**Written submission from Professor Steven Albon FRSE & Dr Justin Irvine, James Hutton Institute**

**Written evidence to Environment, Climate Change and Land Reform Committee**

**SNH report on deer management in Scotland**

**Purpose:** The SNH Report to Scottish Government on Deer Management in Scotland has generated a lot of interest and led to a large number of submissions to the ECCLR Committee website (N=34 as of 6 January 2017). Much of this focusses on the count data for red deer and contests various aspects of the methodology. In our opinion many of the views are not borne out by the underlying science. As we have undertaken much of the analysis and modelling under a partnership contract with SNH we appreciate the opportunity to clarify the detail of what has been undertaken. Here we attempt to identify the scientific evidence to clarify misunderstandings, while at the same time acknowledging what we still do not know, and where there is uncertainty. Also, we review the recent literature on herbivore impacts on the natural heritage.

**Overall status and trends in red deer populations in the Highlands & Islands**

*Key Messages:*

- *There is no evidence that the increase in deer between 1960 and 2000 is due to changes in the method of counting.*
- *The levelling-off of densities since 2000 has happened despite the reduction in competition from sheep and more benign climatic conditions –possibly suggesting that deer management through culling is capable of controlling populations.*

There is a view that current helicopter counting methods are more 'accurate' than the historical foot counts. This remains unfounded since there is no published evidence to support this contention. Consistency of estimates has been demonstrated between counts using the same method (within foot counts[1], and within both foot counts and helicopter counts[2]).

The 60% increase in red deer on the open hill between 1961 and 2000, published in the SNH report, has been attributed in a number of the submissions to the ECCLR committee to a change in count technique. For example, The British Association for Shooting and Conservation (BASC) suggest that this increase "may be partly attributed to improved counting techniques"[3]. Likewise, the British Deer Society asserts that "this assessment is faulty as it does not use the same counting methods when attempting to determine populations, the historic method of foot counting could

[1] Clutton-Brock TH & Albon SD (1991) Trial and error in the Highlands. *Nature* **358,** 11-12.

[2] Daniels, MJ. (2006) Estimating red deer *Cervus elaphus* populations: an analysis of variation and cost effectiveness of methods. *Mammal Review* **36**, 235-247

[3] http://www.parliament.scot/S5_Environment/General%20Documents/(005)_20161205_BASC.pdf.

be considered only 60/80% of an accurate modern aerial count".[4] While, Prof Rory Putman claims that "it is quite possible that numbers have shown little or no increase but simply that the populations were under counted in the past".[5]

However, all three of these assertions are based on two misunderstandings. First, the 60% increase described in the SNH Report occurred over four decades up to the Millennium, when counts were almost exclusively conducted on foot. Only after 2001 was helicopter counting widely adopted. Thus, one is not comparing "apples and pears" as claimed by Prof Putman[5]. Second, the adoption of helicopter counting, including digital photography, does not give consistently higher counts, although when groups of more than 100 deer are observed, a digital image gives a higher number than the immediate visual estimate. There are only two published comparisons of these two counting methods. A study at Letterewe found variable results, with helicopter counts giving higher estimates than foot counts only on particularly rugged, high ground on particular part of the area[6]. While the Deer Commission for Scotland demonstrated that in two of three test sites, ground counts were 10% higher than helicopter counts. In the third site on Rum the helicopter counts averaged just 4% higher. In each of the three test sites the variability between the repeat counts (coefficient of variation) was similar for both methods[2]. We are not aware of any quantitative or published evidence to substantiate Prof Putman's claim that "in estates in which I have myself worked over the years, helicopter counts routinely return figures about 60% higher than those returned by ground counts"[5]. We would very much welcome seeing these data.

