Winter Deaths Among Open-Hill Populations of Red Deer in Scotland

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The national news media, especially north of the Border have been full of reports on the recent heavy mortality of open range (moorland) populations of red deer in some parts of Scotland. Several members of the Society have also been concerned to understand why this has happened and if there is anything that can be done. The Chairman and the Chairman of Scottish Council have asked us to offer some background to the biology and pathology of these episodes of heavy winter mortality, and to answer some of the more "Frequently-Asked Questions".

Winter mortalities in red deer populations are nothing new. Overwinter mortality is in fact the main agent of natural mortality among adult red deer [5] and many other wild ungulates except in places where there are large carnivores present, such as wolves or lynx. Recent events must therefore be seen against a background that there is always a steady trickle of deaths among Scottish red deer populations through the winter period.

Perhaps it is the scale of the scale of the recent mortalities that has caused alarm but, again, such periodic "winter die-offs" or episodes of heavier mortality are nothing new. There has always been a pattern of ongoing low mortality every year punctuated by years of heavier loss. Indeed, such winter die-offs were probably more common in the past than they are now. Older members of the Society will remember the impassioned debate in the July and November 1989 issues of *Deer* following a previous die-off in the winter of 1988/89 [4,12,13] and there were earlier periods of major loss as well in for example 1947, 1955 and 1962/63 amongst others [14].

What actually causes the deaths? Many people have assumed that it is simply shortage of food: either the deep snow prevents the deer reaching the food, or the food is frozen and unpalatable. It is much more complicated than that, because simply lack of food for a few days, or even a week or two, would be unlikely to result in either the scale or the immediacy of these die-offs. Simple starvation would, in addition, first affect the young, the old and the weak, but winter die-offs also take their toll of fit, prime-age animals which are otherwise apparently in comparatively good condition.

The first thing to recognise is that, in winter mortality events like this, there are several biological and pathological processes going on. Some deaths occur almost immediately and during the period of severe weather and extreme cold. Other deaths will follow later – and indeed it is common experience of stalkers and keepers in the Highlands, that the bulk of winter deaths actually occur some weeks after the worst of the weather – with animals often

succumbing as late as March or April… at a time when conditions would seem to be improving.

The more immediate deaths are almost certainly less to do with lack of food, than lack of cover or shelter – lack of warm, places out of the wind in which to lie down and minimise energy losses. All warm-blooded animals use up energy in various ways: they lose some through their coat and skin, they burn some when they move, and they use a lot just to maintain their metabolism. Every living cell needs energy to operate. All of this energy, or fuel, is either derived from food or from the animal's bodily reserves. If an animal is not eating, it will initially use up the glycogen in the liver and will then mobilise the fat stored in the abdomen, beneath the skin and in the bone marrow. In extreme conditions, even an obese or fat deer simply cannot mobilise the reserves fast enough to balance the energy lost through cold, wet and wind chill. Just as a fat person can die of exposure if stranded on a mountain, or succumb to hypothermia in a cold sea, so deer in good condition can and do die from exposure when conditions are bad enough. So, although some of the recent mortality ***will*** be due to lack of food and the exhaustion of the animal's bodily reserves, the bulk of the more immediate mortality is likely to be due to simple exposure and hypothermia.

Deep falls of snow cover over undulations in the ground (the sort of topographical cover deer on the open hill might otherwise use to get out of the wind and find some shelter). Deep snow covers over the banks of long, ragged heather – no use for foraging, but much favoured by deer again as bedding sites to hunker down out of the wind. The importance of ground cover like this, and the significance of thick vegetation in reducing effective wind-speeds and the resultant wind-chill was elegantly explored by Jochen Langbein and is further discussed in "The Deer Manager's Companion; pp. 129-130 [7].

Deep snow even penetrates the tree canopy of woodlands and smothers the ground there too in a cold wet blanket. With nowhere to lie in the dry, the deer chill quickly and most of the more immediate deaths result directly from hypothermia. Therefore, it takes its toll of the young and fit as well as the old and weak. At the time of writing this article [late February], we believe that the majority of the recent Scottish mortality probably falls into this category.

Lack of food may have more to do with the second "rash" of mortality in late winter or early spring. It is this type of mortality which goes on every year and provides the general, background, continuing overwinter mortality, which is regularly reported, not just in these occasional, episodic die-offs.

Deer, like many other wild herbivores, are adapted to cope with food shortage in winter [6]. Even if there is lots of forage about – (and it is not covered by snow)- the vegetation which remains over winter is coarse and indigestible and of low quality: grasses have died back, so they are sere and effectively simply standing leaf litter; heather is dormant, and in any case is always of comparatively low digestibility. So, the deer are faced with overwintering on an

impoverished food supply. In fact, even in a good year, the actual energy intake they can get from this food is less then their energy requirements.

