9. Habitats and species: Summary of Issues

Problem
Loss or deterioration in quality of farmland habitats resulting from the intensification of agriculture in all sectors.

Impact
Loss from farmland, or population declines, of plant and animal species associated with these habitats.
Direct effects:

- Drainage of wetland and removal of woodland remnants
- Removal of boundary features (hedgerows and stone walls)
- Drainage, ploughing and reseeding of upland indigenous grasslands and moorlands
- Intensification of management of arable and pastoral land (loss of mixed, rotational farming systems, shift to autumn tillage, winter grazing of heaths)
- Pesticide effects on non-target plants and invertebrates of managed land

Indirect effects:

- Nutrient enrichment of waterside and boundary or remnant habitats adjacent to fertilized cultivated or grazed land (encourages pernicious weeds)
- Insect and plant mortality from pesticide drift into adjacent remnant and boundary habitats
- Removal of plant and insect food supply of farmland bird and mammal species by changes in cultivation and grazing practices

Systems/Areas at Risk:

Landform, climate and soil character and fertility determine farming systems. 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.

Remedial Measures/ Practical Actions:

Emphasis here is 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. Habitat and species will also be dependent on efforts to deal with nutrient enrichment and pesticide toxicity dealt with in other parts of this report.

Strategies for nature conservation have been developed by different Government Departments and Non-Government Organisations with four major motivations:

1. Protection of rare and endangered habitats and species
2. Conservation of wild game bird populations
3. Augmentation of natural enemies and pollinators on farmland
4. Conservation and enhancement of biodiversity in the agricultural landscape

These contrasting objectives have led to the implementation of varied practical solutions:

- Designation of valuable (small, vulnerable) habitats and sites supporting rare plant or animal species as nature reserves (SSSIs) (Scottish Natural Heritage and predecessor organization). 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 the wider countryside.
- Prescription-based management agreement targeted at farms within defined areas of natural heritage value (Environmentally Sensitive Areas)(SEERAD and predecessor organization). This provided a mechanism to alter the management of the agricultural land to be sensitive to the natural heritage character of specific areas. The reduction of stocking densities of livestock, for example, on machair vegetation and heaths in the Cairngorm Straths had the potential to ameliorate the declines in many plant, bird and insect populations.
- Development of "conservation headlands" (Game Conservancy Trust) where no herbicides or broad spectrum insecticides were applied around the field margins of arable land brought about an improvement of chick survival of game bird populations, due to the critical role of insect food in their diet. This practical measure was voluntarily adopted on several sporting estates but further research identified wider effects of "extended field margins" on farmland birds, butterflies, pollinators and natural enemies of arable crop pests. The additional benefits of conservation headlands for arable farmers beyond the maintenance of game bird populations have led to their promotion in agri-environment schemes and Local Biodiversity Action Plans.
- Beetle banks (Game Conservancy Trust and DEFRA) where sown grassland strips were added between tramlines and not connected to existing field boundaries. These were designed to augment natural enemies on arable land, particularly by providing overwintering refugia for predatory beetles.
- Field-edge management included in Government agri-environment schemes (SEERAD - CPS and RSS, promoted by GCT, SAC and FWAG) diversified Extended Field Margins by promoting the development of sown grassland or wild flower strips in field margins. These provided the dual function of augmenting the pest-specific predators, e.g., parasitic wasps and hoverflies, whose potency as predators was dependent on nectar sources close to the arable crop. A further benefit was the increased activity of bumblebees around these wildflower strips, as pollinators of certain crops, e.g. oilseed rape. These measures also dramatically increased the diversity of incidental plant and invertebrate species in arable land.
- The Set Aside Scheme, initially an annual rotational system initially established to reduce European cereal production by 15%, was later modified to take better advantage of the environmental opportunities that could be realized. The lack of weed leaves and invertebrates associated with winter stubbles (absent due to the predominance of autumn tillage) is responsible for the declines in bird populations. The introduction of permanent set aside options allowed the development of weedy stubbles or sown grass mixtures that were concluded to be good for plants and birds. The later inclusion of a game cover option, a mixture of sown cereals and brassica species has also increased the benefits of this scheme to farmland birds, not just gamebirds.

- RSPB have taken direct action by purchasing farms to manage the land with regard to the resource requirements of farmland birds.
- The Farm Woodland Premium Scheme and Native Pinewood Scheme have also 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 WWT partnerships with private landowners. These schemes also accommodate the planting of new hedgerows and the buffering of riparian vegetation (re: pollution section).