The apparent levelling-off in the population growth was predicted by Clutton-Brock and colleagues in 2004 when analysing the Deer Commission for Scotland count data up to 2000[7]. These researchers attributed a slowing in population growth in the 1990's to 'density dependence' in response to grazing competition for food. However, since then, the effective herbivore density has been reduced substantially due to a decline in hill sheep stocks over the red deer range: by as much as 35-60% in the North West Highlands[8, 9]. Given that there is an accepted negative relationship between deer density and sheep density[10], one might have expected red deer populations to continue to grow in size, because of the reduced competition on summer pastures. Furthermore, one might have expected the reduced feeding competition to have been reinforced by more benign winters and longer, warmer summers, associated with climate change, leading to increased plant productivity

[4] http://www.parliament.scot/S5_Environment/General%20Documents/(009)_20161206_The_British_Deer_Society.pdf.

[5] http://www.parliament.scot/S5_Environment/General%20Documents/(025)_Professor_Rory_Putman.pdf.

[6] Milner, JM, Alexander JS & Griffin, AM (2002) *A Highland Deer Herd and its Habitat*. Red Lion House, London.

[7] Clutton-Brock TH, Coulson TN & Milner JM (2004) Red deer stocks in the Highlands of Scotland. *Nature*, **429**, 261-262.

[8] SAC (2008) Farming's Retreat from the Hills. A SAC Rural Policy Centre report.

[9] Thomson, S (2011) Response from the hills: Business as usual or a turning point? An update of "Retreat from the Hills" A SAC Rural Policy Centre report.

[10] Clutton-Brock TH & Albon SD (1989) *Red deer in the Highlands*, Blackwell Scientific Publications, Oxford.

and, in turn, to higher reproductive and survival rates[11]. Therefore, the levelling off of red deer densities since the Millennium is perhaps counter to what might have been expected, suggesting that there are other drivers of this pattern. We are investigating these drivers, and increased culling effort may be one important candidate accounting for densities levelling off.

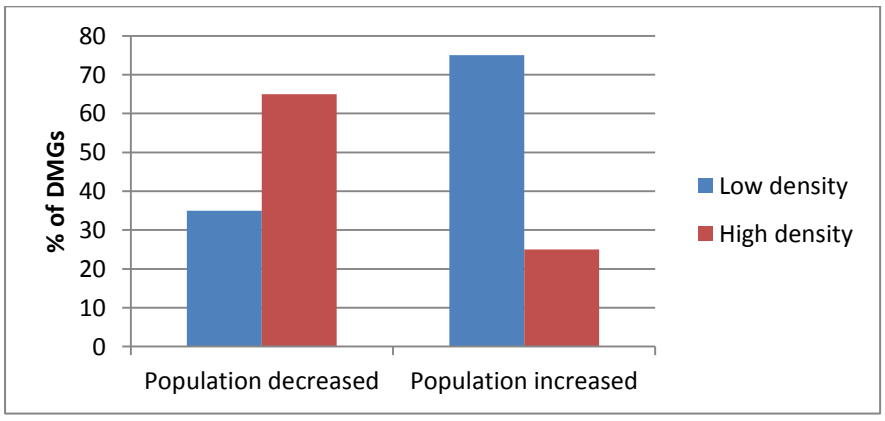
Previous research on the drivers of spatial and temporal variation in red deer density has also quantified the impact of culling[10]. Given the potentially beneficial changes in the environment and reduction in domestic stock, it would be reasonable to infer that culling by deer managers is now preventing the population from growing further. Quantifying the relative role of these different drivers on current red deer populations is the subject of the ongoing work by the James Hutton Institute in partnership with SNH.

**Variation in trends in red deer populations between Deer Management Groups**

*Key Message:*

- *Comparisons between Deer Management Groups demonstrate that deer managers can reduce densities in areas where there is concern over habitat condition (e.g.: Section 7 areas) but there are indications that populations have risen in areas with typically low densities, where there has been less concern over impacts.*

Although the overall density of red deer in the Highlands and Islands has remained largely unchanged since 2000, there is marked variation in the trends between DMGs reflecting different ecologies and management priorities (see Figure 3.2c, p. 24 in the SNH Report). In 33 of the 45 DMGs where the change in population density was estimated between 2000 and 2016 (see Figure 3.3a & 3.3b p. 25-26 in the SNH Report) 17 (52%) showed reductions, while 16 (48%) increased. Reductions were typically in the DMGs with higher densities (65%), whereas when density increased it was typically in the DMGs with lower densities (75%), where culls were not targeted at reducing population sizes and there were no Section 7 agreements in place (see Figure A below).




