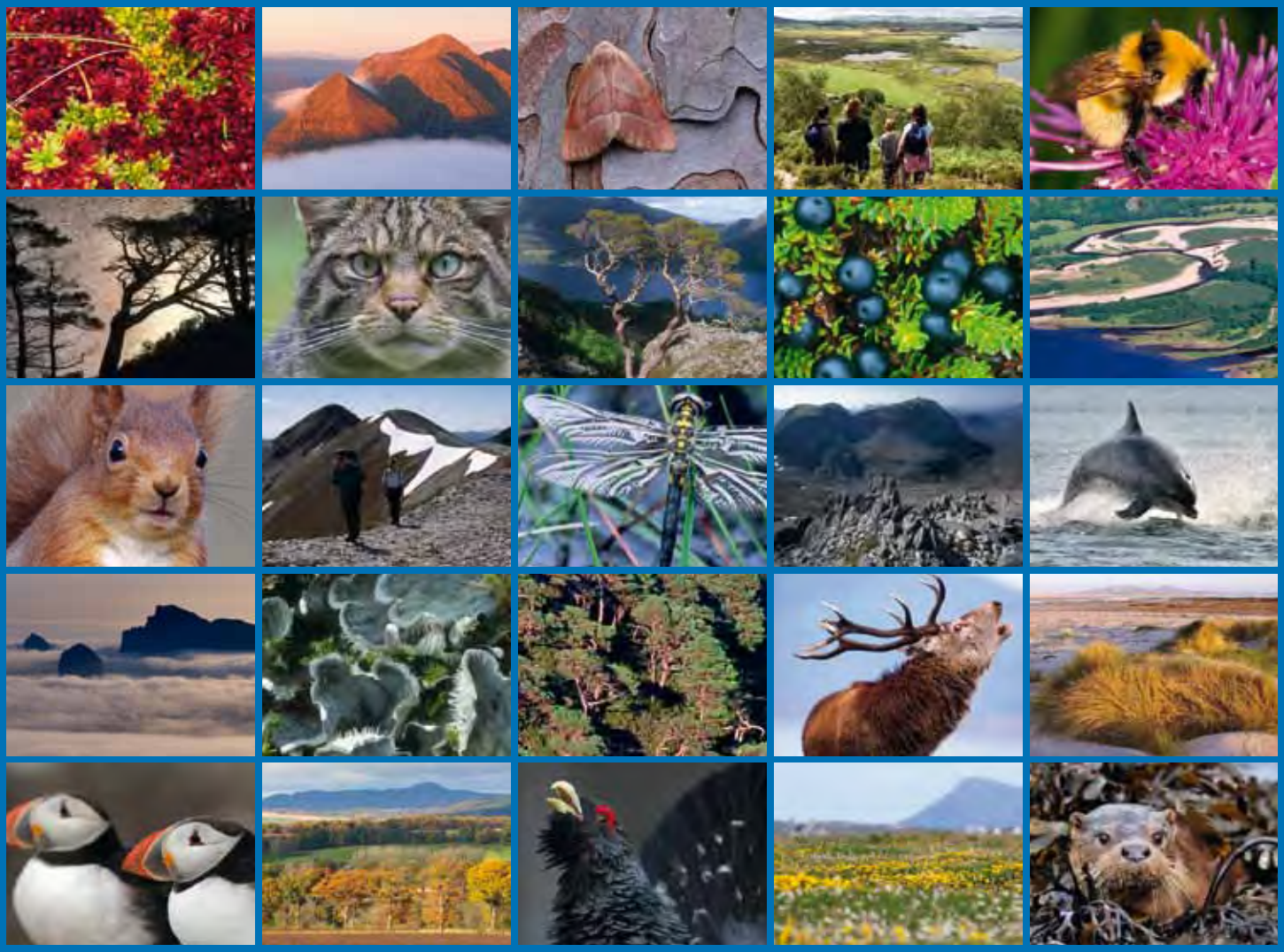
Scottish Natural Heritage
Commissioned Report No. 454

An analysis of the impact on the natural heritage of the decline in hill farming in Scotland



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COMMISSIONED REPORT

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An Analysis of the Impact on the Natural Heritage of the Decline in Hill Farming in Scotland

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COMMISSIONED REPORT

Summary

An Analysis of the Impact on the Natural Heritage of the Decline in Hill Farming in Scotland

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BACKGROUND

Agricultural census data from the Scottish Government has shown that the national sheep flock declined by almost 2.9 million between 1998 and 2009. Similarly, the beef cattle herd declined by 110,783 over the same period. The greatest declines in livestock have been in the hills and uplands of the north and west of Scotland. These declines have been fuelled by a combination of factors, including a general down-turn in the economic viability of hill farms, the foot-and-mouth disease outbreak in 2001, livestock reductions related to agri-environment schemes, and changes in the way that livestock farmers are subsidised. The changes in hill farming and crofting that have resulted from the decline in livestock numbers have had economic, social and natural heritage impacts. Conservation and natural heritage objectives in some parts of Scotland depend on the continuation of livestock farming. Without livestock farming the appearance of the landscape would change, becoming less diverse and for many people less attractive. Livestock farming is also an integral part of the culture and history of rural Scotland, and is vital to the rural economy. The social cohesion of rural communities in the uplands of Scotland is also tightly bound to livestock farming.

The aim of this project was to gather information on what is happening on the ground in terms of livestock declines, the changes in management associated with these declines, and the impacts of these changes on the natural heritage and rural communities. The objectives of the project were to: summarise the natural features (including environmental benefits and potential negative impacts) associated with hill livestock farming; to Identify and assess the impacts of livestock decline in the uplands of Scotland; identify land management changes, exploring the social and economic factors that are driving environmental change; and make recommendations on where and how to secure the identified environmental benefits.

MAIN FINDINGS

- The central part of the project was the analysis of information from three case study areas; South Skye, West Borders and North Highlands. A participative workshop approach was used as the main method of obtaining information about changes and impacts within the case study areas.
- Breeding ewe numbers declined in all three study areas between 1998 and 2008. The number of breeding ewes per hectare of grazing land also declined. Ewe numbers per hectare of grazing land dropped from 1.41 to 1.11 in the West Borders, from 0.64 to 0.39 in South Skye and from 0.31 to 0.18 in North Highlands. The number of holdings with breeding ewes also declined in all three case study areas. A similar pattern was

observed with cattle numbers with overall declines in breeding cow numbers and the number of holdings with cattle, in all three study areas.

- The decline in hill farming and crofting was recognised as a significant issue in all three areas, with numerous impacts highlighted. Many of the same issues were raised across the three study areas. Social, economic and community related impacts were generally seen as more important or serious than natural heritage impacts. There were very few positive or beneficial impacts of the decline identified. More negative impacts on the natural heritage were highlighted in South Skye and North Highlands, than in the West Borders. It tended to be the inbye ground where most of the changes in the natural heritage and landscape had been observed. Many of the patterns of change and impacts on the natural heritage and communities that were brought out in the case studies were relevant to the rest of upland Scotland and the crofting areas.
- Changes in the numbers and distribution of deer, and any future deer management, are key factors that will affect the extent to which future livestock declines impact on the natural heritage.
- Most of the data regarding natural heritage impacts was qualitative and anecdotal. There was very little quantitative data available either from the workshops or elsewhere that was directly linked to recent changes in livestock.
- The decline in livestock numbers is unlikely to stop without economic support for hill farmers and crofters through some form of policy change. If the decline continues then the impacts highlighted in the report are likely to become greater and even more widespread, with wider social issues implicated.

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We would like to thank all the farmers, crofters, estate managers, foresters, conservationists and ecologists who attended the workshops and contributed to the questionnaire surveys; the Strath and Sleat grazing clerks for providing up-to-date livestock numbers; the Scottish Rural Property and Business Association, Crofters Commission and Scottish Crofting Federation for their help in publicising the workshops; the local SNH and RSPB staff within the case study areas; and Maria de la Torre for helpful management of the project.

1 INTRODUCTION

1.1 Background

In 2009 the number of breeding ewes in Scotland was at its lowest level for over 100 years (Figure 1.1), and although there have been a number of peaks and troughs in the total number of sheep over the last century, numbers have not been at current levels since the mid 1940's (Figure 1.1). The national sheep flock declined by almost 2.9 million between 1998 and 2009 (Figure 1.2) (Scottish Government, 2010a). Similarly, the beef cattle herd declined by 110,783 over the same period (Figure 1.4) (Scottish Government, 2010a). These declines have been fuelled by a combination of factors, including a general down-turn in the economic viability of hill farms, the foot-and-mouth disease outbreak in 2001, livestock reductions related to agri-environment schemes, and changes in the way that livestock farmers are subsidised (SAC, 2008).

Although the production of hill livestock has changed markedly over the last 200 years, the system of continuous grazing of hill pastures by hardy breeds of hill sheep has been in place in much of highland Scotland since the beginning of the 19th Century (Watson, 1932). Cattle have to varying degrees augmented this hill grazing pattern but more typically they have been a feature of the more intensively managed lower altitude land on hill farms and crofts. Management of this inbye land is also a special feature of hill farming systems in Scotland, with particular patterns of grazing, cropping and manuring, with strong landscape and biodiversity features, but also a strong interaction with the use of neighbouring hill grazings. The stability of these grazing and land management systems is now under threat in some parts of highland Scotland (SAC, 2008). Throughout the twentieth century, grazing levels were considered to be too high in large parts of the British uplands, leading to heather loss and damage to vegetation and soils (Ritchie, 1919; Fenton, 1937; Wildlife Trusts, 1996). However, the situation in some places has now reversed, with little or no livestock, which may lead to problems associated with under-grazing. In spite of recent widespread declines in livestock there are however still large areas where high levels of grazing remain a conservation concern.

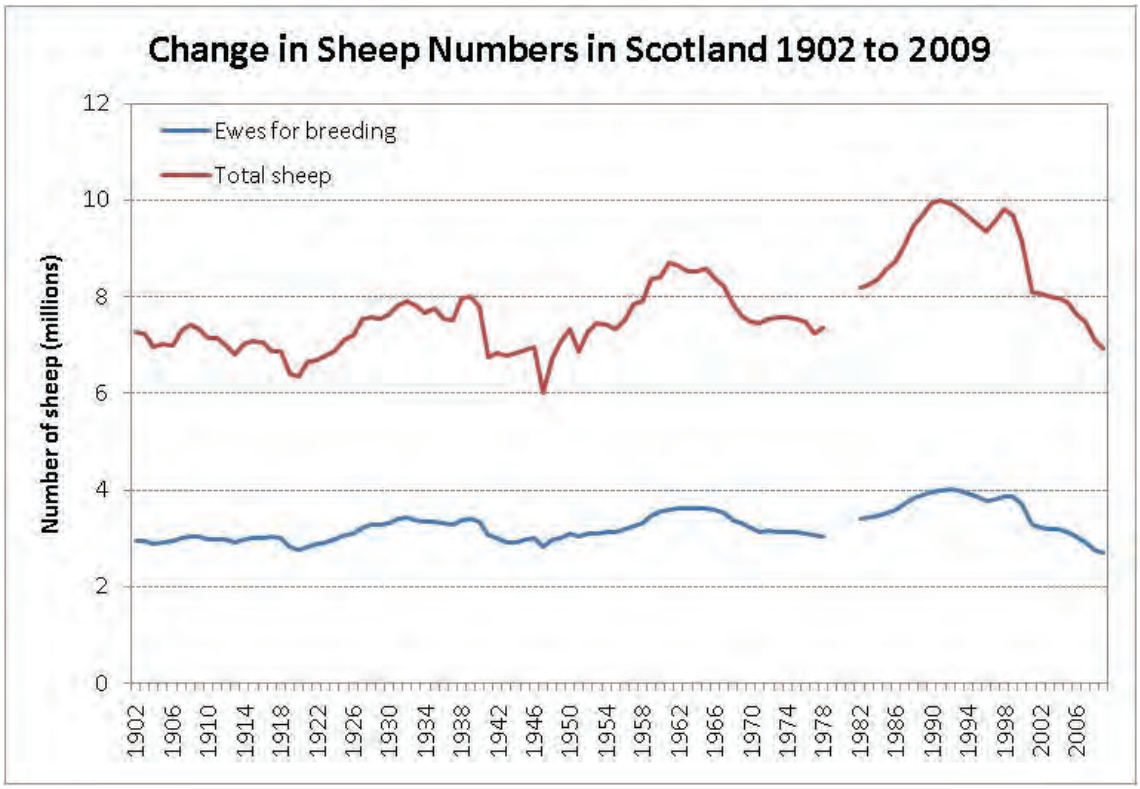

Figure 1.1 - Change in the number of sheep in Scotland between 1902 and 2009 (June agricultural census data). (Source: Agricultural Census Statistics for Scotland 1912-1978 (accessed via EDINA Agcensus); Scottish Government, 2010a).

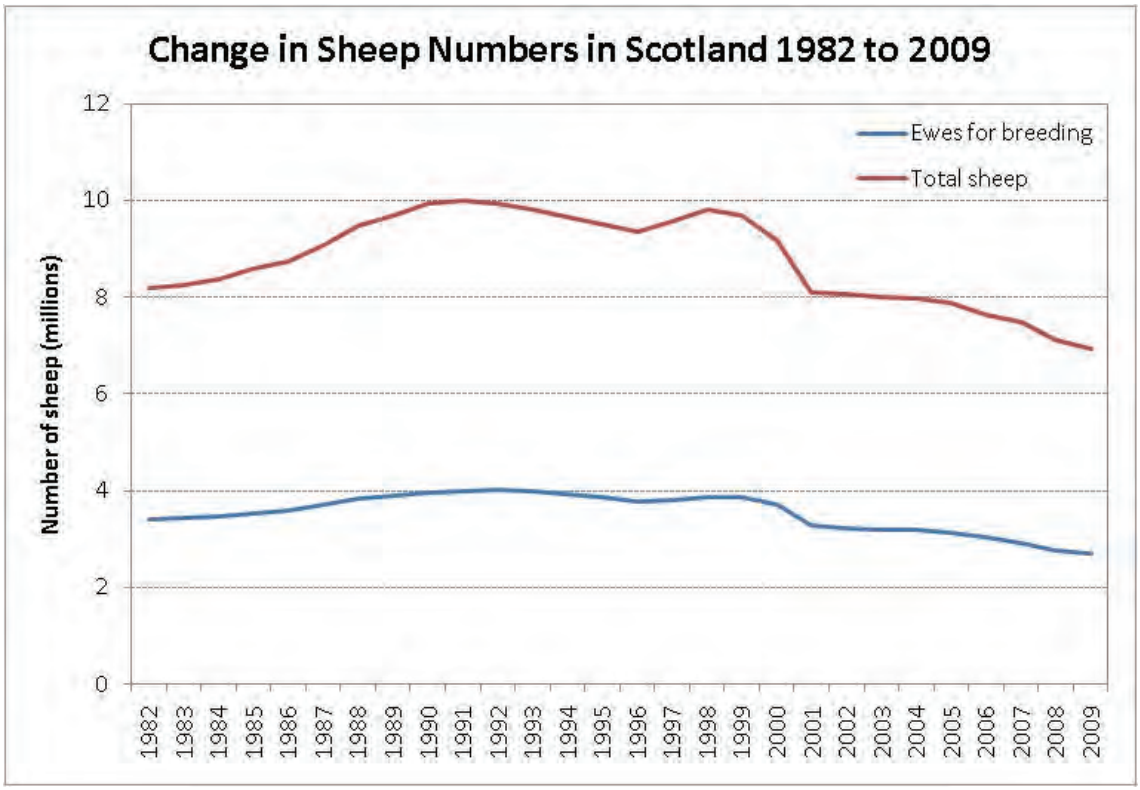

Figure 1.2 - Change in the number of sheep in Scotland between 1982 and 2009 (June agricultural census data). (Source: Scottish Government, 2010a).

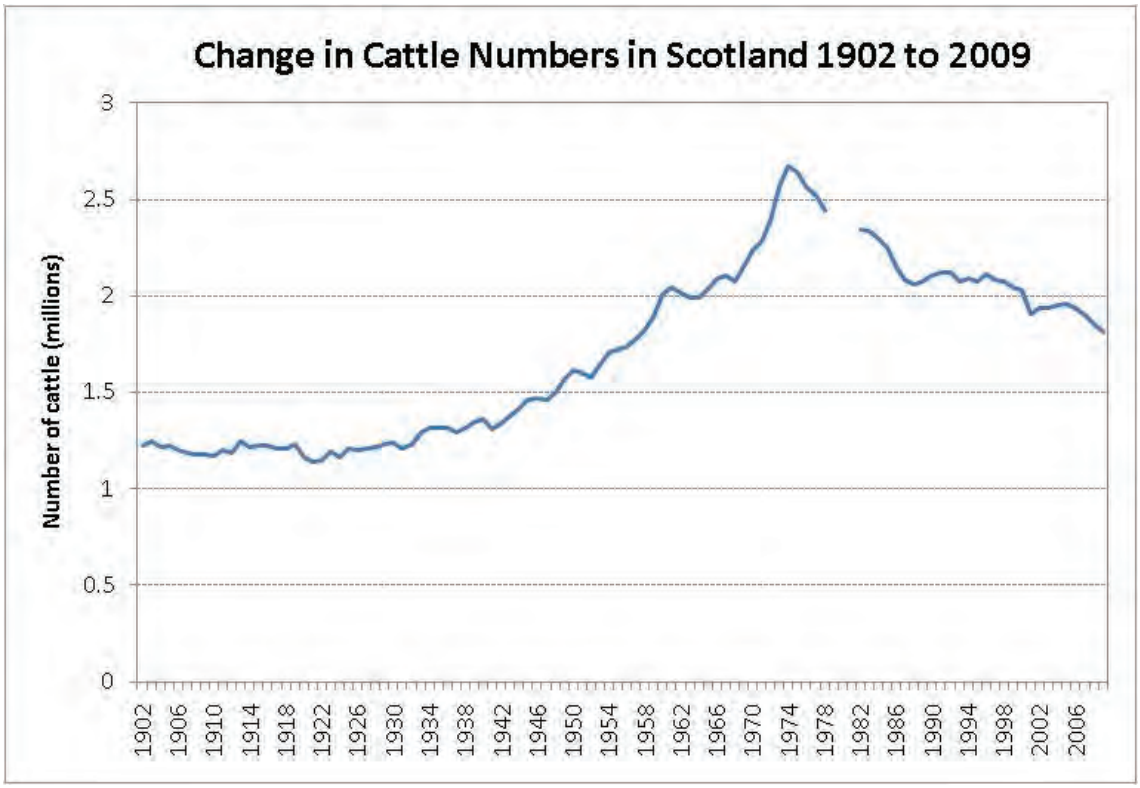

Figure 1.3 - Change in the number of cattle in Scotland between 1902 and 2009 (June agricultural census data). (Source: Agricultural Census Statistics for Scotland 1912-1978 (accessed via EDINA Agcensus); Scottish Government, 2010a).

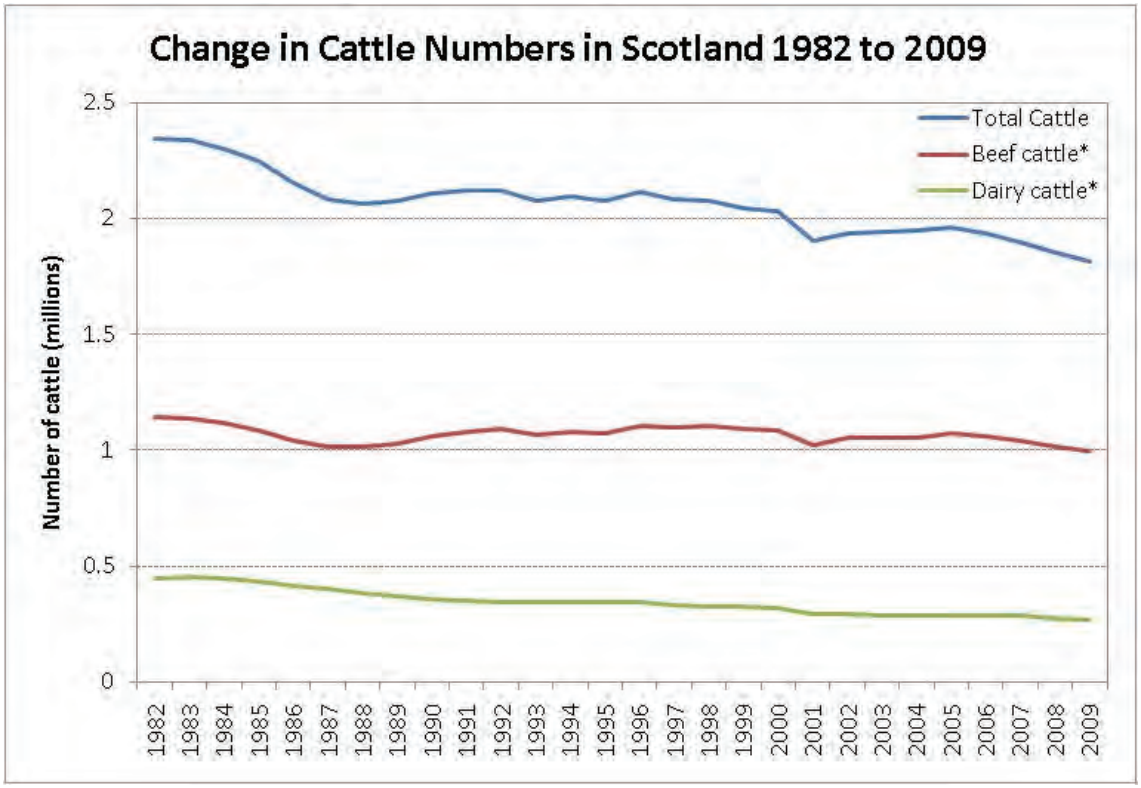

Figure 1.4 - Change in the number of cattle in Scotland between 1982 and 2009 (June agricultural census data). (Source: Scottish Government, 2010a).
** The beef cattle and dairy cattle figures exclude cattle under 1 year old and bulls for service.*

Alongside changes in livestock numbers there have been changes in farm labour. This has not however been a simple linear decline in the workforce associated with the process of down-sizing, as there have been changes in both the number of people employed and in patterns of work, including a shift to part-time working (SAC, 2008).

Morgan-Davies and Waterhouse (2010) working at SAC have been investigating some of the changes occurring at farm level during this period, and similar work is underway to understand how sheep flock structure and management is changing. As indicated within SAC (2008), the patterns of change in Scottish hill farming are complex, uneven and multi-directional. There are interlocking patterns of changing policy, economics and social issues that are driving changes on the farm and croft, that impact on the interactions between labour, livestock and land management. Whilst the headline story is one of almost linear decline, the pattern at a local level, is one of 'steps' with farms reducing stock, often not equally across their land-holding, and often linked to neighbouring or shared landholdings. There have been dramatic changes in sheep management over the last decade, with changes in breed and breeding policy being the most visible. At the local level, changes are often driven by people. There has been a shortage of skilled and semi-skilled farm labour and an increasing trend for part-time farming. At individual farm level, change is often driven by family issues, or by the plans of estates and landlords. What would often have been a generational change in management is now more complex. The social and demographic changes at play in the uplands of Scotland add further complexity and unpredictability.

Conservation and natural heritage objectives in some parts of Scotland depend on the continuation of livestock farming. This is particularly so where there are large areas of important open-ground habitats that would otherwise revert to woodland. Without livestock farming, the appearance of the landscape would change, potentially becoming less diverse and for many people less attractive (Morgan-Davies *et al*., 2008). A populated, working countryside is likely to be more attractive to tourists, and it can contribute to a sense of place and security for people living there. Livestock farming is also an integral part of the culture and history of rural Scotland, and is vital to the rural economy. The social cohesion of rural communities in the uplands of Scotland is also tightly bound to livestock farming. The changes in land management and livestock numbers that have taken place in the hills of Scotland in the last decade are perhaps the most significant for over 150 years. These changes will have a major impact on rural communities, as well as on the environment, landscape and biodiversity of the hills. Some of the impacts will be immediate, whilst others may take many years to come to light. Understanding how these changes will affect the natural environment is vital if key habitats and species are to be protected, and open landscapes maintained.

Livestock management cannot be considered on its own as other hill land-uses such as management for deer stalking and grouse shooting, renewable energy schemes, nature conservation management, and forestry are also key components of the hill system and have significant impacts on the hill environment. In some areas there have been dramatic increases in sheep numbers as some estates have sought to reduce the impacts of louping ill, a disease affecting red grouse, by using sheep as a means of "mopping up" ticks which are the disease vector (Porter *et al*., 2011). Populations of the Mountain hare may also have come under pressure in these areas as the hare is a potential host for the tick and their numbers have been heavily controlled on some estates. For the last few years, the joint working approach between DCS, SNH, Scottish Government and FCS has focused on working with practitioners in designated sites to reduce deer populations to achieve natural heritage objectives.

The expansion of other management practices in the uplands has been shown to influence the rate of agricultural decline. Evidence from a case study by Mather and Thomson (1995) indicated that the effect of afforestation on agriculture depended on the extent of the forest

within the area. They suggested that when the extent is low, the effect of afforestation appeared to be slight, however when the forest extent exceeded 30%, there was a greater effect, with increased agricultural decline. It is possible that as more land is abandoned within a local area a similar trend will emerge where the rate of abandonment will increase once a tipping-point is reached.

Although national policy is a main driver to change, regional and local policies are also important, such as RPAC (Regional Proposal Assessment Committee) regional priorities and opportunities through the SRDP (Scottish Rural Development Programme), local catchment plans, designated sites, national parks, and crofting areas. These local policies have impacts on management system and intensity, livestock numbers and natural heritage issues. Local and regional policies will increasingly interact with the changing face of national and international policy (e.g. new Less Favoured Area Support Scheme (LFASS), and changing Common Agricultural Policy (CAP) support), which fundamentally underpins agricultural systems in these areas.

There are many complexities involved in the issue of livestock in hill farming systems but all of them are people driven or mediated through people. What happens in regards to land management in the uplands, and as a result what happens to biodiversity, is down to people's choices, whether this is a reduction in sheep numbers, partial or total abandonment, a change in breed or intensity, a move to woodland or other management, or no change.

1.2 Rationale

The rationale behind this project relates to the way in which various types of support payments for hill farming and crofting might be targeted in the future. It is particularly important to be able to counteract the decline in hill farming in those areas where it is unlikely to continue without significant public support yet where it serves an important public function that is not rewarded by the market. Many of the public benefits arising from livestock farming are environmental. Since these environmental benefits do not arise everywhere, it is important to know where livestock farming does produce them, so that if an environmental justification is invoked as a rationale for future support, an informed view of where it should be targeted can be made.

The aim of this project was to gather information on what is happening on the ground in terms of livestock declines, the changes in management associated with these declines, and the impacts of these changes on the natural heritage and rural communities.

The objectives of the project were to:

- Review the recent decline in livestock in the EU and Scotland
- Summarise the natural features (including environmental benefits and potential negative impacts) associated with hill livestock farming and crofting;
- Identify and assess the impacts of livestock decline in the uplands of Scotland;
- Identify land management changes, exploring the social and economic factors that are driving environmental change;
- Make recommendations on where and how to secure the identified environmental benefits.

The central part of the project consisted of a series of three case studies which provided the basis for the assessment. A participative workshop approach was used as the main method of obtaining information about changes and impacts within the case study areas.

2 RECENT LIVESTOCK DECLINES IN THE EU AND SCOTLAND

2.1 Livestock decline in an EU context

The agreement to decouple EU direct farm payments from production and introduce the Single Payment Scheme (SPS) was formally made by the Council of Agricultural Ministers in June 2003. The European Commission noted that during the pre-reform discussions concerns were raised by some Member States that full decoupling of CAP support may lead to "abandonment of (agricultural) production, the lack of raw material supply for processing industries, or to social and environmental problems in areas with few economic alternatives" (European Commission, 2008). As such, under the reformed CAP, the SPS provided Member States the scope to retain some coupled support. In addition, the national envelopes established under the Agenda 2000 reforms were extended to enable up to 10% of the national ceiling for any sector's Pillar I payments to be diverted into national envelopes which could be used to support "specific types of agriculture which are important for the protection or enhancement of the environment, or for improving the quality and marketing of agricultural products", otherwise known as Article 69 measures. SAC (2010a) clustered EU-15 countries[1] by (a) the level of coupling remaining (indicated in Table 2.1), and (b) the implementation model selected (historic, static hybrid or dynamic hybrid model).

Table 2.1 - EU-15 clusters by level of sectoral decoupling.

	More Coupled	Less Coupled	Decoupled
Sheep	Denmark Finland France Portugal Spain	Greece	All others
Cattle	Austria Belgium France Portugal Spain	Denmark Finland Greece Netherlands Scotland Sweden	All others

Source: SAC (2010a)

SAC (2010a) showed that across the EU-15 countries, the Single Payment Scheme implementation model (historic, static hybrid or dynamic hybrid) or the extent of coupling remaining in the sector, appeared to be having little impact on the sheep breeding flock across Europe, with rapid declines being witnessed in most clusters (Figure 2.1).

[1] The EU-15 countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

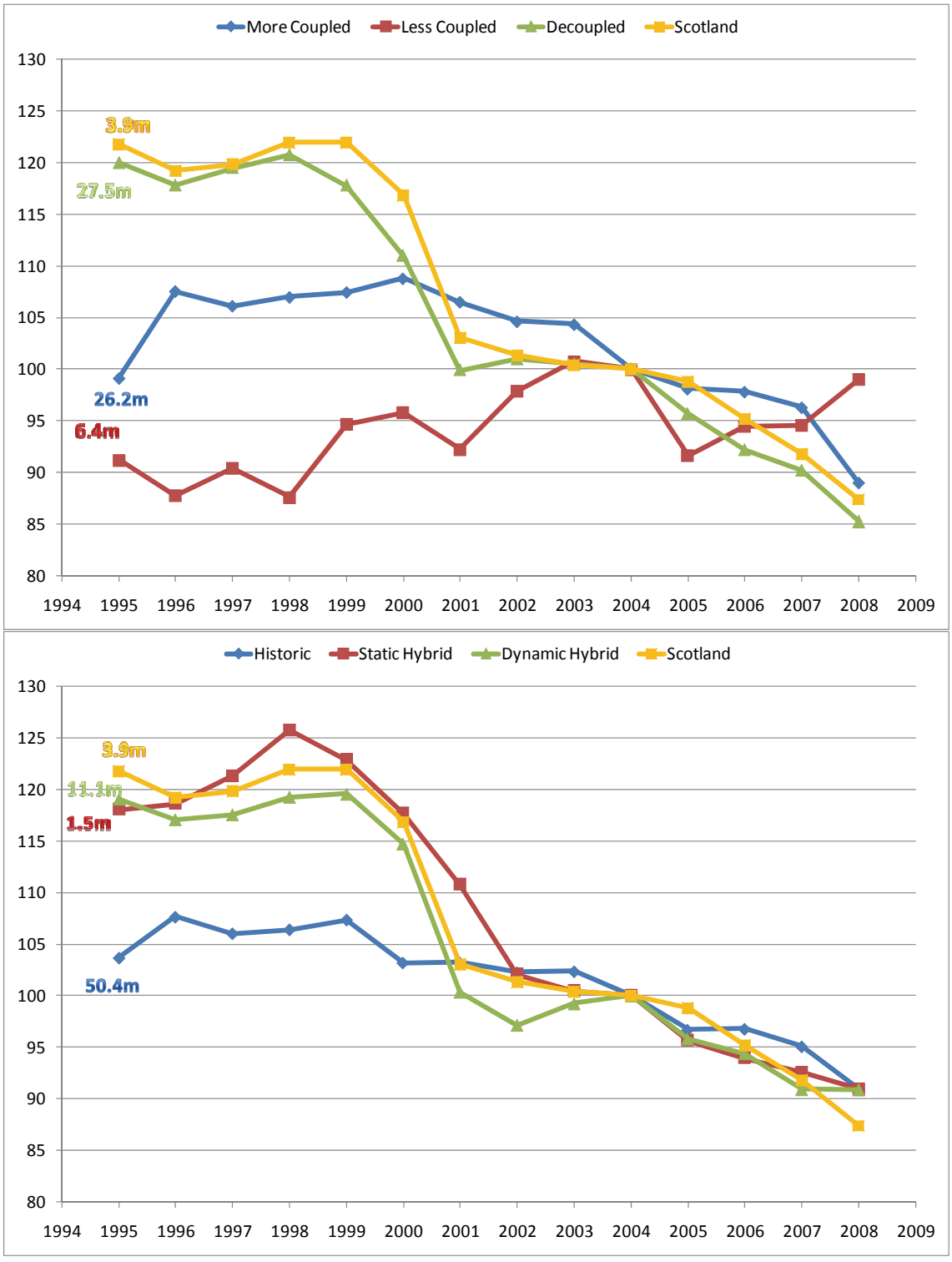

Figure 2.1 - Index of EU sheep breeding flock by level of decoupling (upper graph) and Single Payment Scheme Implementation Model (lower graph) (2004=100). (Source: SAC, 2010a).

Figure 2.2 shows that beef cow numbers remained relatively stable post decoupling, with a slight increase in the cluster of Member States implementing the historic based model. Under the dynamic hybrid cluster a similar pattern emerges after SPS came into force (although it is different in the lead up to 2004), with the static hybrid cluster seeing a continual gradual decline in beef cow numbers until a sharp up turn in 2007. When the level

of coupling in the beef sector was examined SAC (2010a) report that there appears to be a divergence in the trends for beef cow numbers between the two coupled clusters and the decoupled clusters after the implementation of SPS (albeit small differences), with the former two witnessing growth in numbers and the latter seeing a decline.

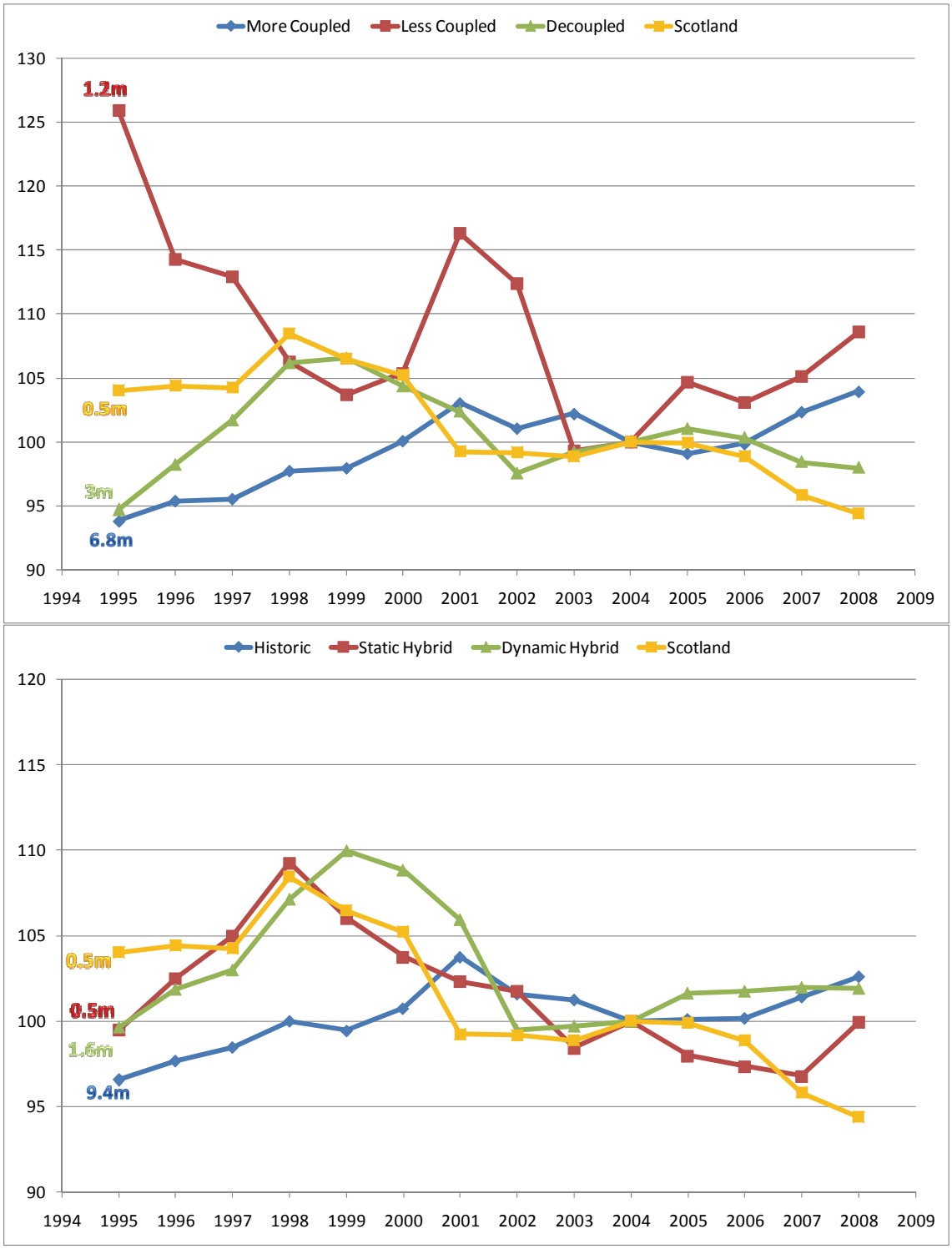

Figure 2.2 - Index of EU beef cow numbers by level of decoupling (upper graph) and Single Payment Scheme Implementation Model (lower graph) (2004=100). (Source: SAC, 2010a).

2.2 Livestock decline in Scotland – recent commentary

QMS (2009a) discuss how Scottish farming is disproportionately dependent upon ruminant livestock farming compared with the rest of the UK and Europe. They highlight that across the EU, only Ireland has a greater dependency on cattle production and only Wales has a higher dependency on sheep production than Scotland. This means that the agricultural sectors in Scotland, Wales and Ireland are particularly vulnerable to the decline in red meat livestock numbers that has been witnessed across much of the EU-15 since the decoupling of CAP and the introduction of the Single Farm Payment in 2005.

Several reports published in 2008, including SAC's *Farming's Retreat from the Hills*, the Royal Society of Edinburgh's *Inquiry into the Future of Scotland's Hills and Islands*, Quality Meat Scotland's *2009 Scottish Red Meat Industry Profile* and the Scottish Government's *2009 Economic Trends in Scottish Agriculture*, have all highlighted the rapid nature, and true extent, of livestock decline in many of Scotland's hill and upland areas. Of particular interest is the rapid decline in sheep numbers, particularly from the North and West Highlands and in the South West (Scottish Government, 2009).

Whilst the Royal Society of Edinburgh (2008) and QMS (2009b) largely focused at national or regional changes, SAC (2008) and Scottish Government (2009) looked at the figures at a more local level. This extra, local dimension revealed that within the Scottish regions there have been significant differences in changes to the number of livestock (and other associated farming practices), meaning that national and regional data can somewhat mask more localised issues surrounding the restructuring of the Scottish livestock sector (see SAC, 2008 and Scottish Government, 2009).

Following the work completed by SAC (2008), the Scottish Government (2009) in their submission of evidence to the Brian Pack "Inquiry into the Future of Support for Agriculture in Scotland", revealed that between 2000 and 2008 the beef breeding herd declined by 10% with the sheep breeding flock falling by 25%. Further they identified that the largest fall in beef cows and prime cattle occurred in the South East (-12%) followed by the South West (-11%), North West (-9%) and North East (-6%). Scottish Government (2009) also revealed that the largest declines in breeding ewe numbers occurred in the North West (32%) and the South West (27%).

Recently, many press commentators have reported that the December 2009 Survey of Agriculture showed that, whilst Scottish livestock numbers continued to decline, the rate of decline was slowing, suggesting that the industry may be stabilising[2] [3] [4]. It was highlighted in the press that the 2009 December figures revealed the smallest annual drop in the beef cow herd for a decade, and with ewe numbers only contracting by 0.2%, it was claimed that this showed growing confidence in both sectors after prolonged periods of contraction[4]. Whilst Richard Lochhead, Cabinet Secretary for Rural Affairs, recognised there are strong regional differences he commented that the 2009 December figures show "welcome signs that the rate of decline in cattle and sheep numbers appears to have slowed and stocking

[2] Davidson, G. 2010. *Livestock decline slowing*. The Scottish Farmer, 12th March 2010. Accessed at:
http://www.thescottishfarmer.co.uk/news/this-weeks-news/livestock-decline-slowing-1.1012970
[3] Arbuckle, A. 2010. *Decline in livestock numbers may have finally bottomed out*. The Scotsman. 12th March 2010. Accessed at:
http://business.scotsman.com/fooddrinkagriculture/Decline-in-livestock--numbers.6146224.jp
[4] Watson, J. 2010. *Census figures show stability returning to livestock sector*. Press and Journal, 12th March 2010. Accessed at:
http://www.pressandjournal.co.uk/Article.aspx/1642801?UserKey

levels may be stabilising"[5]. Stuart Ashworth, head of economics at Quality Meat Scotland, was quoted in the press as saying: "A lot of money was spent by many producers looking after their sheep this winter, but I have seen early signs of confidence returning to the industry, with an increasing number of lambs being held back for the breeding flock"[6], perhaps adding credence to the general feeling that the industry is at last stabilising.

However within the industry there are still concerns being raised that sheep and cattle numbers continue to decline and Alan Craig, president of the Scottish Association of Meat Wholesalers, commented that "while these figures reveal a welcome slowing in the decline in cattle and sheep production, the fact remains that the trend is still downwards and therefore heading in the wrong direction"[7]. Alan Craig is also quoted as saying "the steady decline in numbers which we've had to endure in recent years is eating away at the very fabric of our industry…I believe we've now reached a critical stage and that unless 2010 delivers a genuine turning point, our whole farm-to-plate industry will suffer severe and lasting damage."[8] John Gregor, general manager of Aberdeen and Northern Marts, also added that one of the biggest challenges the company faced in 2010 would be managing the decline in livestock numbers[9].

The issue of livestock decline is particularly emotive in the farming sector and many have discussed the long term impacts of current changes in upland livestock management and how decline can lead to a cascade effect, whereby the actions of a single farmer are not mutually exclusive from his / her neighbours. Condliffe (2009) summarises the issues well stating that "unlike set-aside, the grazing of mountains and moorlands is not something that can be switched on and off with relative ease. The reduction or removal of hefted sheep flocks is a difficult process to reverse. Also, once lost, the accompanying livestock husbandry skills can be difficult to replace." He then continues that "it can be more economic for the farmer to remove the whole flock rather than to manage reduced numbers…this can produce a 'domino effect' leading to the removal of other flocks as neighbouring farms rely on each other's labour."

Whether the declines in livestock continue will depend very much on market prices and on any changes to the rules governing agricultural support payments under future CAP reform. The recommendations from the "Inquiry into Future Support for Agriculture in Scotland", chaired by Brian Pack OBE (Pack, 2010), if implemented, will have significant bearing on whether the declines will continue.

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[5] Arbuckle, A. 2010. *Decline in livestock numbers may have finally bottomed out*. The Scotsman. 12th March 2010. Accessed at: http://business.scotsman.com/fooddrinkagriculture/Decline-in-livestock--numbers.6146224.jp

[6] Abbott, R. 2010. *Sheep decline shows signs of slowing*. Farmers' Guardian, 19 April 2010. Accessed at: http://www.farmersguardian.com/home/business/business-news/sheep-decline-shows-signs-of-slowing/31456.article

[7] Davidson, G. 2010. *Livestock decline slowing*. The Scottish Farmer, 12th March 2010. Accessed at: http://www.thescottishfarmer.co.uk/news/this-weeks-news/livestock-decline-slowing-1.1012970

[8] Fone, N. 2010. *Reverse decline in livestock numbers, say Scots.* Farmers Weekly Interactive, Wednesday 06 January 2010. Accessed at: http://www.fwi.co.uk/Articles/2010/01/06/119401/Reverse-decline-in-livestock-numbers-say-Scots.htm

[9] Watson, J. 2010. *Decline in livestock numbers will be a big challenge for ANM Group.* Press and Journal, 7th April 2010. Accessed at: http://www.pressandjournal.co.uk/Article.aspx/1679463?UserKey=#ixzz0lqM65GGa

2.3 Livestock decline in Scotland – cattle evidence

Data from the annual June Agricultural and Horticultural Census (Scottish Government, 2010a) reveal that the beef herd in Scotland has been relatively stable since the late 1980's, although post decoupling, in 2005, there has been a gradual downward trend (see Figure 2.3). Since 2005 beef cow numbers have fallen by an average of 2.2% per annum with larger falls in 2007 and 2009. Beef cattle numbers have been falling by an average of 1.9% per annum and in 2009, beef cattle numbers fell below 1 million for the first time in over 30 years to 995,225. The significant rise in beef cows in calf but not in milk, up to the year 2000, is perhaps due to a move towards more summer calvings (now accounting for 20% of all beef cows). Whilst there has been a rapid rise in the number of beef cows over 2 years old being kept for future breeding, it is a small actual number (26,010 in 2009), even if it has grown significantly over the period of time. Examination of the December agricultural survey results (Scottish Government, 2010b) show a similar trend with beef cow numbers falling by an average of 1.9% per annum since 2005.

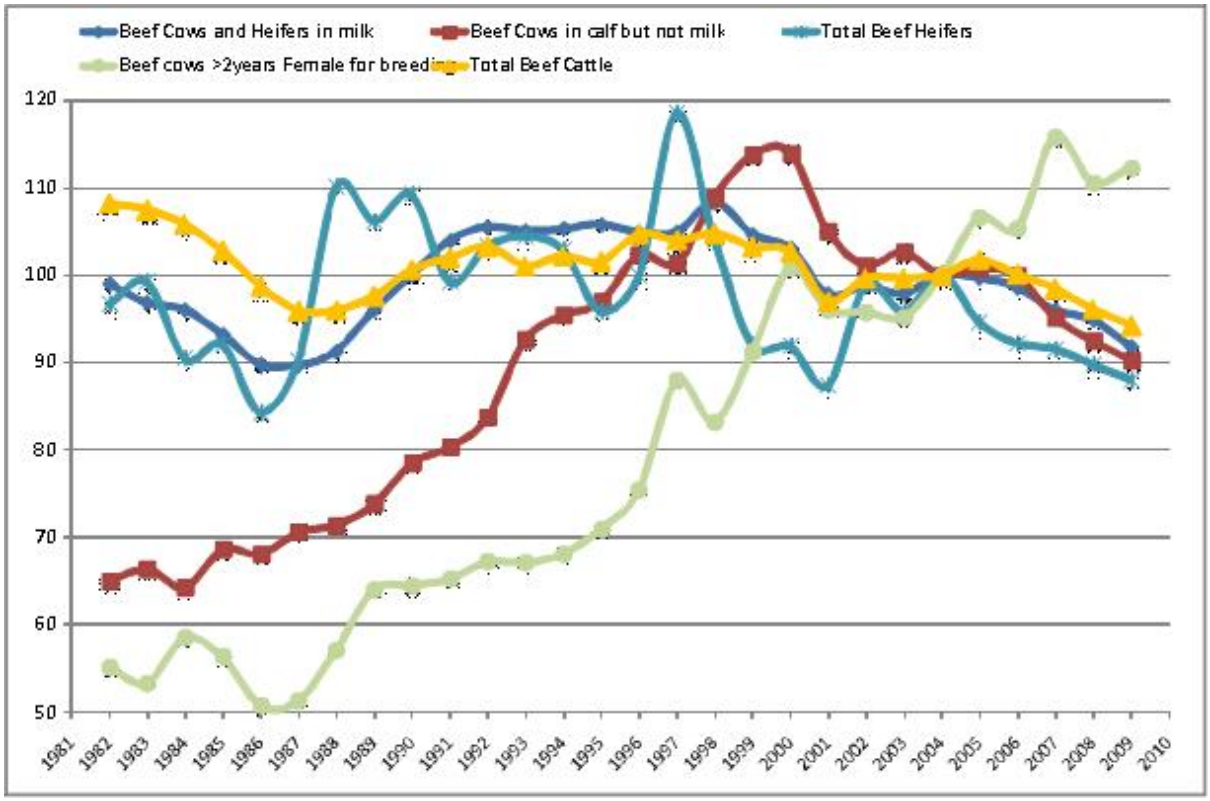


Figure 2.3 - Index of Scottish beef cow numbers from the June Agricultural Census (2004=100). (Source: Scottish Government, 2010a).

Using June Agricultural Census data, Figures 2.4a and 2.4b show the change in the number of holdings with cattle between 2004 and 2009 at the NUTS4 level[10] and parish level[11]. The figures show the wide regional and local variation that exists. Clearly the Western Isles and

[10] The Nomenclature of Units for Territorial Statistics (NUTS) is a hierarchical classification of administrative areas used across the European Union for statistical purposes. There are 41 NUTS4 (also known as LAU1 (Local Administrative Unit level 1)) regions in Scotland. A labelled map of the Scottish NUTS4 regions is available at: http://www.scotland.gov.uk/Resource/Doc/933/0085566.pdf

[11] A map showing the agricultural parishes in Scotland is available at: http://www.scotland.gov.uk/Resource/Doc/933/0009385.pdf

West Dunbartonshire are the only areas to see the number of farmers and crofters with cattle grow over the period, with a 5% increase in the Western Isles and a 4% increase in West Dunbartonshire. The parish level map does however show that, within these regions, there are still significant variations at a local level. For example, there is considerable growth in holdings with cattle in Lewis and Harris, but in North Uist there has been a decline. On the other hand, between 2004 and 2009 there were large falls in the number of holdings with cattle in many NUTS4 regions. For instance, there was a 13.5% decline in Angus, a 12.5% decline in the Borders and an 11.4% decline in both Argyll and Lochaber. Within these regions there were quite large local variations occurring, with some parishes witnessing growth while others seeing large declines in farms and crofts containing cattle. As an example, although small in absolute numbers (e.g. a change of 4 or 5 per parish), in the Borders there was a 33% reduction in holdings with cattle in Yarrow, a 30% reduction in Moffat and a 27% decline in Ettrick, with large percentage increases occurring in Wamphray and in Hutton and Corrie. This highlights that across most of Scotland (with few exceptions) the number of cattle farmers is still declining.

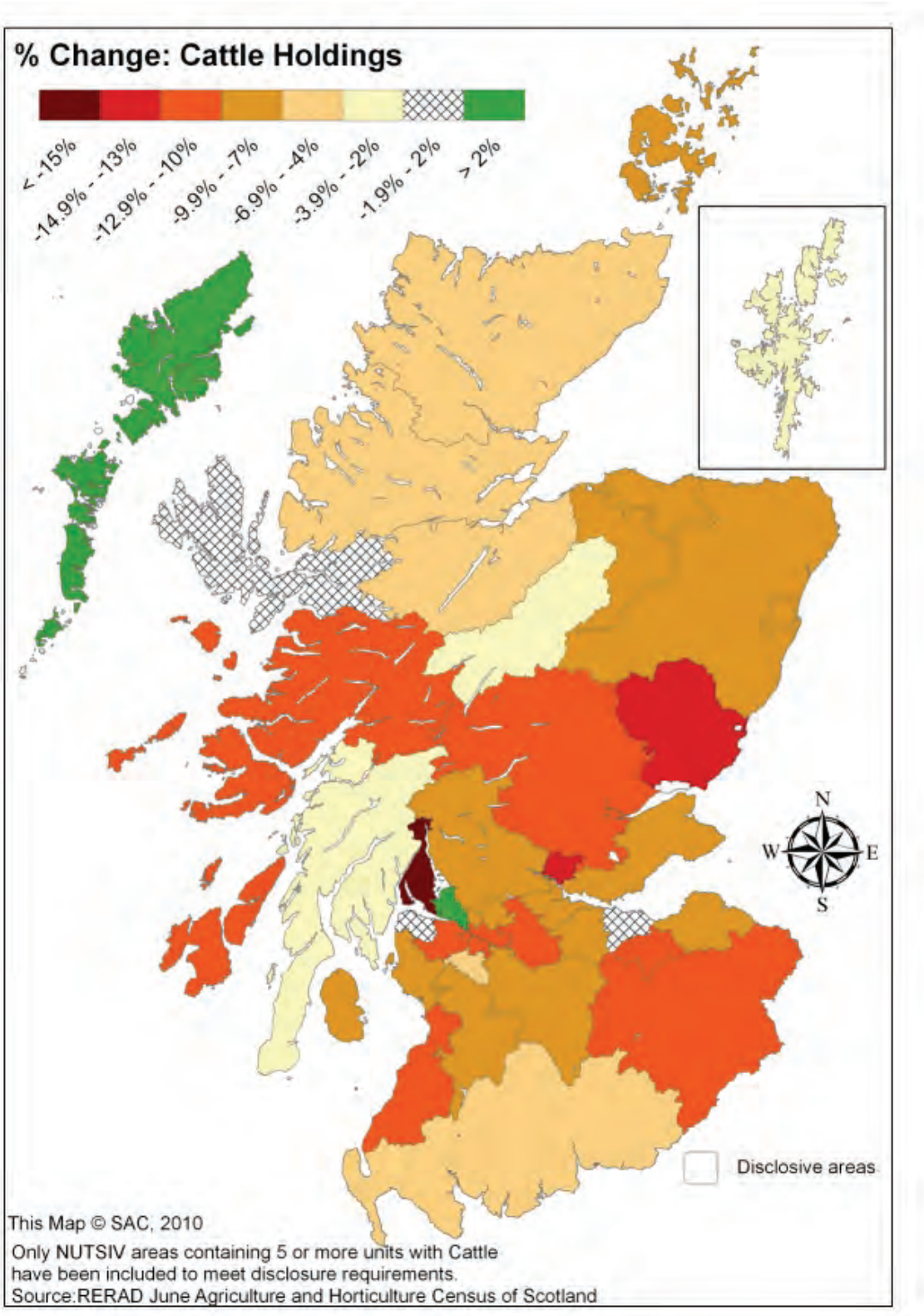


Figure 2.4a - Percentage change in the number of holdings with cattle 2004 to 2009 (NUTS4 areas).

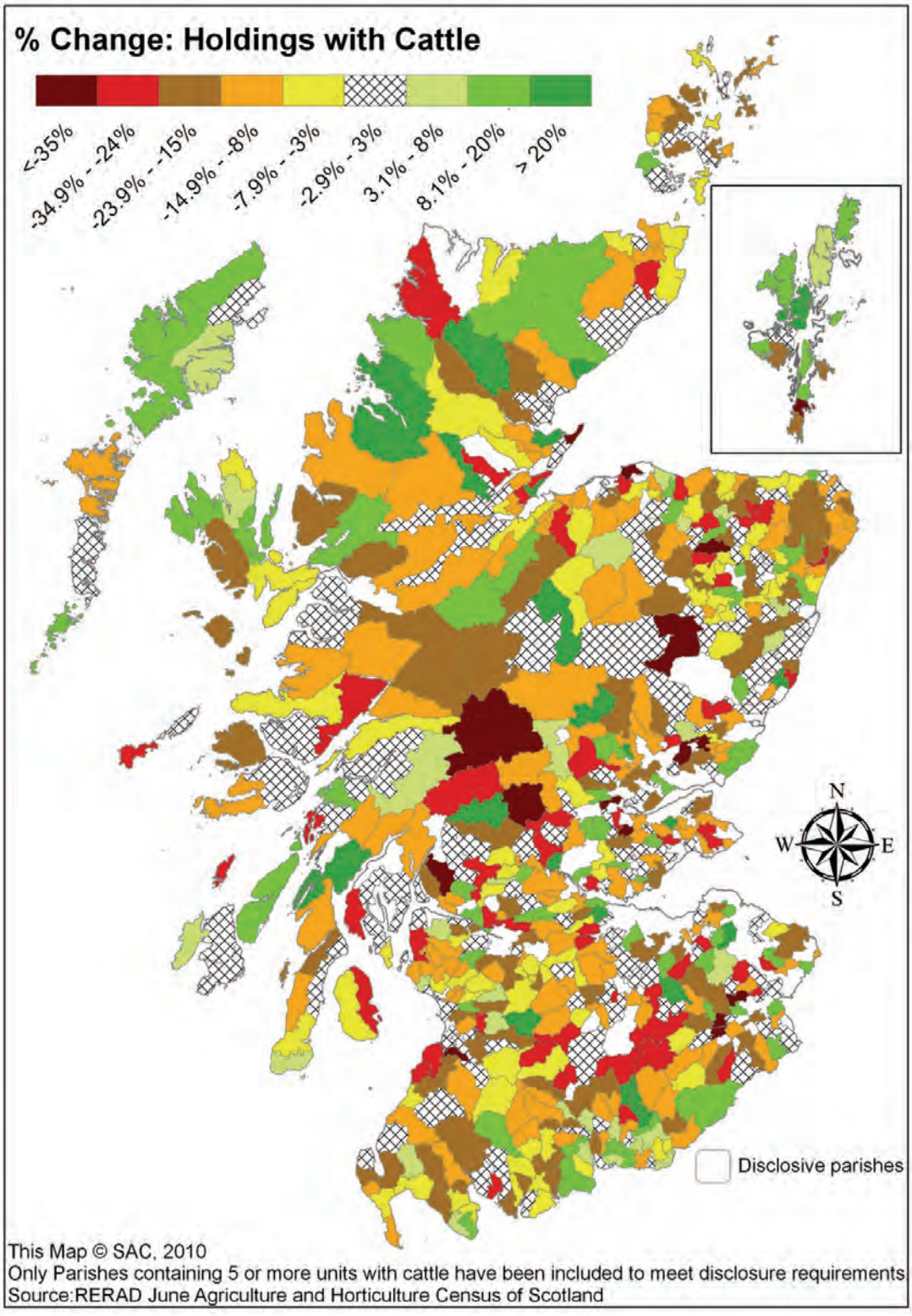


Figure 2.4b - Percentage change in number of holdings with cattle 2004 to 2009 (parish level).

Figure 2.3 shows how Scottish beef cattle numbers have fallen by around 2% per annum between 2004 and 2009. Figures 2.5a and 2.5b show the significant variations that have occurred across Scottish NUTS4 regions and also within these regions at parish level. In Lochaber, the number of cattle has fallen by 25.3% with a 17.5% fall occurring in Skye and Lochalsh and an 11.4% decline in the Argyll and Bute Islands. At NUTS4 regional level, it is evident that there has been considerable cattle decline in the West Central Highlands and Islands and also in the Borders, with little change occurring in some of the main livestock areas that include Aberdeenshire, and Dumfries and Galloway. The Western Isles has seen very little deterioration in cattle numbers over these 5 years, falling by just over 1%. At local level it is evident that there are large variations within each of these areas and even neighbouring parishes are witness to very large percentage changes in cattle numbers (for examples see Table 2.2).

Table 2.2 - Percentage change in local cattle numbers – selected examples.

NUTS4 Region	Parish	Percentage Change
Eilean Siar (Western Isles)	Harris	+38%
	North Uist	-7.6%
Skye and Lochalsh	Bracadale	-37.6%
	Portree	+17.8%
Scottish Borders	Ettrick	-47.8%
	Eskdalemuir	+23.2%

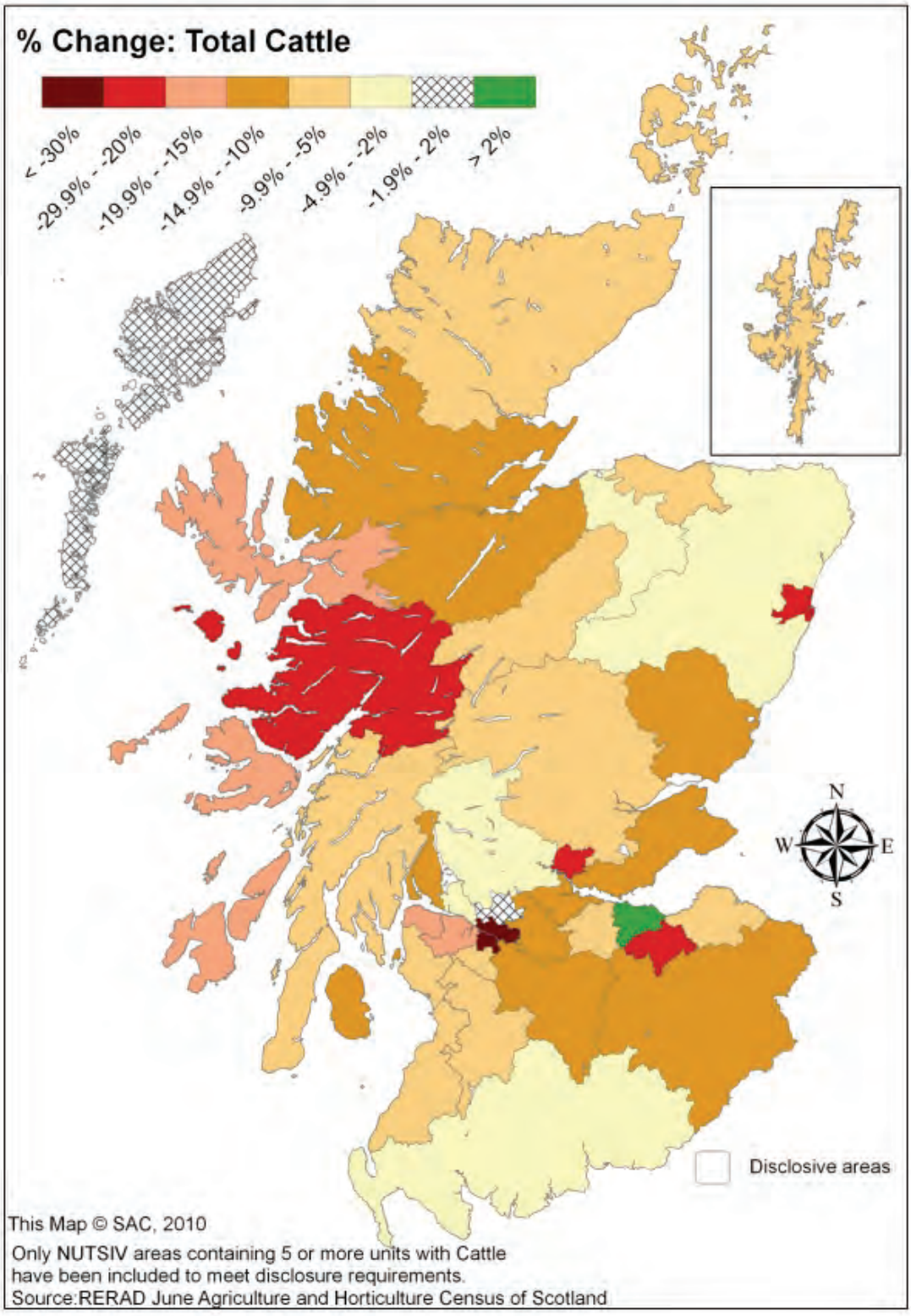


Figure 2.5a - Percentage change in the number of cattle 2004 to 2009 (NUTS4 areas).

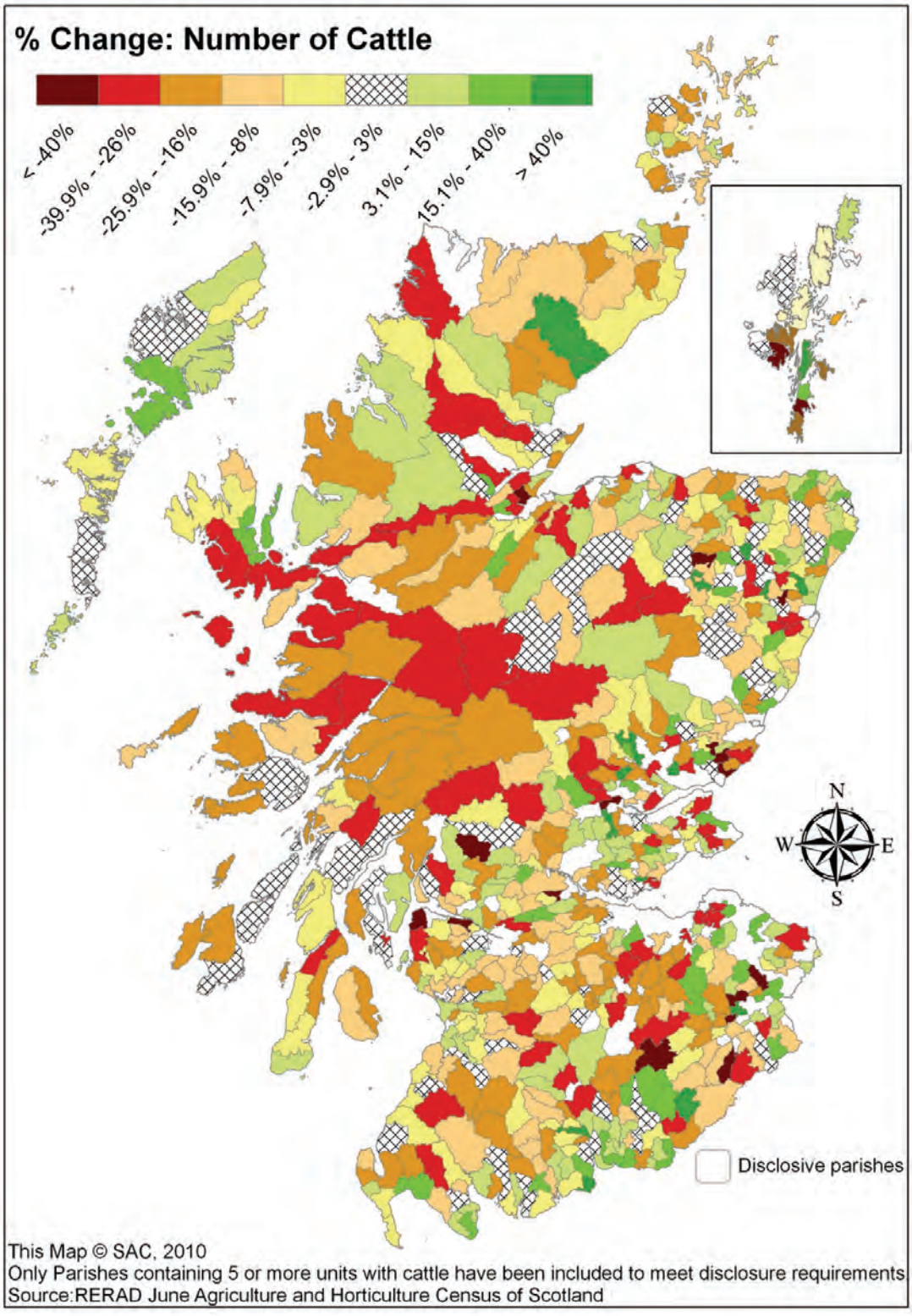


Figure 2.5b - Percentage change in the number of cattle 2004 to 2009 (parish level).

