INFORMATION SHEET

CARTRIDGE PATTERNING

WE NEED TO DO IT - AND BETTER!

It is rare in any discussion about shooting and guns that the word 'pattern' does not occur. Much store is put in what it reveals about gun or cartridge performance and the Gun's success or otherwise in the field. The use of a 'pattern plate' has also long been established to reveal the 'patterning' characteristics of guns and cartridges.

But what do these terms mean, what can be learnt from the practices behind them, and how reliable are their results? Furthermore, can any of these things be done better?

The word 'pattern' is used generally, but rather loosely, to describe the distribution of pellets on a surface (usually a vertical 'plate') at which the cartridge has been fired. More vaguely, it is used for their distribution at some point downrange on their way to the target.

The most common uses of patterning and a pattern plate include:

- testing cartridge performance, checking the chokes and regulating barrels
- checking gun fit
- checking gun mount

Only the first is considered here as it is by far the most important one, both in terms of extent of its use and its considerable importance for shooting successfully with minimal wounding or loss of our quarry. The use of patterning for gun fitting and gun mounting purposes is also important but best done under the guidance of a person experienced in these skills.

How should patterning be done?

How patterning is actually done will depend on what is wanted. Here we are assuming that patterning is mainly to assess the suitability of a given cartridge/choke combination to kill a particular type of quarry, such as a mallard or pheasant, rather than simply break clays. As it is so important to ensure that any bird (or animal) we shoot at is killed as quickly and as humanely as possible, we need to consider some more basics first.

At what range?

Patterning should be done at the *maximum range at which the shooter can consistently hit the quarry species*. This is likely to be a lot closer than the traditional 40yd! If it is 20yd, 25yd or 30yd, so be it – we should be honest to ourselves and fair on the quarry.

The cartridge patterned should contain pellets large enough to ensure that, *at the shooter's maximum accuracy range*, they will penetrate to the vital organs of the quarry species. The emphasis on the maximum range each time is that most shots are taken closer than that, and so the pattern will be more than adequate to ensure a kill, while still ensuring that the occasional longer shot will also kill. NB. There is also a certain minimum range for any load, in that the closer the target the tighter the shot cloud (or pattern). This demands greater accuracy, but, if successful, may well spoil (i.e. waste) the quarry.

How many cartridges?

Ten cartridges should be fired at the simplest of pattern plates/paper. For each pattern, in turn, a 30in circle should be centered (by eye) on the densest part of the pellet strikes and the number falling within the 30in circle, or touched by the edge of the circle, counted. The 10 pellet counts should then be averaged.

The need for at least 10 cartridges was shown most clearly by the former University College London's Ballistic Research Laboratory. To illustrate the variation that can occur, batches of ten cartridges from the *same* box were fired (through the same choke) and pattern percentages within each ten varied from as little as 23% to nearly 70%! [See "New views on choke", John Harradine, BASC, 2001].

One of the risks arising from this variation is that the first shot produces a pellet count or distribution which is close to what is expected – it may then be tempting not to fire any more. It is highly likely, however, that the second cartridge would produce a very different percentage, the third another different percentage, and so on.

With such variability between cartridges the average of a series of *at least 10* firings is the best indicator of the performance of a given cartridge. Fewer than that can give very misleading results. Clearly, for more consistent and predictable results in the field, a cartridge type that shows minimal variation from cartridge to cartridge is worth identifying.

Requirements for lethality

The key requirements for a consistently high kill rate (which all shooters strive for) are:

a) Pellets of the right size - so that, whatever the size, and distance, of the target, each pellet has enough energy to penetrate its protective feathers/fur, skin, muscle and other tissues and reach its vital organs (mainly the brain, heart, lungs and spinal cord)

b) Enough of those pellets to strike the target - to ensure that one or more vital organs are damaged, *as that is what actually kills* (see below)

c) Accurate shooting so that sufficient pellets hit the target each time the trigger is pulled.