[11] Albon SD & Clutton-Brock TH. (1988) Climate and the population dynamics of red deer in Scotland. Pp 93-107 in *Ecological Change in the Uplands* (eds MB Usher & DBA Thompson) Blackwells, Oxford.

*Figure A. The relative change in population densities in Upland DMGs between 2000 and 2016 relative to their initial density in 2000.*

These results suggest that adaptive management through culling may well be feasible. We return to this debate later when considering impacts on the natural heritage.

**Box 1: A note on analysing trends.**

Detecting trends in deer densities relies on analysing the intermittent counts for each DMG. The counts need to be done in a consistent way, which is why the counts coordinated by the statutory body (now SNH) were selected. The statistical model fits a trend line (smoothing spline) through a series of points over the years which represent the density of deer counted in each of the Deer Management Units (the properties/estates), which make up a DMG. The trends estimated by the statistical analysis of density are not designed to be used as a criterion to judge deer management in each DMG, but instead simply to understand whether there is evidence for population change over time – is a given population increasing, decreasing or unchanged? It is the trend that is informative, not necessarily the estimated values for a particular year.

Where there are annual data the detection of trends should be robust. However, as the intervals between consecutive counts increase, detecting what has happened in the intervening period is likely to be less accurately estimated. The average (median) number of counts across the DMGs is nine, varying from just two counts for South Uist (2000 & 2015), only recently added to the survey schedule, to more than 40 for Rum counted since 1961. So while we can be very confident about the trends on Rum (see Figure B), there is as yet very little we can say about the trends in South Uist, though numbers are estimated to have doubled to 3.1 deer km$^2$. Previous work has explored the possibility of adopting a five year rolling count programme to have an 80% chance of detecting a 20% change in density (Albon *et al.* 2009 - *A methodology to describe regional and national deer populations and trends in Scotland,* Final Report to Deer Commission for Scotland).

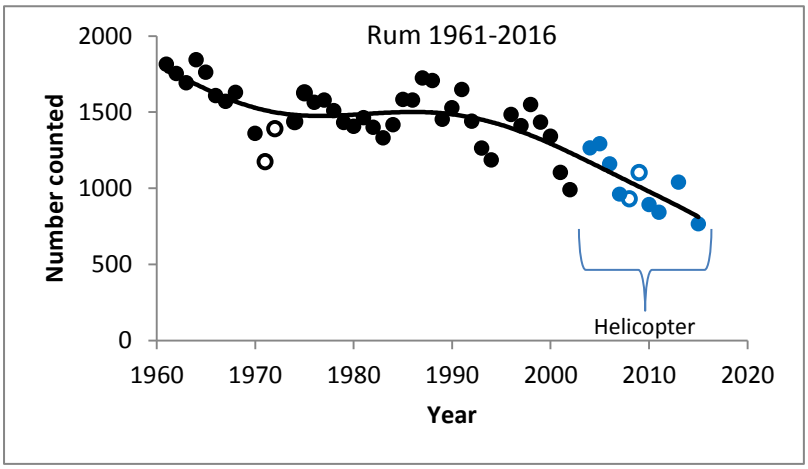



*Figure B. The trend in red deer counts on Rum since 1961. The more recent helicopter counts are shown in blue. Open circles show consecutive counts (1971 & 1972, and 2008 & 2009) where the apparent increases (>18%) were unlikely given the size of the cull. Individual counts can be anomalous but extrapolations smooth these out and produce more reliable trends.*

While the data for Rum shows the population has halved since the 1960s, it also indicates that the numbers counted can be highly variable between years. Indeed there are some biologically improbable increases in numbers between consecutive years. For example, increases of more than 18% between 1971 & 1972 and 2008 & 2009) probably reflect an undercount in the first year of the pair and suggests that, even on an island, some animals can be missed. Some of the increase could also be due to counting some animals twice in the subsequent year. Although the accuracy of the current counting methods is unknown, it would be possible to estimate the confidence interval about any count by adopting slightly different procedures, and also to assess their cost effectiveness. This will be addressed in the ongoing work JHI is undertaking with SNH.