With many areas seeing holdings giving up having cattle since the introduction of decoupled CAP support payments (Figures 2.4a and 2.4b), it is uncertain if the decline in the total number of cattle (Figures 2.5a and 2.5b) is wholly attributable to these farmers and crofters withdrawing from production or if the remaining cattle producers have also restructured and changed their intensity of cattle farming (i.e. extensifying or intensifying). To investigate this further, the change in the relative intensity of cattle per holding across NUTS4 regions and parishes was examined (see Figures 2.6a and 2.6b). At NUTS4 level it is apparent that there is a clear divergence between North/West and East/South, with the former having fewer cattle per holding and the later intensifying and having more cattle per holding. For example, in Perth and Kinross and Aberdeenshire, cattle numbers per holding have increased by around 6%, with Dumfries and Galloway also having a 5% increase. The opposite is occurring in the North/West. Between 2004 and 2009 the average cattle herd in Skye and Lochalsh fell by 16.8%, it dropped by 15.8% in Lochaber, and in Ross and Cromarty it fell by 10.2%. Within these regions at local parish level, it is once more apparent that there are large variations in changes in production intensity with those remaining cattle producers. Many parishes saw average herd sizes fall by over 22% (all the red areas in the parish map). The Scottish Beef Calf Scheme (SBCS) was introduced in 2005 through Article 69[12] in order to protect and enhance the environment through cattle grazing and also to improve the quality and marketing of agricultural products. This scheme pays farmers £70 on the first 10 calves claimed, and then £35 per calf thereafter. The justification of the higher payment on the first 10 calves being that it supports smaller herds. Barnes (2008), in his evaluation of the SBCS, reports that the largest numbers of recipients of support are in the North-West of Scotland, "although the bulk of the funds have been directed towards the North East and South West". Barnes concluded that "net margins per cow (which take into account fixed costs) for all enterprises are negative regardless of support provided by the Scottish Beef Calf Scheme. This suggests that the SBCS on its own does not support the long term viability of beef enterprises. Some structural change will be needed to improve fixed costs". This restructuring does appear to be continuing in many upland areas.

[12] SBCS was first implemented in 2005 using Article 69 of Council Regulation (EC) 1782/2003. The scheme reallocates 10% of the Single Farm Payment Scheme ceiling corresponding to the beef sector to support beef production in Scotland.

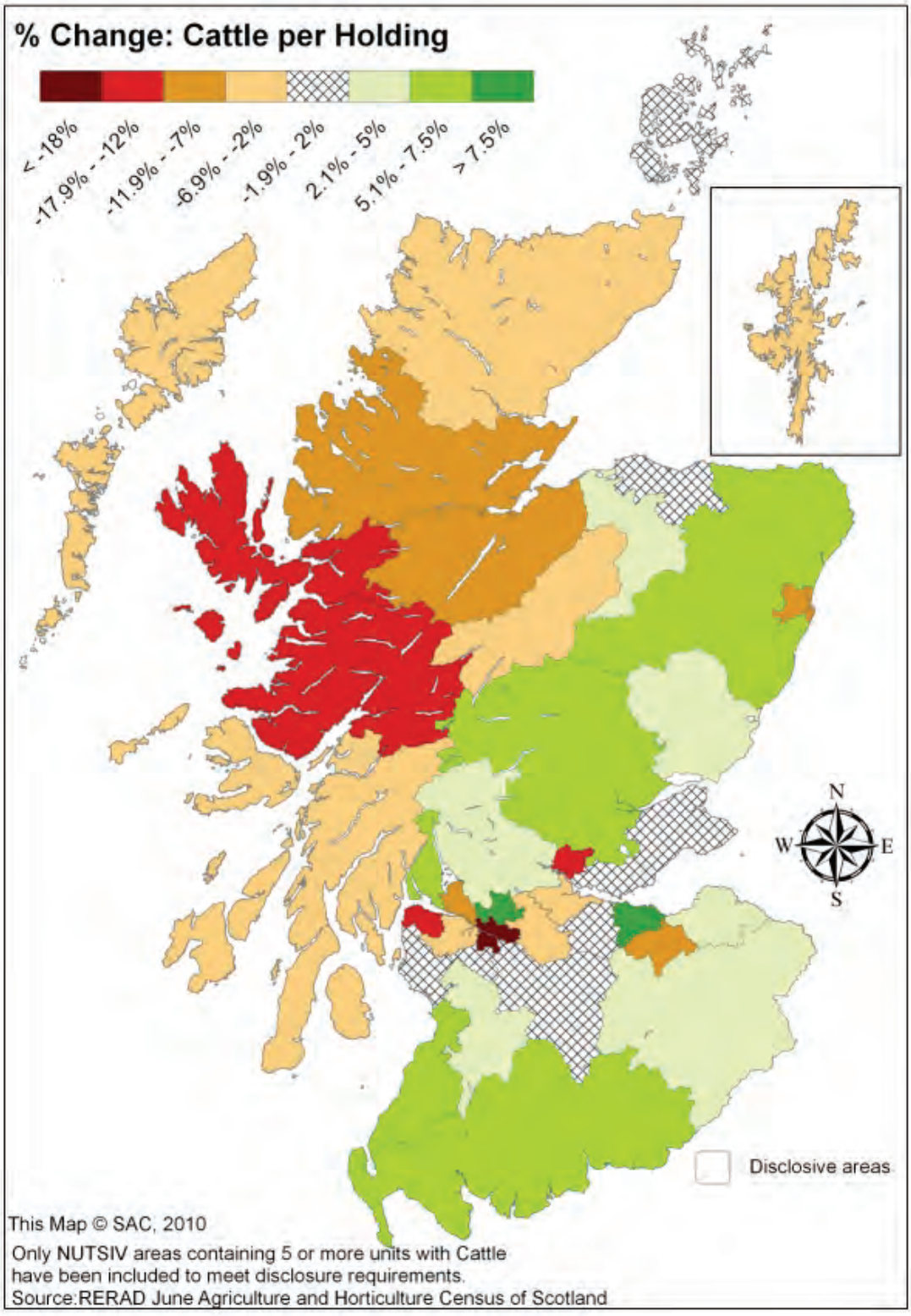


Figure 2.6a - Percentage change in the number of cattle per holding 2004 to 2009 (NUTS4 areas).

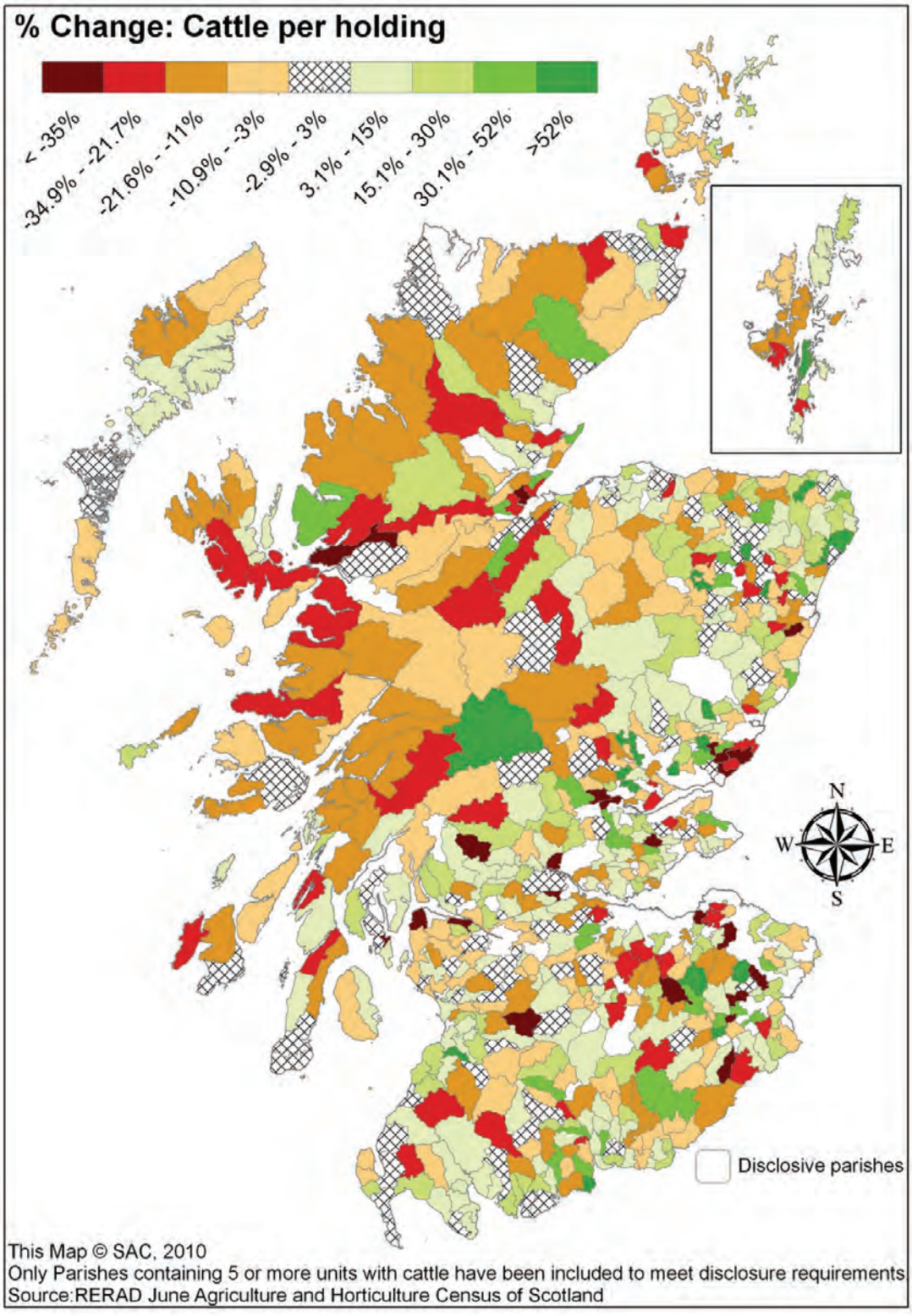


Figure 2.6b - Percentage change in the number of cattle per holding 2004 to 2009 (parish level).

These findings suggest that in the North/West whilst some of the cattle decline can be attributed to farmers and crofters withdrawing from production, part of it is also attributable to the remaining farmers downsizing their herds. In the South/East the overall decline in cattle numbers (Figure 2.5a) is mostly due to the withdrawal of some farms from production[13].

2.4 Livestock decline in Scotland – sheep evidence

Data from the annual June Agricultural and Horticultural Census (Scottish Government, 2010a) reveal that the sheep flock in Scotland changed significantly from the early 1980's with significant changes continuing post decoupling (see Figure 2.7). In the 1980s, in reaction to headage payments, the sheep flock expanded quite rapidly. This raised concerns of overgrazing in the uplands that ultimately led to, for example, the introduction of The Heather Moorland (Livestock Extensification) (Scotland) Regulations 1995[14] in an attempt to overcome this problem. Following a decline in sheep numbers post McSharry reforms of the CAP, there was an upsurge between 1996 and 1998 before poor market prices led sheep farmers to start rationalising their flocks for economic reasons. 2001 saw a large decrease in sheep numbers due to the Foot and Mouth Disease outbreak and subsequent cull of sheep in many parts of the Borders, and Dumfries and Galloway. After a period of relative stability post 2001, the Scottish sheep flock entered a period of rapid decline following the introduction of the decoupled Single Farm Payment in 2005. The breeding flock has been falling at an average rate of 3.6% since 2005, with the total sheep flock falling by an average of 3.2% per annum. As mentioned, some commentators believe that the industry is now perhaps stabilising and between 2008 and 2009 the June Agricultural Census figures showed a fall in the flock of 2.5%. The December Agricultural Survey (Scottish Government, 2010b) also shows that the annual decline was 2.5% between 2008 and 2009 (from 7.7% the previous year) and QMS (2009b) highlight that the total sheep number estimated in December 2008 (4.7 million) was "the first time it has fallen below the 5m head mark for more than three decades". It is perhaps too early to tell if the sheep flock (June count) is going to stabilise around the 6.9 million mark (from its peak of 9.9 million in 1990). Market prices for lamb and farmers' reaction to the new EU electronic identification (EID) rules for sheep, together with any changes to the rules governing agricultural support payments (Pack, 2010), and future CAP reform will have significant bearing on whether the decline will continue or stabilise around the current level.

[13] It is acknowledged that as these figures contain dairy herds a proportion of the figure of withdrawal and cattle losses will come from this sector. In order to meet disclosure requirements it was not possible to map local beef cattle only at parish level.

[14] See http://www.opsi.gov.uk/si/si1995/Uksi_19950891_en_1.htm#end

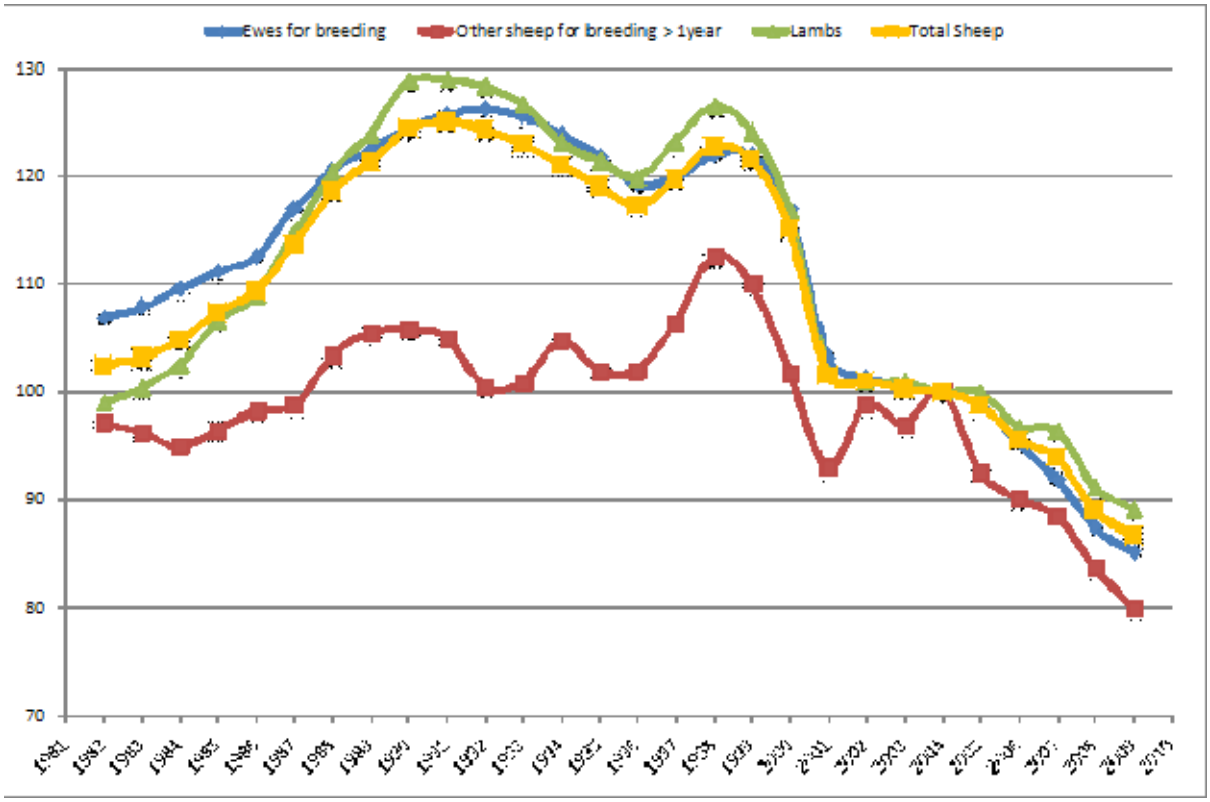


Figure 2.7 - Index of Scottish sheep numbers from the June Agricultural Census (2004=100). **(***Source: Scottish Government, 2010a).*

QMS (2009b) point out the importance of the Scottish Borders (17% of breeding flock), the Highlands (about 14%), and Dumfries and Galloway (about 14%) to the sheep sector in Scotland. Using June Agricultural Census data, Figures 2.8a and 2.8b show the change in the number of holdings that have sheep across Scotland at NUTS4 (breeding ewes) and parish level (total sheep). The figures show the wide regional and local variation that exists in the change in the number of holdings with sheep between 2004 and 2009.

Between 2004 and 2009 there has been a large reduction in the number of holdings with sheep in a band across Scotland reaching from the Western Isles (-12%), through Skye and Lochalsh (-12%), Lochaber (-11.5%), Stirling (-11.5%), and into Perth and Kinross (-14%), with the Shetlands (-12%) also experiencing similar levels of decline in farms and crofts that run sheep. Much of the rest of the Highlands and the Borders area have also witnessed declines in the number of holdings with sheep but to a slightly lesser extent, with Dumfries and Galloway showing relative stability (having lost a number of sheep farmers after the Foot and Mouth Disease crisis in 2001). As with cattle, there is significant variance at local parish level with many areas experiencing falls in the number of holdings with sheep of over 15%, with others having stability and a few areas actually witnessing growing numbers of holdings with sheep (e.g. Glenshiel). There is a difference between sheep kept for breeding and other sheep, which is not immediately apparent from the data. As an example, between 2004 and 2009, Torosay in the South of Mull saw the number of holdings with any sheep fall by 24%, although the number of holdings with breeding ewes actually fell by a third from 18 to 12 over the same period. A different pattern is seen in Tweedsmuir in the Borders where the number of units with breeding ewes only fell by 25% whilst there was a 33% reduction in the number of holdings with any sheep (from 8 to 6 holdings).

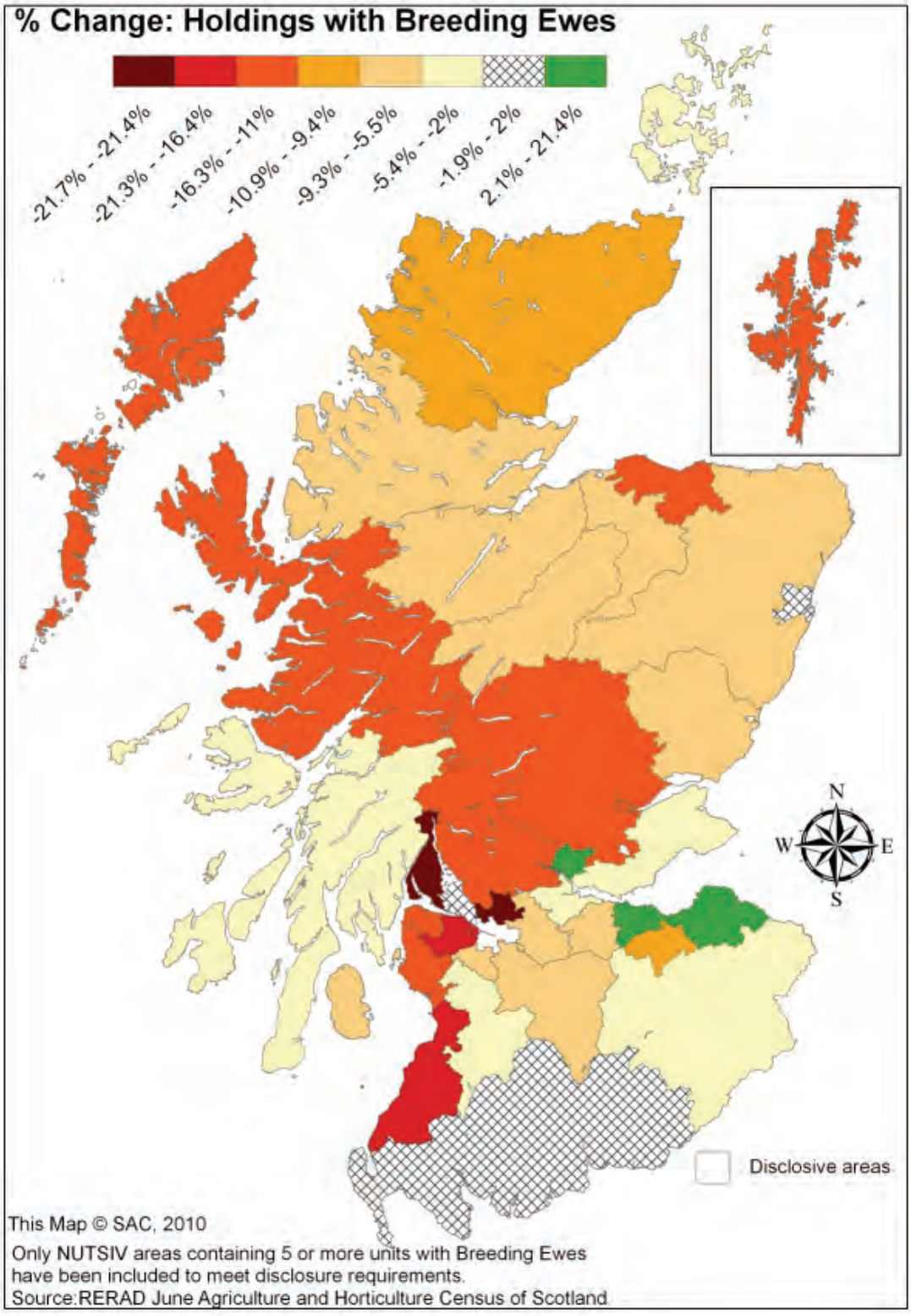


Figure 2.8a - Percentage change in the number of holdings with breeding ewes 2004 to 2009 (NUTS4 areas).

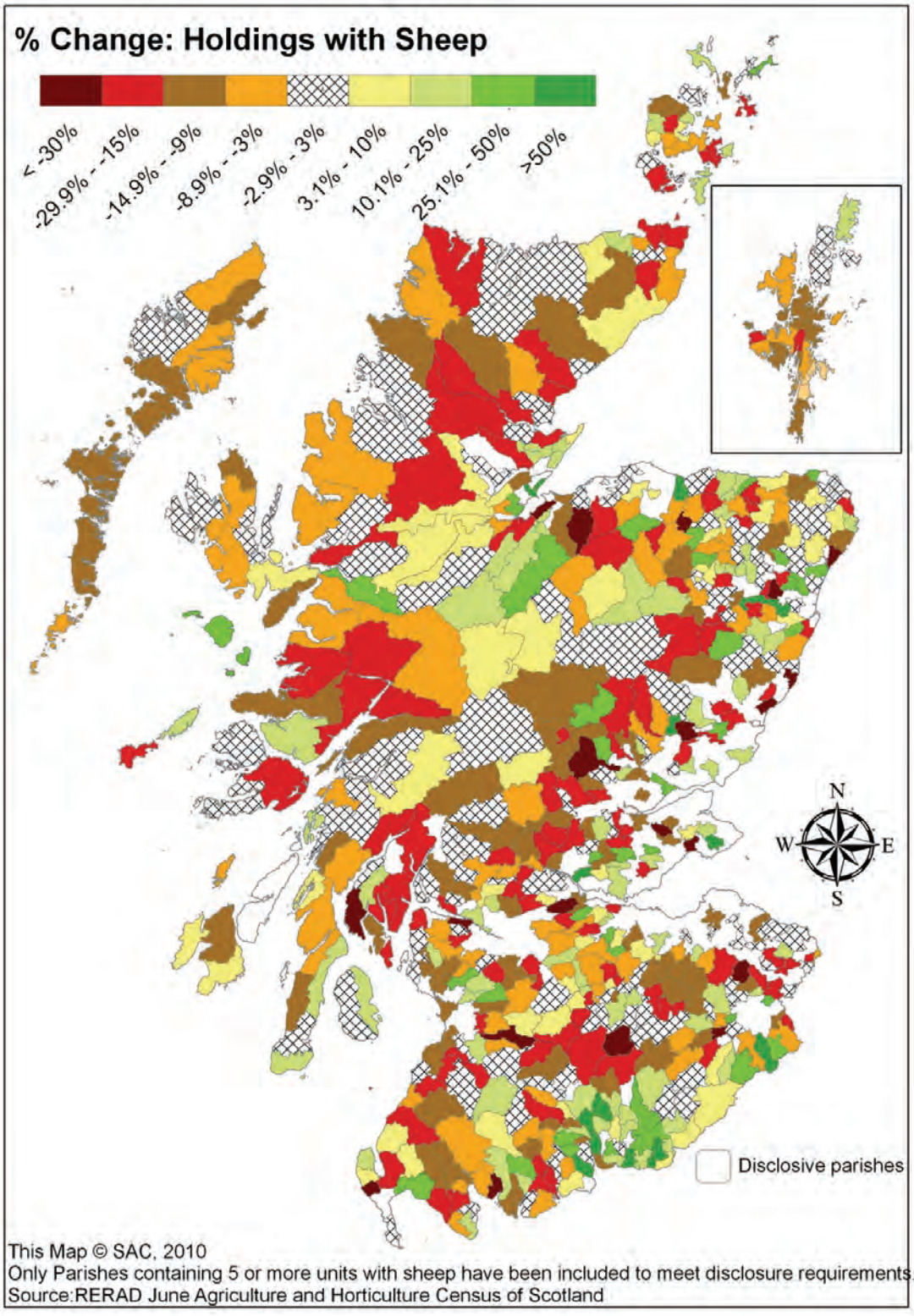


Figure 2.8b - Percentage change in the number of holdings with sheep 2004 to 2009 (parish level).

Figure 2.7 above shows how the Scottish sheep flock has fallen by 12.2% since 2005. Figures 2.9a and 2.9b show the significant variations that have occurred across Scottish NUTS4 regions and also within these regions at parish level. Between 2004 and 2009 in Lochaber the number of breeding ewes has fallen by 34.7% from 68,568 to 44,725 with the number of breeding ewes in the Western Isles falling by 26.9% from 113,259 to 82,780. Other areas with large breeding ewe populations that have seen declines of over 20% include the Argyll and Bute Islands, Ross and Cromarty, Skye and Lochalsh, and the Shetland Islands. The major sheep producing areas in the South, whilst having some reduction in ewe numbers, have not seen the same large declines that have been occurring in the West. For example breeding ewe numbers in Dumfries and Galloway fell by 9.5% from 429,654 to 389,015, with the Borders seeing a 7.9% decline from 480,632 to 442,691. At local parish level there is wide variation in the change in total sheep, with a number of areas, particularly in the North and West Highlands, experiencing declines of over 35%. Arisaig and Moidart have seen the total sheep numbers fall by 55.7% from 5,828 to 2,581, whereas in neighbouring Ardnamurchan, total sheep numbers have fallen by 30.7%. At the opposite end of the spectrum Kirkmichael has seen sheep numbers increase by 76% between 2004 and 2009, rising form 7,114 to 12,552 with similar rises also happening in nearby Glenmuick, Tullich and Glengairn. The rise in these last two parishes may be partly attributed to game estates using sheep on the hills as tick mops.

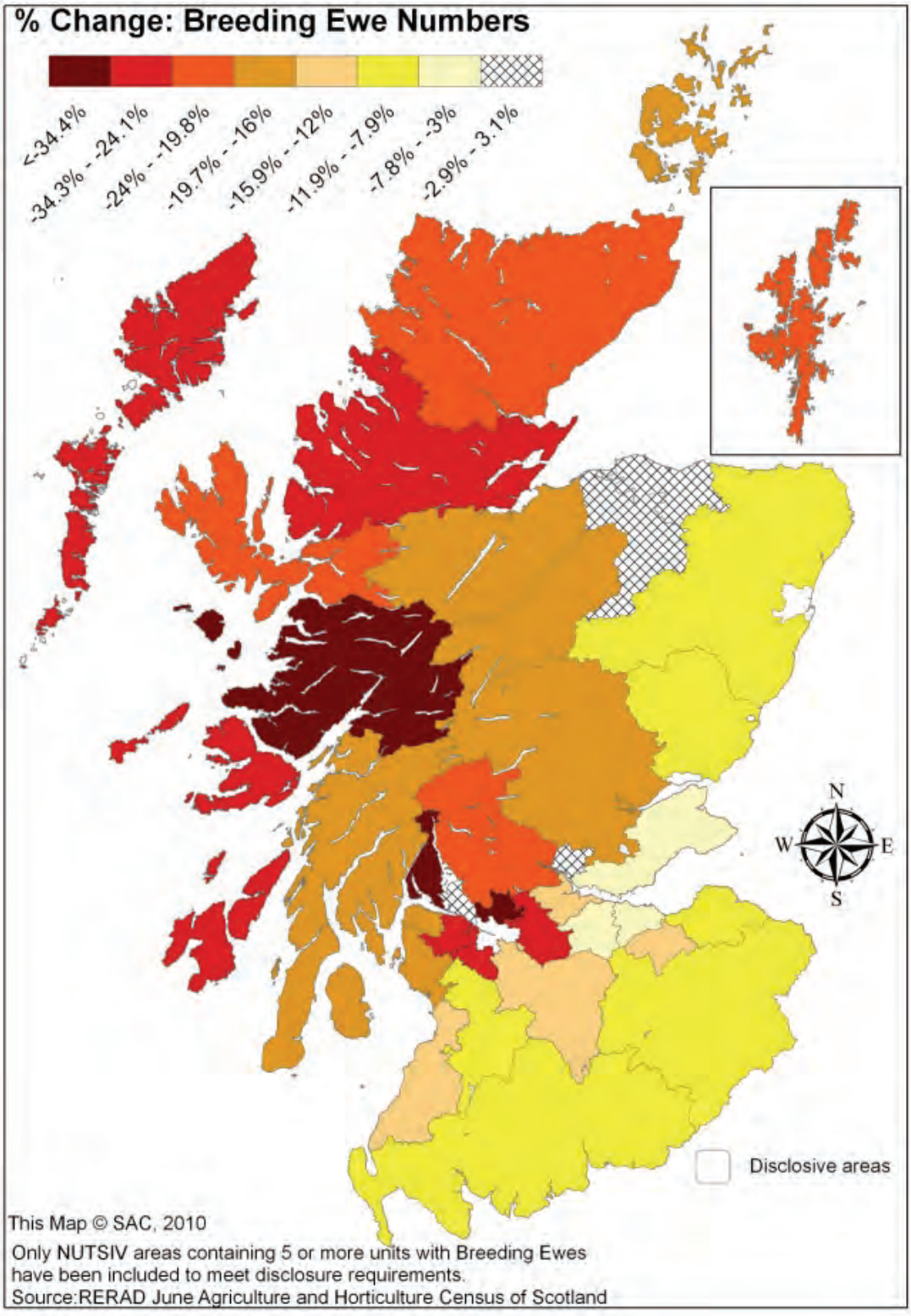


Figure 2.9a - Percentage change in the number of breeding ewes 2004 to 2009 (NUTS4 areas).

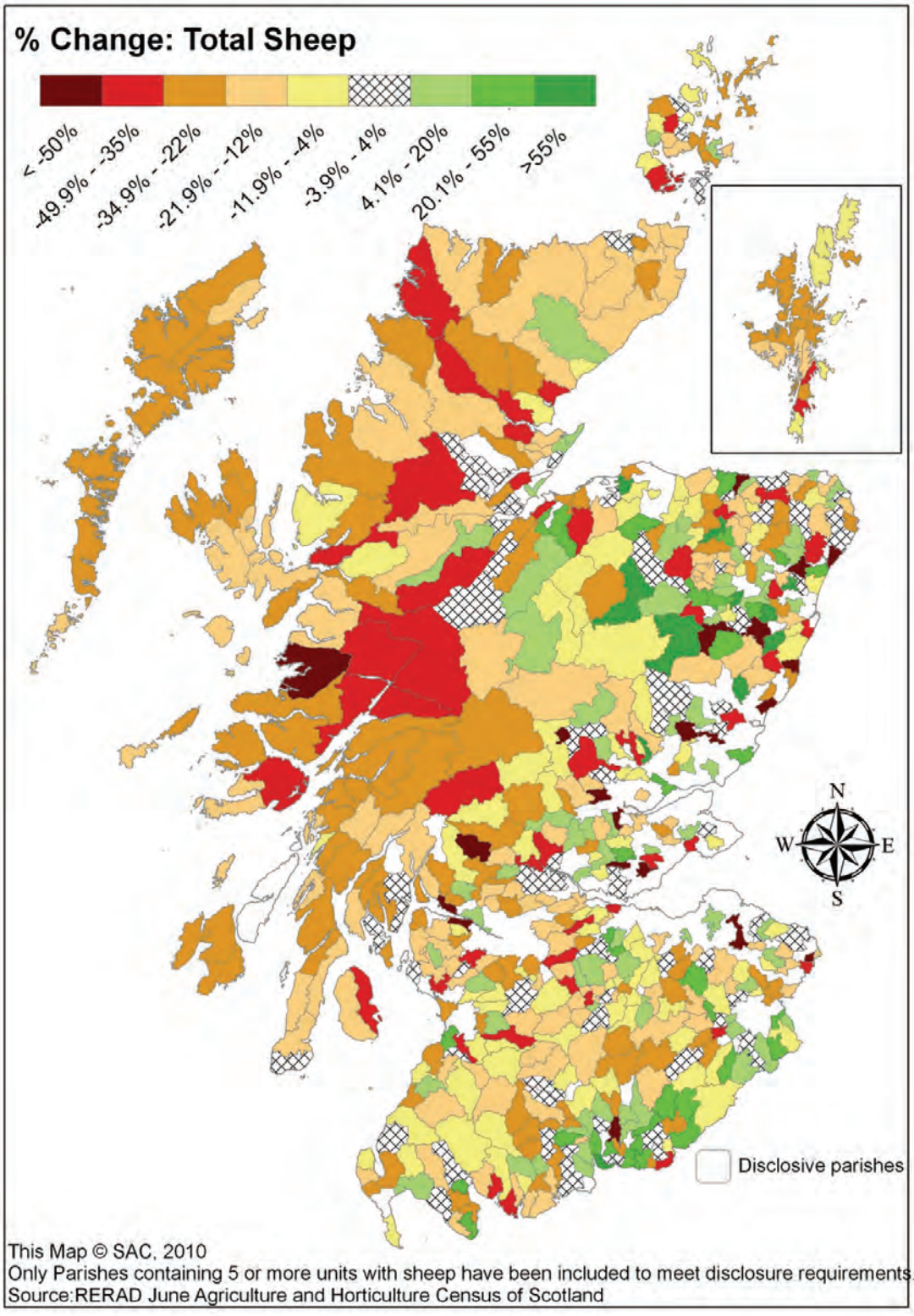


Figure 2.9b - Percentage change in the number of sheep 2004 to 2009 (parish level).

With many areas seeing holdings giving up keeping sheep following the introduction of decoupled CAP support payments (Figures 2.8a and 2.8b), it is uncertain if the decline in sheep numbers (Figure 2.7) is wholly attributable to these farmers and crofters withdrawing from production or if the remaining sheep producers have also restructured and changed their intensity of sheep farming (i.e. extensifying or intensifying). To investigate this further, the change in the relative intensity of ewes per holding across NUTS4 regions and sheep per holding at parish level were examined (see Figures 2.10a and 2.10b). Across Scotland, sheep production appears to be extensifying with the number of sheep per holding increasing in only a very few regions (such as West Moray where average ewe numbers have risen slightly from 306 to 327). Whilst Lochaber has seen large declines in sheep holdings and in total breeding ewes, there has also been a significant downsizing of the remaining sheep holdings with the average number of breeding ewes falling by 26.2% from 233 to 172. A similar decline is seen in the Argyll and Bute Islands, where average ewe numbers per holding have fallen by 22% from 222 to 173 and in Ross and Cromarty where average ewe numbers per holding have fallen by 18.8% from 133 to 108 ewes. Within these NUTS4 regions at local parish level, it is once more apparent that there are large variations in changes in production intensity within the remaining sheep producers. Many parishes have seen average flock sizes fall by over 25% (all the red areas in the parish map) since 2004. This means that we can conclude that apart from a few pockets of intensified sheep production in Scotland, the general trend has been for some farmers to retreat altogether from sheep production whilst the remaining farmers have downsized their flocks.

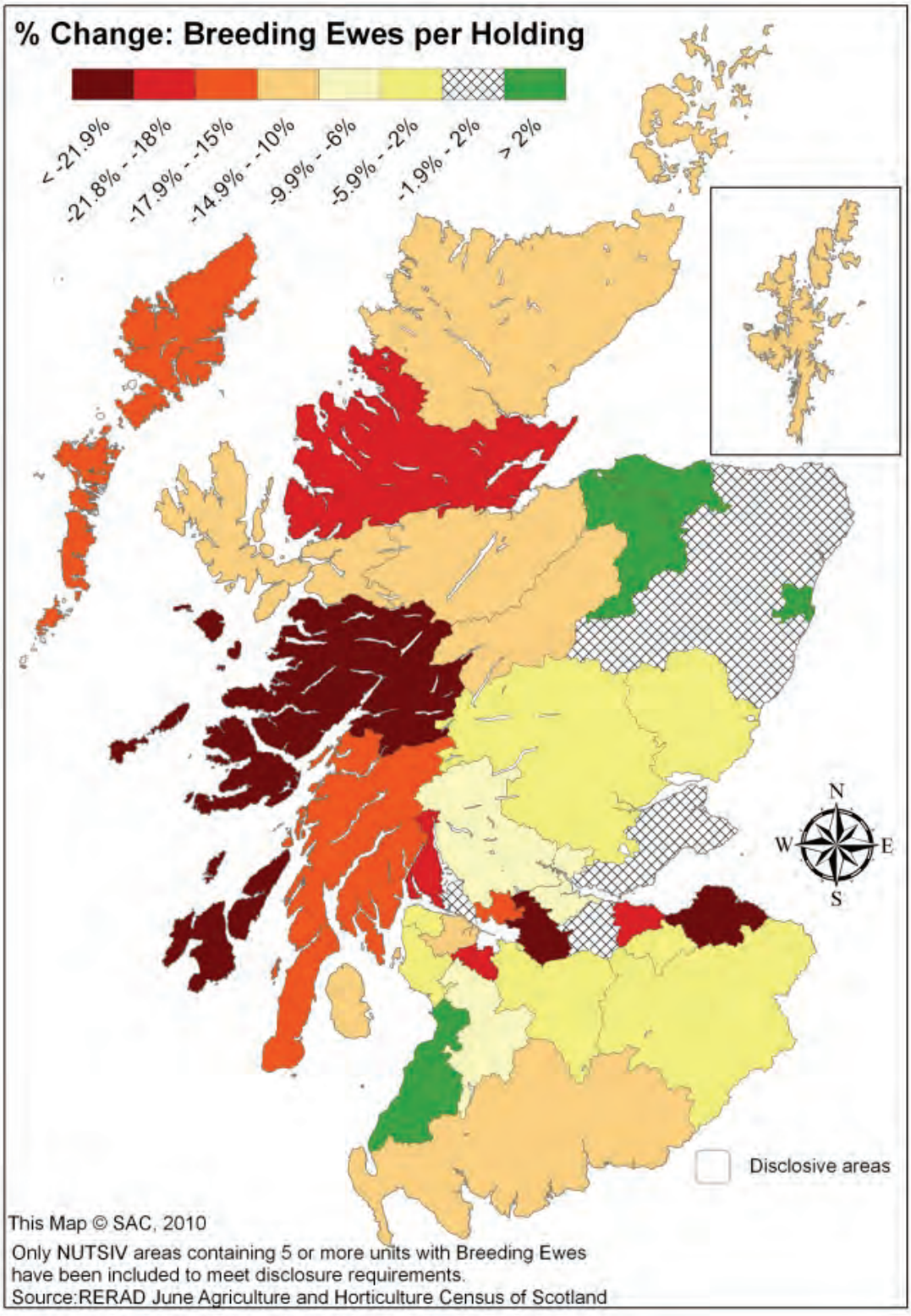


Figure 2.10a - Percentage change in the number of breeding ewes per holding 2004 to 2009 (NUTS4 areas).

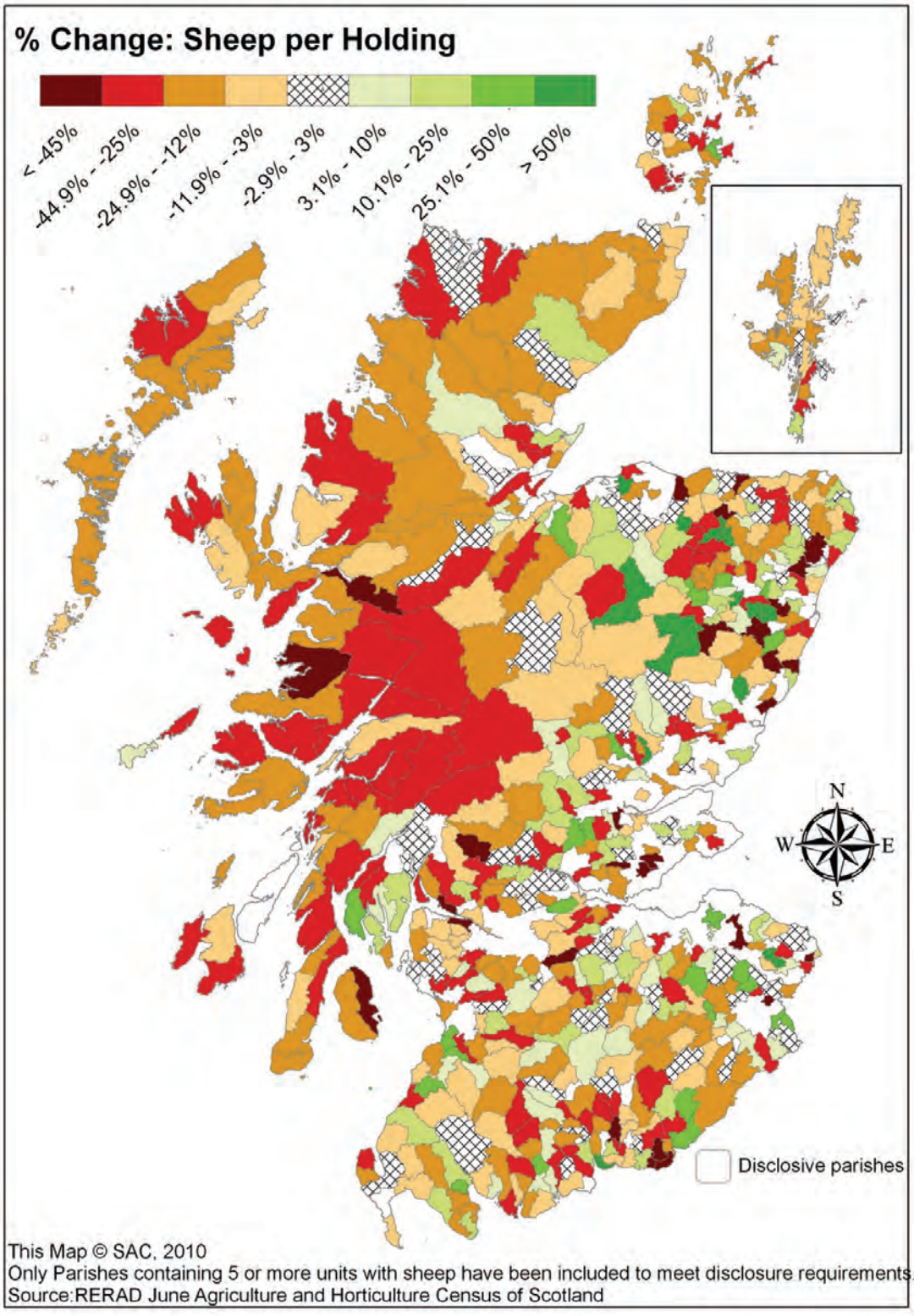


Figure 2.10b - Percentage change in the number of sheep per holding 2004 to 2009 (parish level).

These sections examining changes in sheep and cattle numbers across Scotland have shown how the trends reported by SAC (2008) and Scottish Government (2009) have largely continued. Many upland farmers retreated from production and many of those who remained have downsized as the "freedom to farm" brought in by the introduction of the decoupled Single Payment Scheme in 2005 has been realised. There is clearly considerable restructuring occurring in the uplands as farmers have made rational economic decisions to minimise losses from unprofitable sheep and suckler beef production systems through rationalising their herds / flocks. This was highlighted by QMS (2009b) about the beef sector, where they state that "large herds have been reduced, especially culling low value or low productivity animals".

2.5 Livestock decline in Scotland – grazing evidence

As cattle and sheep numbers have decreased in much of Scotland, it might be justified to assume that the amount of grass required may have reduced, as farmers no longer require as much hay or silage or need as much grassland forage to feed their reduced livestock numbers. At the same time it may be reasonable to assume that in the marginal upland areas, grazing at the margins (improved rough grazings) may be allowed to return to a rough state, meaning that the total amount of rough grazing may be increasing (or alternatively it may be planted with woodland).

Using published figures, it is clear from Figure 2.11 that the area of rough grazing gradually decreased annually from 1982 through to 2003 (through afforestation, losses of land from agriculture and creation of improved pasture). Since then, although there has only been a gradual increase (3%) in the amount of rough grazing up until 2008, that increase actually represented a considerable area of land (121,330 hectares). This is due to the sheer amount of rough grazing existing in Scotland (4 million hectares in 2008). The 5% decrease between 2008 and 2009 is unaccountable, given that it represents 217,664 hectares. Since 1982 there has also been a continual decline in young grass (206,738 ha between 1982 and 2008) with a gradual increase in grass over 5 years old (by 321,023 ha) over the same timeframe. As the area of arable cropping increased by over 100,000 hectares over the same period, it suggests that, whilst some of the land used for young grass has been put under crops, about half has been converted into longer term pastures. Additionally some of the 723,000 hectares of rough grazing that have been lost up until 2009 were transformed into improved pastures, particularly in the 1980s and early 1990s, when support was still available to hill farmers to improve marginal grazing land. The sudden dip in the amount of land under young grass in 2008 and subsequent very large rise in 2009 can probably be attributed to the cessation of set-aside in 2008 under pressure of rising cereal prices. The cereal price spike led to some rotational grass and some former set aside being ploughed up for arable production in 2008, which was subsequently returned to young grass in 2009 after the cereal prices suddenly dropped again in 2009.

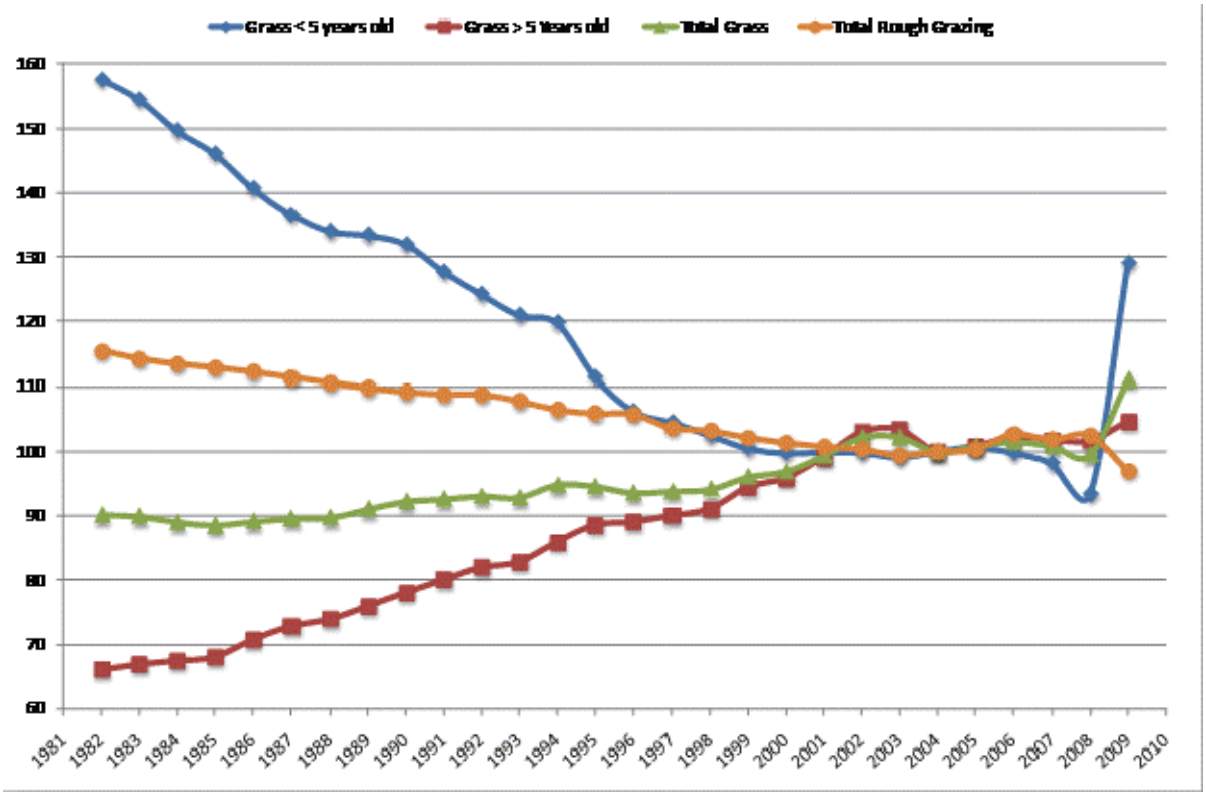


Figure 2.11 - Index of grazing area from June Agricultural Census (2004=100). (Source: Scottish Government, 2010a).

Figure 2.12 reveals that at NUTS4 level the amount of young grassland has fallen significantly (albeit from relatively small actual hectares) in Skye and Lochalsh (59%), Shetland (47%), Lochaber (41%) and the Western Isles (19%). In these areas of limited good quality and cultivatable land, this probably directly correlates to the decline in sheep and cattle from these areas, as there is reduced requirement for good quality pasture and for grassland to provide hay and silage crops for winter feeding. In much of the rest of Scotland there is much more likelihood of former cropping and set aside land being put to young grass in the last 5 years. Looking at the area of grass over 5 years of age (Figure 2.13) it is probable that the increase in area in Skye and Lochalsh, the Western Isles, Shetland, Lochaber and the Argyll and Bute Islands corresponds to the reduction in young grass (i.e. it is not ploughed for fodder crops and subsequently re-seeded) which in turn is likely to be a result of the reduction of sheep and cattle in these areas. In the eastern areas, where there has been a large reduction in the area of grass over 5 years old, this may be due to some grass in longer rotations being ploughed for cereals in 2008 due to market signals, which were subsequently reverted into (young) grass in 2009 as these market signals disappeared.

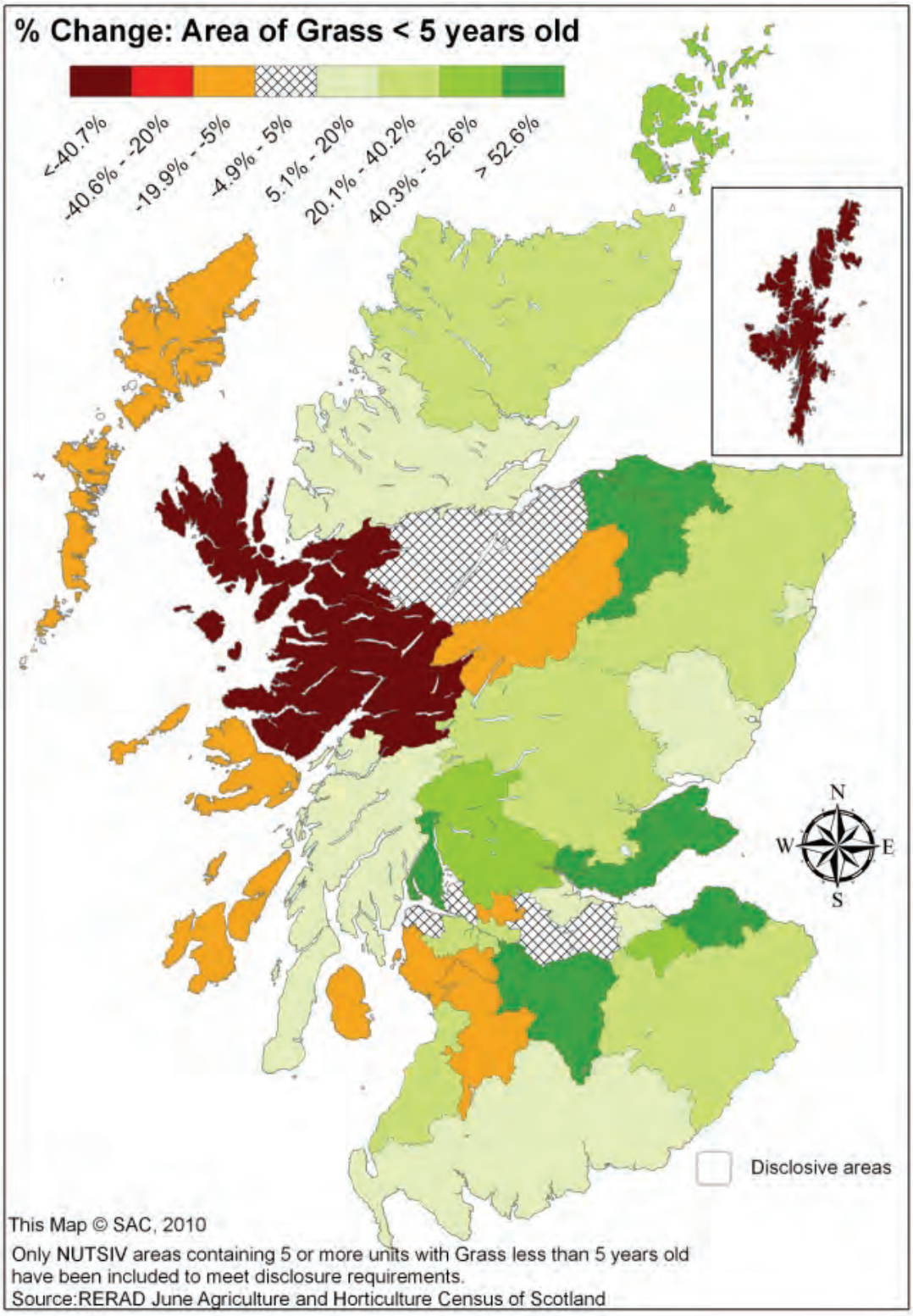


Figure 2.12 - Percentage change in the area of grassland less than 5 years old, 2004 - 2009 (NUTS4 areas).

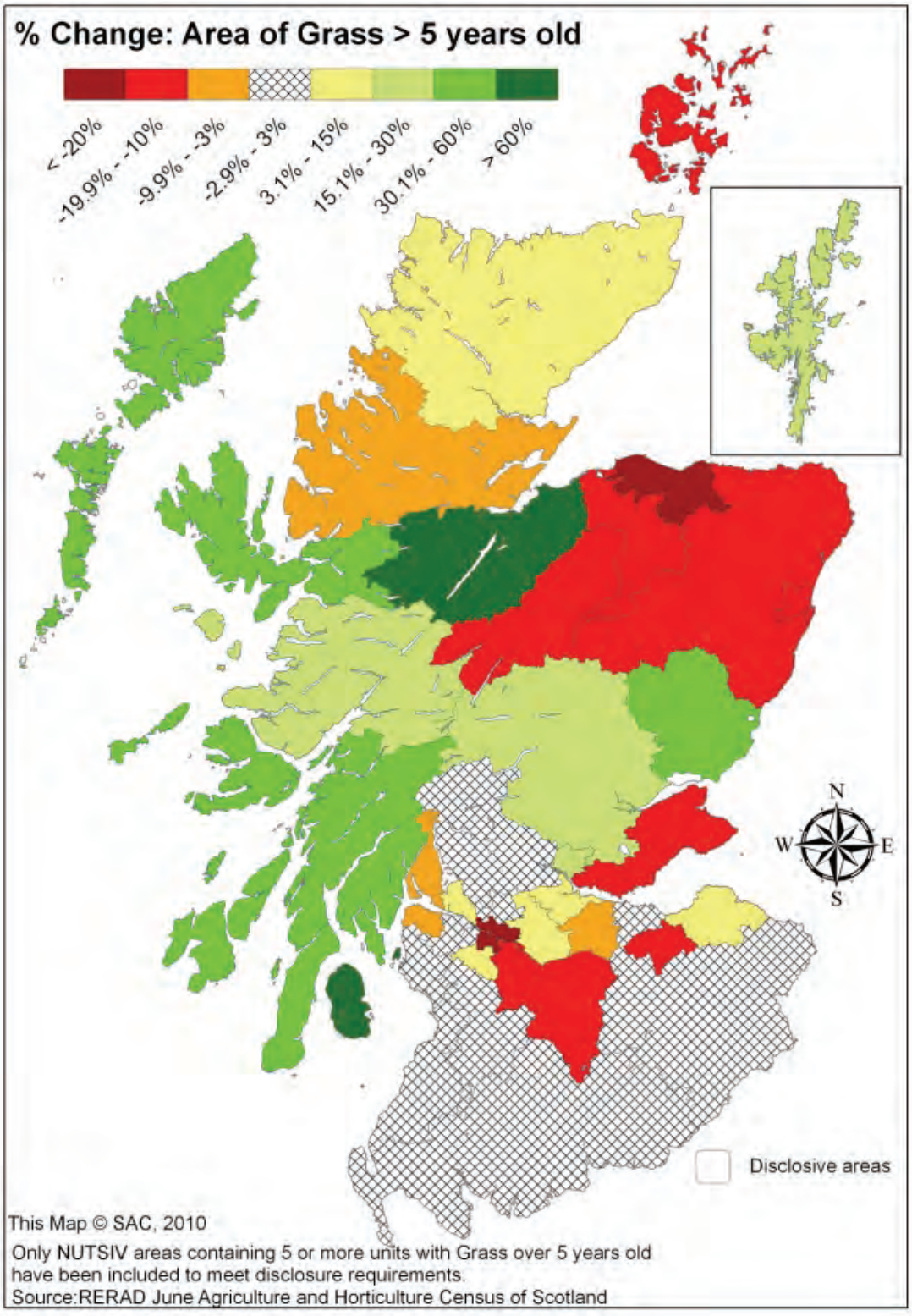


Figure 2.13 - Percentage change in the area of grassland over 5 years old, 2004 - 2009 (NUTS4 areas).

2.6 Livestock decline in Scotland – occupiers and labour evidence

The number of full time occupiers of agricultural holdings has been in long term decline across much of Scotland. Indeed, it has fallen from 14,493 in 1982 to 9,764 in 2009 (a fall of a third) of which 11.5% has been since the introduction of the decoupled CAP Single Farm Payment in January 2005. At the same time, part time farmers engaged in agriculture for more than 50% of their time have also declined, by 26.5% from 5,222 in 1982 to 3,387 in 2009, whilst part time farmers / crofters engaged in agriculture for less than 50% of their time have increased by 44.4% since 1982, rising from 9,682 to 13,038. This reduction in labour input into the management of agricultural land is potentially as significant an impact on the natural heritage as the decline in livestock numbers. Figure 2.14 confirms these general trends during the last 30 years of fewer full time and part time (mainly engaged in farming) occupiers and spouses, and increasing occupiers and spouses engaged in agriculture for less than half their time. These trends are largely due to the economic squeeze that farming has been under for some time and farmers have partially withdrawn from the industry due to difficulties making an adequate living from full time farming. Equally, there have been a proportion of Scottish farmers that have looked for opportunities to expand and benefit from economies of scale and increased production capabilities (or to buy land to ensure grazing livestock units per hectare did not breach the limit set for extensification payments). A result of this type of restructuring is that many "full time farms" sold over this period were fragmented or "lotted" to extract the maximum value for the vendor. This meant that often the farmhouse was sold with some of the land for residential purposes (perhaps to a "hobby" farmer, or commuter), whilst much of the remaining land would be sold to neighbouring farmers who took the "chance in a life-time" to expand locally. This meant that the full time holding's land suddenly disappeared into other full time holdings, with the residential element of the holding becoming a part-time unit. Recently, the downward trend has continued after the advent of decoupled payments as farmers downsize to minimise losses and utilise their "freedom to farm", whilst still receiving their historically based Single Farm Payment. It is perhaps interesting that since the economic recession has taken grip across the UK, the number of full time operators and spouses has seen an up-turn as perhaps some professionals are being forced to return to farming to maintain their living.

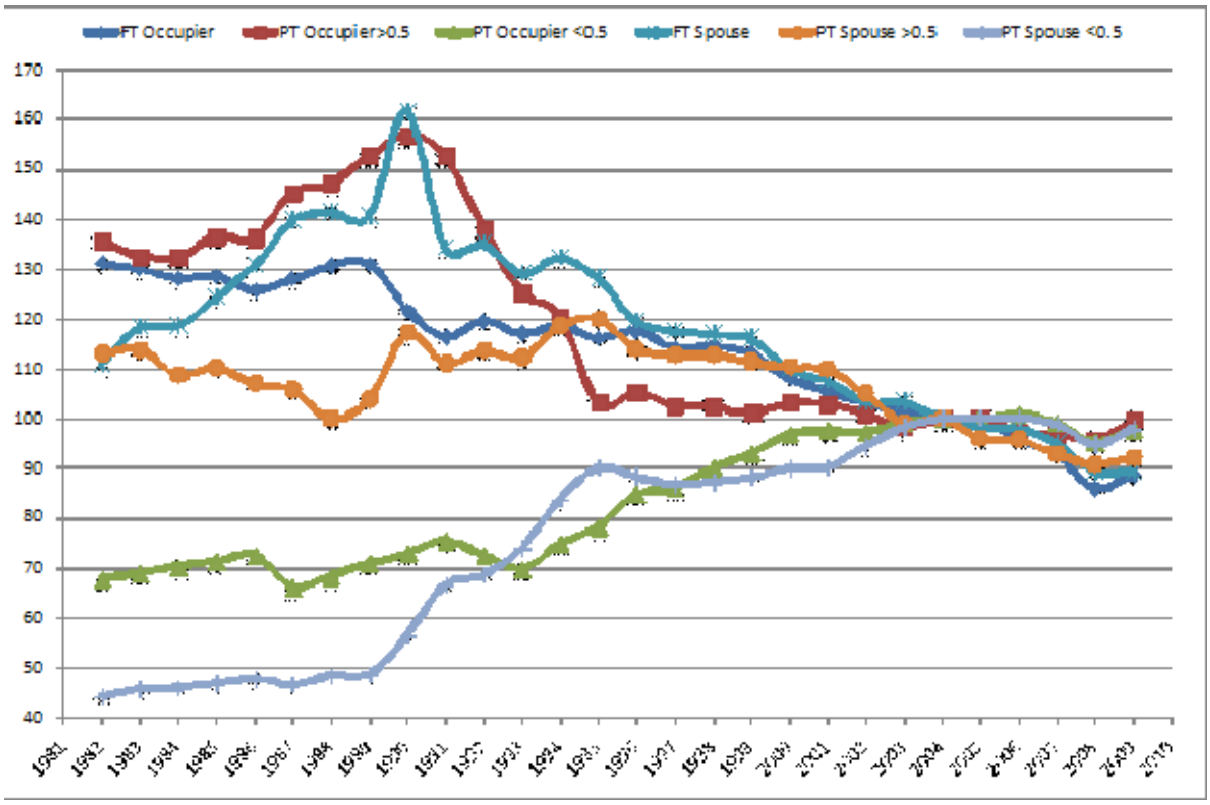


Figure 2.14 - Index of Scottish agricultural occupiers and spouses from June Agricultural Census (2004=100). (Source: Scottish Government, 2010a).

As with changes in sheep and cattle numbers, the restructuring of occupiers is not uniform across the whole of Scotland. Figure 2.15a reveals that at NUTS4 level there have been large declines in full time holders in Shetland (-29%), the Western Isles (-24.8%), Argyll and Bute Islands (-24.7%) and Lochaber (-21.9%). At parish level (Figure 2.15b) there are significant variations in the change of full time holders and some areas (burgundy) have seen declines of over 35%. Figure 2.16a shows that there have been reductions in significant part time holders in Stirling (-30%), Shetland (-20%), and Badenoch and Strathspey (-15%), with some increases in Inverness and Nairn (24%), and Orkney (14%) as the industry restructures. For minor part time holdings (Figure 2.16b) there is a direct increase in Badenoch and Strathspey (33%), and Argyll and the Islands LEC, as farmers and crofters move from full time and major part time to minor part time holdings. Interestingly, there has been a 14.5% reduction in total farmers/crofters in Shetland with large reductions in many other areas, such as Stirling (12.1%), South Lanarkshire (-11.4%) and Lochaber (-11.4%). This again reveals how some farmers/crofters are withdrawing entirely from the industry.

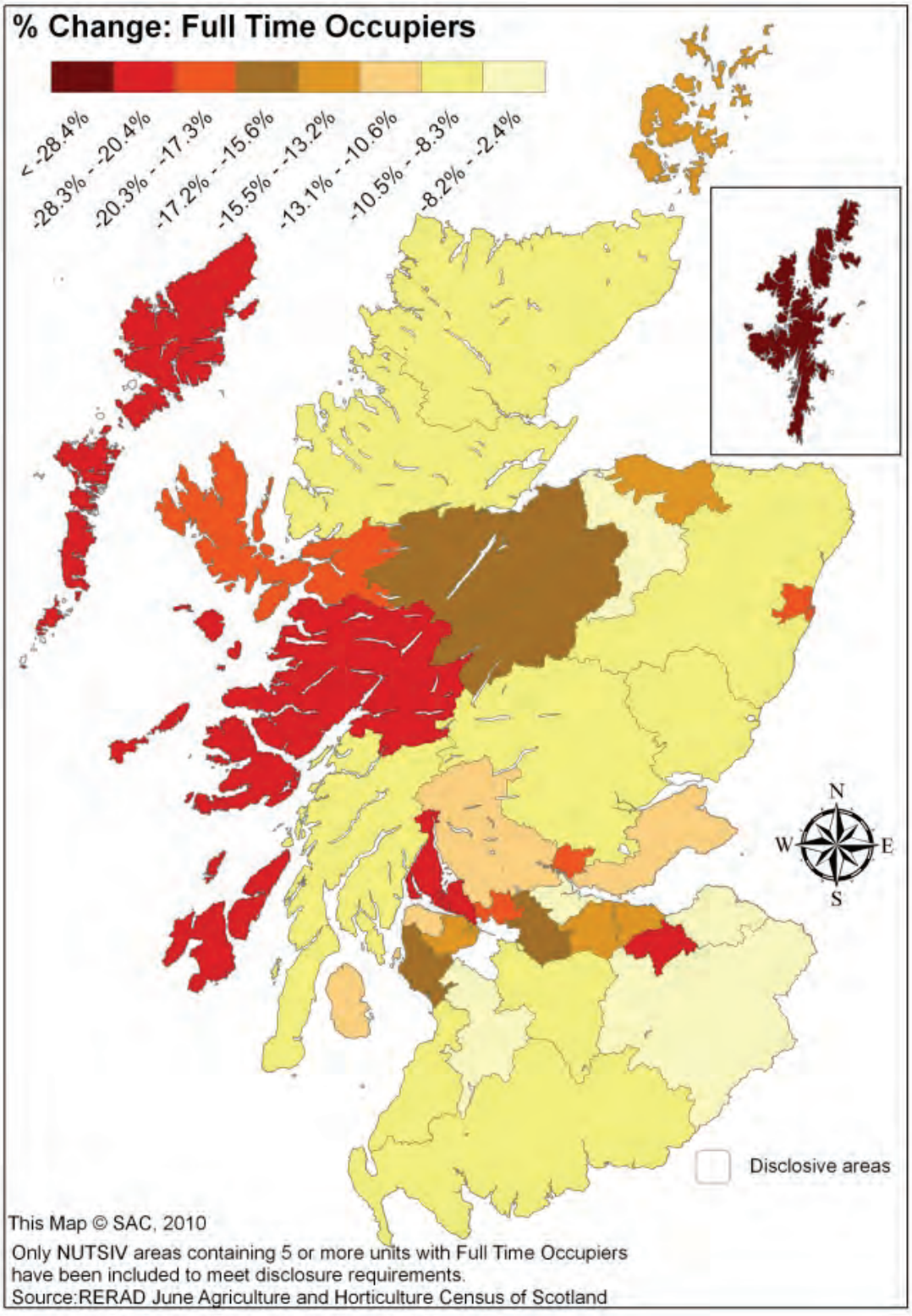


Figure 2.15a - Percentage change in the number of full time occupiers 2004 - 2009 (NUTS4 areas).

