PART 2

STATE OF SCOTLAND'S FARMED ENVIRONMENT: CONTEMPORARY ISSUES

4. HABITATS AND SPECIES

BACKGROUND

In 1992, the UN Convention on Biological Diversity recognized the need to protect biodiversity. The UK was one of the 150 countries to sign up to the convention, and the UK Biodiversity Action Plan (UKBAP) was published in 1994 to develop strategies to protect biological diversity. In Scotland, this is implemented via the Scottish Biodiversity Strategy (Scottish Executive, 2004) which is overseen by The Scottish Biodiversity Forum.

The "Custodians of Change" report of the Agriculture and Environment working group in 2002 concluded that biodiversity and habitat protection was one of the three priority environmental issues for Scottish agriculture for the next 5-10 years (the others being diffuse pollution to water and landscape change). One of the recommendations was that: *"The Executive, its agencies, local authorities and the agricultural industry should focus attention upon, and allocate sufficient resources to ensure that a fully integrated approach to natural heritage and land management is promulgated. In particular, attention will need to be given to implementing Local Biodiversity Action Plans."* (Scottish Executive, 2002)

The initial strategy for conservation was for SNH and its predecessor organisation to designate valuable (small, vulnerable) habitats and sites supporting rare plant or animal species as nature reserves (Sites of Special Scientific Interest - SSSI). However, many SSSIs remained vulnerable to potentially damaging operations and insidious effects from adjacent agricultural land use, and the total species concerned was tiny compared with that in the wider countryside. This encouraged the establishment of prescription-based management agreements targeted at farms within defined areas of natural heritage value (Environmentally Sensitive Areas - ESAs). Thus a mechanism was provided to alter the management of the agricultural land to be sensitive to the natural heritage character of specific areas (Birnie et al., 2004).

Under the UKBAP, Action Plans are developed to protect biodiversity. Originally, work concentrated on protecting small areas of vulnerable habitats and the species that they supported (SSSIs); this has since been extended to improved management agreements on farms within wider areas of natural heritage value.

HABITATS AND SPECIES

Broad habitat change

A classification of "broad habitat" was defined for consistent reporting and monitoring of priority habitats that were identified under the UKBAP. The habitats range from developed land, such as built-up areas and gardens, to semi-natural land, such as grasslands, bog and bracken. Over the period 1990-1998, the largest change was the

overall decline in area of semi-natural habitats, while on the other hand intensive agriculture increased by nearly 37,000 ha (Table 4.1; Scottish Executive, 2005).

Table 4.1: Area of broad habitats in Scotland (1998) in thousand ha

Habitat	1998	Change (1990-1998)
Woodland	1,294	+ 32.3
Intensive agriculture	1,691	**+ 36.7**
Semi-natural	4,535	**- 88.9**
Water	106	+ 0.8
Developed	276	+ 19.4

Source: Scottish Executive (2005)

Woodland, developed habitats and land use for intensive agriculture all increased over the period, with a 9% increase in the area of broadleaved, mixed and yew woodland (Countryside Survey, 2000).

Designated areas

SSSI (Site of Special Scientific Interest) is the main nature conservation designation in Great Britain. Originally under the 1981 Wildlife and Countryside Act, and now in Scotland under the Nature Conservation (Scotland) Act 2004, sites are notified as areas of outstanding quality to protect their flora, fauna, geological or physiographical features. At 31 March 2005, SSSIs in Scotland covered 13% of the land.

SAC (Special Area of Conservation) sites are designated under the 1992 EC 'Habitats' Directive to protect wildlife and their habitats throughout the EU. ***SPA*** (Special Protection Area) sites are designated under 1979 EC 'Birds' Directive to safeguard naturally occurring and migratory species of wild birds. ***Ramsar*** sites are designated under the Convention on Wetlands of International Importance. A designated site may be protected by more than one scheme. For example, about two thirds of the area of SACs and 80% of SPAs and Ramsar sites also have SSSI designation (SNH, 2004).

Table 4.2: Designated Areas in Scotland 1991-2005

	1991 (000 ha)	1995 (000 ha)	2000 (000 ha)	2005 (000 ha)	2005 (000 ha)
SSSI	804	866	958	1,008	1,451
SAC	-	-	718	963	238
SPA	26	76	391	626	139
Ramsar	15	53	240	313	51

Source: SNH (2004)

Biodiversity Action Plans

By 2001, action plans had been developed for 45 habitats and 391 species in the UK. Of these, 41 BAP priority habitats and 261 species either occur in, or have recently been lost from Scotland (Scottish Executive, 2005). Of these 261 BAP species and 41 BAP habitats, 173 species and 31 habitats were considered in Table 4.3 which shows show that, by 2002, 29%of BAP habitats and 18% of BAP species were in decline.

Table 4.3: Status of BAP Species and Habitats in Scotland 2002

	No. of species	No. of habitats
Extinct	5 (3%)	0
Decline (continuing/accelerating)	16 (9%)	0
Decline (slowing)	15 (9%)	9 (29%)
Fluctuating, or no clear trend	8 (5%)	0
Stable	46 (27%)	9 (29%)
Increase	4 (2%)	5 (16%)
Unknown	79 (46%)	8 (26%)
Total considered	173	31

Source: SNH, in Scottish Executive (2005)

Plant species diversity is one measure of botanical composition that can provide an indication of changes in habitat quality. Changes are often associated with land management and atmospheric pollution. Effects of climate change may become evident in the future. The CS 2000 survey reported declines in plant diversity in dwarf shrub heath (- 6.6%) and arable land (- 16.4%). Only for acid grassland the survey identified a significant increase (+ 6.9%) in plant diversity in part due to an increased abundance of plant species associated with less acid conditions.

Table 4.4: Changes in Plant Diversity 1990 – 1998

Habitat	Percentage change
Acid grassland	**+ 6.9**
Bracken	**+ 2.9**
Broadleaved, mixed and yew woodland	**+ 1.2**
Coniferous woodland	**- 1.2**
Bog	**- 1.8**
Improved grassland	**- 2.5**
Fen, marsh and swamp	**- 2.7**
Neutral grassland	**- 3.6**
Dwarf shrub heath	**- 6.6**
Arable and horticultural	**- 16.4**

Source: CS 2000 and SNH, in Scottish Executive (2005)

Birds

Naturally occurring birds and their habitats are protected under the Wildlife and Countryside Act 1981, the Nature Conservation (Scotland) Act 2004 and the EC Birds Directive (79/409/EEC and amendments). SPAs are also protected by the Conservation (Natural Habitaits Etc.) Regulations 1994 (as amended), which transpose the EC Habitats Directive into UK law.

Between 1994 and 2004, 20 out of 53 terrestrial and freshwater breeding birds surveyed in Scotland showed a statistically significant increase in numbers, six showed a significant decrease and 27 no significant change. Of the BAP species included in the survey, only the Song Thrush showed a significant increase in numbers (22%) (Raven et al., 2005).

The UK is also bound by international laws and conventions to protect and conserve waders, and the wetlands on which they depend. Some of these sites are additionally protected by the Ramsar Convention on Wetlands. The Wetland Bird Survey shows that six wader species wintering in Scotland (out of 11 surveyed) increased by at least 10% and two fell by at least 10% between 1974-1978 and 1999-2003. The black-tailed godwit showed the biggest rise in population (542%); the dunlin population decreased by 18% in that period (Musgrove et al., 2001).

Farmland habitats and species

Numerous plant and animal species are associated with the variety of farmland habitats, but the well-publicised population declines or losses of many of these species are mainly related to habitat loss or change. There has been a reduction in the area of the various semi-natural habitats associated with traditional, mixed farming. There has also been an increased intensity of management of the actual cultivated or grazed land. In Scotland, habitat *losses* have occurred predominantly in lowland, fertile areas dominated by intensive arable farming. *Decline* in habitat quality has been a major factor in marginal, grazed upland and north western areas (Birnie et al., 2004).

A recent survey of the effects of cattle on Scotland's natural heritage found that, as cattle are less selective in their grazing behaviour than other domestic herbivores, their impact is different from that of, for example, sheep. Compared to other domestic grazers, cattle result in:

- A more structurally diverse sward,
- A reduction in the cover of tussock forming species,
- Creation of more niches for plant regeneration.

For the habitats for which there is empirical information, in most cases, grazing by cattle is either beneficial or at least neutral, provided that the grazing is at an appropriate stocking density and seasonal pattern. There is, however, very little information on the direct effects of cattle grazing on priority species (Wright et al, 2005). There are also a number of aspects of cattle systems that can prove beneficial for biodiversity, including the need for fodder crops.

Woodland species

In 2000 the Scottish Forestry Strategy (SFS) adopted the native woodland Habitat Action Plans (HAP) of the UKBAP. These plans have wide support and were incorporated within the recent Scottish Biodiversity Strategy. Over the next decade or so they aim to reverse the gradual decline in native woodlands. The targets are:

- Look after and improve the condition of native woods (particularly for ancient semi-natural woods and those that have been designated for conservation);
- Expand the native woodland resource on to unforested land and by conversion from conifer plantation; and
- Restore native woodland to many of the ancient woodland sites which were planted with non-native trees in the 20th century (Forestry Commission, 2005).

The existing SFS's implementation plan also includes an action to review the management of genetic resources. A large part of Scotland’s forest resource is of Sitka spruce, sourced and selected with an eye for timber from particular parts of its natural range in North America. Remnant native woodlands, on the other hand, provide good sources of local-origin genetic material.

However, some woodland species are not restricted to native or semi-natural woods and will benefit from improvements to the wider forest resource. The decline in Capercaillie, for example, is being tackled not only through enhancing the Caledonian pine remnants but also through the "restructuring" of appropriate plantations to provide new Capercaillie habitat such as thickets for young birds and mature stands for lekking. Deer fences, which can kill or injure low flying birds, are being re-sited, marked or removed.

The 2000 SFS introduced the idea of habitat networks. The aim is that new or restored native woodland should expand existing areas and link woods together. One of the key factors in the habitat network concept is the development of woodlands along and around watercourses. Core forests, green corridors and woodland links are the components of a forest habitat network (FCS and SNH, 2003).

13% of Scotland's land area is designated as SSSIs. The most significant change in habitat in the 1990s was the decline of semi-natural habitats by 88,900 ha and the increase in intensively used agricultural land by 36,700 ha. By 2002, from 173 BAP species and 31 BAP habitats considered, 29% of the habitats and 18% of the species were in decline.

ALIEN SPECIES

Alien species are defined in this report as ones not occurring naturally in Britain, i.e. species that have been introduced accidentally or deliberately by humans. (It should be noted that there may be some debate about identifying alien species for Scotland as opposed to the rest of Britain). Accidental entry includes escape, outcasts from gardens, and carriage on vehicles, animals or persons moving between countries, or in products such as grain, hay and timber. The opportunities for alien species to become established are probably still increasing, with greater trade, more people travelling, new crops and management practices, and also climate changes. In particular, the predicted warming during the next century is likely to open Scotland to invasion from an increased number of species, as warmer regions tend to have greater species diversity than cooler regions. (The case of tree mallow, which is native to the south-west and west coast of the UK but now seriously spreading on bird islands in the Firth of Forth region and endangering the puffin population, is an example for the effects of slowly rising temperatures (CEH, 2005).

An SNH audit carried out in 2001 found a total of 988 non-native species in Scotland. The pathway by which the greatest number of species (mostly plants) is introduced to the wild in Scotland is from gardens. Alien species occur in greater numbers in the South and Central Belt regions of Scotland than elsewhere (partly due to the greater human population in these regions). The habitats into which most vascular plants have become established are man-made ones (arable land, waste ground), grasslands and woodlands; very few occur in upland habitats. (Welch et al., 2001)

In Scotland, rhododendron reduces the biodiversity of Atlantic oakwoods while American mink is held partially responsible for the decline of water vole populations. Hybridisation has occurred between non-native sika and native red deer as well as between native and non-native plants. Japanese knotweed undermines flood defences, and the impact of bark stripping by grey squirrels reduces forestry production.