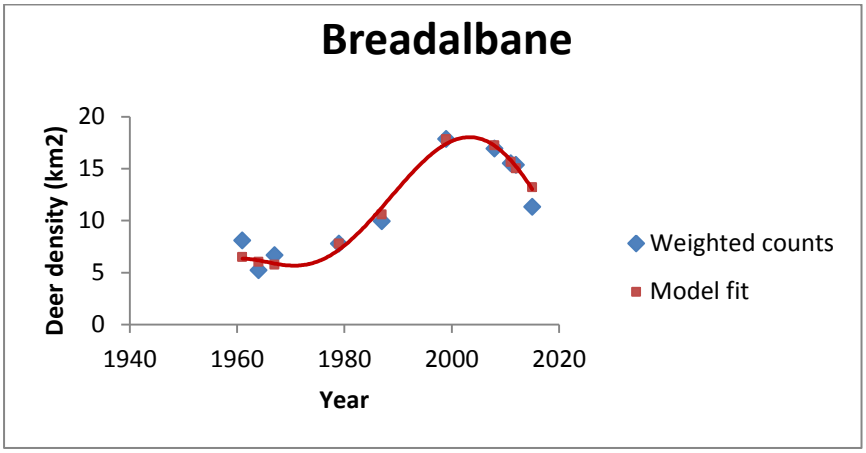
**Differences between counts and model predictions in recent population estimates**

*Key Message:*

- *Comparison of the predicted densities from the JHI model and the last SNH count show that the mean percentage differences are typically within 10-20% of each other. Given the uncertainty about the error around any individual count this is viewed as acceptable.*

The Chairman or Secretary of a number of DMGs, including Breadalbane[12], Glenelg[13], Inveraray & Tyndrum[14], Knoydart (who also comment on issues for neighbouring West Knoydart)[15], North West Sutherland[16] and West Grampian/Tayside[17] have all submitted written evidence either challenging the model estimates of density presented in the SNH Report for 2016, and/or the magnitude of change since 2000, attributed to their DMG.

In the case of Breadlabane DMG, Alan Cory-Wright points out that the SNH Report gives an estimated density of 12.7 red deer km$^2$ compared to a count of 11.24 deer km$^2$ in 2015. The model prediction is just 13% higher than the count. Had we been predicting the population density in earlier counts in 1979, 1987, 1999, 2008 and 2011 our model estimates were within 2% of the reported counts (see Figure C). The variability in the early counts indicates that some specific years are unlikely to be accurate but the trend has been captured reasonably well.




[12] http://www.parliament.scot/S5_Environment/General%20Documents/(003)_20161201_Breadalbane_Deer_Management_Group.pdf
[13] http://www.parliament.scot/S5_Environment/General%20Documents/(017)_20161205_Glenelg_DMG.pdf
[14] http://www.parliament.scot/S5_Environment/General%20Documents/(016)_20161205_Inveraray_and_Tyndrum_Deer_Management_Group.pdf
[15] http://www.parliament.scot/S5_Environment/General%20Documents/(011)_20161130_Knoydart_Deer_Management_Group.pdf
[16] http://www.parliament.scot/S5_Environment/General%20Documents/(027)_20161209_George_Woods.pdf
[17] http://www.parliament.scot/S5_Environment/General%20Documents/(015)_20161205_Julian_Clarke.pdf

*Figure C. The raw counts for Breadalbane DMG with the smoothing spline fitted to show the trend. This is the same curve shown in The SNH Report – see Figure 3.2c, page 24, middle column and middle row.*

In North West Sutherland DMG, George Woods, Chairman, was concerned that there had been no change in density between 2000 and 2016. This is true comparing the two time points but the trend for the intervening years (Figure 3.2c p. 24 in the SNH Report) shows the density rising to a peak in 2009 before declining again to the same density in 2016.