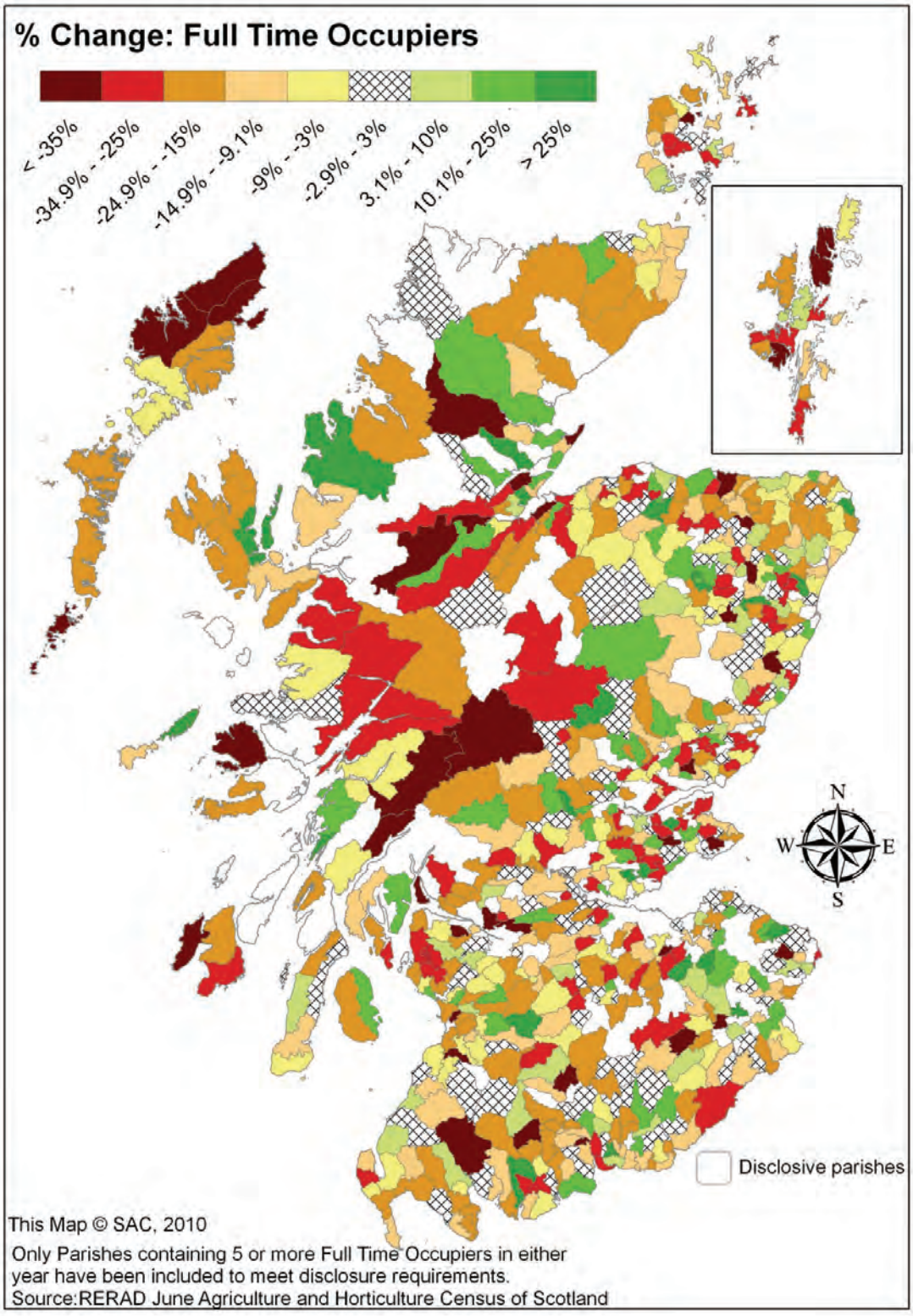


Figure 2.15b - Percentage change in the number of full time occupiers 2004 - 2009 (parish level).

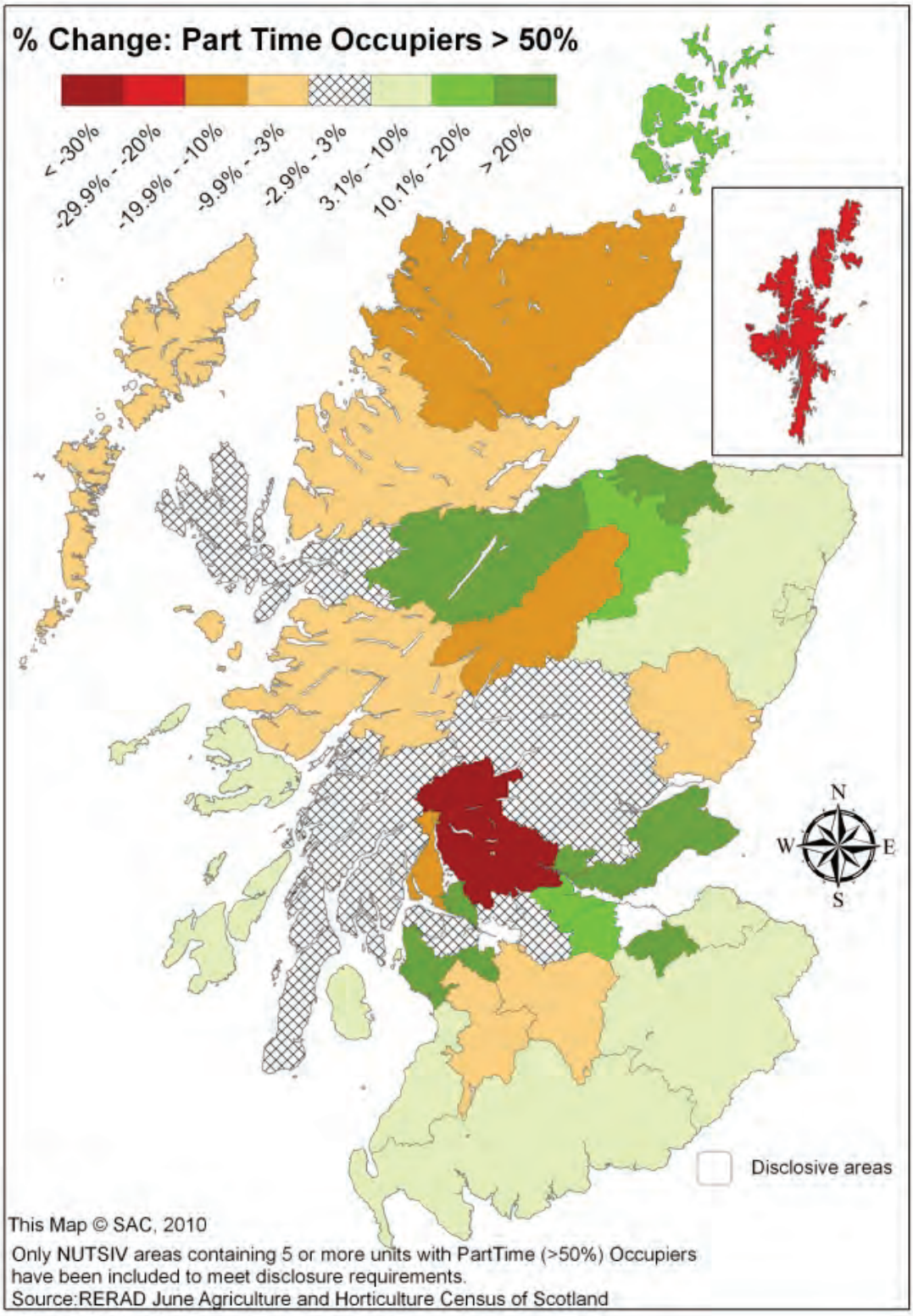


Figure 2.16a - Percentage change in the number of significant part time occupiers 2004 - 2009 (NUTS4 areas).

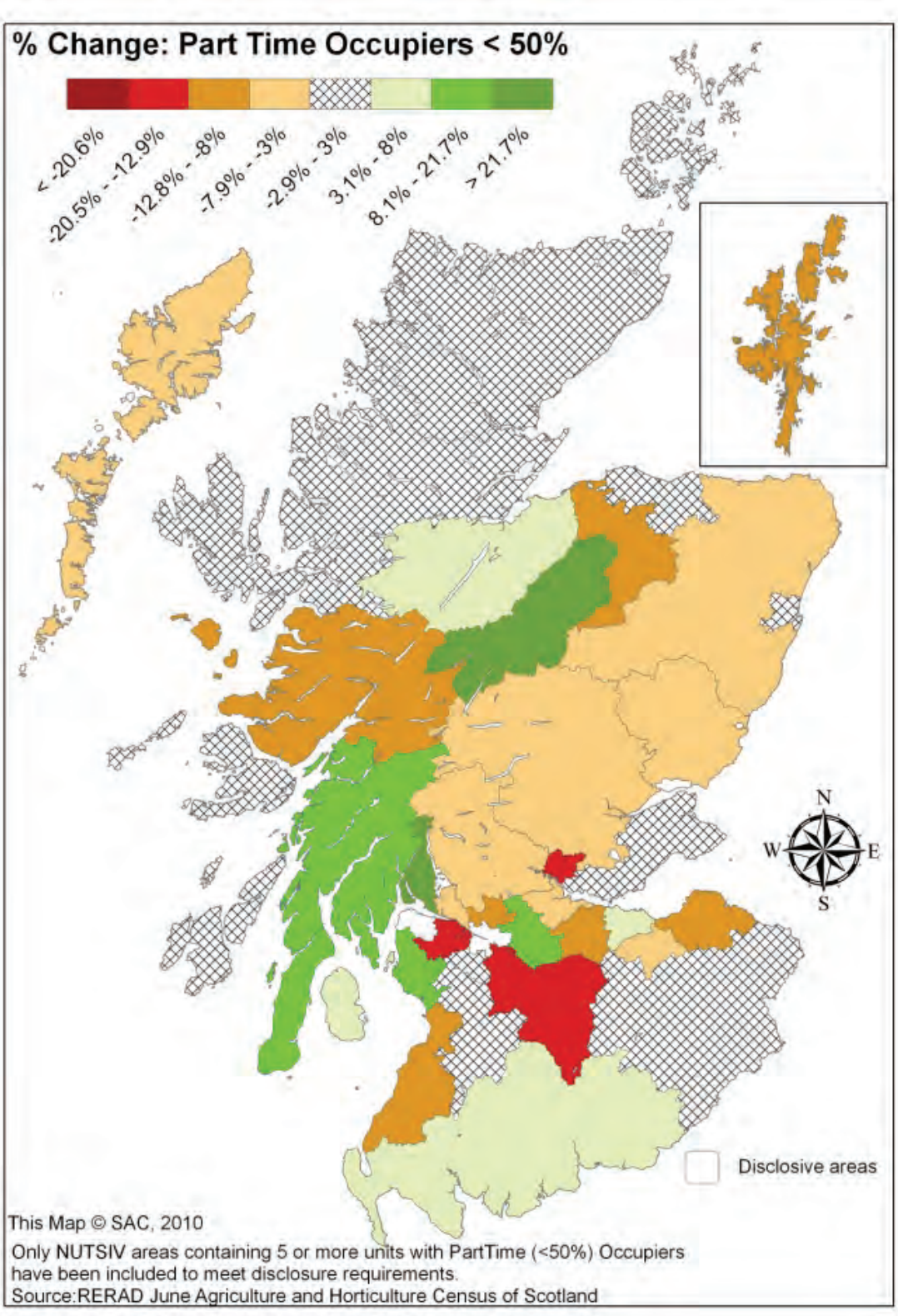


Figure 2.16b - Percentage change in the number of minor part time occupiers 2004 - 2009 (NUTS4 areas).

Linked to the decline in livestock and reduction in full-time holdings is the reduction in full-time employees on holdings (see Figure 2.17), with part-time employment remaining relatively stable over the last decade, whilst the reliance on casual and seasonal employment has increased. The decline in full-time employees has continued post decoupling and anecdotal evidence suggests that part of this directly relates to the decline of sheep numbers, as farmers consolidate by restructuring through reducing costly labour input (shepherds) and concurrently reducing flock size so that the holding can be run as a one-man (farmer) unit.

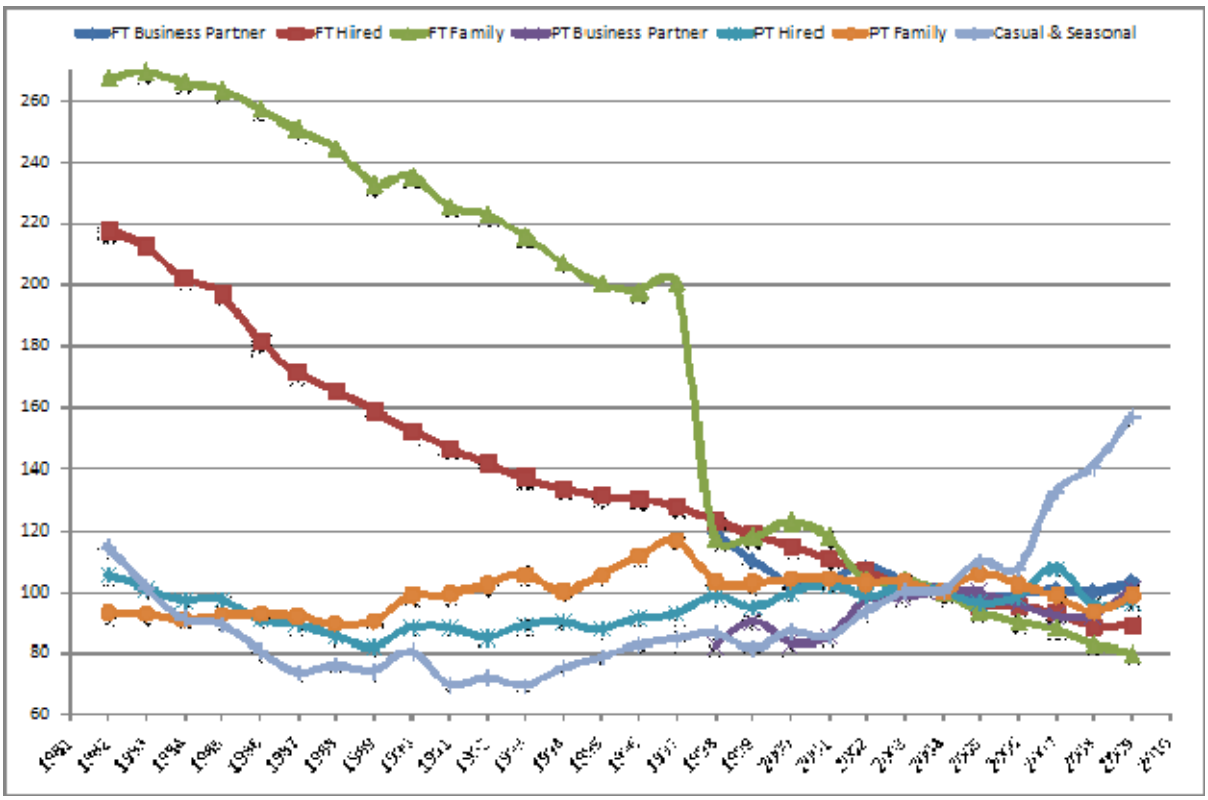


Figure 2.17 - Index of agricultural employees from June Agricultural Census (2004=100). (Source: Scottish Government, 2010a).

At NUTS4 regional level, there has been an increase in full-time employees in Stirling (21%) and Lochaber (17.5%), perhaps in relation to the decline in occupiers (Figure 2.18). The largest declines in full-time employees is occurring on low ground livestock regions, although there have been large falls in many of the upland areas such as the Western Isles (-17.2%), Perth and Kinross (-15.6%), South Lanarkshire (-15.5%), Orkney (-15%), and Ross and Cromarty (-14%). Regular part-time employment appears to be falling across much of Scotland, particularly in the West and Highlands (Figure 2.19), whilst farmers in many areas are becoming more reliant on casual and seasonal employment (Figure 2.20) (which anecdotal evidence suggests is becoming more difficult to find with the appropriate skills, such as shearing, shepherding, calving and lambing, etc.).

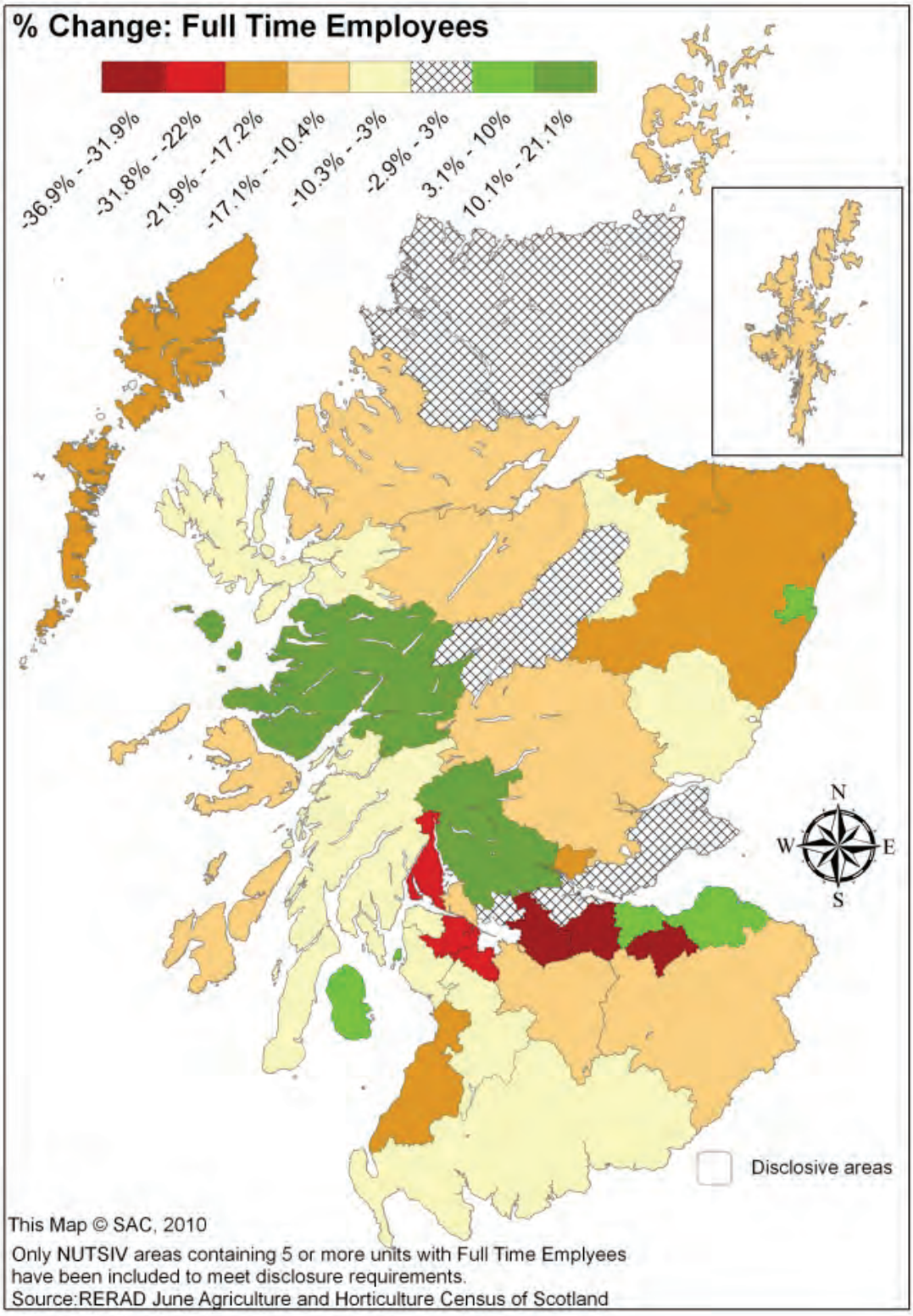


Figure 2.18 - Percentage change in the number of full time employees 2004 - 2009 (NUTS4 areas).

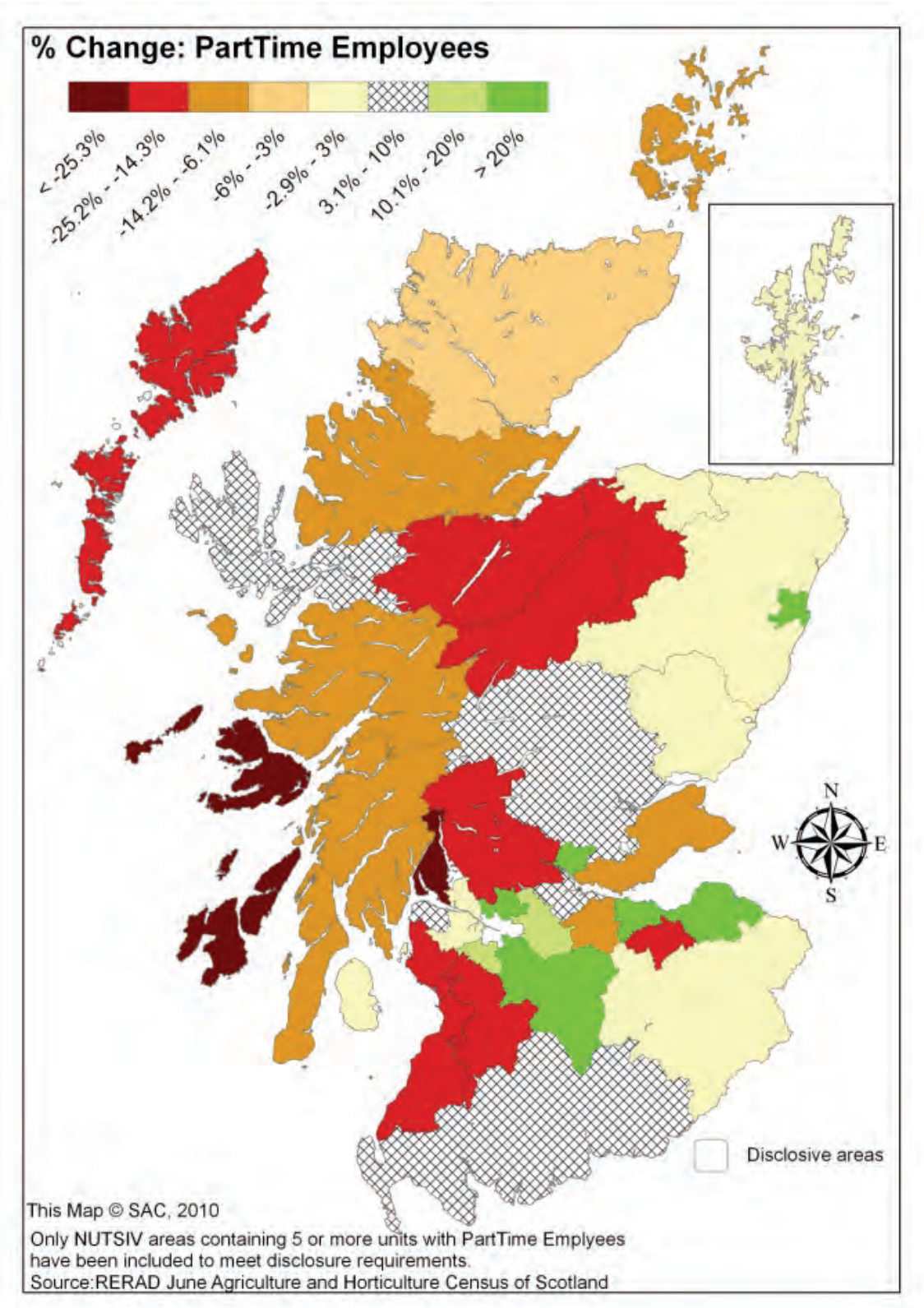


Figure 2.19 - Percentage change in the number of part-time employees 2004 - 2009 (NUTS4 areas).

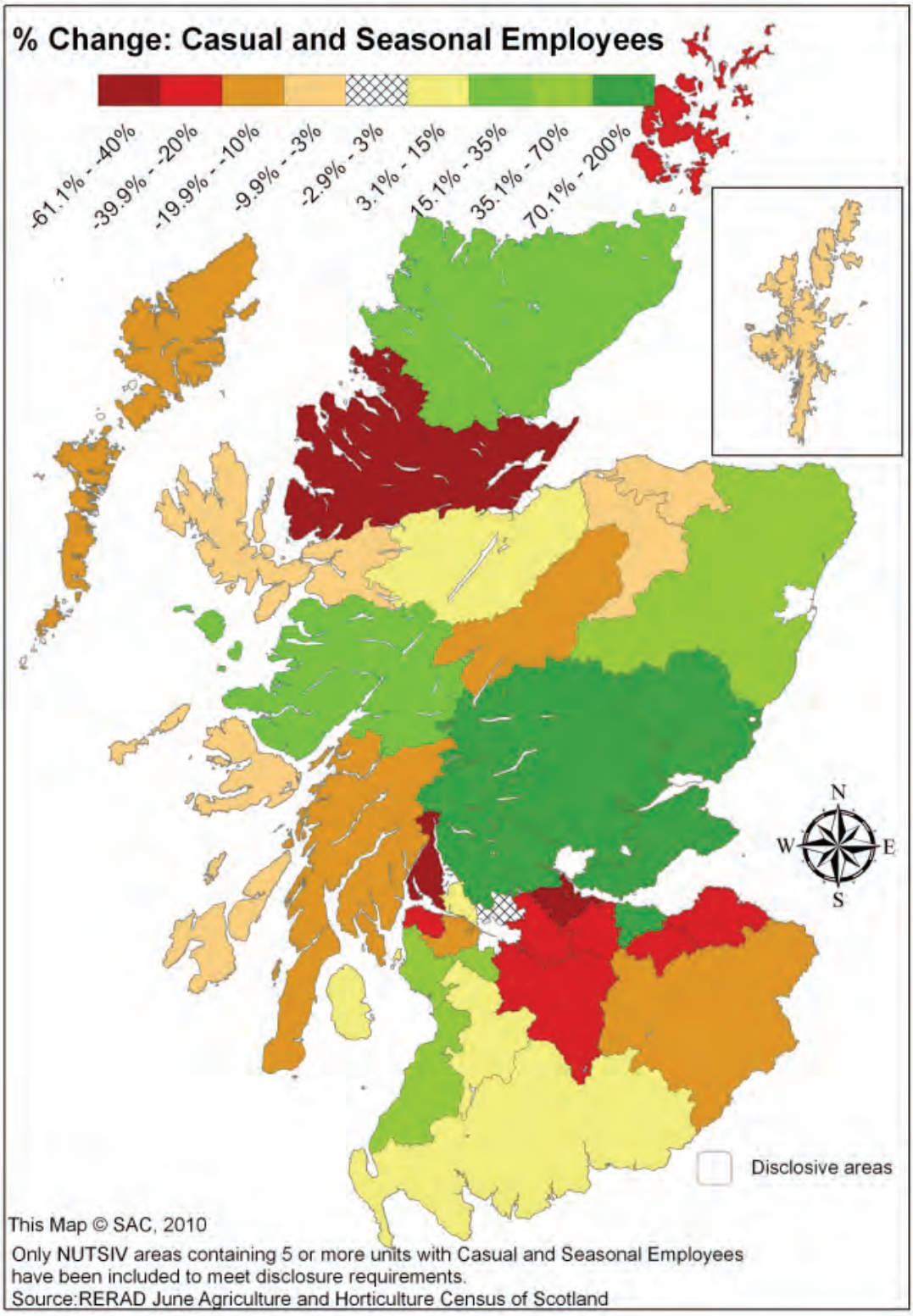


Figure 2.20 - Percentage change in the number of seasonal employees 2004 - 2009 (NUTS4 areas).

3 MAIN FARM TYPES IN SCOTLAND

3.1 Hill sheep (and cattle)

Hill sheep farming is the dominant farm type in the hill and mountain areas of the north and west of Scotland and the higher parts of the Southern Uplands (Figure 3.1). This type of farming utilises large tracts of hill land of poor quality rough grazing and much smaller areas of improved grassland on the inbye ground (Symon, 1959), generally situated near the steading. It is not unusual for a hill sheep farm to have 2000 ha of hill land, with perhaps 50 ha of inbye. Flock sizes are generally around 1500 to 2000 ewes. The stocking density is low and this type of farming can be classified as extensive. The main output is the production of store lambs that are sold-on for further fattening on more productive farms. Older (draft) ewes are also sold for cross-breeding on farms with better land. This is the core of the stratified production system, with upland and lowland farmers taking livestock from the hills (Dewar-Durie, 2000). Hill sheep farming relies on an all-year-round grazing system. Most hill farms off-winter their young female animals (hoggs) on lowland pastures. Female replacements are produced on the farm (closed flock). The ewes are from hardy breeds such as the Scottish Blackface and Cheviot, which tend not to be very prolific (mostly one lamb per ewe) but have good maternal traits. Single-bearing ewes usually lamb on the hill, whilst multiple-bearing ewes are often lambed on the inbye pastures or in sheds. The production of store cattle from hardy hill breeds such as the Highland and Galloway is also important for many hill farms.

3.2 Upland sheep and cattle

This type of farming is predominant in the upland areas of Scotland (Figure 3.1), on lower altitude hill ground where the quality of the pasture is better than on the hill farms, allowing cattle to be finished and lambs to be fattened. Farms tend to be smaller in area than hill sheep farms, but with higher stocking densities. The main output is the production of finished animals (cattle and sheep). Upland farms rely on buying store animals from hill sheep farms. Most of the lambs produced are cross-bred. The calving period is either in autumn or spring. Most upland farms also produce some silage and hay for winter feeding of the animals. Animals graze outside in the summer months but are often brought inside or onto the inbye land during the autumn and winter. Lambing is mainly on the improved grassland and the ewes are more prolific than those on hill farms. Young animals are fattened on grass or in a shed, before being sold directly to the abattoirs.

3.3 Crofting

This type of farming is a form of land tenure with small-scale food production unique to the Western Isles, Shetland and some parts of the Highlands (Figure 3.1). Instead of a farm, the production unit is called a croft. Crofts are organised into townships. Within the township, each individual croft is established on a small area (a few hectares) of better quality inbye land with the bulk of the grazing area shared between several crofts, on what is called ‘common grazing’. It is not unusual for a common grazing area of 2000 ha, to be shared between 10-15 crofts. The common grazing is generally of poor quality rough grassland and heath. Cattle and sheep graze on the common grazing area. The animal husbandry on these common grazings is close to that of hill sheep farms. Cattle are produced mainly for the store market. The better land on the croft is used for hay or silage production, arable cropping, horticulture or pasture. Most crofters work part-time on their crofts and hold other jobs, often outside farming.

3.4 Dairy

Most of the dairy farms in Scotland are situated in the South West of the country, on lowland pastures (Figure 3.1). These pastures are used for grazing and for silage production. Dairy cows graze outside in the spring and summer months and are kept inside during the winter. Some production systems have a policy of continuous housed animals. Young replacement animals are generally bred on the farm, with calves reared on artificial milk. On these farms, slurry management is very important. In 2009, there were 1600 dairy farms in Scotland, with an average of 115 cows per holding. The total milk production in Scotland in 2009 was 1107 million litres (Scottish Government, 2010d).

3.5 Mixed farming (livestock and cropping) and cropping

Most of these farming types are situated in the east of the country, on lowland areas, on good quality soil and pasture (Figure 3.1). The main crops are, in order of importance (number of holdings): barley, potatoes, wheat, oats and oilseeds (Scottish Government, 2010d). Fruit (soft fruits especially) and vegetable production are also important. Mixed farming comprises mostly of cereal production, and lowland cattle and sheep, mainly for fattening purposes. Some of the livestock is sourced from the hill sheep and upland sheep and cattle farm types. Animal production levels are more intensive than those of hill sheep and upland sheep and cattle farming types. In terms of outputs (for 2009), the mixed farms derived most of their income from cattle and cereal production (Scottish Government, 2010c).

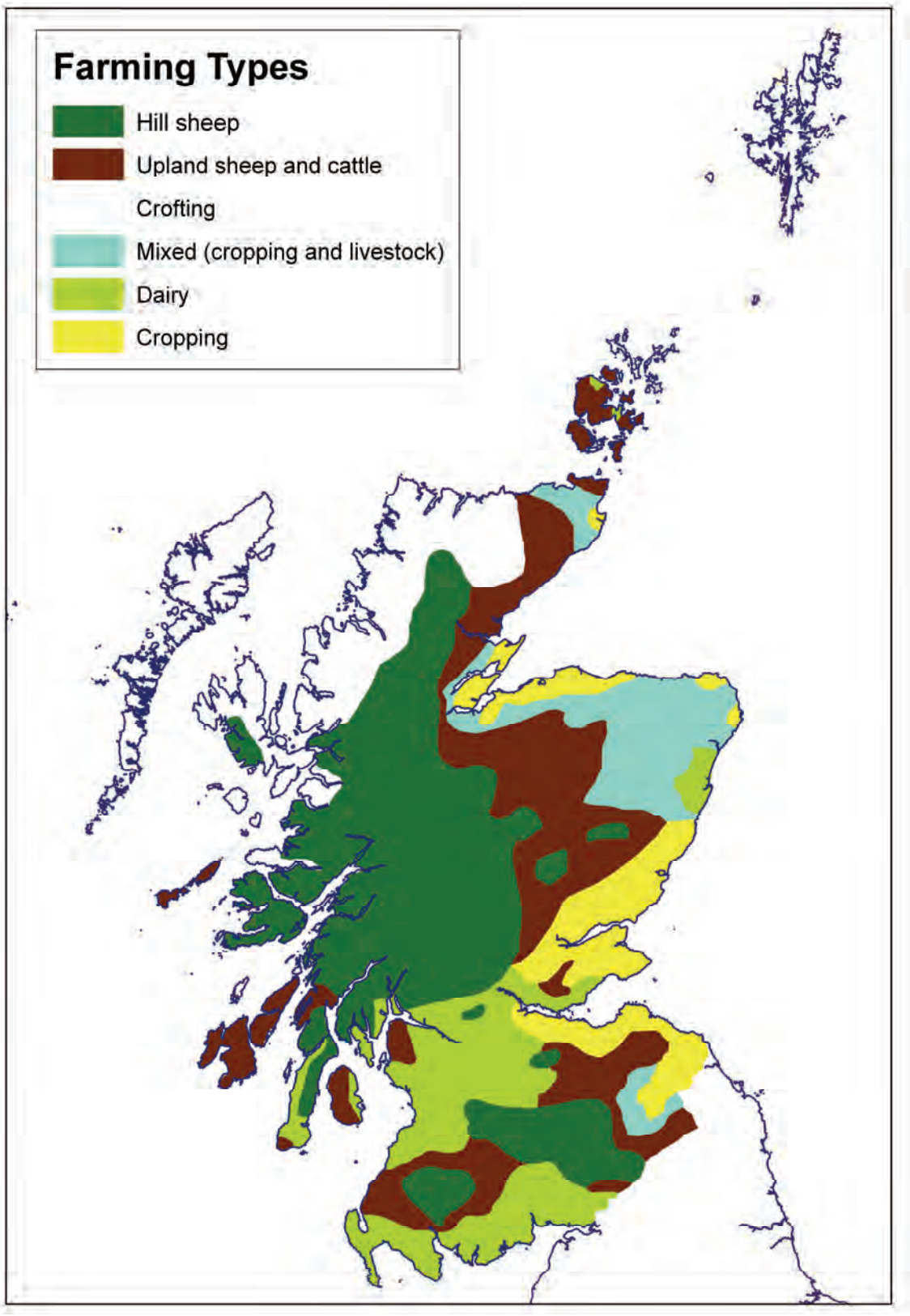


Figure 3.1 - Main farm types in Scotland (based on maps produced by the Department of Agriculture and Fisheries for Scotland, 1975; and Scottish Government, 2010c).

4 NATURAL FEATURES ASSOCIATED WITH HILL LIVESTOCK FARMING

4.1 Outline of the key natural features associated with hill livestock farming and crofting in Scotland

The landscape and natural heritage of much of upland Scotland have been shaped by livestock farming for many centuries. It influences the patterns of settlement, and largely determines the proportion of open to afforested land. Important habitats and species rely on livestock farming, and in some areas conservation objectives depend on the continuation of livestock farming. Grazing is involved in the management of many designated sites (SSSIs and Natura 2000 sites). Appropriate management of grazing livestock can benefit wildlife however poor management can severely harm it. Table 4.1 outlines the main natural features associated with hill livestock farming and crofting in Scotland, together with the benefits and negative impacts that hill farming and crofting may have on the natural features.

Table 4.1 - Natural features associated with hill livestock farming and crofting.

Farm Type	Habitat/feature	Benefit	Negative impact
Hill sheep and cattle	Hill grasslands - tussock grasslands (*Molinia caerulea* grasslands and *Nardus stricta* grasslands)	Tussock grasslands dominated by *Nardus stricta* and *Molinia caerulea* have developed as a result of many decades of grazing by sheep and cattle. They are an important habitat for a range of plant, invertebrate and bird species. Low intensity grazing and trampling by cattle and sheep can increase the structural diversity of tussock grassland producing a more heterogeneous sward. Cattle graze the *Molinia* and *Nardus* tussocks and break them up with their trampling, creating open ground allowing other species to establish, therefore potentially increasing the species diversity of the grassland. Tussock grasslands are an important habitat for meadow pipits and other upland bird species. Meadow pipits are in turn an important food source for raptors and other predators.	High levels of sheep grazing on heath vegetation can lead to the development of *Molinia caerulea* dominated grassland (at moderate altitudes) and *Nardus stricta* dominated grassland (at moderate to high altitudes) replacing the dwarf shrub heath. These grasslands tend to be lower in species diversity and less structurally diverse than dwarf-shrub heath/grassland mosaics.
	Hill grasslands - smooth grasslands (acidic and calcareous *Festuca-Agrostis* grasslands)	Short *Festuca-Agrostis* grasslands are maintained by grazing. Moderate levels of grazing are required to maintain the species richness of montane calcareous grasslands.	The removal of grazing results in the loss of low growing annual and perennial species (including scarce montane species) that are out-competed by taller perennial species.
	Dwarf shrub heath	Low to moderate levels of grazing maintain the structural diversity of dry-shrub heaths and encourage the development of heterogeneous habitat mosaics, which are important for many upland bird species.	High levels of grazing can lead to a loss of structural heterogeneity and a decline in dwarf shrub heath species and their replacement by grassland (*Nardus stricta*, *Molinia caerulea*, *Festuca/Agrostis*) and/or bracken.

Table 4.1 (continued) - Natural features associated with hill livestock farming and crofting.

Farm Type	Habitat/feature	Benefit	Negative impact
Hill sheep and cattle	Blanket bog	Low levels of grazing can maintain the structural diversity of blanket bogs and encourage the development of heterogeneous habitat mosaics, which are important for many upland bird species	Moderate to high levels of grazing can lead to peat erosion, damage to the bryophyte layer, a decline in the cover of dwarf shrubs and damage to other plant species.
	Montane willow scrub and tall herb communities		Grazing prevents the development of montane willow scrub and tall herb vegetation, often restricting it to un-grazed ledges.
	Woodland	Appropriate levels of cattle grazing and trampling can open up woodland benefiting the ground layer and promoting tree regeneration.	Moderate levels of grazing maintain open grassland and heath habitats and prevent the regeneration of woodland. Inappropriate levels of grazing within woodlands (of either sheep or cattle) can lead to damage to trees, shrubs and ground layer vegetation and prevent regeneration.
	Woodland	Sheep grazing in upland oak woodlands can benefit bryophyte and lichen assemblages by creating open woodland with little structural diversity. These grazed woodlands are also important for bird species such as pied flycatcher, redstart and wood warbler.	
	Inbye fields	Grazing maintains short grassland and prevents taller vegetation and scrub developing. Short grassland provides feeding areas for waders such as lapwing and oystercatcher. Poaching by cattle can provide niches for ruderal plants and is important for waders.	High levels of grazing, the application of fertilizer and lime, a change from cattle and sheep, to sheep-only grazing, and drainage of inbye grasslands can all lead to reductions in plant and animal diversity.

Table 4.1 (continued) - Natural features associated with hill livestock farming and crofting.

Farm Type	Habitat/feature	Benefit	Negative impact
Hill sheep and cattle	Hay	Low-input hay meadow management can produce meadows rich in plants and invertebrates. Hay meadow management is also important for a variety of bird and mammal species	
	Silage	Grasslands managed for silage are important for a number of bird (e.g. waders) and mammal species (e.g. brown hare)	Grasslands managed for silage tend to be less species-rich and have a lower conservation value than those managed for hay.
	Fodder crops	The cultivation of fodder crops and grain provides important feeding areas for farmland passerines such as yellowhammer, twite, reed bunting, corn bunting, linnet, greenfinch, tree sparrow, house sparrow, greenfinch, chaffinch and goldfinch.	
	Rush pasture and other wetlands	Low to moderate levels of seasonal grazing within wetlands can lead to increased structural diversity and maintain species richness. These habitats are important for waders such as snipe and lapwing.	High levels of grazing can lead to a loss of structural diversity, a reduction in species diversity, the prevention of flowering, and poaching damage.
	Bracken	Cattle grazing and trampling can break up bracken patches allowing the development of habitat mosaics which are important for invertebrates (e.g. butterflies) and birds.	Inappropriate grazing levels (both high and low) can lead to bracken spread and invasion on to habitats of higher conservation value.

Table 4.1 (continued) - Natural features associated with hill livestock farming and crofting.

Farm Type	Habitat/feature	Benefit	Negative impact
Hill sheep and cattle	Carrion	Carrion is important for a variety of birds of prey and corvids.	
	Dung	Dung is important for a range of invertebrate species and the birds that feed on them.	
	Barns and other buildings	Both old and new farm buildings provide nesting sites for barn owl, swallow, house sparrow and bats.	
	Walls	Dry stone walls provide nesting sites for wheatear and cover for mammals such as stoats.	
	Landscape	Livestock grazing results in an open panoramic hill landscape, with walls, buildings and a patchwork of fields in the inbye-ground. It produces a managed 'tidy' appearance.	Grazing livestock may not be appropriate in areas where "re-wilding" of the landscape is the aim.
	Access	The open landscapes and short vegetation produced by livestock farming provides easy access for walkers.	

Table 4.1 (continued) - Natural features associated with hill livestock farming and crofting.

Farm Type	Habitat/feature	Benefit	Negative impact
Crofting	Pasture grasslands	Traditional grassland management is important for a range of plant, invertebrate and bird species including: lapwing, chough and oystercatcher.	High levels of grazing, the application of fertilizer and lime, a change from cattle and sheep, to sheep-only grazing, and drainage of inbye grasslands can all lead to reductions in plant and animal diversity.
	Hay	Low-input hay meadow management can produce meadows rich in plants and invertebrates. Hay meadow management is also important for a variety of bird and mammal species.	
	Silage	Grasslands managed for silage are important for a number of bird (e.g. waders) and mammal species	Grasslands managed for silage tend to be less species-rich and have a lower conservation value than those managed for hay.
	Fodder and crops	The cultivation of fodder crops and grain provides important feeding areas for farmland passerines such as yellowhammer, twite, reed bunting, corn bunting, linnet, greenfinch, tree sparrow, house sparrow, greenfinch, chaffinch and goldfinch.	
	Buildings	Both old and new crofting buildings provide nesting sites for barn owl, swallow, house sparrow and bats.	
	Wetlands	Wetlands and iris beds managed under a crofting system are important for invertebrates, plants, and birds such as the corncrake, snipe and lapwing.	
	Machair	Traditional management of the machair grassland is important for a range of plant, invertebrate and bird species including: corncrake, redshank, snipe, ringed plover, lapwing, oystercatcher, corn bunting and various wildfowl.	

5 THE IMPACT OF THE DECLINE IN HILL FARMING - LITERATURE REVIEW

5.1 Impacts of livestock decline on the natural heritage

There have been numerous studies that have looked at the impact of grazing animals on the natural heritage of the Scottish uplands (for reviews see Milne *et al*., 1998; Wright *et al*., 2006; Pearce-Higgins *et al*., 2009). This section does not intend to repeat these reviews and therefore focuses on the impacts of reduced grazing levels and the removal of livestock.

5.1.1 Impacts on vegetation

There have been a number of medium to long term studies looking at the effect of removing or reducing livestock from different hill vegetation types in the UK and northern Europe, and the key results from these studies are shown in Tables 5.2 to 5.8. The majority of studies have used small fenced enclosures that excluded livestock but not wild herbivores. There is rather limited information on the effect of reducing rather than removing livestock. Few studies have been carried out on large enclosures or on open hillsides. The studies have shown that the species composition and structure of the vegetation change when livestock are excluded. However, different vegetation types respond in different ways and at different rates. Similar trends in the response of particular species to changing management have been observed (e.g. Marrs *et al*. (1988) and Hill *et al*. (1992) both observed declines in the cover of *Juncus squarrosus* within a range of communities following the removal of livestock). However, some species have reacted in a rather unpredictable manner (e.g. the cover of *Nardus stricta* has shown both an increase and a decrease following the exclusion of grazing livestock (Rawes, 1981; Hill *et al*., 1992)). This unpredictability in vegetation response may be a consequence of the fact that no two vegetation patches have identical species compositions, structures, environments or management histories. Hence, the starting point will differ, even between patches of similar vegetation type on the same hillside, and therefore the response of the vegetation to the same grazing regime will not always be the same (Hulme *et al*., 1999). This varying response at the species level, and its associated unpredictability, is likely to be magnified on open hillsides containing a range of vegetation types. The geographical location, together with the physical and biological environment of the site and the presence or absence of wild grazing animals such as deer, hares and voles, will also effect how the vegetation responds. How a particular patch of vegetation responds to grazing is dependent upon a complex set of direct and indirect interactions between the grazing animal and the individual plants within the grazed vegetation. The way in which an individual plant responds to grazing damage depends upon the functional attributes of the species, together with the time of year in which the damage occurred, the environmental conditions (e.g. climate, soil, altitude and topography), and the competitive interactions with other plants within the vegetation that are themselves responding to the effects of the grazing (Noble and Slatyer, 1980; Grime *et al*., 1988; Milne *et al*., 1998). Functional attributes include physical attributes (such as life form, longevity and maximum height), attributes related to growth and reproduction (such as regeneration mechanism, position of the meristem, and the optimum and range of soil and climate conditions under which the species can compete effectively), and attributes related to grazing (such as digestibility and the presence of anti-herbivore mechanisms) (Grime *et al*., 1988; Armstrong and Milne, 1995) (Table 5.1). The functional attributes of the grazing animal are also important in relation to which individual plants are grazed (Table 5.1). Grazing distribution patterns of free-ranging ruminants are affected by abiotic factors such as slope, distance to water and exposure, and by biotic factors such as the distribution and proportion of different vegetation types, and the quantity and quality of forage within these different vegetation types (Hunter, 1962; Gordon and Illius, 1992; Bailey *et al*., 1996;

Armstrong, 1996; Hester *et al*., 1999). Supplementary feeding, disturbance and the presence of tracks and roads can also influence the distribution of grazing animals. To obtain a detailed understanding of vegetation response requires taking into account both the species dynamics, determined by their functional attributes, the spatial relationship between individual plants and between different vegetation patches and the interactions between the vegetation and the grazing herbivore.

Table 5.1 - The main factors/attributes that affect how individual plants respond to grazing.

Plant functional attributes	Animal functional attributes	Other Factors
Physical attributes: • Life form • Longevity • Structure and height Growth and reproduction attributes: • Regeneration mechanism • Position of the meristem • Optimum and range of soil and climate conditions under which the species can compete effectively Animal related attributes: • Digestibility • Palatability • Presence of anti-herbivore mechanisms (chemical and physical) Competitive interactions with other plants within the vegetation that are themselves responding to the effects of the grazing	Foraging behaviour Diet selection Interaction between grazing animals (same species) Interaction between grazing animals (different species)	Environmental conditions (including climate) Time of year Time

Vegetation always responds to management change, but this response may be gradual or rapid, subtle or clear (Miles, 1987). Any temporal stability within vegetation patches is only relative, as vegetation is constantly changing through time, as individuals die and are replaced, although the rate at which this change occurs can vary greatly (Miles, 1987). Extrapolating which changes are due to the dynamic nature of the vegetation and which are in response to the changed management is therefore difficult, particularly when only minor changes are observed. Since many of the upland species are slow growing, and many of the dominant species such as *Juncus squarrosus* (Welch, 1966), *Festuca ovina* and *Nardus stricta* (Chadwick, 1960) are long-lived perennial species, which spread predominantly by clonal growth, and therefore tend to regenerate episodically (Hill *et al*., 1992), it is likely that due to their slow dynamics, vegetation dominated by these species may take many years to reach equilibrium with their new environment following a change in the environmental or management conditions (Hill *et al*., 1992).

There are a number of other drivers of vegetation change that may affect how vegetation responds to changes in livestock grazing. These include, weather and climate, nitrogen deposition, changes in native herbivore populations (vertebrate and invertebrate), burning and afforestation. Looking at the sensitivity to change of upland plant communities Milne and Hartley (2001) concluded that, at present, it is difficult to predict with confidence the

impact of potential reductions in grazing levels, in combination with other factors such as climate change and increased nitrogen deposition, on the rate of vegetation change in the uplands. In a study carried out by Britton *et al*. (2009) looking at changes in plant diversity within a range of Scottish alpine vegetation habitats over a 20-40 year period, they found that species richness increased in most habitats, while plot scale diversity and beta-diversity declined, resulting in increased homogeneity of the vegetation. They concluded that these changes indicate that closed alpine communities may be considerably more dynamic than had previously been thought. They also suggest that predicting future changes in alpine vegetation will require understanding of complex interactions between multiple drivers including climate change, nitrogen deposition and grazing.

Reducing sheep stocking rates on grass-heath vegetation has had very variable effects (e.g. Hope *et al.*, 1996). At many sites, the reduction in grazing levels has maintained the existing moorland vegetation, but has often been insufficient to increase the cover of dwarf shrubs (Hulme *et al*., 1999; Gardner *et al*., 2001) or to enhance the mosaic of grass, heath and mire communities or overall biodiversity (Gordon *et al*., 2004). In addition, so called 'problem' species such as *Molinia caerulea* have increased in extent and vigour at some sites (Hulme *et al*., 1999; Gardner *et al*., 2001; Milligan *et al.*, 2004).

Gardner *et al*. (2009) recognise that a consistent outcome of the reduction or removal of hill sheep, on former grazed moorland, has been an increase in vegetation height and biomass, and a halt in the decline of dwarf shrub species (Hope *et al.*, 1996; Gardner *et al*., 2001; Gardner *et al*., 2002). This may lead to an improvement in the condition of the vegetation and in some cases, an increase in the extent of dwarf shrubs (e.g. Welch, 1998; Pakeman *et al*., 2003). In most situations, the increase in dwarf shrub cover is very slow and tends to arise from the growth of remnant plants rather than from the establishment of new ones (Marrs *et al*., 2004). Gardner *et al*. (2009) suggest that there are a number of reasons for this. Firstly, both desirable and 'problem' species benefit from a reduction in grazing pressure, with the 'problem' species often responding faster than the slower growing dwarf shrub species (Hulme *et al*., 1999, 2002; Milligan, 2004). This difference in response rate provides one reason why variation in the initial composition of the moorland vegetation has a strong influence on the rate and direction of vegetation change (Hulme *et al*., 1999; Marrs *et al*., 2004; Vandvik *et al*., 2005). Secondly, the spatial distribution of heather and other grazed species tends to become more aggregated within and between different moorland communities, following a period of heavy sheep grazing (Gardner *et al*., 2001). The aggregation of these species limits their ability to expand into neighbouring areas when grazers are removed and significantly reduces the rate of increase and extent of dwarf shrub vegetation (Gardner *et al.*, 2002). Furthermore, if the dwarf shrub is located close to palatable species such as *Agrostis-Festuca* grassland, its expansion may still be constrained by selective grazing even when sheep stocking rates are low (Clarke *et al*., 1995; Palmer *et al*., 2003, 2004).

Modelling work carried out by Critchley *et al.* (2007) demonstrates that the effectiveness of different livestock species and grazing regimes in enhancing moorland vegetation varies with vegetation type. While summer grazing of cattle (either alone or with a low stocking rate of sheep) were predicted to be effective at managing *Molinia caerulea* within degraded wet heath vegetation at Redesdale in Northumberland, in *Nardus stricta* dominated vegetation at Pwllpeiran in mid-Wales, seasonal grazing by sheep at low levels or the removal of grazing were predicted to be the most effective in reducing the extent of *N. stricta*. The reduction in *Nardus stricta* was not due to direct grazing by sheep (Critchley *et al*., 2007). Instead it appears that the main driver of *Nardus stricta* loss under low or no sheep grazing was the accumulation of *Agrostis* species that can out-compete the *Nardus stricta* (Grime *et al*., 1988). Hartley and Mitchell (2005) reported similar effects of grazing mediating the competitive interactions between *Nardus stricta* and heather. The spatially explicit vegetation model predicted that the rate of vegetation change at both sites would be slow

(Critchley *et al*., 2007). Within the degraded wet heath, this was due to the variable distribution of *Molinia caerulea*, which resulted in uneven grazing by cattle. However on similar sites where *Molinia caerulea* had a more even distribution across the different plant communities, the model predicted a rapid rate of change under summer cattle grazing (Critchley *et al*., 2007). Thus the rate of vegetation change and the effectiveness of a specific grazing management regime are strongly influenced by the spatial distribution of a species within a site (Gardner *et al*., 2009). For the *Nardus stricta* dominated site, the lack of heather seed was responsible for the slow recovery of the dwarf shrub vegetation. Although cattle grazing may have been effective in opening up the sward, the lack of viable heather seed and the continued grazing of the bilberry led to little change in the extent of the dwarf shrub vegetation (Critchley *et al*., 2007). At both sites, the predicted accumulation of *Molinia caerulea* on the wet heath and *Agrostis* species on the *Nardus stricta* grass-heath, under low levels of sheep grazing or no grazing, would eventually reduce the structural diversity of the vegetation (Gardner *et al*., 2009). The structural heterogeneity of the vegetation is thought to be important for bird and invertebrate diversity (Pearce-Higgins & Grant, 2006; Hartley *et al*., 2003; Gardner *et al*., 1997).

Both increases and decreases in bryophyte cover have been observed following the removal of livestock from upland vegetation types. Hulme *et al*. (1999) observed a decline in the total moss cover from an *Agrostis-Festuca* grassland in the Cleish Hills after six years of excluding domestic stock. Rawes (1981) looking at the impact of livestock removal from upland grassland communities in the North Pennines also recorded a decline in bryophyte cover from an *Agrostis-Festuca* grassland after 23 years of livestock exclusion, whereas bryophyte cover increased in a *Nardus stricta* grassland. Hill *et al*. (1992) found that the cover of *Polytrichum commune* declined while the cover of pleurocarpous mosses increased in an *Agrostis capillaris - Festuca ovina* grassland in Snowdonia after 24 years of livestock exclusion. Increased competition for light from taller ungrazed vegetation is likely to have been the main driver for the observed declines in bryophyte cover. Miller *et al*. (2010) found that bryophytes increased in a CG12 *Festuca ovina- Alchemilla alpina-Silene acaulis* dwarf-herb community on Ben Lawers after the vegetation had been covered by a cage between spring and autumn over a ten year period. They suggest that the increased bryophyte cover was due to the relief of intensive sheep trampling on the vegetation.

One consequence of the removal of grazing from upland grasslands is the increased risk of fire due to the build-up of dead litter material[15]. The risk of un-controlled fires is particularly high on un-grazed grasslands dominated by *Molinia caerulea*. The fires can easily spread onto other upland habitats and adjacent woodland areas leading to serious damage. In addition to wild fires, any biodiversity gains that have resulted from reductions in grazing levels on dwarf-shrub heath can be wiped out by poorly managed muirburn.

Boatman *et al*. (2008) carried out a review of the environmental benefits resulting from agri-environment schemes in the UK. They found that evidence for benefits of ESA management on heather moorland was mixed, with many of the evaluation surveys showing little or no improvement in the quantity or condition of heather. However some improvements were reported from all parts of the UK, including the Breadalbane ESA in Scotland where the height and cover of heather increased under Tier 2 measures, indicating that the aim of the scheme had been achieved. Boatman *et al*. (2008) found that a consistent theme coming from the evaluation surveys was that success or failure of heather condition targets was strongly related to grazing pressure, with high stocking rates invariably leading to deterioration in the condition of the heather. Boatman *et al*. (2008) suggest that agri-environment schemes work best when targeted to specific areas and situations so that grazing prescriptions closely fit the needs of individual sites. They also suggest that where degradation has been severe, the complete removal of livestock for a period may be

[15] http://www.fires-seminars.org.uk/downloads/FIRES_Policy%20Brief_final.pdf

necessary for recovery. However, there was evidence from the West Penwith ESA that deterioration in heather condition was linked to insufficient grazing, showing the detrimental impact that under-grazing can have in some situations.

Results from the 2007 Countryside Survey (Norton *et al*., 2009) showed that over the period 1998 to 2007:

- The area of acid grassland increased by 8% in Scotland, but there was a decrease in the plant species richness within acid grassland.
- The area of arable and horticultural land decreased by 14% across Scotland as a whole and by 25% in the intermediate uplands and Islands.
- The area of broadleaved woodland increased by 10% across Scotland, but the area of coniferous woodland decreased by 7.1%.
- Across Scotland as a whole, no significant changes were detected in the overall extents of the six habitats which make up the upland landscape mosaic (bracken; dwarf-shrub heath; bog; fen, marsh and swamp; inland rock; montane).
- The area of dwarf-shrub heath declined by over 113,000ha between 1990 and 2007, but changes between 1998 and 2007 were not significant.
- The cover of grass species relative to forbs increased in dwarf-shrub heath and bog.
- There was little change in the bracken cover in the lowlands and true uplands between 1998 and 2007. However, the area of bracken increased by approximately 27% in the intermediate uplands and Islands between 1998 and 2007. This followed an increase of 32% between 1990 and 1998. Norton *et al*. (2009) suggest that the increase in bracken in recent years is likely to be related to heavy grazing pressure, with the species-poor grassland resulting from heavy grazing being more prone to bracken invasion than heather moorland. However, bracken can also spread as a result of reduced grazing pressure on upland grasslands and other moorland habitats, and it is likely that a decrease in summer grazing by cattle is responsible for the spread of bracken in some areas.

Many of the habitat changes that have occurred in the true uplands, and intermediate uplands and Islands are closely linked to changes in agricultural practices (Norton *et al*., 2009), which include changes in the numbers and distribution of livestock.

