Land Use Policy Group

The UK statutory conservation, countryside and environment agencies

A review of environmental benefits supplied by agri-environment schemes

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The Land Use Policy Group
The Land Use Policy Group (LUPG) of the UK statutory nature conservation, countryside and environment agencies comprises the Countryside Council for Wales, Natural England, Environment Agency, Northern Ireland Environment Agency, Joint Nature Conservation Committee and Scottish Natural Heritage.

The LUPG aims to advise on policy matters of common concern related to agriculture, woodlands and other rural land uses. It seeks to improve understanding of the pros and cons of policy mechanisms related to land use, particularly farming and forestry; to develop a common view of desirable reforms to existing policies; and to promote these views.
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www.environment-agency.gov.uk

Northern Ireland Environment Agency
Northern Ireland Environment Agency takes the lead in advising on, and in implementing, the Government's environmental policy and strategy in Northern Ireland. The Agency carries out a range of activities, which promote the Government's key themes of sustainable development, biodiversity and climate change. Our overall aims are to protect and conserve Northern Ireland's natural heritage and built environment, to control pollution and to promote the wider appreciation of the environment and best environmental practices.
www.ni-environment.gov.uk

Joint Nature Conservation Committee
The Joint Nature Conservation Committee (JNCC) is the statutory adviser to Government on UK and international nature conservation. Its work contributes to maintaining and enriching biological diversity, conserving geological features and sustaining natural systems.
JNCC delivers the UK and international responsibilities of the four country nature conservation agencies - Council for Nature Conservation and the Countryside, the Countryside Council for Wales, Natural England and Scottish Natural Heritage.
www.jncc.gov.uk

Disclaimer
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EXECUTIVE SUMMARY

Objectives

1. The objectives of the study are:
   a. To provide a comprehensive review of the evidence for the provision of environmental benefits by UK agri-environment schemes
   b. To summarise and evaluate the evidence base for delivery of environmental benefits.

Introduction

2. Agri-environment schemes in the UK began in 1987 when the first tranche of Environmentally Sensitive Areas (ESA) was launched. These were designed to conserve the biodiversity and landscape of specific areas of high importance. Schemes were structured into tiers, with the lowest levels aimed at maintenance of existing environmental value, and more demanding levels intended to provide enhancements. The ESA approach was introduced in England, Scotland, Wales and Northern Ireland.

3. During the 1990s, ESAs were supplemented by a range of "second generation" schemes designed to test out a variety of different approaches within the four countries of the UK. These differing approaches allowed for both whole and part-farm agreements; the restoration of more intensively managed habitats; the provision of new public access to the countryside and the availability of a wide variety of annual management options as well as one-off capital works payments. Countryside Stewardship (CS) was the first of these schemes and was launched in England in 1991, closely followed by Tir Cymen in Wales in 1992 (with both Tir Cymen and Welsh ESAs replaced by Tir Gofal in 1999). A Habitat Scheme was available in Scotland from the mid 1990s, but was replaced by the Countryside Premium Scheme in 1997, and then by the Rural Stewardship Scheme in 2001, at which time the ESA scheme in Scotland was closed. Meanwhile, the Countryside Management Scheme (CMS) was introduced in 2000 in Northern Ireland. In 1998, a pilot Arable Stewardship Scheme was launched in England, and following its successful evaluation, several arable options were incorporated into CS.

4. During 2005, the English schemes were re-structured into Environmental Stewardship (ES), incorporating an 'entry-level' strand (ELS) as well as a more traditional 'higher-level' strand (HLS). An entry-level scheme, 'Tir Cynnal' has also been introduced in Wales. Following a short-lived Land Management Contract Scheme (launched in 2006), a new Rural Development Scheme opened in Scotland in 2008 to replace all previous schemes. In Northern Ireland, a new CMS, incorporating the ESAs, was launched in 2008.

5. ***As these schemes have evolved, lessons learnt from evaluations have informed changes to the schemes and the design of successors to those that have been closed. The evaluation process has also evolved in response to changes in the nature and structure of the schemes themselves.***

6. Throughout, entry into agri-environment schemes (AES) has been voluntary and dependent on the farmers' willingness to deliver the environmental benefits associated with a given option for a set payment. Nevertheless they have been assigned an important role in the delivery of rural land management policy objectives. ***They have already made substantial contributions to the achievement of UK BAP targets for certain habitats and species*** and are seen as the main vehicle for achieving Defra[1]'s stated aim of reversing the declines in farmland bird populations. AES are also intended to play a significant role in the maintenance and enhancement of landscape character, and in the protection of archaeological and historic features and landscapes. A targeted approach to the development of new public access has the potential to yield dividends in conjunction with existing provision in the form of public rights of way (PROW) and the new statutory open access arrangements. The role of AES in addressing resource protection issues is relatively new, but potentially valuable in those areas where measures beyond good practice are needed to protect sensitive resources, and needs to be co-ordinated with both regulation and cross-compliance under the Single Payment Scheme (SPS) to maximise effectiveness .

Review of evidence

7. The European Commission's Common Monitoring and Evaluation Framework (CMEF) classifies evidence of the effects of agri-environment schemes into three types: 'outputs' (areas and types of land brought into schemes), 'results' (changes in management resulting from scheme participation), and 'impacts' (benefits in relation to scheme objectives). This report is mainly concerned with the third type of evidence, although uptake data have been included in case studies and interpretive comments on the way in which results have been influenced by land management are included where relevant.

8. Scheme evaluations are mainly of two types: short-term, providing evidence mainly about 'outputs' and 'results', and longer-term monitoring of impacts. In accordance with the project specification, this report draws mainly on longer term monitoring studies as sources of evidence.

9. Evidence was assembled using two types of tables, the first summarising the results of each study and the second characterising the nature and quality of the work carried out. These tables are included in an appendix, and are the basis of the review that forms the main body of this report.

Biodiversity and habitats

Arable

10. Arable options were under-represented in early agri-environment schemes, but concern about widespread declines in biodiversity associated with arable land led to an extended range of management options being developed on the basis of extensive research. These were included in schemes from the 1990s onwards. In England, the Arable Stewardship Pilot Scheme (ASPS), which ran from 1998 to 2000 in parts of East Anglia and the West Midlands, was evaluated thoroughly, providing a particularly valuable source of evidence on the impact of arable options in the context of an operational scheme, and was considered to be an ***excellent example of evidence-based policy making***.

[1] Department for Environment, Food and Rural Affairs

11. Monitoring of the ASPS showed that outside the cropped area, it was relatively easy to generate desired vegetation (especially if it was sown) after just a few years of changed management. However, other factors such as geographical region, soil type and surrounding seed sources could also affect outcomes, especially when the objective involved natural regeneration of vegetation. ***Arable options, especially uncropped cultivated margins, were shown to be very successful in conserving rare arable flora,*** but with targeting needed to maximise effectiveness. A range of invertebrate groups, including spiders, plant bugs, sawflies and bumblebees also responded positively to arable options in terms of increased abundance and/or diversity, relative to control farmland.

12. ***Countryside Stewardship (CS) special projects for stone curlew and cirl bunting were both highly successful*****,** showing that targeted management with advisory support can achieve excellent results. For more widespread bird species, ASPS monitoring showed a range of positive responses at the field scale, broadly in line with those expected from research findings, though farm scale responses were limited. ***The results of evaluations, coupled with the strong underpinning research base, suggest that arable options are effective***. Unfortunately uptake of many of these options in ELS in England has been relatively low, and an action plan based on the recent ES review of progress is now being developed to address this issue.

Grassland

13. The conservation of species-rich grasslands has been a key objective of agri-environment schemes since their inception. ***Agri-environment schemes have been successful in targeting higher quality grassland***, at least in England, and evidence from a large number of evaluations of ESAs in England, Wales, Scotland and Northern Ireland indicates that ***the quality of semi-natural grassland as a whole has generally been maintained under agri-environment agreements***, though evidence of enhancement is less pronounced. Whereas many arable options involve taking land out of cropping and managing this on the basis of well defined and researched prescriptions, most grassland options involve adjusting the management of areas that still have a productive role, thus potentially creating tensions between competing objectives[2].

14. ***A survey of BAP priority grasslands in England showed that grasslands within agri-environment agreements were almost twice as likely to be in favourable condition as those outside agreement***, and land in agreement was also more likely to meet condition assessment targets for several individual attributes, in particular herb cover and positive indicator species.

15. ***A case study of hay meadows concluded that agri-environment schemes are probably making a substantial contribution to the UK target area for maintenance of lowland meadows***. Results for upland hay meadows were mixed, but positive evidence of increased conservation value was found for hay meadows in the Dartmoor ESA.

16. Successful rehabilitation, restoration and re-creation of grassland is dependent on appropriate fertiliser, grazing/cutting and hydrological regimes, and often on the re-introduction of target species where they are absent. Low or zero fertiliser

[2] This is also true of some arable options, such as the retention of winter stubbles, the use of spring sown rather than winter sown cereals, and greater use of unsprayed root crops

inputs are generally required to maintain or enhance plant diversity and retain communities of conservation interest. There also needs to be an understanding of appropriate levels of grazing, with monitoring programmes having recorded examples of deterioration due to both undergrazing and overgrazing. For hay meadows, cutting dates are important, with deterioration evident where cutting was carried out too early. There is some evidence that generic AES prescriptions have resulted in increased uniformity of swards, especially in hay meadows, with improvements recorded in poorer quality sites but some deterioration in high quality sites.

17. Lessons from scheme evaluations and supporting research were used to inform the design of grassland management options in Higher Level Stewardship in England and Tir Gofal in Wales. The need was recognised for agreements to be more targeted, to have clearer objectives and be more flexible, allowing management to reflect the needs of the individual site.

18. There has been limited monitoring of the impacts of grassland management on birds (except for waders, see below), but ***management to enhance habitat for corncrake has been successful in achieving a substantial increase in population of this species within its core range in Scotland*.**

Moorland and lowland heath

19. The conservation and restoration of heather moorland and associated habitats has been a key target of agri-environment schemes in the uplands of the UK. A very high proportion of the Upland Heath and Blanket Bog UK priority habitats are within agri-environment schemes. Much moorland monitoring has been concerned with the effect of management on the extent and condition of heather itself, and ***some marked individual success have been reported from all parts of the UK*,** notably in the Exmoor ESA in England, early results from Welsh schemes, Breadalbane and Shetland ESAs in Scotland; West Fermanagh and Erne Lakeland, and Slieve Gullion ESAs in Northern Ireland. Overall, however, evidence for the benefits of AES management is mixed, with little or no improvement in the extent or condition of heather found in a number of evaluations.

20. Botanical monitoring of species other than heather in CS agreements on Bodmin Moor, Tir Gofal in Wales and West Fermanagh and Lakeland ESA in Northern Ireland showed ***positive results in terms of increases in desirable species and/or diversity***.

21. Increases in some bird species were recorded in Exmoor and the North Peak ESAs in England, and ***reduced grazing under CS had positive effects on the numbers and breeding success of black grouse, a declining BAP priority species, in northern England*.**

22. Success or failure in terms of targets for heather condition is strongly related to grazing pressure. High stocking rates invariably lead to deterioration in condition and/or cover of heather. Local factors can also influence higher grazing pressure including high levels of grass in the vegetation, supplementary feeding, and the presence of tracks or roads. However, the vulnerability of habitats varies, and schemes work best when targeted closely to areas and situations so that (grazing) prescriptions closely fit the needs of each individual site. Where degradation has been severe, complete stock removal for a period may be required for recovery. However, undergrazing can also be detrimental;

for example, deterioration of lowland heath in the West Penwith ESA was linked to insufficient grazing.

23. ***In response to these results, more recent schemes have incorporated measures to support shepherding, fencing, and complete removal of stock in winter, to allow greater control of stocking rates.***

24. ***In England, condition monitoring of lowland heath SSSIs has shown a clear benefit of agri-environment scheme support*****,** with over 70% of sites in schemes being in favourable or recovering condition, compared to only 40% of those outside schemes. Outside SSSIs, the condition of lowland heath was generally unfavourable; whilst a judgement was not possible as to whether sites under agreement were in recovery, grazing management and bracken control appeared to be occurring more on sites under agri-environment scheme agreement.

Field boundaries and margins, trees, woodland

25. In Wales, Scotland and Northern Ireland, the ***application of prescriptions to reduce grazing of woodlands resulted in positive impacts on tree regeneration and the ground flora.*** Woodland management has not been a major focus of English schemes.

26. Most monitoring of field boundaries in agri-environment schemes relates to changes in their extent over time. Large quantities of hedges and other field boundaries are now managed under agri-environment schemes. Evaluation of ESA and CS hedgerow agreements in England suggested that most management would meet scheme objectives, and in Wales, traditional boundaries were well maintained or enhanced in several ESAs, but comparisons with non-scheme hedges have not been carried out, nor have biodiversity benefits been directly measured.

27. The widespread establishment of grass margins has generally enhanced plant diversity at field edges, most effectively when sown with a diverse grass/wildflower mixture. ***Grass margins had greater species richness and more bird, butterfly larva and bumblebee food plants than cropped margins***, and the herbaceous flora of adjacent boundaries was more species-rich than comparable boundaries with no sown strip. ***Grass margins increased numbers and/or diversity of spiders, bees, butterflies and grasshoppers***. Effects on invertebrates depend on seed mixture; grass mixtures benefit phytophagous (plant-feeding) species, but nectar feeding insects require the addition of forbs (broad-leaved flowering plants) to the mixture. There is also evidence that grass margins may increase both the density of bird territories and numbers of small mammals.

Wetland & coastal

28. Prescriptions for wetlands cover a range of habitats, including wet grassland and grazing marsh, bogs and mires, fen, marsh, reedbed and open water. Most evaluations have concentrated on wet grassland and grazing marsh. ***In general, evidence from all four countries in the UK indicated that the condition of wet grasslands in AES has been maintained or improved.*** Exceptions were the Somerset Levels and Moors, where evidence of inappropriately high water levels at some sites suggested a need for clearer objective setting and better targeting of options, and some Scottish sites, where

reduced grazing levels had resulted in increases in less desirable plant species and reduced plant diversity.

29. ***Evidence for invertebrates is limited, but studies in Wales and in Northern Ireland indicate some positive impacts of wetland agri-environment schemes****.*

30. Improving habitat for wading bird populations has been a key objective of many schemes. There have been some positive outcomes (e.g. ***increases in breeding oystercatcher and curlew in the Shetland Islands ESA and wintering snipe and woodcock in the Ynys Môn ESA; increase curlew population in the Upper Thames Tributaries ESA***), but in many cases monitoring has shown little evidence of benefits for waders. Where positive effects occurred, they were associated with the presence of nature reserves or higher tier management in ESAs. Sub-optimal water level and sward condition were found to be major causes of failure, hence prescriptions more specifically tailored to the needs of specific sites are required, along with better targeting and advisory support. Within England, the inclusion of these elements in HLS should improve performance.

31. Coastal habitats managed under AES include grassland and heath, sand dunes and salt marshes, but there has been little evaluation of these. However, ***evidence from Wales and Scotland indicates improved condition of coastal heaths and maritime grassland vegetation under agri-environment schemes***.

Historic Environment

32. The key components of the historic environment resource on farmland are archaeological sites, features such as traditional buildings, long-established field boundaries and ancient trees, and designed landscapes such as parkland. These all tend to feature in UK agri-environment schemes, with the exception of ancient trees (some protection is now afforded through ELS).

33. Much of the evaluation evidence focuses on archaeological sites. ***There is clear evidence of benefits for protection of archaeological features in ESAs and national schemes in all four UK countries****.* Also, arable reversion options have greatly improved the protection afforded to archaeological features. Schemes involving the restoration of historic buildings have also provided measurable benefits.

34. ***Schemes have successfully targeted historic field boundaries in England***, with evaluation revealing that management under AES was mainly appropriate, although lack of a baseline precluded the demonstration of significant benefits. ***There is evidence that both CS and Tir Gofal have made a significant positive contribution to the protection and restoration of historic planned landscapes***.

Landscape

35. All UK agri-environment schemes address landscape in their objectives. The way landscape is addressed varies but typically includes definition of target landscapes and their components, providing a focus for delivering management to enhance specific features and thereby strengthen landscape character.

36. ***The ESA monitoring programmes for all four UK countries gave robust evidence of positive scheme results for landscape protectio*n** and (to a lesser extent) enhancement, indicating clear additionality in most cases.

37. Short-term monitoring indicates that CS was designed and delivered appropriately to encourage positive landscape impacts in most agreements, but longer term monitoring of individual character areas would be needed to assess actual impacts in context. For other UK schemes, evidence of landscape benefits so far consists mainly of the scale of scheme outputs in terms of landscape feature management and restoration, but proper assessments of landscape impacts are lacking (athough there was some attempt to look at this in the thematic studies of e.g. hedgerow management).

Public access

38. Provisions for public access to the countryside have been supported through agri-environment schemes from the outset, especially in England and Wales. Key components of access provision include new permissive footpaths and other types of linear routes as well as new public access areas, and educational access.

39. ***Schemes have given rise to a significant number of new access opportunities to farmland in England and Wales, and to some degree have enhanced accessibility in Scotland***[3]. The evidence available suggests provision of additionality, over and above what would have existed without the use of AES. Case studies show that well designed and targeted new access routes offer good value, especially where they link existing routes. However, the impact is lower than it could be if new permissive access was planned more strategically and with more reference to local needs and opportunities in the context of existing access provision outwith the schemes.

40. There is a need for more monitoring and evaluation to assess the level of demand for new public access as well as the extent of use and the quality of the access provided through AES.

Resource protection (Soil & Water)

41. Resource protection has only recently become an explicit objective of some UK agri-environment schemes, although some of the existing measures available to conserve habitats can also play a role in resource protection. Direct evidence of benefits is sparse; therefore it is necessary to rely on indirect evidence such as outputs from mathematical models to assess potential impacts. ***One such study in 2007 indicated average potential reductions in N losses of between 2.1 and 4.3%, and a reduction in P losses of 4.0% from ELS***, based on current levels of uptake for the various management options on offer. Measures to reduce pollution, such as buffer strips, can bring biodiversity benefits as well (see paragraph 27).

42. Agri-environment schemes are likely to function most effectively when seen as part of a package of measures, including regulation and cross-compliance. To achieve maximum impact, they should be used in a targeted manner. It might therefore be expected that those schemes that identify environmental features which require protecting and then introduce appropriate management (e.g. HLS,

[3] In Scotland, legislation is different and grants general rights of responsible access.

Tir Gofal) would have more success than generic schemes such as ELS and Tir Cynnal. ***The integration of AES with other measures in a targeted manner through the provision of advice and support, as exemplified by the England Catchment Sensitive Farming Delivery Initiative[4], is likely to achieve the best results in terms of resource protection.***

Discussion and conclusions

43. The most comprehensive evidence of the impact of agri-environment schemes comes from evaluations of the ESAs. This shows that the ***schemes were generally successful in maintaining, and in some cases enhancing, environmental value.*** Additionality was demonstrated for historic and landscape objectives, and for a range of biodiversity and habitat objectives; for example a review of grassland management prescriptions for all UK ESAs showed good evidence of additionality in respect of habitat condition in most ESAs. Even where condition was maintained rather than enhanced, evidence suggests that in the absence of the schemes deterioration would have occurred. There were however also examples, such as heather moorland and some grassland, where continued deterioration was evident even on land under agreement. In such cases, the results of the evaluations have been used to inform the development of later schemes to improve the likelihood of success.

44. Later schemes have placed greater emphasis on enhancement, with a wider range of management options available and a greater emphasis on targeting. Monitoring has been less comprehensive, but where it was carried out (e.g. the Arable Stewardship Pilot Scheme, CS special projects), ***significant benefits have been demonstrated. Case studies have demonstrated outstanding successes where targeted application of research-based options has been undertaken***, as exemplified by cirl bunting, stone curlew and corncrake, where action under AES has resulted in the exceeding of BAP population targets. Thematic evaluations of the impact of management implementation, e.g. field boundaries, traditional farm buildings, designed landscapes and other landscape feature restoration in schemes including CS, Tir Cymen and Tir Gofal, show evidence of positive change for both feature extent and condition as a result of scheme uptake.

45. ***Overall, there is good evidence that UK agri-environment schemes have delivered significant benefits to biodiversity***, particularly for plants and birds of arable, species-rich grasslands, hedgerows, moorland and lowland heath, and some types of wetland, and that they have the potential to improve on past performance as a result of improvements to the design of the current generation of agri-environment schemes. ***A large proportion of priority habitat for grassland and upland heathland, is now under some form of AES management, with greatly improved prescriptions as a result of the lessons from ESA monitoring and academic research.*** An indication of the potential impact is given by a recent survey of BAP priority grasslands in England, which showed that those in schemes were more than twice as likely to be in favourable condition as those outside schemes.

46. There is less evidence for mammals and invertebrates, but ***there are cases of measured benefits for e.g. bumblebees, sawflies and plant bugs, and some mammal species (e.g. brown hares and voles),*** especially in arable habitats. There is also good evidence to indicate that UK ***agri-environment schemes***

[4] http://www.defra.gov.uk/farm/environment/water/csf/delivery-initiative.htm

are contributing positively to the protection and enhancement of landscape quality and the maintenance of historic features including buildings, planned landscapes and monuments.

47. Resource protection is a more recent objective, with available information currently limited to the outputs from mathematical modelling exercises combined with case studies arising from pilot schemes such as the England and Wales Catchment Sensitive Farming Delivery initiatives. As with other objectives, the flexibility and targeting of management options, in conjunction with the provision of good information and advice to farmers, is crucial to success. The question as to the desirability of adopting a landscape approach to scheme implementation is one that needs to be addressed in the near future.

