt as it poses unique challenges, different from shooting on level ground.

FIGURE 13:SHOOTING STRAIGHT DOWN FROM ELEVATED POSITIONS

Position of the hunter X X X X

Note that the shallower the angle is from which the hunter is shooting the further back along the back he must aim to angle the arrow in towards the vitals.

From this position a heart / lung shot is indicated by the yellow dot and a spinal shot by the red dot.

9. The rear end shot. (Figure 14)

Although this is a risky shot and not generally advised - especially in large animals - a shot, directly from the rear, is sometimes effective as it can pass through the intestines, liver, diaphragm, or spleen and end up in the heart or a lung. Major blood vessels may also be severed rendering it a lethal shot. In an American study it was found that many deer are successfully hunted with rear end shots by cutting the large femoral arteries which run down the inside of the rear legs. Ethically however this is a questionable shot and should not be taken. The target area is small, the risk of wounding high and the predictability of a quick and humane kill uncertain.

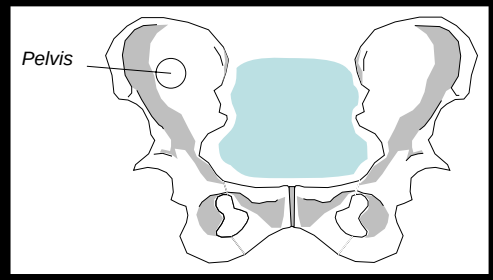
Penetration into the vitals might pose a problem in larger animals by virtue of the distance the arrow will have to travel to reach them. This is even further than a frontal shot. The bones in the rear end of an animal making up the pelvic girdle are generally the most robust of all the bones in the body and can pose a serious obstacle to arrow penetration. Refer back to the illustrations on skeletal structure to refresh your memory.

The risks involved with taking rear end shots are shown in the diagram on the next page.

FIGURE 15:REASONS WHY REAR END SHOTS SHOULD NOT BE ATTEMPTED

As can be seen, the target window is very small and is surrounded by bony structures such as the spinal column, pelvis and femurs which will have a significant influence on arrow penetration.

Pelvis showing target window



Sometimes, (hardly ever by design), the femoral arteries are severed by an arrow and the animal dies quickly.This should never be used as justification for this shot.