Table 5.2 - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Species poor *Agrostis-Festuca* sub-montane grassland (Rhum)	Exclusion of grazing domestic stock	Impact after 12 years: Increase in *Poa pratensis* and *Festuca rubra*. Decrease in *Anthoxanthum odoratum*, *Cynosurus cristatus*, *Trifolium repens*, *Galium saxatile*, *Plantago lanceolata*, *Polygala serpyllifolia*, *Achillea millefolium*, *Luzula multiflora*, *Thymus polytrichus*, *Cerastium fontanum*, *Euphrasia officinalis* and *Veronica officinalis*	Ball, 1974
Species poor *Agrostis-Festuca* sub-montane grassland (Rhum)	Reduced grazing (removal of cattle and sheep, continued grazing by red deer, feral goats and highland ponies)	Impact after 12 years: Decrease in *Thymus polytrichus*, *Plantago lanceolata*, *Cerastium fontanum*, *Linum catharticum*, *Luzula multiflora*, *Prunella vulgaris* and *Carex pulicaris*	Ball, 1974
Festuca-Agrostis grassland (Eastern Jutland, Denmark)	Exclusion of grazing domestic stock	Impact after 6 years: Increase in *Festuca rubra* and *Poa pratensis*. Decrease in *Luzula campestris*, *Agrostis canina*, *Agrostis stolonifera* and *Aira praecox*.	Buttenschøn & Buttenschøn, 1982a, 1982b.
Agrostis-Festuca grassland (Cleish Hills (240m), Fife)	Exclusion of grazing domestic stock	Impact after 6 years: Increase in tall species and grazing sensitive species such as *Deschampsia flexuosa* and *Poa* spp. Decline in low growing species and species tolerant of high grazing intensities including *Festuca rubra*, *Luzula multiflora* and total moss cover.	Hulme *et al*., 1999
Festuca-Agrostis grassland (with a substantial presence of moorland species) (Kirkton Farm (410m), Crianlarich, Perthshire)	Exclusion of grazing domestic stock	Impact after 6 years: Increase in *Molinia caerulea* and dwarf shrub species Decline in species associated with short turf and heavy grazing including *Agrostis capillaris*, *Anthoxanthum odoratum*, *Carex pilulifera* and *Nardus stricta*.	Hulme *et al*., 1999

Table 5.2 (cont) - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Festuca ovina - Nardus stricta grassland (Cwm Idwall (365m), Snowdonia, North Wales)	Exclusion of grazing domestic stock	Impact after 24 years: Decline in the cover of *Nardus stricta* and *Festuca ovina*. Increase in the cover of tussocky *Molinia caerulea* and *Agrostis vinealis*.	Hill *et al*., 1992
Agrostis capillaris - Festuca ovina grassland, with Galium saxatile and Polytrichum commune (Cwm Idwall (365m), Snowdonia, North Wales)	Exclusion of grazing domestic stock	Impact after 24 years: Decline in the cover of *Polytrichum commune*. Increase in the cover of pleurocarpous mosses. Replacement of *Agrostis capillaris* by *Agrostis vinealis*.	Hill *et al*., 1992
Agrostis capillaris - Festuca ovina grassland, with *Galium saxatile* and *Holcus lanatus* (Moel Eilio (380m), Snowdonia, North Wales)	Exclusion of grazing domestic stock	Impact after 13 years: Little change in species composition.	Hill *et al*., 1992
Agrostis capillaris grassland with *Anthoxanthum odoratum*, *Cirsium palustre, Festuca ovina*, *Festuca rubra* and *Rhytidiadelphus squarrosus* (Llyn Llydaw (426m), Snowdonia, North Wales)	Exclusion of grazing domestic stock	Impact after 23 years: Increase in the cover of *Achillea millefolium* and *Festuca rubra*. Almost complete disappearance of *Cirsium palustre*.	Hill *et al*., 1992

Table 5.2 (cont) - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Agrostis - Festuca grassland with patches of *Juncus squarrosus* (Knock Fell (747m), Moor House NNR, North Pennines)	Removal of free ranging sheep (previously at a stocking rate of up to 5.5 sheep/ha during the summer)	Impact after 23 years: Overall increase in the cover of *Deschampsia flexuosa*, *Deschampsia cespitosa*, *Agrostis capillaris*, *Carex bigelowii*, *Festuca rubra* and *Galium saxatile* (the last two species reached a peak after 12 years and then declined). Decrease in the cover of *Juncus squarrosus* and *Vaccinium myrtillus* to near elimination. Decrease in all other forb species apart from *Rumex acetosa* and *Achillea millefolium* which increased. Decrease in bryophyte and lichen cover.	Rawes, 1981
Species-poor grass heath with dominant *Festuca ovina* (Moor House NNR (830m), North Pennines)	Removal of free ranging sheep (previously at a stocking rate of up to 5.5 sheep/ha during the summer)	Impact after 23 years: Increase in the cover of *Carex bigelowii* and *Deschampsia flexuosa*. Decrease in the cover of *Festuca ovina*. Decrease in the cover of bryophytes and lichens.	Rawes, 1981
Grass heath with dominant *Festuca ovina* and abundant *Nardus stricta*, *Juncus squarrosus*, *Empetrum nigrum* and *Sphagnum* (Moor House NNR (830m))	Removal of free ranging sheep (previously at a stocking rate of up to 5.5 sheep/ha during the summer)	Impact after 23 years: Increase in the cover of *Deschampsia flexuosa*. Decrease in the cover of *Festuca ovina* and *Juncus squarrosus*.	Rawes, 1981
Nardus stricta grassland (Moor House NNR (545m), North Pennines)	Removal of free ranging sheep (previously at a stocking rate of up to 5.5 sheep/ha during the summer)	Impact after 23 years: Increase in the cover of *Nardus stricta*, *Galium saxatile* and bryophytes. Decrease in the cover of *Agrostis capillaris*.	Rawes, 1981

Table 5.2 (cont). Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Juncus squarrosus grassland (Moor House NNR, North Pennines, England)	Exclusion of grazing domestic stock	Impact after 18 years: Species change: Decline in the cover of *Juncus squarrosus*, *Festuca ovina*, *Eriophorum angustifolium*, *Carex nigra*, *Luzula multiflora* and *Polytrichum commune*. Increase in *Calluna vulgaris* and *Eriophorum vaginatum*. Structural change: Decrease in the amount of live vegetation in the 0-10cm stratum. Increase in the amount of live vegetation in the 10-20cm and 20-30cm strata. Increase in the amount of dead material in the 10-20cm stratum.	Marrs *et al*., 1988
Molinia caerulea grassland (75% *M. caerulea*, 9% *N. stricta*, 3% *Festuca ovina* and 11% other species) (Mid-Wales)	Exclusion of grazing domestic stock	Impact after 5 years: Increase in *Calluna vulgaris* and *Erica tetralix* (20%) Impact after 18 years: Increase in *Molinia caerulea* to 90%, shading out most other species.	Davies, 1987
Molinia caerulea grassland (>90% *M. caerulea* cover) (Cleish Hills, Fife, Scotland)	Exclusion of grazing domestic stock	Impact after 6 years: Number of species remained the same or showed a slight decline. Decrease in the cover of *Festuca ovina*.	Grant *et al*., 1996a
Nardus stricta, *Danthonia decumbens*, *Narthecium ossifragum* and *Festuca ovina* grassland/wet heath (Penypass (396m), Snowdonia, North Wales)	Exclusion of grazing domestic stock	Impact after 23 years: Increase in the cover of ericoid shrubs (*Calluna vulgaris*, *Erica cinerea* and *Erica tetralix*), which became dominant. Increase in *Molinia caerulea* and *Trichophorum cespitosum*. Decrease in *Danthonia decumbens*, *Festuca ovina* and *Carex* species. *Nardus stricta* remained prominent over part of the site.	Hill *et al*., 1992

Table 5.2 (cont) - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
U5 *Nardus stricta-Galium saxatile* grassland (Ben Challum (500m), Tyndrum, Perthshire)	Exclusion of livestock from an area that had previously been open to grazing at a stocking level of between 1.0 and 1.5 ewes/ha	Impact over 4 years: Mean July surface herbage heights were significantly higher (P <0.001) in the un-grazed area compared with the continuously grazed area in all years. The herbage height increased significantly (P <0.001) in the un-grazed area between year 1 and year 4. A frequency histogram of the herbage surface heights in July of year 4 showed that in the un-grazed area there were no patches of short grassland.	Holland *et al*., 2008
U5 *Nardus stricta-Galium saxatile* grassland (Gleann a'Chlachain (450m), Tyndrum, Perthshire)	Exclusion of livestock from an area that had previously been open to grazing at ~1.0 ewe/ha	Impact after 2.5 years: The profile of the grassland altered, with significantly less vegetation in the lower strata, and more in the upper strata. Although there was little change in the amount of litter, the amount of dead standing material increased throughout the profile, and there was a shift in the distribution of bryophytes up the profile.	Pollock *et al*., 2005

Table 5.2 (cont) - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
CG11 *Festuca ovina-Agrostis capillaris-Alchemilla alpina* grass-heath (Cam Chreag (700m), Tyndrum, Perthshire)	Exclusion of livestock from an area that had previously been open to grazing at a stocking level of approximately 1.0 ewe/ha	Impact after 5 years: A number of annual, and low growing perennial, herbs including *Euphrasia* agg., *Bellis perennis*, *Cerastium fontanum*, *Linum catharticum*, *Persicaria vivipara*, *Alchemilla alpina* and *Thymus polytrichus* declined, while most of the tall perennial sedges, grasses and dwarf shrubs increased. The scarce montane species; *Sibbaldia procumbens*, *Silene acaulis* and *Carex capillaris*, all declined. Some tall-herb species increased in frequency, including *Trollius europeaus* and *Geum rivale*, but few of the tall-herbs flowered. Over the five year period the mean surface height of the vegetation measured in August increased significantly from less than 10cm to over 22cm.	Holland, 2006
CG12 *Festuca ovina-Alchemilla alpina-Silene acaulis* dwarf-herb community (Ben Lawers (1000m), Perthshire)	Sheep-proof cages erected each spring from 1987 to 1996 and dismantled again each autumn	Major shifts in the balance amongst species. Initially graminoids and some forbs increased in cover, the vegetation increased in height and the amount of bare ground decreased. This was followed by a decline in the cover of graminoids as bryophytes flourished (doubling of cover) and litter accumulated (tripling of cover). Miller *et al*. (2010) concluded that sheep grazing is essential for maintaining the dwarf-herb community, and that permanent removal of sheep could lead to the development of bryophyte-rich tall-herb vegetation or montane scrub.	Miller *et al*., 2010

Table 5.2 (cont) - Observed vegetation changes within upland grassland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
MG7 *Lolium perenne* ley grassland (50% *Lolium perenne*, 13% *Trifolium repens*, 37% other species - *Holcus lanatus*, *Carex* spp., *Juncus effusus*, *Phleum pratense*, *Poa pratensis*, *Ranunculus repens*, *Agrostis gigantea*, *Agrostis capillaris*, *Poa trivialis*, *Poa annua*) (Hartwood (245m), North Lanarkshire)	Reduced grazing and un-fertilised (extensification) (previously grazed, cut for silage and fertilised)	Impact over 15 years: Slow but continual change in species composition. Species that benefited from extensification: *Holcus lanatus*, *Agrostis capillaris*., *Poa trivialis*, *Bellis perennis, Trifoilum repens*. Species that declined: *Agrostis gigantea*, *Loilum perenne*, *Poa annua*.	Marriott *et al*., 2009
MG7 *Lolium perenne* ley grassland (64% *Lolium perenne*, 8% *Trifolium repens*, 28% other species - *Festuca rubra*, *Elymus repens*, *Arrhenatherum elatius*, *Poa pratensis*, *Dactylis glomerata*, *Holcus lanatus*, *Holcus mollis*, *Phleum pratense*, *Poa annua*, *Poa trivialis*, *Ranunculus repens*, *Deschampsia cespitosa*, *Urtica dioica*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Cerastium fontanum*) (Sourhope (367m), Borders)	Reduced grazing and un-fertilised (extensification) (previously grazed, and fertilised)	Impact over 15 years: Rapid changes in species composition followed by stabilisation. There were no late-successional species to invade and lead to further changes. Species that benefited from extensification: *Festuca rubra*, *Anthoxanthum odoratum*, *Agrostis capillaris*, *Poa trivialis*, *Trifolium repens*. Species that declined: *Deschampsia cespitosa*, *Urtica dioica*, *Poa annua*.	Marriott *et al*., 2009

Table 5.3 - Observed vegetation changes within blanket bog and wet heath communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Eriophorum vaginatum dominated blanket bog (Troutbeck head (685m) and Silverband (685m), Moor House NNR, North Pennines)	Removal of free ranging sheep (previously at a summer stocking rate of 0.25 sheep/ha (Silverband) and 0.5 sheep/ha (Troutbeck Head))	Impact after 14 years: Silverband - Significant increase in the cover of *Empetrum nigrum*, *Narthecium ossifragum* and *Rubus chamaemorus*. Vegetation density increased by 40%. Troutbeck Head - Significant increase in the cover of *Calluna vulgaris* and *Deschampsia flexuosa*. Significant decline in the cover of *Eriophorum vaginatum* and the leafy liverwort *Diplophyllum albicans*. Vegetation density increased by 20%	Rawes, 1983
Degraded *Calluna vulgaris* dominated wet-heath (Redesdale (300m), Northumberland)	Areas previously grazed at 2.1 sheep per hectare were subject to a range of grazing treatments 1) Summer only 0.7 sheep/ha 2) Winter only 0.7 sheep/ha 3) Year-round 0.7 sheep/ha 4) Year-round 1.4 sheep/ha 5) U-ngrazed 6) Year-round 2.1 sheep/ha (unfenced control)	Impact over 5 years: Increase in frequency of *Calluna vulgaris* in all reduced grazing treatments, no change in unfenced control, greatest increase in un-grazed treatment, least increase in year-round 1.4 sheep/ha treatment. Increase in frequency of *Carex nigra*, *Deschampsia flexuosa*, *Galium saxatile* and *Erica tetralix* under reduced grazing treatments. A range of moss species, including *Hypnum jutlandicum* and *Rhytidiadelphus loreus* were more frequent at higher grazing levels. Substantial increase in the cover of *Molinia caerulea* under the winter only grazing treatment, compared to relatively little change in the cover of *Molinia caerulea* under the summer only grazing treatment.	Hulme *et al*., 2002

Table 5.4 - Observed vegetation changes within dry heath communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Vaccinium myrtillus dominated heath (cover 53% *Vaccinium myrtillus*, 2% *Calluna vulgaris*), (Ashop Valley (310m), Derbyshire Peak District)	Exclusion of grazing livestock (exclosure plot was previously part of a 1600ha tract of unenclosed moorland carrying a thousand ewes and followers)	Impact after 6 years: Significant increases in the cover of grasses (excluding *Nardus stricta*) and *Empetrum nigrum*. Significant decline in the cover of *Nardus stricta*. Abundant flowering of *Deschampsia flexuosa*. Significant increase in the height of *Vaccinium myrtillus* and *Calluna vulgaris*.	Welch, 1998
Vaccinium myrtillus dominated heath (cover 69% *Vaccinium myrtillus*, 28% *Calluna vulgaris*), (Ashop Valley (310m), Derbyshire Peak District)	Exclusion of grazing livestock (exclosure plot was previously part of a 1600ha tract of unenclosed moorland carrying a thousand ewes and followers)	Impact after 6 years: Significant decline in the cover of *Vaccinium myrtillus*. Significant increases in the cover of *Calluna vulgaris*, grasses (excluding *Nardus stricta*) and *Empetrum nigrum*. Significant decline in the cover of *Nardus stricta*. Significant increase in the height of *Vaccinium myrtillus* and *Calluna vulgaris*.	Welch, 1998
Discontinuous *Deschampsia flexuosa* turf intermingled with patches of *Nardus stricta*, *Vaccinium myrtillus* and bare ground. (Western slopes below the Kinder plateau (~500m), Peak District)	Sheep stocking levels reduced from around 2.5 ewes/ha to 0.18-0.43 ewes/ha	Impact after 7 years: Significant increase in the frequency of *Deschampsia flexuosa*, *Calluna vulgaris*, *Vaccinium myrtillus* and bryophytes, creating a *D. flexuosa* dominated sward. Significant decrease in the frequency of bare ground.	Anderson & Radford, 1994

Table 5.5 - Observed vegetation changes within a range of upland communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Eleven sites across the Highlands of Scotland, with a range of grassland and heath communities.	Comparison between areas where sheep had been removed for up to 25 years and areas where stocking rates had remained unchanged	Removal of sheep from five sites was associated with taller vegetation and more signs of vole activity. Relatively few changes in floristic composition (patches of dwarf-shrub vegetation tended to be larger and patches of grassland smaller). Removal of sheep from six sites appeared to have had little or no effect on the vegetation or on vole activity. This was thought to be due to an increase in grazing by red deer and continued heather burning.	Hope *et al.*, 1996
Twelve study sites across the Highlands of Scotland, with a range of grassland and heath communities.	Each study site had an area of reduced sheep grazing and an area of continued sheep grazing.	The study found increased heather abundance, decreased abundance of rough grasses, taller vegetation, and a non-significant trend towards a reduction in heterogeneity were all related to a reduction in the level of sheep grazing.	Pollock *et al*. 2009

Table 5.6 - Observed vegetation changes within Norwegian alpine grass-heath communities following a cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Alpine grass-heath dominated by Vaccinium myrtillus, Deschampsia flexuosa, Nardus stricta, Empetrum sp. and Vaccinium uliginosum. (Setesdal Vesthei (900-1000m), Southern Norway).	Exclusion of sheep from an area with a long history of heavy sheep grazing.	Impact over 5 years: Increase in vascular plant height. Increase in *Deschampsia flexuosa* (the only vascular plant species to show a significant increase). The bryophytes *Straminergon stramineum*, *Pohlia nutans* and *Cephalozia bicuspidate* increased, while *Brachythecium* coll., *Plagiothecium* coll. decreased.	Austrheim *et al*., 2007

Table 5.7 - Observed vegetation changes within alpine flush communities following a decrease or cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Alpine flush communities, (Cross Fell and neighbouring hills, North Pennines)	Removal of sheep from the hill ground as a result of the foot-and-mouth outbreak in the winter of 2001	Impact in the following growing season: Extensive flowering of *Alopecurus ovatus* in flushes above 670m (previously a very shy flowerer). Discovery of *Carex vaginata*. This species was not previously recorded in England, but has now been recorded in 13 separate locations within the North Pennines. Increased flowering of other rare alpine species: *Saxifraga hirculus*, *Epilobium alsinifolium*, *Sedum villosum* and *Myosotis alpestris*.	Roberts, 2010
Alpine flush communities (Cam Chreag (750m), Tyndrum, Perthshire)	Removal of hefted sheep flock from the hill ground (area still grazed by sheep from neighbouring hirsels and by deer)	Impact in the following growing season: Flowering of *Kobresia simpliciuscula* in four separate locations. Intensive botanising of the area by the recorder had failed to locate this species in the 12 years before the sheep numbers were reduced.	J. Holland (pers.com.)

Table 5.8 - Observed changes within particular plant populations following the cessation of livestock grazing.

Community	Grazing Change	Impact on Vegetation	Reference
Gentiana nivalis population within a CG12 *Festuca ovina-Alchemilla alpine-Silene acaulis* dwarf herb community (Ben Lawers (950-1020m), Perthshire)	Protection from sheep grazing	Impact after 9 years: *Gentiana nivalis* plants in un-grazed plots grew taller than did plants in adjacent grazed plots. After 3 years the density of plants within the un-grazed plots began to decline and by year 9 it was only 20% of the density on grazed plots. Perennial vegetation within the un-grazed plots became taller and denser than it was in the grazed plots. The amount of bare soil declined in the un-grazed plots. The loss of potential gaps for seedling establishment was thought to be the main cause for the decline in *Gentiana nivalis* density in the un-grazed plots.	Miller *et al*., 1999
Pseudorchis albida population within a H10 *Calluna vulgaris-Erica cinerea* heath (Tyndrum Community Woodland (190m), Perthshire)	Exclusion of livestock and deer from an area that had previously been subject to a low level of sporadic grazing by sheep and deer.	Impact after 6 years: The removal of grazing animals was accompanied by an initial increase in the number of flowering spikes of *Pseudorchis albida* (60 spikes were recorded two years after enclosure), followed by a dramatic decline. No flowering spikes were recorded after six years of enclosure.	Holland *et al*., 2008

5.1.2 Impacts on fungi

A number of fungi species are associated with grazed or mown, un-improved grasslands, including the waxcap fungi (members of the genus *Hygrocybe*) (Griffith *et al*., 2002). The absence of grazing results in the production of fewer fruiting bodies and the loss of the short cropped vegetation with which the waxcaps are associated (Griffith *et al*., *2002*).

5.1.3 Grazing requirements of different upland habitats

Different upland habitats have different grazing management requirements. Each vegetation type has a range of grazing pressures that will maintain the species composition and structure of the vegetation (MacDonald *et al*., 1998). Grazing pressures outside that range are likely to lead to changes in the structure and composition of the vegetation and potentially a decline in its nature conservation value or its loss. Some habitat types are very sensitive to grazing and trampling and require very low levels of grazing or no grazing at all (e.g. tall herb vegetation and montane willow scub) to maintain their structure and species composition and can be destroyed by high levels of grazing, whereas others require moderate levels of grazing in order to maintain their structure, composition and nature conservation value (e.g. calcareous grassland). Many upland sites have a range of habitats with varying grazing requirements often occurring within a relatively small geographic area. This complex pattern of vegetation has developed over time through the interaction of biological, environmental and anthropogenic factors, in particular grazing. Spatial and temporal changes in grazing have allowed the development of habitats with different grazing requirements in close proximity. Using information from MacDonald *et al*. (1998), and information gathered as part of an SNH project on upland grazing where habitats have different requirements (SNH *Commissioned Report No.402*.), a table of the 'desirable' grazing impact ranges for a range of different habitat types was produced (Table 5.9).

Table 5.9 - Postulated 'desirable grazing impact ranges' for different habitat types.

	Grazing Impact						
	Low (L)	Low to Moderate (LM)	Moderate (M)	Moderate to High (MH)	High (H)	High to Very High (HVH)	Very High (VH)
Calcareous grassland	X	✓	✓	✓	X	X	X
Flush	✓*	✓	✓	X	X	X	X
Tall herb vegetation	✓**	✓	X	X	X	X	X
Montane scrub	✓**	✓	X	X	X	X	X
Blanket bog	✓	✓	X	X	X	X	X
Dry heath	✓**	✓	✓	X	X	X	X
Wind-clipped heath	✓	✓	X	X	X	X	X
Species-rich *Nardus* grassland	X	✓	✓	✓	X	X	X
Alpine moss-heath	✓	✓	X	X	X	X	X
Montane grass-heath	✓	✓	X	X	X	X	X

*Flushes with a low impact are generally stable at high altitude and where they are very wet, but at lower altitudes there is likely to be a loss of structural diversity and the possible succession to scrub.
**At lower altitudes likely to be invaded by trees if a seed source is available (over two to three decades).

5.1.4 Grazing related succession

Several habitat types are linked by succession depending on the grazing management, for example upland calcareous grassland subject to low herbivore impact levels may over time develop into tall herb vegetation or montane willow scrub, however this will depend on factors such as soil conditions, the availability of a local seed source and some level of disturbance to allow seedling establishment within the closed grassland sward. Although no two sites will respond in exactly the same way to changes in grazing levels, some general hypothesised predictions can be made about the impact of changes in grazing level on upland grassland communities and potential successional changes (in terms of NVC community type) that might occur, and these are shown in Figures 5.1 to 5.4. The rate at which these hypothesised changes might occur will vary; some may be rapid occurring within a few years while others may take decades.

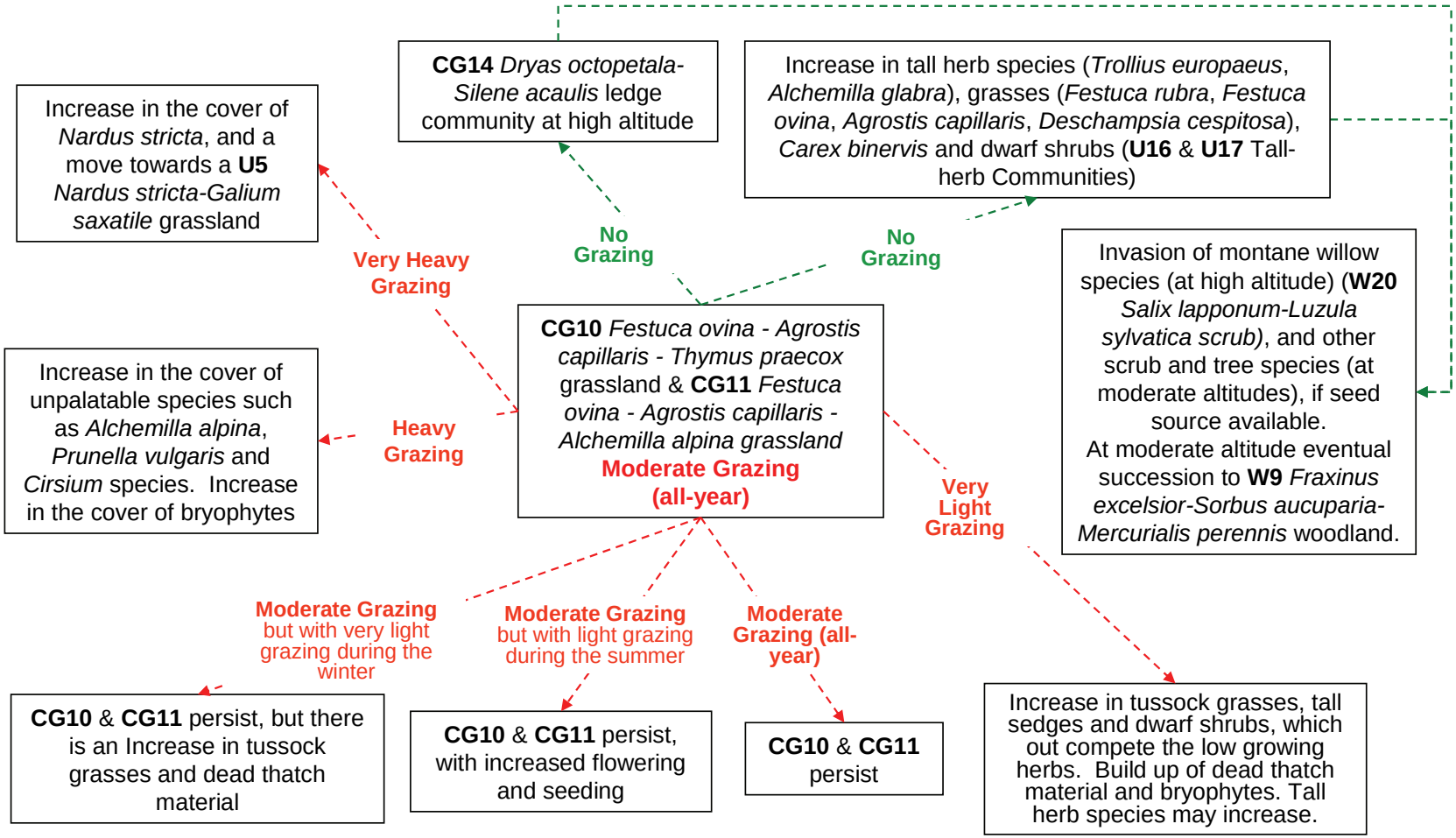


Figure 5.1 - Hypothesised potential impact of changes in grazing on CG10 and CG11 montane calcareous grassland (Rodwell, 1992; Rawes & Welch, 1969; Stewart & Eno, 1998; Holland, 2006).

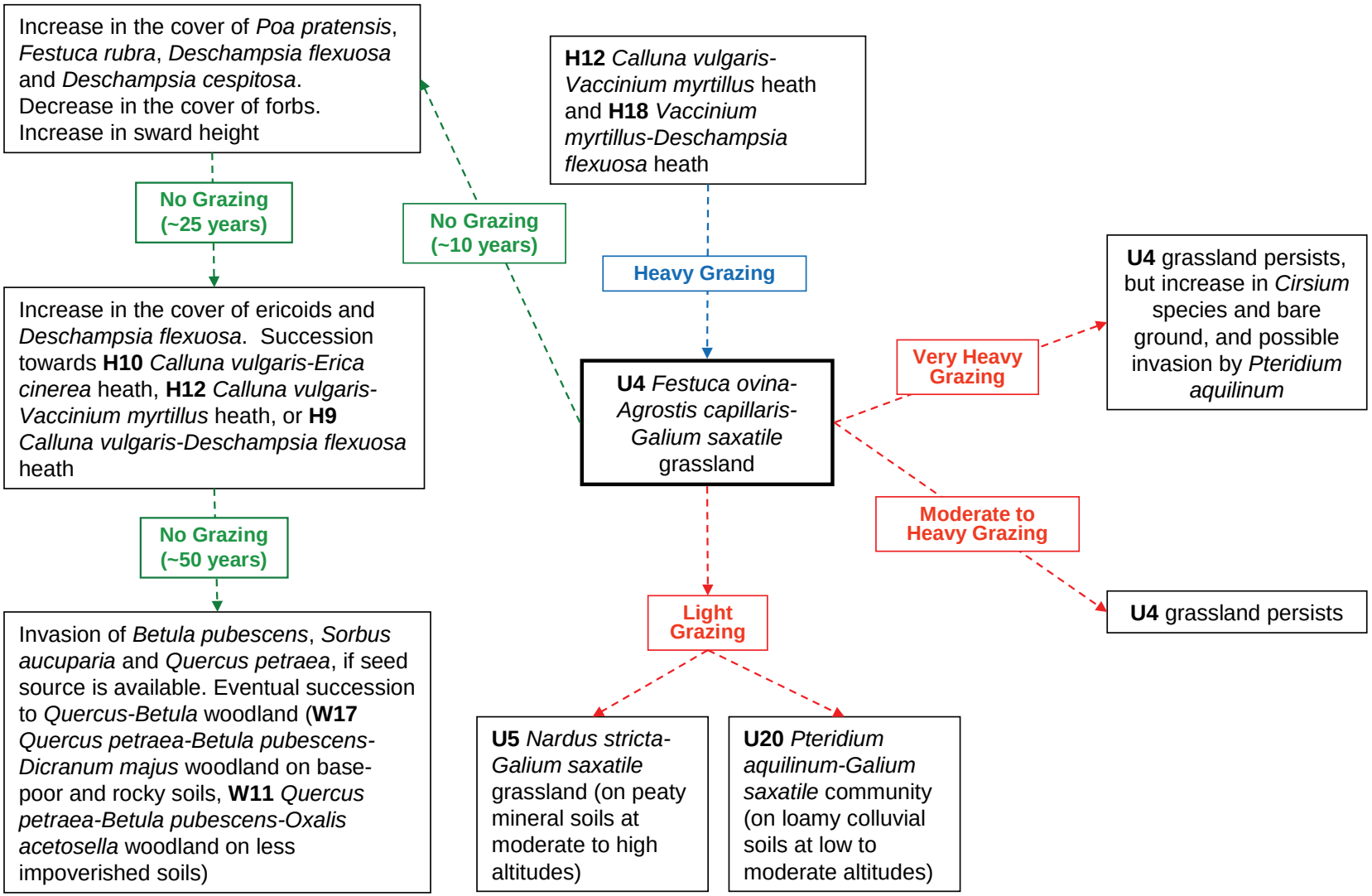


Figure 5.2 - Hypothesised potential impact of changes in grazing on U4 Festuca ovina-Agrostis capillaris-Galium saxatile grassland (Rodwell, 1992; Rawes, 1981; Hill et al., 1992; Ball, 1974).

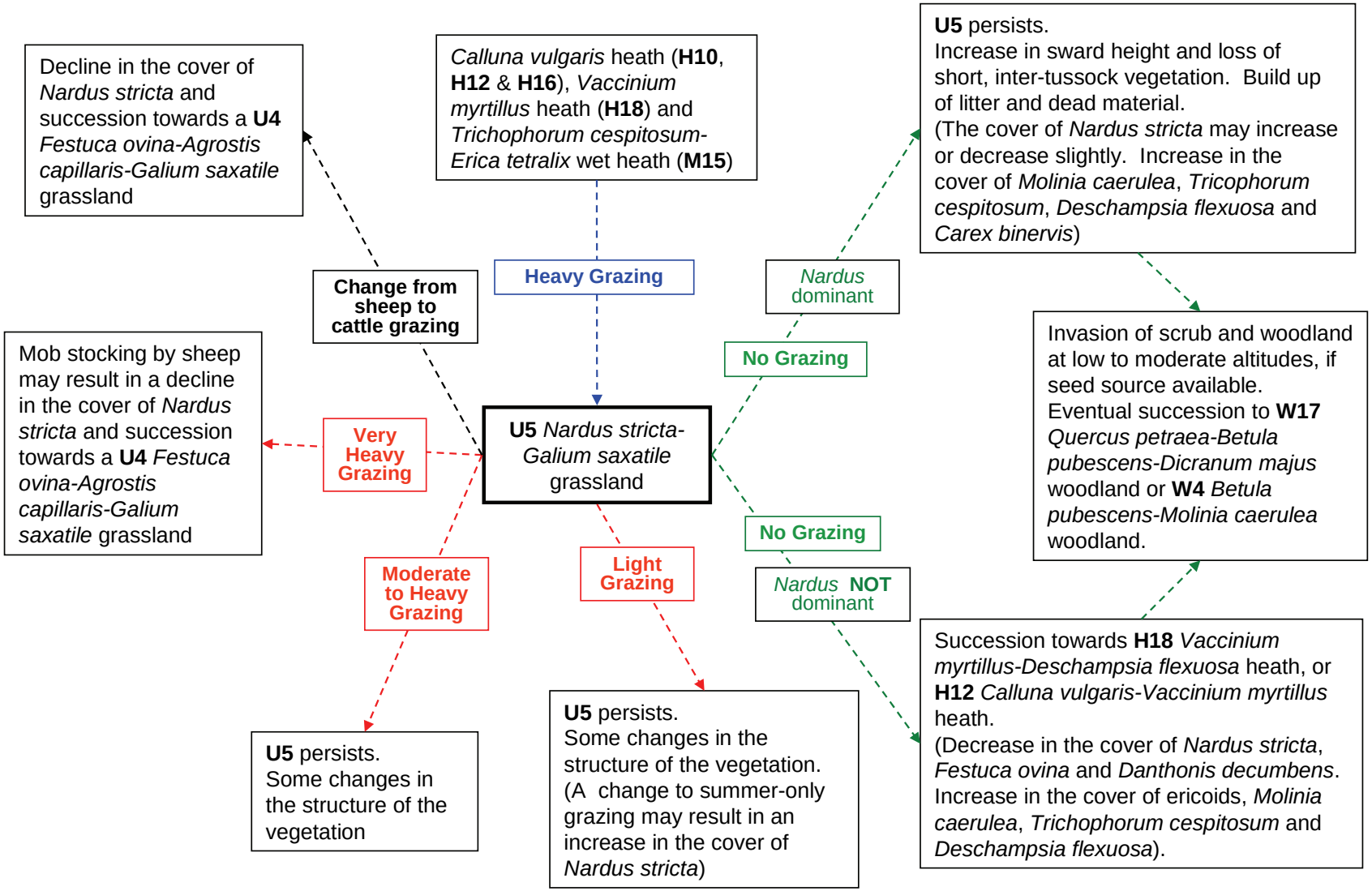


Figure 5.3 - Hypothesised potential impact of changes in grazing on U5 Nardus stricta-Galium saxatile grassland (Rodwell, 1991, 1992; Rawes, 1981; Hill et al., 1992; Grant et al., 1996b; Common et al., 1998).

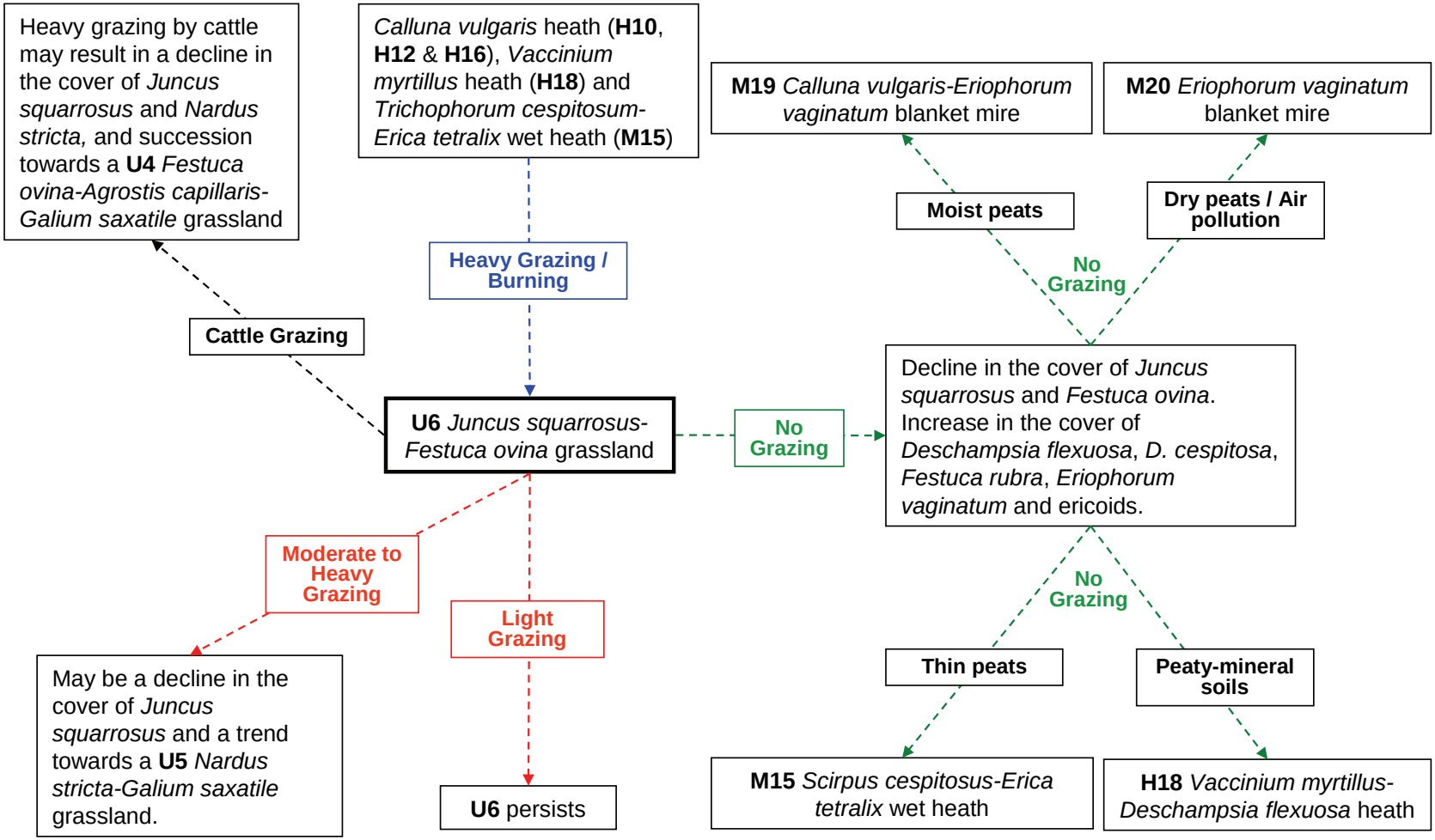


Figure 5.4 - Hypothesised potential impact of changes in grazing on U6 Juncus squarrosus-Festuca ovina grassland (Rodwell, 1991, 1992; Welch and Rawes, 1964; Marrs et al., 1988; Milton, 1940).

5.1.5 Impacts on fauna

Any changes in the composition or structure of hill vegetation as a result of reduced livestock grazing levels will, in turn, have an impact on the insect, bird and mammal assemblages present. Some species and habitats will benefit from the removal of livestock, but for others that are dependent on grazing, the loss of livestock is likely to be detrimental to their condition and conservation value. These changes in the fauna will have further impacts on the composition and structure of hill vegetation.

5.1.5.1 Mammals

Evans *et al*. (2006) showed that livestock grazing levels affect the abundance of field voles in hill grassland communities. Vole abundance was higher in plots with low stocking densities compared with plots with conventional stocking densities, and highest in un-grazed plots. The abundance of voles was also significantly higher in extensively grazed sheep and cattle plots, compared with extensively grazed sheep only plots. They suggest that it may be possible to benefit key upland species and maintain the open character of moorland, by a reduction in sheep grazing pressure and the introduction of low-intensity mixed livestock grazing (Evans *et al*., 2006). A study in the Peak District by Wheeler (2008) found that where sheep had been excluded from areas of *Molinia caerulea*, *Nardus stricta*, *Eriophorum vaginatum* and *Calluna vulgaris,* the field vole densities were between 1.5 and 2.5 times greater than in grazed areas. The population of voles and their predators, such as short-eared owls, were estimated to approximately double under reduced grazing. Hope *et al*. (1996) found that taller vegetation and increased signs of vole activity were associated with the removal of sheep at five of the eleven sites in the Scottish Highlands, where they studied the effects of reduced sheep grazing. At the remaining six sites, the removal of sheep had little or no effect on the vegetation or the vole activity. This was thought to be due to an increase in deer grazing and continued muirburn at these sites. They concluded that the removal of sheep grazing from an area is only likely to cause significant changes to the structure and composition of the vegetation if red deer numbers are low and heather burning is infrequent. Under these circumstances vole numbers are likely to increase (Hope *et al*. 1996). Hill *et al*. (1992) found that in the absence of sheep grazing from hill pastures in Snowdonia, voles became the dominant herbivore and caused large year-to-year variation in the vegetation biomass which was associated with fluctuations in the vole population. They found that *Agrostis vinealis* and *Holcus mollis* were grazed less by voles than *Agrostis capillaris*. The pleurocarpous mosses *Hylocomium splendens* and *Pleurozium schreberi* were found to increase within mats of dead grass in years of high vole abundance (Hill *et al*., 1992).

Albon *et al*. (2007), looking at the grazing impacts associated with different herbivores on Scottish hill vegetation, found that the presence of sheep was associated with the largest increase in grazing and trampling impact, that cattle had the second largest impact, while the presence of red deer was associated with a significantly lower impact than sheep. They suggest that the limited ranging behaviour and greater aggregation of sheep may be reasons for the higher impact associated with the presence of sheep. They suggest that further declines in sheep numbers may limit the extent of their impact, but not necessarily the local magnitude. Growing evidence also suggests that a reduction in competition with sheep may lead to increases in deer densities, and although deer impacts are more diffuse, they may have a greater impact on heather dominated habitats (Albon *et al*., 2007; Clutton-Brock & Albon, 1989). Work currently being undertaken by the Macaulay Institute (Albon, 2008; Albon & Irvine, 2009) has shown that species turnover (beta-diversity) is higher on shorter swards and in sites with both sheep and deer, compared with deer alone.

In a study carried out by Pollock *et al*. (2009) looking at the consequences of reduced sheep grazing on upland habitats, it was found that deer tended to be more abundant where sheep grazing had been reduced, compared to adjacent areas where sheep grazing levels had been maintained. The reduced competition and lower levels of disturbance that result when livestock are removed from hill ground are likely to lead to changes in the population density and distribution of red deer and other wild herbivores.

Other species of mammal such as badger, fox, stoat, wild cat, brown hare and mountain hare that inhabit upland agricultural land are likely to be affected both directly and indirectly as a result of declines in livestock farming in the uplands however no specific references were found.

5.1.5.2 Birds

Gillings *et al*. (2000), when considering the likely implications of scrub and woodland development on bird communities in the uplands, showed that species usually regarded as open moorland species, such as curlew, red grouse and meadow pipit, can persist in open mosaics of scrub and the early stages of birch and Scots pine regeneration, though densities may be lower than in open moorland. However, once canopy closure occurs these species will disappear. Large open moorland patches need to be maintained in order for these species, and more specialist moorland birds such as greenshank and golden plover, to continue to be present in the long-term. Gillings *et al*. (2000) suggest that this may require little management as the areas where scrub regeneration is most likely are at low altitudes whereas these moorland species tend to breed on higher ground. The development of scrub and woodland in areas where the only existing habitat was moorland will benefit many woodland bird species. The number of woodland species gained will outweigh the number of moorland species lost, however some of the moorland species are of high conservation value (Gillings *et al*., 2000). A mosaic of large patches of mature woodland and open moorland is likely to maximise avian diversity (Gillings *et al*., 2000).

A study carried out by Woodhouse *et al*. (2005) on the effects of land-use and agricultural management on birds of marginal farmland in the Llŷn peninsula in north Wales, highlighted the importance of a diversity of habitats and management on marginal upland farmland. They suggest that the most likely way to achieve this is through the allocation of funds to marginal areas via agri-environment and rural development measures. They found that sites that had been abandoned, or that were under-managed, had a high density of trees, a high cover of bracken and supported many common woodland and scrub species. Sites which had been extensively managed and which had a range of semi-natural habitats were important for a number of species, including chough, wheatear, mistle thrush, stonechat and meadow pipit. High densities of linnet and yellowhammer were found on sites with improved grassland and gorse, and swallow and house martin were associated with improved grassland with scrub or bracken.

Calladine *et al*. (2002) monitored the breeding success of black grouse *Tetrao tetrix* at 20 sites in the north of England between 1996 and 2000. The stocking level had been reduced before or during the study at ten of the sites to < 1.1 sheep per hectare in the summer and < 0.5 sheep per hectare in the winter. Each of these sites was paired with a reference site that had stocking levels two or three times the level of the reduced grazing sites. The number of displaying black grouse males increased by an average of 4.6% per year at sites were grazing had been reduced, while numbers declined annually on average by 1.7% in the sites where grazing had not been reduced. The rates of change in the numbers of displaying males peaked in the early years following the reduction in grazing and then declined after about 5 to 7 years. Fifty-four percent of the black grouse hens that were

encountered during the summer at the reduced grazing sites were with broods, which was significantly greater than the 32% at the sites where grazing levels had been unchanged.

From a literature review carried out by Buchanan *et al*. (2006) on the importance of invertebrates for moorland-breeding birds, they concluded that the available data suggests that management regimes that create habitat mosaics with heterogeneous vegetation structure and species composition are likely to increase invertebrate food resources and be most beneficial to breeding moorland birds.

Work carried out by Sim *et al*. (2005) looking at changes in the abundance of British upland breeding birds between 1980-1991 and 2000-2002, found evidence of widespread population declines in three species of breeding waders (lapwing, dunlin and curlew). Some passerine species declined (twite and ring ouzel), while others increased (stonechat, raven). They suggest that there are a number of possible factors that lead to change in upland bird populations, including grazing levels, afforestation, predator abundance and control, acidification, climate change and disturbance (Sim *et al*., 2005). Increased grazing pressure in many parts of the British uplands prior to and during the monitoring period (Fuller & Gough, 1999) are likely to have resulted in a reduction in habitat quality for ground-nesting birds, the loss of preferred vegetation types, changes to invertebrate food supplies and changes in predator numbers. Southern Scotland had some of the most widespread and severe wader declines. It was thought that large scale afforestation together with increased sheep grazing pressure may have been responsible for the declines (Sim *et al*., 2005). Henderson *et al*. (2004) reported significant declines in the abundance of 12 grassland-associated birds in marginal upland areas of Britain between 1968-80 and 2000.

A study looking at the habitat associations of breeding meadow pipits in the British uplands by Vanhinsbergh and Chamberlain (2001) showed that meadow pipit abundance was positively associated with grassland at the landscape level, but that areas, dominated by either grassland or heather, hold lower densities than areas containing a mixture of these habitats. They conclude that a mosaic of heather, bog and grassland may be the optimum habitat for meadow pipits. A reduction in grazing levels in areas dominated by grassland may lead to the development of a more heterogeneous landscape with a mosaic of habitat types which may benefit meadow pipits. This may in turn increase the abundance of predators such as hen harrier. However, the complete removal of grazing from areas already dominated by heather may lead to the replacement of hill grassland patches by heather, which may lead to a small reduction in meadow pipit density.

Work by Vandenberghe *et al*. (2009) has shown that a low intensity, mixed grazing system of sheep and cattle provides a more suitable combination of vegetation structure, plant species composition and invertebrate food supply for meadow pipit foraging activity compared to a more intensive sheep grazing system.

Pearce-Higgins and Grant (2006), in a study looking at the relationships between bird abundance and the composition and structure of moorland vegetation, found that moorland birds vary in their preferences for particular vegetation types and structure. Nine species of moorland bird were studied in detail and, of these, only two species (red grouse and stonechat) were associated with heather. Meadow pipit showed a curvilinear relationship with heather. Skylark and golden plover were associated with short vegetation, curlew and snipe with vegetation that was structurally heterogeneous, and whinchat with dense vegetation (particularly bracken), whereas wheatear showed no strong vegetation association. Six of the species were positively associated with wet vegetation. They concluded that management which promotes heterogeneity and wetland vegetation is likely to support a diverse bird assemblage and be of benefit to particular key species. They suggest that species associated with short open vegetation, in particular waders, may be detrimentally affected by future declines in livestock numbers. Pearce-Higgins *et al*. (2009)

carried out a review of the literature on the drivers of change of upland bird populations in the UK. The three main drivers of population change which they reviewed: the effects of grazing pressure, afforestation, and the decline in grouse moor management, are all relevant to the issue of the decline in hill farming. They conclude that land-use changes have the potential to affect bird abundance, but that it is unlikely that any single driver is responsible for the major changes in species populations that have occurred in some upland areas. The review indicates that increases in grazing since the 1940's may have been responsible for declines in red-grouse, black grouse, dotterel, ring ouzel and golden eagle in some regions. It also shows that the control of predators appears to benefit grouse and ground-nesting waders and that population declines in these species may have been due to reductions in grouse moor management in some areas (Pearce-Higgins *et al*., 2009).

Loe *et al*. (2007) looking at the short-term effects of sheep grazing on an alpine bird assemblage in southern Norway, found that the density of all birds, insect eaters, meadow pipits and willow grouse were significantly higher in grazed enclosures with a sheep density of 0.8 sheep per hectare, compared with un-grazed enclosures. However, there was no clear effect on bird diversity.

5.1.5.3 Invertebrates

Littlewood *et al*. (2006) found that the exclusion of grazing from four 'degraded' acid grassland (*Nardus stricta* or *Molinia caerulea* dominated) sites, which were formerly dominated by dwarf shrubs, aided the restoration of the moorland vegetation and the Hemiptera and Lepidoptera assemblages.

Work by Dennis *et al*. (2008), looking at the effects of livestock grazing on foliar arthropods associated with bird diets in Scottish hill grasslands, found that there were significantly higher numbers of spiders, bugs and beetles in plots with low density sheep grazing (0.9 ewes per ha) and low density sheep and cattle grazing (the equivalent of 0.9 ewes per ha), compared with plots with a higher commercial stocking density of sheep only (2.7 ewes per ha). There was, however, no effect of lower grazing intensity on numbers of brachyceran flies, caterpillars or craneflies. There was a significant increase in the estimated total biomass of foliar arthropods with decreasing grazing intensity, and biomass in the un-grazed treatment was approximately twice that in the commercially grazed treatment. As part of the same grazing project, Littlewood (2008) found that moth abundance and species richness were lowest under the higher sheep stocking treatment and highest under the lower sheep stocking and un-grazed treatments. The impacts of grazing on the structure of the moth community were studied by assigning moth species into particular groupings. There was a significant interaction between grazing treatment and larval foodplant, with a disproportionately high number of grass-feeding species found in the un-grazed treatment. Grazing treatment also interacted with the moths' over-wintering life stage. Moths that over-winter as caterpillars were well represented in the un-grazed treatment whilst those that over-wintered as eggs were higher in the low density sheep grazing treatment. Littlewood (2008) suggests that a continued reduction in livestock grazing on the Scottish hills may lead to an overall increase in moth abundance, but species in some of the functional groups may decline.

Cole *et al*. (2006), looking at the impact of different grazing treatments on carabid assemblages in the Scottish uplands, found that grazing intensity did not significantly influence carabid diversity but did influence the ecological structure of the carabid assemblage. Large flightless *Carabus* species were more abundant in extensively managed plots than in intensively managed plots. Cole *et al*. (2010) also found that the more intensively grazed sites were associated with smaller mobile arthropods, tipulid larvae and earthworms, while sites that were less intensively grazed (during the summer only) were

associated with larger mobile arthropods (e.g. wolf spiders and *Carabus* beetles), and the larvae of sawfly and Lepidoptera.

The dung of grazing herbivores provides an important habitat for many species of higher plant, mosses, fungi and invertebrates and therefore the decline in grazing livestock numbers will have an impact on these species (Cox, 1999).

Many butterfly species associated with grassland habitats require precise grazing regimes to maintain the species-composition and structure of the grasslands for both the larval and adult stages, and the abandonment of grazing land, allowing coarse grasses and scrub to spread, has been responsible for the local decline of a number of species (Asher *et al*., 2001). Several fritillary species that breed in bracken dominated vegetation, including the Pearl-bordered Fritillary (*Boloria euphrosyne*), have declined as a result of the abandonment of grazing land (Asher *et al*., 2001). Grazing of the bracken vegetation maintains the open conditions required by violets which are the larval food-plant. In some areas, particularly in the uplands, overgrazing of the bracken habitat has also resulted in the decline of the Pearl-bordered Fritillary (Asher *et al*., 2001). The habitat management requirements of the Marsh Fritillary (*Euphydryas aurinia*) includes some degree of light grazing, preferably by cattle, in order to maintain an open flower-rich sward containing the larval food-plant Devil's-bit Scabious (*Succisa pratensis*) (Asher *et al*., 2001). Overgrazing by sheep, the cessation of grazing, agricultural improvement or a change from cattle to sheep grazing can all be detrimental. The Mountain Ringlet (*Erebia epiphron*) Britain's only true montane butterfly species is mainly found on sheep and deer grazed mountain grasslands dominated by Mat Grass (*Nardus stricta*) the larval food-plant (Asher *et al*., 2001). Substantial changes to the grazing management of the upland pastures where it is found could adversely affect this species (Asher *et al*., 2001). In Scotland the Scotch Argus butterfly (*Erebia aethiops*) is found in tall, damp grasslands, dominated by Purple-moor grass (*Molinia caerulea*) that are lightly grazed or un-grazed (Asher *et al*., 2001). Populations can increase rapidly following the removal of livestock from damp acidic grassland.

5.1.6 Summary of the main effects of grazing animals on vegetation, fauna, soils and environment

Table 5.10 summarises the main direct effects of grazing animals on vegetation, fauna, soils and environment, together with the impacts they have. In addition to these direct effects, the use of agro-chemicals and veterinary medicines (e.g. sheep dip and avermectin (Webb *et al*., 2006)) can also have a significant impact on the environment.

Table 5.10 - The main direct effects of grazing animals on vegetation, fauna, soils and environment.

Effect	Impact
Grazing	• Causes physical damage to above ground plant parts • Can stimulate growth and tillering in some species • Affects competitive interactions between species
Browsing	• Causes physical damage to woody plants • Affects competitive interactions between species
Trampling	• Causes physical damage to above and below ground plant parts • Affects competitive interactions between species, with some species being more sensitive to trampling than others • Can cause soil compaction, which affects: o soil structure o soil air content o soil water content and hydrology o surface hydrology • Can cause soil erosion • Can affect soil carbon emissions and sequestration • Can open up the sward allowing seed germination and the establishment of new plants • Can cause damage and/or disturbance to nests
Rubbing	• Can cause physical damage to woody plants
Dung and urine deposition	• The presence of dung and urine affects: o soil fertility o availability and levels of soil nutrients o nutrient cycling • Can lead to excessive nutrient- enrichment of soils and the eutrophication of water courses. • The presence of dung can directly affect vegetation by blocking out light preventing photosynthesis and by physically squashing vegetation • Dung is important for a range of invertebrate species (and the birds that feed on them) and fungi • Nitrous oxide and methane produced from dung and urine are important greenhouse gasses
Tick and disease transmission	• Can spread tick borne diseases such as looping ill and Lyme disease • Can spread other infectious diseases
Methane emissions from enteric fermentation	• Methane is an important greenhouse gas

5.1.7 The potential positive and negative impacts of abandonment on the biodiversity of a Perthshire hill farm

As part of a RERAD funded project the authors looked at the potential positive and negative impacts on biodiversity that might occur at SACs hill farm at Kirkton, near Tyndrum in west Perthshire under a scenario where sheep had been removed from the hill and inbye ground. The results from this exercise are shown in Figures 5.5 to 5.8.

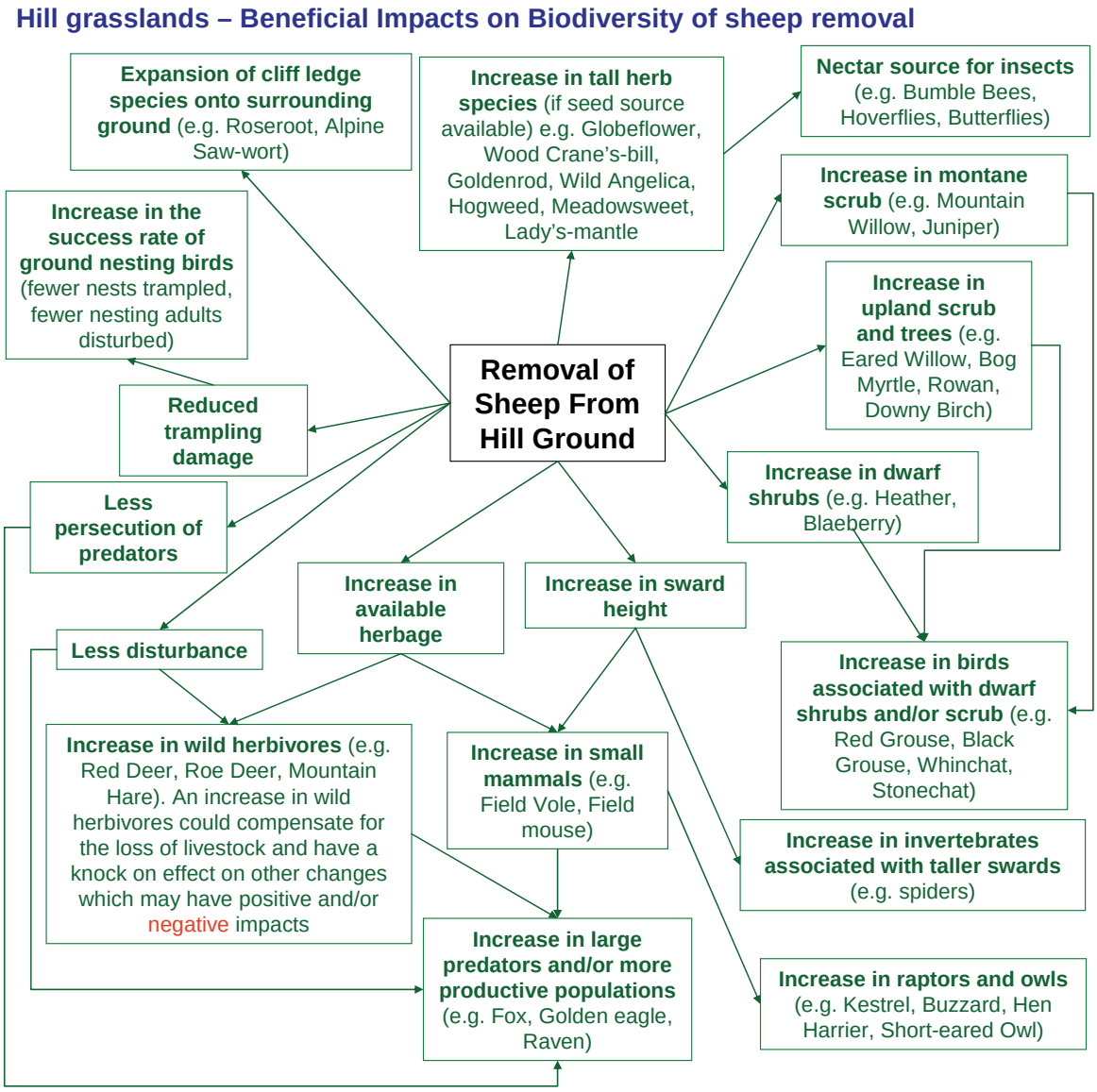


Figure 5.5 - Potential positive impacts on biodiversity of sheep removal from the hill grassland of a farm in west Perthshire.

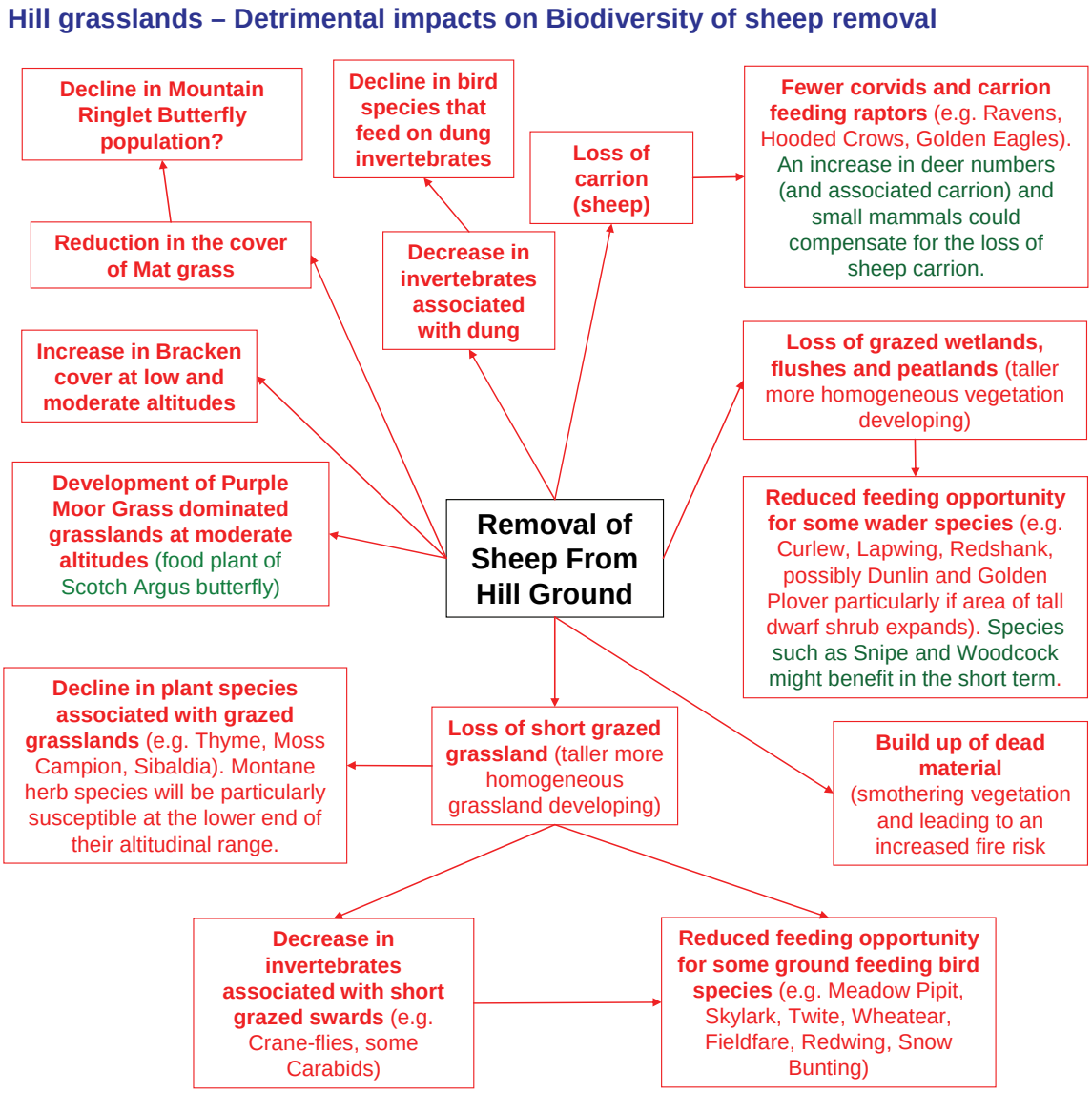


Figure 5.6 - Potential negative impacts on biodiversity of sheep removal from the hill grassland of a farm in west Perthshire.

Inbye grasslands – Beneficial impacts on Biodiversity of sheep removal

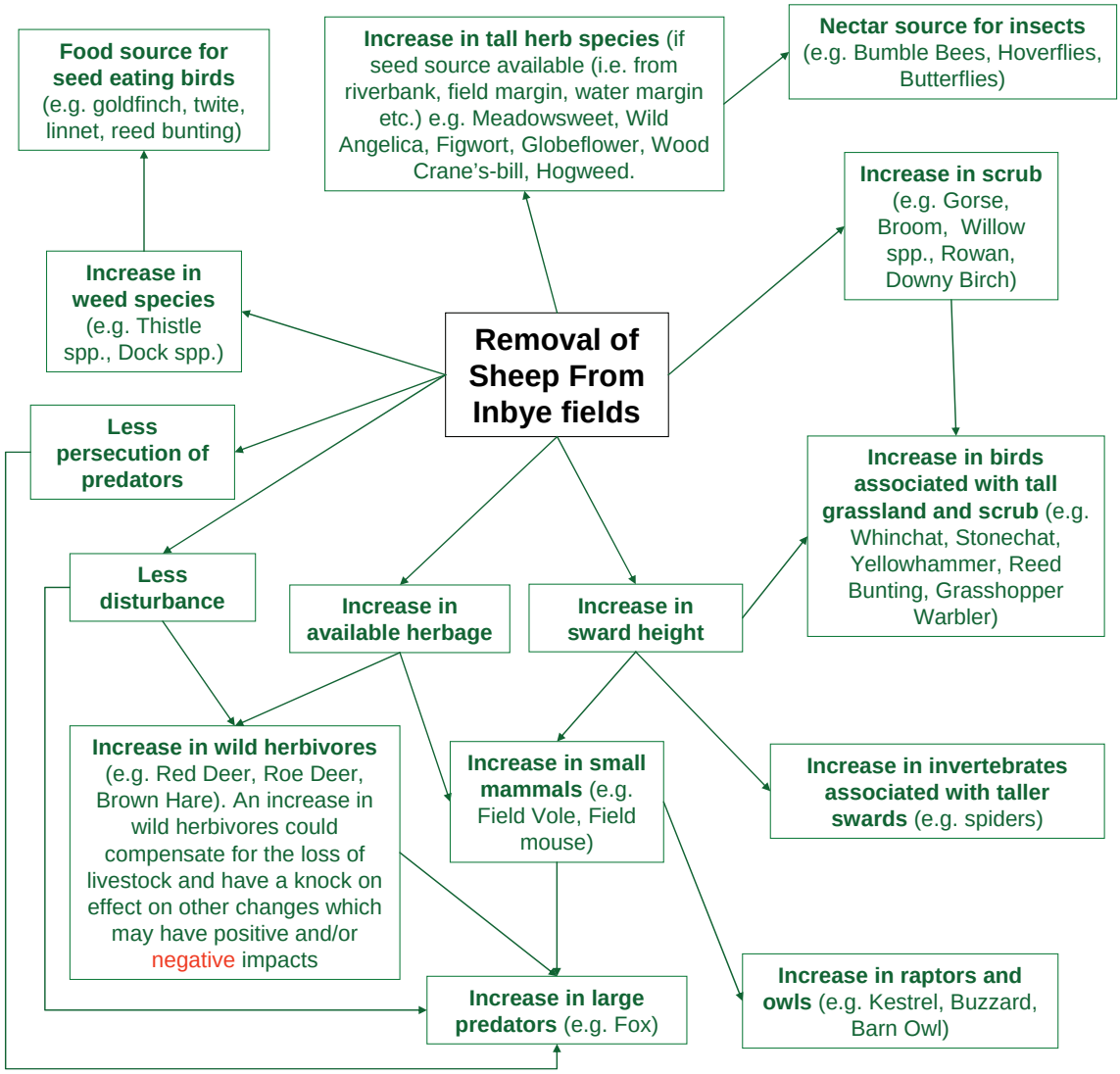


Figure 5.7 - Potential positive impacts on biodiversity of sheep removal from the inbye grassland of a farm in west Perthshire.

Inbye grasslands – Detrimental impacts on Biodiversity of sheep removal

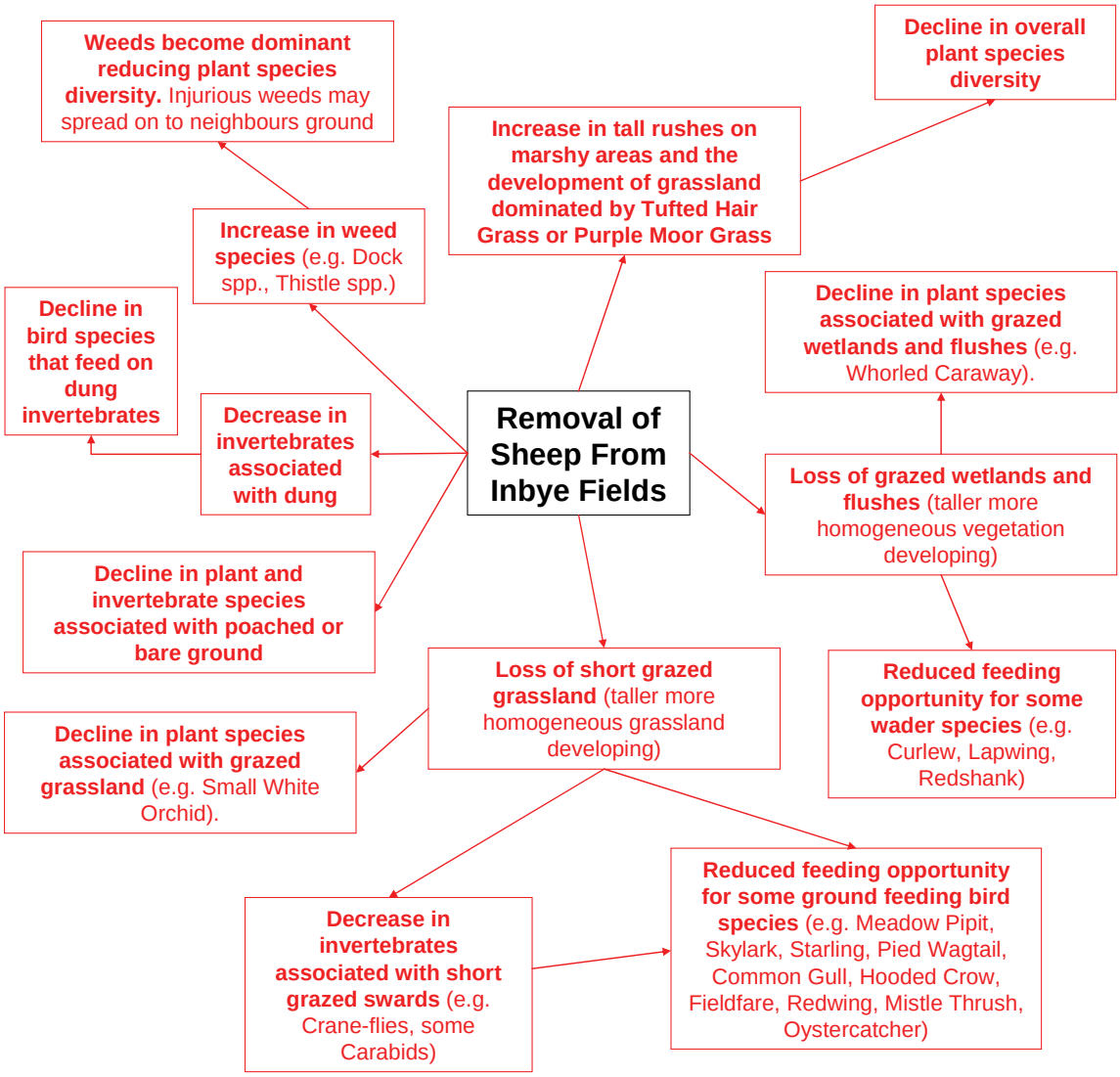


Figure 5.8 - Potential negative impacts on biodiversity of sheep removal from the inbye grassland of a farm in west Perthshire.

5.1.8 Wider European perspective

The abandonment of farms and a reduction in the number of people working in agriculture as a result of socio-economic changes are bringing about severe land-use changes in mountain areas across Europe (Maurer *et al*., 2006; Tasser & Tappeiner, 2002; Baur *et al*., 2006; Agnoletti, 2007). It has been noted that as land has been abandoned so biodiversity has suffered. A study on plant diversity of grasslands in the Swiss Alps by Maurer *et al*. (2006) found that species richness declined and standing biomass increased in abandoned grassland parcels, compared with managed parcels. Maurer *et al*. (2006) concluded that to preserve plant species diversity at the landscape level, a high diversity of land use types has to be maintained. Tasser and Tappeiner (2002) also found that the abandonment of hay meadows and pastures in the South Tyrol led to a reduction in plant species richness. Bauer *et al*. (2006), investigating the effects of abandonment of sub-alpine hay meadows on plant and invertebrate diversity in Transylvania, found that vascular plants, gastropods, diurnal Lepidoptera and nocturnal Lepidoptera differed in their response to abandonment. Plant species richness was higher in extensive hay meadows compared with either abandoned hay meadows, naturally growing birch forest or mature forest, whereas, the species richness of diurnal Lepidoptera was highest in abandoned meadows. The species richness of nocturnal Lepidoptera was highest in birch woodland and the species richness of gastropods was highest in mature forest.

Throughout Europe, traditional low-intensity farming practices are being intensified or abandoned and consequently areas of low-intensity farmland of high nature conservation value are disappearing (Bignal & McCracken, 1996; 2000; 2009). The concept of High Nature Value (HNV) farmland emerged as a response to this problem as it was recognised that, in some areas of farmland, there is a strong relationship between farming practices and biodiversity and that the continuation of those practices is important for maintaining biodiversity and conservation value (Hoogeveen *et al*., 2004; McCracken & Huband, 2005; IEEP, 2007). Generally, high nature value farming systems are low intensity, low input systems, frequently involving the utilisation of semi-natural vegetation by livestock. In Scotland, the areas of HNV farmland coincide with the areas that are experiencing the greatest declines in livestock numbers, suggesting that the HNV farming systems in these areas are in decline. Crucially, a reduction of grazing in systems that are already low intensity and extensive could lead to a decrease in biodiversity. HNV livestock grazing systems are, however, a European policy priority. Each Member States' rural development programme is meant to work towards the Community's strategic objectives, one of which is 'to protect and enhance the EU's natural resources and landscapes in rural areas [including] three EU-level priority areas: biodiversity and the preservation and development of high nature value farming and forestry systems and traditional agricultural landscapes; water; and climate change'. The Environment for Europe Ministerial Conference in Kiev in May 2003 (Council of the Pan-European Biological and Landscape Strategy, 2003) also gave a pan-European commitment to identify 'all high nature-value areas in agricultural ecosystems in the pan-European region' and to protect 'a substantial proportion of these areas under biodiversity-sensitive management by using appropriate mechanisms such as rural development instruments, agri-environmental programmes and organic agriculture, to inter alia support their economic and ecological viability'.

The declines in livestock numbers raise important questions about the future development and management of Scotland's HNV farmland.

5.2 Social consequences of the decline in livestock farming

Although the potentially negative impact of a declining agricultural sector on rural communities is frequently referred to in public debate about livestock decline, there has been little research on the social consequences of a fall in livestock numbers since the publication of *Farming's Retreat from the Hills* (SAC, 2008). The basic logic behind public pronouncements of the social consequences of declining livestock numbers appears to be that most hill farming takes place in remote rural areas, which are areas where agriculture makes a proportionally larger contribution to the local economy. Any decline in that sector, with implications for the upstream and downstream industries, is therefore expected to have a proportionally greater impact on the rural economy and wider community. The presupposition is that if farmers leave the industry or if there are reduced incomes and job losses in associated industries, then existing processes of emigration are likely to be enhanced, further weakening the social sustainability of remote rural areas. Unfortunately, however, research that has directly examined the socio-economic impact of the decisions by farmers to reduce livestock numbers is lacking. There has been recent modelling work that examined the impact of policy change—especially decoupling—on upland farming systems and farm incomes (Acs *et al*., 2010), but this research did not go further to examine the wider impacts of rural society.