They respond to this in several ways. First, they try and reduce their outgoings – energy expenditure - by becoming less active, lying up more and seeking shelter wherever possible, to reduce wind-chill and exposure. In complement to that, they can utilise fat reserves laid down within the body in the autumn to make up the shortfall between what they can gain each day by feeding, and the actual energy requirement of their metabolic needs.

The first thing they can do to reduce outgoings is to adjust their metabolic tick-over speed. Red deer in temperate climates go into a state of reduced metabolic rate over the late winter, which enables them to exist on lower energy requirements than they need in the summer. This has the advantage of reducing what they need to eat but has the disadvantage of making them unable to benefit from excess food even if it is available in winter.

They can also slow down the rate at which they lose energy by taking shelter, but if that shelter is denied them or snowed over then they do not have that option. At the same time, energy requirements are increased in cold weather and, more especially in wet and windy weather, when the evaporation of moisture from the wet coat strips the heat from them. Phil Ratcliffe, in his thesis undertook an elegant analysis of how much more energy a red deer needs to burn up for each increase of wind-speed by 1km per hour and an increase in wind speed of 10km increases energy demand by more than two-and-a-half times. Heat losses are correspondingly higher at lower and lower temperatures and for animals with wet coats [(11)].

And in essence, the major element of their over-wintering “economy” is to depend on fat reserves laid down within the body in the autumn to supplement the shortfall between what they can gain each day by feeding, and the actual energy requirement of their metabolic needs. Simplistically we say that they are designed to overwinter on their fat reserves…. but in truth that would suggest they do not feed at all (like a hibernating mammal); in fact, they simply draw on the fat reserves where required to make up the daily shortfall in energy balance. When all the fat is used, they metabolise their muscle protein and become emaciated.

These factors all combine to affect the deer for weeks after the mid-winter snows have gone. The deer will have used up all their fat reserves, the snows will be replaced by the usual wind, rain and wind-chill and the deer will still be in their winter metabolic depression, so that even though there may be buds and tufts of apparently good forage appearing, more deer will succumb. When all the bodily reserves are consumed, the deer can no longer cope with the burden of parasites that normally live-in balance within their organs. Lung worms, bowel worms, ticks and even lice will overwhelm a deer depleted of all fat and unable to benefit from food. If recently dead red deer from the hill are examined post-mortem, significant

parasitism is invariably present, but the parasites did not kill the deer, they took advantage of the animal as it declined.

Other factors such as the calving date may contribute to calf mortality and there is some evidence for later calving and therefore smaller weaker calves in the winter in recent years. The age and experience of the hinds is also a factor, since older hinds seem to get their calves through the winter better than younger ones, but such factors are much less important than the main ones we have described.

In summary, the deaths we have seen so far are likely to have been directly due to hypothermia and exposure. But there will be many more deaths to come and probably over a much wider geographic area later in the winter, even among the deer that have survived the worst of the winter, because they will simply run out of fat reserves, be unable to make use of what food there is and then will effectively starve to death.

So: Question and Answer.

Are these deaths the result of mismanagement?

No. Overwinter mortality is the main agent of natural mortality among red deer in the absence of predators, so it is completely natural. And it is never constant year to year; it is well-established that there are periodic "outbreaks" of much heavier mortality.

Are these deaths the result of the widely-reported "overpopulation" of deer in Scotland?

Whether or not there is an overall "overpopulation" of deer in Scotland is a complex issue and much debated (and probably the subject of another whole article!). But in relation to this particular issue, we can answer it quite simply. Work by Tim Clutton-Brock, Steve Albon, and their colleagues, first on Rum and later elsewhere in the Highlands has established beyond doubt that over-winter mortality in adult red deer is independent of population density [1,2,9]. And intuitively this makes sense. It is in effect due to the weather It is in effect, due to the weather… and as we have already noted, in heavy mortality-events such as the one just experienced, the animals are probably dying from hypothermia due to lack of shelter, not because they are starving.

Can we do anything to prevent or reduce the level of mortality?

The obvious thing people think about in this context is the provision of artificial food.

Offering "relief parcels" of unfamiliar food at the time is unlikely to help as already noted most of the early mortalities have nothing to do with lack of food and are probably due primarily to hypothermia and exposure – and in any case if they are not accustomed to artificial feeding the animals may well not even touch the food offered.

But we also predict a second wave of deaths later in the winter as some of those animals which have survived so far, will run out of fat reserves earlier than they would otherwise have done. Would feeding them at that point help? Apparently not: there is considerable experience of such responsive "relief-feeding" of deer in the United States (primarily white-tailed and black-tailed deer) when they are observed to be starving at the end of winter. But as we have explained, the sad truth is that the deer by that stage cannot use the food provided and continue to die, even surrounded by superabundance. Increased catabolism of protein materials in late winter as fat stores become exhausted results in hypoglycaemia and a resultant ketosis. The deer probably reaches an irreversible stage of starvation some considerable time before death - a point of no return - and supplementary feeding at this stage is unable to prevent death [3]. Many deer park managers try desperately to save their deer when winter die-offs occur, only to find that no matter how much they provide, the spate of deaths continues.