48. A review of the evaluation of agri-environment schemes at a European level concluded that there were insufficient robust evaluation studies to allow a general judgement of the effectiveness of agri-environment schemes. However, ***monitoring effort in the UK has been considerably greater than that in other member states, and the resulting information is generally of a higher quality***. Within the practical limitations inherent in evaluating schemes on commercial farms, the collection of baseline data coupled with repeat surveys, as well as comparison with non-scheme controls, should be incorporated into evaluations wherever possible. However, short-term evaluations also have a role to play in providing early indications of scheme performance to inform scheme reviews and enable adjustments to deal with any emerging problems. The new 'entry-level' type schemes pose additional challenges for evaluation, and will require a range of approaches from field level monitoring of specific options, to landscape and national scale assessment of the wider scale impacts, using additional data from existing longitudinal surveys, such as the monitoring of bird densities on scheme and non-scheme land in conjunction with the national Breeding Birds Survey.

49. The importance of a strong underpinning research base in developing, refining, and testing options should not be underestimated. ***The large and ever expanding body of such research gives increased confidence in the ability of prescriptions to achieve objectives***, especially in the interim before monitoring data become available.

50. It is recommended that short term monitoring of potential benefits be continued, but the planning of a long-term evaluation strategy incorporating the collection of baseline data and repeat surveys for key indicators, based on a hypothesis-led approach as exemplified by the ASPS evaluation, should be implemented for current new and future schemes. ***Compared to the expenditure on the schemes as a whole, the investment required to confirm their effectiveness is relatively modest***.

51. The current period is a particularly dynamic and exciting one for agri-environment schemes, with major changes to the structure of these schemes in response to experience from the successes and failures of earlier schemes, a greatly increased scientific research base, and funding provided on a larger scale than ever before. This increased funding carries with it an increasing obligation to demonstrate public benefit and value for money, and the next few years will be a crucial test of the ability of schemes to deliver against their objectives.

52. In conclusion, there is good evidence that the much increased coverage, and the kinds of management option now being used within the UK agri-environment schemes, will deliver significant benefits for biodiversity, landscape quality, the protection of historic features and the provision of new or enhanced access opportunities. As a result of experience gained from the evaluation of earlier schemes, the targeting of scheme prescriptions has improved considerably, with greater scope for management tailored to the needs of individual sites. Outstanding successes have been recorded where such targeted management has been applied to implement well-researched solutions to specific issues; the challenge is to achieve the same level of benefits on a broader scale.

CRYNODEB GWEITHREDOL

Amcanion

53. Amcanion yr astudiaeth hon yw:

    a. Cyflwyno adolygiad cynhwysfawr o'r dystiolaeth fod cynlluniau amaeth-amgylcheddol y DU yn esgor ar fuddion amgylcheddol
    b. Crynhoi a gwerthuso'r dystiolaeth fod buddion amgylcheddol i'w cael.

Cyflwyniad

54. Dechreuodd cynlluniau amaeth-amgylcheddol yn y DU yn 1987 pan lansiwyd yr Ardaloedd Amgylcheddol Sensitif (AAS) cyntaf. Bwriad y rhain oedd gwarchod bioamrywiaeth a thirwedd ardaloedd penodol o bwysigrwydd mawr. Strwythurwyd y cynlluniau ar ffurf haenau, gyda'r lefelau isaf yn cael eu hanelu at gynnal y gwerth amgylcheddol presennol, a'r lefelau uwch yn anelu at gyflwyno gwelliannau. Cyflwynwyd dull yr AAS yng Nghymru, Yr Alban, Gogledd Iwerddon a Lloegr.

55. Yn ystod y 1990au, ategwyd AAS gan amrediad o gynlluniau "ail genhedlaeth". Bwriad y cynlluniau hyn oedd profi amryw o wahanol ddulliau ym mhedair gwlad y DU. Roedd y dulliau hyn yn ei gwneud hi'n bosibl i gael cytundebau ar gyfer y fferm gyfan ac ar gyfer rhannau o'r fferm; i adfer cynefinoedd a gâi eu rheoli'n fwy arddwys; i ddarparu mynediad cyhoeddus newydd i gefn gwlad; ac i gynnig amrywiaeth eang o ddewisiadau rheoli blynyddol, yn ogystal â thaliadau gwaith cyfalaf untro. O blith y rhain, Stiwardiaeth Cefn Gwlad oedd y cynllun cyntaf o'r fath ac fe'i lansiwyd yn Lloegr yn 1991 a'i ddilyn yn fuan gan gynllun Tir Cymen yng Nghymru yn 1992. (Yn 1999, disodlwyd Tir Cymen ac AAS Cymru gan gynllun Tir Gofal.) O ganol y 1990au, roedd Cynllun Cynefin ar gael yn Yr Alban, ond fe ddisodlwyd hwn gan y Cynllun Premiwm Cefn Gwlad yn 1997, ac yna gan y Cynllun Stiwardiaeth Wledig yn 2001. Yr adeg honno, daeth y cynllun AAS i ben yn Yr Alban. Yn y cyfamser, yn y flwyddyn 2000 cyflwynwyd y Cynllun Rheoli Cefn Gwlad yng Ngogledd Iwerddon. Yn 1998, lansiwyd Cynllun Stiwardiaeth Âr peilot yn Lloegr, ac ar ôl iddo gael ei werthuso'n llwyddiannus, cafodd sawl dewis âr eu hymgorffori yn y cynllun Stiwardiaeth Cefn Gwlad.

56. Yn ystod 2005, cafodd y cynlluniau yn Lloegr eu had-drefnu'n gynlluniau Stiwardiaeth Amgylcheddol, gan ymgorffori maes 'lefel mynediad' yn ogystal â maes 'lefel uwch' mwy traddodiadol. Hefyd, mae cynllun lefel mynediad, 'Tir Cynnal', wedi'i gyflwyno yng Nghymru. Yn dilyn Cynllun Contract Rheoli Tir byrhoedlog (a lansiwyd yn 2006), yn 2008 rhoddwyd Cynllun Datblygu Gwledig newydd ar y gweill yn Yr Alban i ddisodli'r holl gynlluniau blaenorol. Yng Ngogledd Iwerddon, lansiwyd Cynllun Rheoli Cefn Gwlad yn 2008 sy'n ymgorffori'r Ardaloedd Amgylcheddol Sensitif.

57. ***Gan fod y cynlluniau hyn wedi esblygu, mae'r gwersi a ddysgwyd wrth eu gwerthuso wedi arwain at newidiadau yn y cynlluniau ac wedi dylanwadu ar y ffordd y caiff cynlluniau dilynol eu ffurfio. Mae'r broses werthuso ei hun hefyd wedi esblygu wrth ymateb i newidiadau yn natur a strwythur y cynlluniau.***

58. O'r cychwyn, rhywbeth gwirfoddol oedd ymuno â chynlluniau amaeth-amgylcheddol (CAA), ac maent wedi dibynnu ar barodrwydd y ffermwyr i gyflwyno'r buddion amgylcheddol sy'n gysylltiedig â dewisiadau penodol am dâl gosod. Serch hynny, rhoddwyd iddynt rôl bwysig wrth gyflawni amcanion polisi rheoli tir gwledig. ***Eisoes, maent wedi cyfrannu'n helaeth at gyrraedd targedau Cynllun Gweithredu'r DU ar Fioamrywiaeth ar gyfer rhai cynefinoedd a rhywogaethau*** ac fe'u gwelir fel y prif gyfrwng ar gyfer cyflawni nod penodedig Defra[5] i wrthdroi'r lleihad ym mhoblogaethau adar tir fferm. Hefyd, y bwriad yw i gynlluniau amaeth-amgylcheddol chwarae rôl sylweddol o safbwynt cynnal a chyfoethogi cymeriad y tirwedd, ac o safbwynt gwarchod tirweddau a nodweddion archeolegol a hanesyddol. Mae gan ddull o'r fath ar gyfer datblygu mynediad cyhoeddus newydd y potensial o esgor ar fuddion ar y cyd â'r ddarpariaeth bresennol a geir ar ffurf hawliau tramwy cyhoeddus a'r trefniadau statudol newydd ar gyfer mynediad agored. Mae rôl y cynlluniau amaeth-amgylcheddol o ran ymdrin â phynciau sy'n ymwneud â diogelu adnoddau'n gymharol newydd, ond gallai fod yn werthfawr yn y meysydd hynny lle mae angen mesurau y tu hwnt i arferion da er mwyn gwarchod adnoddau sensitif, ac er mwyn sicrhau effeithiolrwydd rhaid i hyn oll gael ei gydgysylltu â rheoleiddio a thrawsgydymffurfio dan Gynllun y Taliad Sengl.

Adolygu'r Dystiolaeth

59. Mae Fframwaith Monitro a Gwerthuso Cyffredin y Comisiwn Ewropeaidd yn dosbarthu tystiolaeth ar effeithiau cynlluniau amaeth-amgylcheddol mewn tri dosbarth: 'allbynnau' (ardaloedd a mathau o dir sy'n cael eu dwyn i'r cynlluniau), 'canlyniadau' (newidiadau yn y dulliau rheoli o ganlyniad i gymryd rhan yn y cynlluniau), ac 'effeithiau' (buddion mewn perthynas ag amcanion y cynlluniau). Mae'r adroddiad hwn yn ymwneud yn bennaf â'r trydydd math o dystiolaeth, er bod gwybodaeth am y niferoedd sydd wedi ymuno â'r cynlluniau wedi'i chynnwys mewn astudiaethau achos. Hefyd, mae sylwadau deongliadol ar y ffordd y mae rheoli tir wedi dylanwadu ar y canlyniadau wedi'u cynnwys lle bo hynny'n berthnasol.

60. Yn y bôn, ceir dau ddull o werthuso cynlluniau: dull tymor byr, sy'n cyflwyno tystiolaeth am 'allbynnau' a 'chanlyniadau' yn bennaf; a dull mwy hirdymor o fonitro effeithiau. Yn unol â manyleb y prosiect, mae'r adroddiad hwn yn defnyddio astudiaethau monitro mwy hirdymor yn bennaf fel ffynonellau tystiolaeth.

61. Casglwyd y dystiolaeth trwy ddefnyddio dau fath o dabl – y cyntaf yn crynhoi canlyniadau pob astudiaeth a'r ail yn dangos natur ac ansawdd y gwaith a wnaethpwyd. Cynhwysir y tablau hyn mewn atodiad, ac maent yn sail i'r adolygiad sy'n ffurfio prif gorff yr adroddiad hwn.

Bioamrywiaeth a chynefinoedd

Tir Âr

62. Yn y cynlluniau amaeth-amgylcheddol cynnar, nid oedd dewisiadau âr yn cael eu cynrychioli'n ddigonol; ond arweiniodd y pryderon eang ynghylch y dirywiad mewn bioamrywiaeth sy'n gysylltiedig â thir âr at ddatblygu amrywiaeth estynedig o ddewisiadau rheoli ar sail ymchwil helaeth. Cynhwyswyd y rhain

[5] Adran yr Amgylchedd, Bwyd a Materion Gwledig.

mewn cynlluniau o'r 1990au ymlaen. Yn Lloegr, cafodd Cynllun Peilot Stiwardiaeth Âr, a roddwyd ar waith rhwng 1998 a 2000 mewn rhannau o East Anglia a Gorllewin Canolbarth Lloegr, ei werthuso'n drylwyr, gan ddarparu ffynhonnell dystiolaeth hynod werthfawr ar effaith dewisiadau âr yng nghyd-destun cynllun gweithredol, ac fe'i hystyrid yn ***enghraifft ragorol o lunio polisïau ar sail tystiolaeth.***

63. Dangosodd y dasg o fonitro'r Cynllun Peilot Stiwardiaeth Âr ei bod yn weddol hawdd cynhyrchu'r llystyfiant y dymunir ei gael y tu allan i'r llecyn dan gnwd (yn enwedig os caiff ei hau) ar ôl newid y dull rheoli am gyn lleied o amser ag ychydig flynyddoedd yn unig. Fodd bynnag, gall ffactorau eraill, fel rhanbarth daearyddol, y math o bridd a ffynonellau'r hadau yn y cyffiniau, hefyd gael effaith ar y canlyniadau, yn enwedig pan mae'r amcan yn cynnwys adfywio llystyfiant mewn modd naturiol. ***Dangoswyd bod dewisiadau âr, yn enwedig ymylon wedi'u trin a heb fod dan gnwd, yn llwyddiannus iawn o ran gwarchod planhigion âr prin***, ond bod yn rhaid targedu'r gwaith er mwyn sicrhau effeithiolrwydd llwyr. O gymharu'r canlyniadau â thir ffermio dan reolaeth, ymatebodd amrywiaeth o greaduriaid di-asgwrn-cefn – gan gynnwys pryfed cop, chwilod planhigion, pryfed llif a chacwn – yn gadarnhaol i ddewisiadau âr, a hynny o ran cynnydd yn eu niferoedd a/neu yn eu hamrywiaeth.

64. ***Bu prosiectau arbennig Stiwardiaeth Cefn Gwlad ar gyfer rhedwyr y moelydd a breision Ffrainc yn llwyddiannus dros ben*****,** gan ddangos bod dulliau rheoli a dargedir, gyda chefnogaeth a chyngor, yn gallu cyflawni canlyniadau rhagorol. Ar gyfer mathau o adar a geir dros ardaloedd ehangach, dangosodd gwaith monitro'r Cynllun Peilot Stiwardiaeth Âr amrediad o ymatebion cadarnhaol ar raddfa'r maes, a oedd yn cyd-fynd yn fras â'r rheini y disgwylid eu gweld mewn casgliadau ymchwil, er bod ymatebion ar raddfa'r fferm yn gyfyngedig. ***Mae canlyniadau'r gwaith gwerthuso, ynghyd ag ymchwil ategol gref, yn awgrymu bod dewisiadau âr yn effeithiol.*** Yn anffodus, mae'r niferoedd sy'n mynd i'r afael â'r dewisiadau hyn yn y maes lefel mynediad yn Lloegr wedi bod yn gymharol isel, ac erbyn hyn mae cynllun gweithredu (sy'n seiliedig ar adolygiad diweddar y cynllun Stiwardiaeth Amgylcheddol ar gynnydd) yn cael ei ddatblygu i ymdrin â'r mater hwn.

Glaswelltiroedd

65. Bu gwarchod glaswelltiroedd llawn blodau yn un o amcanion allweddol cynlluniau amaeth-amgylcheddol ers y dechrau. ***Mae cynlluniau amaeth-amgylcheddol wedi bod yn llwyddiannus o safbwynt targedu glaswelltiroedd o ansawdd gwell*****,** o leiaf yn Lloegr; ac mae tystiolaeth sydd wedi deillio o werthuso nifer fawr o AAS yng Nghymru, Lloegr, Yr Alban a Gogledd Iwerddon yn dangos bod ***ansawdd glaswelltiroedd lled-naturiol yn eu crynswth wedi'i gynnal, at ei gilydd, dan gytundebau amaeth-amgylcheddol***, er nad yw'r dystiolaeth ynghylch gwelliannau mor amlwg. Tra bod nifer iawn o ddewisiadau âr yn cynnwys rhoi'r gorau i dyfu cnydau ar y tir a'i reoli yn ôl argymhellion sydd wedi'u hymchwilio a'u diffinio'n dda, mae'r rhan fwyaf o'r dewisiadau sy'n ymwneud â glaswelltiroedd yn cynnwys addasu'r modd y caiff ardaloedd eu rheoli – sef ardaloedd a chanddynt swyddogaeth gynhyrchiol o hyd, ac sydd felly â'r potensial o greu tensiwn rhwng yr amcanion sy'n cystadlu â'i gilydd[6].

[6] Mae hyn yn wir hefyd am rai dewisiadau âr fel sofl y gaeaf, defnyddio grawn sy'n cael ei hau yn y gwanwyn yn hytrach na'r gaeaf, a defnyddio mwy o wreiddgnydau heb eu chwistrellu.

66. ***Dangosodd arolwg o laswelltiroedd â blaenoriaeth yn y Cynllun Gweithredu Bioamrywiaeth yn Lloegr fod glaswelltiroedd a chanddynt gytundebau amaeth-amgylcheddol bron ddwywaith yn fwy tebygol o fod mewn cyflwr ffafriol o'u cymharu â'r rheini nad oes ganddynt gytundebau o'r fath***, a bod tiroedd a chanddynt gytundebau hefyd yn fwy tebygol o gyrraedd targedau asesu cyflwr ar gyfer nifer o nodweddion, yn enwedig o ran gorchudd llysieuol a rhywogaethau sy'n ddangosyddion cadarnhaol.

67. ***Daeth astudiaeth achos ar weirgloddiau i'r casgliad bod cynlluniau amaeth-amgylcheddol fwy na thebyg yn cyfrannu'n sylweddol at darged y DU ar gyfer cynnal gweirgloddiau'r iseldir.*** Roedd y canlyniadau ar gyfer gweirgloddiau'r ucheldir yn gymysg, ond cafwyd tystiolaeth gadarnhaol ynghylch cynnydd yn y gwerth cadwraethol ar gyfer gweirgloddiau yn AAS Dartmoor.

68. Mae adsefydlu ac ail-greu glaswelltiroedd yn dibynnu ar wrtaith priodol, ar systemau pori/torri a hydrolegol ac, yn aml, ar ailgyflwyno rhywogaethau targed pan fônt yn absennol. At ei gilydd, nid oes angen dim, neu fawr ddim, gwrtaith er mwyn cynnal neu gyfoethogi amrywiaeth y planhigion ac er mwyn cynnal cymunedau o ddiddordeb cadwraethol. Hefyd, mae angen deall y lefelau pori priodol, gan sicrhau bod rhaglenni monitro wedi cofnodi enghreifftiau o ddirywiad yn sgil tanbori a gorbori fel ei gilydd. Ar gyfer gweirgloddiau, mae dyddiadau torri'n bwysig, oherwydd bydd dirywiad i'w weld os caiff y tyfiant ei dorri'n rhy gynnar. Ceir rhywfaint o dystiolaeth sy'n dangos bod argymhellion generig a geir mewn cynlluniau amaeth-amgylcheddol wedi arwain at gynnydd yn unffurfiaeth y glastir, yn enwedig mewn gweirgloddiau, gyda gwelliannau wedi'u cofnodi mewn safleoedd o ansawdd is, ond peth dirywiad mewn safleoedd o ansawdd da.

69. Defnyddiwyd y gwersi a ddysgwyd yn sgil gwerthuso'r cynlluniau, ynghyd â'r ymchwil ategol, i gyfarwyddo'r dasg o lunio'r dewisiadau rheoli glaswelltir mewn cynlluniau Stiwardiaeth Lefel Uwch yn Lloegr ac yng nghynllun Tir Gofal yng Nghymru. Cydnabuwyd bod angen i gytundebau gael eu targedu'n well, y dylent gynnwys amcanion cliriach ac y dylent fod yn fwy hyblyg, gan adael i'r dulliau rheoli adlewyrchu anghenion y safleoedd unigol.

70. Ychydig o waith monitro a wnaethpwyd i asesu'r effeithiau y mae dulliau rheoli glaswelltiroedd wedi eu cael ar adar (ac eithrio yn achos adar rhydio, gweler isod), ***ond mae rheoli er mwyn cyfoethogi'r cynefin ar gyfer rhegennod yr ŷd wedi bod yn llwyddiannus wrth sicrhau cynnydd sylweddol ym mhoblogaeth y rhywogaeth honno o fewn ei dosbarthiad craidd yn Yr Alban.***

Gweundiroedd a rhosydd yr iseldir

71. Bu gwarchod ac adfer gweundiroedd grug a chynefinoedd cysylltiedig yn darged allweddol i gynlluniau amaeth-amgylcheddol yn ucheldiroedd y DU. Mae canran uchel iawn o Rhostir Uchel a Gorgorsydd, sef cynefinoedd â blaenoriaeth o fewn y DU, yn gorwedd o fewn cynlluniau amaeth-amgylcheddol. Mae llawer o waith monitro ar weundiroedd wedi ymhél ag effaith dulliau rheoli ar faint a chyflwr y grug ei hun, a ***chafwyd adroddiadau am lwyddiannau unigol nodedig o bob rhan o'r DU***, yn fwyaf nodedig yn AAS Exmoor yn Lloegr, canlyniadau cynnar o gynlluniau yng Nghymru, AAS Breadalbane a Shetland yn Yr Alban, AAS gorllewin Fermanage ac Erne Lakeland a AAS Slieve Gullion yng Ngogledd Iwerddon. Yn gyffredinol, fodd bynnag, mae'r dystiolaeth ynghylch buddion

rheolaeth gyda CAA yn gymysg, ac ni chanfuwyd fawr neu ddim gwelliant ym maint na chyflwr y grug yn nifer o'r ardaloedd sydd wedi'u gwerthuso.