There has been a considerable amount of wider work examining English upland communities as part of the Commission for Rural Communities' 'Inquiry into the future of England's upland communities' (Commission for Rural Communities, 2009). The CRC commissioned several pieces of research to identify and evaluate the key drivers of change in England's upland communities and to develop and promote realistic policy recommendations that enable and equip these communities to move towards more secure sustainable futures (Carruthers *et al*., 2009; Step Ahead Research Ltd., 2009; Slee, 2009). Carruthers *et al*. (2009) explored how key stakeholders are imagining and shaping the uplands, how upland public goods and benefits are constructed and valued, what methods are available for developing and informing policy for upland communities and what can be learned from experience outside England. Step Ahead Research Ltd. (2009) used a mix of qualitative methods to explore the views of residents in six case study upland communities about the strengths, weaknesses, threats and opportunities relating to upland communities and economies. Yet while the Inquiry was prompted by changes in upland areas—notably the increased interest in public benefits and a downturn in hill farming—the research does not specifically examine the impact of the downturn in farming on rural communities. Carruthers *et al*. (2009) emphasise the role of hill farmers as stewards of the land and the need to support them in order to allow them to continue to perform this role, but also that farmers are a small proportion of the people living in rural upland communities. The work for this Inquiry does not restrict itself to look at the importance of agriculture; rather it examines the characteristics of rural communities today, the challenges that they face (such as those relating to service provision, transport and affordable housing) and the ways that upland communities can be empowered to help themselves. Consequently, while highly relevant to the present study on livestock decline in Scotland, this work does not add to our understanding of the impact and consequences of livestock decline on rural society today.

There has also been broad research on the future of the uplands that has been conducted as part of the UK Government's Foresight project examining 'Land Use Futures' (Foresight Land Use Futures Project, 2010). Reed *et al.* (2009) detail the drivers influencing change in the uplands and explores a range of possible scenarios for the future of the uplands. They explore scenarios relating to an intensification of land use because of a greater interest in carbon offsetting, global food shortages, incentivised production of energy crops and an expansion of forestry, and an extensification of land use relating to a decline in hill farming and a shift towards re-wilding. With regard to their extensification scenarios, Reed *et al.*

(2009) point to several of the expected socio-economic issues such as a shift towards fewer farms with only a limited number of family farms remaining viable; agricultural land abandonment; potential afforestation, re-afforestation and management for nature conservation; and reduced demand for agricultural inputs and services. But they also suggest that any decline in demand for agricultural inputs might be offset by demand for new goods and services to support diversification (many studies assume that if financial support for upland farming is reduced, more funding would be made available for diversification (see for example Gardner *et al*., 2009)) and that new sources of income could include tourism, recreation and leisure activities; direct processing and marketing of local produce; or new business ventures, such as wind farms. The emphasis of this work is, however, very much on the future; it is focused on what might be, and beyond identifying the current drivers affecting the uplands, does not help understand the current processes and their socio-economic impacts.

There has also been a significant body of work that has emerged from the upland research forum that was fostered by the Moors for the Future Partnership based in the Peak District National Park, culminating in the production of an edited book exploring the drivers of environmental change in the uplands (Bonn *et al*., 2009). With contributions exploring the upland economy, the future of public goods provision and the value of upland landscapes, it is a volume that covers a range of policy, economic and social drivers of change. Although not specifically focussing on the socio-economic impact of livestock decline, Hubacek *et al*. (2009) (also see Slee, 2005) highlight the way that the upland economy has changed. It has moved from being a rural economy based primarily on the production of food, fibre and minerals, to providing a multitude of production and consumption activities. Furthermore, the upland economy looks set to continue to change as a better understanding of the value of ecosystem services has the potential to influence land management and the value of new activities. For Hubacek *et al*. (2009) the focus should therefore not be solely on extraction and production for export, but on the diversity and interconnectedness of local economic activities. This is important because it suggests that, if the upland economy is changing, caution is required when thinking about the economic impact of livestock decline. If, as they suggest, the upland economy has shifted from one focused on production towards one that is more diversified, the impact of decline in one sector may be less significant.

In the context of a lack of direct research into the socio-economic consequences of livestock decline, one way of attempting to understand the consequences is to make inferences from prior research into the impact of policy change, such as that undertaken into the potential changes that could be implemented with regard to LFASS (Schwarz *et al*., 2006), or from the evaluation of the SBCS (Barnes, 2008). Schwarz *et al*. (2006) examined the current impact of LFASS payments with reference to farm businesses and the linkages with upstream and downstream industries and then explored the options for the future of LFASS payments through an analysis of the economic, social and environmental impacts of various scenarios. They found that LFASS payments provide socio-economic benefits to the farming community and indirectly to the wider economy, notably through strong economic linkages with the animal feeds, manufacturing and other service sectors and the meat processing sector. While different farm types have different input requirements and therefore different multipliers, Schwarz *et al.* (2006) suggest that LFA farm types have cumulative industry output multipliers of around 1.7, which means that an increase of £1000 in final demand for the output of a LFA farm type generates an additional output of £700 in all other industries. The size of these multipliers is significant because it highlights that if agricultural output declines there would be significant declines in associated sectors. One of the study's scenarios was the removal of LFASS payments and Schwarz *et al.* (2006) found that, if LFASS were removed, agricultural output in LFAs would experience a large decline (in particular the sheep sector) leading to reductions in output in a range of upstream and downstream industries, especially the animal feeds, fertilisers and veterinary services sectors. Clearly this sort of research is useful as it highlights the inter-sectoral linkages and

therefore the wider impact of decline in one sector, but the utility of such work for helping to understand the current socio-economic impact of a reduction in livestock numbers is limited. Analyses of the impact of potential changes in public funding, based upon modelling, does not tell us what is happening on the ground today and does not go beyond the economic to explore social consequences of people leaving the industry or the area.

The literature on the social and economic impacts of the current decline in livestock numbers is therefore limited. There is much that is not known. Much depends, for example, on how hill farmers choose to behave. If a large number of farmers chose to leave the industry there could be large impacts, but if they downsize and simply cut the size of their operation in order to cut costs, the impact could be less severe. History suggests that many farmers will struggle on, making their decisions against a broad set of concerns rather than solely the economic situation, including tradition and a preference for a particular way of life.

Care is also needed in making strong claims about the social consequences of livestock decline because, as both the Royal Society of Edinburgh (Royal Society of Edinburgh, 2008) and Scottish Agricultural College (SAC, 2010b) highlight, the decline of population in remote rural areas has a long and complex history. When seeking to understand effects and their causes it is potentially difficult to disentangle the long-term issues facing remote rural areas from the more recent challenges facing hill farming.

5.3 Impacts on management strategies

A series of major changes to upland farming in Great Britain have been reported, which relate to the 2005 CAP reform package (e.g. SAC, 2008; Royal Society of Edinburgh, 2008), and it is evident that changes are continuing apace, both at the individual farm level and at regional and national levels (Clothier & Finch, 2009). A decline in the number of sheep is the 'headline' issue, but with local and regional variation in its extent. At the farm level these declines range from small to large overall reductions in sheep numbers, to complete abandonment of sections of farms, often due to practical difficulties of managing and gathering sheep (SAC, 2008; Morris *et al*., 2005).

Responses to CAP reform were very much the focus of interest in a series of Farmer's Voice studies in England (e.g. ADAS, 2006). ADAS (2005) conducted a farm by farm analysis of the considered options for greater financial viability on a number of farm businesses. The favoured approaches, in these business consultant driven studies, included an increase in livestock numbers. Dwyer (2005), in reviewing this work and other ADAS studies, noted these changes but considered that a trend towards more extensive practices were most likely as a result of CAP reform. Lewis and Beetham (2005) also noted the poor economic situation of hill farmers – more locally for the North York Moors study area. They considered that the inherent un-profitability of hill farming and the freedom enabled by CAP reform would lead to further exacerbation of the trend of reduction in moorland flocks. Dwyer (2005) considered that agri-environment schemes, diversification, options for off-farm work and the exploitation of opportunities to differentiate and add-value to products through on-farm processing and sales, were are all favoured business development strategies.

Economic pressures were further highlighted by Turner *et al*. (2008) for hill farms in south-west England. They pointed to significant future pressure as a result of the continuing changes in policy support measures in England as part of the 2005 reforms; given England has a changing profile of SFP. In their analysis, the more marginal farms were the greatest source of concern. The future viability of English hill farms, with poor performance, heavy dependence and high influence of support payments, was also emphasised in the most recent economic reports for England (Harvey & Scott, 2009).

For Scotland, SAC (2008) noted that the trend of stock reduction (both partial and full abandonment), was likely to continue with decoupling and unpredictable incomes. In some case studies it was evident that there were very many different patterns and triggers for change at the farm level. Very similar issues and changes are occurring in Wales.

Turner *et al*. (2008) considered that in terms of structural changes, many hill farmers in the most marginal areas would continue to farm, despite poor income and long hours, perhaps in the hope of better returns. In time though, and with fewer young people entering, farms will disappear and their land will be shared between neighbours.

So whilst the overall pattern during the period of the recent reform to date has been of declining sheep numbers and a trend towards partial or complete abandonment, it is much more complex than this, especially at the farm level. Some commentators have suggested that intensification and enlargement of units in the uplands may be a way forward for some, and given historically high prices for lamb and breeding sheep in 2009/10 this view may become more prevalent.

5.4 Wider environmental and food issues

A continued reduction in livestock numbers would reduce Scotland's net greenhouse gas emissions under current calculation methods, but it is likely that this would also reduce the net capacity of Scotland as a food producer and decrease its self-sufficiency[16]. Much of the rough grazing in Scotland is unsuitable for other cropping, but ruminants have the ability to convert the plant species in these areas into high quality meat products. They also provide breeding and growing livestock for the more intensive lowland sector, contributing towards global food production and the economic well-being of Scotland through the significant food and drink sector. Although livestock in more extensive systems may appear to be less efficient in terms of input-output ratios, they are well adapted to lower input systems, as well as having local cultural, habitat and landscape importance. As with other extensive systems around the world, breeds from these areas are the custodians of genetic agricultural biodiversity, which the UK government is obliged to protect under the Convention on Biological Diversity, set at the first worldwide environment summit in Rio de Janeiro in 1992. The relationships between grazing animals, vegetation and soil carbon remain largely unknown and not part of any official inventory approach.

[16] Waterhouse, A. & Ricci, P. 2010. Upland agriculture - opportunities and threats from climate change. Presentation at the *Carbon in the Uplands - Threats and Opportunities* conference organised by the Heather Trust, Southern Uplands Partnership and Crichton Carbon Centre. 20-21st April 2010, Moffat.
http://www.heathertrust.co.uk/output/presentations.asp

6 CASE STUDY AREAS

6.1 Case study selection

The case study areas were chosen on a regional basis. Since Scotland, at its simplest, has three distinct hill and upland areas with characteristic farming systems: the Highlands (with extensive sheep farming and hill cattle); the Southern Uplands (with more productive hill sheep and cattle farming systems, often supported by more productive upland mixed farming); and the Islands (with a crofting system), a case study area was chosen from within each of these three regions.

The main criteria for the selection of the case study areas were:

1) The areas should be from regions that are geographically distinct and contain different farming systems and have different socio-economic driven farm typologies.
2) The areas should be at the parish cluster level.
3) There have been significant livestock declines over the past ten years within the area.
4) There is a likelihood of further livestock decline within the area.
5) Agriculture remains an important land-use within the area.
6) There is a connection between the natural heritage and the livestock system within the area.
7) There are sufficient land-owners/land managers within the area to make a workshop viable.
8) A suitable location for a workshop is available.
9) SAC has contact with land-owners/land managers in the area and/or has carried out research work in the area.

Following considerable consultation with SNH the following three case study areas were chosen: South Skye, West Borders and North Highlands (Figure 6.1 and Tables 6.1, 6.2 and 6.3).

Table 6.1 - Case study areas - farming types and land areas.

Case Study Area	Main Farming Types	Area (km^2)	Parish	Area (km^2)
1 - South Skye	Crofting and extensive hill sheep	453	Strath	282
			Sleat	171
2 - West Borders	Hill and upland sheep and cattle	470	Yarrow	202
			Ettrick	176
			Kirkhope	92
3 - North Highlands	Extensive hill sheep, crofting and hill cattle	1580	Lairg	525
			Kincardine	617
			Creich	438

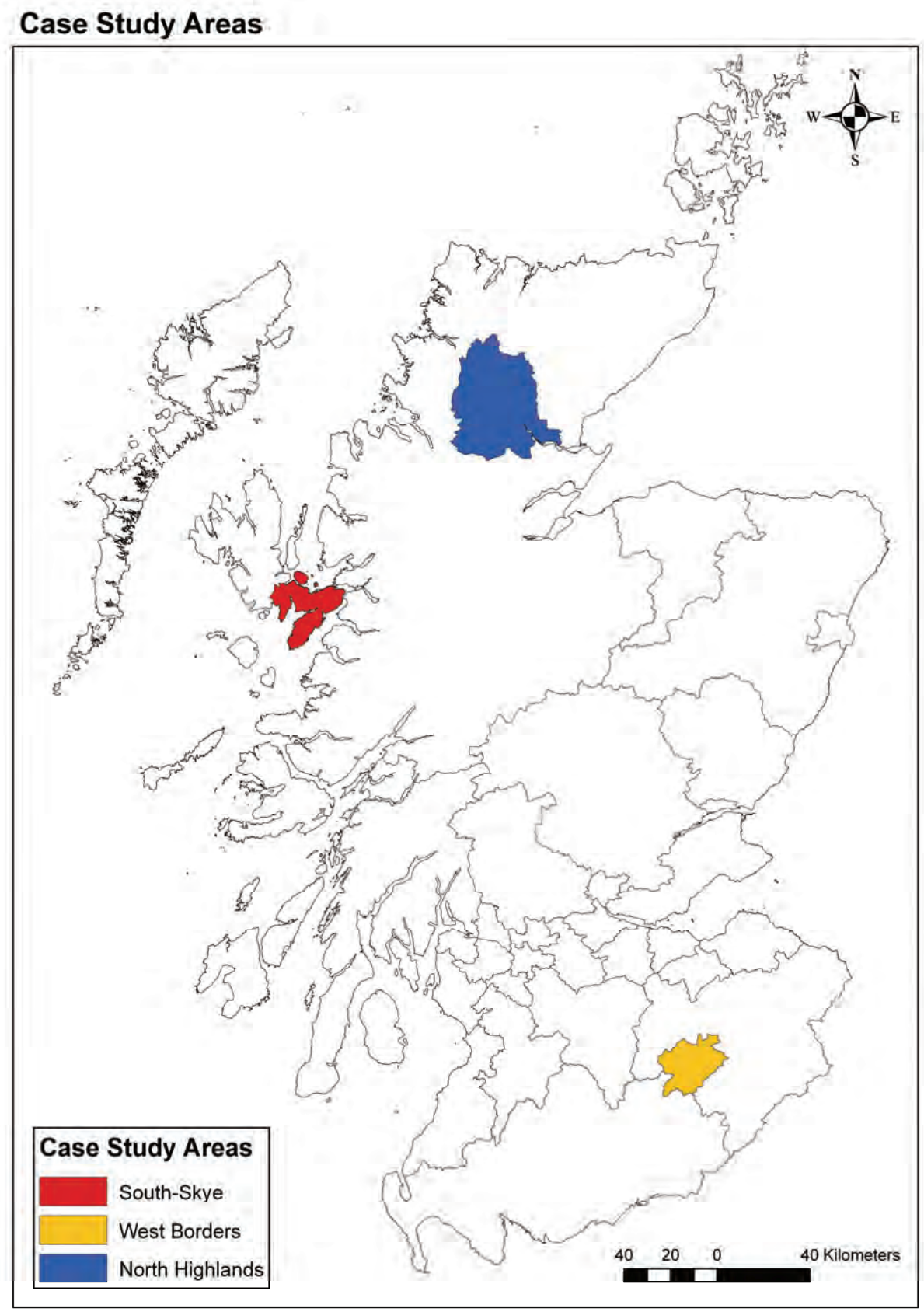


Figure 6.1 - Location of case study areas.

Table 6.2 - Case study areas - number of holdings and average area of each holding.

Case Study Area	No. of holdings (2008)	No. of holdings registered with the Crofters Commission (2008)	Average area of each holding (ha) (2008)
1 - South Skye	488	425	37.4
2 - West Borders	88	0	382.8
3 - North Highlands	310	202	301.3

Source: Scottish Government June Agriculture and Horticulture Census of Scotland.

Table 6.3 - Case study areas - area of grassland and rough grazing.

Case Study Area	Area of grassland (excluding rough grazing) (ha) (2008)*	Area of rough grazing (ha) (2008)*	Approximate ratio of inbye grassland to rough grazing	Grassland and rough grazing as a % of total agricultural land (2008)
1 - South Skye	1113.7	16639.8	1:15	99.7%
2 - West Borders	3131.6	26822.1	1:9	99.6%
3 - North Highlands	4880.6	82335.6	1:17	99.7%

Source: Scottish Government June Agriculture and Horticulture Census of Scotland.
* These figures do not represent the total areas of grassland and rough grazing within the case study areas, only the areas within registered agricultural holdings.

6.2 Changes in livestock numbers within the three case study areas

Breeding ewe numbers declined in all three study areas between 1998 and 2008 (Figure 6.2). The number of breeding ewes per hectare of grazing land (including all grassland and rough grazing) also declined (Figure 6.3). Ewe numbers per hectare of grazing land dropped from 1.41 to 1.11 in the West Borders, from 0.64 to 0.39 in South Skye and from 0.31 to 0.18 in North Highlands. There was a decline in the area of grassland and rough grazing in the West Borders from 32704ha to 29953ha, however there was little change in South Skye and an increase of over 4000ha in the North Highlands (Figure 6.4). The number of holdings with breeding ewes declined in all three case study areas (Figure 6.5). A similar pattern was observed with cattle numbers with overall declines in breeding cow numbers and the number of holdings with cattle in all three study areas (Figures 6.6 and 6.7). The number of full-time occupiers in South Skye dropped from 45 to 18 between 1998 and 2008 (Figure 6.8). There was a corresponding increase in part-time occupiers in South Skye of 27 (Figure 6.9). In North Highlands both the number of full-time occupiers and part-time occupiers fell (by 21 and 3 respectively).

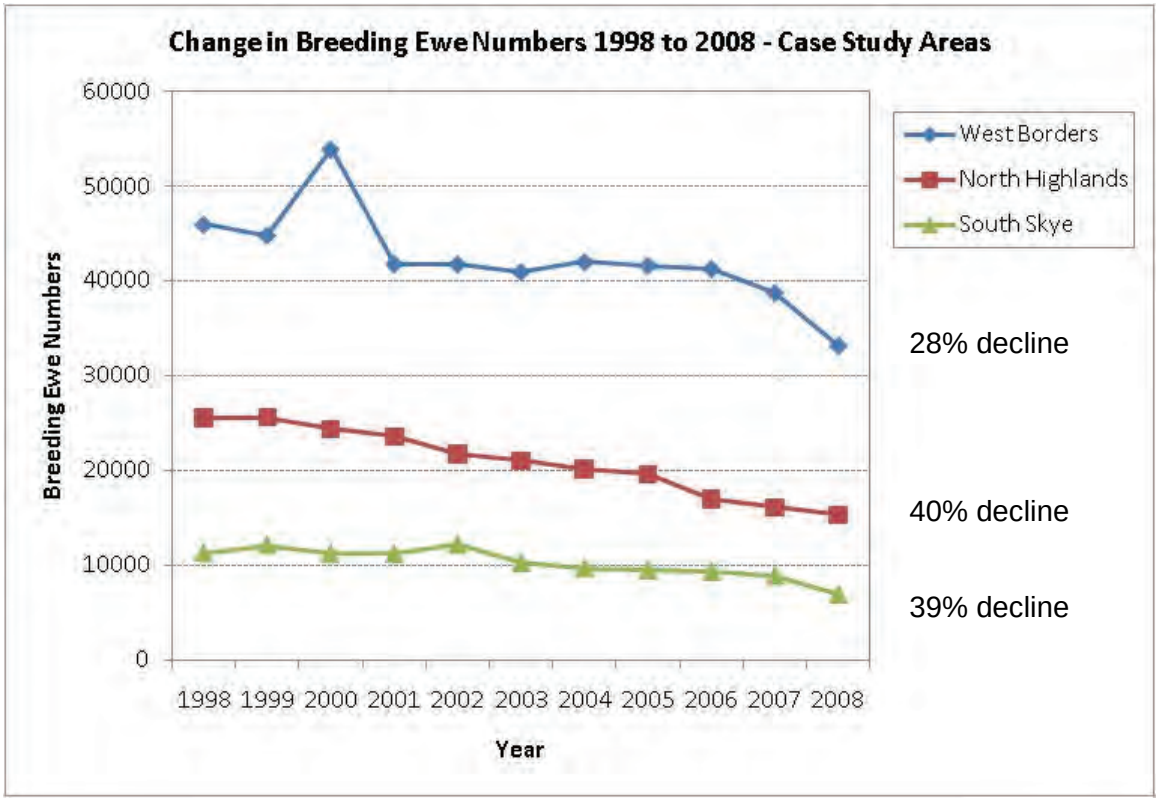


Figure 6.2 - Change in breeding ewe numbers within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

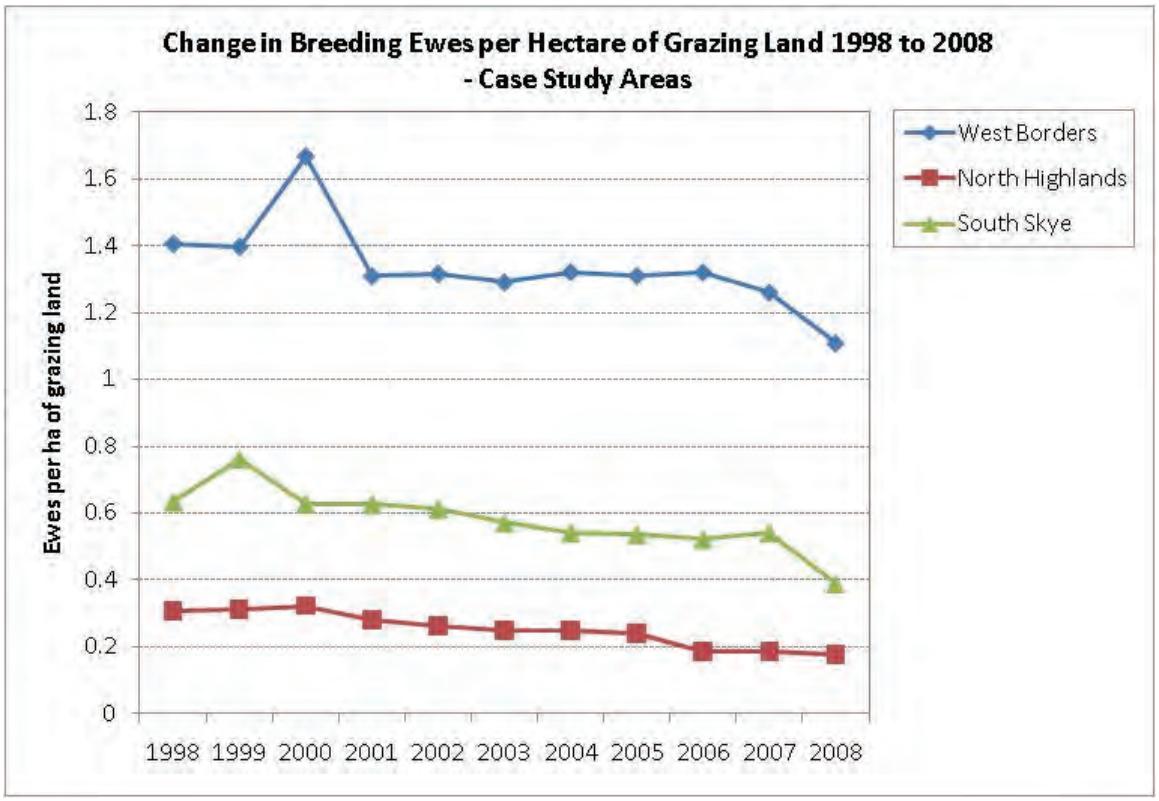


Figure 6.3 - Change in breeding ewe numbers per hectare of grazing land within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

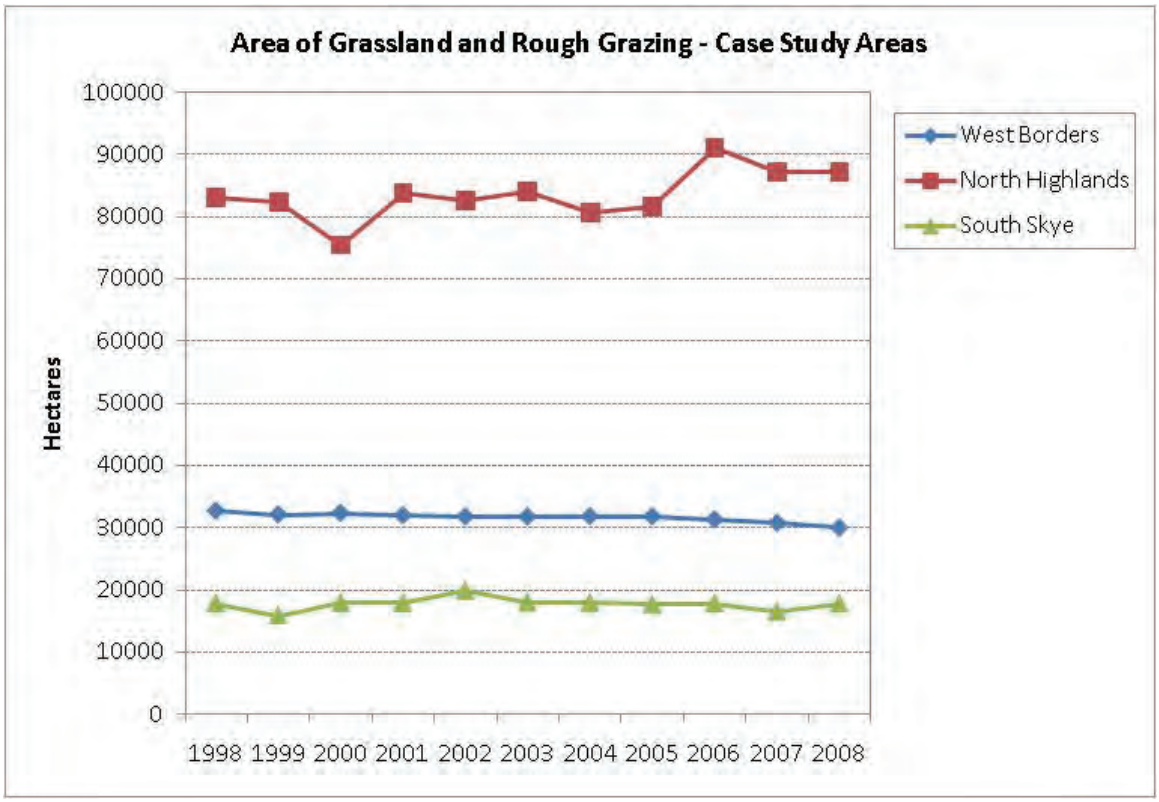


Figure 6.4 - Change in the area of grassland and rough grazing within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

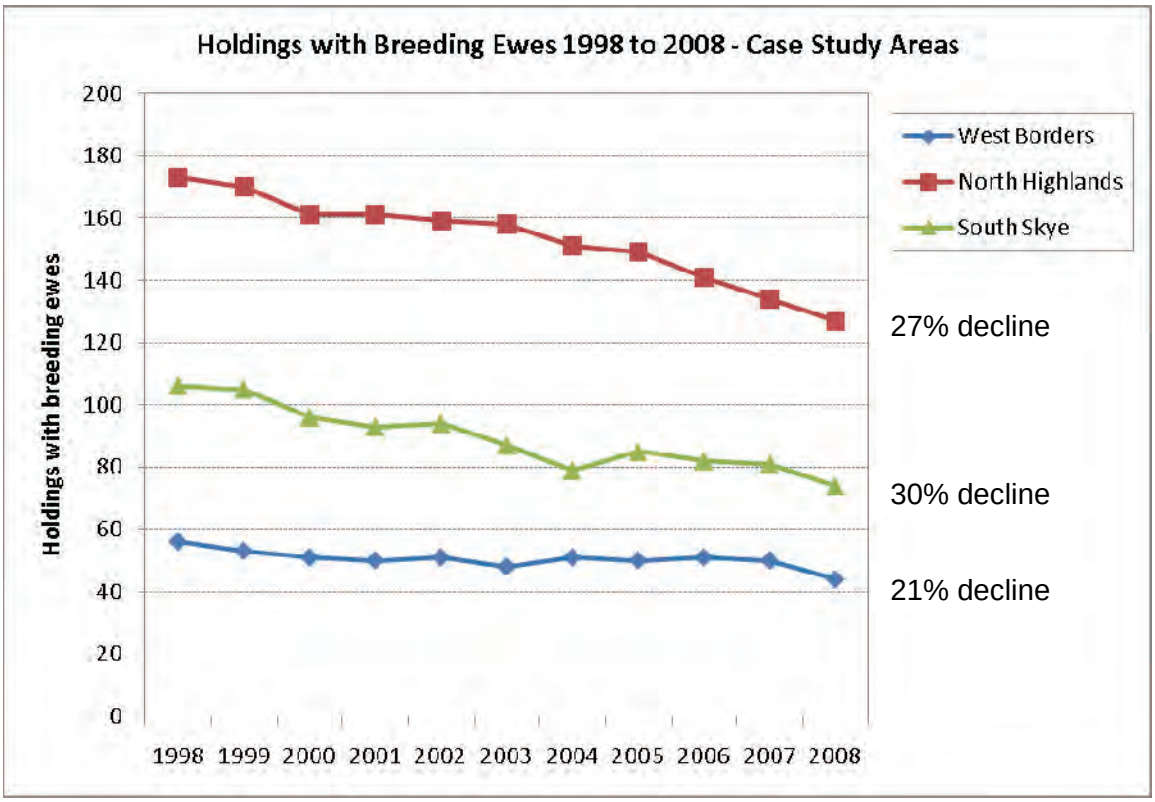


Figure 6.5 - Change in the number of holdings with breeding ewes within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

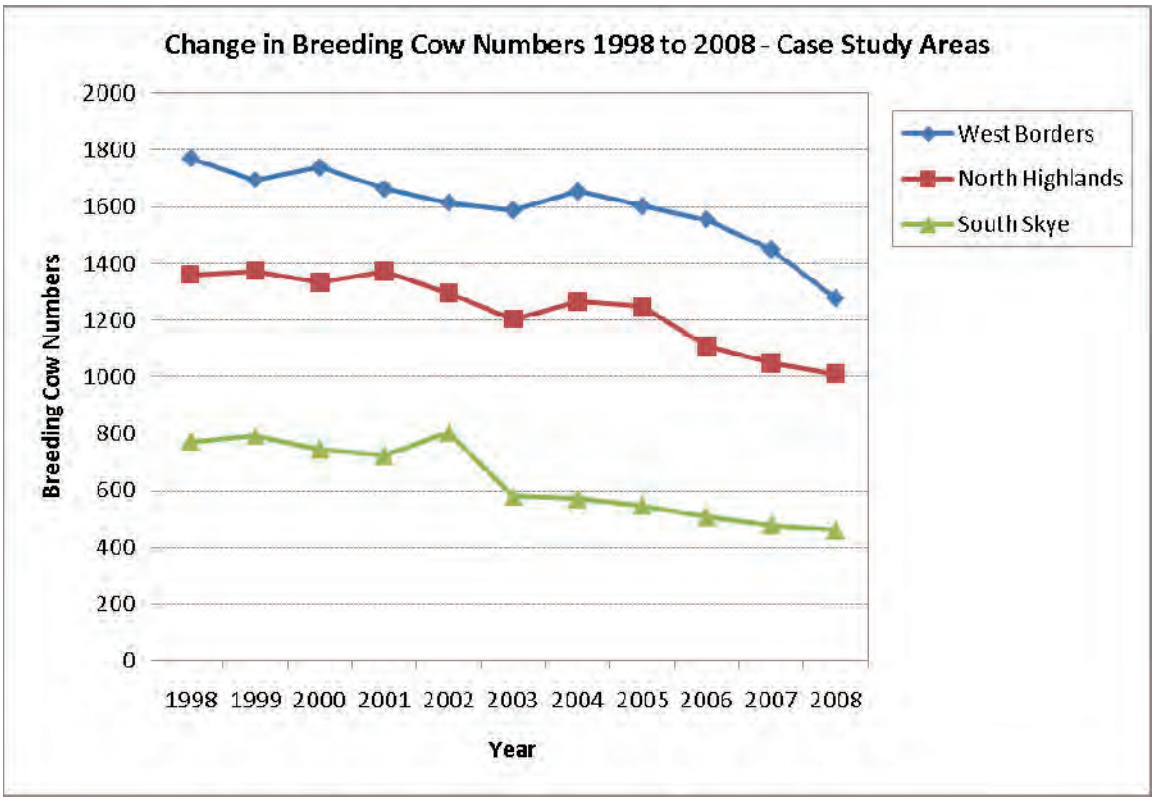


Figure 6.6 - Change in breeding cow numbers within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

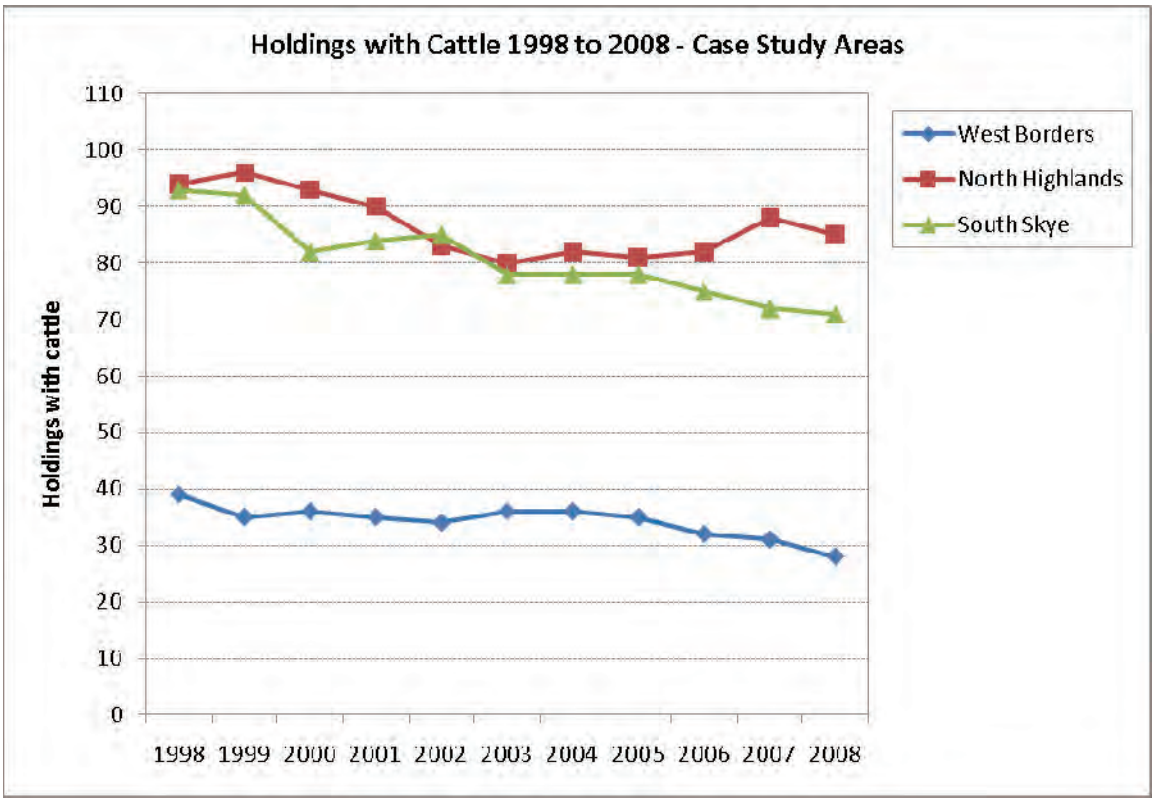


Figure 6.7 - Change in the number of holdings with cattle within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

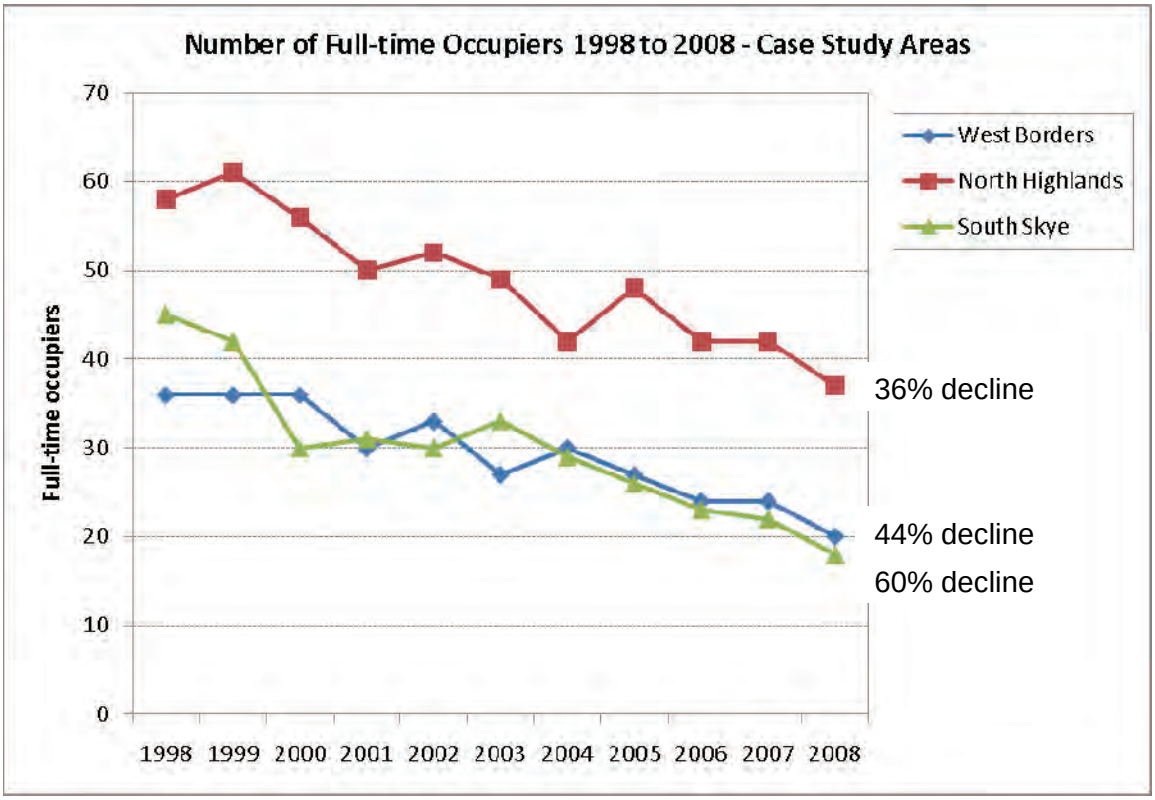


Figure 6.8 - Number of full-time occupiers within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

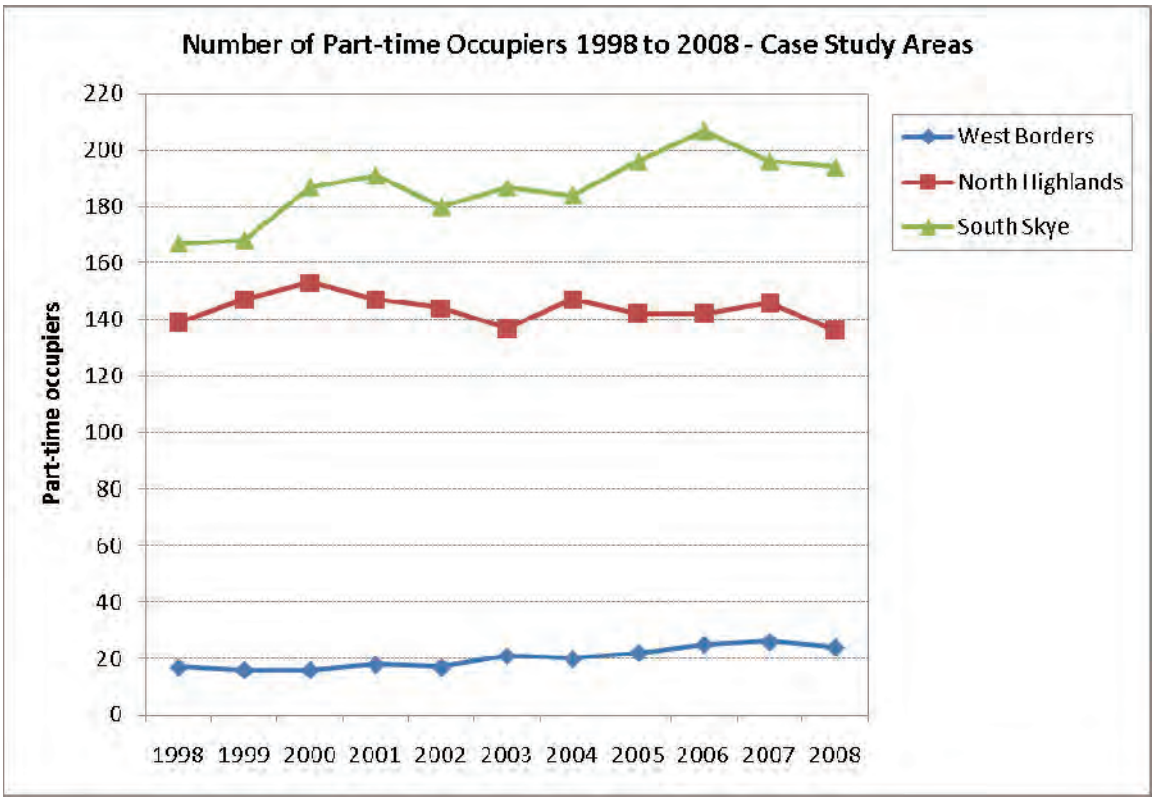


Figure 6.9 - Number of part-time occupiers within the three case study areas. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

6.3 Workshop methodology

Our approach to the case study element of the project was very much people-centred as virtually all the complexities of the issue are people driven. We used a participative workshop approach as the main method of obtaining information about changes and impacts within the case study areas.

Workshops were run within each of the case study areas (Table 6.4). Local stakeholders, including landowners, tenant farmers, local SNH, RSPB and other conservation organisation staff, were invited. Information was gathered from the delegates on changes that have happened in recent years in relation to both farm management and environment in their local area, as well as their views on future changes. The workshop delegates were asked to complete a questionnaire. There were separate questionnaires for farmers and non-farmers (Appendix A and B). The delegates were then asked to mark on large maps where changes in livestock and land-use had occurred over the past 5 to 10 years in their local area, and to write down the impacts of these changes. They were then asked about changes and impacts that might happen in the next 5 to 10 years.

Table 6.4 - Workshop venues and dates

Case Study Area	Workshop Venue	Date	No. of attendees
South Skye	Dunollie Hotel, Broadford	23rd February, 2010	25 (21 crofters/farmers; 4 non-farmers)
West Borders	Yarrow Village Hall	11th March, 2010	19 (10 farmers; 9 non-farmers)
North Highlands	Rosehall Village Hall	9th June, 2010	5* (3 crofters/farmers; 2 non-farmers)

* Completed questionnaires from three other non-farmers from the North Highlands area were also obtained. Although the number of delegates attending the workshop in the North Highlands was low, the delegates who did attend were very knowledgeable about the land management and communities within the area and it was thought that the information they supplied was of sufficiently high quality to be used in the analyses.

7 SOUTH SKYE CASE STUDY AREA

7.1 Brief description of the South Skye study area

The parishes of Strath and Sleat cover an area of 453km^2 of South Skye (Figure 7.1). The area stretches from the Cuillin Hills and Loch Coruisk in the west to Kylerhea in the east, and includes the islands of Scalpay, Pabay and Longay. The highest point is Bla Bheinn (928m) in the west of Strath. The main villages and crofting communities which are listed in Table 7.1 are found on the lower ground mainly by the coast. The estates of Torrin, Strathaird and Sconser in the west of the study area are owned by the John Muir Trust a UK charity dedicated to the protection of wild land.

Table 7.1 - Villages and crofting communities in South Skye.

Strath	Sleat
Breakish	Achnacloich
Broadford	Aird of Sleat
Corry	Ardvasar
Drochaid Lusa	Armadale
Dunan	Calligary
Elgol	Camuscross
Glasnakille	Drumfearn
Harrapool	Duisdalemore
Heaste	Ferindonald
Kilbride	Isle Ornsay
Kilmarie	Kilbeg
Kirkibost	Kilmore
Kyleakin	Kinloch
Luib	Kylerhea
Skulamus	Ord
Torrin	Sasaig
	Tarskavaig
	Teangue
	Tokavaig

Crofting is the principal farming type with some hill sheep and beef. The main commercial forestry plantations are found in the west of the area, between Drochaid Lusa and Kyleakin; north of Kylerhea; and east of Kinloch. Other plantations are found to the west of Broadford; east of Kilmarie; south of Calligarry; north of Teangue; east of Kilbride; and around the Ord area. The LCM 2000 land cover map data (NERC/CEH, 2003) was used to determine the areas of the main land cover classes within the study area. Coniferous woodland covers 6.3% of the study area (Figure 7.2 and Table 7.2). Much of the rest of the area is covered in semi-natural vegetation, the main types being dwarf-shrub heath and acid grassland which cover over 77% of the study area (Figure 7.2 and Table 7.2). Improved grassland covers only 1.4% of the study area (Table 7.2).

Table 7.2 - Land cover (LCM 2000) within the South Skye study area.

Land Cover Class	Area (ha)	Area (%)
Open dwarf shrub heath	22751.0	50.9
Acid grassland	7128.7	16.0
Dwarf shrub heath	4590.9	10.3
Coniferous woodland	2808.7	6.3
Rough neutral grassland	2343.6	5.2
Inland bare ground	1803.9	4.0
Broad-leaved and mixed woodland	1089.0	2.4
Improved grassland	635.0	1.4
Water (inland)	461.3	1.0
Bracken	381.3	0.9
Bog	392.9	0.9
Calcareous grassland	152.2	0.3
Montane vegetation	105.6	0.2
Urban	40.7	0.1

Source: LCM 2000 (NERC/CEH, 2003)

Table 7.3 contains a list of key upland and agricultural bird species that were recorded as breeding within the South Skye study area during the BTO atlas survey of 1988 to 1991 (Gibbons *et al*., 1993). All these species are likely to be affected by future changes in land management (including reduced grazing levels, abandonment of hill and inbye ground, scrub encroachment and afforestation). Some species will benefit from reduced grazing levels and the development of more heterogeneous upland vegetation, whereas others are likely to decline as a result of the abandonment of inbye land and the encroachment of scrub and woodland.

A number of grassland butterfly species that benefit from some degree of grazing, including the Small Pearl-bordered Fritillary (*Clossiana selene*), Dark Green Fritillary (*Argynnis aglaja*) and Small Heath (*Coenonympha pamphilus*), were recorded within at least one of the 10 km squares that comprise the South Skye study area during the Butterflies for the New Millennium atlas survey of 1995 to 1999 (Asher *et al*., 2001). The Scotch Argus, a species that requires very lightly grazed or un-grazed damp grassland dominated by Purple Moor-grass (*Molinia* caerulea) was also recorded.

Red and Roe Deer are found throughout the study area, and Sika Deer have been recorded at the eastern end of Strath (Arnold, 1993). A Skye Deer Management Group deer count in March 2003 gave an estimated deer density of 1.79 deer per km^2 within the Skye DMG Area, which covers most of the southern part of Skye (DCS, 2003). The red deer population in some parts of the area is increasing.

There are a number of designated sites in the area and these are shown in Figures 7.3 to 7.5. The designated features and their current condition are given in Table 7.4. Table 7.4 also includes a column with the potential impact on the designated features of a removal of grazing. The main vegetation types within the Cuillins SPA (part), Strath SSSI, Mointeach nan Lochain Dubha SSSI, and Kinloch and Kyleakin Hills SSSI are shown in Figures 7.6 and 7.7.

Table 7.3 - Key upland and agricultural bird species recorded as breeding within at least one of the 10 km squares that comprise the South Skye study area during the BTO atlas survey of 1988 to 1991 (Gibbons et al., 1993).

	Species
Waders	Golden Plover (*Pluvialis apricaria*)
	Greenshank (*Tringa nebularia*)
	Lapwing (*Vanellus vanellus*)
	Curlew (*Numenius arquata*)
	Oystercatcher (*Haematopus ostralegus*)
	Redshank (*Tringa tetanus*)
	Snipe (*Gallinago gallinago*)
Birds of prey and owls	Golden Eagle (*Aquila chrysaetos*)
	Hen harrier (*Circus cyaneus*)
	Buzzard (*Buteo buteo*)
	Peregrine (*Falco peregrinus*)
Grouse	Red Grouse (*Lagopus lagopus*)
Corvids	Raven (*Corvus corax*)
	Hooded Crow (*Corvus corone*)
Other species	Meadow Pipit (*Anthus pratensis*)
	Skylark (*Alauda arvensis*)
	Ring Ouzel (*Turdus torquatus*)
	Wheatear (*Oenanthe oenanthe*)
	Whinchat (*Saxicola rubetra*)
	Stonechat (*Saxicola torquata*)
	Twite (*Carduelis flavirostris*)
	Yellowhammer (*Emberiza citrinella*)
	Corncrake (*Crex crex*)

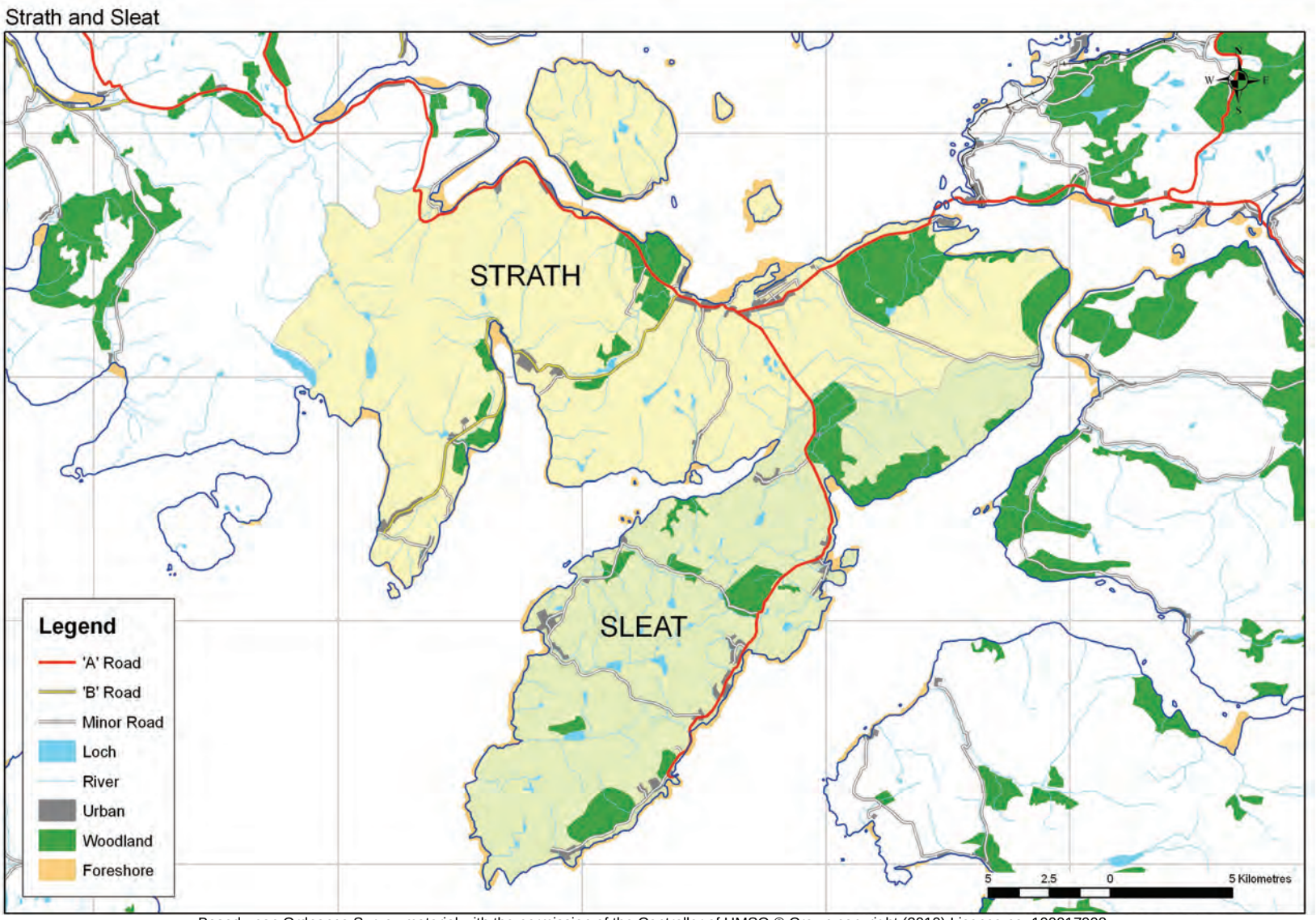
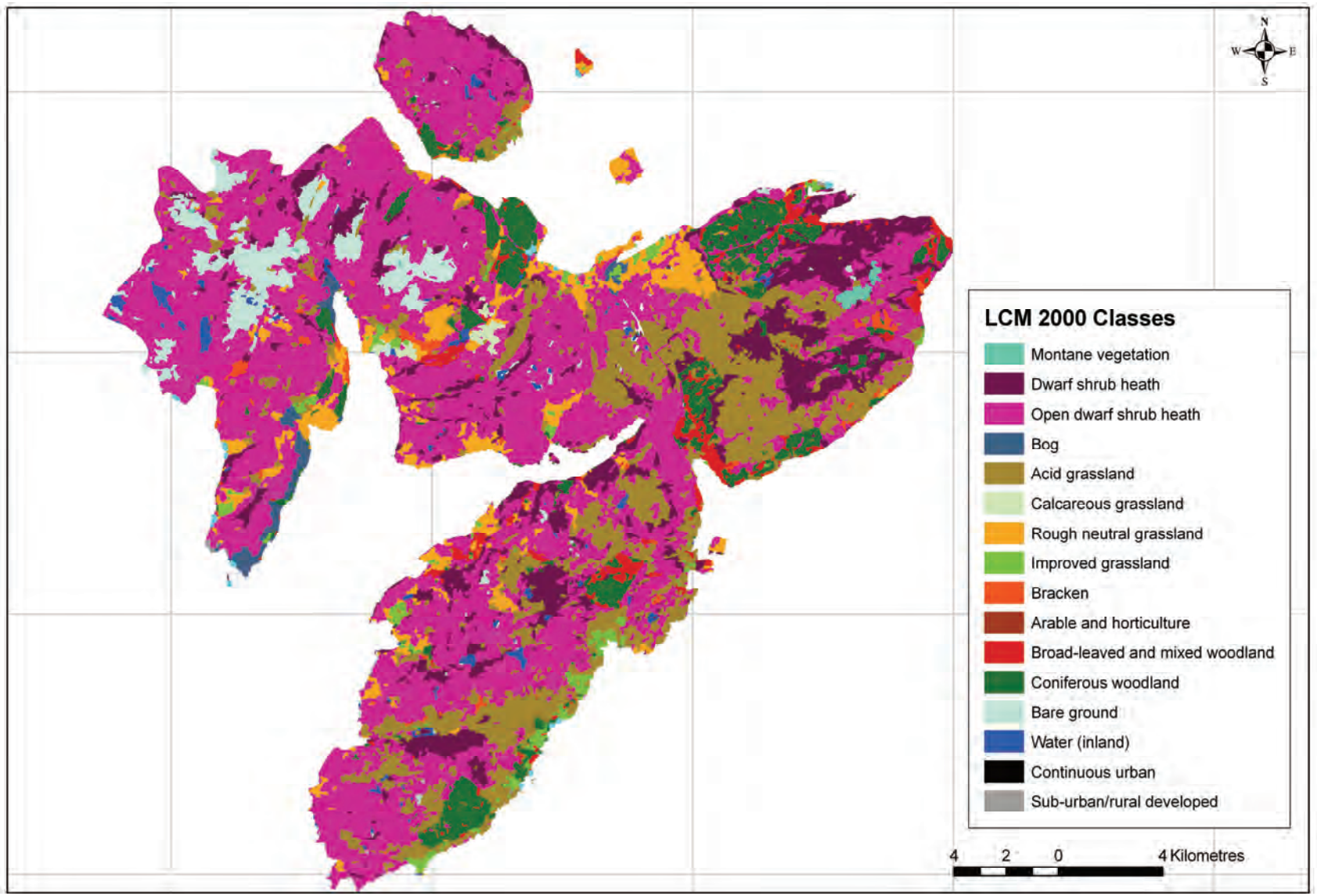


Figure 7.1 - Map of the South Skye study area (parishes of Strath and Sleat).



Based upon CEH Land Cover Map 2000 (LCM2000) data. NERC © copyright.

Figure 7.2 - LCM 2000 land cover map of the South Skye study area.

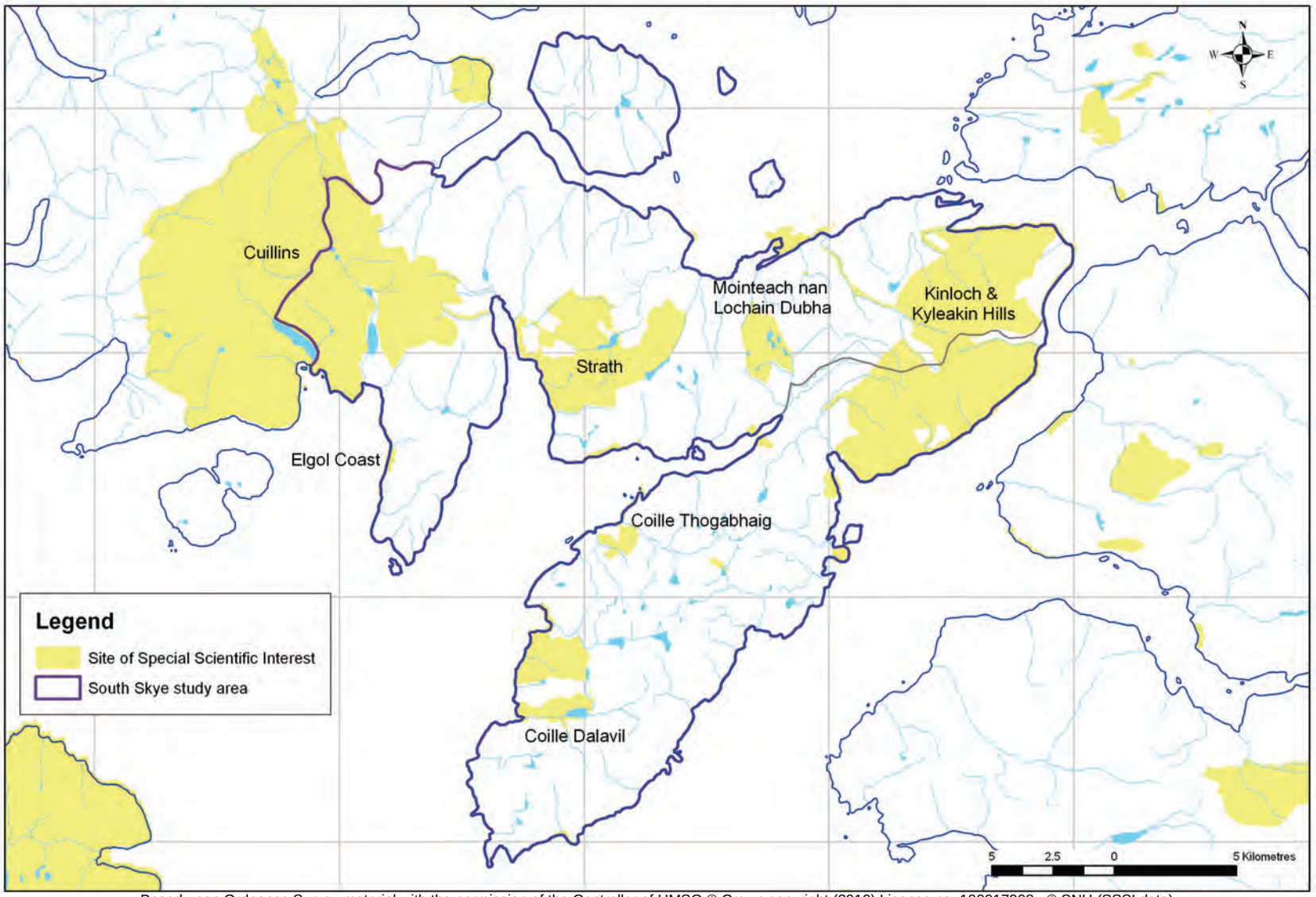


Figure 7.3 - Sites of Special Scientific Interest within the South Skye study area. Sites designated for their Biological interest are labelled.

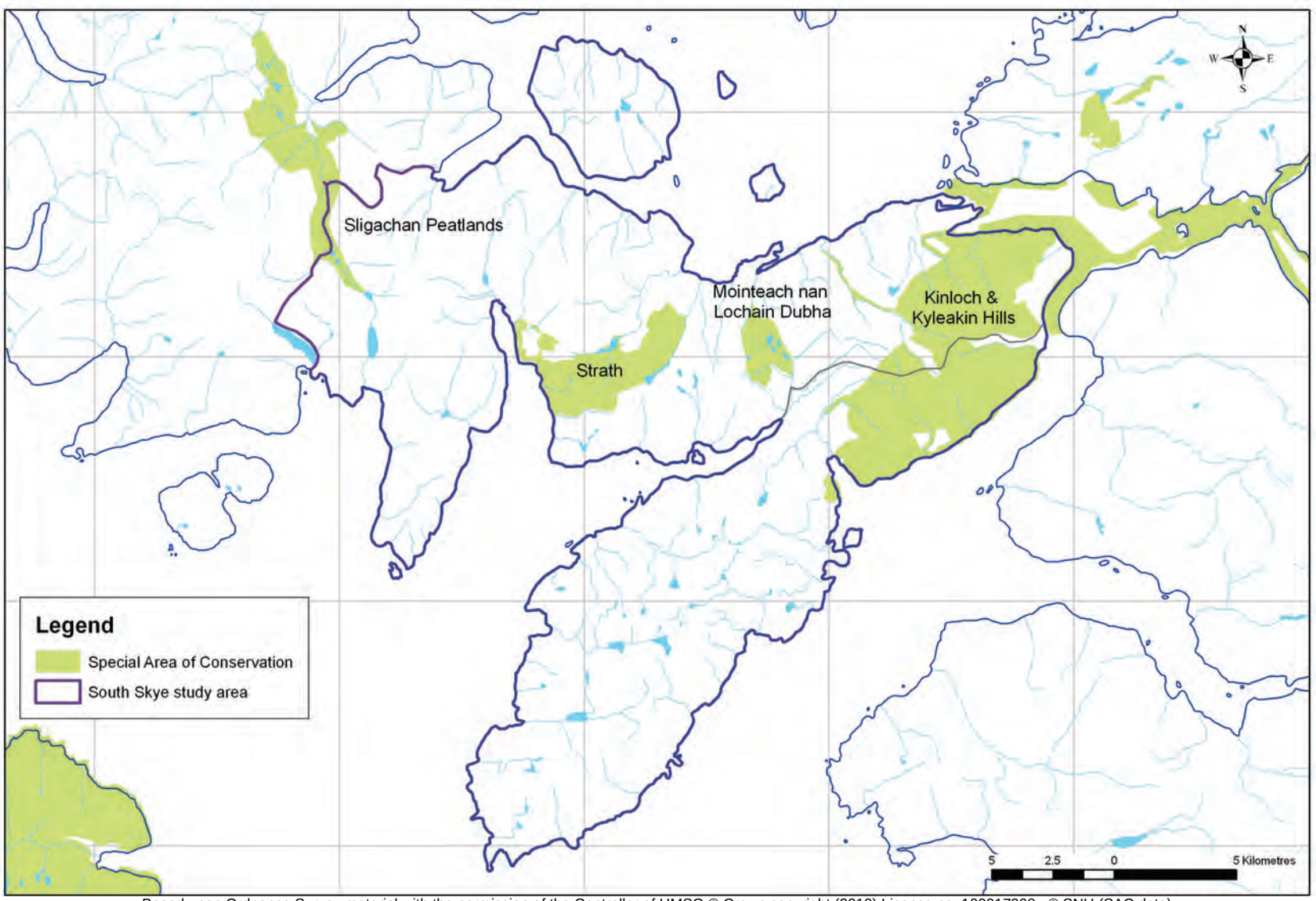


Figure 7.4 - Special Areas of Conservation (SAC) within the South Skye study area.

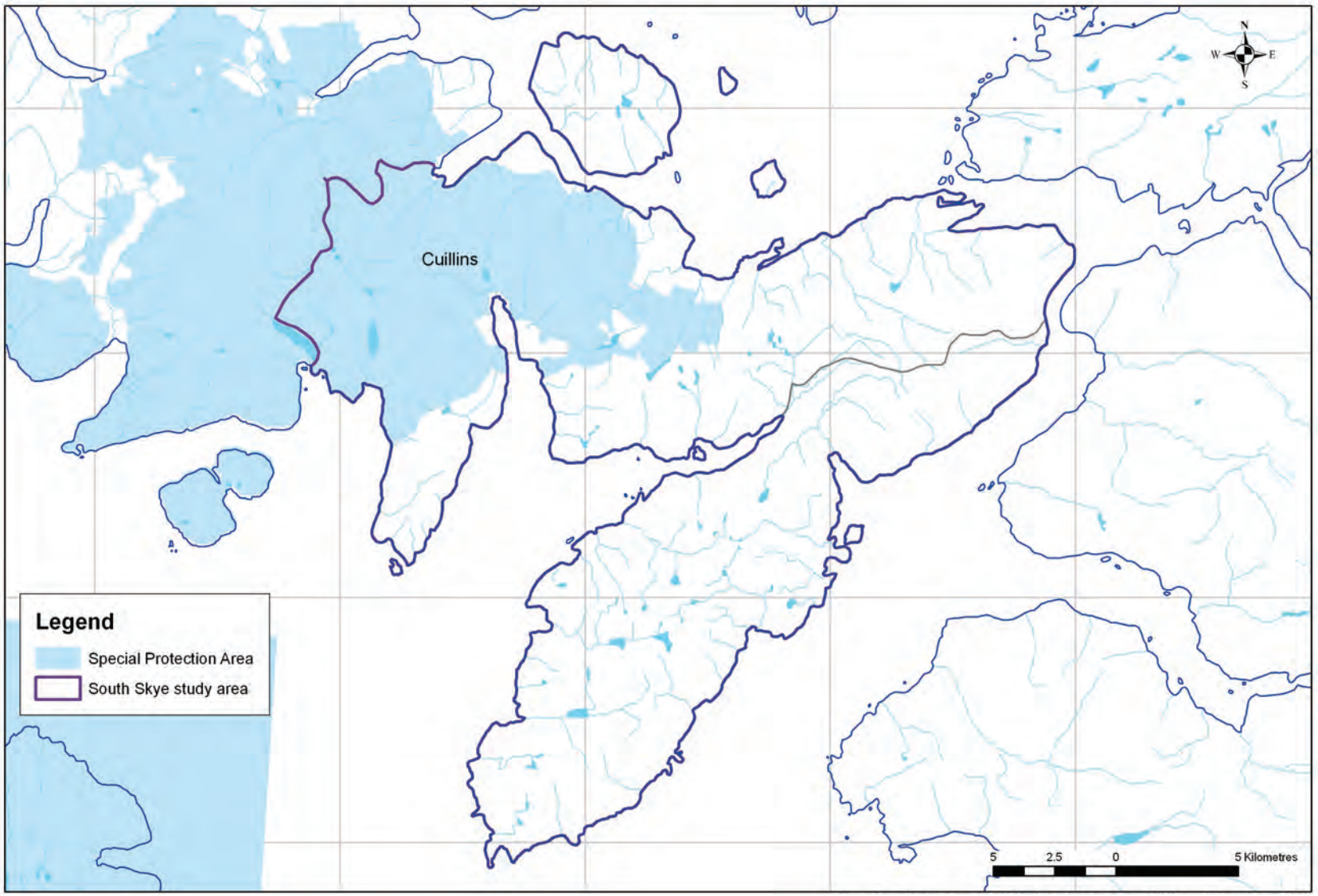


Figure 7.5 - Special Protection Areas (SPA) within the South Skye study area.