Minimum number of pellets needed

What is needed is a *minimum* number of these pellets in the 30in circle again at each person's maximum range, averaged over 10 shots. That number, based on highly detailed studies by American ballistician Tom Roster, is at least 90 for a mallard or 100 for a pheasant at any range up to about 40yd. (Note that there are a minimum number of pellet strikes needed for each type of bird (see Table 1), but none currently available for animal quarry species). *Provided that minimum number is achieved and the pellets are generally well distributed over the 30in circle, then nearly every quarry species which is well placed in the pattern, should be killed.* Statistically, the necessary one or two pellet strikes on the bird's vital organs, which Roster has shown are required to ensure a quick kill, will occur in 19 out of 20 shots, and that in order to ensure those strikes, each bird must be struck, with some 6 or 7 pellets *overall*.

If the minimum average number of strikes in the 30in circle is *not* achieved, then there are three ways of potentially improving the strike rate

- an increase in choke (but be aware that the effect of choke is unpredictable as there is so much variation from cartridge to cartridge)
- a heavier cartridge (with more pellets)
- a more dense shot type (which, by reducing the pellet size slightly, would allow more pellets in the shot cloud)

Species	Minimum 30" pellet count *
Small Duck (Teal)	145
Medium Duck (Wigeon, shoveler, gadwall, goldeneye)	120
Large Duck (Mallard, pintail, pochard)	90
Small Geese (Egyptian)	80
Medium Geese (Pink/Grey)	65
Large Geese (Canada)	55
Small game birds (Woodcock)	160
Medium game birds (Red-legged and grey partridges)	140
Large game birds (Pheasant, red grouse)	100
Medium pest birds (Jackdaw, jay, magpie)	180
Large pest birds (Woodpigeon, crow, rook)	140

Table 1: Minimum 30" pellet count for bird species

*These are based on 30 years of detailed American shooting research

The key is starting with the right-sized pellets (of a given shot material) which are suitable for the intended quarry, at the range you can consistently achieve, and then being sure the cartridge/choke used will deliver a killing pattern. Then, by shooting straight (the most important requirement of all), success should be assured and few birds or animals wounded or lost.

Number of pellets *not* pattern percentages

If pattern *percentages* are wanted then at least three cartridges from the same batch should be opened, the pellets counted and the average total determined. Percentages are not helpful in this context, however, as pattern percentages themselves do not kill – it is the *number of pellets* that counts.

Traditional patterning – how it's done

Let's go back to basics with the widely-used traditional approach and use of pattern plates.

Both are variable and depend on the purpose in mind. Typically, a pattern plate is made of steel, at least 3ft square and fixed some 4ft above the ground. The surface is painted with a thin whitewash (made from hydrated lime and water), or sometimes sloppy estuarine mud, and a cartridge is fired at it usually from 40yd away. A 30-inch circle is then drawn around the observed centre of the pellet strikes using a measured disc or large pair of compasses, the number of strikes within the circle is counted, and they are expressed as a percentage of the number of pellets in the original cartridge. Sometimes the number of 5in diameter 'holes' in the 30in circle are counted as well (i.e. areas of the circle where no pellets have struck). The plate is re-painted and possibly the procedure is repeated for one or two more cartridges.

There are many variations on this approach that have developed over the years:

1. A 30in circle is drawn or fixed on the plate, a cartridge fired at it and the pellets within the circle are counted to give the pattern percentages.

2. Large sheets of paper or cardboard are fixed to a frame and one or more cartridges fired and the pellet holes counted in the paper. The benefit of this approach is that the paper can be removed from the frame after each firing and counted later and in some comfort. Clearly there must be a safety zone behind the paper for the pellets passing through.

3. Pre-printed 30in paper/cardboard circles are fitted to a similar frame, cartridges are fired at them and the pellet holes counted.

4. Pre-printed 30in circles with printed sub-divisions of various sorts, including segments and often a 21in inner circle (which divides the 30in circle into equal-area portions) are used to reveal more detail of the distribution of pellets.