72. Dangosodd gwaith monitro botanegol a gynhaliwyd ar rywogaethau ac eithrio grug mewn cytundebau Stiwardiaeth Cefn Gwlad ar Bodmin Moor, mewn cytundebau Tir Gofal yng Nghymru ac yn AAS Gorllewin Fermanagach a Lakeland yng Ngogledd Iwerddon, ***ganlyniadau cadarnhaol o ran cynnydd mewn amrywiaeth a/neu rywogaethau dymunol*.**

73. Cofnodwyd cynnydd mewn rhai mathau o adar yn AAS Exmoor a'r North Peak yn Lloegr ***a chafodd gostyngiad yn y pori dan y cynllun Stiwardiaeth Cefn Gwlad effeithiau cadarnhaol ar niferoedd a llwyddiant nythu grugieir duon (sef rhywogaeth â blaenoriaeth yn y CGB) yng ngogledd Lloegr.***

74. Mae gan lwyddiant neu fethiant y targedau ar gyfer cyflwr y grug gysylltiad cryf â phwysau pori. Bydd cyfraddau stoc uchel bob amser yn arwain at ddirywiad yng nghyflwr a/neu orchudd y grug. Gall ffactorau lleol hefyd arwain at fwy o bwysau pori, gan gynnwys llawer o laswellt yn y llystyfiant, bwydo ategol a phresenoldeb llwybrau neu lonydd. Fodd bynnag, mae natur fregus y cynefinoedd yn amrywio, a bydd y cynlluniau'n gweithio ar eu gorau wrth gael eu targedu'n agos i'r ardaloedd a'r safleoedd, er mwyn i'r amodau pori gyd-fynd yn agos ag anghenion pob safle unigol. Pan fydd y tir wedi diraddio'n ddrwg, efallai y bydd angen symud y stoc oddi yno'n gyfan gwbl am gyfnod er mwyn rhoi cyfle iddo ymadfer. Fodd bynnag, gall tanbori hefyd fod yn andwyol – er enghraifft, roedd dirywiad yng ngweundir yr iseldir yn AAS Gorllewin Penwith yn gysylltiedig â phori annigonol.

75. ***Mewn ymateb i'r canlyniadau hyn, mae'r cynlluniau diweddaraf wedi ymgorffori mesurau i gynorthwyo bugeilio, ffensio a symud y stoc oddi ar y tir yn gyfan gwbl yn ystod y gaeaf, er mwyn cael gwell rheolaeth dros y cyfraddau stocio.***

76. ***Yn Lloegr, mae monitro cyflwr SoDdGA gweundir yr iseldir wedi dangos yn glir bod cynlluniau amaeth-amgylcheddol wedi bod o fudd*,** gyda mwy na 70% o'r safleoedd sy'n rhan o'r cynlluniau mewn cyflwr ffafriol neu adferol, o'u cymharu â dim ond 40% o'r rheini nad ydynt yn rhan o'r cynlluniau. Y tu allan i Safleoedd o Ddiddordeb Gwyddonol arbennig, roedd gweundir yr iseldir, ar y cyfan, mewn cyflwr anffafriol, ac nid oedd modd barnu a oedd safleoedd a chanddynt gytundeb yn ymadfer, ai peidio. Roedd y gwaith o reoli pori a rheoli rhedyn i'w weld yn digwydd yn amlach ar safleoedd a chanddynt gytundebau cynlluniau amaeth-amgylcheddol.

Terfynau traddodiadol ac ymylon caeau, coed, coetiroedd

77. Yng Nghymru, Yr Alban a Gogledd Iwerddon mae ***rhoi argymhellion ar waith i leihau pori mewn coetiroedd wedi arwain at effeithiau cadarnhaol ar adfywio coed a phlanhigion y ddaear.*** Nid yw cynlluniau yn Lloegr wedi canolbwyntio rhyw lawer ar reoli coetiroedd hyd yn hyn.

78. Mae'r rhan fwyaf o'r gwaith a wnaethpwyd i fonitro terfynau caeau mewn cynlluniau amaeth-amgylcheddol yn gysylltiedig â newidiadau yn eu nifer dros amser. Erbyn hyn, rheolir niferoedd mawr o wrychoedd a therfynau caeau dan gynlluniau amaeth-amgylcheddol. Awgryma'r gwaith gwerthuso a wnaethpwyd ar gytundebau gwrychoedd AAS a Stiwardiaeth Cefn Gwlad yn Lloegr y bydd y rhan fwyaf o'r dulliau rheoli'n cyrraedd amcanion y cynllun; a bod terfynau traddodiadol yng Nghymru yn cael eu cynnal a'u cadw'n dda, neu'n cael eu

gwella, mewn sawl AAS. Ond nid oes gwaith o safbwynt cymharu'r rhain â gwrychoedd nad oes ganddynt gynlluniau wedi'i wneud, ac nid yw'r buddion a ddaw i ran bioamrywiaeth ychwaith wedi'u mesur yn uniongyrchol.

79. Mae sefydlu ymylon porfa dros ardal eang at ei gilydd wedi cyfoethogi amrywiaeth y planhigion a geir ar ymylon caeau, ac mae hyn yn fwyaf effeithiol pan fyddant yn cael eu hau â chymysgedd o laswelltau/blodau gwyllt amrywiol. ***Roedd ymylon porfa yn fwy blodeuog a chanddynt fwy o adar, larfa ieir bach yr haf, a phlanhigion sy'n fwyd i gacwn, nag ymylon a oedd wedi'u cnydio*****,** ac roedd planhigion llysieuol y cyffiniau'n fwy blodeuog na therfynau cyffelyb heb stribed wedi'i hau. ***Arweiniodd ymylon porfa at gynnydd yn niferoedd a/neu amrywiaeth pryfed cop, gwenyn, ieir bach yr haf a cheiliogod y rhedyn.*** Mae'r effeithiau ar greaduriaid di-asgwrn-cefn yn ddibynnol ar gymysgedd yr hadau – mae rhywogaethau llysysol yn elwa ar gymysgedd o laswelltau; ond mae ar bryfed sy'n bwydo ar neithdar angen ychwanegu planhigion llydanddail blodeuog at y gymysgedd. Ceir hefyd dystiolaeth y gall ymylon porfa gynyddu dwysedd tiriogaethau adar a niferoedd mamaliaid bach.

Gwlyptiroedd ac arfordiroedd

80. Ceir amrywiaeth o gynefinoedd yn yr argymhellion ar gyfer gwlyptiroedd, gan gynnwys glaswelltiroedd gwlyb a chorsydd pori, corsydd a migneint, corsydd calch, corsleoedd a dŵr agored. Mae'r rhan fwyaf o'r gwaith gwerthuso wedi canolbwyntio ar laswelltiroedd gwlyb a chorsydd pori. ***Yn gyffredinol, mae tystiolaeth o bob un o wledydd Prydain yn dangos bod cyflwr glaswelltiroedd gwlyb mewn AAS wedi'i gynnal neu'i wella.*** Cafwyd eithriadau yng Ngweunydd a Gwastadeddau Gwlad yr Haf, lle'r awgrymai lefelau dŵr uchel ac amhriodol mewn rhai safleoedd fod angen gosod amcanion cliriach a thargedu dewisiadau'n well, ac mewn rhai safleoedd yn Yr Alban lle'r oedd lleihad yn y lefelau pori wedi arwain at gynnydd mewn rhywogaethau planhigion llai dymunol ynghyd â lleihad yn amrywiaeth y planhigion.

81. ***Mae tystiolaeth o ran creaduriaid di-asgwrn-cefn yn gyfyngedig, ond mae astudiaethau yng Nghymru a Gogledd Iwerddon yn dangos bod rhai effeithiau cadarnhaol wedi deillio o gynlluniau amaeth-amgylcheddol ar gyfer gwlyptiroedd.***

82. Bu gwella'r cynefin ar gyfer poblogaethau adar rhydio yn un o amcanion allweddol llawer iawn o gynlluniau. Cafwyd rhai canlyniadau cadarnhaol (e.e. ***cynnydd yn niferoedd piod môr a gylfinirod sy'n nythu yn AAS Ynysoedd Shetland a giachod cyffredin a chyffylogod yn AAS Ynys Môn; cynnydd ym mhoblogaeth gylfinirod yn AAS Isnentydd Tafwys Uchaf*****).** Ond mewn llawer iawn o achosion, nid yw'r gwaith monitro wedi dangos fawr o dystiolaeth fod yr adar rhydio ar eu hennill. Lle cafwyd effeithiau cadarnhaol, roeddent yn gysylltiedig â phresenoldeb gwarchodfeydd natur neu ddulliau rheoli haen uwch mewn Ardaloedd Amgylcheddol Sensitif. Gwelwyd bod cyflwr y glastir a lefel y dŵr (a oedd yn llai na pherffaith) yn rhai o brif achosion y methiant, felly mae angen argymhellion sy'n fwy penodol a phwrpasol ar gyfer y safleoedd penodedig, ynghyd â gwell targedu a chyngor priodol. Yn Lloegr, dylai cynnwys yr elfennau hyn yn y maes lefel uwch wella'r perfformiad.

83. Mae cynefinoedd arfordirol a reolir dan gynlluniau amaeth-amgylcheddol yn cynnwys glaswelltiroedd a gweunydd, twyni tywod a morfeydd heli, ond ni chafodd y rhain eu gwerthuso ryw lawer. Fodd bynnag, ***mae tystiolaeth o***

Gymru a'r Alban yn dangos bod cyflwr llystyfiant gweunydd arfordirol a glaswelltiroedd arforol wedi'i gyfoethogi dan gynlluniau amaeth-amgylcheddol.

Amgylchedd Hanesyddol

84. Elfennau allweddol yr amgylchedd hanesyddol ar dir fferm yw safleoedd archeolegol, nodweddion fel adeiladau traddodiadol, terfynau caeau sydd wedi hen sefydlu, coed hynafol, a thirweddau wedi'u cynllunio fel parciau. Mae'r rhain i gyd yn dueddol o gael eu cynnwys mewn cynlluniau amaeth-amgylcheddol yn y DU, ac eithrio coed hynafol (cynigir peth gwarchodaeth erbyn hyn trwy'r maes lefel mynediad).

85. Mae llawer iawn o'r dystiolaeth werthuso'n canolbwyntio ar safleoedd archeolegol. ***Ceir tystiolaeth glir o'r buddion a ddaw wrth warchod nodweddion archeolegol mewn AAS a chynlluniau cenedlaethol ym mhob un o bedair gwlad y DU.*** Hefyd, mae dewisiadau trawsnewid tir âr yn laswelltir wedi gwella llawer ar y warchodaeth a roddir i nodweddion archeolegol. Mae cynlluniau sy'n ymwneud ag adfer adeiladau hanesyddol hefyd wedi esgor ar fuddion y gellir eu mesur.

86. ***Mae cynlluniau wedi llwyddo i dargedu terfynau caeau hanesyddol yn Lloegr***. Mae'r gwaith gwerthuso'n dangos bod dulliau rheoli dan gynlluniau amaeth-amgylcheddol at ei gilydd yn briodol, er bod diffyg llinell sylfaen wedi arwain at fethu â dangos buddion sylweddol. ***Ceir tystiolaeth fod cynlluniau Stiwardiaeth Cefn Gwlad a chynllun Tir Gofal wedi cyfrannu'n helaeth at warchod ac adfer tirweddau cynlluniedig hanesyddol.***

Tirwedd

87. Mae amcanion holl gynlluniau amaeth-amgylcheddol y DU yn ymdrin â thirwedd. Mae'r ffordd yr ymdrinnir â'r tirwedd yn amrywio, ond fel arfer mae'n cynnwys diffinio tirweddau targed a'u helfennau, cynnig canolbwynt ar gyfer cyflwyno dulliau rheoli i wella nodweddion penodol, a thrwy hynny gryfhau cymeriad y tirwedd.

88. ***Cyflwynodd pob un o bedair gwlad y DU dystiolaeth gadarn ynghylch canlyniadau cadarnhaol cynlluniau AAS o safbwynt gwarchod y tirwedd,*** ac i raddau llai ynghylch gwella tirwedd. Roedd ychwanegedd amlwg yn y rhan fwyaf o achosion.

89. Mae monitro yn y tymor byr yn dangos bod cynlluniau Stiwardiaeth Cefn Gwlad wedi'u llunio a'u cyflawni'n briodol er mwyn annog effeithiau cadarnhaol ar y tirwedd yn y rhan fwyaf o gytundebau; ond fe fydd angen monitro ardaloedd cymeriad unigol dros dymor hirach er mwyn asesu'r gwir effeithiau yn eu cyd-destun. Ar gyfer cynlluniau eraill yn y DU, mae tystiolaeth ynghylch buddion i'r tirwedd hyd yn hyn yn cynnwys yn bennaf allbynnau'r cynllun o ran adfer a rheoli nodweddion y tirwedd; ond ceir diffyg asesiadau go iawn ar gyfer yr effeithiau ar y tirwedd (er bod peth ymdrech wedi'i wneud i edrych ar hyn yn yr astudiaethau thematig ar reoli gwrychoedd, e.e.).

Mynediad cyhoeddus

90. Mae darpariaethau ar gyfer mynediad cyhoeddus i gefn gwlad wedi'u hategu gan gynlluniau amaeth-amgylcheddol o'r cychwyn cyntaf, yn enwedig yng Nghymru a Lloegr. Mae elfennau allweddol ar gyfer cyflwyno mynediad yn

cynnwys llwybrau caniataol a mathau eraill o lwybrau, yn ogystal ag ardaloedd mynediad cyhoeddus newydd a mynediad addysgol.

91. ***Mae cynlluniau wedi esgor ar gryn dipyn o gyfleoedd newydd o safbwynt mynediad i dir fferm yng Nghymru a Lloegr, ac i ryw raddau maent wedi gwella hygyrchedd yn Yr Alban.***[7] Mae'r dystiolaeth yn awgrymu bod ychwanegedd i'w gael sy'n rhagori ar yr hyn a fyddai wedi bodoli heb ddefnyddio cynlluniau amaeth-amgylcheddol. Dengys astudiaethau achos fod llwybrau mynediad newydd sydd wedi'u targedu a'u cynllunio'n dda yn werthfawr, yn enwedig lle maent yn cysylltu'r llwybrau presennol. Fodd bynnag, mae'r effaith yn llai nag y gallai fod pe bai mynediad caniataol yn cael ei gynllunio mewn modd mwy strategol gan gyfeirio mwy at gyfleoedd ac anghenion lleol yng nghyd-destun y ddarpariaeth bresennol y tu allan i'r cynlluniau.

92. Mae angen mwy o waith monitro a gwerthuso er mwyn asesu lefel y galw am fynediad cyhoeddus newydd, er mwyn asesu ansawdd y mynediad a gyflwynir yn sgil cynlluniau amaeth-amgylcheddol ac er mwyn asesu i ba raddau y caiff mynediad o'r fath ei ddefnyddio.

Gwarchod Adnoddau (Pridd a Dŵr)

93. Dim ond yn ddiweddar y mae gwarchod adnoddau wedi dod yn amcan penodol mewn rhai cynlluniau amaeth-amgylcheddol yn y DU, er y gall rhai o'r mesurau presennol sydd ar gael i warchod cynefinoedd hefyd fod yn berthnasol i warchod adnoddau. Mae tystiolaeth uniongyrchol o'r buddion yn brin, felly rhaid dibynnu ar dystiolaeth anuniongyrchol fel allbynnau o fodelau mathemategol i asesu'r effeithiau posibl. ***Dangosodd un astudiaeth o'r fath a gynhaliwyd yn 2007 fod y gostyngiadau posibl ar gyfartaledd yng ngholledion N rhwng 2.1 a 4.3%, a gostyngiad mewn colledion P yn 4.0% o faes lefel mynediad***, yn seiliedig ar lefelau cyfredol y niferoedd sy'n cael eu derbyn ar gyfer y gwahanol ddewisiadau rheoli sy'n cael eu cynnig. Gall mesurau i leihau llygredd, fel stribedi clustogi, ddod â buddion o ran bioamrywiaeth yn eu sgil hefyd (gweler paragraff 27).

94. Mae'n debyg y bydd cynlluniau amaeth-amgylcheddol yn gweithredu'n fwyaf effeithiol pan fyddant yn cael eu gweld fel rhan o becyn o fesurau, gan gynnwys rheoleiddio a thrawsgydymffurfio. Er mwyn iddynt lwyddo yn y modd gorau posibl, dylid eu targedu. Felly, gellid disgwyl i'r cynlluniau hynny sy'n nodi nodweddion amgylcheddol y mae angen eu gwarchod, ac sydd wedyn yn cyflwyno dulliau rheoli priodol (e.e. maes lefel uwch, Tir Gofal), fod yn fwy llwyddiannus na chynlluniau generig megis maes lefel mynediad a chynllun Tir Cynnal. ***Mae integreiddio cynlluniau amaeth-amgylcheddol â mesurau eraill mewn modd a dargedir, trwy ddarparu cyngor a chefnogaeth (fel y gwna'r Cynllun Ffermio Sensitif i Ddalgylch yn Lloegr[8]), yn debygol o gyflawni'r canlyniadau gorau o ran gwarchod adnoddau*.**

Trafodaeth a chasgliadau

[7] Yn Yr Alban, mae'r ddeddfwriaeth yn wahanol gan roi hawliau cyffredinol ar gyfer mynediad cyfrifol.

[8] http://www.defra.gov.uk/farm/environment/water/csf/delivery-initiative.htm

95. Mae'r dystiolaeth fwyaf cynhwysfawr ynglŷn ag effaith cynlluniau amaeth-amgylcheddol yn deillio o werthuso'r AAS. Mae hyn yn dangos ***bod y cynlluniau, at ei gilydd, wedi bod yn llwyddiannus wrth gynnal – ac, mewn rhai achosion, wrth ychwanegu gwerth amgylcheddol.*** Dangoswyd ychwanegedd yn amcanion hanesyddol ac amcanion tirwedd, ynghyd ag amrywiaeth o amcanion bioamrywiaeth ac amcanion cynefinoedd – er enghraifft, dangosodd adolygiad ar argymhellion rheoli glaswelltiroedd pob AAS yn y DU dystiolaeth dda o ran cyflwr y cynefin yn y rhan fwyaf o'r Ardaloedd dan sylw. Hyd yn oed lle cafodd y cyflwr ei gynnal yn hytrach na'i wella, mae'r dystiolaeth yn awgrymu y byddai dirywiad wedi digwydd yn absenoldeb y cynlluniau. Fodd bynnag, cafwyd enghreifftiau hefyd (fel gweundiroedd grug a rhywfaint o laswelltir) lle'r oedd dirywiad parhaus i'w weld, hyd yn oed ar dir dan gytundeb. Mewn achosion o'r fath, mae canlyniadau'r gwaith gwerthuso wedi'u defnyddio i gyfarwyddo'r dasg o ddatblygu cynlluniau diweddarach, er mwyn ceisio sicrhau eu bod yn fwy tebygol o lwyddo.

96. Mae cynlluniau diweddarach wedi rhoi mwy o bwyslais ar gyfoethogi, gydag amrywiaeth ehangach o ddewisiadau rheoli ar gael ynghyd â mwy o bwyslais ar dargedu. Bu'r gwaith monitro'n llai cynhwysfawr; ond lle cafodd ei gynnal (e.e. Cynllun Peilot Stiwardiaeth Âr, prosiectau arbennig Stiwardiaeth Cefn Gwlad) ***mae buddion sylweddol wedi dod i'r amlwg. Mae astudiaethau achos wedi dangos llwyddiannau ysgubol lle cafodd dewisiadau'n seiliedig ar ymchwil eu targedu a'u rhoi ar waith*** fel y gwnaethpwyd gyda breision Ffrainc, rhedwyr y moelydd a rhegennod yr ŷd, lle mae gweithredu dan gynllun amaeth-amgylcheddol wedi arwain at ragori ar dargedau'r cynllun gweithredu bioamrywiaeth. Dengys gwaith gwerthuso thematig ar effaith y dulliau rheoli (e.e. terfynau caeau, adeiladau fferm traddodiadol, tirweddau cynlluniedig a gwaith arall ar adfer nodweddion y tirwedd mewn cynlluniau gan gynnwys Stiwardiaeth Cefn Gwlad, Tir Cymen a Thir Gofal) dystiolaeth ynghylch newid cadarnhaol ym maint a chyflwr y nodwedd o ganlyniad i fod yn rhan o'r cynllun.

97. ***Yn gyffredinol ceir tystiolaeth dda fod cynlluniau amaeth-amgylcheddol y DU wedi esgor ar fuddion sylweddol i fioamrywiaeth*** yn enwedig o ran planhigion ac adar tir âr, glaswellt llawn blodau, gwrychoedd, gweundiroedd a rhostir yr iseldir, a rhai mathau o wlyptiroedd, a bod ganddynt y potensial o ragori ar eu perfformiad yn y gorffennol o ganlyniad i wella'r ffordd y caiff y genhedlaeth bresennol o gynlluniau amaeth-amgylcheddol eu cynllunio. ***Mae canran uchel o gynefinoedd â blaenoriaeth o safbwynt glaswelltiroedd a rhostiroedd yr ucheldir bellach dan ryw ffurf ar reolaeth cynlluniau amaeth-amgylcheddol, ac mae'r rhain yn cynnwys argymhellion gwell o lawer o ganlyniad i'r gwersi a ddysgwyd yn sgil monitro AAS ac ymchwil academaidd.*** Cynigir un arwydd o'r effaith bosibl gan arolwg ar laswelltiroedd â blaenoriaeth yn y Cynllun Gweithredu Bioamrywiaeth yn Lloegr, lle dangoswyd bod y rheini a oedd yn rhan o gynlluniau fwy na dwywaith yn fwy tebygol o fod mewn cyflwr ffafriol o'u cymharu â'r rheini nad oeddynt yn rhan o gynlluniau.