Alien species can also affect human health, e.g. phytophotodermatitis through contact with giant hogweed or leptospirosis spread by the brown rat. There have been relatively few successful control eradication programmes against non-native species. Control measures are generally not implemented until a species becomes a problem, by which stage they are very expensive (Birnie et al., 2004).

A total of 13 mammals are considered to be alien in Scotland. Four species are of domestic/ feral origin: the domestic cat, the feral ferret, the feral goat and the American mink. Another four species have been long established in Scotland – the rabbit, the house mouse, the common/brown rat, and the brown hare. Three species have been introduced deliberately for "aesthetic" or sporting purposes: the grey squirrel, which is now implicated in the decline of the native red squirrel; Sika deer and fallow deer. Also, the hedgehog (although not an alien to Scotland) has been introduced for aesthetic reasons to the Outer Hebrides where it did not occur naturally, and has seriously damaged the ground-nesting native avifauna on some islands (Welch et al., 2001). Alien birds include pheasant and red-legged partridge.

Biological invasions, accidental or deliberate, by non-native species are a significant component of human-caused environmental change, often resulting in a significant loss of bio-diversity, economic value and function of the invaded ecosystem. Climate change is likely to facilitate future invasions of Scotland, as warmer regions have greater variety in species than cooler regions. Whereas some alien species have long been established in Scotland (e.g. rabbit, house mouse), others have only become a noticeable presence and potential problem more recently (American mink, Japanese knotweed, tree mallow).

CONSERVATION OF HABITATS AND SPECIES

The emphasis has been on habitat conservation and restoration on farmland, because most associated species will directly benefit from the increase in the area and distribution of such habitats. This strategy has led to the implementation of a range of practical solutions:

- Designation of SSSIs (SNH).
- Prescription-based management agreements targeted at farms (ESAs) (SEERAD).
- Development of "conservation headlands" or "extended field margins" providing benefits for farmland birds, butterflies, pollinators and natural enemies of arable crop pests as well as the maintenance of game bird populations (Game Conservancy Trust - GCT). Field-edge management is also included in Government agri-environment schemes (SEERAD – CPS RSS and LMCs.
- Beetle banks (sown grassland strips added between tramlines).
- The initial rotational Set Aside Scheme was modified to capitalize on the environmental opportunities. The lack of weed leaves and invertebrates associated with winter stubbles is held responsible for the population declines in bird populations. Permanent set aside options allowed the development of weedy stubbles or sown cereals and brassica species.
- The Farm Woodland Premium Scheme and Native Pinewood Scheme have encouraged the conversion of arable and pasture land (FWPS) and heathland or semi-natural grassland (NPWS) to woodland.

- Wetland and flooded meadow restoration have also been funded through the CPS and RSS incentive payments or by SNH, RSPB or the Wildfowl and Wetlands Trust (WWT) partnerships with private landowners. These schemes also accommodate the planting of new hedgerows and the buffering of riparian vegetation.
- RSPB have taken direct action by purchasing farms to manage the land with regard to the resource requirements of farmland birds.
- Organic Aid Scheme (OAS) (SEERAD) is partly supported because of its in-field biodiversity benefits.

Priority habitats from Scottish Local Government Habitat Action Plans are now included in prescriptions for RSS for particular regions (Birnie et al., 2004).

The UKBAP priority species review is currently being carried out and will be finished by the end of 2006. The aim of this review is to ensure the correct species and habitats are included as UKBAP priorities (UKBAP 2005). On 15 December 2005 the Deputy Environment Minister announced the publication of 'the Scottish Biodiversity List', a requirement under Part 1 Sect 2 (4) of the Nature Conservation (Scotland) Act 2004 (Scottish Biodiversity Forum, 2005). The Species identified in the last review from 1995 are listed in the summary of 1999 issues.

To prevent the impact of potentially damaging land management operations on SSSIs, prescription-based agreements were established by the Government on farms within defined areas of natural heritage value (ESAs). The GCT's research into the decline of red grouse and grey partridge led to solutions that had wider-ranging benefits for wildlife on farmland. Management options like grassland or wildflower strips in field margins and beetle banks have been included in the RSS. Policy changes like the introduction of NVZ rules and the SFP are likely to lead to less intensive farming methods and more beneficial conditions for habitats and species.

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5. LANDSCAPE

WHAT IS LANDSCAPE?

The term landscape can mean different things to different people: Landscape encompasses all the physical elements of the environment that surround us – the natural (landform, water, and natural vegetation) and the cultural (the patterns of land use, buildings and other structures – old and new). But as well as the physical fabric, it is people's experience and perception of the land and adjacent sea that turns their surroundings into landscape.

Scotland's landscape is made up of

- the physical foundations (predominantly hard-rock geology, which created extensive upland and mountainous areas)
- the natural land cover (peatlands, pine- and oakwoods, heather moorland)
- the cultural overlay (through woodland clearance, agricultural activities, settlements) (SNH, 2003).

Landscape as an overarching concept affects all aspects of agriculture/environment interactions. The adoption of sound landscape management practices yields benefits in terms of conservation of cultural heritage and enhanced quality of life, and economic benefits in terms of the landscape supporting tourism and recreational activities (Birnie et al., 2004). At present the National Scenic Areas (a landscape designation) have no legal status in the planning process although this may be revised within the terms of the new Planning Bill. There are strong landscape interests within the context of the two Scottish National Parks.

HISTORIC LANDSCAPES OF SCOTLAND

For its size Scotland has the most varied geology and natural landscapes of any country on the planet (SNH, 2002). It has been influenced by six thousand years of farming, and many physical traces survive of past land use, particularly since medieval times (Ritchie, 2003). Individual features of the past combine to form historic landscapes and these can be significant both visually and archaeologically. The Historic Land Use Assessment (HLA) website, developed by HS and RCAHMS, has mapped relict historic landscapes. (Council for Scottish Archaeology (CSA), 2005)

Scotland's lowland managed landscapes are cultural landscapes of varied and distinctive character. Their basic structure still reflects the period of enclosure and improvement which reached its peak in the late 18th and early 19th centuries, as well as the suitability of land for different agricultural systems.

Scotland's moorland, hill and mountain are characterized by bold landforms and openness. They are generally viewed as wild and predominantly natural (SNH, 2003).

Landscape encompasses the physical foundations, natural land cover, and cultural influences. Scotland's landscape has been shaped by six thousand years of farming. Whereas the uplands are viewed as predominantly natural, the character of the lowlands shows the suitability of the land for a variety of agricultural systems.

INTEREST IN SCOTTISH LANDSCAPE OVER TIME

For over a century, amenity bodies have been actively concerned for the care of Scotland's landscape. A broader statutory approach had to await the post-war emergence of the Town and Country Planning system. 1967 saw the founding of the former Countryside Commission for Scotland (CCS), with a responsibility for the conservation and enhancement of the natural beauty and amenity of the countryside and its enjoyment. Legislation also placed a duty on all public bodies to have regard to natural beauty and amenity (Countryside (Scotland) Act 1967, sections 1 and 66) (SNH, 2003).

In 1992, CCS and NCCS (Nature Conservancy Council for Scotland) were dissolved and Scottish Natural Heritage (SNH) established with the aim to achieve sustainable land management for both landscape and wildlife in areas termed Natural Heritage Areas.

The Government is currently deliberating on whether to ratify the European Landscape Convention (ELC), a Council of Europe initiative. It applies to all landscapes and is thus not just a traditional designation-based approach. Its aim is the promotion of landscape protection, management and planning, with the concerns of people and communities central to its working (Thomson, 2004). Ross Finnie stated in March 2005: *"I recently gave my consent to the proposal from UK Ministers that the UK should sign and ratify the European Landscape Convention. The main aims of the convention are compatible with our approach to landscape policy and will bring many advantages for Scotland."*

LANDSCAPE CHARACTER ASSESSMENT (LCA)

Table 5.1: Main types of habitat in Scotland
in % of total countryside

	Scotland	*GB*
Bog	25.4	*9.6*
Improved grassland	13.1	*23.7*
Dwarf shrub heath	12.5	*6.4*
Coniferous woodland	12.4	*5.9*
Acid grassland	9.3	*5.6*
Arable and horticultural	8.0	*22.7*
Fen, marsh and swamp	4.2	*2.4*
Broadleaved, mixed + Yew woodland	3.7	*6.4*
Neutral grassland	2.1	*2.7*
Bracken	2.1	*1.9*
Built-up and gardens	1.9	*5.8*
Standing open water and canals	1.1	*0.8*
Boundary and linear features	1.1	*2.2*
Montane	0.6	*0.2*
Inland rock	0.5	*0.2*
Calcareous grassland	0.3	*0.3*
Rivers and streams	0.3	*0.3*
Other	*1.0*	*1.1*

Source: NFUS (2003)

SNH, in partnership with local authorities and others, undertook a national programme of landscape character assessment (LCA) between 1994 and 1998. That assessment classified Scotland into 372 "landscape character types", categorized by SNH into 18 natural heritage settings, geographically defined mainly on the basis of dominant land cover.

Scotland's unique countryside and landscapes are made up of a huge diversity of habitats. Table 5.1 shows the share of the main types of habitat in Scotland's landscapes (and, for comparison, in GB). (National Farmers Union Scotland (NFUS), 2003)

CHANGE IN SCOTTISH LANDSCAPES

The present-day diversity of our landscapes is obviously a result of past change, natural and human-induced, planned and unplanned. Some significant past changes have been relatively sudden, such as those brought about by large-scale afforestation, hydro-power or quarrying developments. Others have been more gradual, including the gradual loss of trees and woodland, and the associated complex losses of shelter, moisture retention, biodiversity and biological productivity, from apparently wild places (Macdonald, 2004).

Forces for change within each landscape type are varied, and changes may be inter-related. For example, a decline in stock farming on the hills may be associated with abandonment of hill grazing areas, neglect of drystone dykes and dereliction of buildings. The most severe impact on landscape character is driven by the following forces for change:

In agriculture – loss of agricultural land to other uses; changes in hill farming; neglect or loss of hedgerows (including hedgerow trees); neglect of drystone dykes; conversion of steadings; and inappropriate use of post and wire fencing.

In forestry – new coniferous afforestation; planting of open/wild/moorland; neglect or decline of woodland and shelterbelts; and maturity or decline of woodland and trees (Tyldesley, 1999).

The National Countryside Monitoring Scheme of SNH has shown that landscape change has been a feature of all agricultural contexts in Scotland since 1945:

- arable production has reduced in the west and north and intensified in the east
- significant areas of rough grazings have gone under forestry
- crofting systems have become increasingly based on sheep (Birnie et al., 2004).

Current changes which have provoked debate are the loss of aesthetic quality and amenity due to the insensitive siting of structures such as windfarms and communication masts and their infrastructure in areas of high value in terms of landscape and tranquil recreation (Macdonald, 2004). However, a MORI survey carried out in March 2003 showed that those people who lived closest to windfarms tended to be most positive about them and most supportive of expansion (Braunholtz, 2003; Warren et al., 2005))

In the future, farmers are not only expected to give us agricultural produce but also access to recreation opportunities in the countryside; to maintain and enhance Scotland's diverse landscapes, wildlife and biodiversity, and to act as stewards of our wider natural resources. The quality of the Scottish environment and the scenic character of the landscape could become the greatest marketing assets of the agriculture industry (SNH, 2005).

