Red deer research on the Isle of Rum NNR: management implications

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Foreword

The Hebridean island of Rum hosts the world's longest running research study of a deer population. The work has given rise to internationally acclaimed science on the ecological and evolutionary forces driving change in animal populations. Insights have come to the fore on individual and sex differences in survival, productivity and behaviour. Every year, some of the findings from Rum are published in top-rated scientific journals. Importantly, this ground-breaking science has informed deer management practices in Scotland and elsewhere, as well as influencing other important studies of animals across the world.

At the same time, the study is bringing wider understanding of the natural world into our lives. These are the deer that starred in the BBC's 'AutumnWatch' and numerous other recent TV programmes. Visitors to Rum can now observe deer from the relative comfort of a purpose-built hide, which is a very welcome development.

In summer 2014 we visited Rum and had a unique opportunity to meet the research team and hear fascinating revelations about the research. We left determined that an accessible summary of the work should be published which would inform deer managers, in particular, about the nature, importance and relevance of the research. There are really important messages here which can help managers make the most of their sporting resource while at the same time safeguarding the natural environment. In particular, the relationships between deer density and productivity have wide scale implications, and the relatively recent climatic effects on deer need to be considered very carefully.

We are delighted to see this resulting publication, and especially so because the work is being carried out on one of our National Nature Reserves (NNRs). The island is also home to an up and coming community which has recently taken ownership of the village through the establishment of a Community Trust. The community and SNH are working very closely together to maximise benefits to the community from the management of this special island and the deer that live there.

Red deer in Scotland are emblematic of wild places, and the deer research on Rum remains in the top cadre of scholarship. We hope this publication marks a new beginning in helping us manage deer sustainably.

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Director Environment and Forestry, Scottish Government

Ian Ross OBE,
Chairman, Scottish Natural Heritage

Introduction

This booklet is for deer managers. We have summarized key findings from over four decades of research on the red deer population of the Isle of Rum, principally that living in the North Block of the island but with some reference to wider studies around the island. Each of these findings has been covered in more detail in the scientific papers cited.

To ease reading, we give recommendations for deer managers in italics.

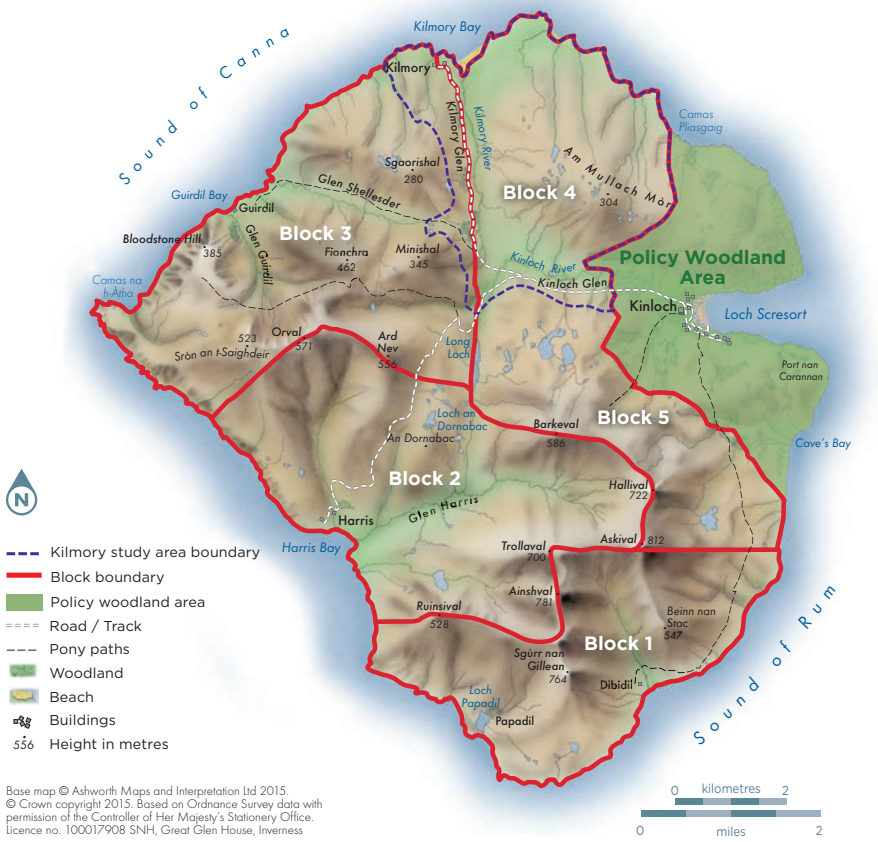

Figure 1. The Isle of Rum NNR showing the five deer management blocks. Block 4, also known as the North Block, is the site of the long term study described here.