98. Ni cheir cymaint o dystiolaeth ar gyfer mamaliaid a chreaduriaid di-asgwrn-cefn, ond ***ceir achosion lle mae buddion wedi'u mesur ar gyfer cacwn, pryfed llif a chwilod planhigion e.e., ynghyd â rhai mathau o famaliaid (e.e. ysgyfarnogod a llygod pengrwn*****),*** yn enwedig mewn cynefinoedd âr. Hefyd, ceir tystiolaeth dda sy'n dangos bod ***cynlluniau amaeth-amgylcheddol y DU yn cyfrannu'n gadarnhaol at warchod a gwella ansawdd y tirwedd ac at gynnal nodweddion hanesyddol gan gynnwys adeiladau, tirweddau cynlluniedig a henebion.***

99. Mae gwarchod adnoddau'n amcan mwy diweddar, ac mae'r wybodaeth sydd ar gael ar hyn o bryd wedi'i chyfyngu i allbynnau ymarferion modelu mathemategol ynghyd ag astudiaethau achos sy'n deillio o gynlluniau peilot fel y Cynlluniau Ffermio Sensitif i Ddalgylch yng Nghymru a Lloegr. Yn yr un modd ag amcanion eraill, mae hyblygrwydd a sut y caiff dewisiadau rheoli eu targedu, ar y cyd â chyflwyno gwybodaeth a chyngor da i ffermwyr, yn hanfodol i'r llwyddiant. Yn y dyfodol agos, rhaid ymdrin â chwestiwn arbennig – sef pa mor ddymunol fyddai mabwysiadu dull tirwedd wrth roi'r cynlluniau ar waith.

100. Daeth adolygiad ar werthuso cynlluniau amaeth-amgylcheddol ar lefel Ewropeaidd i'r casgliad na cheir digon o astudiaethau gwerthuso cadarn i farnu'n gyffredinol ar effeithiolrwydd cynlluniau amaeth-amgylcheddol. Fodd bynnag, ***mae'r gwaith monitro o fewn y DU wedi bod yn sylweddol fwy nag mewn aelod-wladwriaethau eraill, ac yn gyffredinol mae'r wybodaeth sy'n deillio ohonynt o ansawdd gwell.*** O fewn y cyfyngiadau ymarferol sy'n gynhenid wrth werthuso cynlluniau ar ffermydd masnachol, dylai'r dasg o gasglu data llinell sylfaen a chynnal arolygon ailadroddus, yn ogystal â'r dasg o gymharu'r canlyniadau â rheolyddion nad ydynt yn rhan o gynlluniau, gael eu hymgorffori o fewn y gwaith gwerthuso ble bynnag y bo modd. Fodd bynnag, mae gan y gwaith gwerthuso tymor byr ran i'w chwarae hefyd o safbwynt cyflwyno arwyddion cynnar ynghylch perfformiad y cynllun, fel y gellir cyfarwyddo'r adolygiadau a chyflwyno newidiadau er mwyn delio ag unrhyw broblemau. Mae'r cynlluniau 'lefel mynediad' newydd yn cyflwyno sialensiau ychwanegol o ran gwerthuso, a bydd angen amryw o ddulliau monitro (yn cynnwys monitro dewisiadau penodol ar lefel y maes, asesiadau tirwedd ac asesiadau cenedlaethol ar yr effeithiau ehangach), gan ddefnyddio data ychwanegol sy'n deillio o arolygon hydredol presennol, fel monitro dwysedd yr adar a geir ar diroedd sy'n rhan o gynllun ac ar diroedd sydd heb fod yn rhan o gynllun ar y cyd â'r arolwg cenedlaethol ar adar sy'n nythu.

101. Ni ddylid dibrisio pa mor bwysig yw cael sylfaen ymchwil gadarn wrth ddatblygu, mireinio a phrofi dewisiadau. ***Mae maint sylweddol a bythol gynyddol gwaith ymchwil o'r fath yn rhoi mwy o hyder i ni yng ngallu'r argymhellion i gyflawni'r amcanion,*** yn enwedig dros dro hyd nes y bydd data'r gwaith monitro ar gael.

102. Argymhellir y dylid parhau â'r gwaith o fonitro'r buddion posibl yn y tymor byr. Ond argymhellir hefyd y dylid cynllunio strategaeth werthuso hirdymor sy'n ymgorffori'r data llinell sylfaen a'r arolygon ailadroddus ar gyfer dangosyddion allweddol, yn seiliedig ar ddull damcaniaethol fel gwaith gwerthuso'r Cynllun Peilot Stiwardiaeth Âr – a hynny ar gyfer y cynlluniau presennol, y cynlluniau newydd a'r rhai a gaiff eu llunio yn y dyfodol. ***O'i gymharu â'r gwariant ar y cynlluniau yn eu crynswth, mae'r buddsoddiad sydd ei angen i gadarnhau eu heffeithiolrwydd yn eithaf rhesymol.***

103. Mae'r cyfnod presennol yn un hynod ddynamig a chyffrous i gynlluniau amaeth-amgylcheddol, a cheir newidiadau mawr i strwythur y cynlluniau hyn wrth ymateb i brofiad yn sgil llwyddiannau a methiannau'r cynlluniau blaenorol, sail ymchwil wyddonol fwy, a chyllid ar raddfa fwy nag erioed o'r blaen. Mae'r cynnydd hwn yn y cyllid yn dod â dyletswydd gynyddol yn ei sgil i ddangos buddion cyhoeddus a gwerth am arian, a bydd yr ychydig flynyddoedd nesaf yn hollbwysig o ran profi gallu'r cynlluniau i gyflawni eu hamcanion.

104. I gloi, ceir tystiolaeth dda y bydd ymestyn y cynlluniau a'r math o ddewisiadau rheoli sydd bellach yn cael eu defnyddio yng nghynlluniau

amaeth-amgylcheddol y DU yn esgor ar fuddion sylweddol o ran bioamrywiaeth, ansawdd y tirwedd, gwarchod nodweddion hanesyddol a chyfleoedd mynediad newydd neu well. O ganlyniad i'r profiad a gafwyd wrth werthuso cynlluniau blaenorol, mae argymhellion y cynlluniau bellach yn cael eu targedu'n fwy effeithiol, a cheir cyfle gwell o lawer i roi dulliau rheoli ar waith sydd wedi'u teilwra'n ôl anghenion y safleoedd. Lle mae dulliau rheoli o'r fath wedi'u rhoi ar waith i greu atebion sydd wedi'u hymchwilio'n drylwyr er mwyn datrys problemau penodol, mae llwyddiannau ysgubol wedi'u cofnodi. Y sialens yn awr yw cyflwyno buddion ar yr un lefel ar raddfa ehangach.

1. INTRODUCTION

1.1 Objectives

The objectives of the study are:

- To provide a comprehensive review of the evidence for the provision of environmental benefits by UK agri-environment schemes
- To summarise and evaluate the evidence base for delivery of environmental benefits.

Outputs include:

1. a comprehensive summary of the available evidence from research, monitoring and evaluation projects, categorised by type of evidence (see below);
2. for selected key management prescriptions, a qualitative assessment of the potential contribution of observed uptake levels to delivery of scheme objectives;
3. a synthesis and interpretation of the evidence base to provide a concise summary of the evidence for the provision of environmental benefits.

Barnett (2007) recently highlighted the continuing importance of high quality evaluations in informing the work of the European Commission on agri-environmental policy. This project aims to provide a review of the environmental benefits supplied by agri-environment schemes in the UK. It is intended that this review will produce evidence to assist the Commission and the UK Government in appraising and supporting agri-environment schemes as a policy for providing public goods, in the form of environmentally positive management of agricultural land.

1.2 Context: Agri-environment schemes in the UK

1.2.1 Beginnings: Environmentally-Sensitive Areas

Concern over the impact of agriculture on biodiversity and the landscape during the 1970s and early 1980s led to the development of agri-environment schemes, through which farmers were paid to manage land in an environmentally sensitive manner, as an counter-incentive to market and policy drivers encouraging intensified land use. The fore-runner of agri-environment schemes in the UK was the 1985 Broads Grazing Marshes Conservation Scheme. This was followed in 1987 by the first tranche of Environmentally Sensitive Areas (ESAs), each supporting specific management practices directed towards the conservation of the wildlife and landscapes characteristic of the area. ESAs were designated initially for a combination of reasons, but broadly focused around landscapes of high value containing characteristic habitats whose ecological quality was under threat from agricultural intensification. Most commonly, this involved the conversion of permanent grassland/moorland to arable, or intensification of pastoral management on semi-natural habitats via drainage, increased inputs and higher stocking rates. Three further tranches of ESA were designated in 1988, 1993 and 1994, so that eventually, 43 ESAs were established in the UK, 22 in England, 6 in Wales, 10 in Scotland, and 5 in Northern Ireland (Table 1.1). The tranche 3 and 4 ESAs included some ‘part-farm’ schemes more tightly defined around specific habitats (e.g. Upper Thames Tributaries, Essex Grazing Marshes) as well as others targeting whole farms

and entire landscapes, mainly in the national parks (e.g. Lake District, Exmoor). The combined area was 3,356,000ha, or around 15% of agricultural land (Swash, 1997). Farmers within the designated areas could enter into five-year management agreements (ten years, from 1992). The objectives of the scheme were: "to maintain and enhance the landscape, wildlife and historic value of each area by encouraging beneficial farming practices". Agreements were structured into tiers. Tier 1 aimed to retain and maintain existing habitats by largely preserving established practices, whilst higher tiers aimed to maintain wildlife value of more valuable habitats, enhance existing habitats and/or create new habitats through active management. The later tranche ESAs generally involved a greater focus on higher tier management options than the early ones. Although initially, agreements were offered to anyone who was able to comply with the required management prescriptions, after the first five-years in England and Wales, entry into agreements became conditional upon farmers agreeing to acceptable level of likely environmental benefit, as assessed by scheme project officers (i.e. discretionary). Following the first 5-year reviews of the earliest ESAs, schemes began to offer funding for capital works programmes to complement the annual management payments. Payments secured specific restoration of field boundaries, traditional buildings, creation of wetland areas, and other locally-appropriate activities.

1.2.2 Feature-targeted, widespread schemes

Whilst the ESAs supported management to maintain and enhance the environment in some of the most significant areas of environmental interest, it was realised there was a need for a vehicle to promote a wider range of environmentally beneficial management outside ESAs. In 1991 the pilot Countryside Stewardship (CS) Scheme was launched in England, developed and run by the Countryside Commission, in collaboration with English Nature and English Heritage. As well as experience with the ESAs, CS drew lessons from the short-lived experiment in offering payments to farmers for environmental management of voluntary set-aside land, the Countryside Premium Scheme, which operated in Eastern England from 1989 to 1992. CS targeted not by geography but by broadly defined 'landscape type', and was a discretionary, largely part-farm scheme[9] which was potentially available to any land manager in England. From the start, it offered a long menu of annual and capital payments for use within agreements, so that land management and habitat and feature restoration and creation were pursued together, in most cases. Although its budget increased significantly during the 6-year pilot phase and its capital budget was strengthened by incorporation of a new hedgerow restoration scheme, from 1992, it proved so popular that demand outstripped supply from 1993 onwards. This necessitated the operation of strict targeting and scoring and ranking of applications, to attempt to ensure that only those offering the best range of potential environmental benefits would be funded. In 1996 the scheme transferred largely unchanged to the responsibility of the then Ministry of Agriculture, Fisheries and Food (MAFF).

In response to the measures defined in the new EU Agri-Environment Regulation (2078/1992), the smaller Habitat, Moorland and Countryside Access Schemes were established by MAFF in England, in 1994 and 1995. The Habitat Scheme targeted long-term (20-year) set-aside for habitat creation and water quality protection; the Moorland Scheme sought managed reduction of grazing pressure on upland areas based upon compensation for stock removal; and the Countryside Access Scheme supported public access to land set-aside under the EU arable regime. Following a

[9] The upland landscape type within CS was the only one for which agreements had to be whole farm.

joint MAFF and England-agency Review of Environmental Schemes in 1995, it was agreed that these three schemes would be closed once they completed their first five years, and the lessons from them would be incorporated into appropriate revisions to CS, beyond that point.

Experience from the CPS and subsequent environmental management of compulsory set-aside land (using cross-compliance) from 1992 onwards, led to a realisation of the potential value of extending the CS target landscapes to include in-field arable biodiversity. This led to the establishment in 1998 of an Arable Stewardship Pilot Scheme (ASPS) in two areas in East Anglia and the West Midlands, leading to roll-out of many of the arable options into appropriate ESAs and, in 2002, into CS.

Equivalent schemes were established in Wales, Scotland and Northern Ireland over a similar period. In Wales, ESAs were supplemented by the Countryside Council for Wales' Tir Cymen whole-farm scheme in 1992 (piloted in 3 areas), along with Habitat and Moorland schemes broadly similar to those operating in England. All these schemes closed in 1999, to be replaced by Tir Gofal. Developed and run by the Countryside Council for Wales (CCW), this whole-farm scheme was transferred to the Welsh Assembly Government (WAG) in 2006. In Scotland, agri-environment measures were extended to the whole country through a Habitat scheme in the mid 1990s (again based upon the EU measure for 20-year set-aside), followed by the Countryside Premium Scheme in 1997 (a menu-based scheme similar to Tir Cymen and CS). This was in turn replaced by the Rural Stewardship Scheme, in 2001, and the ESA scheme in Scotland was also closed at this time. In Northern Ireland, the Countryside Management Scheme was introduced in 2000 by the Department of Agriculture and Rural Development (DARDNI), to complement the ESAs by offering a similar kind of simple, whole farm environmental management approach, on a discretionary basis, to all land managers in the province. In contrast to the menu-based schemes in England, Wales and Scotland, CMS placed more emphasis upon whole farm plans for resource protection and included a smaller range of habitat management and restoration options, reflecting key environmental priorities within Ireland, at that time[10].

1.2.3 Organic aid schemes

The other important strand of agri-environment scheme development during the late 1990s was the start of support for organic farming, justified initially on infant industry grounds but increasingly also on environmental grounds. Organic aid schemes which covered the anticipated income losses during the conversion phase were offered in all countries of the UK. In recent years, as the evidence of the environmental management benefits of organic farming has accumulated, the organic schemes have also begun to offer ongoing payments for such management.

1.2.4 Other schemes

There were also schemes run by the conservation agencies for special sites and SSSIs, such as the Wildlife Enhancement Scheme in England, Natural Care in Scotland etc. These are now being incorporated into the general agri-environmental schemes. These special schemes are outside the remit of this study.

[10] A similar pattern is also evident in the main agri-environment scheme for the Republic of Ireland, the REPS.

1.2.5 Recent developments (from 2003) and the advent of 'broad and shallow' entry-level schemes

The Policy Commission on the Future or Farming and Food (Curry, 2002) recommended a new approach to agri-environment schemes, *viz*. the development of a 'broad and shallow' scheme, to run alongside and complement a more demanding 'narrow and deep' scheme, targeting higher levels of environmental benefit. The 2000 and 2003 reforms of the CAP, with the opportunity to raise additional funds for schemes through modulation, provided an opportunity to re-structure agri-environment schemes to encourage greater participation. In spring 2005, following a review of Defra's agri-environment schemes, Environmental Stewardship (ES) replaced all the previous agri-environment schemes in England. Following a successful evaluation of a pilot Entry Level Scheme in four areas representing arable, mixed, lowland grassland and upland farming (Boatman *et al*., 2004), the Curry proposals were translated into the Entry Level and Higher Level of the Environmental Stewardship scheme. Organic farming support was also incorporated through the Organic Entry Level scheme.

Entry Level Stewardship is open to all farmers and landowners in England and operates on a points allocation system: applicants can choose options from a menu, each of which is assigned a number of points per unit area, length etc. All those who reach a threshold number of points are guaranteed entry and payment of a flat rate per hectare of land entered into the scheme. Thus, for the first time, the majority of farmers will be involved in a scheme to encourage positive environmental management. However, unlike ESAs, this basic level scheme does not include any provision for capital works. The Higher Level strand is more similar to previous schemes, with selective entry, individual payment rates for each option, funding for management and capital works, and targeting of objectives at the level of the Joint Character Area (JCA). The history of Environmental Stewardship, and the evaluation of its precursors, have been described in full by Radley (2005).

An entry level scheme, 'Tir Cynnal', was also introduced in Wales in 2005, and a 'broad and shallow' Tier 2 Land Management Contract Scheme was launched in Scotland in 2006. All prior Scottish schemes closed to new applications in 2007 and an integrated successor scheme, the Rural Development Scheme, opened in 2008, which offers environmental management support alongside help to develop and diversify the farm business, as appropriate.

In Northern Ireland, reluctance to develop a new entry-level scheme on the grounds that the CMS already offered something sufficiently flexible to complement ESAs, led instead to a review and launch of a new CMS (NICMS) in 2008. This incorporates the ESAs and offers a wider range of management options to all farmers in the province, with a target to achieve 50% cover of NI farmland within the next few years.

One important aspect of broad and shallow schemes, by contrast to predecessor approaches in the UK, is the conscious decision to use these to achieve some level of basic, positive environmental management across the majority of UK farmland, rather than seeking specific environmental benefits only in particular priority locations or situations. Thus the schemes are relatively simple to apply for, applications can be easily assessed for conformity with scheme criteria, all payments are simple and regular, and the administrative costs of the scheme are comparatively low. At the same time, uptake of the schemes is rapidly growing such that more than 50% of farmed land in England, at least, is now in the scheme.

The advent of the 'broad and shallow' ELS-type schemes in England, Wales and Scotland has implications for methods of monitoring and evaluation. They will require monitoring which is larger scale, to enable it to capture the cumulative impact of changed management on many holdings across whole landscapes and watersheds. In addition, the broader range of environmental impacts now covered by these schemes will require monitoring and evaluation which can detect outputs, results and impacts in respect of resource protection, as well as biodiversity, landscape, history and amenity. These implications are explored further in section 3.2.

1.2.6 Conclusion

Three types of agri-environment scheme have been implemented in the UK. The first were the ESAs, targeted towards the specific needs of geographically limited areas identified as being of particular environmental value. These were tier-based schemes, with the lower tier aimed at maintenance of environmental value, and voluntary higher tiers providing opportunities for enhancement. These were followed by national, competitive[11], feature-targeted schemes to extend support for environmental management into the wider countryside outside ESAs. Recently, a third type of scheme has emerged, the 'broad and shallow' approach with open entry to all eligible farmers, which aims to provide a basic level of evnvironmental management on a majority of farmland. The competitive feature-targeted approach is retained in 'Higher Level' schemes, but the ESA schemes have now closed or been amalgamated with national schemes.

As these schemes have evolved, lessons learnt from evaluations have informed changes to the schemes and the design of successors to those that have been closed. The evaluation process has also evolved in response to changes in the nature and structure of the schemes themselves. Stages in this iterative evolutionary process will be illustrated by examples throughout the review of evidence in part 2 of this report, and disussed further in section 3.

1.3 The role of agri-environment schemes in achieving environmental policy goals

Agri-environment schemes are a voluntary, payment-based policy approach to the provision of environmental goods and services from land management. The strengths of this approach include:

- the ability to provide a positive management incentive through payment, and supporting advice and facilitation (particularly in higher level agreements), to encourage farmer learning and active management of valued environmental resources;
- the ability, increasing over time, to negotiate and agree tailored management activities which are sensitive to individual needs and opportunities in each locality and in respect of each individual farm business;
- a medium-to-long term commitment to sensitive management and the delivery of environmental benefits, between both parties to the contract, which is explicit and binding;

[11] The Welsh Tir Gofal scheme is an exception in that it is not competitive.

- compatibility with continuing commercial management of land, in the overwhelming majority of cases.

At the same time, a voluntary, payment-based approach also has some limitations. These may include a lack of funding for sufficiently high levels of uptake (generally, or in respect of particular targets) to achieve environmental goals; as well as vulnerability to competitive pressures from other land management drivers (most notably, agricultural prices). In relation to the achievement of some particular environmental goals, continuing commercial management of land may not be viable and therefore more complete public intervention (e.g. land purchase and public management) may be more cost-effective. However, this approach is only feasible for limited areas of particular value, and agri-environment schemes are likely to remain the major vehicle for delivery of environmental benefits in the wider countryside, over an above those assured through regulation and cross-compliance, in the foreseeable future.

All these features have been identified to some degree, in the evaluation evidence surrounding UK schemes. In general terms therefore, the schemes appear best-suited to providing the detailed and positive aspects of environmental protection and enhancement which work comfortably alongside day-to-day commercial land management. But the key to maximising their effectiveness is to seek to work with their strengths by using them in an integrated way alongside other mechanisms, notably including regulatory protection and advice and information. They require strong legislative back-up to protect features and resources of the highest importance; and good information, training and advice to support effective management to achieve their goals.

With respect to biodiversity, UK agri-environment schemes have been identified as having major role to play in achieving UK Habitat Action Plan targets for habitats subject to agricultural management, and Species Action Plan targets for species dependent on agricultural habitats, or widespread species that use agricultural land. Today, substantial proportions of priority habitats are managed under agri-environment schemes, and the increased targeting, greater flexibility and outcome-led approach of the new higher-level schemes should result in greater benefits for the most valued habitats, in time, as well as improving the condition of many Sites of Special Scientific Interest. Agri-environment schemes have already made substantial contributions to the achievement of BAP targets for certain bird species (see later sections of this report) and HLS now has local targets for several more species, where local populations exist. For the most widespread species, entry level schemes are likely to provide the main vehicle for reversing declines, especially now that set-aside has been abolished. Progress in this regard will also contribute to achieving a favourable trend in the Government's Wild Bird Index, which incorporates trends in farmland, woodland, water and wetland birds. Agri-environment schemes are also likely to be the most effective vehicle for conserving rare arable plants.

A common feature of heritage policy throughout the UK is that it tends to focus on individual sites and structures (Beacham, 2006 and BEFS, 2007). In recent years policy reviews suggest that very little of the UK's historic environment resource (c.5%), falls under statutory protection. Policy for management of the historic environment is not undertaken within a target-orientated framework and in this sense it differs from the approach developed for biodiversity and habitats. Nevertheless, the potential for agri-environment schemes to make a significant contribution to the maintenance and enhancement of both the protected and un-protected resource has been recognised by the statutory bodies responsible for the promotion and protection of the historic environment, across the UK.