Would provision of supplementary food earlier be of any help? In practice, to have any real effect in reducing overwinter mortality, provision of supplementary food would have to seek to boost the levels of body fat with which the deer enter winter in the first place. Such feeding would have to start very early on, not just when one begins to realise that there might be a problem, in effect, starting to feed directly after the rut [7,8]. Most adult wild deer will be entering the winter with reasonable fat reserves anyway – certainly enough to tide them over the average winter, so that supplementary feeding in most years would not be required and rather an expensive luxury. Particularly severe winters cannot always be predicted in advance!!

There is actually, very little evidence to suggest that, even when this is carried out as a routine practice, supplementary feeding has any positive effect on overwinter survival of adult deer (whatever else it may achieve). And it is in general not a practice the Society advocates. Supplementary feeding seems in practice to cause more problems than it solves, and the Society strongly advises against it. Although some deer may benefit, there is evidence that the majority of the deer may suffer reduced body condition when feed stations are provided, since the deer do not use them as supplements to their widespread foraging, but congregate in the vicinity of the feed, where only a few can eat enough to provide what they need. There are also problems associated with increased risk of transfer of disease and additional issues associated with localised environmental damage around feed stations. Most importantly, because animals which get accustomed to coming to artificial feed tend to become reliant on that feed and reduce the amount of natural foraging they do in result, they tend to end up with a reduced intake overall, unless the manager is providing virtually 100% of maintenance needs for every animal, which proves impossible in practice. [For a fuller review of the arguments for and against supplementary feeding over winter and the scientific evidence for any claimed effect on body weight, survival, antler size etc, the reader is encouraged to see Putman and Staines, 2004 [10]]

Shelter is more important than food if the winter proves to be severe. Managers may contemplate opening up forest blocks to allow deer access, but this would be an emergency measure only. Since any woodlands not already available to the deer are presumably still fenced because they are still vulnerable to browsing damage, opening them up like this, even in emergency, may of course lead to significant consequential levels of damage to the growing trees.

Should deer-managers reduce their annual cull to compensate for the heavy natural mortality?

Such episodic events have a series of knock-on consequences. As we have noted, there may be some considerable mortality among adult red deer at the time. There is likely to be a second phase of significant mortality later in the winter when some of those which have survived the immediate cold snap run out of fat reserves too early. To compound these effects of adult mortality, there is likely to be a reduced recruitment of juveniles to the adult population the following spring, since equally heavy casualties amongst calves means that fewer of last year's calves will survive to join the adult population the following year. There may even be repercussions for recruitment the following year as well since hinds pregnant after the rut may fail to deliver a live calf next summer because of abortion or foetal death.

So… when faced like this with particularly heavy snow and cold weather, and these heavy losses, should managers reduce their annual cull to compensate for the heavy natural mortality?

This may appear in some senses a non-question now because the cull-season is now finished for this year anyway. However, in more general terms, for several reasons we do not believe that the best response to a winter a die-off is to contemplate a reduced cull.

In the first place, although managers may have indeed recorded a lot of dead animals - and, as noted, there may yet be more to come in late winter when fat reserves are exhausted even amongst the immediate survivors - the actual effect of those losses at a population level may be less than might be anticipated. Cull planning should be based on population census data of remaining living deer, not upon the count of carcases. Furthermore, good management takes a longer-term view and should adjust itself to average situations over a longer period of time and the analysis of long-term trends, rather than as knee-jerk response to chance one-off events. There are two reasons for us to recommend that the responsible thing to do is to continue with the cull as planned, then review in following seasons what effect the winter mortality and possibly low recruitment next year has actually had on the population overall. The first reason is that population counting is notoriously prone to underestimating the actual numbers of deer present and the second reason is that deer populations rebound both swiftly and efficiently after apparent mass mortalities. We therefore would suggest that adjustment to cull targets should be spread over the next two to three seasons, based upon the numbers of deer on the ground.

There is even an argument that says you should increase your cull of younger stock in the next season, because surviving juveniles may be permanently compromised by the stresses of their first winter and never make good beasts. We know that fertility of hinds is related more to body condition and size at the start of the rut than to anything else.

In conclusion,

Overall, these heavy mortalities experienced in some years as a result of extreme weather conditions are periodic, but not in any sense unusual. In general, the populations recover well, although of course we may have concerns for the welfare of those **individuals** which may suffer and ultimately may die. This winter has been particularly hard though – and not just for members north of the border. Subscribers to BDS Bytes will know that Jochen Langbein, Norma Chapman and Arnold Cooke are seeking to collate information on the precise impact of this cold snap and the actual extent of mortalities among deer populations both north and south of the border.

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