A brief history of the study

The population of red deer in the North Block has been intensively monitored for scientific research by the Universities of Cambridge and Edinburgh, funded by the Natural Environment Research Council, since 1972. All animals in the study area are individually known from artificial or natural markings, and monitored throughout their lives: from birth, through all reproductive attempts, to death. Following cessation of culling in 1972, the population has not been managed, so mortality of resident deer is due to natural causes [1]. Genetic analyses are used to identify the fathers of the calves born each year, to investigate stag breeding success, to assess the inheritance of characteristics like antler size, and to monitor the occurrence of inbreeding [2]. The project has generated approximately 150 scientific publications and 3 books, with findings from the study appearing in numerous textbooks.

One core theme that runs through many of the study's findings is the difference between stags and hinds, especially as juveniles [1], in environmental sensitivity, life history and behaviour, a theme that is reflected in many of the management implications below.

In the absence of culling or supplementary feeding, the study population's density is strictly dictated by the overwinter carrying capacity of the land. Interestingly, even long after release from culling, the density of deer in the North Block (typically 18 deer per square km^2) is not consistently the highest found among the management blocks on Rum, nor is it untypical of the densities estimated from deer counts across Scotland either in the past [3] or in recent years [4].

For more details about the project including a full list of scientific publications and links to the original research, please go to http://rumdeer.biology.ed.ac.uk

Counting hill deer

Counting deer is an important prerequisite to planning and executing deer management. The accuracy of ground counts has been extensively validated on Rum [3]. Most recently, in 2003-2005, the Deer Commission for Scotland (DCS) compared counting methods on three relatively small and isolated open hill sites in the Highlands, including Rum. That study found no consistent difference in the number counted by helicopter or a ground walking team, both being highly repeatable [5]. Comparison of helicopter and ground counts of the North Block of Rum in late winter 2005 with those of a single researcher following a long-established census route and individually identifying the deer seen, found no significant differences in the total number of deer counted, further suggesting that the walking team and the helicopter methods are accurate and equivalent [5]. Accurate classification of deer by sex and age is more difficult; analysis of ground counts on Rum demonstrated systematic misclassification of young stags as hinds [3].

A deer count conducted by a well-organised walking team or a helicopter in open ground will give managers a reliable index of the number of deer present.

Density

One of the most important decisions that deer managers need to make is what density of hinds and stags to maintain. Since the 1972 cessation of culling in the North Block, hind density has increased from an average of 6.5 to 12.8 adult hinds per km², and stag density has decreased from 8.2 to 2.7 adult stags per km². This change, from a stag-biased to a hind-biased population, can be largely attributed to the fact that many aspects of red deer performance, particularly of stags, are highly dependent on population density, and in particular on the density of hinds, because of its effect on food availability. For example, as hind density increases calving dates get later [6,7] and first and second winter mortality of calves increases, with mortality falling disproportionately on males [7,8]. In addition, hind age at first breeding gets later [9], hind fecundity declines [10,11], the sex ratio of calves born becomes more female-biased [10], calf birth weight declines [11], male yearling spike length declines [12], adult stag antler size declines [13,14], antler casting and cleaning dates get later [14], and stag emigration increases [15]. These effects are summarised in Table 1.

Calf traits	Effect	Hind traits	Effect	Stag traits	Effect
Birth weight	Declines	Age at first breeding	Gets later	Yearling spike length	Declines
First winter survival	Declines (esp. in males)	Annual fecundity	Declines	Adult antler size	Declines
Second winter survival	Declines	Calving date	Gets later	Antler casting and cleaning dates	Gets later
		Birth sex ratio	Becomes more female-biased	Emigration	Increases

Table 1. Effects of increasing hind density on a range of traits in red deer calves, hinds and stags.

An experimental demonstration of these effects took place on Rum in the early 2000s: as part of a study of the effects of manipulation of adult sex ratio, the hind density in Block 3 of Rum (see Figure 2) was substantially reduced. Subsequent monitoring showed a 25% increase in stags using the block [15].

Reducing deer density, especially hind density, will increase calving rates, the proportion of stag calves born, calf and yearling survival (especially in stags) and antler size. It will also reduce stag emigration.

Sustainable yield

The sustainable yield of harvestable venison or stags is based on many biological factors (number of animals, recruitment rates, quality of forage, and so on). Calculations based on the Rum data suggest that in that population, the highest yields of venison would come from maintaining an intermediate hind density [3]. Similarly, the maximum yield of harvestable stags would be achieved by maintaining a hind cull of between 10% and 20% (Figure 2; [16]).