Having signed and ratified the European Landscape Convention (ELC) in 2007, the Government considers that the UK is already compliant with the ELC's requirements. However, "it wishes to facilitate a strengthening of performance through policy and practice across as wide a section of society as possible". Agri-environment schemes have the potential to make a significant contribution to landscape maintenance and enhancement. However, in order to maximise benefits, a co-ordinated approach to the planning and location of agreements is essential.

Enhancing access opportunities and access quality is a feature of countryside policies in all four UK countries. However, recognition of the potential for agri-environment schemes to promote access goals is not explicit within the EU legislative framework. Currently, broader strategic policy developments on access planning in Scotland, and England and Wales, provide a useful starting point to achieve a more targeted use of agri-environment schemes to maximise the value of the access opportunities that they offer.

With regard to the protection of water, soil and air quality, the traditional view in UK policy appears to have favoured regulatory and advisory approaches over voluntary payment mechanisms, to deliver policy goals. However, in the light of positive experience from other countries, as well as a growing appreciation of the potential of current UK schemes in this regard, particularly if coupled to locally-sensitive advice and support, agri-environment schemes are increasingly seen as an important component. The issue of water quality in particular is now becoming an increasingly important objective of the newer schemes. As is the case for landscape, the importance of co-ordination, in respect of scheme uptake and the selection of appropriate management options, is often crucial to achieving goals for the protection and enhancement of these resources.

Table 1.1 Environmentally Sensitive Areas in the UK, by year of introduction.

Year	England	Wales	Scotland	Northern Ireland
1987	Broads Pennine Dales Somerset Levels and Moors South Downs West Penwith	Cambrian Mountains	Breadalbane Loch Lomond	
1988	Breckland Clun North Peak Suffolk River Valleys Test Valley	Lleyn Peninsula	Central Borders Machair of the Uists, Benbecula, Barra & Vatersay Stewartry	
1993	Avon Valley Exmoor Lake District North Kent Marshes South Wessex Downs South West Peak	Radnor Ynys Mon	Cairgorm Straths Central Southern Uplands Western Southern Uplands	Antrim Coast, Glens and Rathlin Moounres and Slieve Croob West Fermanagh & Erne Lakeland
1994	Blackdown Hills Cotswold Hills Dartmoor Essex Coast Shropshire Hills Upper Thames Tributaries	Clwydian Ranges Preseli	Argyll Islands Shetland Islands	Slieve Gullion Sperrins

2. REVIEW OF EVIDENCE

2.1 Overview of evidence types

Evidence can take a number of forms, and the nature of the evidence has important implications for its interpretation and the value that can be placed upon it. In particular, evidence can concern one of three types of agri-environment scheme effect (following the classification used within the European Commission's Common Monitoring and Evaluation Framework (CMEF): outputs, results, and impacts.

> "Following the causal chain of the "intervention logic", the "hierarchy of indicators" starts from the *inputs*, i.e. the financial and/or administrative resources which will generate the *outputs* of programme activities pursuing *operational or measures-related objectives*. The subsequent *results* are the immediate effects of interventions, which should contribute to the achievement of the *specific objectives*. *Impacts* should contribute to reaching the *overall objectives* of the programme which, in a well designed programme, must correspond to the previously identified needs."
>
> (Commission of the European Communities - CEC, 2005)

Outputs are 'activities directly realised within programmes… the first step towards realising the operational objectives of the intervention' (CEC, 2005). For agri-environment schemes, these are the immediately quantifiable results of land entering schemes – i.e. the areas and types of land brought into the schemes. Examining outputs can give an indication of the extent to which scheme resources are tackling environmental priority areas and issues, including the extent to which they capture the sites of highest natural value and/or those facing the greatest environmental degradation or threat of loss or damage. However, output data does not in itself give evidence of the generation of environmental benefits; rather, it can indicate the potential of the schemes to generate benefits, on the basis of the area and types of land that have become involved, which should then be subject to enhanced management.

Results are the next stage of effects: 'the direct and immediate effects of the intervention. They provide information on changes in, for example, the behaviour, capacity or performance of direct beneficiaries' (CEC, 2005). This is information which indicates the likely success of schemes in delivering against key goals. So, for example, results might include the length or proportion of degraded hedgerows which have been subject to restoration works under schemes, or the extent to which schemes have achieved enhanced grassland management practices within agreements, or the lengths of new paths created. As with output data, this kind of information does not itself constitute a measurement of environmental change (or more accurately, *additionality* relative to the *counterfactual*)[12]. However, it gives an indication of the extent to which such change might reasonably be expected, based upon independent assessment of the quality and extent of changed farm management practices on land under agreement.

[12] Additionality is the extent to which a policy delivers something different, over and *above what would have happened in its absence* (a scenario referred to in economics as 'the counterfactual')

Impacts correspond to 'the ***benefits*** of the programme both at the level of the intervention but also more generally in the programme area.' (CEC, 2005). This refers to the ultimate effects of these schemes upon the environment – i.e. improved habitat extent and quality, changes in numbers and distribution of species, enhanced landscape character, improved quality of historic features and improved public enjoyment from access to the countryside.

In general, it is much easier to determine the outputs and results of agri-environment schemes than to determine their impacts. This is because:

- outputs and results can be detected within the first few years of land entering schemes, whereas many impacts take much longer to become apparent;
- it can be difficult sometimes to be sure that measured changes in environmental variables (e.g. species declines or increases) are directly attributable to the schemes themselves, and not due to other changes in the environment;
- there are methodological challenges in appropriately quantifying the nature and degree of environmental impacts from schemes – for example, measuring the extent of improved landscape quality, or the increase in public enjoyment produced by new access routes and areas (which depends not only upon supply, but on public demand and usage).

Bearing these points in mind, the monitoring and evaluation of UK agri-environment schemes has generally focused upon providing two quite distinct types of evidence, in respect of scheme performance.

1. Short-term evaluations (generally 1-3 years) of both the adequacy and appropriateness of scheme prescriptions and targeting, based upon independent expert judgement using scheme uptake data, as well as early field assessments and examination of agreement contents and the negotiation process. This provides evidence mainly about scheme outputs and results, within a timescale that enables learning and feedback to improve scheme design and operation. It does not in itself provide much quantified evidence of scheme impacts except in respect of activities which have almost immediate environmental outcomes (most commonly, the restoration of landscape features or creation of new habitats).

2. Longer-term (usually 5 years+) assessments of environmental change relative to a baseline period, which are focused primarily upon trying to identify scheme impacts. Unlike the shorter-term studies, they generate less information that can be used directly to improve scheme performance, partly because of their long-term nature (most schemes are subject to review and modifications at least every 5 years), and partly because of the difficulty of understanding fully the causal relationships between scheme content and observed changes, in many cases. Nevertheless, they provide the best available means, to date, for measuring the ultimate environmental consequences of the schemes.

In view of the characteristics of these two approaches, it is perhaps unsurprising that formal policy evaluations have tended to rely most heavily upon the first approach, particularly as the schemes developed, through the 1990s. As a result, the second type of approach has been more prevalent in academic and independently-generated research activity (including research by NGOs), although it was also an important element in the monitoring in respect of ESAs. However, in response to some critical

reviews of agri-environment scheme evaluation, in recent years (e.g. Kleijn & Sutherland, 2003), policy makers have increased the attention given to this kind of study.

In respect of the focus of this project, we view the term 'environmental benefit' to be largely coincident with environmental impact, within the CMEF terminology. However, we also believe that in respect of some areas and aspects of environmental benefit, results can also be a valid source of evidence. These considerations have influenced the range of studies identified and used in our analysis, such that we use more information from the second type of study, as described above. In addition, we have identified and analysed information which goes beyond scheme monitoring and evaluation, to include research that has investigated the wider context of the relationship between agricultural management and environmental impacts, wherever this is relevant to the likely impact of the schemes themselves.

2.2 Types of study examined

Bearing the discussion in 2.1 in mind, the following typology has been used to classify the findings of the studies identified in this review into numbered categories, recognising that some studies may include more than one of these types of evidence:

1. Underpinning research, helping to identify and understand environmental impacts of agriculture and possible solutions to negative impacts;
2. Development and testing of solutions in terms of effectiveness and suitability for inclusion in agri-environment schemes;
3. Evaluation of agri-environment schemes based on data collection; this may be at 'scheme' or 'option' level, or a combination of both;
4. Expert opinion, where data are unavailable or as an adjunct to data-based evaluation;
5. Modelling, which may be undertaken as an addition to any of the above.
6. Case studies.
7. Reviews

In practice, most studies reported here fall into categories 2 and 3. Category 3, in particular, has been covered as comprehensively as possible. Key studies under categories 1 and 2 have been drawn on where appropriate to complement the results from scheme evaluations. Whilst not evaluating the results of the schemes directly, these studies have the advantage of being able to conform to formal experimental designs with controls, and so provide valuable evidence of the potential benefits of scheme options.

The modelling and case study categories are particularly pertinent where sufficient time has not elapsed for meaningful data to be collected against which to assess the impact of the scheme, as in recent evaluations of the impact of Environmental Stewardship (Boatman *et al.*, 2007a, b; Vickery *et al.*, 2008). They have been particularly valuable for evaluation of impacts on resource protection issues (protection of soils and water quality), where direct evidence of benefits is largely lacking due to the recent addition of resource protection as an objective in agri-environment schemes, and the difficulty of obtaining such evidence in the short term.

2.3 Collation and assessment of evidence

A search of both the published and 'grey' literature was carried out using a range of sources, including standard bibliographic search engines, websites of Government departments and agencies, and websites of relevant research institutes. In addition, unpublished reports of scheme evaluations were provided by LUPG members.

Evidence has been assembled separately for each of the current primary agri-environment scheme objectives:

- Biodiversity (wildlife) conservation
- Protection of the historic environment
- Maintenance of landscape quality and character
- Promotion of public access
- Natural resource protection (soil and water quality)

Also, some evidence for the first of the secondary objectives (Higher Level Scheme only), flood management, has been assembled, but evidence for the second of these, genetic conservation, appears to be lacking.

Some of these objectives have been in existence far longer than others. The earliest schemes were primarily focused on wildlife, landscape and, in some cases, historic environment objectives, with others being added at later dates. Accordingly, the amount of information available varies enormously, with the greatest number of studies directed at biodiversity benefits and the least information available for those objectives introduced most recently (resource protection and the HLS secondary objectives). The largest amount of information applies to England, but monitoring and Research results for England were comprehensively reviewed by Ecoscope (2003). Hence, in agreement with the project sponsors, this review concentrates on evidence reported after the Ecoscope report for England, although some key studies conducted pre-2003 are still included where relevant. Most of the evidence available relates to the 'classic schemes', i.e. ESAs and to a lesser extent, the national schemes preceding Environmental Stewardship in England, and Tir Cynnal in Wales because of the time lags inherent in monitoring and evaluation programmes. Monitoring of the national schemes in Scotland is also still at an early stage.

Studies have been assessed according to the categories enumerated above, and also through methodological criteria which influence the quality of the results, e.g. experimental design, geographical coverage, degree of replication, use of controls, availability of baseline data for evaluations, spatial scale etc.

The results of the evidence survey were initially assembled according to the above criteria into a set of tables. Different tables were designed for each evidence type, incorporating the information relevant in each case. Two types of tables have been produced:

1. **Results tables**: these are for summaries of the key points emerging from each study, cross-referenced to the characterisation tables (see below). Only one type of table is used for all categories.

2. **Study characterisation tables**: these capture information about the type and quality of evidence sources. There is a different table for each category (excluding evidence categories 1 and 7).

Study characterisation tables have not been included for category 1 because the volume of evidence of this nature is very large, and it would have been too time

consuming to tabulate all sources under this category. Key examples of underpinning research are included in the synthesis and interpretation of the evidence base where they are particularly relevant to the development of agri-environment options, but this type of evidence has not been exhaustively reviewed. Reviews were not included in study categorisation tables because the format was not appropriate for this type of source material; accordingly they have been summarised in 'results' tables only.

These tables then formed the basis for the textual review of evidence that follows. The tables themselves are reproduced in Appendix 6.

2.4 Summary of agri-environment scheme evaluation approaches in the UK

Whilst agri-environment schemes are now found throughout Europe, evaluation of their impact has been variable. Concern about the effectiveness of agri-environment schemes, based on a specific example in the Netherlands, led to a call for more scientific evaluations (Kleijn *et al*., 2001). A review of the value of schemes in conserving biodiversity concluded that in many of the 62 evaluation studies reviewed, the research design was inadequate to reliably assess the effectiveness of the scheme (Kleijn & Sutherland, 2003). The authors concluded that there were insufficient scientifically robust evaluations to allow a general judgement of the effectiveness of agri-environment schemes in Europe. This is not necessarily the case in the UK however, where the amount of effort expended in research and evaluation has been much greater than in other EU member states. Nearly half (29 out of 62) of the studies reviewed by Kleijn & Sutherland derived from the UK, and the general quality of the evaluations was higher than in other member states.

Monitoring and evaluation of agri-environment schemes in the UK has been carried out since their inception in 1987. Initially, each ESA had a monitoring programme based around pre-defined objectives and performance indicators (PIs). Baseline surveys were carried out and followed up by one or more re-surveys. In England, these surveys concentrated on vegetation change, though some bird surveys were also carried out. In Wales and Scotland, landscape, historic/archaeological features and (in Wales) public access were also monitored, whilst in Northern Ireland, ground beetles and spiders were monitored in addition to plants.

A comprehensive review of monitoring of English agri-environment schemes was carried out by Ecoscope (2003). In England, a theme-based programme of monitoring was adopted from 2000 for both CS and ESA schemes. Carey *et al*. (2002) carried out a baseline survey of CS and also compared the quality of land in CS and the English countryside as a whole. They also estimated the national extent of broad and priority Habitats in CS, and Carey *et al*. (2005) did the same for ESAs. Re-surveys include Critchley *et al*. (2004), Kirkham *et al*. (2006a, b, c), and other themed reports include Bickmore *et al*. (2004, 2004a), McLaren *et al*. (2002), and Manchester *et al*. (2005a, b), among others. A comprehensive programme of monitoring was carried out on the Arable Stewardship Pilot Scheme (ADAS, 2001a) and follow-up surveys were carried out in 2002 (Bradbury & Stephens, 2004; Browne & Aebischer, 2003). The pilot Entry Level Scheme was evaluated by Boatman *et al*., (2004), and an evaluation of the operation of Environmental stewardship during the first two years was carried out by Boatman *et al*. (2007). However, the timescale was such that these evaluations were not able to measure impacts directly.

In Wales, monitoring up to 1999, including baseline reports for each ESA, were reviewed by Anon (1999). Subsequent follow-up evaluations were produced for each ESA (ADAS 2000, 2000a, b, d; 2001, 2002, 2002a, Ardeshir, 2005)). Two re-survey

reports have been produced for Tir Gofal, though analysis is still at an early stage (Anon., 2006; Jackson, 2007). A number of additional surveys have been carried out on specific topics

A comprehensive and co-ordinated programme of ESA monitoring was carried out in Scotland (Bell *et al*., 2007; Cummins *et al*., 2007, 2007a; Nolan *et al*., 2007, 2007a; Pearce *et al*., 2007; Scott *et al*., 2007, 2007a; Truscott *et al*., 2007). A five year monitoring programme of the CPS, RSS and Organic Aid Scheme began in 2004, but only a preliminary report has so far been produced (Scott Wilson Scotland Ltd., 2008).

Biological evaluations of the Northern Ireland ESAs have also been carried out, with re-surveys ten years after baseline surveys (McAdam *et al*., 2004a, 2005), but so far only baseline monitoring of the Countryside Management Scheme has been performed (McAdam *et al*., 2004).

In addition to the scheme evaluations, many of the prescriptions adopted in the UK are based on research which has already demonstrated positive benefits (e.g. Sotherton (1991); Boatman *et al*. (2000); Morris *et al*. (2004); Stoate *et al*. (2004); Walker *et al*. (2007)), though evaluation within the scheme itself is also important to ensure that these benefits are carried through when implemented within the scheme concerned.

2.5 Biodiversity & habitats

2.5.1 Arable

This section covers prescriptions specifically associated with arable land, i.e. those generally labelled in scheme literature as 'arable options'. The biodiversity benefits of grass margins or buffer strips are largely dealt with in the section on boundaries, trees and woodland, though some of the studies described below did include comparisons with grass margins.

2.5.1.1 Background

The development of agri-environment scheme measures for the conservation of arable biodiversity was recently reviewed by Grice *et al*. (2007).

Arable options were poorly represented in the early agri-environment schemes in England. Stubbles were represented in the South Downs, West Penwith, Breckland and Cotswold Hills ESAs, conservation headlands were available for support in the South Downs, Breckland, Clun South Wessex Downs and Costwold Hills ESAs, and Breckland also offered the option of uncropped wildlife strips. The latter option was developed for conservation of rare annuals characteristic of cultivated land, as a result of trials carried out at Weeting Heath and Tuddenham in the early 1980s (Grice *et al*., 2007). Grass margins were also supported in a number of English ESAs. However, until 2002, the only options available nationally on arable land in Countryside Stewardship were grass margins and beetle banks, though two 'special projects' were established, one for cirl buntings in Devon (see Box 1 and Appendix 1), and one for stone curlews in central southern England.

Concern about declines in widespread species associated with arable land, such as brown hare, farmland birds, and arable flora, led to the setting up of the Arable Stewardship Pilot Scheme (ASPS) in 1998 in two areas: an arable dominated area in East Anglia (EA), and a mixed farming and livestock area in the West Midlands (WM). A wide range of options was tested in the ASPS, and as a result, overwintered stubbles, wild bird seed mixtures, pollen and nectar mixture and conservation headlands were available for support under CS from 2002. These have been carried forward into Entry Level Stewardship, with the addition of 6m uncropped cultivated margins (the equivalent of the uncropped wildlife strips first introduced in the Breckland ESA), skylark plots, beetle banks and some cropping options for stock rearing areas including undersown spring cereals, cereals for whole crop silage and brassica fodder crops, both the latter being followed by stubbles. A range of enhanced versions are available under HLS, plus fallow plots for ground-nesting birds.

Arable options were absent from Welsh ESAs, but when introduced in 1992, Tir Cymen included rough grass margins and uncropped wildlife margins, and further prescriptions were added in 1996, including unsprayed cereal crops, unsprayed cereal crop with wildlife stubble, conversion of improved grassland to spring sown cereal or oilseed rape, and unsprayed root crops for winter grazing. A wider range of options was included as voluntary options in Tir Gofal, including unsprayed cereal, rape and linseed crops, winter stubbles with limited winter grazing, undersown spring cereals or oilseed rape, unsprayed root crops followed by winter grazing, rough grass margins, uncropped fallow margin and wildlife cover crops. Tir Cynnal requires that 5% of the area under agreement must qualify as semi-natural wildlife habitat, and if the percentage is lower than this, options are available to create new habitat. These

include leaving uncropped margins on cereal land, creating grass margins on cereal land, establishment of wild bird cover crops, and establishment of unsprayed root crops.

Arable options were also poorly represented in Scottish ESAs. Cairngorm Straths had a voluntary Tier 2 option to manage some arable land to encourage birds by limiting use of agrochemicals and providing protection from cultivation at nesting time. The Argyll Islands and Shetland Islands ESAs also had optional provisions to protect bird nests from cultivation on up to 4ha of in-bye land, and there were special arrangements for managing machair in the ESA covering the Uists, Benbecula, Barra and Vatersay. The CPS offered a wider choice; in addition to grass margins and beetle banks, conservation headlands, extensive cropping (traditional crop rotations) and management of cropped machair were supported. These were carried forward into RSS, with the addition of options for spring cropping and unharvested crops.

There were no arable options in the original ESAs in Northern Ireland; options for retention of winter stubble, spring cereals and wild bird cover and conservation cereals were however introduced to ESAs and the Countryside Premium Scheme under the 2000-2006 NIRDP.

2.5.1.2 Key sources of evidence

Aebischer *et al*. (2000) and Grice *et al*. (2007) reviewed the evidence for the impact of the CS special project on stone curlew and cirl bunting.

Hassall *et al*. compared invertebrate populations in arable margin options in the Breckland ESA with fully sprayed headlands.

A substantial programme of monitoring was carried out for the ASPS over the three years following its introduction (ADAS, 2001). The programme was well designed, and sets a benchmark for this type of evaluation. There were three stages to the methodology. Firstly indicators were chosen which were expected to respond to the scheme prescriptions, and predictions of resonses made to construct hypotheses against which the outcomes could be measured. Then species abundance and distribution were measured on land with agreements and non-agreement (control) land, with sampling regimes designed to reflect the scale at which target groups were expected to range. Thus vertebrates were sampled at the whole farm scale, whilst insects and plants were sampled at the level of individual options. Observed outcomes were then compared with the expectations from stage 1. In retrospect, the monitoring period was not sufficiently long for the prescriptions to have their full impacts, nevertheless some interesting results emerged for plants and some invertebrate groups. Results for birds were less clear cut, but follow-up surveys after five years provided evidence of benefits to a wide range of species (Bradbury & Stevens, 2004; Browne & Aebischer, 2003).

The value of cereal field margin options in CS and ESAs in England for the conservation of arable flora was assessed by Walker *et al*. (2007). Samples for each option were assessed in 20km squares in eight regions, selected at random from squares containing the least common option in the CS/ESA database, and compared with conventionally managed crops on the same farms. Sampling was stratified at 1, 3 and 5m from the edge of the field margins.

Several studies have investigated the benefits of alternative margin options for bumblebees, and Pywell *et al*. (2006) monitored use of CS margins by bumblebees in 2004.