It is widely anticipated that the introduction of the Single Farm Payment and other policy changes will have significant impacts on agricultural activities, and hence on future land use patterns in rural Scotland. These impacts will result in both broader regional changes, e.g. regional shifts of specific production systems such as cattle moving from the north-west to the east of Scotland, and specific changes at a farm scale. Such changes in land use patterns could have a strong visual impact which may, in turn, impact upon public and other stakeholder preferences for the rural landscape in Scotland (Schwarz et al., 2005)

Farmers are increasingly expected to act as stewards of natural resources by maintaining landscape, wildlife and biodiversity. Future trends indicate continued restructuring and intensification in the east, and possible extensification of hill and upland systems in the west and north (Birnie et al., 2004)

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6. ACCESS

HISTORY

Scotland has a long tradition of enjoyment of access to land and inland water for recreation. Yet many of these customary freedoms were coming into question through the 1960's- 80's. On the other hand, in the 1990s, Government was committed to promoting outdoor activities as a means to a healthier lifestyle, and to help rural economies through the attraction of visitors and tourists (SNH, 2003b). The election of the Labour Government in 1997, and subsequently the establishment of the Scottish Parliament, brought a political commitment to legislating on outdoor access.

The Access Forum was set up in 1994 to promote debate between recreation and land managing interests and the main public bodies. The Forum had an advisory role in the development of the Land Reform (Scotland) Act 2003, and on the Scottish Outdoor Access Code (SNH, 2003a). The Paths for All Partnership was set up in 1996 to promote the development of path networks because of the growing demand for more paths near to where people live and work. A survey carried out in 2001 found that the vast majority said they would not change their level of participation in the countryside if the access law was changed, but a significant majority indicated they would participate in sightseeing, short walks and picnics more often (Scottish Executive, 2003). SNH does not anticipate that there will be a sudden surge of extra visitors to the outdoors, rather a steady increase in responsible access in the years ahead as people become more aware of and confident about using access rights and with improving access opportunities – including the development of path networks (SNH, 2003b).

THE LAND REFORM (SCOTLAND) ACT 2003

The Land Reform (Scotland) Act 2003 and the Scottish Outdoor Access Code came into effect on 9 February 2005. The Act establishes statutory access rights which have to be exercised responsibly. Owners have the duty to manage land and conduct ownership in a way that respects access rights. The Code gives guidance to both the public and land managers on responsible behaviour in relation to the Act. The extent of the duty of care owed by a land occupier to anyone on that land is not affected by the Act (SNH, 2005a).

The Land Reform (Scotland) Act 2003 establishes statutory rights of non-motorised access to most areas. The Scottish Outdoor Access Code provides practical advice on interpretation of responsible behaviour associated with access rights.

Access rights under the Act do not extend to motorised access, hunting, shooting, fishing, and having a dog (or other animal) not under proper control. Local authorities may appoint rangers to advise and assist land owners and members of the public with access rights.

Land to which the new statutory rights do not apply is relatively limited in extent, including the curtilage of buildings and farmyards, quarries, railway property and airfields. Land which is growing crops is not included within the rights but access along

field margins, tramlines and between rows of vegetables is within the rights so long as unnecessary damage is avoided.

Although the new access rights do not extend to farmyards, farmers are encouraged in the Code to continue to allow access (Code page 86).

Local authorities have the duty to:

- defend and assert access rights and routes
- publicise the Scottish Outdoor Access Code
- establish Local Access Forums (which advise and assist on access matters)
- prepare and review core path plans (SNH, 2003b)

PATHS

It is estimated that there are 50,000km of paths and tracks in Scotland. SNH have developed a Scottish Paths Record as a planning, monitoring and management tool for local authorities (SNH, 2002). About 15,000km are recorded as rights of way. However, 84% of these routes are "claimed" rights of way, i.e. they have not been asserted and their status is uncertain. The new access rights clearly apply to the majority of existing paths and tracks – including farm tracks.

Local authorities have a duty to draw up a core path plan within 3 years of the legislation being passed. The core path plan will have regard to the likely usage and desirability of paths, and a balance with landowner interests (SNH, 2005a).

The new arrangements for protecting and developing path networks are expected to supercede the existing rights of way arrangements which have proved very difficult to operate. SNH / Paths for All have published guidance on good practice on Core Paths Plans, Outdoor Access Strategies and Local Access Forums. Under the new LMC Menu Scheme, a measure to improve access offers Tier 2 payments for the provision and maintenance of continued access paths across a holding, including signposting, gates, bridges etc. It is expected that the Tier 3 payments (to be introduced in 2007) will also offer an access option.

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7. CULTURAL HERITAGE

SCOTLAND'S POLICY ON CULTURAL HERITAGE

As part of its intention to work towards sustainable development, the Government seeks to encourage the preservation of our heritage of sites and landscapes of archaeological and historic interest, so *"that they may be enjoyed today and passed on in good order to future generations"*. The Scottish Executive's position is set out in Historic Scotland's document *Passed to the Future*. Their primary policy objectives are that sites should be preserved wherever feasible and that, where this proves not to be possible, procedures should be in place to ensure proper recording before destruction, and subsequent analysis and publication (Scottish Executive, 1998). There is no existing Scottish Executive strategy or programme for the historic environment and although some historic environment targets might be addressed in the new SRDP none are identified in the existing agricultural strategy.

ANCIENT MONUMENTS AND HISTORICAL SITES

There are 3 arms of the curatorial services for the historic environment: the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS), Historic Scotland and the Local Authority Archaeology Services. An *ancient monument* is any of a wide range of sites, ruins, or other evidence of past human action. This definition extends from the obvious relict buildings, to crop marks in fields indicating the outline of former structures.

RCAHMS was established in 1908 by Royal Warrant to list the surviving heritage from the earliest times. Since then, the scope and range of duties has widened considerably. Data, including aerial photographs, are now available through a number of online databases (e.g. http://hsewsf.sedsh.gov.uk/gisdl.html). The main database, CANMORE, lists details of 250,000 archaeological sites in Scotland, including monuments, buildings and maritime sites. RCAHMS work also includes surveys into native woodlands, farm buildings and an assessment of historic land use (RCAHMS, 2005).

Historic Scotland is the government agency responsible for administering legislation relating to Scotland's ancient monuments and historic buildings, looking after and presenting monuments in state care, and funding archaeological projects. Their primary duties relate to dealing with *Scheduled Ancient Monuments* (SAMs) and *Listed Buildings. SAMs* have been given legal protection under the Ancient Monuments and Archaeological Areas Act (1979). By law, ancient monuments must be considered to be of national importance before they can be scheduled. The scheduled status of a monument extends from the structure or artifact of interest to the surrounding land. Designation of monuments for scheduling is the responsibility of Scottish Ministers, administered through Historic Scotland. Scotland now has more than 7,800 scheduled monuments. Table 7.1 shows numbers and extent of sites in intensively used agricultural land (and therefore under a high risk of being damaged or altered in any way).

Local Authorities are responsible for the curation of archaeological sites in their areas, primarily through the planning system (eg NPPG 5 Archaeology & Planning) and the majority hold their own Sites and Monuments Record (SMR) database. A Concordat has recently been signed with the RCAHMS to integrate these with the national database so that they can be accessed through a single portal. The majority is still recorded as point-based information and for adequate identification for land managers these need to be presented in areal format. Local authority archaeologists have a significant role in supplying desk-based archaeological information to support environmental audits under the agri-environment programme.

Table 7.1: Scheduled monuments and other archaeological sites on agricultural land in Scotland (after Wordsworth 2005)

Scheduled sites in arable land	**1,858**
Scheduled sites in improved pasture	**2,630**
Percentage of arable land now Scheduled	**0.6%**
Extent of Scheduled areas in arable land	**5,306 ha**
Extent of total SAM area	**16,570ha**
Total archaeological sites in arable land	**19,437**
Total archaeological sites in improved pasture	**31,556**
No of Scheduled sites identified as cropmarks	**1,226**

Scotland has more than 250,000 known archaeological sites. 7,800 of these are SAMs and therefore protected under the Ancient Monuments and Archaeological Areas Act (1979).

PROTECTIVE MEASURES

The need for prevention of damage by farming practices, particularly from cultivation of archaeological sites on arable land, is well recognized but the mechanisms for doing this are poorly implemented. Maps of archaeological sites are not currently supplied in Scotland except as part of the basic Conservation Audit for the Rural Stewardship Scheme (RSS). Furthermore, sites being selected for management (under RSS) are often not the most significant or most in need of management (Wordsworth, 2005). The option for maintenance of vernacular buildings was dropped from the Countryside Premium Scheme in 1998, though it is under consideration as an option under the new Land Management Contracts (LMCs).

Table 7.2: Archaeological sites managed under agri-environment schemes in Scotland. Data supplied by SEERAD.

CPS			RSS			ESA		
Year	Number	Area	Year	Number	Area	Year	Number	Area
1997	57	126.57	2001	154	236.57	1994		100.03
1998	82	144.96	2002	162	272.32	1995		374.17
1999	102	86.99	2003	486	357.39	1996	17	71.67
2000	173	148.18	2004	478	576.51	1997	47	317.93
						1998	29	43.64
	414	506.70		1280	1442.79	1999	42	177.91
						2000	0	0.00
						2001	0	0.00
						2002	12	41.13
							147	1126.48

Please note: The areas supplied for 1994 and 1995 are based on expenditure for archaeological options within ESA's.

Source: Data supplied by SEERAD.

The management of scheduled sites can be subject to restriction through management agreements which are normally agreed between the landowner and Historic Scotland and commonly include limitations on farming practices. As well as the use of the Ancient Monuments and Archaeological Areas Act (1979) to protect sites through primary legislation, there are restrictions on development of archaeological sites through the national planning policy guidelines (Adderley et al., 2001). Advice and information on all aspects of archaeology in Scotland, particularly public participation, is provided by the Council for Scottish Archaeology (CSA), a voluntary membership organisation.

More recently, protection is offered through Good Agricultural and Environmental Conditions (GAEC) that form part of the Single Farm Payment. It is primarily limited to sites already legally protected as monuments and buildings of national importance, namely SAMs and Listed Buildings. Protection is also offered to Designed Landscapes listed in the national inventories produced by HS and SNH. Protection for other archaeological and historic sites on farmland offered under GAEC is also applicable to many of the additional agricultural payments, such as Set-Aside and LFA. These cover potentially 90% of Scottish farmland.

The introduction of Land Management Contracts (LMCs) from 2007 offers the opportunity to provide protection to all archaeological sites and historical landscapes on farmland across Scotland. Information can be accessed through the online database Pastmap (currently still lacking data held in local Sites and Monuments Records) (RCAHMS, 2005).

The Forestry Commission is responsible for ensuring that forest expansion does not impinge on the archaeological heritage. Since 1988, all proposals for new tree planting have involved consultation with archaeological authorities. The Forestry Commission encourages private woodland owners to protect important archaeological sites through the Woodland Grant Scheme and Farm Woodland Premium Scheme, which only funds new planting in appropriate locations which meet the criteria of the UK Forestry Standards. These include the conservation of heritage features and take account of the cultural and historic landscapes (Yarnell, 2002).

Management and protection of cultural heritage sites is under supervision from HS, SNH, SEERAD and the Forestry Commission with support from the CSA. The Ancient Monuments and Archaeological Areas Act (1979) protects sites through primary legislation, and there are restrictions on development through the national planning policy guidelines. Funding to support this work is available for example through agri-environment and woodland schemes.

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Links to other BNs

8. FRESHWATER

Scotland has over 90 per cent of the volume and 70 per cent of the total surface area of fresh water in the UK, with more than 30,000 lochs and 6,600 river systems. Scottish agriculture depends on freshwater for livestock waterings and, whilst most pasture and crop systems are rain-fed, there is localised freshwater abstraction for **irrigation** of high water demanding crops (e.g. potatoes, field vegetables). Agricultural land and buildings generally drain to surface and groundwaters and impact upon them. Artificial **drainage** is a feature of improved agricultural land in Scotland. Point source and diffuse **pollution,** and localised **soil erosion** are associated with arable agriculture principally in lowland Scotland, whilst erosion has been associated with livestock grazing in the hills and uplands. **Flooding** frequently causes damage and loss of crops.