Some people use a digital camera to speed up the tedious process of patterning cartridges, by photographing each pattern immediately for later analysis at a convenient time. The 30in circle must be drawn, of course, before the picture is taken. This method can be problematic if many pellet strikes are missed through poor photographic conditions.

How traditional patterning results are typically used

The results from these patterning approaches are used in various ways:

1. To check that a given cartridge (with or without a certain degree of choke) gives a 'satisfactory pattern'. This is generally considered to be a more or less uniform distribution of pellets over the 30in circle, with few 'holes'. NB. The results will apply only to the specific gun/choke combination used – they cannot be assumed to apply to any other gun or choke.

2. To check that a given choke gives a 'true' pattern, by comparing the pattern percentage recorded with the expected percentage traditionally associated with that degree of choke (namely, 40% with cylinder, 60% with half choke, 70% with full choke). Conversely such patterning is also used to find out what a particular choke actually is. For example, if it produces a 60% pattern (whatever its actual physical constriction at the muzzle) then it is deemed to be half choke.

3. To achieve a preferred pattern percentage or distribution of pellets over the 30in circle from a given barrel/choke combination ('barrel regulation').

Problems with traditional patterning

***The main problem is that if the purpose of patterning is to evaluate cartridge performance, check a choke, or get a particular type of pattern, the traditional way of doing it may well produce misleading results and the wrong conclusions*. This is because patterning is often done or interpreted incorrectly.**

There are many causes of such problems:

1. A small pattern plate or sheet of paper may not capture all the pellets in the central 30in of the pattern, especially if the gun is not fitting the user well or it (or the user) is not shooting straight to the point of aim. This results in misleading pellet counts and percentages as well as wrong distributions of pellets.

2. Even on a conventional pattern plate or sheet of paper it can be difficult to draw a 30in circle over the densest part of the pattern especially if the pattern is very widespread, thereby missing some of the pellet strikes.

3. If a fixed 30in circle is being used then, unless gun fit and shooting technique are good, the patterns themselves may well not be centered on the centre of the 30in circle. Again the result is that pellets are not counted that should be counted, and unreliable results are obtained.

4. Expressing the number of pellets inside the 30in circle as a percentage of the total in the cartridge requires the number in the cartridge to be known. This can be obtained from manufacturers' figures, published tables, estimated from the weight of shot in the cartridge, and so on. All these methods vary and may not be wholly reliable, as actual loadings of cartridges can vary considerably. Opening a cartridge is the only way to know precisely how many pellets are in each, but the numbers within each cartridge also vary, so a *minimum* of three should be opened and counted to get an average.

5. Firing only one or two cartridges of a given type can be highly misleading because of the considerable variation in patterning performance from cartridge to cartridge even from the same box. A *minimum* of five is required but even this is not very reliable. The aim really should be to fire 10 cartridges each time. Only then is it likely that a reliable indication of the typical number of pellets and their general distribution (and even the number of 'holes') over the 30in circle for that cartridge will be obtained.

6. Patterns conducted at the traditional 40 yards may be different from those achieved at the 20-30yards which is normally used in the field. Similarly they may not reliably indicate the pattern beyond 40yd. This is because as the mass of pellets (shot cloud) travels downrange, the individual pellets, after initially interacting with each other, are moving in various directions. Moreover, the shot cloud can expand at an increasing rate (trumpeting). The result is that the *pellet distribution at any one point downrange cannot reliably be used to predict what it will be at any other point.*

7. The number and distribution of the 5in 'holes' (or 'patches') can also be misleading. They are often interpreted as holes in the pattern through which a bird might escape being shot. (NB Birds do not fly through shot clouds – shot clouds pass through birds!). But, of course, the number and distribution of pellets on a pattern plate or paper is only a two-dimensional representation of a constantly-changing, three-dimensional collection of pellets travelling downrange. At 40yd a shot cloud can be more than 5ft wide and over 20ft long. The pattern of pellets on the plate or paper represents the accumulation of *all* the pellets in the cartridge on one final surface – it *cannot* reveal the numbers and distribution of pellets at an earlier time when the shot cloud and target bird meet. At most, 'holes' may only show up major faults in cartridge manufacture, or barrel, but even this is not certain.