A number of small scale surveys of arable plants and birds have also been made in Wales. Kay (1997) assessed arable flora at selected Tir Cymen sites. The assessment consisted of making species lists and Domin scores from sites in

appropriate options. Some control sites were monitored, but this does not seem to have been done systematically. Similar surveys of sites in the Gower were undertaken by Woodman (1998, 2007). The first survey covered Tir Cymen sites, but only three out of 33 sites monitored were not in scheme options. The second survey appears to have consisted of simple records of rare species found at the sites visited. It is presumed that these were in Tir Gofal, though this is not stated in the report, and it is not clear that any comparisons were made with non-scheme sites.

Bosanquet (2003) surveyed bryophytes on arable land in South Wales. The thirty fields surveyed included seven fields in Tir Gofal in Carmarthenshire, but no comparisons were made between fields in and not in the scheme.

Thomas *et al*. (2000) monitored birds on seven farms in Tir Cymen in comparison with seven control farms not in the scheme. However, no firm conclusions could be drawn as the sample size was too small and arable crops (one of the target habitats) were not present until the final two visits. Williams (2002) carried out a baseline survey of numbers of breeding lapwings on Tir Gofal farms, and Lucas (2005) surveyed lapwings on two farms undertaking Tir Gofal options to encourage breeding lapwing.

In addition to evaluations of scheme agreements, there is a large body of research on the development and testing of agri-environment options. Some key studies are noted below.

2.5.1.3 Key findings

2.5.1.3.1 Habitat general

2.5.1.3.2 Plants

Critchley *et al*. (2004) described the results of vegetation assessments carried out during the evaluation of the ASPS. Vegetation was sampled from 294 sites representing overwinter stubble, spring fallow, undersown cereals, grass leys, wildlife seed mixtures, conservation headlands, no fertiliser conservation headlands, sown and naturally regenerated grass margins, and uncropped cultivated margins. Vegetation characteristics and differences between options were broadly as predicted, based on a review of research in the published literature. Habitat option had a notable effect on the vegetation in naturally regenerated options, though the amount of variation accounted for was small, and cultivation and year of succession had larger effects. However, habitat establishment method had a much stronger effect in sown options, and the variation accounted for was greater than other factors. The authors conclude that, in contrast with attempts to enhance botanical diversity of grasslands, creation of simple habitats on arable land is relatively straightforward because the effects of the establishment method are readily predictable, especially where cover is sown. However, other factors such as geographical region, landscape and soil properties affected naturally regenerated vegetation, and need to be taken into account in setting objectives.

Walker *et al*. (2007) compared uncropped cultivated margins (UCM), spring fallow (SF) and cropped conservation headlands (CH), with and without (CH(NF)) fertiliser. Species diversity, including rare species, was highest in UCM, followed by SF and CH(NF) margins, with little difference between CH and cereal crop controls. Agri-environment option management accounted for more variability than uncontrolled environmental factors. Soil properties had a greater effect at uncropped than in cropped sites. It was concluded that the agri-environment schemes are effective in conserving arable plants, but better targeting, improved control of competitive

species and more research on the habitat requirements of rare species could improve efficacy.

Kay (1997) found considerable variation in the Tir Cymen sites monitored, often as a result of different interpretations of the management required. He recommended some changes to the prescriptions to clarify certain aspects of the management requirements. Woodman (1998) recorded some relatively uncommon arable species at Tir Cymen sites. There appeared to be little difference in species richness or species type between the main options surveyed, uncropped wildlife margins and unsprayed cereal crops. However, in a further survey in 2006, he concluded that the uncropped fallow margins had greatest diversity and frequency of threatened species, followed by unsprayed cereals with winter stubbles. Other options surveyed were wildlife cover crop and unsprayed roots.

Bosanquet (2003) highlighted the impact of early autumn ploughing in preventing reproduction of bryophytes, and suggested that conservation of the bryophyte flora was best achieved using Tir Gofal's "retention of winter stubbles in cereal, rape and linseed crops" option. Undersowing was found to be detrimental to arable bryophytes.

2.5.1.3.3 Invertebrates

Hassall *et al*. (1992) compared uncropped wildlife strips (UWS), conservation headlands (CH) and conventionally managed (fully sprayed, FSH) headlands in the Breckland ESA in terms of their impacts on spiders, carabid beetles and Heteroptera in. The total abundance of each group was highest in UWS, followed by CH, and least in fully sprayed headlands. Species diversity for spiders and Heteroptera, and species richness for all three groups, was higher in UWS and CH than FSH, and the management regimes also affected the community structure.

Invertebrate groups were monitored in the ASPS at the level of individual options (ADAS, 2001a). Groups monitored included bumblebees, plant bugs (Hemiptera: Heteroptera and Auchenorhynca), ground beetles (Carabidae) and sawflies. Results are summarised in Table 2.1, in terms of changes in abundance, species richness and community composition. Plant bugs and sawflies responded to several options, but responses of carabid beetles were less than expected.

Pywell *et al*. (2005) reported the ASPS results for bumblebees in detail. They concluded that wildlife seed mixtures had the potential to provide the best foraging habitat for bumblebees, provided that preferred forage species, such as red clover, were introduced. Further research was needed to refine and target the management prescription.

Although not tested in the pilot scheme, arable options eventually rolled out into CS included a pollen and nectar mixture, based on research carried out in the interim (e.g. Pywell *et al*., 2003). Pywell *et al*. (2006) the CS prescriptions for six metre margins sown with grasses or grasses and wildflowers, and pollen and nectar mixtures, with conventionally managed cereal crops as controls. Bumblebees were more abundant in July and August on pollen and nectar mixtures than in the other prescriptions. They were virtually absent from the cereal crop. Species richness was higher on margins sown with pollen and nectar mix or wildflowers.

Carvell *et al*. (2007) report on a multi-site experiment to test prescriptions available in Environmental stewardship, including conservation headlands, uncropped cultivated margins, 6m grass strips, grass/wildflower mixture and pollen/nectar mixture. Uncropped margins sown with mixtures containing nectar- and pollen-producing plants were more effective in providing bumble bee forage than margins sown with a

grass mix, allowed to regenerate naturally or managed as conservation headlands. However, the abundance of flowers in the legume – based pollen and nectar mix was low in May and June, and declined after the second year. The diverse mix of native wildflowers had lower average densities of bumblebees, but had the potential to provide foraging resources throughout the season.

Parish & Sotherton (2004a) found that butterflies and bumblebees were 15 and 40 times more abundant respectively in game crops in Scotland than in conventional crops. Although these were not specifically managed under agri-environment prescriptions, the results suggest that wildlife seed mixture – type prescriptions are likely to provide good habitat for pollinators in summer as well as providing seed sources for birds in winter.

2.5.1.3.4 Birds

Both the special projects targeted at birds in the Countryside Stewardship scheme were deemed highly successful (Aebischer *et al*., 2000). Fallow plots were created for nesting stone curlews under special project provisions, and also on set-aside. Grice *et al*. (2007) reported that the number of stone curlew pairs in central southern England had risen from 63 in 1997 to 103 in 2005. The total breeding population in England exceeded the BAP target of 300 pairs by 2005. The impact of the special project for cirl buntings is recorded in the case study (Box 1).

Few positive responses were observed in the first two years of the ASPS. However, there were higher numbers of granivorous passerines on scheme sites compared to controls in both winters in the West Midlands, and a positive effect on breeding lapwing across both pilot areas although the effect was much stronger in East Anglia. Starlings, greenfinch, house sparrow and reed bunting also showed positive effects in the breeding season.

After five years, consistent responses between ASPS regions were recorded at the field scale for wintering birds (Bradbury *et al*., 2004). Granivorous passerines were present at higher densities on stubbles than other field types, and densities were also high on fields with wildlife seed mixtures and (in the West Midlands) fields with livestock and those with game feeders. Skylarks also showed a positive response to stubbles in both pilot areas. Assessments at the farm scale showed higher winter bird counts on scheme farms than control farms in the West Midlands, but not in East Anglia. It was considered that the apparent lack of response at the farm scale may be due to the levels of set-aside stubbles and game crops present on the East Anglian control farms.

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Table 2.1 **Summary of results for invertebrates from the ecological evaluation of the Arable Stewardship Pilot Scheme (ADAS, 2001a). A = abundance, SR = species richness, CC = change in community composition. +: increase; -: decrease; ~ no response; ns = non-significant; responses in both pilot areas except EA = East Anglia only; WM = West Midlands only. Where no symbol is shown, the group was not assessed.**

Option	Bumblebees	Plant bugs	Ground beetles	Sawflies
Stubbles	A+ (EA)	A+ (WM); SR+ (EA), CC	A(larvae)+	A(adults)+; A(larvae)-
Undersown spring cereals		~	~	A(adults)+(ns)
Cereal crop margins	~	A+ (WM); CC (WM)	~	A~; SR+
Grass margins	~	A+; SR+; CC	A~; CC	SR+
Beetle banks			A~; CC	SR+
Uncropped strips	A+	A+; SR+(EA); CC (EA)		A+; SR+
Wildlife seed mixtures	A+	A+; SR+; CC		SR+

In summer, presence/absence of both field and boundary-nesting species in the ASPS pilot areas at a field scale after five years was associated with the presence of certain ASPS options; many of the responses could be explained in terms of provision of nest sites or food resources (Stevens & Bradbury, 2006). For example, the option for overwintered cereal or linseed stubble followed by shallow spring cultivation and spring/summer fallow was strongly selected by skylark, lapwing and yellow wagtail, a result that is consistent with expectations from previous research (Sheldon, 2002; Bradbury & Bradter, 2004; Donald, 2004). Skylarks, along with linnets, also selected fields that had contained wildlife seed mixtures or stubble in the previous winter. This is supported by the work of Gillings *et al*. (2005), who showed that the density and population trend for skylarks was related to the amount of cereal stubble in survey squares. Options incorporating reduced pesticide inputs (conservation headlands and low input cereals) were selected by whitethroats, greenfinches, chaffinches, yellowhammers, and corn buntings, again in agreement with previous research (Brickle *et al*., 2000; Hart *et al*., 2006), though reed bunting showed a negative association with these options. Grass margin options were selected by boundary nesters such as whitethroats and yellowhammers, and also by skylarks.

Despite these positive associations at the field scale, most species showed no response at the farm scale. Farm scale effects were found for only three species in East Anglia and one in the West Midlands. It is hypothesized that this may be a result of territoriality during the breeding season, precluding local increases in density in response to options at the levels implemented in the pilot areas.

Separate surveys of grey partridges were also undertaken in 2002 (Browne & Aebischer, 2004; Bradbury *et al*., 2004). Densities of adult grey partridges fell in both regions, with no difference between scheme and control farms, but breeding productivity showed a two-fold increase on agreement farms relative to controls, so the autumn density declined less on agreement farms in East Anglia (-30%) than on control farms (-60%).

To assess the effectiveness of over-winter seed provision by agri-environment schemes in Scotland, Perkins *et al*. (2008) compared bird use of patches of seed-bearing crops with that of other seed-rich habitats on 53 farms in eastern Scotland over three winters. Seed-bearing crops were the most frequently selected habitat, and held 28% of birds of the 10 species recorded. Outside schemes, cereal stubble was the most selected habitat and held 44% of birds.

BOX 1. CASE STUDY: CIRL BUNTING AND SKYLARK

The cirl bunting and the skylark are bird species that are dependent on farmland habitats in the UK, and have some similarities in their ecology. Both eat seeds and other vegetable matter in the winter and feed their chick on invertebrates during the breeding season. However, cirl buntings breed in hedgerows whilst skylarks nest on the ground and prefer open ground well away from hedges and trees. Skylarks are widely distributed across the majority of the UK, whilst cirl buntings are currently confined to a small area of the south Devon coastline. The status of the cirl bunting has been improved by the targeted implementation of tailor-made agri-environment scheme options; can the same be achieved for widely distributed species such as the skylark?

Research has shown that in winter, cirl buntings foraged preferentially in stubble or fallow fields, especially those with a high incidence of broad-leaved weeds. In summer, most losses of chicks were due to starvation or predation, but growth rates and survival were higher later in the season when Orthoptera (grasshoppers and bush crickets) became more important in the diet. The research programme suggested that a reduction in mixed farming, fewer winter stubbles and intensification of grassland were important factors in the decline of cirl buntings. Accordingly, a 'Special Project' was developed under the Countryside Stewardship (CS) scheme, including options for maintenance of low-intensity grassland, overwinter stubbles following low-input barley, and grass field margins. Between 1991 and 2004, over 214 CS agreements were established in the area of Devon where cirl buntings were still present, at least 152 of which had special project options. In total, over 1000 ha of special project land was entered into the scheme over this period. Cirl buntings showed a rapid response to the provision of options under CS, with numbers increasing to an estimated 453 pairs in 1998 and 697 in 2003. Although set-aside stubbles probably contributed to the recovery, Peach *et al*. (2001) showed that numbers had increased by 83% in tetrads with land entering CS between 1992 and 1998, compared to only 2% on adjacent land with no CS. Cirl buntings used SP stubbles to a significantly greater extent than the conventional stubbles, which contained fewer weed seeds. SP stubbles also contained greater densities of broad-leaved weeds.

Skylarks prefer to nest in low vegetation, and their decline is thought to be largely due to the change from spring to autumn-sown crops, coupled with increased intensity of production resulting in taller, denser crops which have restricted the number of breeding attempts and lowered breeding productivity per year as a result. Research undertaken during the "SAFFIE" project showed that breeding success and productivity of skylarks in winter wheat fields could be increased through the adoption of small undrilled patches. These undrilled patches are now available as 'Skylark plots' in Entry Level Stewardship. In winter, skylarks show a preference for set-aside and stubble fields. Gillings *et al*, (2005) showed that skylarks declined by 34% on squares with no stubble, compared with only 13% on squares with stubble present. Where stubbles exceeded 20 ha/km^2, skylark population trends were stable or increasing.

With the exception of EF6 (overwintered stubbles), taken up by over 9% of agreement holders, uptake of ES options likely to benefit skylark is currently very low. Skylark plots were only taken up by 1.5% of agreement holders. The amount of overwinter stubble is equivalent to 6.4% of the area of the holdings on which this option is situated. It is possible that the decline of skylark may be exacerbated by the abolition of set-aside, and if this is to be offset, the provision of seed-rich stubbles as provided for cirl buntings under the 'Special Project seems likely to be the best solution. In addition, methods of increasing the uptake of skylark patches need to be investigated to improve productivity during the breeding season.

A fuller account of this case study is given in Appendix 1.

In addition to the evidence from evaluations summarised above, arable options for birds are supported by a wealth of research carried out to test the options prior to implementation within schemes, to provide further evidence of their efficacy after implementation, or to investigate potential improvements. These studies show that, at least under the conditions applying during the research, the options can provide measurable benefits for farmland bird species.

Evidence for the impact of agri-environment schemes on birds has been fully reviewed by Vickery *et al*. (2004; 2008). In terms of arable options, research on the value of stubbles and the development of undrilled patches to increase the breeding success of skylarks is described in Box 1 and Appendix 1. Increased productivity of grey partridges in response to conservation headlands was described by Rands (1985, 1986; see also Sotherton, 1991 for a review of evidence of the benefits of conservation headlands). A number of studies have recorded the benefits of game crops and wild bird seed mixtures as a source of food for granivorous birds in winter (Boatman & Stoate, 2002; Henderson *et al*., 2004; Stoate *et al*., 2003, 2004; Parish & Sotherton, 2004b), and Parish & Sotherton (2004a) found that up to 80 times as many birds were recorded from game crops in the summer as from conventional crops, suggesting that the similar wildlife seed mixtures could also provide good summer feeding habitat. Sheldon *et al.* (2004) showed that lapwing nest survival was higher in the option for overwintered stubbles followed by spring/summer fallow in the ASPS scheme, than on conventionally managed fields.

Thus the options currently available in ES have a sound evidence base to indicate their effectiveness. Unfortunately however, uptake of most of these options in ELS has been low (Boatman *et al*., 2007a, b), and Vickery *et al*. (2008) concluded that with current uptake patterns the scheme is unlikely to deliver for a number of species. They recommended adjusting the points allocation system for ELS to encourage greater uptake of 'in-field' options, and considering how the effectiveness of options could be increased. These issues have been addressed in the recent ES review of progress, which incorporates an action plan to implement a programmes of changes over the next few years.

2.5.1.3.5 Mammals/other fauna

There is little direct evidence from evaluations of the effects of arable options within agri-environment schemes on mammals. However, brown hares were included in the ASPS evaluation. They showed no response to the ASPS during the initial evaluation. However, in winter surveys carried out in 2002, after the scheme had been running for five years (Browne & Aebischer, 2004), the density of brown hares had increased by 35% on scheme farms in East Anglia, but declined by 18% on non-scheme farms. In contrast, numbers remained stable in the West Midlands on both scheme and non-scheme farms.

2.5.1.4 Summary and conclusions

Monitoring of the Arable Stewardship Pilot Scheme showed that it was relatively easy to generate desired vegetation with relatively predictable results especially if sown, after just a few years of changed management. However, region, soil type and landscape affect outcomes, especially for naturally regenerating vegetation. Arable options can be successful in conserving rare arable flora, especially uncropped cultivated margins, and this was supported by surveys of arable options in Tir

Cymen. However, ASPS monitoring showed that targeting is needed to maximise effectiveness.

A study in the Breckland ESA indicated that uncropped wildlife strips were most valuable for invertebrates (carabids, spiders, plant bugs), followed by conservation headlands. Results from ASPS monitoring showed varying responses between management options, invertebrate groups and pilot areas. Plant bugs and sawflies responded to several options, but responses of carabid beetles were less than expected. Bumblebees were more abundant in pollen and nectar mixtures than in other options tested in July and August, but the abundance of flowers in the legume – based pollen and nectar mix was low in May and June, and declined after the second year. A diverse mix of native wildflowers may be more effective in providing foraging resources throughout the season. Wildlife seed mixtures and game crops also attract large numbers of foraging bumblebees.

The CS special projects for stone curlew and cirl bunting were both highly successful, showing that targeted management with advisory support can achieve excellent results. For more widespread bird species, monitoring of the ASPS showed a range of positive responses in both winter and summer after five years at the field scale, broadly in line with those expected from research findings, though farm scale responses were limited. Most arable options are supported by a strong research base showing measurable benefits for the species concerned. Thus options currently available in ES have a sound evidence base to indicate their effectiveness. Unfortunately however, uptake of most of these options in ELS has been low, and some adjustments to the scheme to increase uptake of 'in-field' options are likely to be necessary if targets for widespread farmland bird species are to be achieved. These issues are being addressed through an action plan emerging from the recent ES review of progress.

Numbers of hares responded strongly to the implementation of ASPS in East Anglia, but showed little change in the West Midlands.

In conclusion, there is strong evidence of the effectiveness of the range of arable options now included in agri-environment schemes, from both evaluation and research sources. The ASPS evaluation was highlighted as an excellent example of evidence-based policy making, and provided evidence of benefits arising from implementation of options within a scheme (as opposed to evidence acquired under more controlled conditions in research projects). It also illustrated some of the difficulties inherent in carrying out such evaluations and interpreting the resulting data. In particular, it is important that sufficient time is given for management prescriptions to take effect, and the results need to be set in the context of the surrounding landscape and existing management.

2.5.2 Lowland grassland and other grazed habitats

2.5.2.1 Background

The conservation of species-rich grasslands has been a key objective of agri-environment schemes since their inception. For convenience, this section included grassland in both the lowlands and uplands, with the special case of hay meadows addressed as a case study (Box 2, Appendix 2). Options may support creation (including reversion from arable), management, or restoration of different types of grassland.

All ESAs had some grassland interest. Swash (1007) described the grassland resource in ESAs throughout the UK, including areas of permanent grassland in each ESA, and the presence/importance of different grassland types of high botanical interest in ESAs in England and Wales. Prescriptions for different types of grassland included in English ESAs are summarised in Table 2.2.

Table 2.2 Summary of tiers relating to grassland types in English ESAs (from Ecoscope, 2003).

Stage	ESA	Improved grass	Wet grass	Calcare-ous grass	Other grass	Upland grass	Grass reversion
I	Broads	√	√		√		√
	Pennine Dales					√	
	Somerset Levels & Moors	√	√		√		
	South Downs		√	√			√
	West Penwith	√			√		
II	Breckland		√				√
	Clun		√		√		√
	North Peak					√	
	Suffolk River Valleys	√	√		√		√
	Test Valley	√	√		√		√
III	Avon Valley	√	√		√		√
	Exmoor	√				√	
	Lake District		√			√	
	North Kent Marshes	√	√				√
	South Wessex Downs	√		√	√		√
	South West Peak					√	
IV	Blackdown Hills	√			√		
	Cotswold Hills	√			√		√
	Dartmoor	√				√	
	Essex Coast	√	√				√
	Shropshire Hills	√				√	
	Upper Thames Tributaries	√	√		√		√

Hay meadows were a particular objective of the Cambrian Mountains, Radnor, and Preseli ESAs in Wales. Prescriptions for herb-rich grassland were included in all

Scottish ESAs and grassland was also a focus of the West Fermanagh and Erne Lakeland ESA in Northern Ireland.

The Countryside Stewardship (CS) Scheme in England had prescriptions for lowland and upland hay meadows, culm pastures, upland in-bye and rough grazing, chalk and limestone grassland, and for re-creating grassland on cultivated land.

Grassland options within Entry Level Stewardship (ELS) in England consist of management of permanent pasture with low or very low inputs (setting maximum rates of Nitrogen fertiliser and organic manure), management of rush pastures and an option for mixed stocking, with additional basic options in the LFA for enclosed rough grazing and moorland/rough grazing. Two, four or six metre wide buffer strips on grassland are also supported.