IRRIGATION

Irrigation is predominantly used in Scotland for potato crops, also for salad crops, grass and soft fruits. These are grown most commonly in the east of Scotland, also in the north-east around Moray and in the west around Ayrshire. The east coast areas are in greater need of irrigation because of the drier climate and lighter soils. In the north-east there is also greater ware potato production, which requires more water than seed production. Abstractions of water from surface waters and groundwaters affect the natural hydrological cycle. Abstractions are most commonly made during dry periods when river flows are naturally low, exacerbating drought conditions. Small streams are particularly vulnerable because the instantaneous abstraction may constitute a high proportion of the natural flow. New regulations and charging systems are now being introduced (2006) by SEPA, with full controls over abstractions exceeding 10m3/day. Because of higher yields of arable crops, water requirements for agricultural purposes are increasing: Since 1950, the amount of water used has risen from 170mm annually to 300mm in 2000. Particularly eastern areas of Scotland, with a high percentage of crop production and low rainfall, are at risk of lack of water (Sylvester-Bradley, 2005). The possible impacts of climate change on the need for and availability of water for crop irrigation in Scotland is an area of concern. Clearly demand reduction through improved water management systems could reduce this potential problem, and this may in any case happen due to the imposition of higher charges.

Agricultural demand for water abstraction for irrigation purposes may continue to increase, causing localised problems with low flow rates and water table lowering. This could be exacerbated by changes in rainfall regimes possibly associated with a changing climate. Measures to control abstraction have now been extended throughout Scotland via the provisions of the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) which affect all abstractions greater than 10m3/day, or impoundments where the height differential between the upstream and downstream water surfaces is greater than 1 metre. A new system of charging for abstracted water has been introduced by SEPA. This represents a significant increase in costs to the water abstractors and may add further pressure for the adoption of water conservation measures by farmers.

DRAINAGE

It is estimated that about 50% of improved agricultural land in Scotland has artificial drainage networks of surface ditches and/or sub-surface tile drains. Drainage of agricultural land modifies hydrological flow paths and flow rates. This may lead to accelerated runoff rates, and in turn may cause an increased risk of localized flooding. Conversely, a general lowering of the water-table can increase soil infiltration capacity which will tend to reduce the frequency of storm runoff. Changes in the hydrological flow paths have a secondary impact on water quality through changes in the transport of nutrients such as nitrogen and phosphorus. The presence of field drainage systems can increase the risk of contamination of ground and surface water with faecal pathogens after slurry or farm yard manure applications. In hill situations, particularly on blanket bog, some efforts are being made to block drains and restore the peatland hydrology (e.g. by SNH and RSPB).

There is very little information available on the extent or condition of agriculture-related artificial drainage systems in Scotland. Lack of grant support, high labour costs and low profitability may mean that many land managers are failing to maintain drainage systems. This could be having variable environmental effects and some monitoring should take place.

POLLUTION

The recently produced “characterisation report” (associated with the implementation of the Water Framework Directive), identifies where the water environment is at risk of being harmed and although there are problems, the majority of Scotland's rivers are of high quality. Forty-three per cent of the water bodies in the Scotland river basin district are at risk of being harmed - this compares to over 80% of waters in most of Europe. In addition, most of Scotland's river water bodies are of good quality: 72% are not affected by pollution; 73% are not affected by abstractions or dams; 66% are not affected by engineering works. The length of both poor (1,077km to 717km) and seriously polluted (91km to 51km) rivers in Scotland fell between 1999 and 2004. Leaking silos and silage effluent tanks, escape of animal slurry, pollution by chemicals, fuel oil, farm drainage and others can contribute to the pollution of water. There has been a significant reduction since 2000 in the number of reported **point-source pollution** incidents involving agricultural sources.

There remain, however, concerns about agriculture-related **diffuse pollution. Nitrogen** fertilizer is generally applied to crops as a combination of nitrate and ammonium compounds. Whilst ammonium ions are adsorbed onto soil particles, nitrate ions are highly mobile in soils and can be easily leached to ground or surface waters. Nitrogen applications to agricultural land in Scotland have ranged between 114 and 127 kg/ha between 1986 and 2003 and the rates of application to tillage crops in Scotland is around 40% less than in England and Wales because of cropping differences. Nonetheless nitrate concentrations in surface waters in Scotland are strongly correlated with proportion of arable land in their contributing catchments. Thus diffuse nitrate pollution has probably been driven by past changes in farming practices, and particularly the switch from mixed farming to cereal farming that occurred over much of eastern Scotland in the 1980s. The

EC Nitrates Directive (91/676/ EEC) now provides a framework to protect water bodies from agricultural nitrate pollution. This includes the designation of Nitrate Vulnerable Zones, where mandatory practices of fertiliser use are implemented. Whilst improved nutrient management and the introduction of landscape features like buffer strips may help reduce contemporary losses of nitrates from agricultural soils, it is believed that it will take some time for these improved management measures to have a significant effect.

Phosphate fertilizer is also applied to agricultural land. In contrast to nitrogen, phosphorus is strongly adsorbed onto the fine particles in soil and consequently water pollution only occurs where these particles are washed into streams via **erosion** by surface water runoff, often during heavy rainfall events. Soil erosion in arable soils in Scotland is thought to have increased since the 1980s in association with changes in arable cropping practices. Although applications of phosphate to agricultural land in Scotland has been around 40 to 45 kg/ha since 1983, changes in agricultural practices have locally increased the loss of soil particles to surface waters. Thus phosphate pollution may be strongly associated with increased soil erosion. Excess phosphorus in freshwaters can lead to localised **eutrophication**. This may adversely affect the freshwater biota, and the quality of private water supplies.

Besides agriculture the main sources of phosphorus are outputs from sewage treatment works. Orthophosphate concentrations in surface waters provide an indicator of trends in total phosphorus. SEPA data show significant drops in the average organophosphate concentrations in both their South East and South West areas. Between 1993 and 2001 the percentage of sites across Scotland with mean concentrations <25 µg P/l and =125 µg P/l averaged 45% and 16% respectively. By 2004, the percentage of sites with mean concentrations <25 µg P/l had increased to 58% and the percentage of sites =125 µg P/l had fallen to 7.5%. These data probably reflect significant improvement in water quality principally through improved sewage treatment, however diffuse phosphate pollution form agriculture remains a concern. Under the Urban Waste Water Treatment Directive (UWWTD) (91/271/ EEC), the Ythan Estuary, Dean Water, South Calder Water, River Almond, the lower part of the River Don and their respective catchments are all designated sensitive areas. Discharges into waters that have been designated as sensitive require additional treatment to remove nutrients. SEPA forecasts that agricultural activities will still be the largest polluting sector by 2012.

Shallow groundwater sources are especially at risk of contamination by faecal coliforms from livestock waste material. For example, of 1750 private water supply samples tested from Aberdeenshire between 1992-98, 30% failed on the basis of faecal coliforms, 41% failed on total coliforms and 15% failed on nitrate levels (Reid et al, 2003). However, progress is being made with regard to bathing water quality. Under the EU Bathing Waters Directive, some 60 bathing waters around the Scottish Coast are regularly monitored by SEPA. In 2005 95% (57 out of 60) of the Scottish bathing waters met European standards, and for the first time ever all recognized bathing waters on the west coast met the required standards. This provides evidence that the collaborative work of many Scottish agencies and land management interests to reduce diffuse pollution impacts is having a positive effect.

The Water Framework Directive (2000/60/EC)(WFD) is a wide-ranging and ambitious piece of European environmental legislation which became law in Scotland at the end of 2003 through the Water Environment and Water Services (Scotland) Act 2003 (WEWS). The Directive establishes a new legal framework for the protection, improvement and sustainable use of surface waters, transitional waters, coastal waters and groundwater across Europe in order to:

- **Prevent deterioration and enhance status of aquatic ecosystems, including groundwater**
- **Promote sustainable water use;**

FLOODING

Fertile agricultural land often occurs within floodplains. Flood defenses for farmland therefore have been a major element of land management in these areas. Agricultural practice has often been associated with the canalization and embankment of rivers, whilst drainage has contributed to the loss of floodplain habitat and long-term habitat change. Drainage of fertile land has been a major element of agricultural policy in the past, but this policy is now changing and more emphasis is being placed on delivering public benefits and agricultural enhancement.

Analysis of available long river flow records shows high variability in both the frequency and severity of floods since the 1950s. Whilst the 1980s and 90s were exceptional for many rivers, the frequency of flooding was higher in the 1950s, especially in the north. Recent flood events would suggest that flooding is becoming more frequent. Some of these problems can be attributed to the changes in land use and development within floodplains. Some 6.7% of Scotland's prime agricultural land is within flood risk areas. The responsibility for protecting agricultural land and property from flooding in Scotland lies primarily with land owners. The Water Environment and Water Services (Scotland) Act 2003 (WEWSA) introduced a duty on Scottish Ministers, SEPA and responsible authorities to promote sustainable flood management: "The Scottish Ministers, SEPA and the responsible authorities must promote sustainable flood management." Amongst a range of things, Local Authorities are responsible for planning control, the establishment of Flood Appraisal Groups to provide practical guidance and information on flood risk, assessment of watercourses in non-agricultural areas for conditions likely to pose flood risk and maintenance of watercourses. The provisions of the WFD include a more coherent overall approach to river basin management including flood mitigation.

During the present century it is anticipated that Scotland's climate will become wetter, more stormy, and sea levels will rise. This will result in an increased flood risk both inland (adjacent to rivers and smaller water courses) and along low-lying coasts. It is anticipated that flooding is likely to increase across Scotland this century. Depending on the scenario used, floods are likely to significantly increase in frequency and volume by the 2080s, and in especially sensitive river basins, floods which presently occur on average once in fifty years could occur twice as frequently. (Scottish Executive, 2002).

Agricultural practices have a role in regulating run-off particularly through increased storm water storage, restoration and management of wetlands and upland areas. This can reduce downstream flooding risk. Because a significant area of prime agricultural in Scotland is itself at risk, reducing accelerated run-off through changed cultivation techniques and riparian zone management, may have agricultural and environmental benefits as well as reducing flood risk. In a similar way to control of agricultural pollution, this points to the benefits of a catchment-based approach.

KEY RESOURCES

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9. FORESTRY AND FARM WOODLAND

HISTORY

After the last ice age, woodland recolonised much of Scotland. The reduction of natural woodland began about 4,000 years ago with land clearing for farming and grazing. From the 17th century, the demands of timber for industrial purposes increased (SNH, 1993). The total woodland area in Scotland reached a low around the beginning of the 20th century. Since then it has steadily increased with an increase in the proportion of conifers. New planting of woodland peaked in 1988/1989, when 25,000 ha of new woodland were created per year. Since then new planting has declined to below 6,000 ha in 2004 (Scottish Executive, 2005). Half of the UK's forests are in Scotland, but Scotland is still one of the least wooded countries in Europe.

Table 9.1: Area and types of woodland in Scotland 1913 – 2005

	1913	1924	1947	1965	1980	1995	2005
Area (000 ha)		435	513	656	920	1,282	1,334**
% of total land	4.4*	5.5	6.5	8.3	11.7	16.3	17.0**
Conifers % of total land		3.2*			10.6*	13.5*	13.4**
Broadleaves % of total land		2.3*			1.1*	2.8*	3.6**

Source: Forestry Commission (2005), in Key Scottish Environment Statistics
* SNH (2001)
** Forestry Commission (2005)

After a steady increase over the last century, 17% of Scotland's total land area is woodland in 2005.

GENERAL

The amount of woodland is of significant environmental importance. The extent of forestry has wide-ranging effects on wildlife habitats, the physical environment and is an indication of the development of paper and timber production. In addition, woodland has aesthetic and recreational properties.

The ecological value of semi-natural woodland, in terms of the diversity of plant communities and species present, is often closely related to woodland age and origin. Ancient woodland is a small and highly fragmented, but vitally important part of Scotland's natural and cultural heritage. Of the 14,500 ASNO sites (Ancient Woods of Semi-natural Origin, see Table 9.2) most are smaller than 10 ha. LEPO (Long-Established Woods of Plantation Origin) have been plantations from the mid-1800s, mostly of native species (SNH, 2004).