8. The nominal choke of the gun being used may not match the actual degree of bore constriction traditionally measured at the muzzle. Perhaps more importantly, the whole choke cone profile may influence the actual pattern thrown more than the particular degree of choke constriction at the muzzle.

9. Cartridges of similar specification but from different manufacturers, especially if the shot material itself is different, can produce very different results even through the same barrel/choke, as the UCL Ballistics Research Laboratory showed so clearly a number of years ago.

Are sub-divided pattern plates helpful?

Sub-division of the 30in circle into inner circles or segments is an option but generally contributes little useful additional information on pattern distribution and can be mis-leading. It tends to focus undue attention on individual patterns, whereas what really counts is the *average* performance of the given cartridge/choke combination over the whole area. At most, an inner 15in circle (which actually constitutes one quarter of the area of the 30in circle but may look as though it is half the area) can usefully indicate excessively tight patterns, where most of the pellets are in the centre of the 30in circle, with few in the outer 'half.

In summary…

The simplicity of this approach to patterning is one of its attractions. It works for any bore of gun, *as long as it produces the appropriate minimum pellet count in the 30in circle.* It avoids the complication and difficult interpretation of counting different segments of the 30in circle or counting 5in 'holes' in the patterns, and avoids the distractions of pattern percentages.

What is required is the rigorous approach of five to 10 cartridges being patterned correctly for *each type (=size) of quarry*, and, if necessary, at different ranges. *Patterning the gun once and assuming that that will suffice for all types of shooting thereafter is inadequate,* especially with non-lead cartridges, each of which may behave differently with a given gun/choke combination. A snipe cartridge needs large numbers of small pellets to ensure the bird's tiny vital organs will be struck. A goose will need far fewer but much larger pellets, because its vital organs are much larger and more effectively protected. For both types (= size) of bird there is still a minimum number of pellets needed in the 30in circle at each person's individual maximum range, to ensure the required strikes on their vital organs. This is essential both to ensure a clean kill and a quick retrieval, rather than the quarry being wounded and lost.

In conclusion

It should be clear that a pattern plate has considerable value, but only if used in the correct way for the purpose in mind. A vital first step towards improving shooting effectiveness for most shooters, is to check that their gun fits well and that they are shooting straight. If we cannot consistently hit our target in the first place we have a problem. *Lack of success in the field can be due simply to poor gun fit and gun mounting technique.* At this point a few minutes with a qualified coach or an experienced Shot, perhaps at a pattern plate, can be invaluable.

Another solution to the accuracy problem is to practise on clays at regular intervals, (especially the unpredictable helice-ZZ-type!), if necessary, with the guidance of a coach. *It is not defensible to practise on living targets if the result is birds (or animals) being hit with only one or two pellets which are not going to kill them.*

Once we are shooting well on the clays, and consistently hitting all the types of target likely to be encountered in the field, then we should go to the second step. This is to use the pattern plate to make sure that we are using the right cartridge/choke combination *to ensure that each bird or animal that is hit is killed and nothing less.* It will not always work, of course, but that must be the objective and we should not be satisfied with much less than that.

Finally, it is essential to do the patterning exercise correctly, to get the most out of it. This is both to increase our success of (and satisfaction) in the field, and to reduce unnecessary wounding and wastage of hit birds or animals. No golfer uses one club for all shots on the course; no fisherman uses one rod for all types of fishing. So it should be in our shooting. *The right gun and the correct cartridge and choke should be used for our intended target, each combination suited to the type of quarry, and within the range that each of us can consistently shoot accurately.* This can only benefit our shooting, our quarry, and the sport itself.

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