A wide range of options is available under Higher Level stewardship (HLS) including maintenance, restoration or creation of species-rich, semi-natural grassland, wet grassland for breeding waders or for wintering waders and waterfowl, semi-improved or rough grassland for target species, and enhanced buffer strips on intensive grassland. Supplements for hay-making, raised water levels and inundation grassland are also available. A further range of options including arable reversion, options to prevent erosion/run-off and seasonal livestock removal are available for resource protection (see section 2.9)

In Wales, Tir Cymen had options for upland grassland, old pastures and hay meadows, marshy grassland, limestone grassland, partially improved grassland and hay meadow reversion. Tir Gofal allows for management of unimproved and semi-improved grassland as well as improved grassland. There are also options to convert improved to semi-improved grassland, restore semi-improved grassland and to manage improved grassland for breeding lapwing or overwintering wildfowl. Under Tir Cynnal, there is an option for reducing inputs to revert improved grassland to semi-improved grassland.

The Countryside Premium Scheme (CPS) in Scotland had options for creation and management of species-rich grassland as well as management of grassland for birds. Its successor, the Rural Stewardship Scheme (RSS) had similar options, though with several different management prescriptions to manage grassland for birds.

Under the Northern Ireland agri-environment schemes, all grassland is included in the agreement. There are separate specifications for the management of improved and unimproved grassland, species-rich dry grassland, calcareous and wet grassland, species-rich grassland cut for hay, and bird breeding, feeding and nesting sites.

Critchley *et al*. (2003) summarised management practices in the 188 grassland options identified within agri-environment schemes throughout the UK at the time of the review (Burke & Critchley, 2001). Where conservation of landscape character was the main aim, relatively high inputs were allowed. However, in 65% of the options, inorganic fertiliser was prohibited, and in most of the remainder only small applications of around 25-50 kg N/ha/annum were allowed. Farmyard manure was permitted in 61% of the options, generally up to 12.5 t/ha/annum. Lime was generally prohibited. Stocking density was also often limited, with maxima ranging from 0.15 LU/ha in Welsh uplands to 1.4 LU/ha on improved grassland. Timing and method of haymaking were also specified where relevant, and maintenance of high water levels required in wet grassland.

2.5.2.2 Key sources of evidence

A programme of repeat botanical sampling of grasslands was carried out in the ESAs and some other schemes, with the focus on changes in botanical composition of grasslands. Methods are described by Critchley (1997) and Critchley *et al*. (2003). Where possible, comparisons were made with non-scheme land, but suitable comparisons were not always available. Sampling methods ranged from single quadrats to multi-scale records from larger plots. Critchley *et al*. (2003) reviewed the results for ESAs throughout the UK.

Since the review by Critchley *et al*. (2003), Manchester *et al*. (2005) surveyed upland grassland in the Shropshire hills, Blackdown hills and South West Peak ESAs in 2003, and compared the findings to a baseline survey in 1994/5.

Carey *et al*. (2002, 2005), compared the botanical status of agreement land in CS and ESAs in England with that of the wider countryside using data from the Countryside Survey.

Hewins *et al*. (2005) compared the condition of BAP priority grassland types within and outside agri-environment agreements in England, but were unable to assess change as there were no comparable baseline data.

Jackson (2007) reported the results of a re-survey of sites in Tir Gofal in 2006-7, which were originally surveyed in 2001-2. 181 grassland sites were re-surveyed, including 11 marshy grassland, 81 unimproved acid grassland, 78 semi-improved grassland, and 11 unimproved limestone grassland.

Kirkham *et al*. (2006) surveyed arable reversion agreements over five years old in English ESAs and CS agreements

A comprehensive programme of monitoring of Scottish ESAs over ten years recorded changes in botanical composition in fixed quadrats on ESA agreement land (Cummins *et al*., 2007; Nolan *et al*., 2007a; Bell *et al*., 2007; Scott *et al.*, 2007a; Nolan *et al*., 2007; Pearce *et al*., 2007; Truscott *et al*. 2007; Scott *et al.*, 2007). Herb-rich grasslands were monitored in eight of the nine ESAs.

McAdam *et al*. (2004a) re-surveyed in 2003, habitats under ESA agreement in Northern Ireland that were previously surveyed in 1993. Ten hay meadows, 28 wet pastures, 11 limestone grassland sites and 14 unimproved grassland sites were surveyed.

2.5.2.3 Key findings

2.5.2.3.1 Habitat general

2.5.2.3.2 Plants

Results of monitoring schemes for hay meadows have been reviewed in a case study (Box 2, Appendix 2). Some evidence for effectiveness of agri-environment schemes in conserving hay meadows is also available from Switzerland. Hay meadows are the most widely adopted measure to conserve biodiversity in the Swiss agri-environment scheme. Knop *et al*. (2006) found that species richness and evenness were significantly higher on meadows in the scheme than for those outside the scheme. Results for grasslands in general and grazed swards are summarised below.

Critchley *et al*. (2003) summarised the results of botanical monitoring of ESAs in England, Wales, Scotland and Northern Ireland, in the context of the UK Biodiversity Action Plan. For semi-natural grassland, quality had been maintained in 22 out of 38 samples (i.e. sets of quadrats or plots), and rehabilitation (i.e. improvement in condition) was found in nine samples. However, condition had declined in seven samples. Seventeen samples included non-agreement land, and change was detected in nine of these. For six samples, non-agreement land showed indications of deterioration whilst condition of samples from agreement land was maintained or improved. These included acidic and calcareous heath in Breckland, fen meadow in the Test valley, calcareous grassland in the Clwydian ranges and wet grassland in Radnor. In a further sample in West Fermanagh and Erne Lakeland ESA, there was no change on non-agreement land, but the agreement land showed improvement. However, there were two samples where improvements occurred on non-agreement land but not on land under agreement (South Wessex Downs and Central Borders).

Of 30 improved and semi-improved grassland samples, nine showed signs of restoration towards Habitat Action Plan (HAP) communities. Comparisons with non-agreement land had been made for six samples. For two of these (Test Valley damp semi-improved pasture; West Fermanagh and Erne Lakeland improved), there was no change on agreement land but the non-agreement land had deteriorated. However, on three (two in Radnor and one in South Downs ESAs), condition had improved on non-agreement land but not on land under agreement.

Most evidence of rehabilitation was found where fertiliser rates had been reduced or where none was permitted, e.g. Breckland, South Downs, Radnor, Suffolk River Valleys fen meadow, Pennine Dales, West Fermanagh and Erne Lakeland. Changes in grazing intensity were also associated with restoration or rehabilitation (e.g. Suffolk River valleys, Breckland, Broads ESAs). However, inappropriate grazing levels had apparently contributed to deterioration in Central Borders and South Downs (undergrazing) and Radnor (overgrazing). Evidence of deterioration due to under- or over-grazing was also found in Tir Cymen sites (Reaston & Knightbridge, 1997; Knightbridge *et al*., 1998). The hydrological regime is also important for wet grasslands. For example, prolonged winter and early spring flooding had caused deterioration of grasslands in the Somerset Levels and Moors ESA..

Where restoration or rehabilitation are objectives, the availability of propagules is important. In most cases of arable reversion, signs of development towards target communities were only found where species-rich seed mixtures had been sown. Restoration and rehabilitiation are long-term processes, and full restoration is unlikely within the ten-year period of most agri-environment agreements.

Overall, Critchley *et al*. (2003) conclude that the quality of semi-natural grassland as a whole is likely to be maintained under agri-environment agreements, but that successful rehabilitation, restoration and re-creation will depend on appropriate fertiliser, grazing and hydrological regimes, with re-introduction of target species where they are absent.

BOX 2. CASE STUDY: HAY MEADOWS

The area of semi-natural, or unimproved grasslands has declined dramatically during the twentieth century. Habitat Action Plans drawn up for grasslands include "Upland hay meadows" and "Lowland meadows". Upland hay meadows (UHM) correspond with National Vegetation Classification (NVC) community MG3, and it is estimated that there are currently less than 1000 ha in England and 100 ha in Scotland. Lowland meadows (LM) include three NVC communities: MG5, MG4 and MG8. There are 5-10,000 ha of MG5 grassland in England and Wales and 2-3,000 ha in Scotland, less than 1500 ha of MG4 flood meadow in England, and less than 1000 ha of MG8 in England and Wales, and 6-800 ha in Scotland.

The maximum total area under options specific to meadow management in the English ESAs was over 10,000 ha in 2004, two thirds of which was in the Pennine Dales ESA. In the same year, there were around 6,400 ha in LM, and *c*. 6,800 ha under UHM options of Countryside Stewardship (CS) Scheme in England. Although there were over 15,000 ha in options for maintenance, restoration or creation of species-rich grassland (SRG) in HLS by May 2008, the hay-making supplement was claimed on only just over 2000 ha. In Wales, there were 1,711 ha of Unimproved Neutral Grassland in Tir Gofal in January 2007. The total area of land in options for herb-rich pasture in Scottish ESAs peaked at over 7,900 ha in 2002. The area under the option for SRG management in the Scottish Countryside Premium Scheme (CPS) was highest in 2001 at around 5,300 ha. In its replacement, the Rural Stewardship Scheme (RSS), the area under SRG management eventually reached over 11,000 ha in 2006, when the scheme closed. In Northern Ireland, there were 546 ha under SRG hay management prescriptions in 2007. It is not known what proportion of grassland that corresponds to priority habitats is within agri-environment agreements, but it has been estimated that there were 1053 ha of Lowland Meadow priority habitat and 183 ha of Upland Hay Meadow priority habitat in English ESAs, and land in CS and ESAs had a much higher proportion of high value grassland than English countryside as a whole.

In a review of semi-natural grassland contributions to HAP targets agri-environment schemes throughout the UK, outcomes ranged from deterioration through maintenance to rehabilitation. Most instances of rehabilitation or restoration occurred where no fertiliser was allowed or applications were reduced on scheme entry. A survey of the condition of BAP priority grasslands in England within and outside agri-environment schemes found that only 7% and 18% UHM and LM respectively were in favourable condition, but pass rates were higher for LM and UHM in agri-environment agreements than for those not in agreements. In the Pennine Dales ESA, species richness increased between 1987 and 1995, but declined again between 1995 and 2002, though sites under Tier 2 management fared better than those in Tier 1. However, in the Dartmoor ESA, most sites increased in conservation value between 1995 and 2003. A survey of wet grassland in three ESAs suggested that the scheme was least maintaining hay meadows within the Avon Valley and the Upper Thames tributaries, but in the Somerset Levels and Moors ESA, land managed under the raised water level tier was increasingly characterised by species adapted to conditions of high soil moisture content.

Overall, the quality of semi-natural grassland as a whole is likely to be maintained under agri-environment agreements, but successful rehabilitation, restoration and re-creation will depend on appropriate fertiliser, grazing and hydrological regimes, with re-introduction of target species where they are absent, after sward conditioning by harrowing etc. This will require a pro-active approach, which may need significant input from an adviser. Agri-environment schemes are probably making a substantial contribution to the UK target area for maintenance of lowland meadows, and the UK target area for restoration and re-creation of lowland meadows is possibly being met. Surveys of upland hay meadows differed between different areas of the country, some indicating improvements and others suggesting declines in condition within ESAs. For the benefits achieved so far to be maintained, and hopefully enhanced, it is essential that a substantial proportion of sites, including the best examples, are transferred to new schemes when previous schemes come to an end.

A fuller account of this case study is given in Appendix 2.

Some further surveys have been carried out since the review by Critchley *et al*. (2003). The results of a survey of upland grassland in the Shropshire Hills, Blackdown hills and South West Peak ESAs in 2003 suggest that relevant performance indicators were currently being met and that characteristic vegetation communities were being maintained (Manchester *et al*., 2005). At the plot scale, the mean number of species recorded was similar to the baseline survey (1994/1995) in the Blackdown Hills and Shropshire Hills ESAs, but had declined in the South West Peak ESA. However, at the scale of the quadrat 'nests' within plots, there was a reduction in the mean number of species between years for all of the ESAs, though numbers of species did increase at some sites. Declining species richness in the Blackdown Hills may have been due to a lack of management or abandonment of land marginal for agriculture. In the Shropshire Hills, there was an increase in species characteristic of acid conditions. It was suggested that this may reflect a reversion towards more desirable calcifugous grassland types as a result of restrictions on lime application imposed under ESA management. [13]However, changes in the South West Peak ESA sample are more difficult to interpret.

Carey *et al*. (2002) found that CS land had a higher proportion of grassland habitats, and was more likely to be typical of low fertility situations, than in the countryside as a whole. The total number of species recorded in lowland grassland in the scheme was also higher than for the countryside in general. Carey *et al*. (2005) also found that ESAs had a lower proportion of improved grassland and a higher proportion of semi-improved grasslands than the countryside as a whole.

Hewins *et al*. (2005) surveyed the condition of around 500 BAP priority grasslands in England with post-1980 survey data demonstrating that they supported grassland of high botanical quality at the time of survey, and compared sites within and outside agri-environment schemes. Grasslands within agri-environment agreements were almost twice as likely to be in favourable condition as those outside agreement, and this relationship was statistically significant. Land in agreement was also more likely to achieve condition assessment targets for several individual attributes, in particular herb cover and positive indicator species. However, cause and effect could not be attributed as there were no previous suitable data for comparison, and a subsequent re-survey would be needed to examine relative changes in condition on scheme and non-scheme land.

Jackson (2007) reported the results of monitoring of sites in Tir Gofal in 2006-7. Compared to 2001-2, rank grasses and undesirable species, but also desirable species decreased in abundance in marshy grasslands and in acid grasslands, with an increase in *Molinia caerulea* in acid grasslands. However, on limestone grasslands there was little change in desirable species and a decline in undesirable species and rank grasses. On semi-improved grasslands the mean abundance of both desirable and undesirable species increased, but rank grasses showed little change. The authors considered that monitoring needed to be carried out over a longer time period in order to corroborate early-recorded trends. They also noted that only limited analysis had so far been carried out, and more detailed analysis was required to evaluate the results fully.

Final reports of a ten year monitoring programme for the Scottish ESAs were published in 2004 (Cummins *et al*., 2007; Nolan *et al*., 2007a; Bell *et al*., 2007; Scott *et al.*, 2007a; Nolan *et al*., 2007; Pearce *et al*., 2007; Truscott *et al*. 2007; Scott *et al.*,

[13] Under HLS, a more positive view of the use of lime is now taken on certain types of semi-natural grassland.

2007). In the Argyll Islands, Breadalbane, Central Borders, Loch Lomond, the Machair and Stewartry ESAs, there was no change in species richness and/or botanical diversity of Tier 1 herb-rich grassland plots. There were too few long term plots to assess changes under Tier 1 in the Shetland Islands. In Cairngorm Straths, the species richness in Tier 1 declined.

On Tier 2 plots the number of species and/or diversity decreased between the initial and follow-up surveys in the Argyll Islands, Breadalbane, Central Borders, the Machair ESA (non-machair grasslands), Shetland Islands, and Stewartry probably due to reduced grazing. In Loch Lomond and machair grasslands there were no significant overall changes in species richness or diversity but some indication of an increase in species adapted to lower grazing levels. Tier 2 grasslands were not monitored in Cairngorm Straths. Overall, the results consistently indicated that herb-rich grasslands in the ESAs were undergrazed as a result of Tier 2 grazing prescriptions.

In the West Fermanagh and Erne Lakeland ESA of Northern Ireland, there was no significant change in plant species number between 1993 and 2003 in samples of unimproved grassland, wet pasture, hay meadow or limestone grassland (McAdam *et al*., 2004a). Analysis of grassland soils indicated a significant decrease in mean soil phosphorus between assessments on wet pasture, limestone grassland and hay meadows in ESA agreements.

In addition to prescriptions for the maintenance and rehabilitation of existing semi-natural grasslands, and restoration from improved swards, many schemes also have options for the creation of grassland from cultivated land (often termed arable reversion). However, development into swards approaching semi-natural grassland in species composition and quality attributes is a slow process. Kirkham *et al*. (2006) found that even after 12 years, grassland created from arable land had significantly lower plant species richness, forb cover and number of 'high value' species than semi-natural grassland comparisons. Critchley *et al*. (2002) examined the relationships between plant species richness, functional type and soil properties of grasslands in ESAs, and considered the implications for grassland restoration. Soil P and pH had the strongest relationship with the plant community variables investigated. The role of P concentration in limiting grassland restoration is highlighted as a topic in need of further research.

In addition to evaluations of the impact of scheme management on the botanical status of grasslands, there is a large body of research on grassland management undertaken to inform the development and refinement of agri-environment prescriptions. Recommendations for managing grassland have been brought together in the Lowland Grassland Management Handbook (Crofts & Jefferson, 1999). The conservation management of upland hay meadows has been recently reviewed by Jefferson (2005).

Davies *et al*. (2006) investigated factors affecting the creation of species-rich grassland. The target was a sward approximating to MG5 grassland, achieved in most treatments by 2004, 11 years after sowing. Early cutting followed by aftermath grazing were initially most effective, provided cuttings were removed, but continuous sheep grazing produced the most diverse sward by 2004.

Pywell *et al*. (2007) investigated methods of enhancing the diversity of species-poor grassland. Turf removal is effective but expensive. Alternatively, measures to reduce productivity for 3-5 years can be followed by harrowing and seeding to encourage establishment of desired species.

Stevenson *et al*. (2007) described how the results of evaluations of grassland in agri-environment schemes and research results had informed the development of Environmental Stewardship in England, especially HLS. They noted that agreements were more likely to be successful when clearly targeted at sites of high value or potential, when objectives were explicit, and when there was enough information to assess scheme progress. Therefore, four principles were enshrined in the Higher level strand of the new scheme: (1) A baseline survey (the Farm Environment Plan) had to be submitted with the application; (2) there would be clear eligibility criteria based on sward, physical and soil properties; (3) there would be a clear link between the agreement options and the environmental objectives; (4) there would be greater flexibility for prescriptions to be tailored to the site. In relation to the last condition, prescriptions are only described generally in the handbook, and the detail of implementation is agreed between the participant and the Natural England adviser. A set of decision keys based on scientific evidence were produced to allow non-specialists to identify land of high value or potential.

Critchley *et al*. (2007) also described how the results of the specific case of the evaluation of the Pennine Dales hay meadows were taken into account in developing options in the HLS (see case study, Appendix 2).

2.5.2.3.3 Invertebrates

There were no significant differences in numbers of carabid beetles caught in grassland habitats in West Fermanagh and Erne Lakeland ESA in Northern Ireland between 1993 and 2003 (McAdam *et al*., 2004a). Numbers of spiders also changed little between 1993 and 2003 in areas managed under options for unimproved grassland and limestone grassland, but fell in wet pasture and hay meadows, probably as a result of an unusually dry summer. Changes in species composition on unimproved grassland suggested a more diverse vegetation structure. In wet grassland, there was a positive shift in community structure towards species characteristic of wetlands. Changes in species composition in hay meadows and limestone grassland indicated that these communities were being maintained.

In Switzerland, species richness of grasshoppers and bees was higher on hay meadows in the agri-environment scheme than conventionally managed meadows, but there was no difference for spiders. Species evenness was higher in scheme meadows for bees but not spiders or grasshoppers (Knop *et al*., 2006). Aviron *et al*. (2007) found that grasslands within and outside the Swiss scheme differed more in the composition of butterfly communities than number of species. The effect of the scheme on butterfly diversity varied according to field slope and orientation and the amount of prescription land and other semi-natural elements in the landscape.

2.5.2.3.4 Birds

Most evidence relating to the impact of grassland options in agri-environment schemes on birds relates to wet grassland, which is reviewed in section 2.5.5.3.3.

Williams (2002) surveyed Tir Gofal sites where the option to manage improved grassland for breeding lapwing, by limiting stocking rates during the breeding season, had been implemented. Only two out of 30 areas covered by this prescription held breeding pairs. There were, however, breeding pairs adjoining prescription land on four farms and a further three farms within Tir Gofal had two or more breeding pairs.

Lucas (2005) surveyed two farms undertaking Tir Gofal options for breeding lapwing in the Vale of Glamorgan. Five pairs nested on one farm and ten on the other. Breeding was confirmed at both sites.

Corncrakes have been a particular target of agri-environment schemes in the northern and western isles of Scotland, with considerable success. Further details are given in Box 3.

2.5.2.4 Summary and Conclusions

It appears that agri-environment schemes have been successful in targeting higher quality grassland, at least in England. Evidence from a large number of evaluations of ESAs in England, Wales, Scotland and Northern Ireland indicated that the quality of semi-natural grassland as a whole is likely to be maintained under agri-environment agreements, but evidence of enhancement was found on only a minority of sites.

Successful rehabilitation, restoration and re-creation will depend on appropriate fertiliser, grazing and hydrological regimes, with re-introduction of target species where they are absent. However, in contrast to arable options, which with a few exceptions constitute taking land out of cropping and managing on the basis of well defined and researched prescriptions, grassland options involve adjusting the management of areas that still have a production role, this creating tensions between competing objectives. For example, low or no fertiliser inputs are generally required to maintain or enhance plant diversity and retain communities of conservation interest, but this inevitably reduces productivity.

There also needs to be an understanding of appropriate levels grazing levels, with examples recorded in ESAs in England and Wales of deterioration due to both undergrazing and overgrazing. Undergrazing was a consistent feature of ESAs in Scotland. In Northern Ireland however, communities were maintained or enhanced. For hay meadows, cutting dates are important, with deterioration evident where cutting was carried out too early.

There was some evidence that generic prescriptions were increasing uniformity of swards, especially hay meadows, with improvements in the poorer sites but some deterioration in high quality sites.

Lessons from evaluations of schemes and supporting research were drawn on in the design of Higher Level Stewardship in England. Agreements need to be more targeted, have clear objectives and be flexible, to allow management to reflect the needs of the individual site.