Table 9.2: Origin of historic woodland (1999)

	Woodland area (km^2)			% semi-natural
	Semi-natural	Plantation	Total	
Ancient (ASNO)	891	591	1,482	60
Long Established (LEPO)	249	1,628	1,877	13
Other historic woods	51	119	170	30
Total	1,191	2,338	3,529	34

Source: SNH (2001)

Most plantations are stands of exotic species, planted during the 20th century. They are often dense, even-aged monocultures, but opportunities are being taken to diversify them, particularly as they reach harvesting age. A large proportion of recent plantations of native species is classed as "new native woodlands" and will be managed according to the guidelines for semi-natural woodlands. 97.8% of the woodland area is in woodlands of 2ha and over (Forestry Commission, 1999).

Table 9.3: Woodland area by principal species

Species/Groups	**Total area (ha)**	**% of total area**	
		Categ.	**Species**
Pine	264 154	29	23.5
Sitka Spruce	527 591	58	47.0
Larch	65 213	7	5.8
Other conifers	51 297	6	4.6
Mixed conifers	8 235	1	.7
Total conifers	916 490	100	81.6
Oak	21 114	10	1.9
Beech	9 961	5	.9
Sycamore	10 882	5	1.0
Ash	4 904	2	.4
Birch	77 780	38	6.9
Elm	1 343	1	.1
Other broadleaves	18 685	9	1.7
Mixed broadleaves	61 690	30	5.5
Total broadleaves	206 363	100	18.4
Total all species	**1 122 853**		100.0

Category: species/group % of conifer or broadleaved category
Species: species/group % of all species

Source: Forestry Commission (1999)

The most recent woodland survey, the National Inventory of Woodland and Trees Scotland, carried out by the Forestry Commission in 1995, showed that Sitka spruce was by far the most widely spread conifer, with pine coming a second; the main broadleaved species was birch (see Table 9.3). A total of 17 881 woods in Scotland are over 2 ha with a mean wood area of 70.2 ha; the total of 64 525 woods from 0.1 – 2 ha have a mean area of 0.44 ha. (Forestry Commission, 1999)

In 2004, 79% of all forest land in Scotland was conifers and 21% was broadleaved species. The many small sites of ancient and long-established woodland areas are an important part of Scotland's natural and cultural heritage.

WOODLAND MANAGEMENT

Woodland is managed by the Forestry Commission, other public bodies (including other government departments and local authorities), and private owners. Only a very small,

but growing area can be classed as Farm Woodland (see Table 9.4). The Forestry Commission manages just over a third of woodland in Scotland. The Scottish Forestry Grants Scheme (SFGS) has been developed to implement the Scottish Forestry Strategy. It aims to encourage the creation and management of woods and forests to provide economic, environmental and social benefits now and in the future. As part of the SFGS the Farmland Premium scheme offers additional grants for planting trees on land that has been in agricultural use during the previous three years. Annual payments compensate for farming income foregone. Grant payments are made for either 10 or 15 years depending on the percentage of broadleaves established within the scheme. To qualify for payments over 15 years, the percentage of broadleaves must be at least 60% at planting and must not subsequently drop below 50%. The RSS and LMCs also provide support for farm woodland management.

51% of Scotland's woodland area is certified as sustainably managed.

Table 9.4: Woodland on agricultural holdings

	1989	**1994**	**1999**	**2004**
'000 ha	97.7	140.8	197.2	239.0

Source: Scottish Executive Statistics (2005)

Following a peak of over 25,000 ha at the end of the 1980s, the area of new planting has declined to 6,793 ha in 2004. The area of new broadleaf plantings by non-Forestry Commission owners, however, shows an exception to the overall trend with an increase from 127 ha in 1985 to a peak of 7,784 ha in 2001 and 4,177 ha in 2004. Broadleaf planting has been encouraged under the Broadleaved Woodland Grant Scheme and its successors, the Woodland Grant Scheme and Scottish Forestry Grant Scheme. The area of forest restocked annually more than doubled between 1985 and 2004. In 2004, the total area restocked was 8,896 ha (Scottish Executive, 2005).

By 2000, about 90 km^2 (0.8% of the total area of plantation) was felled annually. As nearly half of Scotland's plantations are less than 30 years old, timber production is projected to double between 2000 and 2015 (SNH, 2004).

About a third of Scotland's forests are managed by the Forestry Commission. In 2004, the Forestry Commission carried out 90ha of new planting, 34% of which was broadleaved species; non-Forestry Commission owners planted 6,703ha new with 62% broadleaves.

SCOTTISH FORESTRY STRATEGY

The Scottish Forestry Strategy (published in 2000) is the Scottish Executive's framework for taking forestry forward, through the first part of the new century and beyond. The strategy proposes five *Strategic Directions for Scottish Forestry* (under each of which several priorities for action have been defined):

- to maximize the value to the Scottish economy of the wood resource
- to create a diverse forest resource of high quality
- to ensure that forestry in Scotland makes a positive contribution to the environment
- to create opportunities for more people to enjoy trees, woods and forests in Scotland
- to help communities benefit from woods and forests

At the current rate of establishment (less than 8,000 ha per annum) Scotland's forest area will be short of the current Scottish Forestry Strategy's aspiration of 25% woodland cover by 2050 (Tipper and McGhee, 2005). The Scottish Forestry Strategy is currently under review.

The overarching principle for the Scottish Forestry Strategy is sustainability; the other principles are integration, positive value, community support, diversity and local distinctiveness. The Scottish Forestry Strategy is currently (2005) under review.

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Links to other briefing notes

10. SCOTTISH AGRICULTURE AND CLIMATE CHANGE

PAST AND FUTURE

Accelerated climate change over the late 20th century is widely accepted as being a result of increased emissions of greenhouse gases (GHG). Scotland's mean annual temperature rose by 1.1 ^{o}C between 1860 and the present. The UK Climate Impacts Programme (UKCIP) used a global climate model to forecast over the next 100 years. Their Climate Change Scenarios report (Fuller et al., 2002) showed that by 2080 sea levels are forecast to rise by as much as 60cm around Scotland, whilst summers may become drier and warmer and snowfall could decrease by up to 90%. In July 2003, the British Irish Council published climate change scenarios for the Scottish islands, including the Orkney Islands, the Western Isles and the Shetland Isles. The computer model used in the UKCIP scenarios is too coarse to show these islands, so a new model was developed. This indicated that by 2080 annual average temperatures will increase by as much as 1.8C in the Western Isles, 2C in the Orkney Islands and 2.2C in the Shetland Isles. Rainfall in summer might decrease by 22% in the Western Isles, 27% in the Orkney Islands and 19% in the Shetland Isles. Average snowfall could decrease by 89% and sea levels rise by up to 69 cm around all three islands. These changes could have both direct and indirect impacts on Scotland and there is clearly a need to examine the role of agriculture and forestry in mitigating them.

PRESENT

The UK is party to the UN Framework Convention on Climate Change. Under this, the 1997 Kyoto Protocol set legally binding targets under which the UK must reduce emissions of a "basket" of six GHGs to 12.5% below baselines (1990 for CO_2, methane, nitrous oxide, and 1995 levels for fluorinated compounds) by 2008-2012 (Scottish Executive, 2005). At present the Scottish climate change programme commits Scotland to achieving an "*equitable share*" of the UK's Kyoto target. This share has not yet been specifically defined but is taken as "*taking action in the same or similar areas as the UK Government, where we have the devolved powers to do so.*" Scotland's overall GHG emissions fell 5.7% from 1990 to 2002 (71.6MtC). Figure 10.1 shows the sectoral share of this change.

Despite the overall reduction, emissions estimates actually increased for energy supply, land use change and transport. In their evidence to the Environment and Rural Development Committee (Scottish Parliament, 2005) SEPA indicated that the reduction in Scottish emissions appeared to be "*an inadequate contribution to the UK's domestic target*".

Scotland's contribution to the UK's domestic target for reductions in GHG emissions is currently inadequate (SEPA).

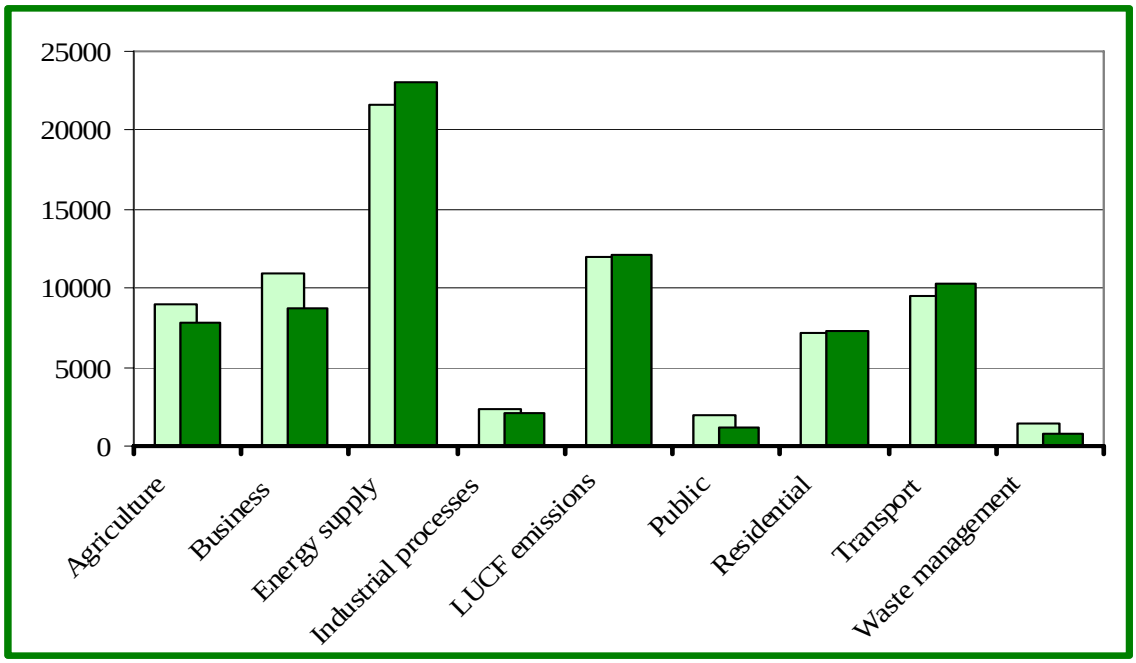

Figure 10.1: Sectoral GHG emissions for Scotland 1990 and 2002 in equivalent mass of CO_2 (Kt).

AGRICULTURE, LAND USE CHANGE AND FORESTRY

Estimates of the emissions from agriculture, land-use change and forestry (LUCF) in Scotland suggest that they contribute around 28% of the UK's total equivalent mass of CO_2 emissions (Table 10.1). It should be noted that these estimates have high uncertainties of up to +/- 19% (Baggott et al., 2005). Published sources provide conflicting estimates and **the ERDC enquiry (Scottish Parliament, 2005) recommended that a comprehensive independent audit of progress under the Scottish climate change programme should be commissioned.** Accepting these uncertainties, the available estimates suggest that the contributions from Scottish agriculture to GHG emissions declined by about 13% between 1990 and 2002 in absolute terms whilst those from LUCF increased by about 1.4%. It should be noted that these figures do NOT include the positive contributions to carbon sequestration have been made through forest planting and tree growth in Scotland, and possibly through the less intensive use of agricultural land. These contributions are likely to have occurred in Scotland but the regional GHG inventory figures do not yet include data on them and there is clearly more research needed on life cycle analyses of the main GHCs related to agriculture (i.e. Carbon Dioxide, Methane, Nitrous Oxide and Ammonia).