Linkages

These various measures have achieved some diversification of the agricultural landscape that had been lost in recent years and benefits wildlife by introducing entirely different habitats into the agricultural landscape. The addition of new habitats has an accumulative effect on species numbers at the landscape scale if there are viable areas of a particular habitat and there is allowance for a sufficient lag for colonisation to occur. Area of landscape occupied by particular habitats can restrict the viability of wildlife populations when below 10%. New habitats are often located on poor quality agricultural land rather than strategically placed to maximise the wildlife benefits for the area concerned. The types of habitat or linear features must be considered in relation to the cultural history of an area and has consequences for the visual landscape (re: Section 11). Priority habitats from Scottish Local Government Habitat Action Plans, that are identified from the local natural heritage and character, are now included in prescriptions for Rural Stewardship Schemes for particular regions.

There is a lack of coordination of priorities in dealing with Environmental Impacts on farmland and this has compromised some schemes over others. For example, the lack of implementation of adequate controls on nitrogen fertilizer inputs means that riparian zones are often too enriched to restore natural riparian or field boundary vegetation.

Research gaps

Restoration of upland vegetation is slow after changes have been made to grazing management. The structural changes in vegetation that occur within five years have benefits for insect species diversity. However, there are often irreversible changes to the status of the grassland because drainage and lime alter the structure, moisture and nutrient status so that the restoration of native grassland is prevented without major intervention. Often, a different dominant plant species prevents the favoured restoration, e.g., bracken and rush. There is still little understanding of the soil and community processes that control these dynamics.

9. Habitats and species: Critical Commentary

9.1. Problem

Agricultural landscapes are a mixture of managed land areas, remnants of semi-natural habitats (e.g., wetland and woodland) and boundary features (hedgerows and fence lines)(Pollard *et al*., 1974; Greaves and Marshall, 1987; Fry 1991). In the uplands, indigenous (semi-natural) grasslands and moorlands are primarily managed with extensive grazing systems, without substantial enclosure of land (Bunce and Barr, 1988; Bardget *et al*., 1995; Thompson *et al*., 1995). Numerous plant and animal species are associated with the variety of farmland habitats but the well-publicized population declines or losses of many of these species are mainly related to habitat loss or change (Conyers, 1986; Luff and Rushton, 1989; Fry 1991; Warren, 1993; RSPB, 2001). As such, most emphasis here will be placed upon habitat conservation and remediation on farmland because most associated species will directly benefit from the increase in the area and distribution of such habitats (Houghton *et al*., 1988).

9.2. Impact

The direct effects of intensification of agriculture in the last half century have been twofold. There has been a reduction in the area of the various semi-natural habitats associated with traditional, mixed farming (Bunce and Barr, 1988; Wascher *et al*., 2000). There has also been an increased intensity of management of the actual cultivated or grazed land (Aebischer and Potts, 1988; Baines, 1990; Bardgett *et al*., 1995; Boatman *et al*., 2000). The physical effects have typically been a trend towards more continuous cropping, due to a decline in crop rotations and the use of break crops or grass leys on land suitable for arable cropping (Wilson *et al*., 1999). There has also been a shift to autumn from spring tillage except where regional climate is generally too wet for autumn cultivation (RSPB, 2001). Drainage, ploughing, reseeding, and application of lime and fertilizers have been used to intensify management of marginal grasslands and enable an increase in stocking densities of sheep and cattle (Rushton *et al*., 1989). The use of fertilizers and pesticides (particularly herbicides) on cultivated and grazed land has been responsible for selecting out many of the arable weeds or meadow plants that were associated with these systems (Hooper, 1987; Fry, 1991). Instead, herbicide and nitrogen tolerant pernicious weeds prevail (Hooper, 1987). In arable crops, cleavers, creeping thistle and couch grass are now serious problems, whereas in pastures, ragwort, bracken, rushes and docks are problems. In the uplands, the increased stocking densities of sheep (and, to a lesser extent, cattle) have led to a deterioration in the quality of heather moorland or conversion from heathland to grassland (Thompson *et al*., 1995; Fuller and Gough, 1999).