We agree with the ADMG[18] quoting from a previous minister, Paul Wheelhouse, writing to the RACCE committee in 2014 accepting their conclusion that "we need to continue to focus on the impacts of deer rather than their absolute numbers. What matters is not so much absolute numbers, but, more importantly, the monitoring of trends in populations. It is also helpful to understand locally what the sustainable deer density is, in order to achieve land management objectives."

**Impacts on the natural heritage**

Key messages:

- Sheep have a significantly greater impact than deer on upland habitats. However, the impact of deer increases as deer density increases both at land-ownership and regional scales.
- Removing sheep may not benefit biodiversity because the absence of domestic grazers can alter the impacts of deer on their habitats, particularly heather-dominated plant communities, and drive negative changes in diversity.
- Where plant communities with contrasting grazing sensitivity to, or requirement for grazing to maintain them, exist side by side, there is an inherent conflict in managing for the conservation of both.

Previous work (1997-2003) surveying grazing and trampling impacts on seven upland plant communities (habitats) in DMGs distinguished the impacts of species of domestic and wild herbivores, and demonstrated that sheep have greater impacts than deer.[19] However, the impact of deer increases as deer density increases both between DMUs (estates) within DMGs but also between DMGs. The strongest relationships between impact and deer density across DMGs were found on heather dominated communities (Dwarf-shrub heath) and Blanket bog. Density dependent impacts on grass-dominated communities were weaker and often not statistically significant. Such relationships could inform 'target' deer densities.

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18 http://www.parliament.scot/S5_Environment/General%20Documents/(019)_20161205_ADMG.pdf

19 Albon SD, Brewer MJ, O'Brien S, Nolan AJ & Cope D. (2007) Quantifying the impacts associated with different herbivores on rangelands. *Journal of Applied Ecology*, **44**, 1176-1187.

Ironically, the reductions in sheep densities since 2000, particularly beyond enclosed land, may not simply mitigate previous high impact on natural grasslands but instead increase the concentration of deer impacts on adjacent heather communities and drive negative changes in diversity.[20] This is partly because deer, in particular hinds, move into areas vacated by sheep. Understanding the role of spatial layout of adjacent communities, a determinant of herbivore impact, may importantly inform the management and prioritisation of the conservation of one plant community over others.[21]

In the habitat mosaic of upland Scotland, adaptive deer management is highly challenging. The contrasting grazing requirements of different plant communities that abut each other, means that in some habitats low deer density will lead to 'favourable' condition and potentially maintain biodiversity, but lead to 'unfavourable' conditions in other habitats a hundred metres or so, away, because they require more intense grazing.

Inevitably this means that practical deer management planning has to accept some level of failure in terms of meeting the ideal habitat-specific targets everywhere. How a new approach is implemented will depend on agreeing priorities both locally and nationally for each habitat. It will require considerable effort in documenting the level of impact on the natural heritage. The current established methods for assessing the grazing and trampling impacts of herbivores are time consuming, which raises the question of who will do the monitoring in the future? Assuming sufficient regular monitoring is carried out, the critical level of perceived damage at which intervention is triggered will need to be clearly defined and locally agreed. The solutions may include putting sheep back onto hill ground, to reduce local deer pressures, rather than simply culling more deer. Mixed species grazing can enhance habitat quality and maintain plant diversity so we probably need to devise more integrated approaches. These challenges need to be met to achieve multiple benefits for a wider community of interests.

As independent scientists, we want to develop these proposals in conjunction with SNH, ADMG and other key stakeholders in deer management and the natural heritage.

[20] DeGabriel JL, Albon SD, Fielding DA, Riach DJ, Westaway, S & Irvine RJ (2011) The presence of sheep leads to increases in plant diversity and reductions in the impact of deer on heather. *Journal of Applied Ecology*, **48**, 1269-1277.

[21] Moore EK, Britton AJ, Iason G, Pemberton J & Pakeman RJ (2015) Landscape-scale vegetation patterns influence small-scale grazing impacts. *Biological Conservation*, **192**, 218-225.