Agriculture and forestry directly contribute less than 2% of the GDP of Scotland but they are critical to the environmental economy. In terms of carbon cycling, 28% of Scottish emissions are estimated to result from agriculture and LUCF, only slightly less than from energy supply (32%). Together these sectors account for a disproportionately large volume of the total UK emissions from these sectors. This disproportionate effect is due to the very large volume of organic matter in the soils of Scotland, the high livestock numbers involved in Scottish agriculture, and to the continued expansion of the forested area.

Scottish agriculture, land use change and forestry currently make disproportionately large contributions to UK Greenhouse Gas Emissions.

Table 10.1: Sectoral greenhouse gas emissions for Scotland 1990-2002

Equivalent Mass of CO_2 (kt) and % of Scottish total						**UK CO_2 (kt) and Scottish % of UK total**	
Emissions	**1990**	**1995**	**2000**	**2002**	**% change 1990-2002**	**1990**	**2002**
Agriculture	8941 (12)	8696 (11)	8102 (11)	7788 (11)	-12.9	56598 (16)	48495 (16)
Business	10946 (14)	8678 (11)	7568 (10)	7119 (10)	-35.0	99340 (11)	82583 (9)
Energy supply	21565 (28)	24167 (32)	24973 (33)	23030 (32)	+6.8	270547 (8)	218622 (11)
Industrial process	2382 (3)	1396 (2)	1865 (2)	2116 (3)	+11.2	67711 (4)	39078 (5)
Land use change and forestry (LUCF) emissions	11970 (16)	12008 (16)	12306 (16)	12135 (17)	+1.4	19633 (61)	13611 (89)**
Public	1913 (3)	1389 (2)	1332 (2)	1110 (2)	-42.0	16116 (12)	12099 (9)
Residential	7211 (10)	7311 (10)	7374 (10)	7328 (10)	+1.6	81737 (9)	91035 (8)
Transport	9452 (12)	11619 (15)	10863 (14)	10250 (14)	+8.4	124895 (8)	131578 (8)
Waste management	1427 (2)	1237 (2)	908 (1)	724 (1)	-49.3	26668 (5)	11342 (6)
*Total CO_2 Emissions (Mt C)**	*75808(100)*	*76501 (101)*	*75292 (99)*	*71599 (100)*	*-5.6*	*762245((10)*	*648444 (11)*

*** Total does not equal the sum of emission subsets due to rounding*

**** Reflects a reported decrease in English LUCF emissions due to a less intensive use of land. This decrease is based on very limited data and is under review.*

Source: Baggott et al. (2005)

MANAGING THE SOILS OF SCOTLAND

The soils of Scotland contain the bulk of the UK soil carbon pool. It is estimated that 13.6% (>1 m ha) of Scotland's land surface is overlain by deep peat soils. This represents about 5000 tonnes of carbon stored per hectare or about 10 times the equivalent stored in the mineral soils which are more common in England. Taken together, the carbon stored in the deep peats and the shallower peaty soils of Scotland is about 170 times more than stored in all the vegetation of Scotland (Milne and Brown, 1997). Soil carbon can be lost either through climate change or as a consequence of inappropriate land management (e.g. drainage of deep peats). Either would have major effects in relation to added GHG emissions. Biological mitigation can occur via 3 routes:

1. conservation of the existing soil carbon pools
2. sequestration by increasing the size of the carbon pools
3. substitution of sustainably produced biological products (e.g. use of timber rather than concrete or biofuels for heat and power)

The ERDC recommended that there should be more research on the processes of GHG release from Scottish soils and the potential for mitigating GHG emissions, and to use this to develop a co-ordinated soil protection strategy (Scottish Parliament, 2005).

The greatest potential for mitigating future GHG emissions from UK soils lies with Scottish agriculture and forestry. Policy for these areas is wholly devolved.

ROLE OF AGRICULTURE

A significant proportion of agricultural emissions are of methane rather than CO_2. 69% of Scotland's methane emissions arise from agriculture, with cattle responsible for 49%. Between 1990 and 2002 methane emissions fell by 9%, largely resulting from a reduction in the numbers of livestock. This contributed substantially to the overall reduction in agricultural emissions of 12.9% between 1990 and 2002. Scottish agriculture has a direct role in the conservation of soil organic matter which potentially has considerable benefit in terms of avoiding GHG emissions. The effects of agricultural policy e.g. through Common Agricultural Policy (CAP) reform may have direct impacts e.g. through cross-compliance measures which are a condition of public funding via the Single Farm Payment (SFP) introduced in January 2005, and indirect effects through changes in economic viability of particular enterprises which may lead to reductions of particular types of livestock (e.g. beef cattle) particularly in high-cost areas (e.g. Highlands and Islands). As with the forestry sector, the Forward Strategy for Scottish Agriculture has no specific focus on climate change although it was recognized as a key issue in the AEWG Report.

There are opportunities to integrate climate change mitigation within agricultural policy. However, the ERDC noted that little thought appears to have been given to integrating climate considerations into potentially useful policy mechanisms, such as land management contracts. The ERDC further identified the need to examine the contribution that various strands of land-related policy make to greenhouse gas emissions so that it will be possible to develop feasible and acceptable sectoral targets for reducing land use emissions.

ROLE OF FORESTRY

It is estimated that forests globally sequester some 25% of the carbon emitted by world-wide fossil fuel combustion. The comparable figure for the EU15 is 15%, for Sweden 145% and for the UK 2%. As a high carbon-emitter the UK could improve its position through increased tree cover. Some 17% of Scotland is tree covered (c.f. 7.6% in England). The Scottish Forestry Strategy aims to increase cover from 17% to 25% by 2050 – implying the planting of approximately 10,000 to 12,000 hectares of new woodlands per year. Provided sites are carefully selected to avoid excessive loss of soil carbon, the growth of the forest resource could be used to transform land areas that are currently sources of greenhouse gas emissions (including methane from livestock, nitrous oxide and CO_2 from soils and CO_2 from fertilizer manufacture) to sinks. This role is not explicit in the current Forestry Strategy, highlighting that policy in the forestry sector is relatively underdeveloped in terms of climate change. If there is an increase in Scotland's forest cover from 17% to 25% over the next 15 years, and carbon reserve management is implemented in existing forests, then carbon removals by forests could rise to over 2 million tonnes of carbon per annum by 2030 and to over 2.5 million tonnes of carbon per annum by 2040. Wood fuel output from Scotland's forests could make an additional contribution of 0.6m to 1.5m tonnes of avoided C emissions per year. A new research

programme on 'Carbon dynamics in forests' at Forest Research will combine knowledge of growth processes, yield modelling and life cycle analysis under predicted scenarios of climate change.

At the current rate of establishment (less than 8,000 hectares per annum) Scotland's forest area will be well short of the current Scottish Forestry Strategy's aspiration of 25% woodland cover by 2050 (Tipper and McGhee, 2005).

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11. SOILS

GENERAL

The Scottish soil resource contains a number of internationally important soil types including montane soils and peat. Podzols are the most common soil type occupying 18,480 km^2 or 24% of the land area. Peats occupy 16,940 km^2 or 22%; gleys occupy 10,780 km2 or 14% of the land area; brown earths 9,240 km^2 or 12%; montane soils 3,850 km^2or 5%; and lithosols, regosols, alluvial soils, rankers, rendzinas, calcareous soils and magnesian soils make up the remaining 4% or the land area.

Human activities have modified a large proportion of Scottish soils: Nearly 80% of the land area in Scotland is classified as agricultural and approximately 16% of the land area is forested. In the lowlands, soils have been significantly modified by activities such as forest clearance, grazing, drainage and arable farming. In the uplands, management of sheep and deer, and forestry has contributed, in varying degrees, to changes in soil characteristics.

Peatlands are an important resource in Scotland, both for their conservation and environmental value. It is estimated that 44% of UK terrestrial carbon is contained within Scottish peatlands, but they have been impacted by commercial extraction for horticulture, drainage, overgrazing, pasture improvement and forestry. Raised bogs are mainly found in the central belt and the Grampian coastal plain. (SEPA, 2001)

There is a dominance of acidic, organic matter rich soils in the west and more mineral, less acidic soils in the east. Scotland has over one million hectares of blanket bog, approximately 10% of the world's coverage.

SOIL PHYSICAL DAMAGE – EROSION, COMPACTION, POACHING

Overgrazing by sheep and/or deer, poor muirburn practices, hedge and windbreak removal, downslope ploughing, cultivation of excessively steep slopes, winter cropping which leaves soil bare at times of maximum rainfall and high winds can all lead to erosion. (SNH, 1995) There has been a major expansion of footpath networks in popular mountain areas, and much of this is eroding. Downhill skiing has also created localised erosion.

In general lowland soils are in better physical condition. In some arable areas, the general shift from spring to autumn sowing of cereals may have reduced soil erosion (Dargie and Briggs, 1991).

The best evidence of erosion is available from blanket peat. The greatest extent of peat erosion (20%) is in the Monadhliath Mountains (see Table 11.1). However, **the most severely eroded areas are found in the eastern Southern Uplands and eastern Grampians** along with evidence of land management pressure such as grazing and burning. Soil erosion can also result from forestry practices, particularly during planting

and harvesting. Recent changes in ground preparation techniques, such as the use of mounding rather than ploughing, have reduced the risk of soil erosion (SEPA, 2001).

Table 11.1:
Regional extent of erosion in upland Scotland

Region	Extent of area eroded
Southern Uplands (east)	3.5 %
Southern Uplands (west)	1.1 %
Midland Valley	3.9 %
Trosshachs	7.0 %
Lochaber	3.2 %
Central Highlands	5.8 %
Cairngorms	1.5 %
Eastern Grampians	8.1 %
Monadhliath	20.0 %
North west Highlands (south)	1.5 %
North west Highlands (central)	8.2 %
Easter Ross	10.1 %
Wester Ross	6.9 %
Caithness	0.5 %
North west Highlands (north)	6.8 %
Western Isles	6.0 %

Source: Grieve et al. (1996)

Compaction is a problem in intensive arable production on soils with high silt and clay contents, particularly systems where yield increases with late harvesting (root crops) or where multiple cropping takes place (intensive silage grass).

Poaching, on the other hand, is common in animal production on imperfectly drained soils in the wetter areas in the west of Scotland.

In forestry, clearfelling results in soil disturbance with possible erosion and compaction.

Erosion is the most common type of soil physical damage in Scotland, caused e.g. by overgrazing, inappropriate cultivation of steep slopes, and the extension of footpath networks in popular areas.

SOIL CHEMICAL AND BIOLOGICAL CHANGES

A national-scale threat to soil quality in Scotland is enhanced acidification. In Paterson (1989), classified the land areas of Scotland as:

- Strongly acidified 24.6%
- Vulnerable 36.1%
- No immediate risk 35.7%
- No data 3.6%

The vast majority of organic waste applied to land in Scotland is agricultural waste, comprising manures, slurries and silage effluent. In 1996-1997, 185,000t of sewage sludge or 19% of the total produced was recycled to just over 4,000 ha of agricultural land at 597 sites; in 2002 it was 40% of the total. This is expected to rise to over 858,000 wet tonnes by 2005-2006, as a result of additional sewage treatment. Most sludge is likely to be applied to agricultural land.

The use of **inorganic fertilisers and pesticides can impact on soil quality through changes in nutrient turnover rates, organic matter decomposition rates and the build up of pesticide residues in the soil**. However, the long term impacts are as yet unclear. Inorganic fertiliser application to arable land has averaged 122kg/ha/y for N and 49 kg/ha/y for P in recent years. In addition, 7,767 t (active ingredients) of pesticides were applied to arable land in 1998.