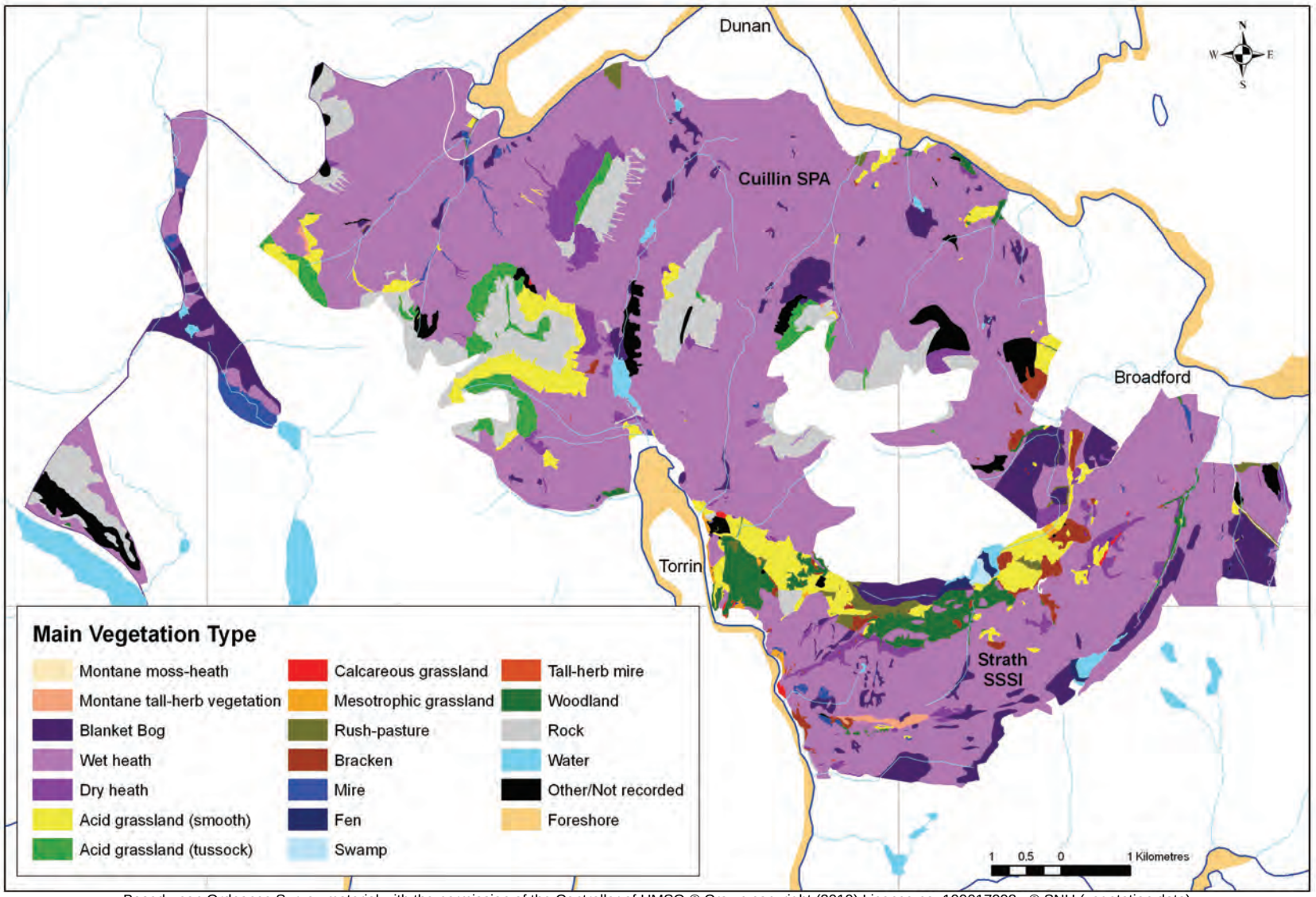


Figure 7.6 - Main vegetation types within the Cuillin SPA (part) and Strath SSSI.

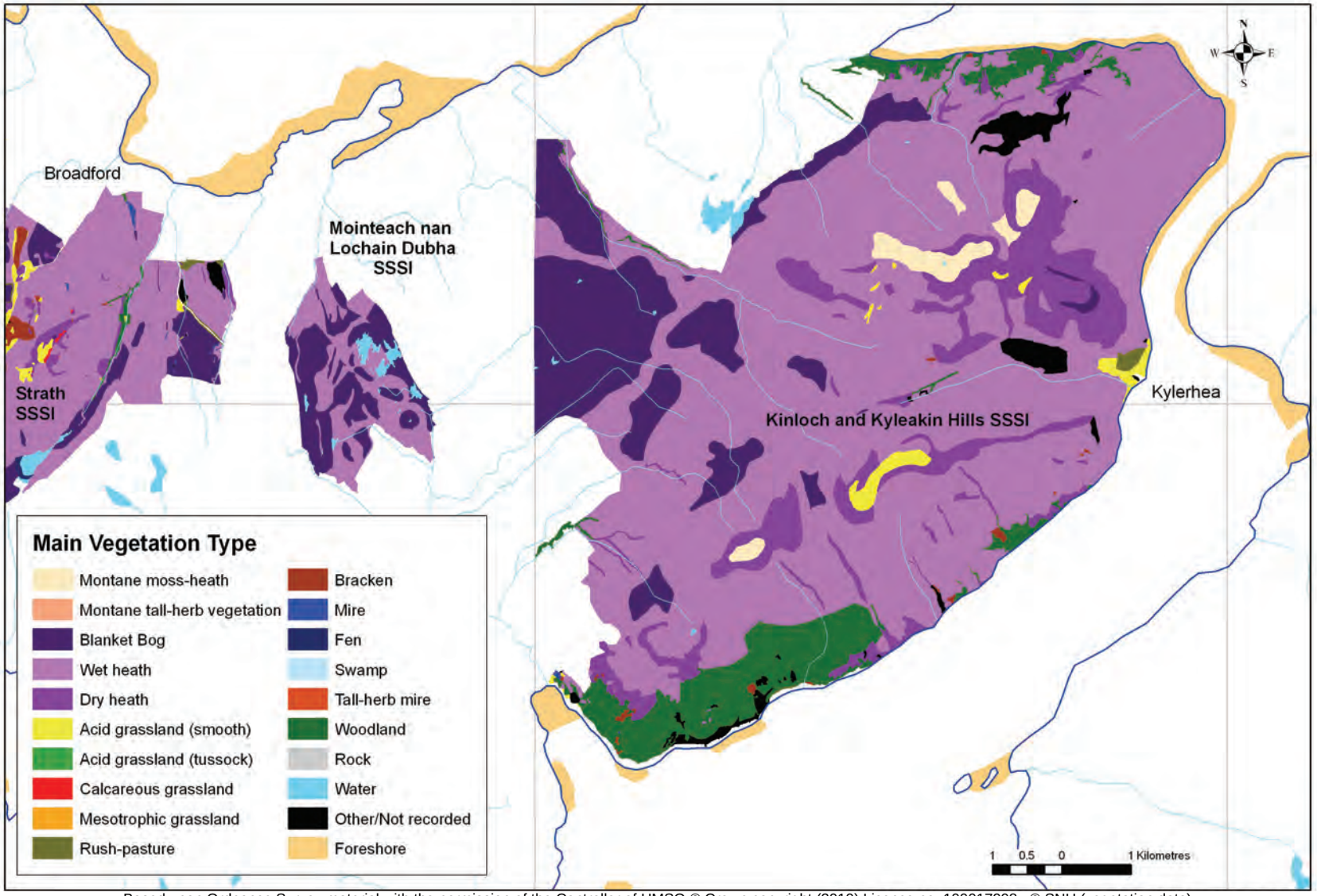


Figure 7.7 - Main vegetation types within the Mointeach nan Lochain Dubha SSSI and Kinloch and Kyleakin Hills SSSI.

Table 7.4 - Sites of Special Scientific Interest (SSSI) within the South Skye study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Cuillins	3251.46	Fen, marsh and swamp (Upland)	Alkaline fen	Favourable Maintained	- (long term)?
		Bogs (Upland)	Blanket bog	Favourable Recovered	- (long term)?
		Bryophytes	Bryophyte assemblage	Favourable Maintained	
		Fen, marsh and swamp (Wetland)	Flood-plain fen	Favourable Maintained	- (long term)?
		Fen, marsh and swamp (Wetland)	Open water transition fen	Favourable Maintained	
		Calcareous grassland (Upland)	Sub-alpine calcareous grassland	Unfavourable No change	+ (short term)? - (long term)
		Dwarf shrub heath (Upland)	Sub-alpine dry heath	Unfavourable Declining	+ (short term) - (long term)?
		Inland rock	Tall herb ledge	Favourable Maintained	+
		Broad-leaved, mixed and yew woodland	Upland birch woodland	Unfavourable Declining	+ (short term) - (long term)?
		Vascular plants	Vascular plant assemblage	Unfavourable No change	
Coille Dalavil	242.52	Bogs (Upland)	Blanket bog	Favourable Maintained	- (long term)?
		Dragonflies	Dragonfly assemblage	Favourable Maintained	
		Fen, marsh and swamp (Wetland)	Flood-plain fen	Favourable Maintained	- (long term)?
		Lichen	Lichen assemblage	Unfavourable No change	
		Broad-leaved, mixed and yew woodland	Upland oak woodland	Unfavourable No change	+ (short term) - (long term)?
Mointeach nan Lochain Dubha	410.07	Bogs (Upland)	Blanket bog	Favourable Maintained	- (long term)?
		Standing open water and canals	Oligotrophic loch	Favourable Maintained	
Elgol Coast	38.42	Supra-littoral rock (Coast)	Maritime cliff	Favourable Maintained	
		Broad-leaved, mixed and yew woodland	Scrub	Favourable Maintained	- (long term)?

Table 7.4 (continued) - Sites of Special Scientific Interest (SSSI) within the South Skye study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal grazing have a potential impact on the feature?
Coille Thogabhaig	144.30	Other invertebrates	Beetles	Unfavourable Recovering	
		Bryophytes	Bryophyte assemblage	Favourable Maintained	
		Lichen	Lichen assemblage	Favourable Maintained	
		Inland rock	Rocky slopes (includes inland cliff, rocky outcrops, chasmophytic vegetation)	Favourable Maintained	
		Broad-leaved, mixed and yew woodland	Upland oak woodland	Unfavourable Recovering	+ (short term) - (long term)?
Kinloch and Kyleakin Hills (Monadh Chaol Acainn is Cheann Loch)	5099.72	Montane habitats	Alpine heath	Favourable Maintained	- (long term)?
		Bogs (Upland)	Blanket bog	Unfavourable Recovering	+ (short term)? - (long term)?
		Bryophytes	Bryophyte assemblage	Unfavourable No change	
		Lichen	Lichen assemblage	Unfavourable No change	
		Mammals	Otter (*Lutra lutra*)	Favourable Maintained	
		Dwarf shrub heath (Upland)	Sub-alpine dry heath	Favourable Maintained	- (long term)?
		Dwarf shrub heath (Upland)	Sub-alpine wet heath	Unfavourable Recovering	+ (short term)? - (long term)?
		Broad-leaved, mixed and yew woodland	Upland oak woodland	Unfavourable Declining	+ (short term) - (long term)?
Strath	1844.66	Standing open water and canals	Base-rich loch	Favourable Maintained	
		Other invertebrates	Molluscs	Favourable Maintained	
		Mosaic	Upland assemblage	Favourable Maintained	- (long term)?
		Broad-leaved, mixed and yew woodland	Upland birch woodland	Unfavourable No change	+ (short term) - (long term)?
		Vascular plants	Vascular plant assemblage	Unfavourable No change	

7.2 South Skye livestock changes

The Scottish Government's June agricultural census data shows that breeding ewe numbers in Sleat and Strath declined by 3037 and 1405 respectively between 1997 and 2008 (Figure 7.8). Data for 2010 from the Sleat and Strath grazing clerks indicates that breeding ewe numbers in Strath have continued to fall (Figure 7.8). Breeding cow numbers also declined in both parishes during the period 1997 to 2010 from 348 to 223 in Sleat and 342 to 240 in Strath (Figure 7.9).

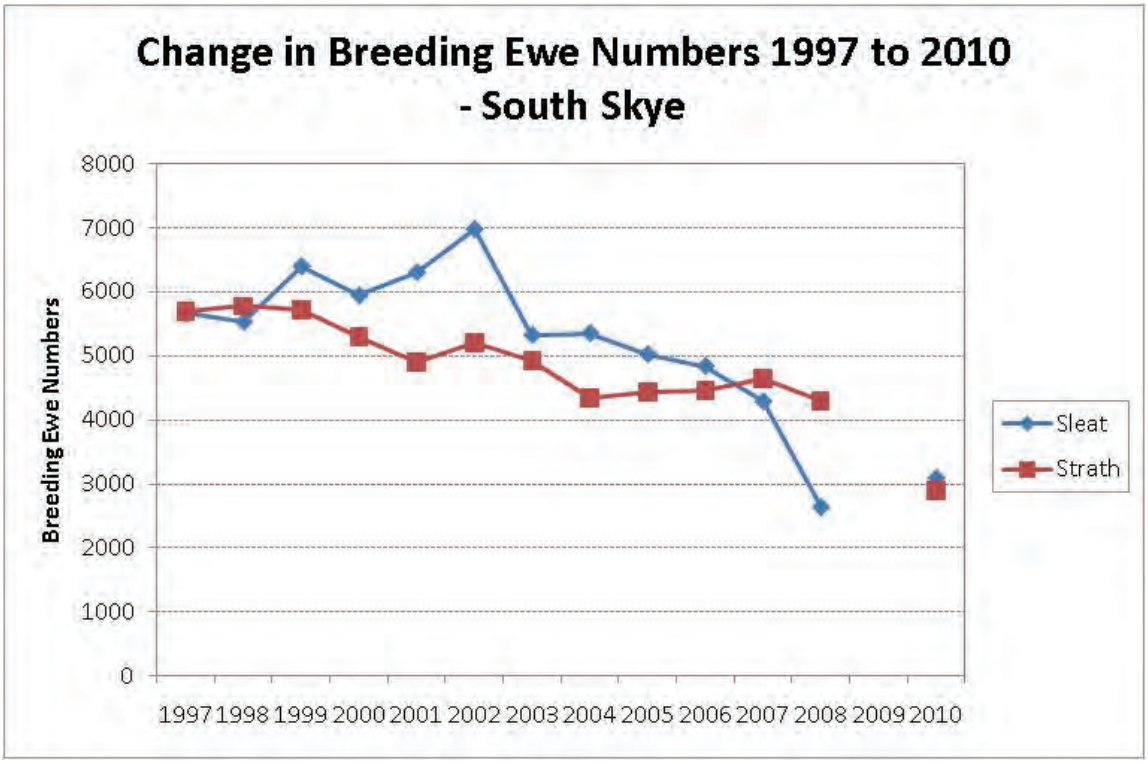


Figure 7.8 - Change in breeding ewe numbers in Sleat and Strath between 1997 and 2010. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland. The 2010 data (February 2010) were collated by the Sleat and Strath grazing clerks).

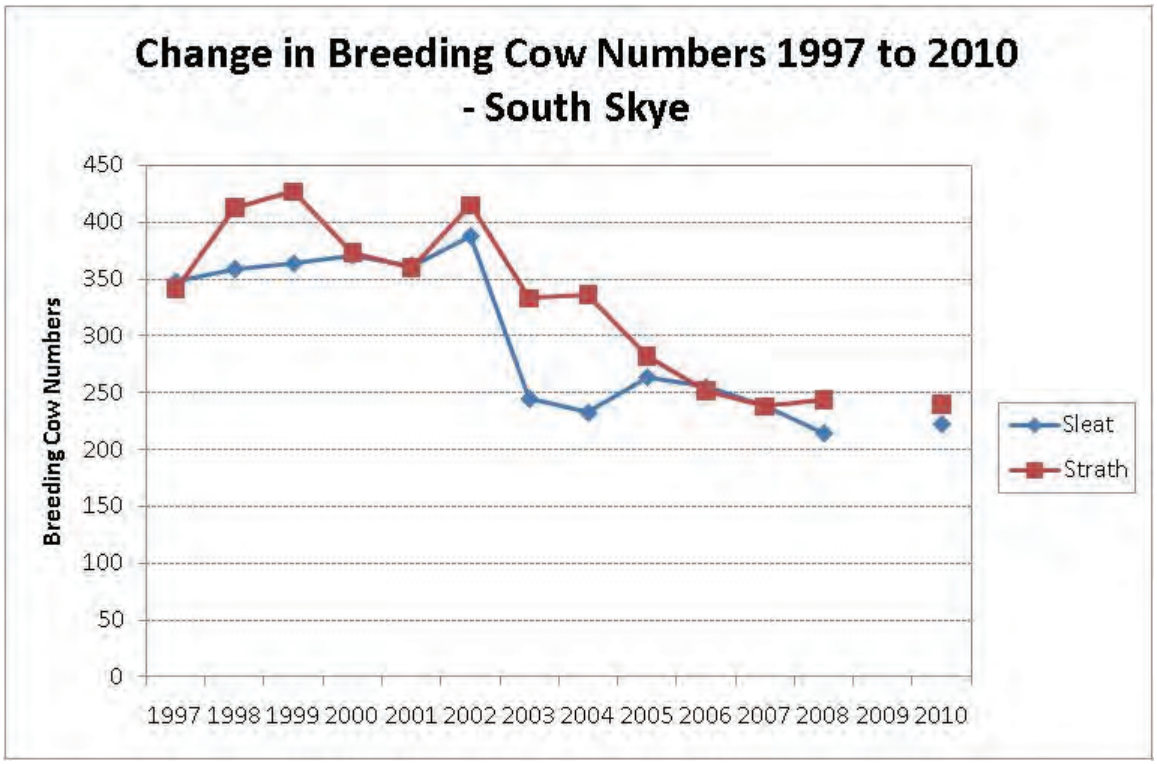


Figure 7.9 - Change in breeding cow numbers in Sleat and Strath between 1997 and 2010. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland. The 2010 data (February 2010) were collated by the Sleat and Strath grazing clerks).

7.3 South Skye workshop results

7.3.1 South Skye - questionnaire results

Summary results from the crofters questionnaire survey carried out at the South Skye workshop are given in Tables 7.5 and 7.6 and Figure 7.10. The questionnaire results from the non-farmer workshop delegates are given in Table 7.7 (a, b, c and d). Figure 7.11 shows the locations of the main changes in livestock within the South Skye study area over the last 5-10 years that were identified by the workshop delegates. The numbers and locations are not necessarily completely accurate but give an indication of the changes that have occurred.

Table 7.5 - Summary results from the crofters' questionnaire survey carried out at the South Skye workshop.

Number of completed questionnaires	20 10 Strath; 10 Sleat
Number of businesses within each farm type:	
Crofts	7
Crofts/LFA sheep & beef	5
Crofts/LFA sheep	4
Crofts/LFA beef	2
LFA sheep & beef	1
Number of businesses within each tenure type:	
Owner occupier	2
Tenant	16
Owner/Tenant	2
Number of crofts/farms with arable crops	3
Number of crofts/farms with forage crops	5
Number of crofts/farms with in-bye ground	12
Number of crofts/farms with rough grazing	11
Number of crofts/farms with common grazing	18
Number of crofts/farms with woodland	7
Average area of croft/farm (excluding LFA sheep and beef business)	19.4ha
Number of crofts/farms with sheep	13
Number of crofts/farms with cattle	16
Average number of breeding ewes per croft/farm with sheep (excluding LFA sheep and beef business)	82.3
Average number of beef cows per croft/farm with cattle (excluding LFA sheep and beef business)	8.5
Average number of people working on the croft/farm	1.7
Average percentage of time spent working on the croft/farm	35.8%
Number of crofts/farms with other enterprises	7

Table 7.6 - Summary results of the changes that have occurred since 2005 from the questionnaire survey carried out at the Skye workshop.

Changes since 2005	Yes	No
Changes in livestock or management?	18	3
Changes in permanent labour?	2	13
Changes in casual labour?	1	14
Changes in other enterprises?	4	10
Have your neighbours changed their animal numbers?	13	5
Have your neighbours changed their animal management?	7	9
Have your neighbours changed their mix of enterprises?	4	13
Any changes in local farming infrastructure?	6	12
Any changes in the local community?	10	5
Any changes in local landscape?	9	8
Any changes in quality of grazing?	15	4
Quality of grazing improved	6	
Quality of grazing declined	9	
Have the changes in the area influenced some of your own changes?	5	12

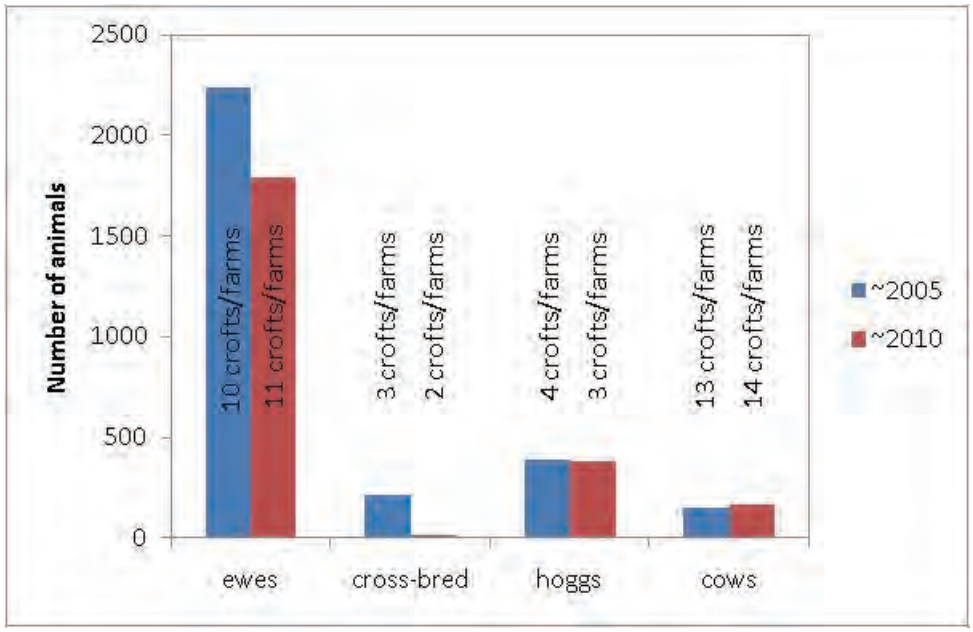


Figure 7.10 - Livestock numbers kept by the workshop crofters/farmers in 2005 and 2010.

Table 7.7 - The main changes and impacts on the natural heritage due to the decline in crofting and hill farming in South Skye as outlined by the conservationists at the Skye workshop.

a) Landscape

Changes Observed	**Importance** Very important = 1 Important = 2 Not very important = 3	**Cause of the Change**
Loss of species-rich meadows	1	Switch from hay to silage production. Change in fertilizers from organic to chemical
Decline in the mosaic of croft habitats and management	1	Pastoral system dominating, lack of cultivation
Reduction in area of inbye	1	Housing development, particularly in coastal fringe
Increasing quantities of rank heather	2	Lack of grazing / controlled burning
Increasing natural regeneration	3	Removal of grazing pressures
Crofting landscape degraded	3	No stock, no growing of root crops or other fodder. Some crofts abandoned and no longer used. No diversity.

b) Vegetation

Changes Observed	**Importance** Very important = 1 Important = 2 Not very important = 3	**Cause of the Change**
Loss of permanent pasture	1	Development
Increase in rushes	1	Abandonment, lack of cutting
Widespread loss of species-rich grasslands	1	Change in seasonal management of croftland and abandonment, use of fertilizers.
Decline in quality and diversity of species-rich grasslands	1	More concentrated sheep grazing as less shepherding in hills
Reduction in good heather cover in some areas	1	High grazing levels. Deer may have replaced sheep. Un-controlled burning
Increase in silage production	1	Switch from hay to silage production.

c) Fauna

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Decline in bat numbers	1	Reduction in insect populations - development
Otter disturbance	1	Coastal development
Decline in bumblebees	1	Loss of species-rich meadows
Decline in raptors	1	Less fallen stock. Reduction in deer numbers in some areas e.g. FCS Kinloch
Decline in croftland passerines - yellowhammer, twite, reed bunting, corn bunting	1	Decline in cultivation, abandonment, less seasonal management of grasslands. Lack of root crops leading to reduced levels of feeding available especially in the winter.
Decline in upland waders (golden plover, dunlin, snipe, curlew, greenshank)	1	
Decline in croftland waders (lapwing, snipe, corncrake)	1	Decline in cattle numbers. General decline in cultivation and crofting. Switch from hay to silage
Decline in moorland passerines and grouse	1	Possibly partly due to grazing pressures and weather.
Decline in invertebrates (including moths and bumblebees)	1	Vegetation change and loss of habitat
Decline in hen harrier	1	
Change in red deer numbers and distribution	2	Increasing encroachment of deer into areas where they were previously controlled
Decline in House sparrow	2	Fewer old buildings now available for nest sites due to development
Golden eagle productivity in slow decline	2	Carrion important in winter - so lack of carrion is a factor.
Decline in brown hares	2	
Increase in corvids (recent)	2	Dispersal from landfill, reduction in control
Changes in the numbers and distribution of carrion feeders - ravens to eagles	3	With stock numbers lower - fewer sheep carcasses. But difficult to measure!
Decline/extinction of mountain hares	-	

d) Community

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Increase in housing development	1	People want to live in the rural environment
Development on crofts has sub-divided units	1	Development has led to a change in the crofting ethos

7.3.2 Changes that have happened in the South Skye area in recent years and the impacts of these changes

The workshop participants identified a number of changes that had occurred in recent years in the south of Skye, some of which directly relate to local livestock and land management changes, but others relate to social, economic and land-use changes that are taking place more widely. Although livestock numbers and active crofting management had declined in many of the crofting townships, sheep and cattle numbers and cultivation had increased in at least one of the crofting areas i.e. Camuscross.

Key changes and impacts perceived by participants:

- An overall decline in sheep numbers (see Figure 7.11). In much of the south and east of the area sheep numbers had been reduced. In the far west of the area the sheep had been removed completely from the land owned by the John Muir Trust.
- An overall decline in cattle numbers, but with local increases in some areas (see Figure 7.11)
- A decline in the number of active crofters
- Absenteeism and abandonment of crofts resulting in a degraded crofting landscape in many of the crofting townships
    - Crofts abandoned and un-worked with no livestock grazing - increase in rushes, gorse, bracken, ragwort and brambles
    - Loss of species-rich meadows - decline in invertebrates (bumblebees, moths)
    - Increase in invasive non-native species (rhododendron, Japanese knotweed). The Japanese knotweed used to be grazed by sheep in spring but now that numbers have decreased, the weed is spreading
    - Lack of cultivation, no fodder crops or grain grown anymore, area perceived to be dominated by a pastoral system
- Increasing natural regeneration and increase in planted woodlands (Figure 7.12), some of which have failed. The conifer plantations have increased the crossbill population but few other species have benefited
- Extensive felling of coniferous woodland in recent years has had a major impact on the landscape
- Increasing quantities of rank vegetation, including heather, with scrub and birch tree regeneration, resulting in an increased fire risk
- Increasing numbers of red deer and encroachment into areas where they were previously controlled, perceived to be causing damage to crops in some areas
- Decline in croft-land passerines (yellowhammer, twite, reed bunting, skylarks, pied wagtails) - lack of root crops and cultivation leading to reduced levels of feeding available especially in the winter
- Golden eagle productivity in slow decline - change in available winter carrion levels

- Housing development on crofts - has led to a loss of in-bye permanent pasture, a decline in the number of old buildings for nest sites (for house sparrows etc.) and a general change from the crofting ethos
- Declines in upland waders (golden plover, curlew, dunlin, snipe)
- Declines in croftland waders (lapwing, snipe, corncrake) - decline in cattle numbers, lack of cultivation, switch from hay to silage. Lapwings are still present but are struggling
- Increase in corvids on the in-bye ground - reduction in control, dispersal from hill ground (reduced carrion) and from landfill sites
- Increase in buzzards and sparrowhawks
- Increase in Greylag geese numbers having a negative impact on inbye grasslands, but a decrease in Greenland white-fronted geese numbers down to high twenties (half of what they used to be)
- Changes in the climate (30% wetter) have made it harder to cultivate and make hay
- Decline in breeding hen harriers from 5 pairs ten years ago to none now. Probably due to a loss of habitat as the conifer plantations have matured
- Mountain hares are now almost extinct, having been frequent in Sleat in the past. The decline in grouse shooting and the lack of appropriate heather management together with climate/weather changes have probably led to the decline in mountain hares
- Brown hare numbers have also declined
- Increase in tick numbers and the spread of Lyme disease
- Loss of skills and traditional practices
- Lack of experienced labour (e.g. sheep gatherers)
- Decline in local sales points in the last 20 years, with the main market now in Portree
- A lack of managed muirburn
- An increase in mink numbers and other vermin

Other issues raised:

- Lack of help for new entrants
- Difficult for outsiders to get into crofting and gain access to land. There is a need to either create new crofts or make existing crofts that are not being used available to new entrants
- Lack of crofts and housing – when crofts do sell they are very expensive
- There has been a cultural change in the attitude of people towards crofting
- The average age of crofters is increasing and few local youngsters are interested in farming/crofting or nature conservation. There is little incentive for young people to take up crofting/farming, and life is easier outside crofting
- The increased bureaucracy, regulatory burden, cross-compliance and paperwork were putting people off bothering with livestock (e.g. EID)
- There is a need for improved funding and viable incentives that target crofters. Most of the participants felt that funding was targeted at farmers and larger producers. They struggled to find anything in the current schemes that they could do
- Crofts held for successors (so can be effectively left unmanaged, but held in family until someone might want to use it – which can often be when they retire from another job, which in turn continues the trend of old crofters)
- The nearest slaughterhouse is in Dingwall, which means high transport costs and increased stress levels for transported animals
- Although the local veterinary surgeons were still active, they dealt less and less with large animals and more with pets
- The population in Sleat had increased, but this increase was not related to crofting. The local Gaelic college was mentioned as one factor for the increase in the local population

- The 'pull' factor of the buoyant economy over the reference period meant that there were lots of employment opportunities in non-agricultural sectors (particularly construction) which led to many crofters down-sizing their agricultural activities in order to take advantage of this boom. However, the recent economic downturn (with increased unemployment) may entice some crofters to increase stock numbers again, especially with improving stock prices.
- The lack of suitable (casual / contract) labour is often cited locally as a reason for the removal of stock. Providing training opportunities could help (in part) to remedy this, for example training in core skills which are required to manage upland sheep flocks (ATV driving, dog handling, sheep management, shearing, muirburning, cattle management, etc). Whilst this wouldn't wholly remedy the situation, it may well help reverse a decline, especially if there are people looking to 'return to the land', but don't have the necessary skills.
- There are large areas on Skye where deer numbers are increasing rapidly as a result of a lack of management and these will more than make up for any reductions in sheep / cattle numbers.

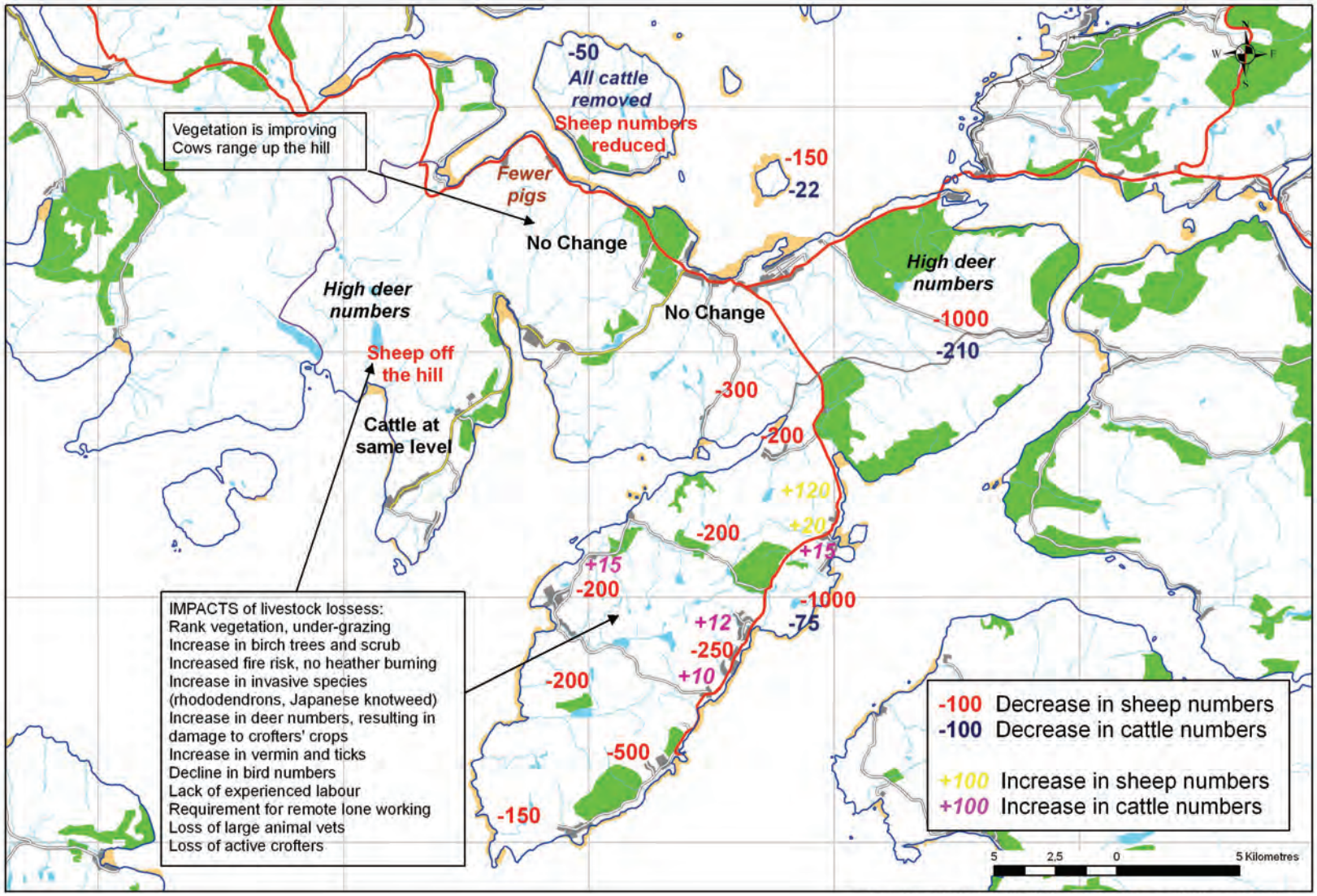


Figure 7.11 - Indicative changes in livestock within the South Skye area from information gained at the workshop.

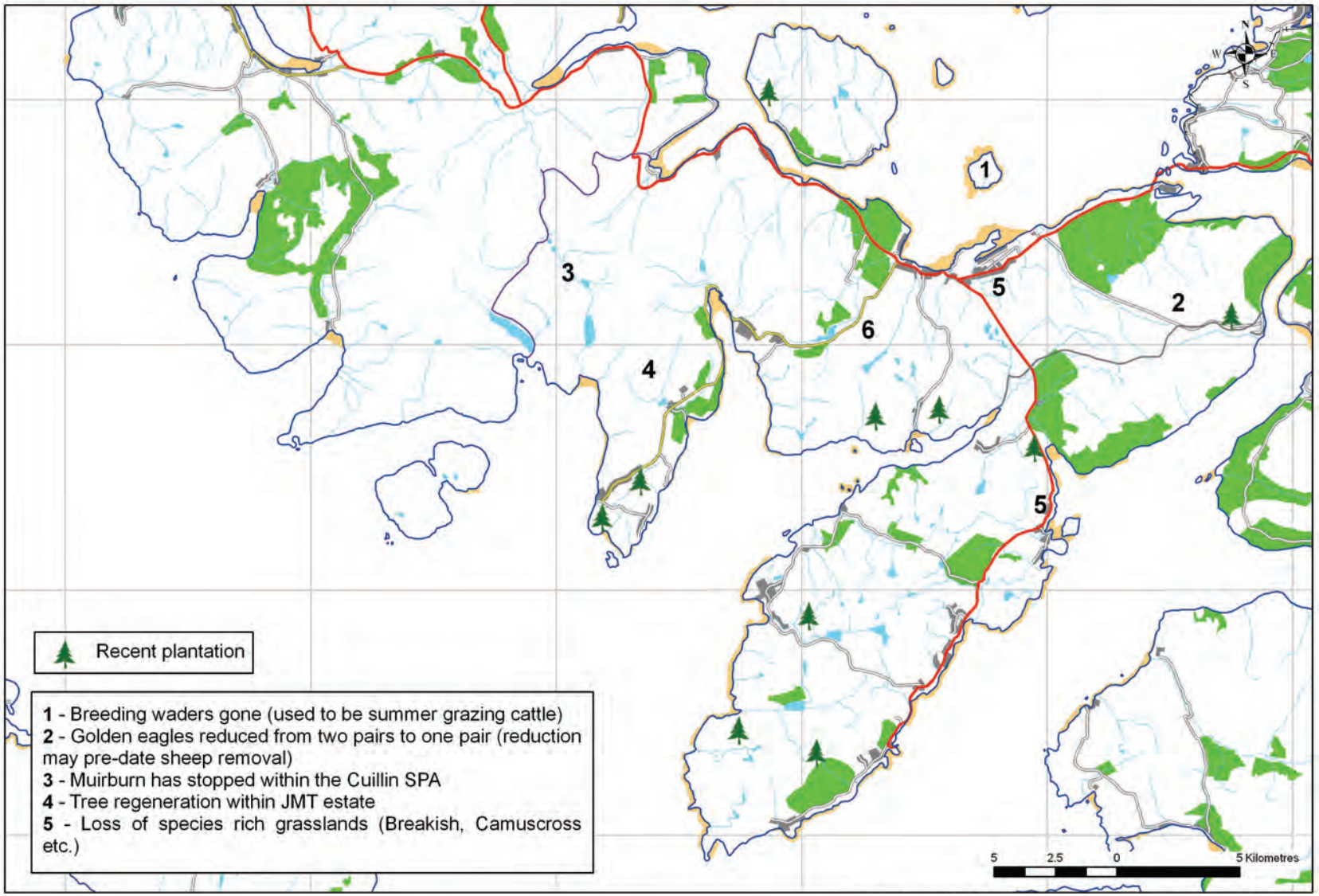


Figure 7.12 - Other changes within the South Skye area from information gained at the workshop.

7.3.3 What management changes might take place in South Skye in the future?

It was generally expressed that there was difficulty in thinking how management might change because of unknown factors such as:

- The future direction of support/CAP reform
- What happens to markets i.e. the need for good prices to encourage people to keep going
- Crofting Reform Bill
- Absenteeism initiative
- Climate change and food security i.e. these may influence prices and refocus attention on production

Some of the changes that might happen in the future that were suggested by the delegates included:

- A continued decline in livestock numbers and fewer active crofters
- A decline in the number of young people starting crofting/farming
- A couple of participants expressed an interest in expanding horticulture as they considered livestock were too much bother and didn't make much money
- More collaboration and working together
- Diversification (e.g. pigs)

Some of the impacts of future declines in crofting and livestock production that were highlighted included:

- Increase in trees/scrub (negative impact)
- Increase in coarse species such as rushes and bracken (negative impact)
- Decrease in species diversity
- Changes to soil structure and reduced fertility
- Increase in deer (negative impact)
- Increased fire risk
- Tourism may suffer due to changes in the landscape

7.4 South Skye - future impacts on the natural heritage and landscape

It is likely that the small area of improved grassland in the coastal crofting areas is most at risk of under-management if livestock numbers continue to fall in the area, leading to an increase in the area of rough grassland and the encroachment of scrub. This will have detrimental effects on a number of bird species that rely on patches of short, grazed grassland for foraging. In the short-term the dwarf-shrub heath vegetation that dominates the area may benefit from further reductions in livestock numbers, however the impact of any reduction in livestock grazing may be off-set by increased red deer numbers, however this will depend on what deer management is undertaken in the future. There is the potential for Bracken to spread onto some of the un-managed grassland and heath. The extent of the grassland-heath mosaic in the east of the area may decline as the heath vegetation recovers under reduced grazing pressure.

8 WEST BORDERS CASE STUDY AREA

8.1 Brief description of the West Borders study area

The parishes of Kirkhope, Ettrick and Yarrow cover an area of 470km^2 of the Borders region (Figure 8.1). The area stretches from Meggethead in the west to Yarrowford in the east, and includes part of the Ettrick Forest and the valleys of the Yarrow Water and Ettrick Water. The highest point is Broad Law (840m) in the far west of the parish of Yarrow. The main villages and hamlets are listed in Table 8.1.

Table 8.1 - Villages, hamlets and main farms in the West Borders study area.

Yarrow	Kirkhope	Ettrick
Cappercleuch	Ettrickbridge	Buccleuch
Dryhope	Gilmanscleuch	Cacrabank
Meggethead	Kirkhope	Crosslee
Mountbenger	Newburgh	Ettrick
Sundhope	Redfordgreen	Ettrickhill
Yarrow		Gair
Yarrow Feus		Glenkerry
Yarrowford		Hopehouse
		Ramseycleuch
		Wardlaw

Upland sheep and beef is the principal farming type. The main commercial forestry plantations are found in the north of the parish of Yarrow and in the southern half of the parish of Ettrick, with other large plantations to the south of St. Mary's Loch (Yarrow and Ettrick) and to the south of Ettrickbridge (Kirkhope). The LCM 2000 land cover map data (NERC/CEH, 2003) was used to determine the areas of the main land cover classes within the study area. Coniferous plantations cover 21% of the study area. Much of the rest of the area is covered in semi-natural vegetation, the main types being acid grassland and dwarf-shrub heath which cover over 50% of the study area (Figure 8.2 and Table 8.2). Improved grassland along the valleys of the Ettrick and Yarrow covers 4.7% of the area, a much higher percentage than in the South Skye study area. There is also some arable and horticultural land along the river valleys, covering 1.8% of the area (Figure 8.2 and Table 8.2).

Table 8.2 - Land cover (LCM 2000) within the West Borders study area.

Land Cover Class	Area (ha)	Area (%)
Acid grassland	11871.7	25.3
Open dwarf shrub heath	10414.6	22.2
Coniferous woodland	9852.8	21.0
Rough neutral grassland	5039.7	10.7
Bog	2507.3	5.3
Improved grassland	2216.7	4.7
Dwarf shrub heath	1249.5	2.7
Broad-leaved and mixed woodland	1198.1	2.6
Arable and horticulture	855.9	1.8
Bracken	646.8	1.4
Water (inland)	607.0	1.3
Calcareous grassland	388.1	0.8
Urban	73.3	0.2
Inland bare ground	34.0	0.1

Source: LCM 2000 (NERC/CEH, 2003)

Table 8.3 contains a list of key upland and agricultural bird species that were recorded as breeding within the West Borders study area during the BTO atlas survey of 1988 to 1991 (Gibbons *et al*., 1993). All these species are likely to be affected by future changes in land management (including reduced grazing levels, potential abandonment, afforestation, wind farm development and increased sporting management).

The Dark Green Fritillary and Small Heath, two butterfly species of upland habitats that require some degree of grazing, were recorded within at least one of the 10 km squares that comprise the West Borders study area during the Butterflies for the New Millennium atlas survey of 1995 to 1999 (Asher *et al*., 2001). The Scotch Argus, a species that requires very lightly grazed or un-grazed grassland was also recorded.

Red Deer have only been recorded in two 10km squares at the south west corner of the study area, however Roe Deer have been recorded throughout the area and Sika Deer are present in the west and north of the area (Arnold, 1993).

Part of the Tweedsmuir Hills SSSI is in the north west of the study area (Figures 8.3 and 8.4) and there are a number of other smaller Sites of Special Scientific Interest within the study area (Table 8.4). The designated features and their current condition are given in Table 8.4. Table 8.4 also includes a column with the potential impact on the designated features of removing grazing animals.

Table 8.3 - Key bird species recorded as breeding within at least one of the 10 km squares that comprise the West Borders study area during the BTO atlas survey of 1988 to 1991 (Gibbons et al., 1993).

	Species
Waders	Golden Plover (*Pluvialis apricaria*)
	Lapwing (*Vanellus vanellus*)
	Dunlin (*Calidris alpina*)
	Curlew (*Numenius arquata*)
	Oystercatcher (*Haematopus ostralegus*)
	Redshank (*Tringa tetanus*)
	Snipe (*Gallinago gallinago*)
	Dotterel (*Charadrius morinellus*)
Birds of prey and owls	Hen harrier (*Circus cyaneus*)
	Buzzard (*Buteo buteo*)
	Merlin (*Falco columbarius*)
	Peregrine (*Falco peregrinus*)
	Short-eared Owl (*Asio flammeus*)
	Barn Owl (*Tyto alba*)
Grouse	Black Grouse (*Tetrao tetrix*)
	Red Grouse (*Lagopus lagopus*)
Corvids	Raven (*Corvus corax*)
	Carrion (*Corvus corone*)
Other species	Meadow Pipit (*Anthus pratensis*)
	Skylark (*Alauda arvensis*)
	Ring Ouzel (*Turdus torquatus*)
	Wheatear (*Oenanthe oenanthe*)
	Whinchat (*Saxicola rubetra*)
	Stonechat (*Saxicola torquata*)
	Linnet (*Carduelis cannabina*)
	Yellowhammer (*Emberiza citrinella*)

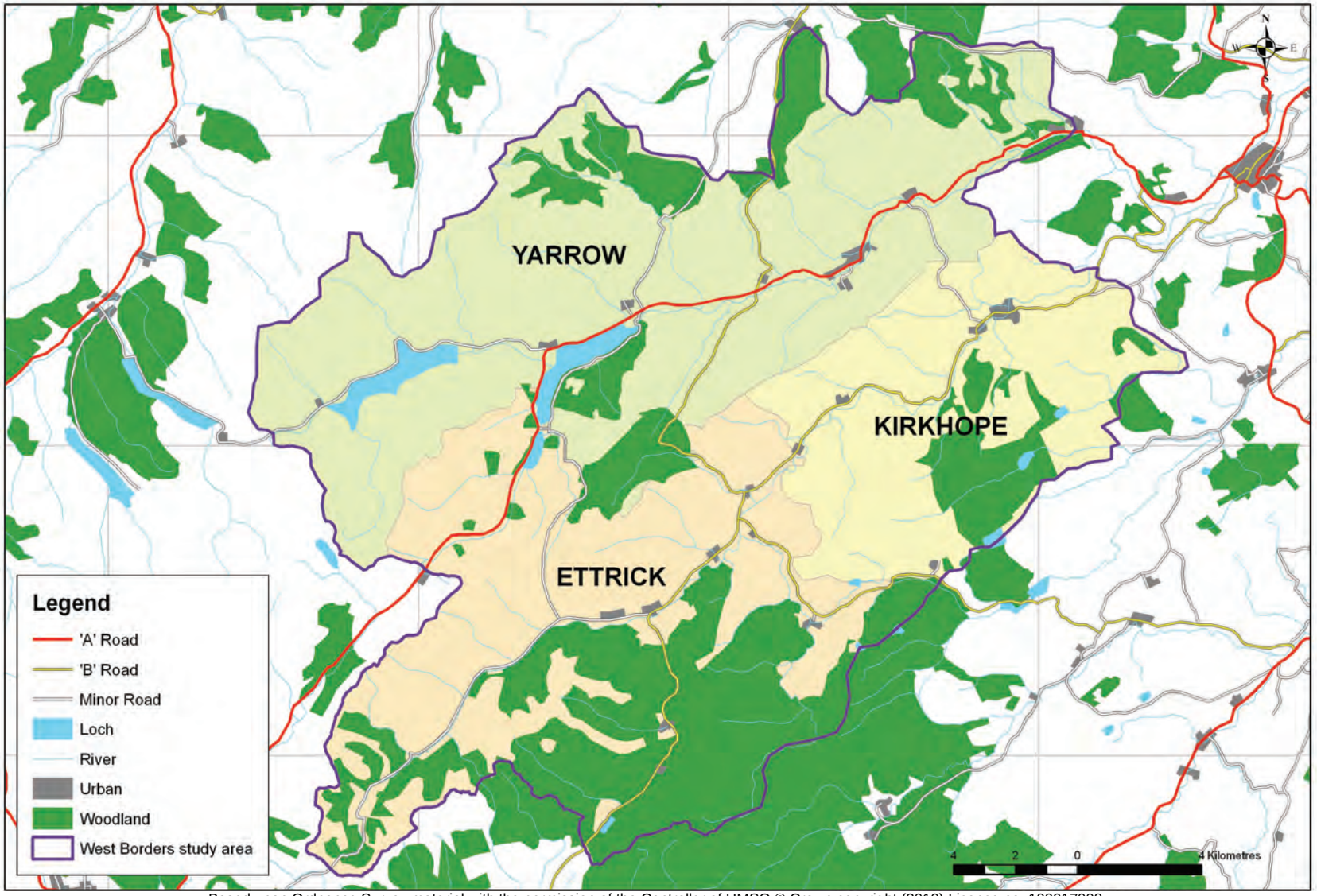
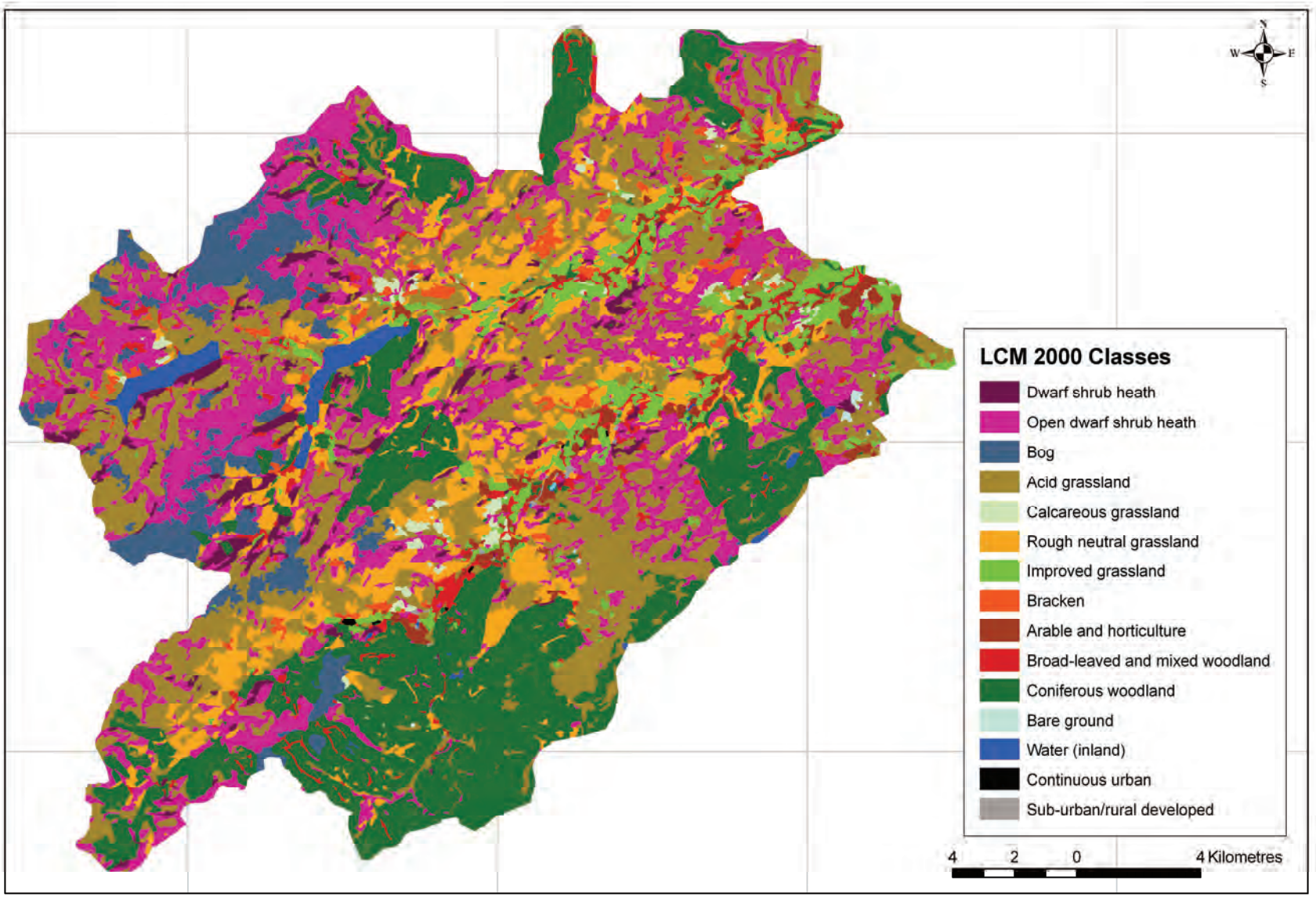


Figure 8.1 - West Borders study area (parishes of Yarrow, Kirkhope and Ettrick).



Based upon CEH Land Cover Map 2000 (LCM2000) data. NERC © copyright.

Figure 8.2 - LCM 2000 land cover map of the West Borders study area.

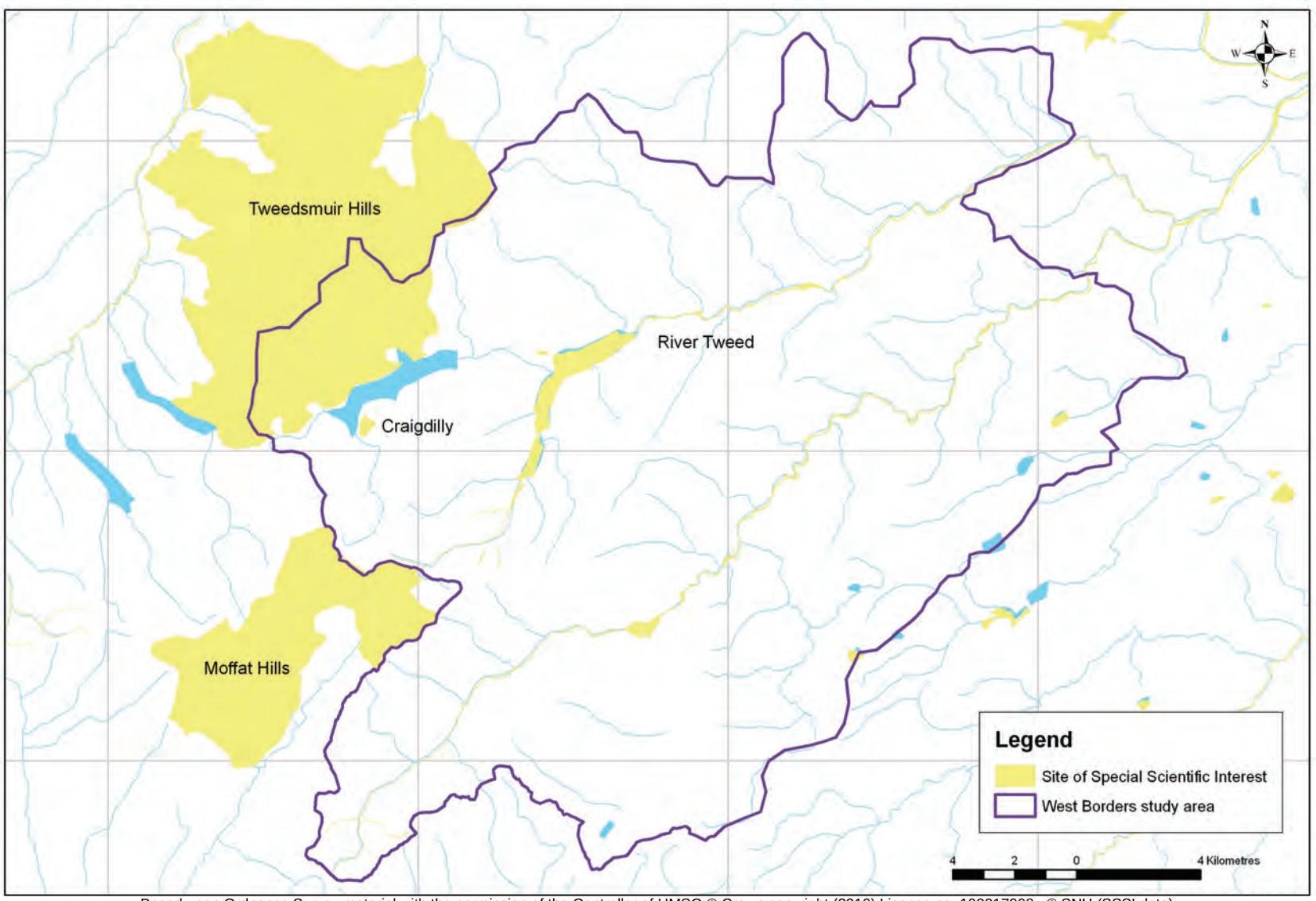


Figure 8.3 - Sites of Special Scientific Interest within the West Borders study area. Sites designated for their Biological interest are labelled.

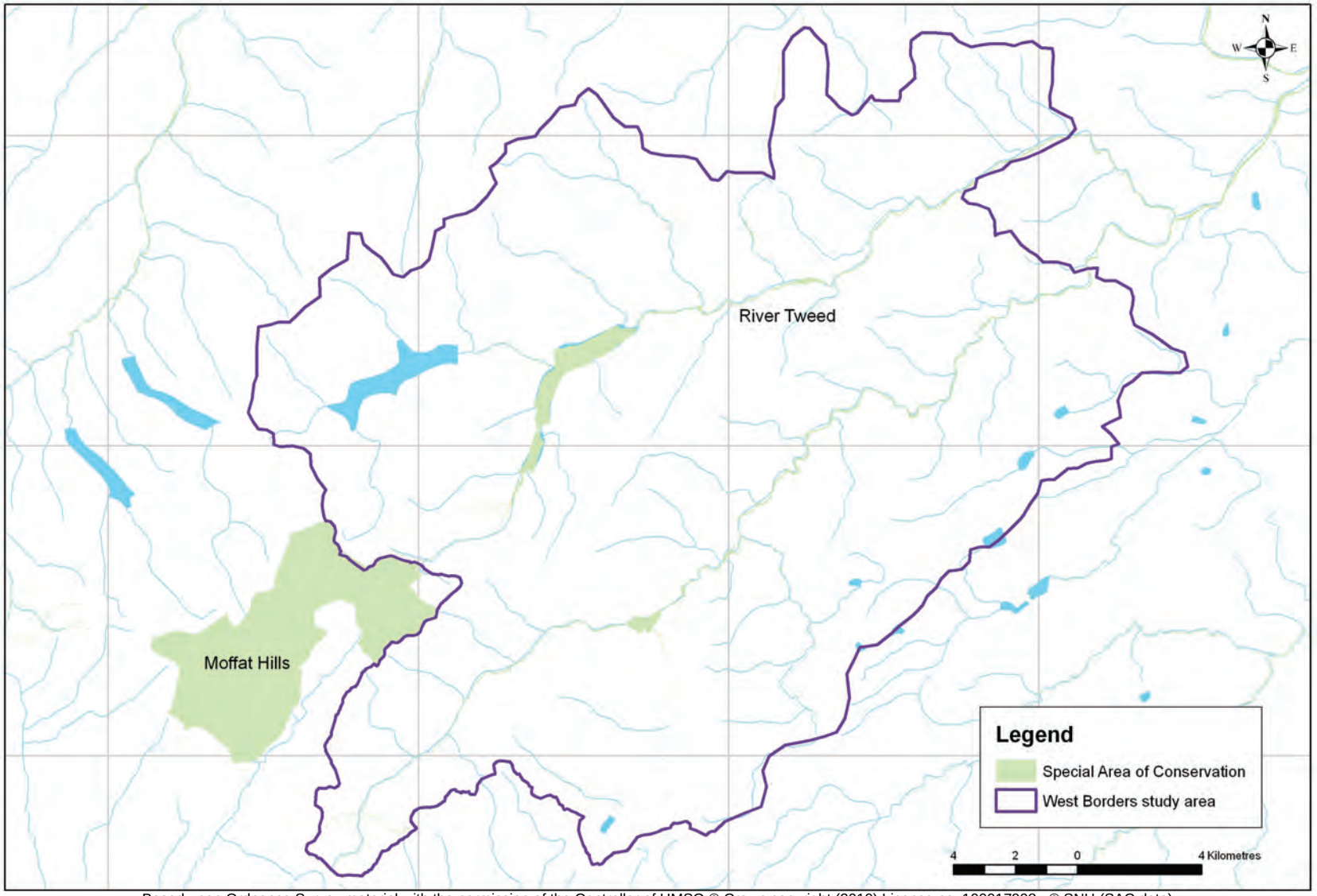


Figure 8.4 - Special Areas of Conservation within the West Borders study area.

Table 8.4 - Sites of Special Scientific Interest (SSSI) within the West Borders study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Tweedsmuir Hills	2019.44	Birds - assemblages of breeding birds	Breeding bird assemblage	Favourable Maintained	- (long term)?
		Bryophytes	Bryophyte assemblage	Favourable Maintained	
		Mosaic	Upland assemblage	Unfavourable Declining	- (long term)?
		Vascular plants	Vascular plant assemblage	Unfavourable Declining	
Craigdilly	22.51	Broad-leaved, mixed and yew woodland	Scrub	Favourable Maintained	- (long term)?
Henderland Bank	4.08	Broad-leaved, mixed and yew woodland	Upland mixed ash woodland	Favourable Maintained	- (long term)?
Riskinhope	8.31	Fen, marsh and swamp (Wetland)	Flood-plain fen	Favourable Maintained	- (long term)?
Hermanlaw	4.24	Broad-leaved, mixed and yew woodland	Upland birch woodland	Favourable Maintained	- (long term)?
Akermoor Loch	16.07	Standing open water and canals	Mesotrophic loch	Favourable Maintained	
KingsideLoch	9.73	Fen, marsh and swamp (Wetland)	Basin fen-schwingmoor type	Favourable Maintained	
		Bryophytes	Bryophyte assemblage	Favourable Maintained	
		Standing open water and canals	Oligotrophic loch	Favourable Maintained	

Table 8.4 (continued) - Sites of Special Scientific Interest (SSSI) within the West Borders study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Moffat Hills	12.83	Stratigraphy	Caradoc - Ashgill	Favourable Maintained	
		Geomorphology	Fluvial Geomorphology of Scotland	Favourable Maintained	
		Stratigraphy	Llandovery	Favourable Maintained	
		Quaternary geology and geomorphology	Quaternary of Scotland	Favourable Maintained	
		Mosaic	Upland assemblage	Unfavourable Declining	+ (short term) - (long term)?
St Mary's Loch	252.17	Standing open water and canals	Oligo-mesotrophic loch	Favourable Maintained	
River Tweed	628.05	Fish	Atlantic salmon (*Salmo salar*)	Unfavourable Recovering	
		Other invertebrates	Beetles	Unfavourable Recovering	
		Fish	Brook lamprey (*Lampetra planeri*)	Unfavourable No change	
		Other invertebrates	Flies	Unfavourable Recovering	
		Fish	River lamprey (*Lampetra fluviatilis*)	Unfavourable No change	
		Fish	Sea lamprey (*Petromyzon marinus*)	Unfavourable No change	
		Rivers and streams	Trophic range river/stream	Unfavourable No change	

8.2 West Borders livestock changes

The Scottish Government's June agricultural census data shows that breeding ewe numbers in Ettrick and Yarrow declined by 5629 and 6202 respectively between 1997 and 2008 (Figure 8.5). The decline in breeding ewe numbers in Kirkhope was less dramatic with a loss of 679 ewes over the period 1997 to 2008. Breeding cow numbers also declined in all three parishes, particularly in Yarrow and Ettrick, where they fell by 248 and 163 respectively over the period 1997 to 2008 (Figure 8.6).