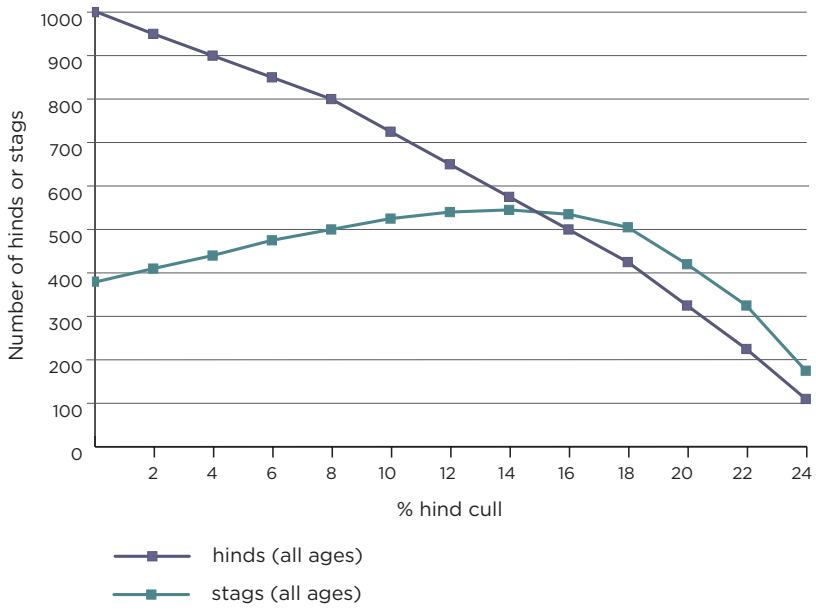

Figure 2. Stag numbers are maximised when hinds are culled at a rate of 10–20%. The plot shows the equilibrium values from a model based on Rum data, scaled to a population of 1,000 hinds and accounting for the effects of hind density on reproduction and survival. From [16].

Accurate information about a population, including numbers, recruitment rates, mortality and cull data, can be used to model the rate of culling that would best fulfil a deer manager's objectives.

Ranging behaviour

On Rum, hinds are strongly hefted to a home range, usually in the same area as their mother, throughout their lives [1]. Stags emigrate from their mother's home range, typically in their second year, and adopt a completely different 'feeding range', which may be quite large, for the rest of their lives [1]. However, stags move again in the rut, targeting areas with high densities of hinds; if successful, they will rut in the same area year after year. Recent analysis has shown that, at least on Rum, stags frequently return to the general area of their birth to rut [17].

The strong hefting of hinds on Rum means that they do not quickly spread out to fill vacant space following a cull in one area. This was demonstrated in the sex ratio manipulation on Rum (mentioned above), in which hind density was relatively easily reduced and maintained at a lower density in Block 3 despite higher densities in adjacent blocks (See Figure 1; [15]). Conversely the wider ranging of stags made it harder to obtain and sustain a reduced stag density in Block 1 due to ingress of stags from adjacent blocks [15].

In populations which, like Rum, have strong hind hefting, local reductions of hind numbers are relatively easy to achieve, but to effect a widespread reduction in hind density, culling needs to occur across all parts of an area.

Variation and extremes in weather

Our research on Rum has shown that red deer performance is sensitive to weather at many times of the year, via its effects on food availability in spring and exposure in autumn and winter. For example, major storms that occur in the rut delay mating and hence calving [11,18]. Hind fecundity in a given spring, and the proportion of stag calves born, are reduced by higher rainfall in the previous autumn and winter [10,11]. Variation in the weather experienced before and during the first year of life sets up large differences in the lifetime performance of individuals born in different years or 'cohorts'. For example, higher temperatures in April and May lead to calves being born with heavier birth weights, conferring higher fecundity and longer lives in hinds when they reach adulthood [9].

Warm springs also result in stags growing larger antlers that year. Exceptionally poor winters can cause death on a scale far greater than density effects. However there is little evidence that the density and winter weather interact, i.e. that they exacerbate each other in affecting winter mortality [19].

Weather effects mean that hind and stag numbers can change unpredictably from year to year, so regular counting and a responsive culling regime is required.

Climate change

Long-term records make it possible to assess the effects of climate change over recent decades. Climate change has resulted in rising temperatures and increased plant growth on Rum – the growing season has got longer [20] and the grasslands now have more vegetation [21]. This has led to substantial changes in the timing of events in the deer population, including an earlier rut and calving season (by about 12 days since 1980) and earlier antler casting and cleaning in stags [20]. The carrying capacity of the ground for deer may be increasing, indicated by a small but steady increase in the North Block hind population size [11].