Afforestation can have a range of effects on soil quality. The presence of a tree canopy alters the microclimate experienced by the soil. Temperatures are generally lower in a forest and transpiration and interception of rainfall by the canopy result in drying of the forest floor. Both temperature and moisture content strongly influence soil microbial processes. Planting and felling operations can damage physical, chemical and biological components of soils if not properly managed. The disturbance caused can result in the oxidation and loss of soil organic matter, resulting in the emission of CO_2 (SEPA, 2001)

POLICIES AND LEGISLATION

Interest in the Scottish soil resource is shared between farmers, foresters and urban soil users, and those who are responsible for management or regulation of the activities that impinge on it. Adderley et al. (2001) recommended SEERAD should appoint an Advisory Committee on Scottish Soils with members drawn from government bodies and soil scientists. Its main tasks would be to review available data and monitor soil.

A wide variety of legislation and guidelines directly and indirectly pertain to the management of soils in Scotland. In the rural setting these are principally concerned with the protection or conservation of other environmental elements such as water quality and natural heritage: The Control of Pollution Act 1974; The Food and Environmental Protection Act 1985; The Control of Pesticides Regulations 1986; The Plant Protection Products (Basic Conditions) Regulations 1997 and The Pesticides (Maximum Levels in Crops, Food and Feeding stuffs) (Scotland) Regulations 2000, all provide legislation on the use of pesticides on soil albeit within a set of wider environmental issues.

The Sludge (Use in Agriculture) Regulations 1989 and The Sludge (Use in Agriculture) (Amendment) Regulations 1990 establish maximum annual applications for metals contained in sludge and set maximum permitted metal concentrations in agricultural soil treated with sludge.

Soil protection is not specifically addressed by current environmental protection legislation (SEPA, 2001). However, many agri-environment schemes have soil protection implications. Under the Arable Area Payments Scheme set-aside is subject to different management regimes which may be beneficial to soil structure; under the LFA scheme, the switch from headage to area payments is likely to lessen erosion risk from livestock; Suckler Cow Premium and Sheep Annual Premium may have increased erosion risk due to overgrazing. (For other schemes see under subject, e.g. woodlands, OAS, RSS, SSSI etc) (Adderley et al., 2001). The definition of Good Agricultural and Environmental Condition (GAEC), for the purposes of cross-compliance for receiving the new Single Farm Payment, has a number of soil protection measures including erosion protection and organic matter. The EU Thematic Framework for Soil Protection has not been ratified and there is no legal requirement for Scotland to develop a Soil Protection Strategy although other parts of the UK have.

No single piece of Scottish legislation addresses the management and protection of soils alone. However, the quality of soil is directly and indirectly addressed by a wide variety of environmental guidelines and regulations.

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Links to other subjects

12. DEVELOPMENT DIVERSIFICATION AND LAND USE CHANGE INCLUDING ENERGY CROPS

URBANISATION

The bulk of agricultural land loss up to 1988 was to forestry. However, the area of built-up land in Scotland increased by 46% between 1946 and 1988. This was highly selective and mainly on improved grassland and arable farmland (Mackey et al., 1998). By 1996, 2.6% of Scotland's land area (2,056km^2) was classified as urban. There has been a significant change in the number of households in Scotland: between 1981 and 1999 there was an 18% rise (332,000) despite a falling overall Scottish population. Projections suggest that by 2012 there will be a further 12% increase. This suggests that there will be continued pressure for the development of green field sites particularly around existing settlements.

LAND ABANDONMENT

Over the past 200 years industrial development has produced over 11,500ha of vacant and derelict land comprising over 5,000 individual sites predominantly within the Central Belt areas of North Lanarkshire, West Lothian and the City of Glasgow (Scottish Executive, 2000a). The principal former use of vacant land is agriculture and of derelict land it is mineral extraction. The most common new use of vacant land is for housing. Under the Pollution Prevention and Control (Scotland) Act 1999, regulated industries are required to return sites to their original condition once their activities have ceased. This should prevent the creation of further derelict land. It is also possible that some reclaimed sites may be used for growing biomass energy crops such as short rotation coppice. This is currently being pioneered by Scottish Coal.

LAND USE CHANGES AND HABITAT LOSSES

In 1988 about 60% of Scotland's land cover was semi-natural vegetation. This followed a decline of about 17% over the period since 1945 (Mackey et al., 1998; SNH, 2001a). Forest plantations on sites with acid grassland, mire, heather moorland and former woodland habitats accounted for over 81% of this decline. The bulk of the remainder (13%) related to loss of acid grassland and heather moorland habitats though pasture improvements by liming, fertilizing and reseeding. Both these major changes were grant-aided and government support for such schemes is no longer available.

The UK has been subdivided into 37 broad habitats for the purposes of biodiversity action planning and monitoring (Jackson, 2000). The latest Countryside Survey (Haines-Young et al., 2000) indicates that between 1990 and 1998 there continued to be losses in acid grassland (-4.9%), dwarf shrub heath (-5.4%) and neutral grassland (-14.8%) habitats but there were statistically significant increases in fen, marsh and swamp (18.7%) and broadleaved woodland (9.0%). These changes are thought to be a positive reflection of changes in government policy and support mechanisms for forestry and agriculture.

CHANGES IN ARABLE AND MIXED FARMLAND HABITATS

Since 1945, changes in agricultural practices particularly through increased mechanization and specialization and the design of CAP subsidies have had a significant effect in arable settings with the west of Scotland becoming predominantly pastoral and the eastern lowlands arable. The associated effects of these changes in terms of declines in arable weed species and farmland birds are well documented (Mackey et al., 2001). Hedgerows reduced by 50% between 1947 and 1988 (Mackey et al., 1998). However there is no evidence of further losses of these features between 1990 and 1998 (Haines-Young et al., 2000) although mixed farming has continued to decline throughout this period (Birnie et al., 2002). **The changing focus of agricultural support and the requirements of GAEC suggest that further significant losses of landscape structure in arable settings are unlikely over the next decade.**

CHANGES IN GRASSLAND HABITATS

There was a 10% loss of rough grassland between 1947 and 1988. This was mainly due to afforestation and pasture improvement (SNH, 2001b). There was an estimated reduction in the area of calcareous grassland of 16% between 1990 and 1998 due mainly to continued conversion to more intensively managed pasture. The significant increase in the "fen, marsh and swamp" broad habitat is partly due to failure to maintain land drainage in wetter grassland areas (McGowan et al., 2001). **It is likely that this process of reversion in improved grasslands will continue over the next decade as marginal grasslands become less financially viable to maintain (i.e. drain maintenance, liming and fertilizer costs.**

Methods of grass conservation have also radically changed since 1990. Hay production has reduced by over 35% and silage production, especially wrapped silage, has increased. **It is likely that these trends will continue and there will be further declines in hay production over the next decade.**

HEATHS AND MOORLAND HABITATS

Between 1947 and 1988 heather moorland was reduced by around 23% (Mackey et al., 1998). This was principally due to afforestation or conversion to rough grassland through direct pasture improvement or indirectly through grazing pressure (Hartley, 1997). In northern Scotland sheep numbers are thought to have increased by about 50% between 1975 and 1966 (Harding et al., 1994). Sheep numbers in the Scottish LFA increased by 18% between 1982 and 1998 as sheep displaced cattle. Red deer numbers are thought to have risen by 100% over the 30 years to 1989 (Staines et al., 1995). The introduction of the SFP is likely to have greatest impact on marginal hill sheep farms with a strong incentive to reduce stocking or de-stock completely, although minimum requirements for land management are defined under GAEC. **It is likely that previous trends for increased stocking rates on these habitats will be reversed. The critical factor in relation to habitat recovery or change will be the relative balance of domestic and wild herbivores.**

RECREATIONAL LAND USES

Between 1970 and 1999 about 25,000ha of agricultural land were converted to recreational use. This was equivalent to the area of land converted to roads, housing and industrial development during the same period (Birnie et al., 2002). However, these apparent changes are possibly less significant than indirect recreational effects. Principal amongst these is "horsiculture" (Quetier and Gordon 2003). Data from the SEERAD JAC indicate that between 1983 and 1999 there was a 145% increase in horse numbers in the former Grampian Region. Particularly high proportions of agricultural holdings within the Aberdeen travel to work area report keeping horses. However, this is likely to be significantly under-reported since the JAC does not collect information from non-agricultural rural households, other studies suggest that 80% of horses are kept where their owners live (Mellor et al., 2001) and it has been shown that for a given area of Scotland horse numbers were more than three times that recorded in the JAC.

By underestimating the increase in horse numbers particularly in the travel to work areas of the major urban centres we fail to capture a major contemporary land use change and particularly its economic and environmental impacts. No research has been carried out on these impacts.

DIVERSIFICATION OF AGRICULTURAL CROPPING

Scotland's cereal area fell to a 30-year low in 2005. The JAC shows that combinable crop area fell by 6% to around 457,000ha, the lowest since 1973. The greatest reduction was in winter barley (8%), followed by wheat (5.5%) and spring barley (5.4%). It is thought that the main driver of this change is CAP reform and further reductions are envisaged by the NFUS. The advent of the SFP also means that growers have more cropping choice particularly in the niche and non-food sector. The main candidate crops are thought to be:

- **Linseed**: offers high contract prices; can be grown on set-aside land; added value markets in animal feed markets
- **Biodiesel**: contracts available for spring or winter oilseed rape (double-low types only); can grow rape or cereal crops as fuel for home use.
- **Bioethanol**: cereals and sugar beet are potential sources but no contracts or processing facilities; bioethanol plants are planned.
- **Fibre**: contracts for 2006 for hemp not on set-aside are available.
- **HEAR**: High Erucic Acid Rape is a long-standing industrial crop. HEAR varieties require isolation from conventional rape; contracts are available and HEAR can be grown on set-aside.
- **Niche Crops**: There is a list of pharmaceutical contracts including borage, echium and camelina (not on set-aside), crambe and hemp seed and fibre (which can be grown on set aside).

It is likely that some of these cropping alternatives will become more important in the next decade but they will be highly dependent on market price and processing capacity. Grant incentives would also affect their adoption and potentially facilitate market developments.

BIOMASS FUELS RELATED TO FORESTRY AND AGRICULTURE

Biomass fuels are a particular opportunity and have been extensively reviewed in the past 2 years in relation to agricultural diversification (e.g. Towers et al. 2004). Table 12.1 provides a summary of the main biomass fuel groups and fuel types (adapted from Towers et al., 2004).

Table 12.1: Main biomass fuel groups and types

BIOMASS FUEL GROUP	FUEL TYPE
Agricultural Residues	1. Straw 2. Animal Manures (Wet) 3. Animal Manures (Dry) 4. Animal By-products
Wood Residues	5. Forestry Residues 6. Wood Processing Co-products
Energy Crops	7. Short Rotation Coppice (SRC) 8. Short Rotation Forestry (SRF) 9. Energy Grasses 10. Energy Crops for Liquid Biofuels

Source: Towers et al. (2004)

It is likely that the production of biomass fuels will become locally important over the next decade, however in Scotland the main potential is thought to be associated with wood residues rather than energy crops.

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13. LAND TENURE AND LAND OWNERSHIP

HISTORY

With the exception of Orkney and Shetland where the Norse influence provided an alloidal tenure system (where land is held subject to no superior), the dominant form of land tenure across Scotland historically has been feudal. Its origins can be traced back to King David I (1124-1153). The feudal system of tenure was not imposed in Scotland (unlike in England) but developed gradually. Feudalism is a system of land tenure within which property rights are derived from an ultimate authority (paramount superior) and inheritance depends upon primogeniture (inheritance by the first born male). Whilst in legal theory the ultimate authority is God, in practice it is the Crown. By assuming ultimate ownership of land, Scottish monarchs could operate a system of patronage by granting land to lesser nobility in exchange for financial and military obligations and had the power of forfeit where this exchange was not honoured, or there was no male heir. Strategic marriages are therefore a key feature of the history of land ownership in Scotland (Wightman, 1996).

A detailed history of feudalism is not relevant here but its effects on the patterns of land ownership in Scotland over the ensuing 850 years are.

The historical legacy of feudal tenure is that Scotland now has one of the most highly concentrated patterns of private land ownership in the world.