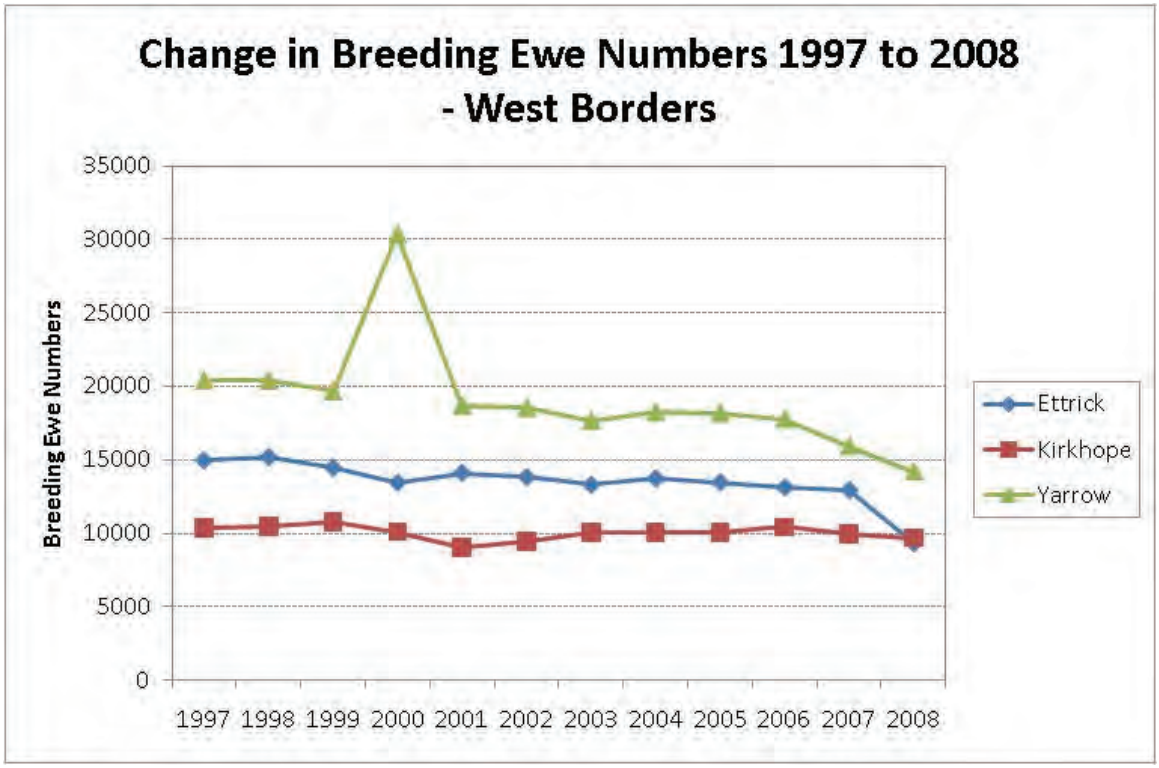


Figure 8.5 - Change in breeding ewe numbers in Ettrick, Kirkhope and Yarrow between 1997 and 2008. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

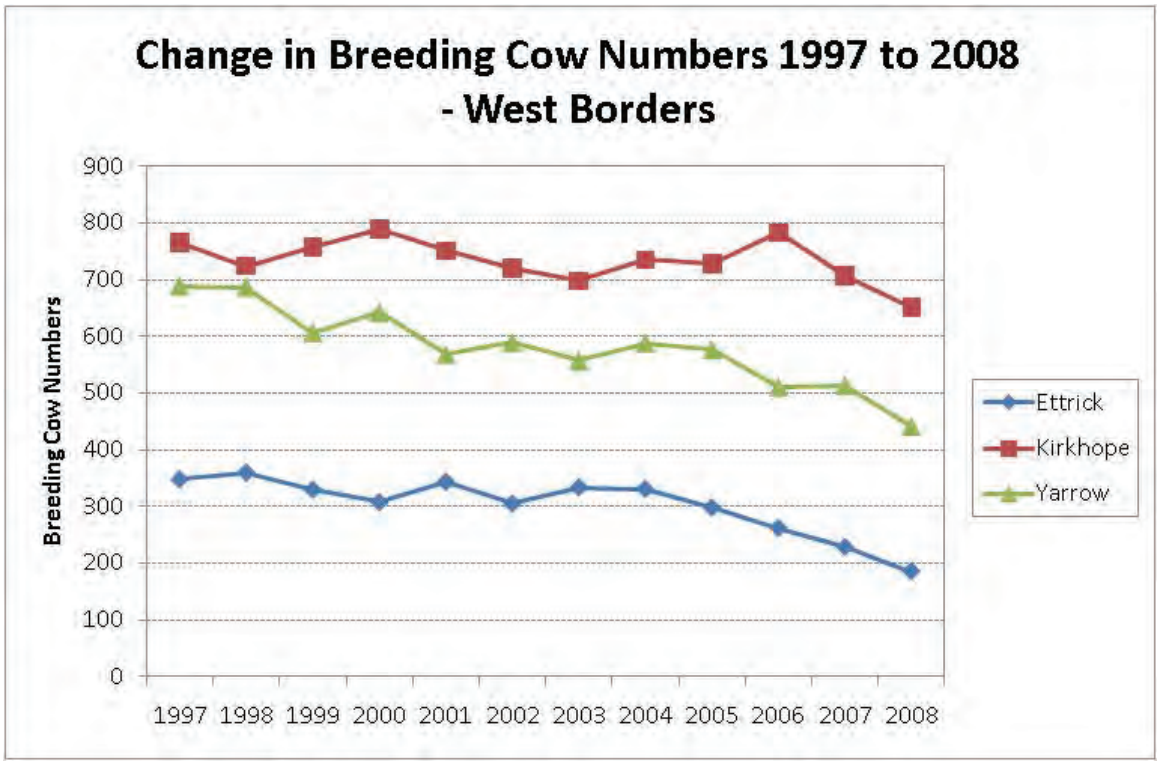


Figure 8.6 - Change in breeding cow numbers in Ettrick, Kirkhope and Yarrow between 1997 and 2008. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

8.3 West Borders workshop results

8.3.1 West Borders - questionnaire results

Summary results from the farmers questionnaire survey carried out at the West Borders workshop are given in Tables 8.5 and 8.6 and Figures 8.7. The questionnaire results from the non-farmer workshop delegates are given in Table 8.7 (a, b, c and d). Figure 8.8 shows the locations of the main changes in livestock within the West Borders study area over the last 5-10 years that were identified by the workshop delegates. The numbers and locations are not necessarily completely accurate but give an indication of the changes that have occurred. Other changes including new woodland planting are shown in Figure 8.9.

Table 8.5 - Summary results from the farmers' questionnaire survey carried out at the West Borders workshop.

Number of completed questionnaires	10 (6 Yarrow, 3 Kirkhope, 1 Ettrick)
Number of businesses within each farm type:	
LFA sheep	1
LFA sheep & beef	9
Number of businesses within each tenure type:	
Owner occupier	3
Tenant	6
Owner/Tenant	1
Number of farms with arable crops	2
Number of farms with forage crops	6
Number of farms with in-bye ground	9
Number of farms with rough grazing	10
Number of farms with woodland	5
Average area of farm	923 ha
Number of farms with sheep	10
Number of farms with cattle	9
Average number of breeding ewes per farm with sheep	1318
Average number of beef cows per farm with cattle	117
Average number of people working on the farm	3
Average percentage of time spent working on the farm	84%
Number of farms with other enterprises	3

Table 8.6 - Summary results of the changes that have occurred since 2005 from the farmers' questionnaire survey carried out at the West Borders workshop.

Changes since 2005	Yes	No
Changes in livestock or management?	9	1
Changes in permanent labour?	5	4
Changes in casual labour?	2	7
Changes in other enterprises?	4	4
Have your neighbours changed their animal numbers?	5	4
Have your neighbours changed their animal management?	5	4
Have your neighbours changed their mix of enterprises?	2	7
Any changes in local farming infrastructure?	6	3
Any changes in the local community?	7	2
Any changes in local landscape?	5	4
Any changes in quality of grazing?	2	7
Quality of grazing improved		
Quality of grazing declined	2	
Have the changes in the area influenced some of your own changes?	1	8

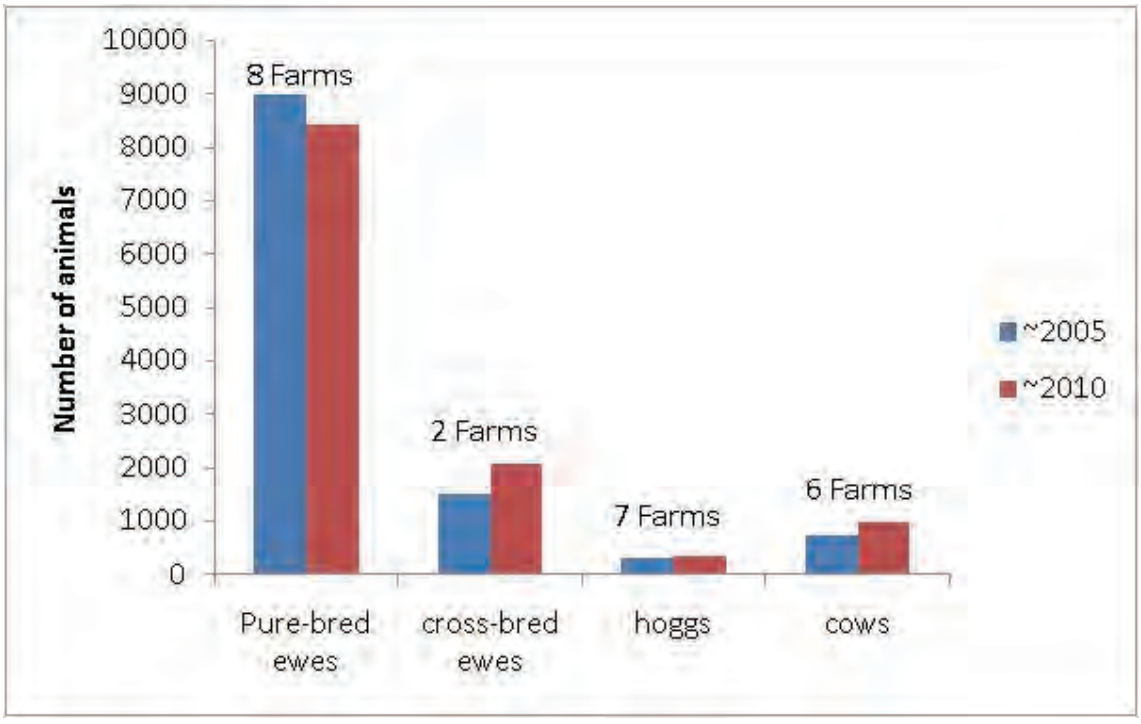


Figure 8.7 - Livestock numbers kept by the West Borders workshop farmers in 2005 and 2010.

Table 8.7 - The main changes and impacts on the natural heritage due to the decline in hill farming in the West Borders study area as outlined by the non-farmers in their questionnaire survey at the West Borders workshop.

a) Landscape

Changes Observed	**Importance** Very important = 1 Important = 2 Not very important = 3	**Cause of the Change**
Loss of sheep farms - some cleared for sporting purposes, some in line to be planted with commercial forestry. Decreased ewe numbers on upland SSSIs	1	Change in the subsidy system and the currently very large grants for forestry. High land values are preventing active or would be farmers from buying the land. Farmers are also being forced into early decisions as grants won't last forever. Strategy of some estates to restore heather cover on hills and increase sporting management. Availability of SNH Natural Care grants (on SSSIs).
Small scale woodland restoration and native woodland planting	2	Efforts by local NGOs and grants (WGS, SFGS, SRDP and locational premium). Changes in the economics of hill farming and the nature of the support mechanism (less linkage to production) have led to farmers revisiting what/how they use the land. Poor returns from livestock coupled with increased capital values have made some (particularly older) farmers consider the future of continuing with the current model. Woodland for some has been seen as an attractive option, and this trend is likely to continue. Environmental enhancement. Local strategy for riparian woodland.
Tree boxes - wood pasture	2	Borders Forest Trust wood pasture initiative to put trees back into the landscape based on historic maps
Increased muirburn for grouse	2	Increased interest in grouse moor management. Area between Yarrow and Ettrick taken in hand for grouse moor management
Perceived small increase in cattle on the hill ground	1	
Increased capital works being undertaken on some farms through environmental grants	2	SRDP funding
Lots of empty second homes - Farm cottages sold off by estates and farms. House prices too high for local families.		
Increased development for residential property	2	High house prices. Older farmers selling off land for retirement. Decreasing profit levels from farming.

b) Vegetation

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Restoration of heather in some areas	1	Reduction in grazing pressure on hill
On SSSIs aim to improve dwarf shrub cover, blanket bog and other upland habitats	1	Grant incentives
Changes in grazing management on some of the hills has led to more rank vegetation and the encroachment of scrub	1	Loss of balance in land management
Continued loss of heather in some areas despite agri-environment schemes	1	Combination of changes in shepherding practices and subsidy payments, but also poor understanding by public bodies, leading to an imbalance in land-use
More roadside hedges		Grants and planting being allowed outside fields on roadsides
Roadside trees no longer managed	2	Farmers no longer have time to manage roadside trees

c) Fauna

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Decline in mountain hares		
Decline in black grouse in some areas		More predation, habitat loss and afforestation
Increase in black grouse populations in other areas where targeted management has occurred	2	Environmental schemes. Increased predator control. Forest restructuring
Outbreak of signal crayfish in the Ettrick which have been allowed to multiply		
Increase in raptor species particularly buzzards	1	Changing opinion on raptors as pests and thus reduced persecution. Stricter control of pesticide application. Increase in prey species?
General increase in wildlife on some of the hill ground	1	The introduction of more keepers on the hill ground has had an effect on vermin species
Less breeding waders?	2	Continued decline in lapwing and curlew
Increase in pheasants		Diversification of farm/estate income

d) Community

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Declining population	1	Fewer people employed directly on farms, more contracting and fewer farms in production.
Changes in the community structure	1	Economic factors including housing and employment
Loss of post office and shop in Ettrick and Ettrickbridge		More holiday homes
Decline in school roles. The number of school children is now very low in Ettrick and the school may have to close soon	1	Loss of agricultural jobs and declining population
Steading conversions	2	Many older agricultural buildings have been converted to new housing, but this has slowed down as the housing market has fallen
Local public houses struggling to survive.	2	Changes in the way people are living their lives

8.3.2 Changes that have happened in the West Borders area in recent years and the impacts of these changes

The participants identified a number of changes in the flora, fauna, landscape and rural community that had occurred in recent years in the West Borders study area. As with the Skye workshop, some of these changes relate directly to local livestock and land management changes, but others relate to social, economic and land-use changes that are taking place more widely.

Key changes in flora, fauna, landscape and rural community as indicated by the workshop delegates:

- Decline in livestock numbers (particularly sheep) (see Figure 8.7 for an indication of the scale and extent of the declines)
- Three hill farms in the upper part of the valley have been taken back in hand, with one turned over to game management (loss of 2500 sheep)
- Increase in forestry and woodland area (see Figure 8.8):
    - Native broadleaves
    - Riparian
    - Wood pasture
    - Conifer plantations (largely static in extent but some restructuring)
- Forest restructuring:
    - This has had a positive effect on black grouse numbers
    - Clear felling has had a negative impact on the landscape
- Less forage crops grown and less reseeding and drainage. Silage is the only crop grown
- Taller grassland and encroachment of scrub in some areas where grazing has been reduced
- Continued loss of heather in some areas despite agri-environment schemes
- More ragwort
- Water margins have been fenced off (resulting in taller vegetation) and wetlands have been created in some areas
- Buzzards, magpies, rooks, ravens, carrion crows, goshawks, badgers and foxes have all increased – This has had a perceived impact on song birds, waders, red and black grouse, and lambs
- Grey partridge disappeared
- A perception that there are less lapwings and curlews
- Black grouse numbers are still low, with some change in local distribution, and targeted effort at recovery
- Less rabbits
- Increase in muirburn as a result of an increased interest in grouse moor management
- There has been a growth in pheasant shooting
- Flooding has become a bigger issue in recent years
- Consented wind turbine development
- Social impacts
    - local schools struggling for numbers
    - Increase in commuters and second-home owners (‘lifestyle’ residents)
    - Conversion of older agricultural buildings into new housing
    - Fewer young people employed in agriculture. Only ten people in the area under 30 actively working in farming
    - Ageing farming population
    - Lack of local skilled farm labour, which causes problems at gathering and lambing etc.

- A number of farms and some other small rural businesses have been lost which has had a knock on effect on other businesses
- Decline in the number of shepherds and hired staff. Labour pattern is changing. One shepherd used to look after 300 ewes, now it is more than 1000 ewes
- The rural economy is declining. Even forestry jobs are going, since it is cheaper to use machinery than men, or use contractors
- St. Boswells' market: 10,000 less livestock go through it now. More private sales, more sales direct to processors
- Infrastructure (roads especially) will be a problem soon, with all the tree lorries using them

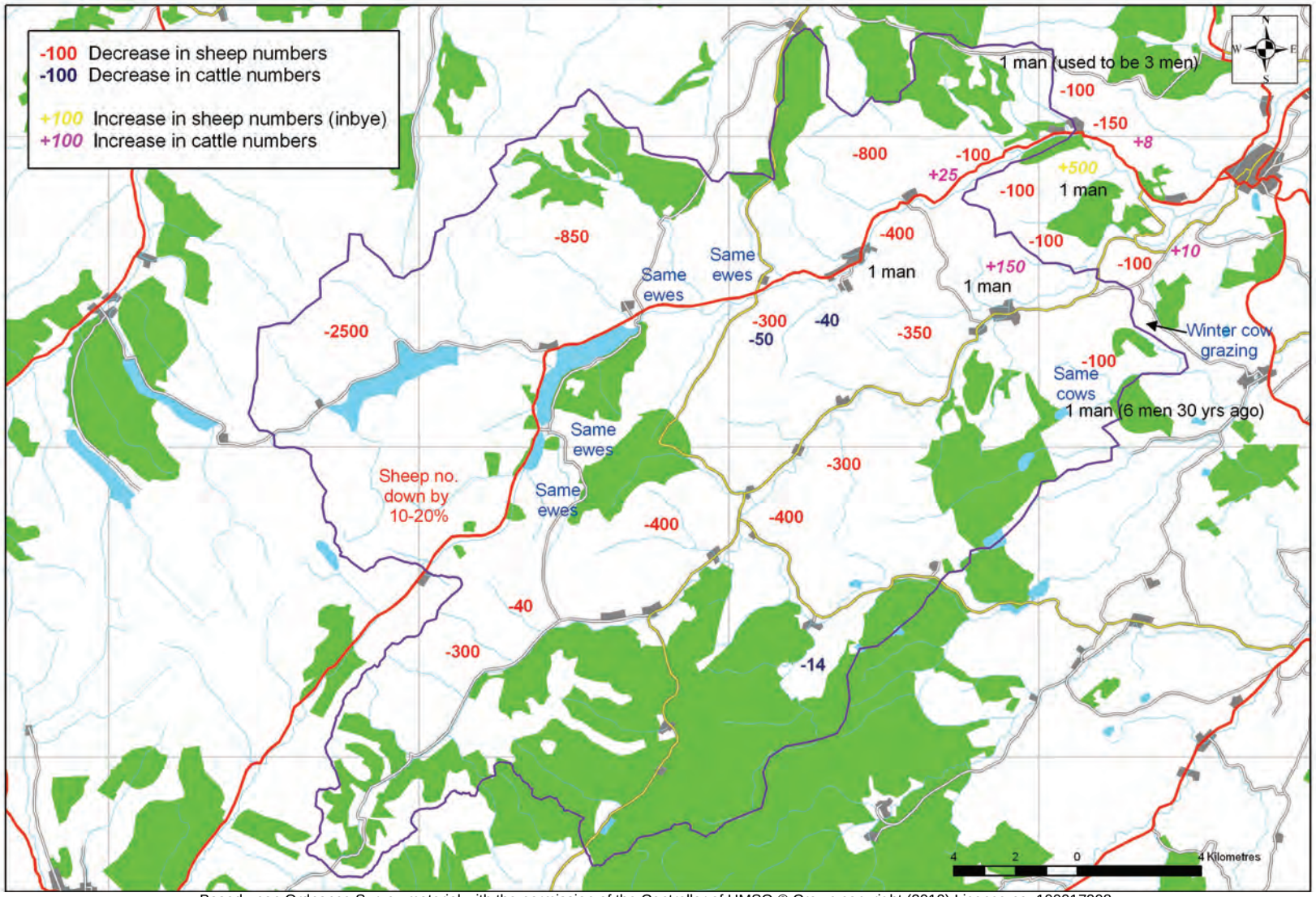


Figure 8.8 - Indicative changes in livestock within the West Borders study area from information gained at the workshop.

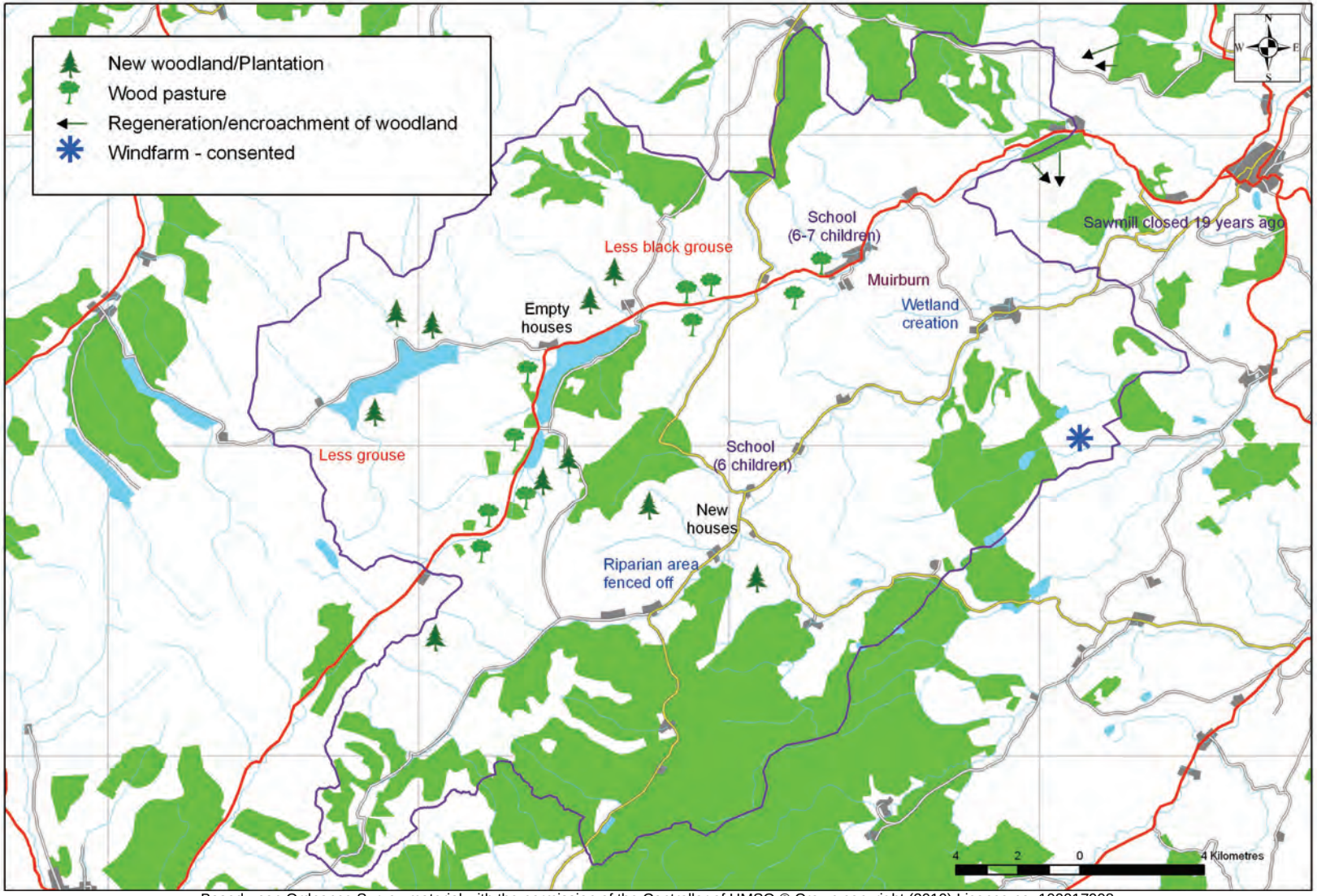


Figure 8.9 - Other changes within the West Borders study area from information gained at the workshop.

8.3.3 What management changes might take place in the West Borders in the future?

Some thoughts from the workshop delegates on future changes are listed below:

- Livestock numbers will carry on falling, leading to a loss of critical mass
  - They stated that the loss of support will be especially hard on the cattle farmers, who will not be able to afford the labour that cattle production requires. This will lead to the abandonment of cattle farming
  - Inbye sheep will also go, whilst ewes on the hills might stay the same
  - On the sheep farming side, they said that having a less intensive system to reduce costs will not be possible, because of the farm types and the climate
  - Tenant farmers will be stuck since their tenancy does not allow them to reduce livestock numbers too much
- Labour employed will decline and skills will be lost. A point will be reached where you cannot shed any more labour
- Larger scale management of the land will appear, with maybe one manager dealing with 2-3 farms, and only 2-3 stockmen on each farm (farms will amalgamate and there will be a loss of small family farms)
- Long term future very dependant on Europe. Less money will come from the EU, because of the enlargement to EU-27
- Farmers will only produce products that sell
- Trees and forestry will increase if the sheep and cattle go
- Farming population will age and no new entrants will come
- Wind farm development with some income generation
- Increase in woodland and forests
- Increase in grouse management and sporting interests
- If there is a decline in farms, then likely to be a reduction in support and infrastructure

Some of the potential impacts of these future changes that were highlighted included:

- The vegetation will become rank
- Dykes and hedges will not be maintained
- It will be costly to erect new fences if the farmers decide to fatten lambs, etc.
- The wildlife will suffer, ground nesting birds will disappear, sika deer may appear
- Markets and hauliers will stay the same (they are already at a minimum)
- There will be a change in the social fabric, with more retirees coming and more holiday homes
- Diversification and tourism were not seen as a solution. They said that the area is too far from the main centres and cities to make it a proper leisure destination. Also they stressed the difficulty in starting a new venture that has nothing to do with farming. Tourism is also, very seasonal in the area
- The tenure system does not encourage change in the management of the land or indeed new entrants coming into farming

8.4 West Borders - future impacts on the natural heritage and landscape

Although livestock numbers in the West Borders study area have reduced considerably in recent years the number of ewes per hectare of grazing land in 2008 still exceeded 1 ewe per hectare, suggesting that the herbivore impact levels on habitats in some areas are likely to be moderate to high. Therefore further reductions in livestock numbers may benefit habitats such as the dwarf-shrub heath vegetation that covers almost 25% of the area. Some of the acidic hill grasslands are also likely to benefit from reduced grazing levels, increasing their structural heterogeneity. However complete abandonment of the hill grasslands and dwarf-shrub heaths would be detrimental and may lead to the spread of bracken and the loss of habitat mosaics. At present Red Deer are not widespread in the area however Roe Deer and Sika Deer are more widely distributed. In the short term any increase in the deer population is unlikely to fully off-set any further reductions in livestock, other than at a local level. Although the area of productive improved grassland is unlikely to reduce significantly in the short-term, there is a risk that the area of cultivated land will decline, which may have an impact on a number of bird species that are associated with cropland. The LCM 2000 data (NERC/CEH, 2003) indicates the presence of a small amount of calcareous grassland which may be at particular risk of under-grazing. Perhaps the biggest threat to the upland grassland and moorland habitats is the further expansion of commercial forestry and native woodland. Increased afforestation will also have a considerable impact on the landscape of the area. If recent trends continue then the active management of heather moorland, including muirburn, for grouse shooting, may become more widespread. This will have an impact on the vegetation, fauna and landscape of the hill ground. What happens to sheep management in relation to changes in game management is less obvious, as the systems are now working more closely together, where previously they were seen to be in conflict.

9 NORTH HIGHLANDS CASE STUDY AREA

9.1 Brief description of the North Highlands study area

The parishes of Lairg, Kincardine and Creich cover an area of 1580km^2 of the North Highlands (Figure 9.1). The area stretches from Loch Borralan in the west to Ospisdale in the east, and from Loch Merkland in the north to Crom Loch in the south. The area includes Strathcarron, Strath Oykel, Glen Cassley, Loch Shin and Strath Tirry. The highest point is Ben More Assynt (998m) in the north-west of the parish of Creich. The main villages, crofting communities and farm steadings are listed in Table 9.1.

Table 9.1 - Villages, crofting communities and main farm steadings in the North Highlands study area.

Lairg	Creich	Kincardine
Achnairn	Achany	Achnahanat
Arscaig	Achinduich	Amatnatua
Claonel	Altass	Ardgay
Colaboll	Anvershin	Ardgayhill
Corrykinloch	Auchintoul	Birchfield
Dalchork	Bonar Bridge	Brae
Dalnessie	Clashcoig	Croick
Gruids	Craigton	Culrain
Lairg	Gablon	Doune
Rhian	Inveran	Dounie
Sallachy	Invercassley	Kincardine
Saval	Linsidemore	Lower Gledfield
Torroble	Little Creich	Lubcroy
	Migdale	Oykel Bridge
	Ospisdale	Rhelonie
	Rosehall	Soyal
	Spinningdale	The Craigs
	Whiteface	Upper Ardchronie
		Wester Gruinards

Crofting, and hill sheep and beef are the principal farming types. A large part of the area is covered in commercial forestry plantations with extensive forests in Strath Oykel, Strathcarron, to the east of the A836 north of Lairg, and at the north end of Loch Shin. The LCM 2000 land cover map data (NERC/CEH, 2003) was used to determine the areas of the main land cover classes within the study area. Coniferous woodland covers 13.4% of the study area (Figure 9.2 and Table 9.2). Dwarf-shrub heath and blanket bog vegetation types dominate the hill ground covering over 60% of the study area, with acid grassland covering a further 12.5% (Figure 9.2 and Table 9.2). Montane vegetation is found on the high ground in the south-west and north-west of the study area (Figure 9.2). Improved grassland, which covers 3.1% of the area, is found mainly on the inbye ground along Strath Oykel, Strath Tirry and Strathcarron, and around Bonar Bridge (Figure 9.2). The small amount of arable and horticultural land is concentrated on the north side of the Dornoch Firth between Little Creich and Skibo Castle (Figure 9.2). Fishing and other sporting interests are economically very important in the area.

Table 9.2 - Land cover (LCM 2000) within the North Highlands study area.

Land Cover Class	Area (ha)	Area (%)
Open dwarf shrub heath	57280.0	36.3
Bog	25128.0	15.9
Coniferous woodland	21202.8	13.4
Acid grassland	19679.4	12.5
Dwarf shrub heath	12601.4	8.0
Montane vegetation	6251.1	4.0
Improved grassland	4865.2	3.1
Water (inland)	4683.8	3.0
Broad-leaved and mixed woodland	3023.1	1.9
Inland bare ground	1158.5	0.7
Bracken	843.9	0.5
Rough neutral grassland	684.9	0.4
Arable and horticulture	117.0	0.1
Calcareous grassland	188.5	0.1
Urban	48.4	0.0

Source: LCM 2000 (NERC/CEH, 2003)

Table 9.3 contains a list of key bird species that were recorded as breeding within the North Highlands study area during the BTO atlas survey of 1988 to 1991 (Gibbons *et al*., 1993). All these species are likely to be affected by future changes in land management (including reduced grazing levels, abandonment, scrub encroachment, afforestation, wind farm development and increased sporting management).

A number of butterfly species that benefit from some degree of grazing, including the Pearl-bordered Fritillary, Small Pearl-bordered Fritillary, Dark Green Fritillary and Small Heath, were recorded within at least one of the 10 km squares that comprise the North Highlands study area during the Butterflies for the New Millennium atlas survey of 1995 to 1999 (Asher *et al*., 2001). The Scotch Argus, a species that requires very lightly grazed or un-grazed damp grassland was also recorded.

Red Deer, Roe Deer and Sika Deer have been recorded throughout the study area (Arnold, 1993). An average deer density of 12.1 deer per km^2 was estimated for the North Ross Deer Management Area following a count in March 2008 (DCS, 2008). A count by the West Sutherland Deer Management Group in March 2002 gave an average deer density of 7.1 deer per km^2 (DCS, 2002). An open range count carried out by DCS within the Beinn Dearg SAC in July 2009 gave a deer density of 22.9 per km^2 (DCS, 2010).

There are a number of designated sites in the area and these are shown in Figures 9.3, 9.4 and 9.5. The designated features and their current condition are given in Table 9.4. Table 9.4 also includes a column with the potential impact on the designated features of removing grazing animals. The main vegetation types within the Grudie Peatlands SSSI, Strath an Loin SSSI, Cnoc an Alaskie SSSI, Strath Duchally SSSI and Beinn Dearg SSSI are shown in Figures 9.6 and 9.7.

Table 9.3 - Key bird species recorded as breeding within at least one of the 10 km squares that comprise the North Highlands study area during the BTO atlas survey of 1988 to 1991 (Gibbons et al., 1993).

	Species
Waders	Golden Plover (*Pluvialis apricaria*)
	Greenshank (*Tringa nebularia*)
	Lapwing (*Vanellus vanellus*)
	Dunlin (*Calidris alpina*)
	Curlew (*Numenius arquata*)
	Oystercatcher (*Haematopus ostralegus*)
	Redshank (*Tringa tetanus*)
	Snipe (*Gallinago gallinago*)
	Dotterel (*Charadrius morinellus*)
Birds of prey and owls	Golden Eagle (*Aquila chrysaetos*)
	Hen harrier (*Circus cyaneus*)
	Buzzard (*Buteo buteo*)
	Merlin (*Falco columbarius*)
	Peregrine (*Falco peregrinus*)
	Short-eared Owl (*Asio flammeus*)
	Barn Owl (*Tyto alba*)
Grouse	Black Grouse (*Tetrao tetrix*)
	Red Grouse (*Lagopus lagopus*)
Corvids	Raven (*Corvus corax*)
	Carrion/Hooded Crow (*Corvus corone*)
Other species	Meadow Pipit (*Anthus pratensis*)
	Skylark (*Alauda arvensis*)
	Ring Ouzel (*Turdus torquatus*)
	Wheatear (*Oenanthe oenanthe*)
	Whinchat (*Saxicola rubetra*)
	Stonechat (*Saxicola torquata*)
	Linnet (*Carduelis cannabina*)
	Twite (*Carduelis flavirostris*)
	Yellowhammer (*Emberiza citrinella*)

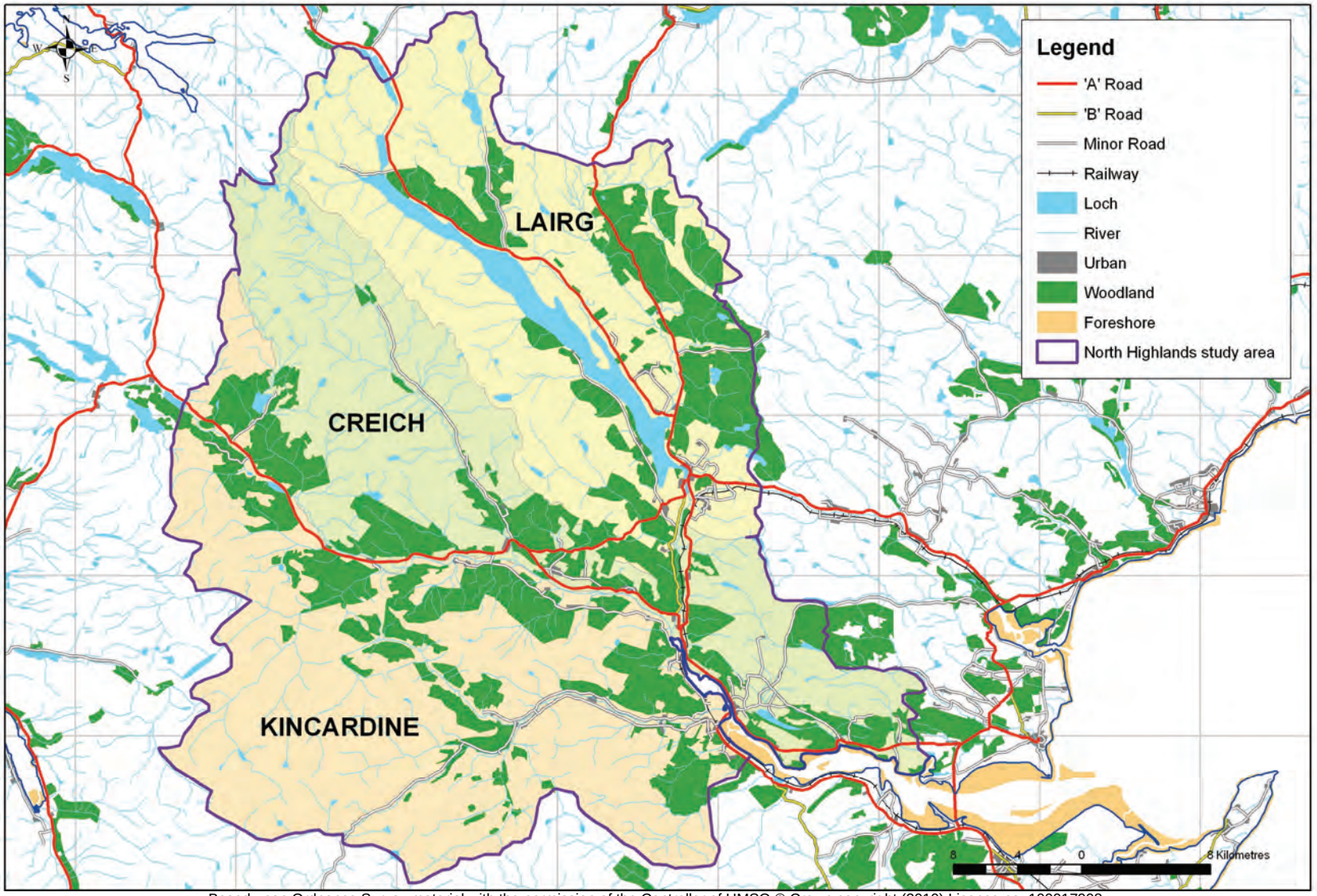
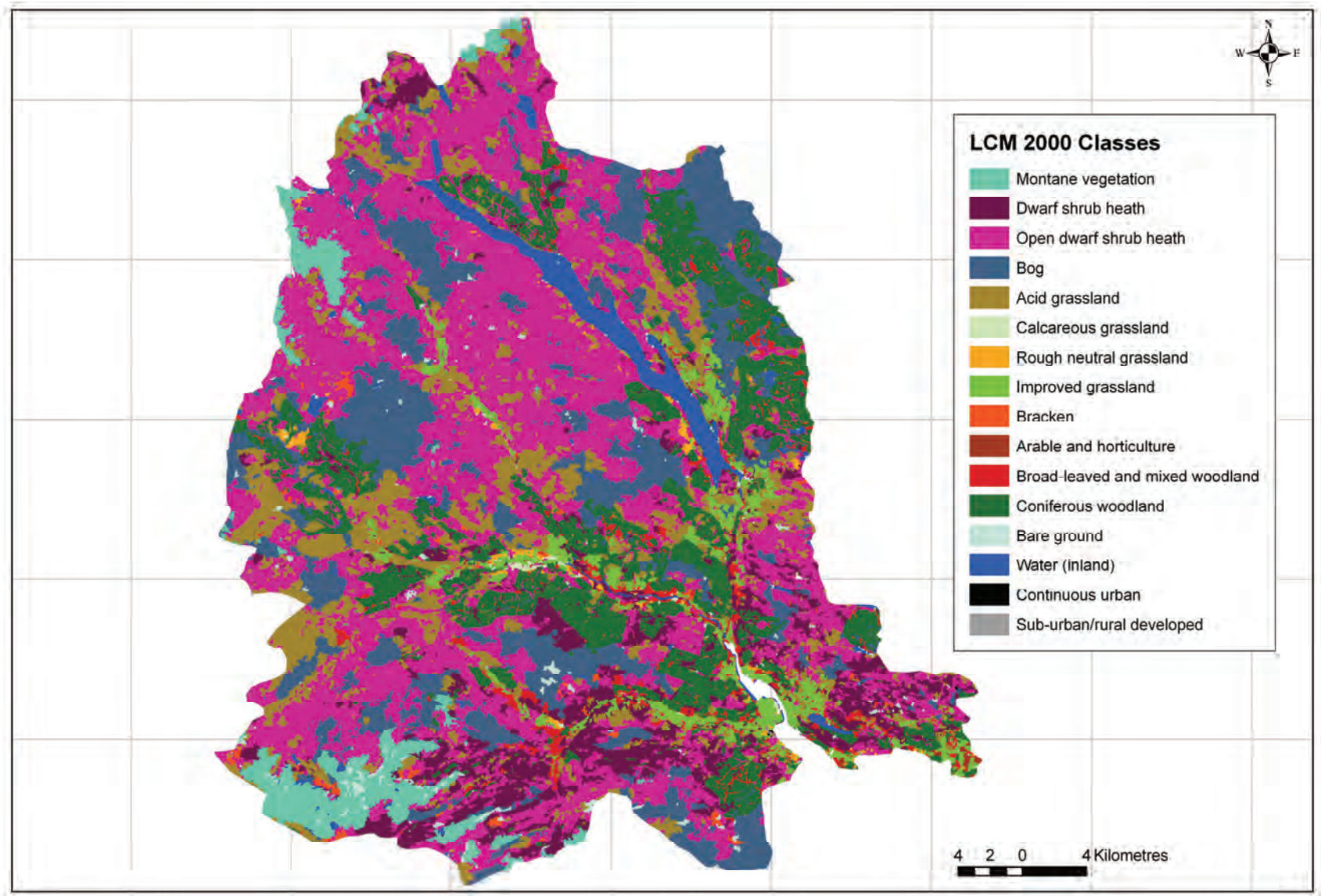


Figure 9.1 - North Highlands study area (parishes of Lairg, Creich and Kincardine).



Based upon CEH Land Cover Map 2000 (LCM2000) data. NERC © copyright.

Figure 9.2 - LCM 2000 land cover map of the North Highlands study area.

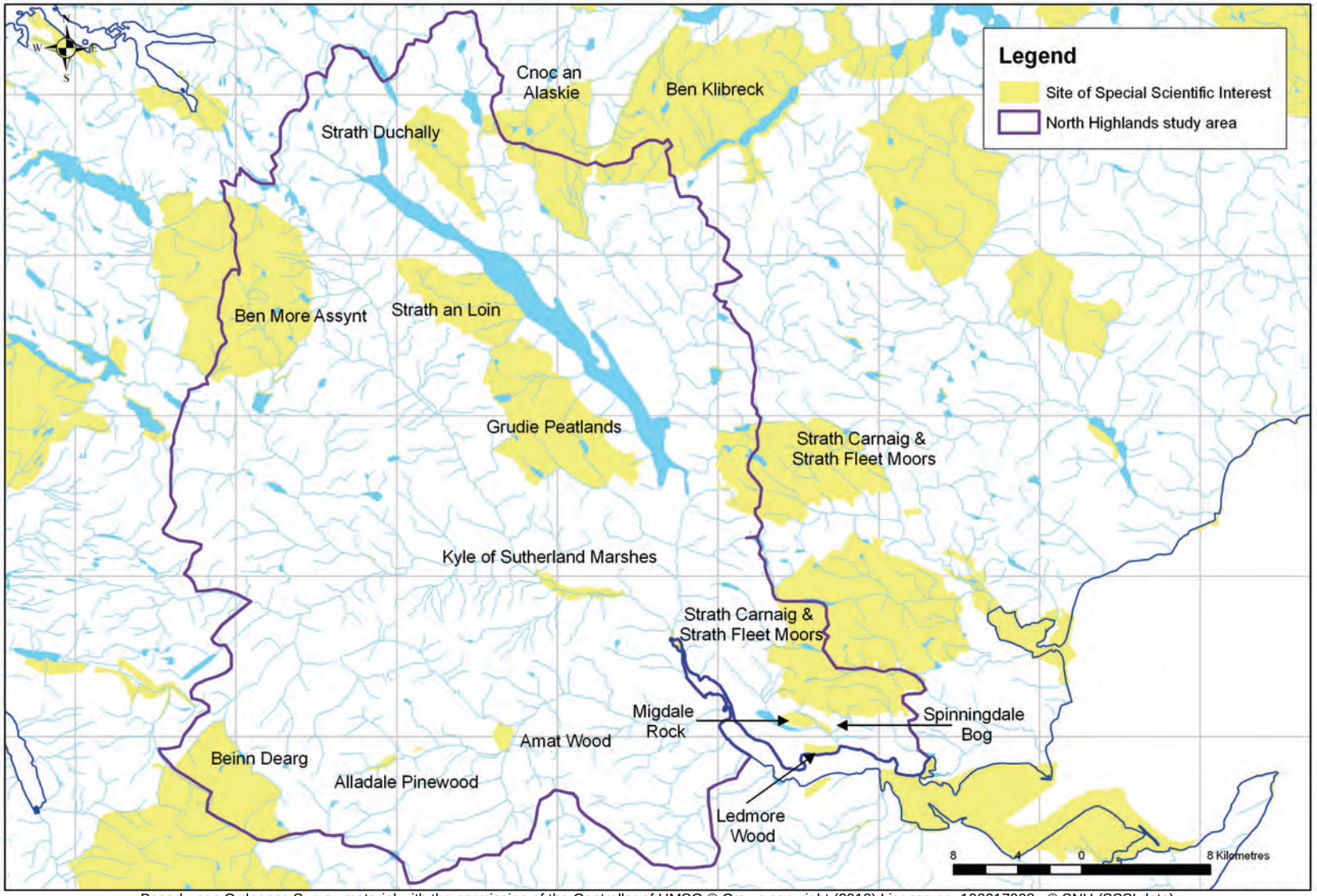


Figure 9.3 - Sites of Special Scientific Interest within the North Highlands study area. Sites designated for their Biological interest are labelled.

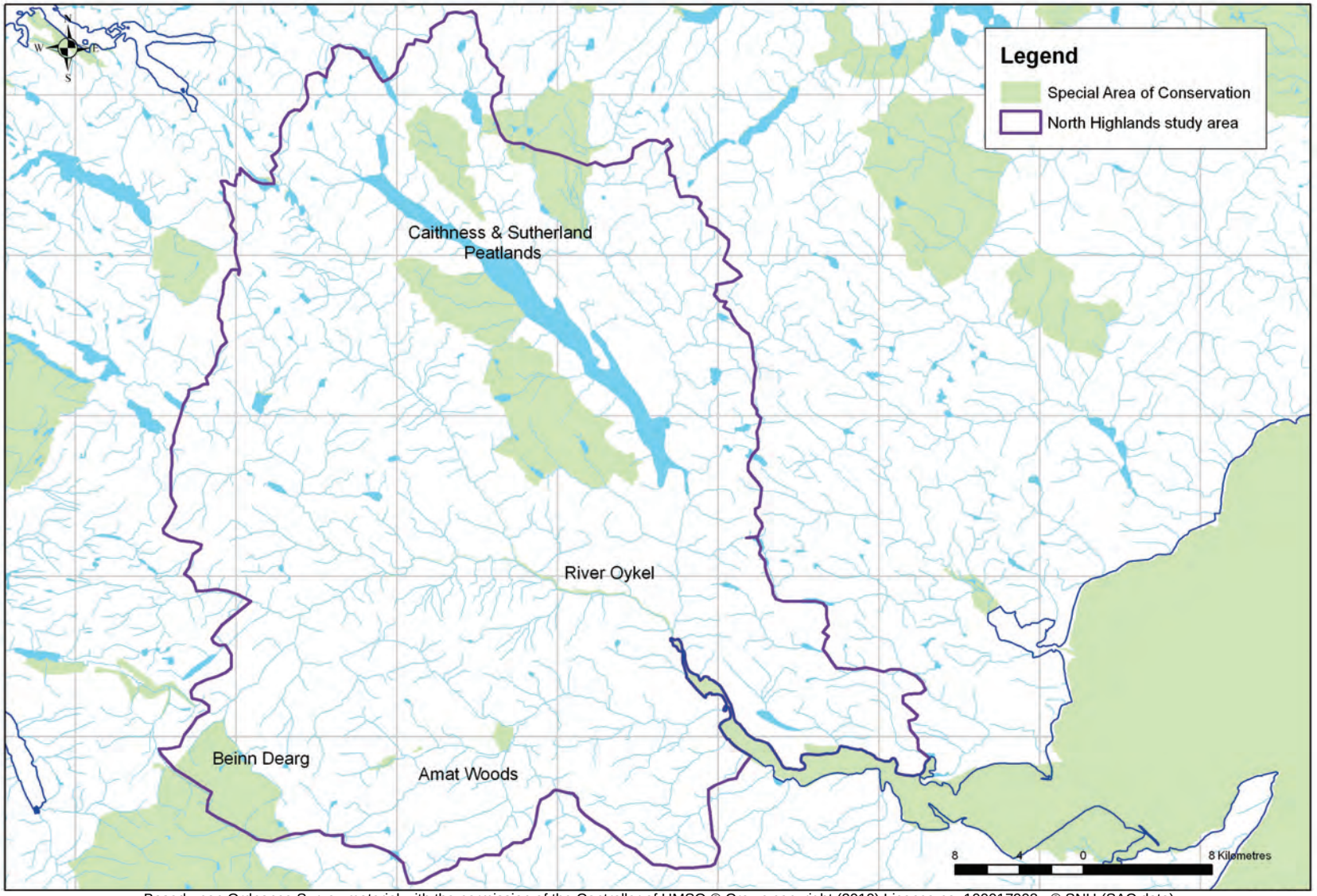


Figure 9.4 - Special Areas of Conservation (SAC) within the North Highlands study area.

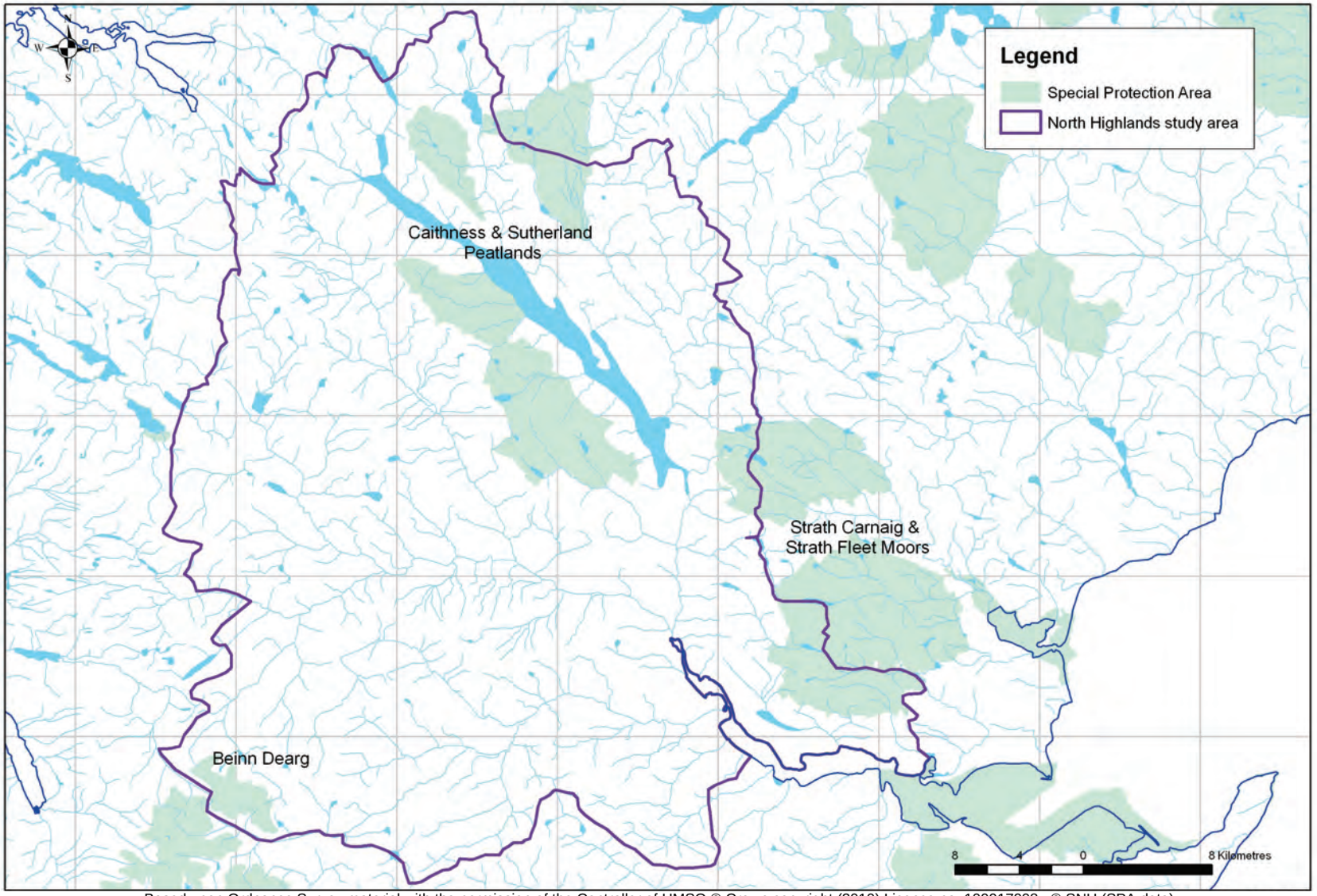


Figure 9.5 - Special Protection Areas (SPA) within the North Highlands study area.

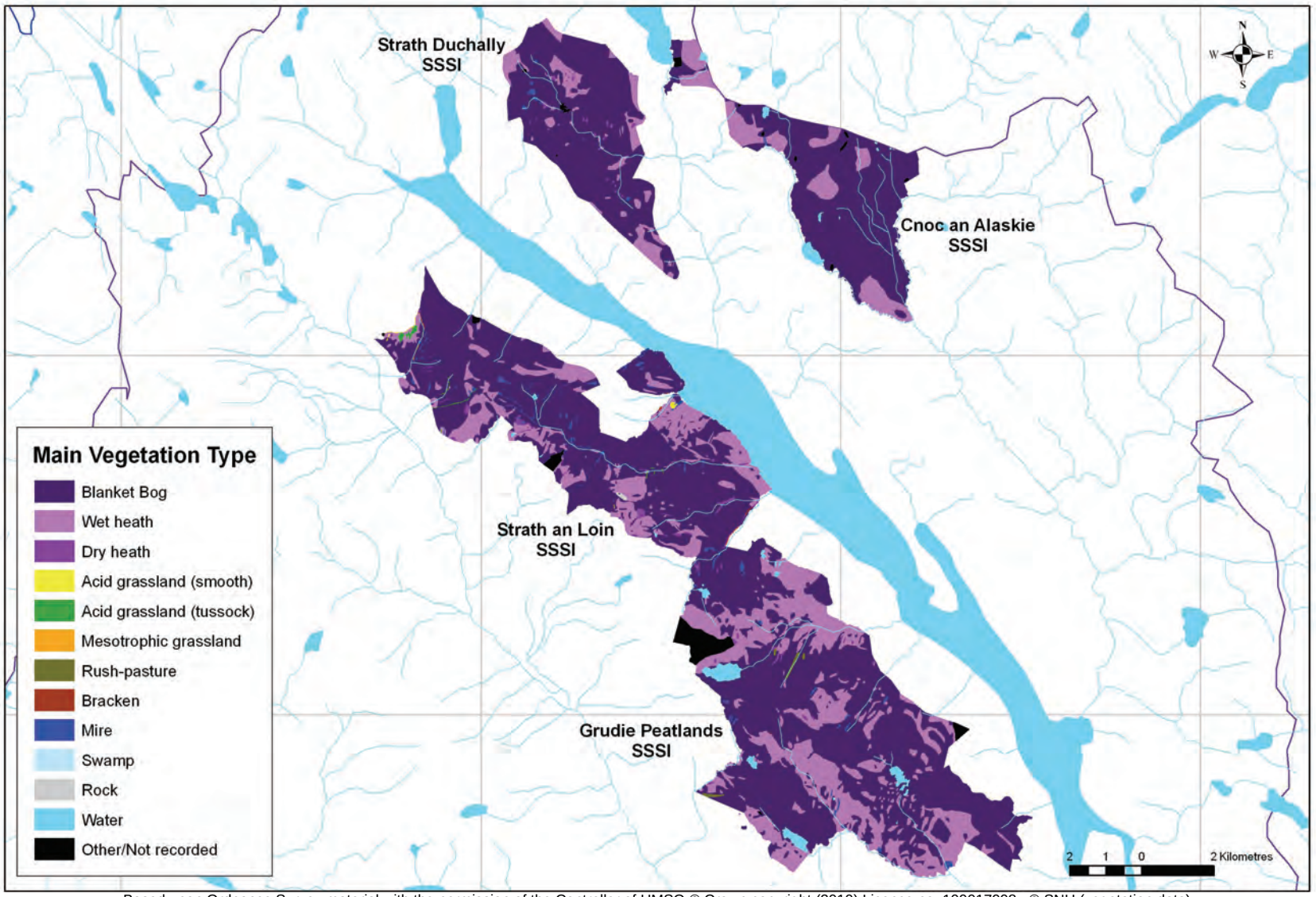


Figure 9.6 - Main vegetation types within the Grudie Peatlands SSSI, Strath an Loin SSSI, Cnoc an Alaskie SSSI and Strath Duchally SSSI.

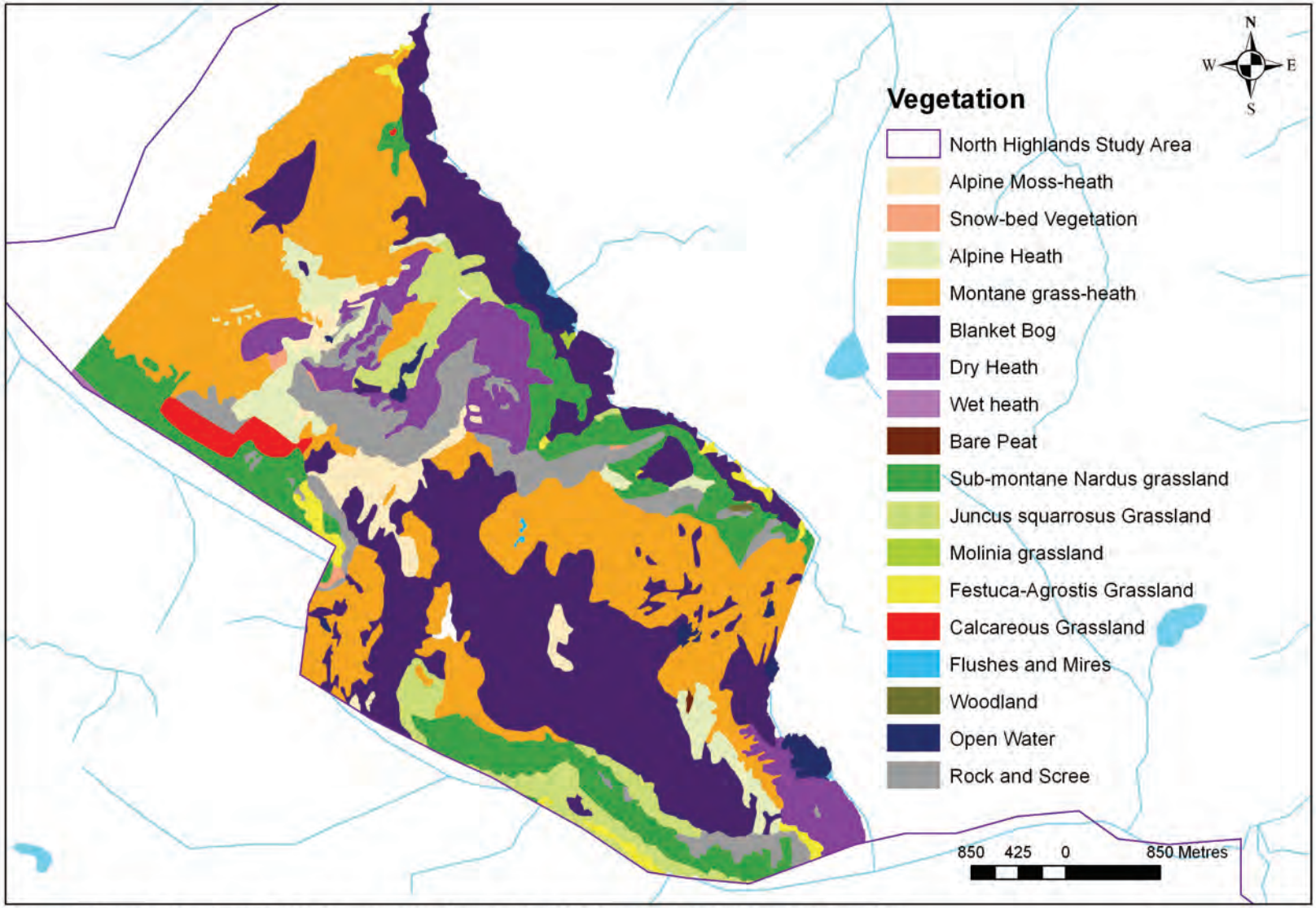


Figure 9.7 - Main vegetation types within the Beinn Dearg SSSI (inside the study area boundary).

Table 9.4 - Sites of Special Scientific Interest (SSSI) within the North Highlands study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Beinn Dearg	2549.26	Birds - assemblages of breeding birds	Breeding bird assemblage	Favourable Maintained	- (long term)?
		Mosaic	Upland assemblage	Unfavourable Declining	+ (short term)? - (long term)?
		Vascular plants	Vascular plant assemblage	Unfavourable No change	
Ben More Assynt	5040.51	Standing open water and canals	Eutrophic loch	Favourable Maintained	
		Rivers and streams	Oligotrophic river/stream	Favourable Maintained	
		Mosaic	Upland assemblage	Favourable Recovered	+ (short term)? - (long term)?
Ben Klibreck	839.95	Montane habitats	Alpine heath	Favourable Maintained	- (long term)?
		Bogs (Upland)	Blanket bog	Unfavourable Declining	- (long term)?
		Standing open water and canals	Oligotrophic loch	Favourable Maintained	
		Broad-leaved, mixed and yew woodland	Upland birch woodland	Unfavourable Recovering	+ (short term) - (long term)?
Cnoc an Alaskie	1651.53	Bogs (Upland)	Blanket bog	Favourable Maintained	
		Birds - assemblages of breeding birds	Breeding bird assemblage	Favorable Recovered	+ (short term)? - (long term)?
		Birds - aggregations of breeding birds	Greenshank (*Tringa nebularia*), breeding	Favourable Maintained	
Alladale Pinewoods	79.08	Coniferous woodland	Native pinewood	Unfavourable Recovering	+ (short term) - (long term)?

Table 9.4 (continued) - Sites of Special Scientific Interest (SSSI) within the North Highlands study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Amat Wood	154.27	Coniferous woodland	Native pinewood	Unfavourable Recovering	- (long term)?
		Broad-leaved, mixed and yew woodland	Upland birch woodland	Unfavourable Declining	- (long term)?
Grudie Peatlands	4784.67	Bogs (Upland)	Blanket bog	Favourable Maintained	- (long term)?
		Birds - aggregations of breeding birds	Dunlin (*Calidris alpina schinzii*), breeding	Favourable Maintained	
		Birds - aggregations of breeding birds	Golden plover (*Pluvialis apricaria*), breeding	Favourable Maintained	
		Birds - aggregations of breeding birds	Greenshank (*Tringa nebularia*), breeding	Favourable Maintained	
Kyle of Sutherland Marshes	369.09	Fen, marsh and swamp (Wetland)	Flood-plain fen	Unfavourable No change	
		Vascular plants	Vascular plant assemblage	Favourable Maintained	
		Broad-leaved, mixed and yew woodland	Wet woodland	Favourable Maintained	- (long term)?
Ledmore Wood	92.47	Broad-leaved, mixed and yew woodland	Upland oak woodland	Favourable Maintained	- (long term)?
Migdale Rock	145.69	Coniferous woodland	Native pinewood	Unfavourable Declining	- (long term)?
		Vascular plants	Vascular plant assemblage	Favourable Maintained	

Table 9.4 (continued) - Sites of Special Scientific Interest (SSSI) within the North Highlands study area designated for their biological or biological and geological interest. Source: SNH Sitelink website (accessed on the 26th January 2011).

SSSI	Area (ha) within Parish Cluster	Feature Category	Feature Description	Condition	Would the removal of grazing have a potential impact on the feature?
Spinningdale Bog	28.54	Fen, marsh and swamp (Wetland)	Valley fen	Unfavourable Declining	+ (short term)? - (long term)?
Strath an Loin	2343.52	Bogs (Upland)	Blanket bog	Favourable Maintained	- (long term)?
Strath Carnaig & Strath Fleet	4428.89	Birds - aggregations of breeding birds	Hen harrier (*Circus cyaneus*), breeding	No Data	- (long term)?
Strath Duchally	1616.24	Bogs (Upland)	Blanket bog	Favourable Maintained	- (long term)?
		Birds - aggregations of breeding birds	Dunlin (*Calidris alpina schinzii*), breeding	Unfavourable Declining	
		Birds - aggregations of breeding birds	Golden plover (*Pluvialis apricaria*), breeding	Unfavourable Declining	
		Birds - aggregations of breeding birds	Greenshank (*Tringa nebularia*), breeding	Favourable Maintained	

9.2 North Highlands livestock changes

The Scottish Government's June agricultural census data shows that breeding ewe numbers in Creich, Lairg and Kincardine declined by 3253, 2983 and 2625 respectively between 1997 and 2008 (Figure 9.8). Breeding cow numbers also declined in Creich and Kincardine during the period 1997 to 2008 from 542 to 391 in Creich, and 432 to 323 in Kincardine (Figure 9.9). Breeding cow numbers were more stable in Lairg declining by 23 over the 11 year period (Figure 9.9).