There have been initial direct (Hamilton *et al*., 1981; Sotherton and Rands, 1987; Jepson, 1989) but mainly indirect effects from the chemical inputs in modern agriculture (Aebischer and Potts, 1987). Nitrogen fertilizers enrich the soils of adjacent field boundary and remnant habitats and the increased fertility tends to favour pernicious weeds over the previous, more diverse, flora (Marshall, 1985). Likewise, herbicide drift also selects out the susceptible species in neighbouring semi-natural vegetation and encourages dominance of the same pernicious weeds that are now commonplace in the cultivated and grazed land (Pollard *et al*., 1974; Bunyan and Stanley, 1983; Cuthbertson and Jepson, 1988). Riparian vegetation has been affected in a similar way by nitrogen in run-off and leachate and the vegetation is often dominated by docks, hogweed and problem grasses (Environment Agency, 1998).

9.3. Systems/Areas at Risk

The landform and productivity of a specific location determine intensity of farming practices. In general, the greatest habitat losses have occurred in lowland, fertile areas dominated by arable farming (Bunce and Barr, 1988; Wascher *et al*., 2001). However, decline in habitat quality has been a major factor in marginal agricultural areas (Thompson *et al*., 1995; RSPB, 2001).

9.4. Remedial Measures/ Practical Actions

Solutions to these problems are many and varied and have depended on the part of the agricultural landscape being targeted for remedial work and the motivation of the landowners or policymakers for carrying out the work. Habitat and species (biodiversity) will also be modified by and may benefit from efforts to deal with other environmental impacts of agriculture and there are numerous links with other parts of this report.

9.4.1. Government nature conservation in agricultural landscapes

The initial strategy for conservation was for Scottish Natural Heritage and its predecessor organization to designate valuable (small, vulnerable) habitats and sites supporting rare plant or animal species as nature reserves (SSSIs). 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 the wider countryside (Bunyan and Stanley, 1983). This encouraged the establishment of a prescription-based management agreement targeted at farms within defined areas of natural heritage value (Environmentally Sensitive Areas). This provided a mechanism to alter the management of the agricultural land to be sensitive to the natural heritage character of specific areas (Houghton *et al*., 1988; Sutton and Tittensor, 1988; Egdell *et al*., 1993). The reduction of stocking densities of livestock, for example, on machair vegetation and heaths in the Cairngorm Straths had the potential to ameliorate the declines in many plant, bird and insect populations (Henderson *et al*., 2000).

9.4.2. Private conservation initiatives

Concern amongst owners of both lowland and upland sporting estates about the plight of game bird populations initiated the Game Conservancy Trust's research into the declines of red grouse in the uplands and grey partridge in the lowlands (Boatman *et al*., 2000). The identification of the critical role of insect food for chick survival of grey partridge led to a number of practical solutions that have had broad-ranging benefits for wildlife on farmland (Hooper, 1987; Morris and Webb, 1987; Boatman *et al*., 2000). The development of "conservation headlands" where no herbicides or broad spectrum insecticides were applied around the field margins of arable land brought about an improvement of chick survival (Boatman *et al.* 1989). The diet of grey partridge chicks was particularly dependent on sawfly larvae that flourished on weeds in the field margin (Barker et al., 1999). This practical measure was adopted on several sporting estates, but further research on the benefits of field margins for butterflies (Dover, 1997) and natural enemies of arable crop pests (Wratten, 1988; Dennis and Fry, 1991; Dennis *et al*., 1992; Marino *et al*., 2000) revealed benefits of conservation headlands for arable farmers beyond the maintenance of game bird populations. There was significant research into the conservation and crop protection benefits of existing field boundaries and margins (Ekbom *et al*., 2000) and on experimental sown grass strips (Thomas *et al*., 1988; 1989). This led to the implementation of beetle banks for the augmentation of natural enemies on farmland, particularly by providing overwintering refugia for predatory beetles represented by sown grassland strips that were added between tramlines and not connected to existing field boundaries (Boatman *et al*., 1989), and these are promoted by DEFRA and GCT as part of an integrated pest management package (http://www.gct.org.uk/menus/research.htm; http://www.defra.gov.uk/erdp/docs/annexes/annexi/section3/option4a/htm#4b).