For several hundred years, fewer than 1500 private estates have accounted for around 80-90% of Scotland's land area. By the beginning of the 18th century there were around 9500 "landowners" in Scotland, dropping to around 7637 in 1814. By 1873 some 118 people owned over 50% of the land area of Scotland. Despite considerable social and political agitation during the latter part of the 19th century, which resulted in the provision of security of tenure to Highland crofters with the 1886 Crofters' Holdings Act, Scotland's feudal land laws survived intact until the end of the 20th century. It is a remarkable fact that legally the notion of feudal superiority was only removed with the Abolition of the Feudal Tenure Act in 2000 (Warren, 2002).

Land ownership has been a particularly contentious issue over the past decade and various aspects of land reform have lain at the heart of the present government agenda since 1997. The land reform process and the related debate are well documented by Warren (2002). The seminal work of Wightman (1996) not only addressed the fundamental lack of contemporary data on ownership patterns but also highlighted why landownership remains an important issue for modern Scotland, economically, culturally, and environmentally. In terms of the latter he highlighted that "*landowner motivation, land use decisions and the assumptions underlying property rights and obligations, can have marked effects on environmental stewardship standards*" (*op. cit.* p14). Because of its land tenure history, the environmental management of most of Scotland is concentrated in the hands of relatively few individuals. This can be seen as both a weakness and an opportunity.

CONTEMPORARY PATTERNS OF OWNERSHIP

Private

There are approximately 33,000 main agricultural holdings in Scotland of more than 1ha. It is estimated that over 35 % of these are tenanted and worked under agreements which limit the scope of the tenant's property rights and therefore their management options. The most common example of this relates to the planting of woodlands where ownership of the timber reverts to the landlord. There are also some 17,500 crofts held under crofting tenancy. There are peculiar characteristics associated with all of these tenurial arrangements (e.g. common grazings in crofting areas) that fundamentally affect environmental management options.

With respect to the sporting estate sector, Warren (2002) highlights the fact that most are run at substantial annual losses, and can be considered as luxuries rather than businesses, often representing only a small part of their owners' total assets. Consequently, finances may only be one of several factors in driving management decisions. **This fact has been highlighted by Bryden (1997) as being a significant limitation to the effectiveness of fiscal or monetary incentives designed to direct land use patterns.** MacGregor and Stockdale (1994) have also highlighted the high turnover of estate owners in some areas which exposes the land to inconsistencies in long-term management. The open nature of the land market now means that some 30% of Scottish sporting estates are not in UK ownership, with a fourfold increase since 1970 in the area under such ownership.

Information for estates sold in 2004 indicates that some 81% of buyers were from the UK, 12% from mainland Europe and the remaining 7% from elsewhere (Strutt and Parker, 2005).

The lack of control over the market for large estates in Scotland is often contrasted with the excess of control over crofting tenure. This is summarized by Warren (2002): "*thus the tenure of 2ha of bog and rock is tightly controlled, while the ownership of 20,000ha is unrestricted*" (p.50)

Public

In the 19th century state ownership of land was not common in Scotland, with only 0.3% in 1872. However, with the strategic decisions that flowed particularly from the events of the two World Wars, there was a significant increase in state ownership.

Today around 12% (*c.*1.3M ha) of Scotland is owned by public bodies.

The largest areas are held by the Forestry Commission (773,000ha), SEERAD and the local authorities respectively. The MoD and SNH have relatively smaller land holdings.

Not-For-Profit Organisations

Although ownership by not-for-profit organizations can be traced back to the 1930s with the National Trust for Scotland (NTS) purchasing part of Glencoe, such ownership has accelerated since the 1980s. This phenomenon is widely perceived as the consequence of ineffective conservation policy (Warren, 2002). Between 1980 and 1995 the area owned by this sector rose by 146% (to 133,500ha).

The purchase of the Mar Lodge estate in 1995 elevated the NTS to the third largest landowner in Scotland.

The RSPB and the John Muir Trust are other conservation organizations with major land holdings and as a group the conservation bodies now constitute the largest non-public landowner in Scotland (Warren, 2002). If this trend were to continue, their land holding could soon exceed that in public ownership. However, doubts have been expressed about the long term sustainability of the growth in such land ownership and charitable bodies were much less active in the land market in 2004 (Strutt and Parker, 2005).

Community Organisations

Although community ownership is not a new phenomenon, it was given new meaning in 1992 with the purchase of North Lochinver Estate by the Assynt crofters. This triggered a number of similar purchases including Borve and Annishadder on Skye in 1993, Eigg in1997 and Knoydart in 1999. Later community buy-outs have been assisted by the creation of HIE's Community Land Unit in 1997 and the setting up of the Scottish Land Fund through the National Lottery in 2001. Whilst community "right to buy" has been a flagship component of recent land reform in Scotland it is important to note that where such a right has been in existence for some time (e.g. under the Transfer of Crofting Estates Act 1997) it has rarely been exercised. One of the prime motivations behind the successful "buy-outs" appears to be a reaction to difficult landowners. There seems little hard data on the environmental management ambitions of these community organizations but anecdotal evidence suggests that they are strongly environmentally motivated and active in securing relevant agri-environment and woodland grants.

Community ownership has seen a rise since the purchase of North Lochinver Estate by the Assynt Crofters in 1992, and is now supported by HIE's Community Land Unit and the Scottish Land Fund.

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14. GENETICALLY MODIFIED (GM) CROPS

BACKGROUND – REGULATORY FRAMEWORK

The release of Genetically Modified Organisms (GMOs) in the EU is controlled under Directive 2001/18/EC which, in the UK, is implemented via the Environmental Protection Act (1990) and the Genetically Modified Organisms (Deliberate Release) (Scotland) Regulations 2002. This is a devolved responsibility: The Scottish Executive consents to the release of GM crops for research and development purposes in Scotland. DEFRA acts as a clearing house for applications for deliberate release, provides the secretariat for the Advisory Committee on Release to the Environment (ACRE), and co-ordinates the international presentation of UK policy. Ministers also take advice from the Health and Safety Executive, the Food Standards Agency and SNH as appropriate. (Scottish Agricultural Science Agency, 2004)

FARM SCALE TRIALS IN SCOTLAND

The farm scale evaluations (FSEs) were a three-year research programme which lasted until 2002/2003. The FSEs allowed independent researchers to investigate the impact on biodiversity of the management of four types of herbicide tolerant GM crop: spring oil seed rape, winter oil seed rape, fodder maize and beet (the latter two not tested in Scotland). The FSEs took place on 18 trials sites on five farms in Scotland in Aberdeenshire, Fife, and Ross-shire. The main results for oil seed rape (OSR) were:

Winter OSR: Similar total weed densities were found in both GM and conventional crops. However, there were significant differences in the abundance of different types of weed. Seed numbers from grass weeds were five times greater in the GM crop and this difference persisted in the seedbank in the following year. Broad-leaved weeds produced three times more seeds in the conventional crops. As a consequence, there were more butterflies and bees in conventional winter rape because there were more flowering weeds. The numbers of springtails, however, were higher in the GM crop.

Spring OSR: Although the numbers of surviving broad-leaved weeds were similar in conventional and GM crops, the plants had a 70% lower biomass in the GM crops. Seed rain was also lower, with 80% fewer broad-leaved weed seeds. Overall, the weed seedbank was smaller following GM crops. Butterfly numbers were higher in the fields and field margins of conventional spring rape crops, attracted mainly by the greater number of flowering weeds. Most other insect groups, including bees, were found in similar numbers in the GM and conventional fields, although there were some seasonal differences. (Scottish Executive, 2005)

Overall, conventional fields in the FSEs showed greater numbers of broad-leaved, flowering weeds and consequently more butterflies and bees. Seed numbers from grass weeds were higher in the GM crops. However, there were differences between winter and spring sown OSR, as well as seasonally.

GM NATION – THE PUBLIC DEBATE

The GM Public Debate arose from a recommendation in the Agriculture and Environment Biotechnology Commission's report on "Crops on Trial". In May 2002 the Secretary of State announced that the UK Government and the devolved administrations would sponsor a national GM dialogue on GM issues. The aim was to create a dialogue between all strands of opinion on GM, to deepen public understanding of the issues surrounding GM technology, and to improve the evidence base to enable Government to make informed decisions. It comprised three main components:

- a public debate, managed by an independent steering board;
- a review of the scientific issues relating to GM crops and food, conducted by a panel of independent scientists chaired by the Government's Chief Scientific Advisor working with DEFRA's Chief Scientist; and
- a study into the costs and benefits of GM crops, by the Government's Strategy Unit.

The findings of the *public debate* suggest that people are generally uneasy about GM crops and food. It was, however, pointed out that the general public may have a lower degree of outright opposition to GM than the participants in the debate.

The *science review* found that worldwide there have been no verifiable ill effects reported from the consumption of products from GM crops over seven years. It concluded that the main environmental risk with current GM crops is their potential impact on farmland biodiversity.

The Strategy Unit's study concluded that any *economic benefit* from the crops presently available is likely to be limited in the short term but that future developments in GM crops could potentially offer more significant benefits. Much would depend on consumer attitudes towards GM food and crops. (Scottish Executive, 2004a)

A UK-wide public debate on GM took place in summer 2003. The debate found that the general public was uneasy about the introduction of GM crops and food. A science review, carried out at the same time, concluded that the main risk from GM crops is the potential effect on biodiversity.

EXECUTIVE POLICY AND OUTLOOK

The Scottish Executive recognises that the public are uneasy about GM and that there is limited support for the commercial planting of GM crops in Scotland. However, there is no scientific evidence nor are there powers within the framework of European legislation to ban all GM crops.

In relation to the farm-scale evaluation crops, ACRE have advised that GM herbicide-tolerant beet and spring-sown rape should not be approved for planting on the basis of the management regimes tested under the trials, and that the consent for herbicide-tolerant maize should be amended to restrict the management conditions under which it can be grown. In the meantime no GM crops can be grown in Scotland. The Executive does not dismiss the longer-term potential of GM technology.

In order to provide assurance that farmers will be able to meet consumer demand for non-GM produce the Executive plans to establish statutory coexistence measures. Groups of farmers wishing to establish voluntary GM-free zones will be provided with guidance.

(Scottish Executive, 2005) A consultation will consider the desirability of a separate threshold for organic crops and separation distances between GM and non-GM crops. (Scottish Parliament, 2004)

Mark Ruskell, Green MSP for Mid-Scotland and Fife officially lodged a GM Liability Bill proposal in the Scottish Parliament with support from four political parties and all independent MSPs. The Bill would make GM companies strictly liable for any economic damage as a result of contamination caused by GM crop trials and commercialisation, to prevent the consequences GM contamination had in North America where, since the widespread introduction of commercially grown GM crops, there have been numerous instances of non-GM farmers losing markets and livelihoods. Contamination incidents have cost the US economy at least $12bn between 1999 and 2001. (Scottish Green Party, 2005)

The draft EU Directive on Environmental Liability establishes liability for environmental damage to protected species and habitats resulting from a range of activities, including the release of GM organisms. It does not cover damage to private property or any economic loss, for example losses arising from GM contamination of non-GM crops. It is this issue which the Executive will seek to address in its consultation on co-existence. (Scottish Parliament, 2004)

The Scottish Crop Research Institute (SCRI) strongly supports GM research in Scotland. According to the SRCI, the arguments for GM technology are compelling at a commercial level; the introduction of this technology will bring new options and added value to agriculture, providing major opportunities to make quantum leaps in crop performance. As potatoes and barley (the main crops for Scotland) are not high priorities for the major multi-national corporations, it is essential that relevant programmes are in place (SCRI, 2005).

The Executive realises that the general public in Scotland is uneasy about GM crops and food. However, under European legislation a total ban of GM crops is not possible, and the longer-term potential of GM technology is not being dismissed.
The Executive works towards establishing statutory co-existence measures (also addressing the problem of losses through contamination of non-GM crops with GM) and will give guidance to farmers wishing to create voluntary GM-free zones.

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