On hill ground, climate change may increase the carrying capacity of the ground for deer, implying an increase in density under a constant cull regime. Since this will come about through changes in the growth of vegetation it does not necessarily imply a decline in the condition of the vegetation.

Antler size

Almost half of the variation in adult stag antler size (measured either as the number of points or the weight of cast antler) is due to age, and about a quarter is due to environmental effects of various kinds (Figure 3). Less than 20% of the total variation is inherited [13]. In contrast to general wisdom, there is no detectable effect of 'going back' in terms of antler length on Rum, and the number of points declines by an insignificant half point per antler from the age of 11 onwards [22].

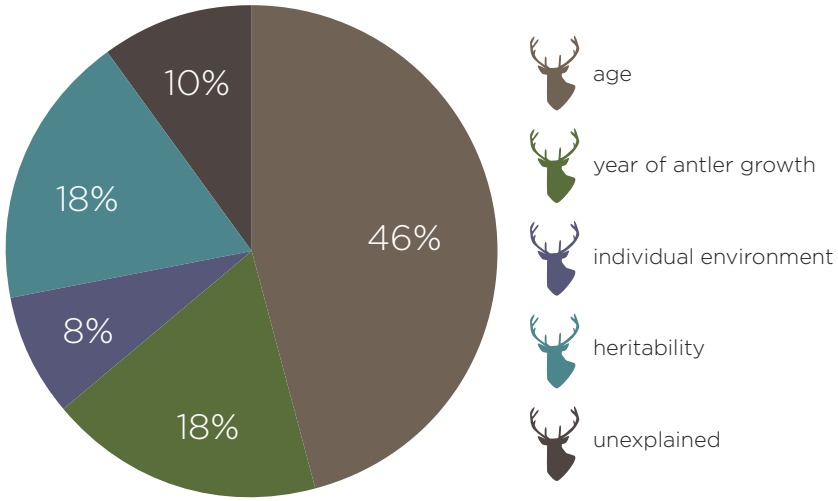

Figure 3. Causes of variation in weight of antlers of stags aged 3 or more.

Since managers rarely know the age of a stag precisely, nor the environmental variation a stag has experienced in his life, the prospects for improving antler size genetically, by selective culling, are poor. Antler size is easier to enhance by improving the environment, e.g. by reducing density. Number of points is not necessarily a good guide to identifying very old stags.

Orphaning young deer

Red deer mothers invest heavily in maternal care over many months, and sometimes years. Mothers and daughters continue to range together throughout their lives [1]. The loss of the mother in the first two years of life affects the survival of young deer of both sexes, and also the antler growth of yearling males. For young females, the loss of the mother even after two years of age continues to reduce survival [23].

Managers should strive to cull young deer (calves and even yearlings) alongside their mothers, in order to avoid the adverse effects of orphaning.

Yeld hinds

A yeld hind is one that does not have a calf at foot: either the hind did not calve in the preceding season or the calf died young. Yeld hinds fall into two classes: poorly-performing hinds that regularly fail to conceive or lose their calves, and high quality hinds taking a year off, which is increasingly likely as they get older [22].

Culling yeld hinds is an effective way of targeting poor performers and older hinds, and has the advantage of avoiding orphaning (left).

Ageing

Amongst individuals who survive to more than two years of age, natural lifespan is longer in females (average 11 years) than males (average 10 years). Both males and females show substantial changes in performance across their lives [22]. This is characterised by increases through their early years, reaching prime age at about 8-10 years, with optimal values for hind fecundity, calf birth dates and weights, survival of a hind's calves, stag breeding success and antler size in these age classes. Stag performance drops off more rapidly with age than does that of hinds [22].

Deer mangers should be mindful of these age effects on performance.

Closing remarks

The island of Rum is but a tiny part of the red deer range in Scotland, and we are well aware of the many differences in landscape, habitat and climate around Scotland, and in deer performance and behaviour across the entire range. Our findings on Rum are representative of hill red deer living in the intricate landscape and Atlantic climate of western Scotland. In contrast, we know that snow lie is an important determinant of winter survival in hill deer in the central highlands [3]. There are also some regional differences in behaviour: for example the Rum hinds live in small and strongly hefted groups and come down to graze in the glen bottoms by day, whereas further east on the mainland one is much more likely to encounter large herds of deer which range widely and come down to the roadside mainly by night or in severe weather. Many deer populations share their range with sheep, and high sheep populations appear to depress deer density [3]. Red deer living in forestry show many contrasts with hill deer in performance and behaviour [3]. Despite these differences, there is evidence that the patterns reported here, particularly those concerning density, are relevant across much of Scotland [3] and we hope some of the findings will prove useful to deer managers as they lay their plans.

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