9.4.3. Government agri-environmental initiatives

Management options for modifying the edges of cultivated land were diversified by the development of sown grassland strips in field margins, and wild flower strips in the field margins and as alternatives to grassy beetle banks. These provided the dual function of augmenting many of the pest-specific predators, e.g., parasitic wasps (Marino *et. al*., 2000) and hoverflies (Cowgill, 1989), whose potency as predators was dependent on nectar sources close to the arable crop. A further benefit was the increased activity of bumblebees around these wildflower strips, as pollinators of certain crops, e.g., oilseed rape (Cresswell, 2000). These measures also dramatically increased the diversity of incidental plant and invertebrate species in arable land (Boatman *et al*., 1989; Houghton *et al*., 1988; Chiverton and Sotherton, 1991). Adoption of these practices has been enhanced by their inclusion as options in the recent Countryside Premium Scheme and current Rural Stewardship Scheme (SEERAD). They are now actively encouraged by SEERAD through these agri-environmental incentive schemes and by FWAG when they prepare Farmland Biodiversity Action Plans at the individual farm level.

BTO and RSPB highlighted alarming declines in bird populations on lowland (RSPB, 2001) and upland (Fuller and Gough, 1999) farmland over recent decades. A lack of weed leaves associated with winter stubbles (absent due to the predominance of autumn tillage) and invertebrates throughout the year were implicated in the population declines. RSPB have lobbied government to reform European agricultural policy (Birdlife International lobbied the European Commission) to address the problem. RSPB took direct action by purchasing farms to manage the land with regard to the resource requirements of the farmland birds.

The Set Aside Scheme, initially an annual rotational system initially established to reduce European cereal production by 15%, was later modified to take better advantage of the environmental opportunities that could be realized. The introduction of permanent set aside options allowed the development of weedy stubbles or sown grass mixtures that were concluded to be good for plants and birds (Firbank *et al*., 1999). The later inclusion of a game cover option, a mixture of sown cereals and brassica species, has also increased the benefits of this scheme to farmland birds, not just gamebirds (Macleod, 2001). This represented the first whole-field modification of management in the wider agricultural landscape (although some ESA schemes had previously prescribed changes to field management, mainly the stocking rates applied to grazed land) and that addressed some of the losses in food and habitat resources that came about from the intensity of management in the cultivated ground (Sutton and Tittensor, 1988; Henderson *et al*., 2000).

9.4.4. Other farm based habitat restoration/creation initiatives

The Farm Woodland Premium Scheme and Native Pinewood Scheme have also 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 or RSPB partnerships with private landowners. These schemes also accommodate the planting of new hedgerows and the buffering of riparian vegetation (re: pollution section). This has achieved some diversification of the agricultural landscape that had been lost in recent years and benefits wildlife by introducing entirely different habitats into the agricultural landscape (Way, 1989). The addition of new habitats clearly has an accumulative effect on species numbers at the landscape, assuming there are viable areas of habitat and there is allowance for a sufficient lag for colonization (Fry, 1991). Areas of landscape occupied by particular habitats can restrict the viability of wildlife populations when below 10% (Peterken, 2000). Different regions are classified by landscape character and the historic settlement patterns and the landform and climatic constraints have provided an inheritance of regional diversity in cultural landscapes (Luff et al.,1989; Burel and Baudry, 1990). The predominance of enclosed land, the types of field boundaries (hedges and stone walls) and prevalence of moorland hills or woodland give a distinct identity to these landscapes. Very little coordination of incentive schemes has taken place to ensure landscape character is conserved. Some recent measures have included the incorporation of priority habitats from Scottish Local Government Habitat Action Plans (Scottish Biodiversity Group, 1997) into prescriptions for Rural Stewardship Schemes, for particular regions. Other visual landscape considerations are dealt with elsewhere (Section 11).

9.5. <u>Conflicts with other environmental amelioration measures</u>

The lack of coordination of priorities in dealing with Environmental Impacts on farmland has compromised some schemes over others. For example, the lack of implementation of adequate controls on nitrogen fertilizer inputs means that riparian zones are often too enriched to restore natural riparian vegetation (Environment Agency, 1998). The aggressive colonization by common species prevents the achievement of natural heritage objectives for these habitat creation projects. Similarly in the uplands, change in botanical composition is very slow in response to reduced grazing intensities (Olff and Bakker, 1991). Structural changes in vegetation that are realized in one to five years do have consequences for insect species diversity (Dennis *et al*., 1997; Gardner *et al*., 1997; Dennis *et al*., 1998) but there are often irreversible changes to the status of the grassland because drainage and lime alter the structure, moisture and nutrient status so that the restoration of native grassland is prevented without major intervention. Heathland restoration has been realized by the reduction of stocking rates (Gardner and Lobo, 2001). This is in contrast to lowland heathland restoration, which requires large energy inputs, removing topsoil and artificially denuding the nutrients from target areas. These schemes are not sustainable at sites in the UK where N deposition often exceeds 40 kg ha^{-1} y^{-1}, assuming no leachate from adjacent cultivation or pasture management. Broader thinking is required to coordinate those measures designed to deal with the soil, water and air quality of farmland with realistic and achievable habitat creation schemes.