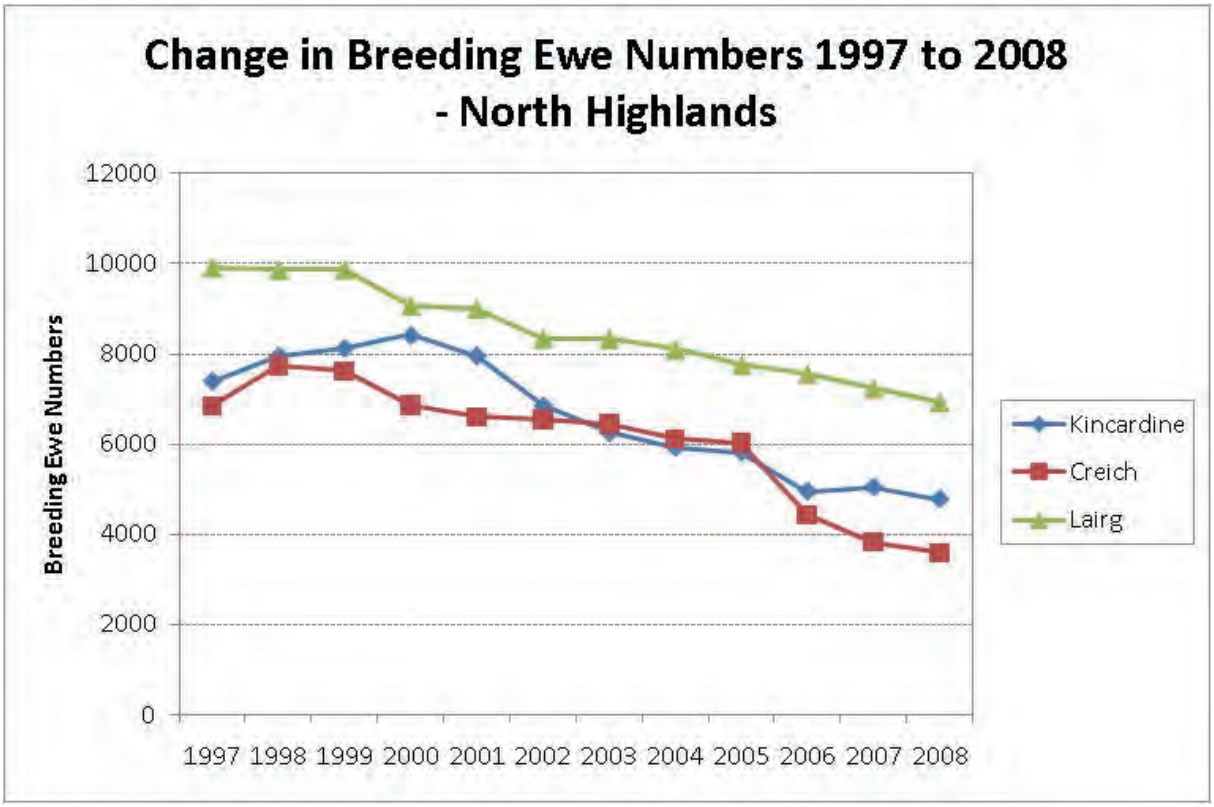


Figure 9.8 - Change in breeding ewe numbers in Creich, Kincardine and Lairg between 1997 and 2008. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

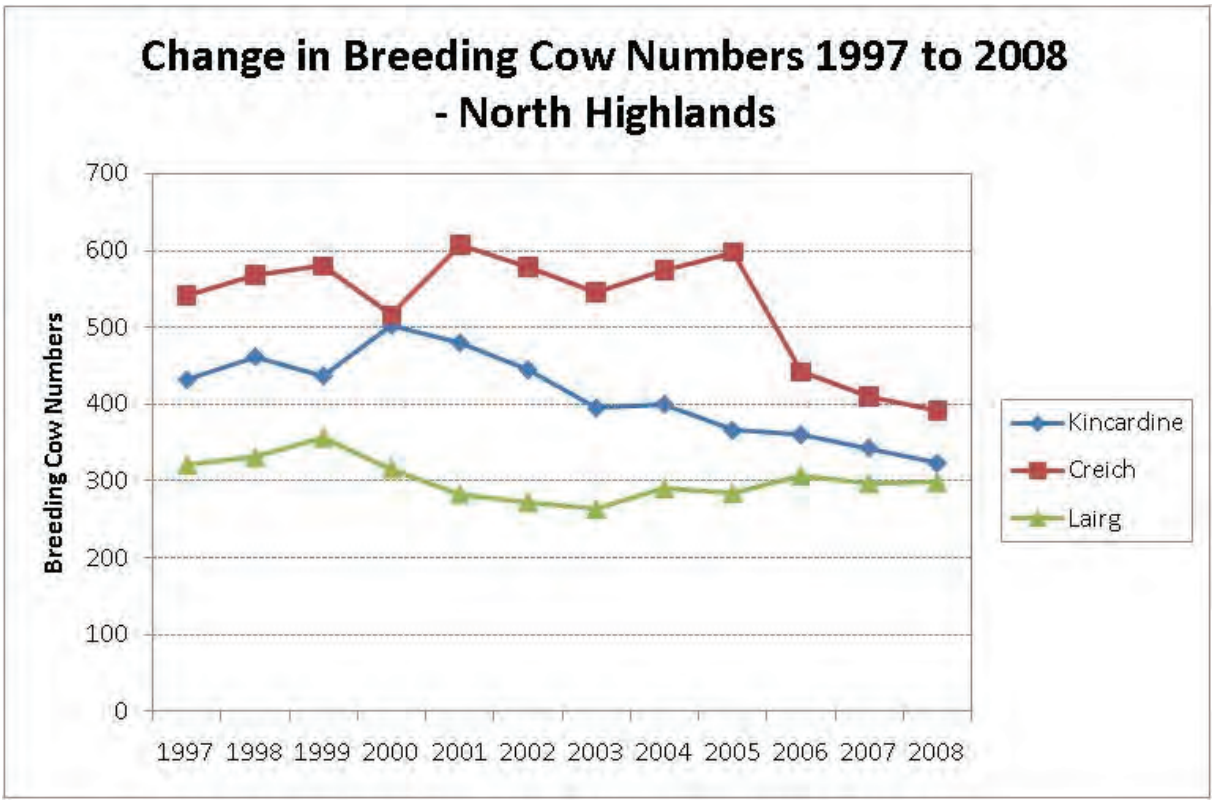


Figure 9.9 - Change in breeding cow numbers in Creich, Kincardine and Lairg between 1997 and 2008. (Source: Scottish Government June Agriculture and Horticulture Census of Scotland).

9.3 North Highlands workshop results

9.3.1 North Highlands - questionnaire results

Summary results from the crofters questionnaire survey carried out at the North Highlands workshop are given in Tables 9.5 and 9.6 and Figure 9.10. The questionnaire results from the non-farmer workshop delegates are given in Table 9.7 (a, b, c and d). Figure 9.11 shows the locations of the main changes in livestock within the North Highlands study area over the last 5-10 years that were identified by the workshop delegates. The numbers and locations are not necessarily completely accurate but give an indication of the changes that have occurred. Other changes including windfarm development and new woodland planting are shown in Figure 9.12.

Table 9.5 - Summary results from the farmers/crofters' questionnaire survey carried out at the North Highlands workshop.

Number of completed questionnaires	3 (1 Lairg, 2 Creich)
Number of businesses within each farm type:	
Crofts/LFA sheep	1
LFA sheep	1
LFA beef and sporting estate (deer and salmon)	1
Number of businesses within each tenure type:	
Owner occupier	1
Tenant	1
Other	1
Number of crofts/farms with arable crops	0
Number of crofts/farms with forage crops	0
Number of crofts/farms with in-bye ground	3
Number of crofts/farms with rough grazing	2
Number of crofts/farms with common grazing	1
Number of crofts/farms with woodland	2
Number of crofts/farms with sheep	2
Number of crofts/farms with cattle	1
Number of crofts/farms with other enterprises	1

Table 9.6 - Summary results of the changes that have occurred since 2005 from the questionnaire survey carried out at the North Highlands workshop.

Changes since 2005	Yes	No
Changes in livestock or management?	3	0
Changes in permanent labour?	0	3
Changes in casual labour?	0	3
Changes in other enterprises?	0	3
Have your neighbours changed their animal numbers?	3	0
Have your neighbours changed their mix of enterprises?	1	1
Any changes in local farming infrastructure?	1	
Any changes in the local community?	1	
Any changes in local landscape?	2	
Any changes in quality of grazing?	2	
Quality of grazing improved		
Quality of grazing declined	2	
Have the changes in the area influenced some of your own changes?	0	3

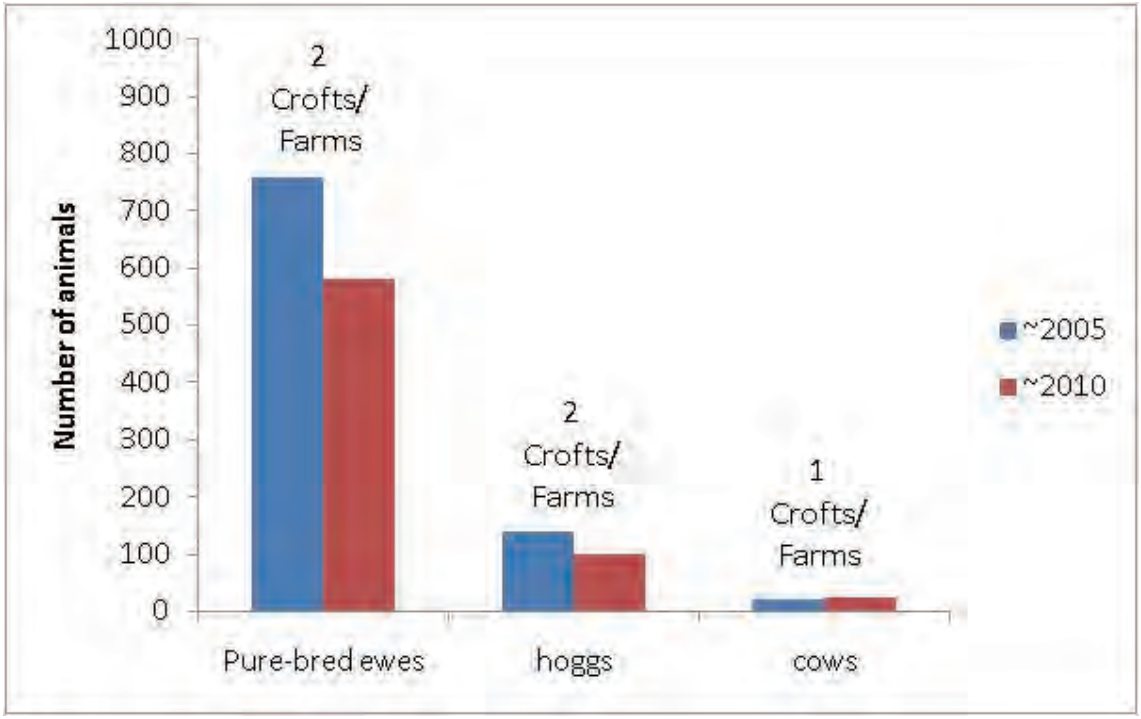


Figure 9.10 - Livestock numbers kept by the North Highlands workshop crofters/farmers in 2005 and 2010.

Table 9.7 - The main changes and impacts on the natural heritage due to the decline in hill farming in the North Highlands study area as outlined by the non-farmers in their questionnaire survey (includes data from two workshop delegates and three people who did not attend the workshop).

a) Landscape

Changes Observed	**Importance** Very important = 1 Important = 2 Not very important = 3	**Cause of the Change**
Less livestock and infrastructure associated with agriculture	1	1) Change in subsidy payments. 2) Poor financial return for the efforts involved. 3) Not attractive for young people to take up farming.
Increased woodland cover (Commercial Forestry)	1	1) Sale of agricultural ground to state and private forestry.
Increased woodland Cover (native woodland plantations and regeneration)	1	1) Generous grants available that have increased. 2) Reduction in grazing levels.
Bracken increase	2	1) Reduction in grazing levels – especially cattle.
Decline in heather	2	1) Reduction in grazing, poor management of muirburn.
Loss of rich grasslands / fen meadow	2	1) Changes from hay to silage. 2) Loss of cattle grazing on wet meadows 3) Increase in siltation and flooding of Kyle of Sutherland.
Increase in housing	3	1) A considerable area of good agricultural (croft) ground has been lost to housing in the last 5 years but there has been a sharp decrease in those actively managing the ground.

b) Vegetation

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Increase in bracken, ragwort, gorse and other 'weed' species	1	1) Less livestock. 2) No incentive to control bracken and expensive.
General increase in native woodland species, especially birch and rowan.	1	1) Generally due to reduction in grazing or specifically through woodland grant schemes.
Increase in tufted hair-grass (*Deschampsia cespitosa*) and rushes (*Juncus* spp.)	1	1) Large increase in these species (to the detriment of others) on both re-seeds (improved hill ground) and wet pasture. Caused by reduction of grazing and lack of active management of these areas.
General decrease in biodiversity of moorland and grassland plant species.	1	1) Caused by reduction of grazing and lack of active management of these areas.
Areas of poor heather burning	2	1) New estate owners wanting to improve shooting potential. 2) Poorly managed muirburn
Heather cover decline in the south east of the area	1	1) Large scale early burning by graziers. All mature stands burnt. 2) Patch burning on Skibo Moor (Spinningdale) in an effort to create a new grouse moor.

c) Fauna

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Hen harrier decline in breeding population	2	1) Change in the condition and quality of heather. 2) Loss of heather cover for nesting. 3) Suspected persecution
Decline in black grouse in some areas	1	1) Change in vegetation/habitat cover
Black grouse increase in some areas		1) Black grouse have benefited from some new native woodland schemes (e.g. south east of Lairg) and a targeted project to the north of the Dornoch Firth where the RSPB is encouraging landowners to reduce the levels of deer grazing.
Decline in merlin population	1	1) Change in the condition and quality of heather.
Decline in curlew population	1	1) Change in vegetation/habitat cover especially lack of grassland/heather mosaics on moorland.
Decline in adder population		1) Reason not known – used to be seen regularly, but not seen for years.
Increase in midge population		1) Lot more midges in the last 5 years – might be due to more woodland cover (shelter from wind) and general weather/climate trends.

d) Community

Changes Observed	Importance Very important = 1 Important = 2 Not very important = 3	Cause of the Change
Very few younger people in crofting or farming, many young people moving away to get jobs	1	1) Further education opportunities outside the parishes. 2) Can't make money from crofting making it unattractive. 3) Disintegration of local society, with fewer young people staying in the area. 4) Lack of local job opportunities.
More housing	1	1) Relatively affordable prices for people selling property in the south of the UK. 2) A clean and healthy environment in which to live
Increase in non-agricultural residents	1	1) Less attractive for local people to stay in the area to make a living from agriculture. 2) People looking for the rural idyll.
Reduction in the traditional 'feel' of the area		1) Fewer farming families.
Change in demographics		1) More older people and fewer children to keep village schools open.
Community "spirit" changing		1) With many more people moving into the area and changes in the way these communities are serviced, there is a consequent change in the way the local population interacts with each other. Community interactions tend to be more "issue" based rather than "social".
Commuter Suburbs		1) Many villages and hamlets in the study area now have a fairly high proportion of people who commute long distances to work. This might explain why there is less time to manage the land!
The number of crofts/farms may have decreased slightly but the number of active crofters/farmers has declined a lot.		
High prices of houses and land, and high cost of equipping a holding.		

9.3.2 Changes that have happened in the North Highlands area in recent years and the impacts of these changes

The participants identified a number of changes that had occurred in recent years in the North Highlands study area, some of which directly relate to local livestock and land management changes, but others relate to social, economic and land-use changes that are taking place more widely.

Key changes in flora, fauna, landscape and rural community as indicated by the workshop delegates:

- Decline in sheep numbers due to the economics of crofting and hill farming and the subsidy system (SFP), which has allowed people to have no stock at all and still receive payments. In many areas sheep have been completely removed from the hill ground rather than simply reduced in number. See Figure 9.6 for an indication of the scale and extent of the declines
- The number of cows has tended to be more stable and has increased in some areas partly as a result of RSS payments which were very favourable for crofters with small numbers of animals
- On one common grazing, with 28 shareholders, only two are actively grazing the hill ground. In total, 12 crofters have sheep on the inbye ground (not many animals in some cases). It is the same story for all the common grazings in the area
- Commercial forestry restructuring and expansion, and increase in native woodland planting schemes, mainly as a result of the available grants
- More sporting interests (salmon fishing, deer stalking and red grouse)
- Increase in renewable energy schemes (windfarms and hydro-schemes). The topography of the landscape and available grid connections make this area very suitable for further windfarm development
- No forage crops grown and less reseeding and ploughing
- Although hay is still made when possible, the weather has become wetter making it more difficult. There is also a lack of available machinery in the local area to make hay. Small bale hay has to be bought which is expensive
- Increase in bee keeping
- Increase in the number of horses (particularly close to the towns)
- Increase in deer population (problems with deer management in some places)

Impacts of these changes:
On vegetation:

- Rank vegetation has developed where grazing has been reduced.
- Encroachment of commercial forestry onto previously grazed land.
- Decline in heather condition and quality in some areas

On fauna:

- Decline in the breeding population of hen harriers
- Woodland expansion has benefited black grouse in some areas (at least in the short term)
- Sparrowhawks, buzzards, corvids, pine martens, badgers and foxes have all increased
- Increase in barn owls
- Decline in hill passerines (wheatear, meadow pipit)

On the landscape:

- Local farm infrastructure has become worse (less maintenance of fences, fanks etc.)

On social/local community:

- A decline in rural skills, especially cattle husbandry
- Markets have closed or reduced business. Lairg now has 20,000 fewer sheep in the 1st sale than it had 10 years ago
- School rolls are declining (e.g. Rosehall School has dropped from 29 students to 5)
- Crofting is no longer sustainable on its own, and crofters need a second job to sustain the croft
- There is less local trade, and the community is less reliant on local businesses as transport has improved (people would go to Tain or Inverness or Thurso instead of getting things locally)
- It is difficult for new entrants/young farmers to set up farm/crofting businesses as there are no places on the market. The SFP is also a problem for new farmers as 'older' or 'less active' farmers keep their SFP and sell the land without it

Other Issues raised by the delegates:

- Without an existing holding (from a parent or relative), it is almost impossible to enter farming/crofting
- Farming/crofting is non viable without subsidies, and always has been
- There are few direct employment benefits for locals at the new windfarm and hydro-scheme developments as most of the jobs are subcontracted out to companies outside the area
- Even though there is extensive forestry in the area there are relatively few local forestry jobs. In the past crofters often worked part-time for the forestry and were given incentives to do so, but this doesn't happen anymore
- Woodland grazing under the new SRDP option would improve the vegetation in some woodlands
- Salmon fishing and deer stalking are very important for jobs in the area (more important than farming). Clients pay considerable fees to shoot and fish and the hotels and restaurants, etc. are dependent on income from these visitors
- Some estates had put sheep (wethers) back on to the hills as tick mops, but the delegates did not know to what extent this had been done
- The wool price has improved, but it is now difficult to get shearers

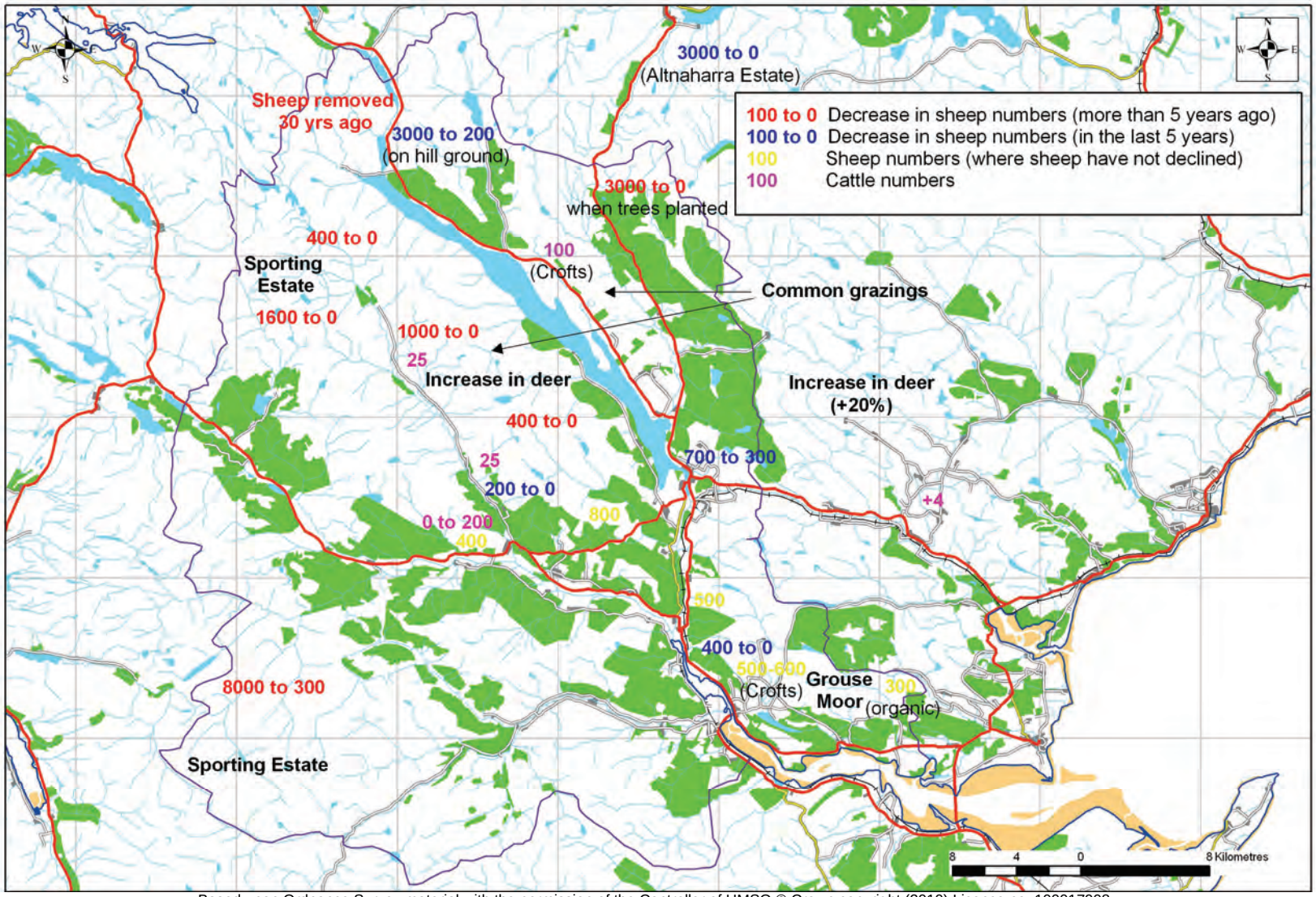
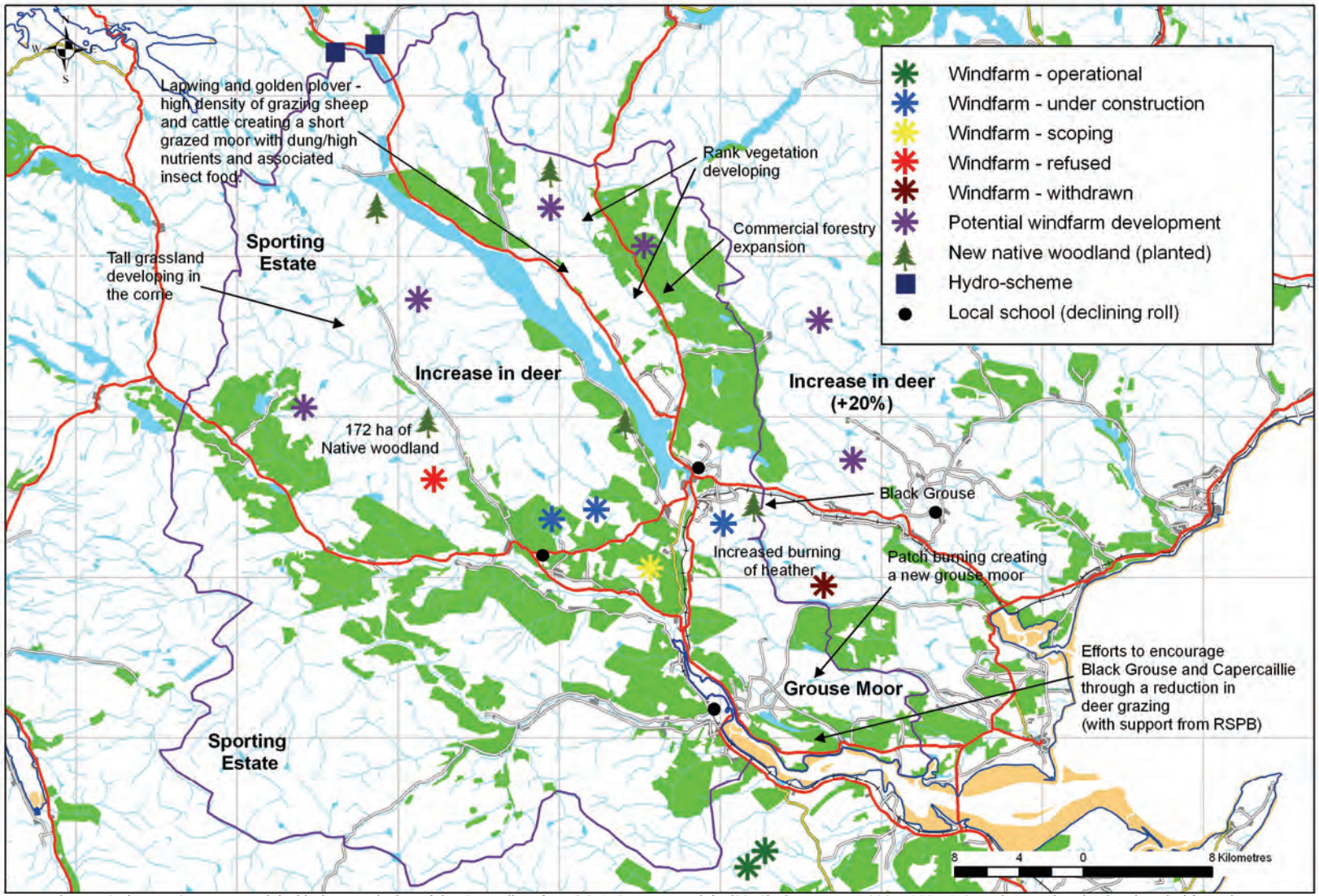


Figure 9.11 - Indicative changes in livestock numbers within the North Highlands study area from information gained at the workshop.



Based upon Ordnance Survey material with the permission of the Controller of HMSO © Crown copyright (2010) Licence no. 100017908. © SNH (vegetation data). The wind farm data came from the Highland Council website except for the potential wind farm development information which came from the workshop delegates.

Figure 9.12 - Other changes within the North Highlands study area.

9.3.3 What management changes might take place in the North Highlands in the future?

- How sheep numbers change in the future will depend on future subsidies. However, there will soon be a tipping point in animal numbers where it will be impossible to re-stock the hills
- Tree cover will continue to increase
- Local skills will be lost. At the local high school, very few students showed any interest in entering land based jobs (less than 2%), and the expectations of working on the land are very low. Also, there are no opportunities for apprenticeships in the area, and young people are expected to go to university and not into trade
- The issue of improved deer management was raised. The idea of eating healthy red meat, such as venison, is not marketed well. It could be an opportunity for farmers and landowners if the whole industry was more integrated (from deer management through to the marketing and sale of venison)

9.4 North Highlands - future impacts on the natural heritage and landscape

Any further reductions in livestock numbers are unlikely to have major impacts on the hill ground within the North Highlands study area unless deer numbers are managed. Deer are likely to move in to areas where livestock have been removed. Without targeted deer control some of the important dwarf-shrub heath and bog habitats are likely to remain at risk of moderate to high herbivore impact levels. Some areas of calcareous grassland and improved grassland in the inbye ground and crofting areas may be at risk of under-management if livestock numbers continue to fall, leading to an increase in the area of rough grassland, with reduced structural heterogeneity, and the encroachment of scrub and woodland. The area of cultivated land may also decline as a result of reduced labour and changing economics. This may have an impact on a number of bird species including finches and buntings that feed on weed seed and spilt grain. The potential loss of upland habitat within the area to further afforestation and wind farm development are likely to be major issues that will have impacts on both the natural heritage and landscape of the area.

10 CONCLUSIONS FROM THE CASE STUDIES

The decline in hill farming and crofting was recognised as a significant issue by the workshop delegates in all three areas. Many of the same issues were raised at the three workshops (Table 10.1). Social, economic and community related impacts were generally seen as more important or serious than natural heritage impacts by the majority of workshop delegates. There were very few positive or beneficial impacts identified. More negative impacts on the natural heritage were highlighted by the delegates at the South Skye and North Highlands workshops, than at the West Borders workshop. This may be due to the complete removal of livestock from large areas of hill ground and the abandonment of some croft land in South Skye and the North Highlands, whereas although sheep numbers had declined in the West Borders, most of the hill and inbye ground remained actively managed. Although some of the impacts raised were not directly linked to a decline in livestock farming, nearly all of them had some connection with the issue.

Most of the people at the case study workshops were farmers or crofters with only limited, often anecdotal, knowledge of the natural heritage changes that had been occurring, but with clear views about the negative social and economic impacts of the decline in hill farming and crofting. Information provided by the conservationists and other non-farmers also tended to focus on the negative rather than positive impacts. Most of the data provided by the workshop delegates in terms of natural heritage changes was qualitative and anecdotal. There was very little quantitative data available either from the workshops or elsewhere that was directly linked to recent changes in livestock.

Table 10.1 - The main natural heritage impacts mentioned at the workshops.

Impacts	South Skye	West Borders	North Highlands
Decline in area, quality and diversity of species-rich lowland grassland and/or fen	✓		✓
Decline in black grouse in some areas		✓	✓
Decline in brown and/or mountain hares	✓	✓	✓
Decline in cultivation, forage crops, reseeding and drainage	✓	✓	✓
Decline in hay production	✓		✓
Decline in hen harriers	✓		✓
Decline in merlins			✓
Decline in inbye/croftland passerines	✓		
Decline in inbye/croftland waders	✓	✓	
Decline in invertebrates (including moths and bumblebees)	✓		
Decline in moorland passerines	✓		
Decline in the quality and condition of heather moorland in some areas	✓	✓	✓
Decline in upland waders	✓	✓	✓
Disappearance of grey partridge		✓	
Loss of permanent pasture	✓		
Increase in bracken			✓
Increase in corvids	✓	✓	
Increase in non-native invasive plant species	✓		
Increase in ragwort		✓	✓
Increase in tall, rank vegetation	✓	✓	
Increase in rushes and/or tufted hair-grass	✓		✓
Increase in silage production	✓		
Increased muirburn		✓	✓
Increase in scrub	✓	✓	✓
Increase in woodland planting (commercial conifer)	✓		✓
Increase in woodland planting (native)	✓	✓	✓
Increase in woodland regeneration	✓		✓
Increase in deer numbers	✓		✓
Increase in foxes and badgers		✓	✓
Increase in pine martens			✓
Increase in buzzards and/or sparrowhawks	✓	✓	
Increase in goshawks		✓	
Increase in pheasants and/or red-legged partridge		✓	
Increase in black grouse in some areas (targeted management)		✓	✓
Restoration of heather moorland in some areas		✓	

Impacts marked in red were generally perceived to be negative; impacts marked in green were generally perceived to be positive; impacts marked in blue were seen as either positive or negative.

11 SYNTHESIS WORKSHOP

In addition to the case study area workshops there was a further national workshop mainly of ecological experts, with knowledge of particular species groups or habitats within the uplands. This workshop was used to review the information gained from the local workshops and to scale up the impacts to a national level. The workshop delegates were split into two groups. One group was asked to consider what impacts two scenarios; a reduction in sheep numbers plus the removal of cattle, and the complete abandonment of the land, would have on species diversity and habitats on inbye ground and croft land. The other group was asked to consider what impacts the two scenarios would have on the natural heritage of the hill ground. The workshop was held in Edinburgh on 25th March 2010. Fifteen delegates attended the meeting.

11.1. Synthesis workshop results - impact diagrams

The results from the two workshop groups for the two scenarios; (1) a reduction in sheep plus the removal of cattle, and (2) abandonment, are shown in Figures 11.1 to 11.4.

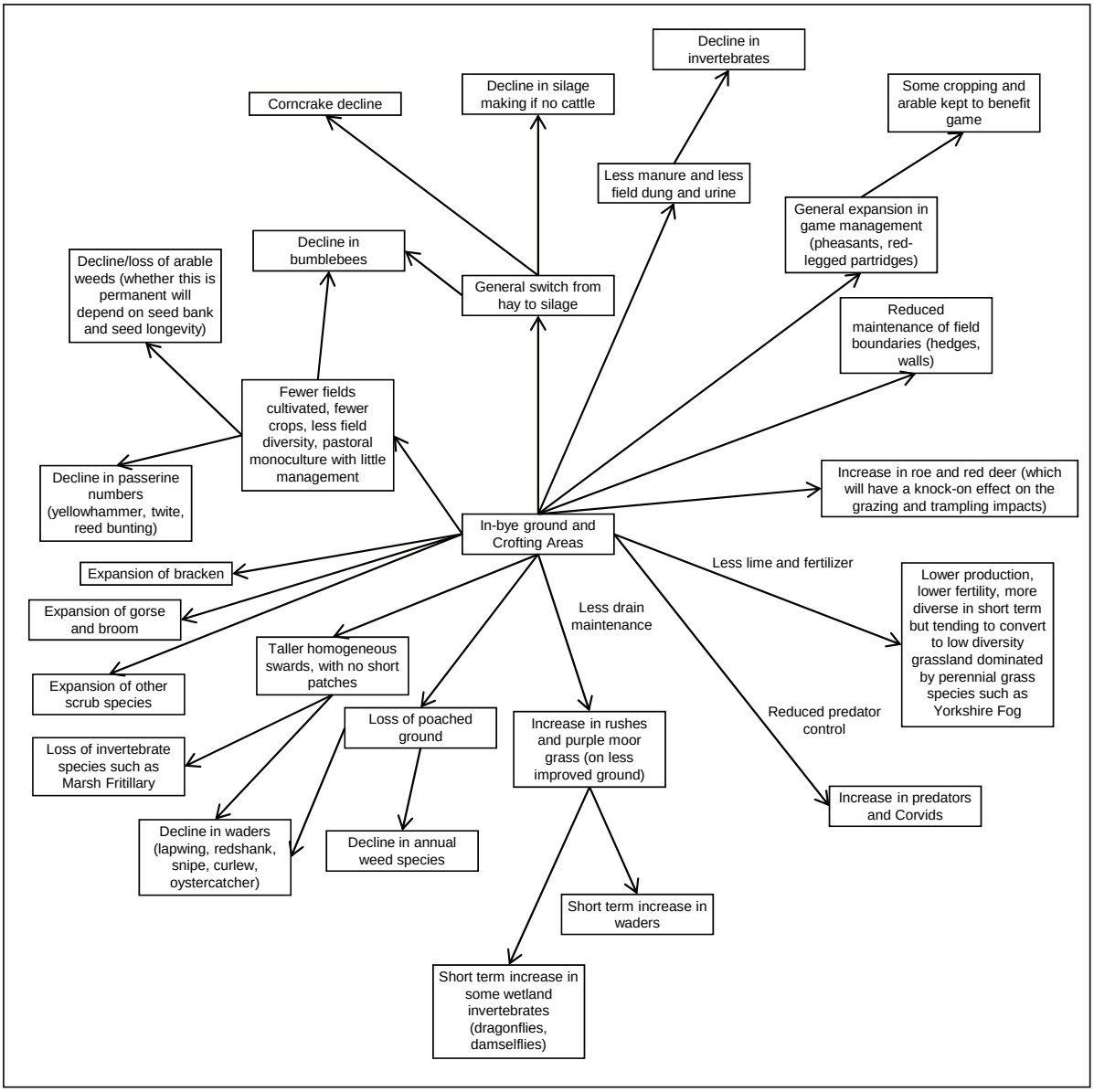


Figure 11.1 - The impact of a reduction in sheep numbers and the removal of cattle on the natural heritage of in-bye ground and croft land.

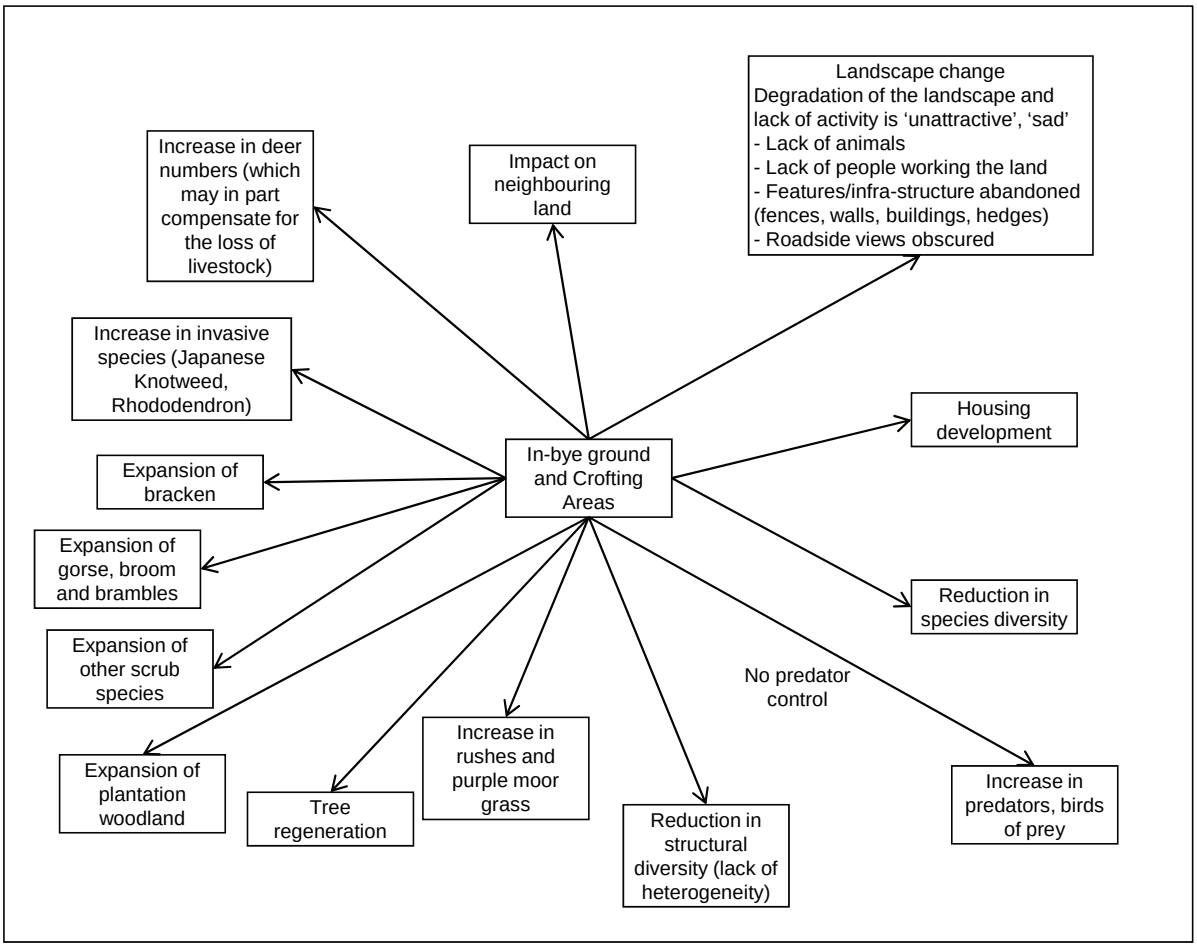


Figure 11.2 - The impact of abandonment on the natural heritage of in-bye ground and croft land.

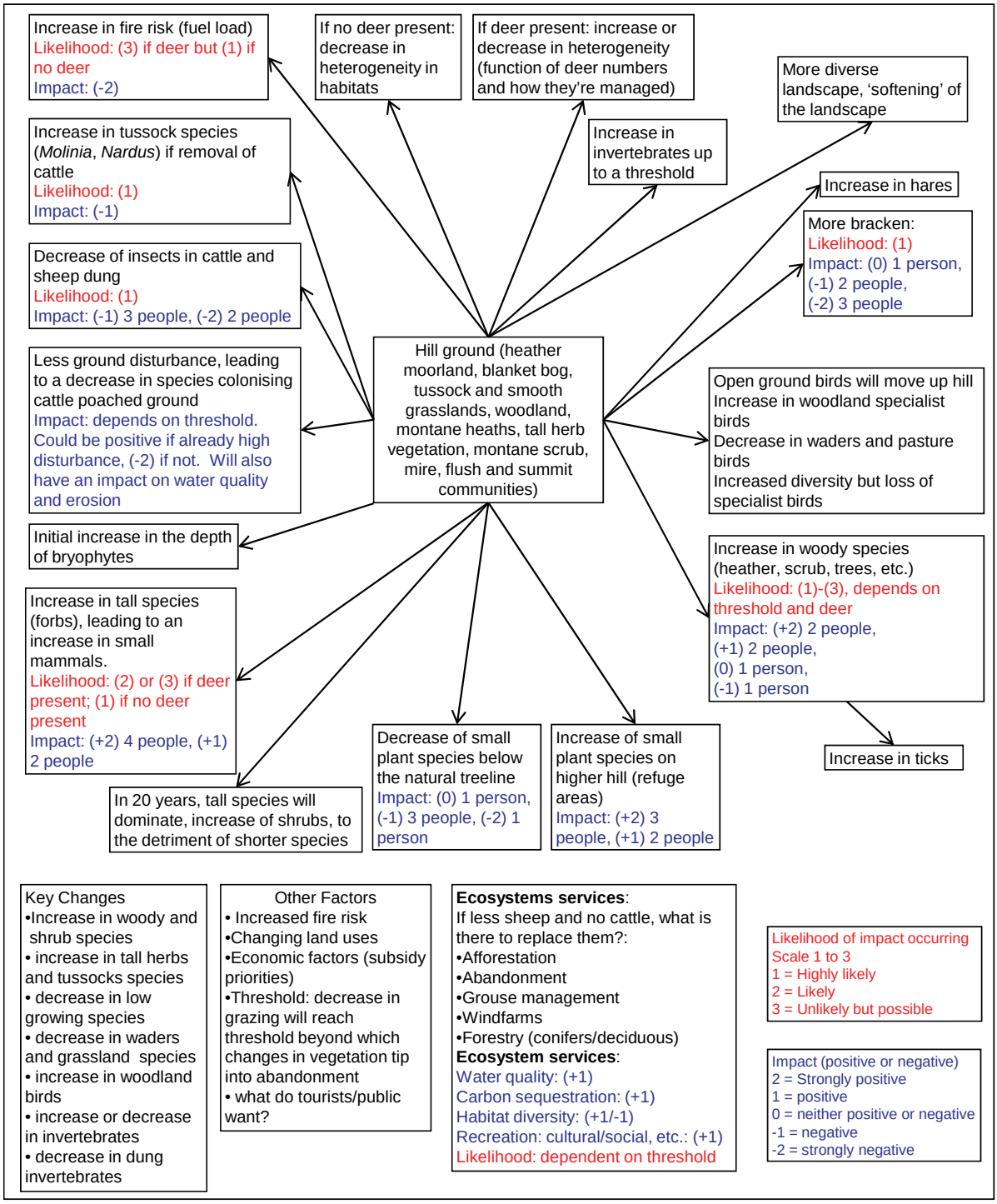


Figure 11.3 - The impact of a reduction in sheep numbers and the removal of cattle on the natural heritage of hill ground.

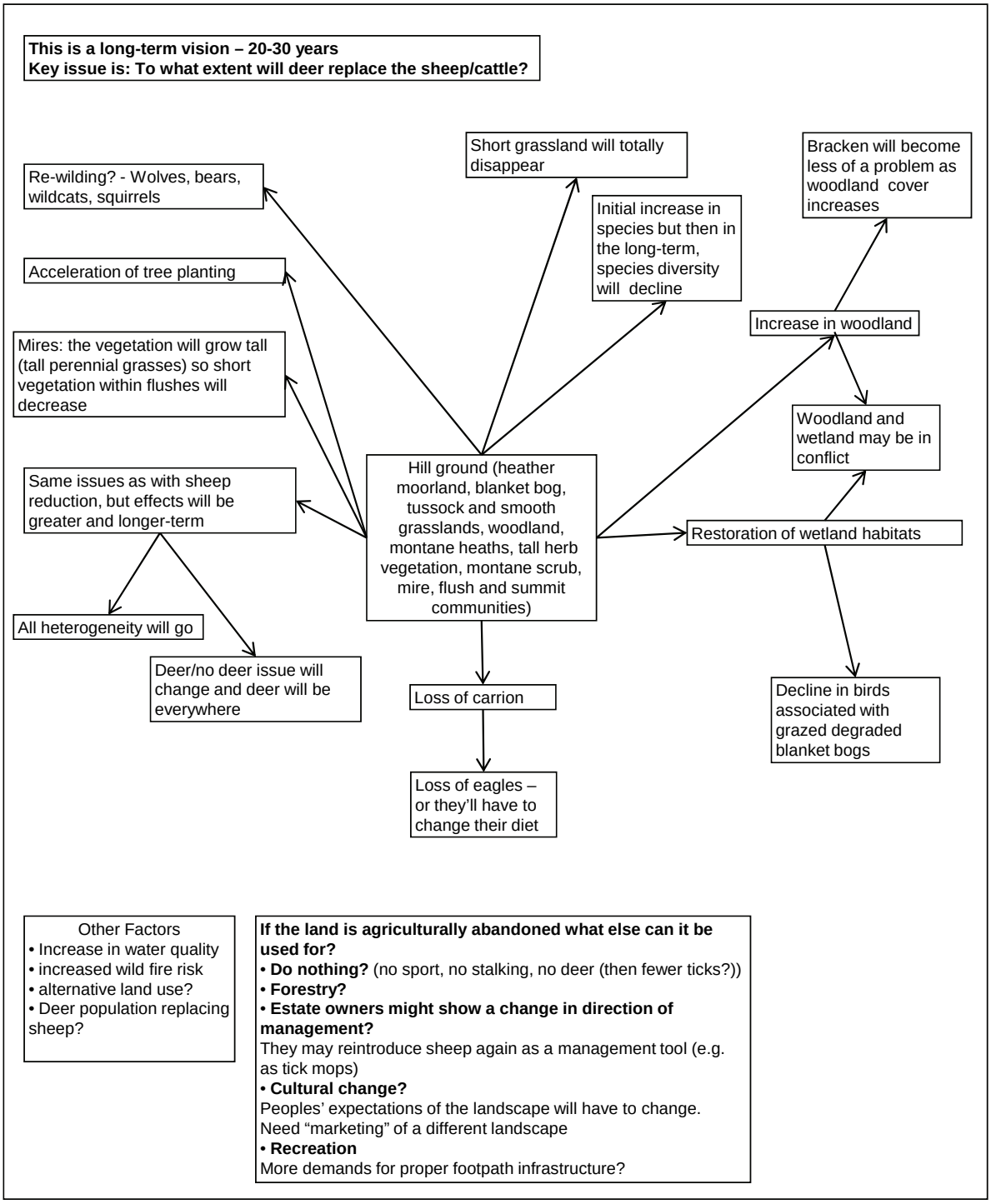


Figure 11.4 - The impact of abandonment on the natural heritage of hill ground.

11.2 Evaluating the impacts

Some of the key impacts that were highlighted by the delegates were then collated into a table and the delegates were asked to assign a value to each in terms of whether they thought the impact was positive, neutral or negative (2=strongly positive, 1=positive, 0=neutral, -1=negative, -2=strongly negative). Since some of the impacts can be both positive and negative depending on the criteria considered, the delegates were asked to consider the impacts in relation to nature conservation, cultural value, and socio-economics. The median values are shown in Table 11.1. There were very few impacts that were considered to be strongly positive (marked in green in Table 11.1), but far more that were considered strongly negative (marked in red in Table 11.1), particularly relating to the inbye ground.

Table 11.1 - Values assigned by the workshop delegates to some of the main impacts they highlighted at the workshop. The median values are shown.

Hill Ground	Nature Conservation	Cultural Value	Social and economic
Less short grassland	-1	0	-0.5
More tall grassland	0.5	0	0
Upland bird communities move up hill	-1	0	-0.5
More woody species	1	0.5	1
More small mammals	**2**	0.5	0
Increase in small species 'up hill'	1	0	0
Decrease in small species 'down hill'	-1	0	0
Softening of the landscape	1	0.5	0
More tussock species	-1	-1	-0.5
Less ground disturbance – less dung , less insects	-1	-1	0
Re-wilding	**2**	1	1
Deer	-1	0	0.5
More bracken	-1	-1	-1
Less diversity in habitats	**-2**	-1.5	-1

Inbye Ground	Nature Conservation	Cultural Value	Social and economic
Reduced diversity of crops/grass (monoculture)	**-2**	-1.5	**-2**
More/better wetland due to reduced drain maintenance	1	0	-1
Decline in passerines	-1.5	-1	0
Decline in arable weeds	**-2**	-1	0
Expansion of scrub/rushes	-1	-0.5	-1
Increase in corvids	-1	-1	-1
Increase in invasive species	**-2**	-1	-1.5
More bracken	-1.5	-1	-1
More trees	**2**	0.5	0.5
Reduced linear features	-1	**-2**	-0.5
Loss of historic landscapes	-1	**-2**	**-2**
Increase in deer	-1	0	0
Loss of species rich grassland / hay meadows	**-2**	**-2**	0
Decline in soil quality e.g. loss of organic manure	-1	0	-1.5
Locally more intensive livestock (displaced from the hill), more poaching	-1	-1	-0.5
Less intensive livestock – less poaching	0	0	0

2= strongly positive, 1 = positive, 0=neutral, -1= negative, -2 = strongly negative

The workshop concluded with a group discussion where a number of questions were asked:
1) How do we manage land to try and maintain the benefits or to mitigate detrimental changes?
2) What are the policy changes that are required and how do we achieve them?
3) Do we have the mechanisms to understand the impacts? Does it matter?
4) Is irreversibility an issue?

Some of the comments and issues that were raised during the discussion are listed in Appendix C.

12 IMPACTS OF FUTURE DECLINES IN UPLAND LIVESTOCK FARMING

Information from the literature review, census data and workshops has been used to determine the features and areas that are thought to be most at risk from further declines in livestock and these are shown in Table 12.1.

Table 12.1 - Features and areas thought to be most at risk from further declines in livestock.

Feature	Main Areas	Main threat
Montane calcareous grassland	Central Highlands	Under-grazing
Upland grass-heath mosaics	Borders Dumfries & Galloway North Highlands	Expansion of forestry Expansion of forestry Expansion of forestry
Upland acidic grasslands	West and Central Highlands	Under-grazing and bracken encroachment
Improved grassland including rotations	Throughout, but especially in crofting areas	Abandonment
Fodder crops and other cropping land	Throughout	Lack of cultivation

The features and areas thought most likely to benefit from further declines in livestock are shown in Table 12.2.

Table 12.2 - Features and areas most likely to benefit from further declines in livestock.

Feature	Main Areas
Dwarf-shrub heath	Borders Central Highlands
Blanket bog	Borders Central Highlands
Tall herb vegetation	Central Highlands
Montane willow scrub	Central Highlands
Upland woodland and scrub	Throughout

13 CONCLUSIONS

The changes in land management and livestock numbers that have taken place in the hills of Scotland in the last decade are perhaps the most significant for over 150 years. These changes will have a major impact on rural communities, as well as on the environment, landscape and biodiversity of the hills. Some of the impacts will be immediate, whilst others may take many years to come to light. Understanding how these changes will affect the natural environment is vital if key habitats and species are to be protected, and open landscapes maintained.

Sheep and cattle numbers in Scotland continued to decline between 2004 and 2009, with the greatest declines (in terms of percentage change) occurring in the north and west. There were also changes within farm labour and in management practices. In some areas the changes have been on the hill ground, while in others they have been on the inbye ground. It is in north and west Highlands and islands that the impacts of the decline in livestock farming are likely to be greatest.

There was evidence from all three case study areas of a decline in sheep and cattle numbers over the last ten years, as well as a decline in the number of holdings with sheep and the number of holdings with cattle. It is not only livestock numbers that have declined but there has also been a decline in the number of full-time occupiers and the amount of labour. This reduction in labour and therefore management of the land is perhaps as important a factor in relation to impacts on the natural heritage and landscape as the reduction in livestock. Land has been abandoned in some places, while in other areas there has been expansion of woodland and forestry and more active game management. There was also evidence from the case study areas of impacts related both directly and indirectly to the declines in livestock farming, on the natural heritage and landscape, and in particular on the socio-economics of the local communities.

Within the South Skye case study area it is likely that the small area of improved grassland in the coastal crofting areas is most at risk of under-management if livestock numbers continue to fall in the area, leading to an increase in the area of rough grassland and the encroachment of scrub. This will have detrimental effects on a number of bird species that rely on patches of short, grazed grassland for foraging. In the short-term the dwarf-shrub heath vegetation that dominates the area may benefit from further reductions in livestock numbers, however the impact of any reduction in livestock grazing may be off-set by increased red deer numbers, however this will depend on what deer management is undertaken in the future. There is the potential for Bracken to spread onto some of the un-managed grassland and heath. The extent of the grassland-heath mosaic in the east of the area may decline as the heath vegetation recovers under reduced grazing pressure.

Although livestock numbers in the West Borders study area have reduced considerably in recent years the number of ewes per hectare of grazing land in 2008 still exceeded 1 ewe per hectare, suggesting that the herbivore impact levels on habitats in some areas are likely to be moderate to high. Therefore further reductions in livestock numbers may benefit habitats such as the dwarf-shrub heath vegetation that covers almost 25% of the area. Some of the acidic hill grasslands are also likely to benefit from reduced grazing levels, increasing their structural heterogeneity. However complete abandonment of the hill grasslands and dwarf-shrub heaths would be detrimental and may lead to the spread of bracken and the loss of habitat mosaics. At present Red Deer are not widespread in the area however Roe Deer and Sika Deer are more widely distributed. In the short term any increase in the deer population is unlikely to fully off-set any further reductions in livestock, other than at a local level. Although the area of productive improved grassland is unlikely to reduce significantly in the short-term, there is a risk that the area of cultivated land will

decline, which may have an impact on a number of bird species that are associated with cropland. Perhaps the biggest threat to the upland grassland and moorland habitats is the further expansion of commercial forestry and native woodland within the West Borders study area. Increased afforestation will also have a considerable impact on the landscape of the area. If recent trends continue then the active management of heather moorland, including muirburn, for grouse shooting, may become more widespread. This will have an impact on the vegetation, fauna and landscape of the hill ground. What happens to sheep management in relation to changes in game management is less obvious, as the systems are now working more closely together, where previously they were seen to be in conflict.

Any further reductions in livestock numbers within the North Highlands study area are unlikely to have major impacts on the hill ground unless deer numbers are managed. Deer are likely to move in to areas where livestock have been removed. Without targeted deer control some of the important dwarf-shrub heath and bog habitats are likely to remain at risk of moderate to high herbivore impact levels. Some areas of calcareous grassland and improved grassland in the inbye ground and crofting areas may be at risk of under-management if livestock numbers continue to fall, leading to an increase in the area of rough grassland, with reduced structural heterogeneity, and the encroachment of scrub and woodland. The area of cultivated land may also decline as a result of reduced labour and changing economics. This may have an impact on a number of bird species including finches and buntings that feed on weed seed and spilt grain. The potential loss of upland habitat within the area to further afforestation and wind farm development are likely to be major issues that will have impacts on both the natural heritage and landscape of the area.

Some of the changes in the natural heritage that were reported in the case study areas are not entirely due to the decline in livestock farming in the local area, but are a result of wider national and global changes. There are clearly both positive and negative impacts on the natural heritage of the decline in hill farming. Many of the patterns of change and impacts on the natural heritage and communities that were brought out in the case studies are relevant to the rest of upland Scotland and the crofting areas.

Any changes in the composition or structure of hill vegetation as a result of reduced livestock grazing levels will, in turn, have an impact on the insect, bird and mammal assemblages present. Some species and habitats will benefit from the removal of livestock, but for others that are dependent on grazing, the loss of livestock is likely to be detrimental to their condition and conservation value. These changes in the fauna will have further impacts on the composition and structure of hill vegetation. Changes in the numbers and distribution of deer, and any future deer management, are key factors that will potentially affect the extent to which livestock declines impact on the natural heritage. In areas where red deer are present their numbers appear to increase when sheep have been removed from hill ground and therefore in these areas deer have the potential to off-set at least in part the impacts associated with the removal of sheep. It is much more difficult to manage wild deer, in terms of their numbers, grazing locations and behaviour, than it is to manage livestock, and therefore in some places herbivore impacts on sensitive habitats may actually increase as a result of livestock removal.

The removal of hefted livestock from one area tends to lead to the breakdown of the hefting system with animals from neighbouring hefts filling the vacuum created. For this reason in areas where sheep numbers have been traditionally high there are relatively few situations where grazing livestock have been completely removed from areas of un-fenced hill ground. In many parts of the Scottish uplands the pattern of livestock declines will have created a range of grazing levels at a local level, which may have benefited the natural heritage. However, in parts of the north and west Highlands where there has been wholesale removal of livestock over extensive areas this range of grazing levels may have been lost.

Grazing levels have often been too high in many upland areas including designated sites, leading to high herbivore impact levels and damage to some important upland habitats. The recent reduction in livestock numbers is therefore likely to have benefited some of these upland habitats, such as dwarf-shrub heath and blanket bog. Even montane grasslands that rely on grazing may benefit from reduced herbivore impact levels, however if the grazing impacts become too low then grasslands, in particular species-rich, montane calcareous grassland, are at risk of structural and compositional changes leading to successional change and the eventual loss of the grassland habitat. This emphasises the fact that there is no such thing as an optimal grazing level for the uplands, different habitats require different levels of grazing to maintain their biodiversity and conservation value. Most habitats found on hill farms and within the crofting areas benefit from some degree of grazing and low-input management and the study has shown the importance of maintaining high nature value farming in these areas.

It is difficult to predict long-term changes to upland habitats as a result of the decline in livestock farming, due to other factors such as increasing deer numbers, other land management practices, including the expansion of sporting management and afforestation, and climate change, which will all influence how the vegetation responds. However over the long-term there is a risk of woodland and scrub expansion into the upland fringe reducing the area of grassland and heath. This upland fringe habitat is however likely to benefit a range of both upland and scrub species. The area of upland habitat mosaics may decline as the vegetation becomes more spatially homogeneous. The spread of bracken at low and moderate altitudes may lead to the loss of some important grassland and heath vegetation. Expansion of native and conifer plantations on land previously grazed by livestock may also lead to loss of important upland habitat.

Information gathered from the literature review and workshop delegates indicated that the pastures and cultivated land on the inbye ground and within the crofting areas were more at risk of change and species loss due to abandonment than the hill ground. It tended to be the inbye ground where most of the changes in the natural heritage and landscape had been observed.

The social and economic impacts of the decline in livestock farming in the uplands were seen as particularly important to the workshop delegates, both the farmers and conservationists. The decline in farming was leading to de-population, the closure of schools and shops and the disintegration of community life. The continuation of farming was seen as vital to maintaining thriving local communities.

The rate of decline in livestock numbers may be slowing down as a result of higher lamb, ewe and wool prices, probably driven by supply and demand. However, in the short term, the decline is unlikely to stop without economic support for hill farmers and crofters through some form of policy change. Changes to the support payment rules recommended by the "Inquiry into Future Support for Agriculture in Scotland" (Pack, 2010), if implemented, are likely to have an impact. If the decline continues then the impacts highlighted in this report are likely to become greater and even more widespread, with wider social issues implicated.

The EU is committed to supporting the preservation and development of High Nature Value farming areas. The traditional agricultural landscapes found in much of upland Scotland and the islands are recognised as High Nature Value farming areas, which require support.

There are many complexities to the management of the land in the uplands but all of them are people driven or mediated through people. What happens in regards to land management in the uplands, and as a result what happens to biodiversity, is down to people's choices.

Livestock production in the hills and uplands of Scotland is under-going a period of rapid change, hastened and disturbed by policy changes in regard to support payments and agri-environment schemes. There is a large measure of consensus amongst a wide range of stakeholders, including farmers, crofters and conservationists, that at a general level these changes raise very serious issues and that there are many broadly negative impacts upon the natural environment, although there are localised positive effects. The issues that play a part are deep-seated and embedded within the lives of the people that manage the land at a local level. The key to management of land for natural heritage benefit is the intimate inter-linking of natural heritage issues directly with social and economic issues, within the local communities that manage the land. Measures taken at a national or local scale to manage any of the social, economic or environmental inputs or outcomes need to consider the whole system. To be effective in understanding, monitoring or changing the impact of livestock management upon the natural environment, a structure needs to be in place that will consider how to support or change elements of the whole system, not just small elements. Supporting wider farming interests, whether this is targeted through a High Nature Value approach or more generically to regions, localities or particular systems, may be needed to achieve narrow natural heritage aims. Given the scale, momentum and direction of travel, such as the issue of the ageing population of active land managers, then the policy solutions are likely to be major and need to have considerable impact. It may need to be accepted that there are no affordable solutions to specific issues, nor one that the local land management community can or is willing to undertake. Greater compliance and obligation is less likely to succeed than positive measures, due to the difficulty of enforcing people to continue traditional farm and croft management, in which they are increasingly volunteers, rather than being economically dependent upon it.

14 RECOMMENDATIONS

- There is a relatively large amount of information on the effects of livestock removal on different upland vegetation types, but there is comparatively little information on the effects of reduced livestock grazing on upland habitats and inbye land. Targeted monitoring should be carried out in these situations, particularly on semi-natural and improved grasslands.

- Deer are very much linked to the issues of livestock management and local land based management capability. The management of deer and livestock need to be considered together, with improved integration of deer and sheep management plans. Targeted monitoring of areas, where significant land-use change has, or is likely to occur, is important, including areas outside designated sites. This should include monitoring of herbivore numbers, their distribution and foraging patterns as well as their impacts on the natural heritage.

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APPENDICES

Appendix A - Farmers Questionnaire

The impact of declining livestock numbers - Individual questionnaire

Please note that your answers will be held in strict confidence. Any questions are for the purpose of this research and will be destroyed after completion of the research project. Approximate numbers are fine.

1. Structure of the farm

Please fill in the following table:

Name of the farm	
Parish	
Type of business (please circle)	LFA sheep/ LFA sheep + beef / LFA beef/ Other……..
Tenure (please circle)	Tenant / Owner-occupier / Mixed tenure / Other ……..

For this past year (2009), please fill in the following table:

	Hectares		Approx. numbers
Arable crops		Breeding ewes	
Forage crops		Lambs	
Inbye/improved grass		Other sheep	
Rough grazing/heather		Beef cows	
Woodland		Calves	
Others		Others (please precise)	
Total farm size			

Number of people working on the farm (excluding casual and seasonal):

Who? (yourself, wife, partner, etc.)	% time

Number of casual/seasonal workers on the farm:

Number of persons	Number of hours

Have you got any other enterprises on your farm? (e.g. diversification, tourism, etc) (please tick and list)

Yes		No	

What?

2. Changes since 2005

Have you made any changes since 2005? (please tick)

Yes		No	

If No, why? (please list)

If Yes, please summarise the changes using the following tables:

a) Animal numbers and management			
	~2005	**2009/10**	**If possible, please explain why this is?**
Number of pure bred ewes			
Number of cross-bred ewes			
Number of home-reared replacement (e.g. hoggs)			
Breed of rams			
% lamb sold store			
% lamb sold fat			
Number of beef cows			
Number of purchased cattle			
Breed of bull			
% calf sold store			
% calf sold fat			
Please tick:	**earlier**	**later**	**same**
Do you lamb?			
Do you calve?			

b) Any other changes in your management? (e.g. gathering frequency, away-winter the animals, rent more land, etc.)	
What?	**Why?**

c) Any other changes in your labour? (please tick and list)				
	Yes	**No**	**What?**	**Why?**
Permanent labour				
Casual/seasonal labour				

d) Any changes in your other enterprises? (e.g. have a B&B, work as contractor, etc.) please list	
What?	**Why?**

3. Changes in the parish

In your local parish, have you noticed? (please tick and list)

	Yes	**No**	**What?**
Any changes in your neighbours' animal numbers?			
Any changes in your neighbours' animal management?			
Any changes in your neighbours' mix of enterprises?			
Any changes in the local farming infrastructure (market, hauliers, etc.)?			
Any changes in the local community?			
Any changes in the local landscape?			
Any changes in the quality of grazing?			
Any changes in the vegetation or wildlife?			

Do you think that these changes in the parish have influenced some of <u>your</u> own changes? (please tick and list)

Yes		**No**	
Why?			

Appendix B - Non-farmers questionnaire

The impact of declining livestock numbers - Individual questionnaire

Please note that your answers will be held in strict confidence. Any questions are for the purpose of this research and will be destroyed after completion of the research project. Approximate numbers are fine.

1. Your personal situation

Please fill in the following table:

Name	
Parish or parishes you are working in or are familiar with	
Occupation	
Speciality	Vegetation/landscape/social community /fauna/ marine/ Others……..

2. Changes since 2005

In the area you are familiar with, have you noticed any changes since 2005 in?

a) The landscape (please tick)	**Yes**		**No**	

If yes,				
What (please list)	**Rank the importance of the change** (please tick)			**In your opinion, what caused the change?** (please list)
	Very important	Important	Not very important	
i)				
ii)				
iii)				
iv)				
v)				
vi)				

b) The local vegetation species (please tick)	**Yes**		**No**	

If yes,				
What (please list)	**Rank the importance of the change** (please tick)			**In your opinion, what caused the change?** (please list)
	Very important	Important	Not very important	
i)				
ii)				
iii)				
iv)				
v)				
vi)				

c) The local fauna species (please tick)	**Yes**		**No**	

If yes,				
What (please list)	**Rank the importance of the change** (please tick)			**In your opinion, what caused the change?** (please list)
	Very important	Important	Not very important	
i)				
ii)				
iii)				
iv)				
v)				
vi)				

d) The local community (village, hamlets, etc.) please tick	**Yes**		**No**	

If yes,				
What (please list)	**Rank the importance of the change** (please tick)			**In your opinion, what caused the change?** (please list)
	Very important	Important	Not very important	
i)				
ii)				
iii)				
iv)				
v)				
vi)				

Do you think that since 2005 (please tick)	Increased	Decreased	Stayed the same
The number of farmed animals			
The number of crofts/farms			

Appendix C - Comments and issues raised by the delegates during the discussion at the end of the synthesis workshop

- Unless we have a vision**,** it is hard to formulate policies
- What are the drivers? People and community or nature conservation?
- Changes in livestock are bringing social changes in the community, which will have an impact on what we have now. Once it has gone, how do we get it back?
- What about the cultural aspect? How do we preserve it?
- Ecological and cultural are two different things that need to be looked at separately – this goes back to the Vision issue – what do we want?
- The aim could be to have a fully functional ecosystem and an ecologically sustainable land use. We're not there yet, more monitoring is needed
- There is no natural ecosystem in Scotland – a fully functional ecosystem is not necessarily natural
- What do we want in the future?
- Diversity of management brings about diversity of habitat and structure. All habitats are managed
- We need diversity of management and of policies. One policy does not fit all
- Politicians like single policies. This might lead to single outcomes (e.g. the previous policy led to high sheep numbers, the current policy is leading to sheep removal and abandonment)
- Perhaps the abandonment of livestock farming in places and an increase of livestock in other places is beneficial for diversity?
- Are we reaching a tipping point now in terms of livestock numbers and management?
- There is a problem with the policy mechanism
- A key issue is that if things continue there will be fewer and fewer people on the land with the skills to do any management. We may know what we want but we might not have the people with the skills to do the job anymore
- A whole Scottish policy is not good, there is not enough variation – an area-level policy would be better
- Policies cannot be seen to support livestock production anymore, so we need to show that a particular management (e.g. sheep production) is good for conservation, in order for it to be maintained and supported
- Farms are more specialised now – which leads to less diversity. It is likely that we will get fewer farms, but bigger ones – policies to slow down this trend should be encouraged
- Food production will become important again on the policy agenda. As a result of climate change we might find in the future that Britain is an important place for farming and food production
- Plant species diversity will decline from lack of grazing – overgrazing is less of an issue
- We need to consider what plant species were present in the hills more than 200 years ago, before large scale sheep farming was established in the Highlands
- We should support farming so that it can change at a moderate pace
- Agri-environment schemes such as the Rural Stewardship Scheme have been beneficial
- Both support for farming and agri-environment schemes are required. There is a need for farming or other land management activity in the first place, as without the land management, agri-environment schemes can't work
- How do deer fit into the whole issue?
    - The degree to which declines in livestock numbers will affect the biodiversity of the hills will depend very much on how deer populations respond and how

deer populations are managed. The herbivore impacts from increasing deer populations may in part compensate for the losses in livestock
    - Deer can bring benefits to the environment as well as problems, and can provide economic activity
- Social drivers are fundamental to the future of the hills
- Sporting estates rely on private financial support. Like farming the economic returns from many sporting estates are also un-sustainable. What will happen if there is not enough private money put into the estates? We'll have no farmers and no estates/game management…then what?
- The issue of ecosystem services was raised. Ecosystem services provide a rationale, giving a clear human focus for doing things; they put an economic value on something and provide a framework. Ecosystem services bring everything together.
- What are the gaps in our knowledge with regard to the decline in hill farming?
    - We don't fully understand the impacts of land-use changes on ecosystem services. Monitoring tools and data are required
    - The links between grazing and Carbon in the uplands are not fully understood
    - How grazing affects ecosystem services needs to be explored
    - We need some economic values (not necessarily in terms of pounds) in relation to the ecosystem services hill farming provides
    - We need to link management and ecosystem services
    - Long-term monitoring is required

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