9.6. Economic Evaluation of Policy

In the case of comparing the delivery mechanisms of agri-environmental schemes, Whitby and Saunders (1996) compared two such schemes in England: the Environmentally Sensitive Area (ESA) and the Sites of Special Scientific Interest (SSSI). They found that the negotiated entry approach of SSSIs was less costly, because of the saved producer surplus and because some land is conserved at no cost at all. However, the authors acknowledge that their measurement of transaction costs was incomplete, and this was probably the most significant cost component in the case of SSSIs.

With respect to the cost and benefits of agri-environmental schemes, de Snoo (1999) conducted an investigation in Holland into the effects on biodiversity and farm economics of stopping the spraying of crop protection chemicals on field margins. The effects on crop gross margins were variable, depending on whether or not reductions in input costs as a result of reduced spraying offset the reductions in yield. They found that there were positive effects on botanical, invertebrate and vertebrate biodiversity in the unsprayed margins. Boatman and Sotherton (1988) found rather negligible costs (between £2 and £9 per ha) associated with non-spraying of arable field margins in Scotland.

In a more in-depth analysis compared to that of de Snoo (1999), Kleijn *et al*. (2001) found management agreements were not effective in protecting the species richness of the investigated species groups (plants, birds, hover flies and bees) in agri-environmental schemes in intensively used Dutch agricultural landscapes. A similar *ex post* monitoring study of the ESA scheme in Scotland also found that there was no clear, general, improvement in botanical diversity as a result of participation in the scheme (Cummins *et al*., 2000). These studies measure benefit in physical terms as improved species diversity and/ or habitat quality. However, there are other potential benefits of agri-environmental schemes, such as landscape quality and recreational benefits. Several authors have attempted to measure by contingent valuation the monetary value of the total benefits of the ESA scheme, and found that these exceed the exchequer costs (Garrod *et al*. 1994 and Garrod and Willis, 1995), implying an unfulfilled demand.

Wynn (2001) compared the cost-effectiveness of different farm types participating in the ESA scheme in Scotland with a view to determining whether there were potential gains to targeting, and found that there was considerable variability in both cost and biodiversity. Thompson *et al*. (1999) found that the benefits of the South Downs ESA in England could be improved at no extra cost by focusing on conservation rather than restoration of chalk grassland, the target habitat.

In other cost-effectiveness analyses (CEAs), Badger (1999) undertook a simulated CEA of different policy mechanisms in the Scottish Cairngorms, and concluded that different instruments scored more highly under different criteria, e.g. whether exchequer outlay or area protected. In a study comparing the cost-effectiveness of two different approaches to native pinewood woodland ecosystem restoration in Scotland, Macmillan *et al*. (1998) found that natural regeneration was both less costly and provided a superior ecosystem compared to replanting. Moran *et al*. (1996) compared the cost-effectiveness of Global Environment Facility (GEF) investments and found a wide spectrum of cost-effectiveness across different countries, and Babcock *et al*. (1997) found variability in cost-effectiveness of habitat management under the conservation reserve programme (CRP) in different areas of the United States.

There have been several informal studies comparing the biodiversity management performance of different types of land managers, such as farms and non-farms. Nowicki *et al*. (1999) suggested that farmers had a repository of land management experience which meant that they were ideal custodians of the countryside. Wynn (2001a) found that the cost-effectiveness of biodiversity management of agricultural landscapes was comparable between farms and non-farms, and questioned the rationale, therefore, of excluding non-farms from agri-environmental schemes. Thompson *et al*. (1997) refer to an 'on-going debate' concerning the importance for biodiversity of grouse moor management in the uplands of Scotland. They compare such benefits of grouse management as vermin control, preservation of moorland habitat and the structural diversity of heather with disadvantages such as persecution of raptors, arrested woodland regeneration and restricted access.

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Please see appendix 4 for selected bibliography on habitats and biodiversity