There has been little wide-scale monitoring of the impacts of grassland management in agri-environment schemes on birds (except for wet grassland, see section 2.5.5.3.3), but there is good evidence that management schemes to enhance habitat for corncrake have been successful in achieving a substantial increase in population (though not range) of this species in its core range in Scotland.

BOX 3. CASE STUDY: CORNCRAKES

O'Brien *et al*. (2006) documented changes in the population of corncrakes in the northern and western isles of Scotland. Corncrakes suffered a long-term decline throughout the 20th century as a result of changes in mowing practices following the introduction of mowing machines, and later the introduction of silage making, resulting in high chick mortality. By 1990 they were largely confined to the northern and western Scotland. A survey in 1978-79 revealed between 700 and 746 singing corncrakes (Cadbury, 1980); this number had declined to 574 in 1988 (Hudson *et al*., 1990). In 1992, measures to conserve corncrakes were introduced as the Corncrake Initiative; firstly paying farmers to delay mowing and mow from the field centre outwards to allow birds to escape, then later including the provision of tall cover early and late in the season. The recovery programme provides an example of concerted action by Government agencies and Non-Government Organisations, similar to that undertaken for cirl bunting (Box 1, section 2.5.1.3.4) and stone curlew section 2.5.1.3.4) in England. The conservation schemes included the Machairs and Argyll Islands ESAs, CPS and RSS options, but also other initiatives run by the RSPB, SNH, and the National Trust for Scotland. Initially, virtually all land managed for conrcrakes was provided through the Corncrake Initiative, on nature reserves or management agreements administered by the RSPB, but increasing amounts were supported by agri-environment schemes, leading to a five-fold increase in the area of land within schemes between 1992 and 2003.

O'Brien *et al*. (2006) report on the results of annual monitoring in the core range, and a national survey in 2003. In the core of the range, 1040 singing males were found in 2004, compared to only 446 in 1993, having increased in ten of the 11 years since then (Figure C1). The national survey revealed 832 males in 81 National Grid squares, compared to 480 in 83 squares in 1993. Between 1993 and 2003, more than 70% of corncrakes in the core area occurred in kilometre squares in which conservation schemes were implemented. A range of methods including population modelling, radiotracking were used to assess the impact of corncrake friendly management. It was concluded that the estimated changes in breeding productivity likely to be associated with the observed changes in mowing management could account for the change in population trend. It is difficult to determine the individual effects of specific schemes, nevertheless in combination they appear to have resulted in a considerable increase in the corncrake population.

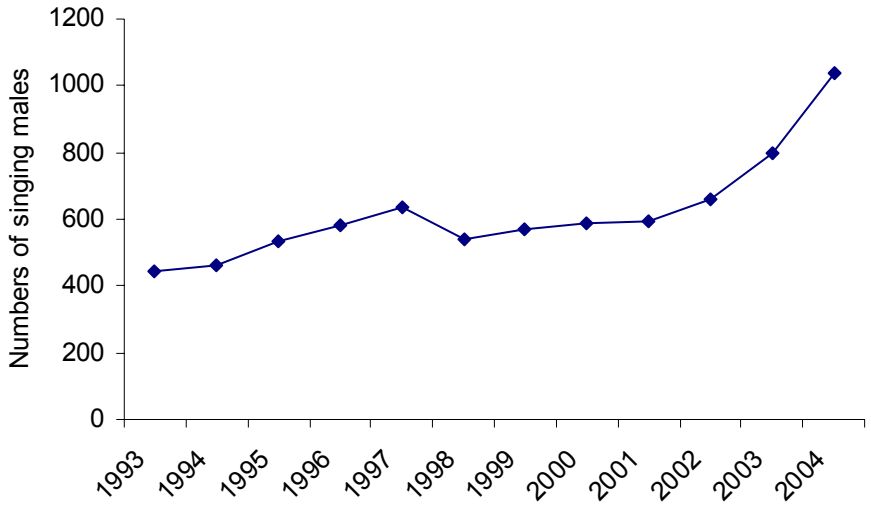

Figure C1 Number of singing male corncrakes recorded in the core range, 1993-2004.

2.5.3 Moorland and lowland heath

2.5.3.1 Background

The conservation and restoration of heather moorland and associated habitats have been key objectives of most agri-environment schemes covering the uplands of the UK. Semi-natural upland grass communities were considered in the previous section and the special case of hay meadows in Appendix 2. The current section considers the habitats of the open moorland, though fauna characteristic of the mosaic of habitats at the moorland edge are also included. Lowland heaths are also included.

Prescriptions relating to moorland management were included in the North Peak, Exmoor, Lake District, South West Peak, Dartmoor and Shropshire Hills ESAs in England, all Scottish ESAs except the Machair of the Uists and Benbecula, Barra and Vatersay, and the Antrim Coast, Glens and Rathlin, Sperrins, and Slieve Gullion ESAs in Northern Ireland. Lowland heath was a focus of the Breckland, Blackdown Hills and West Penwith ESAs.

CS in England contained prescriptions for regenerating suppressed heather and heather on improved land, management of heather moorland and enhanced heather moorland, with supplements for stock removal, heather burning and upland commons management. There were also options for re-creating, maintaining and enhancing lowland heath. In ELS, there is only one simple option for management of moorland and rough grazing, but in HLS, creation, restoration and maintenance of moorland and lowland heath are all supported, as well as maintenance and restoration of rough grazing for birds, and there are supplements in the uplands for shepherding, seasonal livestock exclusion, moorland re-wetting and management by burning, cutting or swiping.

Both Tir Cymen and Tir Gofal in Wales contained management guidelines for moorland and heathland, however, Tir Cynnal does not contain any options specifically addressed towards heathlands.

The CPS in Scotland included options for stock disposal, muirburn and bracken control, and also for management of coastal heath. In addition to similar options, the RSS also included prescriptions for moorland management, bracken eradication and management of lowland heath. Both CPS and RSS included moorland management plans.

The current agri-environment schemes in Northern Ireland include management prescriptions for heather moorland and rough moorland grazing.

2.5.3.2 Key sources of evidence

A considerable number of evaluations have considered the impacts of agri-environment schemes in the uplands for England, Scotland, Northern Ireland and Wales.

In England there are a number of studies that evaluate ESA schemes at various sample unit spatial scales, covering higher plants, moorland, birds and hay meadows. These include evaluations focused on the Dartmoor ESA (Kirkham *et al.,* 2005, 2004), the Pennine Dales ESA (Critchley *et al.,* 2004), the Shropshire hills, Blackdown Hills and South West Peak ESAs (Manchester *et al.,* 2005a). A study was also made of BAP Broad and Priority Habitats under ESA agreement for all England that provides a broad assessment of upland schemes and compares ESA

with CSS (Carey *et al.,* 2005). Calladine *et al*. (2002) assessed the effects of grazing management under CS on black grouse in the north of England.

In a study of lowland heath by Hewins *et al.* (2007), a random sample of English non-SSSI lowland heathland stands, both inside and outside of agri-environment agreements, was surveyed during 2005 and 2006 to provide baseline information on condition. The schemes included Environmentally Sensitive Areas (ESA), the Countryside Stewardship Scheme (CSS) and the Wildlife Enhancement Scheme (WES).

Several local studies have been conducted in England. These include a five year monitoring programme to determine the impact of a Countryside Stewardship agreement on a range of plant communities on Bodmin Moor (Dale, 2002), botanical monitoring of the rough land management tier in the West Penwith ESA (Toogood *et al*., 2006), monitoring of the effects of the Exmoor ESA moorland restoration tier on heather at Winsford allotment (Darlaston & Glaves 2004), and a follow-up to earlier surveys of moorland birds on Exmoor (Geary 2002).

In Wales, heather moorland was the subject of monitoring in the Cambrian Mountains ESA in Wales (ADAS, 2000; Ardeshir, 2005); Tir Cymen (Knightbridge *et al*., 1998) and Tir Gofal (Jackson, 2007). Heather moorland was also monitored in eight of the nine ESAs in Scotland (Bell *et al*., 2007; Cummins *et al*., 2007, 2007a; Nolan *et al*., 2007a, b; Scott *et al*., 2007; Truscott *et al*. 2007). In Northern Ireland, botanical and invertebrate monitoring were carried out in West Fermanagh and Erne Lakeland ESA (McAdam *et al*., 2004a), and in the Antrim Coast, Glens and Rathlin, the Sperrins and Slieve Gullion ESAs (McAdam *et al*., 2005).

2.5.3.3 Key findings

Upland heather moorland forms the subject of a case study (Box 4, Appendix 3), but as it is the key habitat in the uplands and covers a large area, parts of the review section from the case study are reproduced here.

2.5.3.3.1 Habitat general

Upland heathland

Much of the monitoring of heather moorland has been concerned with the effect of management on the amount and condition of heather itself. A synopsis of the outcomes is given below.

Ecoscope (2003) reported on the results of assessments in all six of the English ESAs containing heather moorland. In Dartmoor, it was concluded that in the period up to 1997 the quality of the moorland vegetation had continued to decline, and levels of uptake were well below target for the scheme. In Exmoor, an assessment covering the period 1993-1996 indicated that the amount of heather moorland in the scheme was substantial, but condition appeared likely to be deteriorating, and the extent of heather remained threatened. In the Lake District, target uptake for heather moorland was not achieved, but the quality of the vegetation was not assessed.

BOX 4. CASE STUDY: HEATHER MOORLANDS

There have been considerable losses of heather moorland in recent decades. Currently there are around 270,000 ha of heather moorland in England, 80,000 ha in Wales, up to 69,500 ha in Northern Ireland and between 1,700,000 and 2,500,000 ha in Scotland. The British Isles hold a large proportion of the European area of this habitat which is of international importance. Losses or degradation of heather moorland have occurred through agricultural land improvements, including ploughing, reseeding, liming and fertilisation at lower elevations, and drainage and moorland 'gripping', heavy grazing by sheep (and, in certain areas, red deer and cattle), poorly managed burning and afforestation. The time of year and length of grazing period, stock shepherding, supplementary feeding, heather management by burning or swiping, and control of scrub and bracken are all important management factors influencing the vegetation composition and condition of heather moors.

A high proportion of upland heather moorland is under agreement in agri-environment schemes. In ESAs and the CS in England in 2004/5 there were total around 150,000 ha in moorland management options, 128,000 ha in moorland enhancement options and 19,000 ha in recreation, reversion and regeneration options. By 2008 there were over 61,000 ha in the moorland option of Entry Level Stewardship (ELS), and 53,000 ha in maintenance or restoration options of Higher Level Stewardship (HLS). It was estimated that there were 1,700 ha of upland heathland priority habitat, including mosaics under CS agreement in England in 1998-1999 and 24,812 ha of upland heath priority habitat in ESAs, with a further 25,183 ha in mosaics. There were 35,423 ha of high mountain and upland heath in Tir Gofal in January 2007. In 2000, over 3,500 ha were receiving payment for bracken control and over 41,000 ha for muirburn under ESA or CPS options in Scotland, and by 2006 the area under bracken control options had increased to over 5,700 ha under RSS. The option covering the largest area of ESAs was stock control, peaking at over 122,000 ha in 2001. Nearly 200,000 ha were receiving payment for moorland management in the RSS in 2006. Over 50,000 ha of heather moorland were being managed under agri-environment schemes in Northern Ireland by 2007.

Results of agri-environment schemes have been mixed, with little or no improvement in the quantity or condition of heather found in many of the evaluation surveys carried out. There have however been some marked successes reported in all parts of the UK, notably in the Exmoor ESA in England, early results from Welsh schemes, Breadalbane and Shetland ESAs in Scotland; West Fermanagh and Erne Lakeland, and Slieve Gullion ESAs in Northern Ireland. The conclusions of monitoring reports reveal a number of common principles which have emerged independently from the evaluations. It is clear that change in heather amount and condition is related to stocking rate, and that high stocking rates invariably lead to deterioration in status of the heather. However, the vulnerability of habitats to degradation varies, with dry heath able to withstand higher levels of grazing pressure than wet heath and blanket bog. Another factor is the amount of grass present in the vegetation. A positive feedback operates whereby heavy grazing leads to invasion of heather stands by grass, which attracts the sheep and so encourages increased grazing, which in turn leads to further increases in grass cover. Thus, increasing heather cover is most difficult where it is already low, and in such sites complete withdrawal of grazing for a period may be the only way to achieve recovery. Other factors encouraging higher levels of grazing are supplementary feeding, and the presence of tracks or roads. In more recent schemes, measures have been introduced to allow shepherding and fencing, as well as allowing for complete removal of stock in winter. It remains to be seen how effective these measures are, but the successes in some schemes noted above show what can be achieved.

A fuller account of this case study is given in Appendix 3.

The Shropshire Hills were monitored between 1994 and 1997. The monitoring indicated that heather was suppressed at the start of the scheme, but lack of repeat survey data meant that a full assessment of the impact of the scheme could not be made. In the South West Peak, an assessment between 1993 and 1996 revealed that the uptake target for moorland had been achieved, and grazing pressure had declined, but the condition of heather was not assessed.

Overall, Ecoscope (2003) concluded that "some ESA grazing prescriptions may not maintain moorland habitats in favourable condition, and may not be effective in enhancing condition when habitats are in unfavourable condition. Grazing rates therefore need to be fixed on a flexible basis, which takes into account the type of habitats involved, their condition, conservation and landscape objectives and farming business".

Since the Ecoscope report, upland heath appears to have received less attention in terms of evaluation in relation to its area than grassland in English agri-environment schemes. Kirkham *et al*. (2005) reported on monitoring of moorland vegetation between 1994 and 2003. Grazing pressure on heather increased over the survey period, particularly between 1994 and 1997, and *Calluna* cover declined. Grazing pressure was too high to prevent decline of heather due to suppression, and there was little evidence of enhancement from a degraded starting point. It was concluded that maintenance management under Tier 1 prescriptions may not bring about restoration, and that Tier 2 or even off-wintering of stock may be necessary.

Darlaston & Glaves (2004) assessed the effects of the Exmoor ESA moorland restoration tier on heather at Winsford allotment between 1993 and 2003. In contrast to the results from Dartmoor, stocking rates were substantially reduced in summer and no stock were grazed in winter. Heather grazing index (percentage grazed shoots) had fallen from 88% in 1993 to 29% in 2003, and heather cover and height had also increased. Mean heather cover increased from 5% in 1993 to 29% in 2003. However, it was noted that even with good regeneration, recovery was slower than scheme targets allowed for, and this would need to be taken into account in setting indicators for success under the Higher Level Scheme.

In the first generation of agri-environment schemes in Wales (ESAs and Tir Cymen), monitoring of both the Cambrian Mountains ESA and Tir Cymen showed a rapid overall improvement in heather condition on existing heathland under agreement in response to reductions in stocking density (Anon, 1998b). Heather (*Calluna vulgaris*) on non-agreement land was grazed significantly more than that on land under ESA agreement. There was a significant increase in the amount of heather grazed near to tracks and paths and when there was more grass in the sward. This was also found in the later assessment in the Cambrian Mountains (see below). A quarter of heathland sites in Tir Cymen recorded increases in *Calluna* cover of between 15-20%. On some sites, however, these beneficial changes were accompanied by an increase in less palatable vegetation, especially purple moor grass and bracken. Lessons from this early monitoring were taken forward in the design of the Tir Gofal scheme. A greater range of habitat types was recognised, and greater discretion was given to project officers to allow for the development of site specific grazing regimes. Provisions were also made for bracken control and scrub management, and increased emphasis was placed on the need for controlled burning and away-wintering of stock.

In 2000, a re-survey of 20 heather moorland sites previously surveyed in 1997 was undertaken in the Cambrian Mountains ESA in Wales (ADAS, 2000a). Half the sites were under ESA agreement and half were not. The grazing index was lower on agreement land than on non-agreement land; however, although the grazing index had not increased between 1993 and 1997, it had increased between 1997 and 2000. The grazing index was correlated with the number of stock. It was lower on dominant heather than sub-dominant, and was negatively related to the cover of heather. It was concluded that sheep are drawn to graze where grass is present among the heather, and grazing of the adjacent heather leads to suppression. Therefore, more precision may be needed in setting stocking rates for different areas according to their vulnerability, through the use of shepherding or additional fencing. In cases of severe overgrazing, complete removal of stock was recommended to allow recovery.

Despite the conclusions of the two reports cited above, a further re-survey of the Cambrian Mountains in 2004 found that heather had deteriorated on a number of Tier 1 sites, with high or very high grazing indices being recorded (Ardeshir, 2005). However, the performance indicators did appear to have been met on two of the three Tier 2 sites recorded. Once again, it was concluded that stocking rates were too high and more precision was needed in controlling sheep in vulnerable areas. Levels of heather grazing were found to be higher when heather levels in the vegetation were low, there were patches of grass, tracks and paths within the heather, and stocking levels were higher.

Habitats surveyed in Tir Gofal in 2001-2 were re-surveyed in 2006-7 (Jackson, 2007). On upland heaths, the mean abundance of dwarf shrubs increased, the desirable species increased in frequency and mean abundance, the height of the heather and the building and mature heather phases all increased. However, only three upland heath sites were monitored, so the results need to be treated with caution.

Monitoring of Scottish ESAs was carried out between 1995 and 2004. Tier 1 land was monitored in all ESAs, but Tier 2 land was only monitored in what were considered to be the most important habitats ('Focus habitats') in each ESA. Tier 2 monitoring of heather moorland was carried out in Argyll Islands, Breadalbane, Cairngorm Straths, Central Southern Uplands and Western Southern Uplands, Loch Lomond, and Shetland Islands ESAs. Results differed between the ESAs.

Among these, the largest areas of upland heath occur in the Western Southern Uplands and Central Southern Uplands (known in combination as the Southern Uplands). The area of dwarf shrub heath in these ESAs decreased during the monitoring period by 10,600ha, or 13% of its original area, in contrast to a national increasing trend (Cummins *et al*., 2007). There was also a general decline in the quality and area of dwarf shrub heaths on land in the scheme, even though 75% was subject to Tier 2 measures. Furthermore, this decline was greater than on land outside the scheme. Although the Tier 2 measures reduced grazing pressure, cover of *Calluna* still decreased considerably, and changes in other species indicated a general decline in condition. It was concluded that the grazing levels on Tier 2 sites were not suitable for conserving or enhancing heather.

In Loch Lomond, there was a 9% decrease in the area of heather vegetation between 1996 and 2003, but an increase in the percentage cover of heather, resulting in an overall decrease of 8% in the index of heather cover (Nolan *et al*., 2007b). In contrast, on out-scheme land there was a 4% increase in heather vegetation, but a reduction in percentage cover leading to an overall 51% decline in the heather cover index. Tier 1 management was however successful in maintaining heather condition,

showing a reduction in suppressed heather on land in the scheme compared to little change on land outside the scheme. There was little evidence of enhancement arising from Tier 2 measures, indicating that grazing levels were still too high.

In contrast to the Southern Uplands, results were much more positive in the Breadalbane ESA (Nolan *et al*., 2007a). There was little change in area of dwarf shrub heaths and Tier 1 requirements maintained heather condition and reduced the amount of suppressed heather, compared to an increase in areas outside the scheme. In addition, grazing intensity was reduced on land in Tier 2 measures, and height and cover of heather increased, indicating that the aim of enhancement had been achieved.

In Cairngorm Straths, only three holdings were available for monitoring. Cover, height and condition of heather was improved on land 100 m away from the moorland or holding edge, but the scheme was less successful on land nearer the edge (cf. results of 1998 survey in Cambrian Mountains above) (Bell *et al*., 2007).

In the Argyll Islands ESA, the area of heather on Tier 1 land was maintained but heather condition declined due to a decrease in mean height (Cummins *et al*., 2007b). There was a slight decrease in area and little change in height or condition of heather on Tier 2 land, indicating that stocking levels were probably too high, even though cover was low on some sites to start with.

In the Shetland Islands ESA, the area of heather vegetation on land in the scheme changed little, but heather cover within that area increased slightly, compared to a decrease on non-scheme land (Truscott *et al*. 2007). The number of sites in the scheme with suppressed heather decreased, and the mean height of heather increased, compared with a small decrease on out-scheme land. The Tier 2 measures were therefore judged successful for the cover, height and condition of C*alluna* in comparison with land outside the scheme.

Only Tier 1 moorland was monitored in the Stewartry ESA. There was a 16% decrease in heather vegetation within the ESA compared to a 23% decrease outside the scheme (Scott *et al*., 2007). Cover of *Calluna* decreased by 22% on land in the scheme.

In Northern Ireland, monitoring of the West Fermanagh and Erne Lakeland ESA was carried out between 1993 and 2003 (McAdam *et al*., 2004a), and four other ESAs were monitored between 1994 and 2004 (McAdam *et al*., 2005). McAdam *et al*. (2004a) found that there had been a significant increase in mean cover of heather from 41% to 50%, and that dwarf-shrub cover had increased or been maintained on 85% of sites. On the remaining sites, where cover remained below 25%, it was thought that further reductions in stocking rates would be needed if condition was to improve. In addition to the changes in heather cover, there was also a decrease in several grass species, especially mat grass *Nardus stricta*, a decrease in bare ground and in increase in *Sphagnum* mosses, the latter two being indicative of reduced trampling.

There was no significant change in heather cover between 1994 and 2004 in the Antrim Coast, Glens and Rathlin or the Sperrins ESAs. Grazing levels ranged from none through light to heavy in these two ESAs. On two sites in the Antrim Coast, Glens and Rathlin ESA where grazing levels were high, heather cover was low and condition poor in both surveys. In Slieve Gullion ESA, where grazing levels were recorded as none on half the sites with the rest subject to light grazing, mean heather cover increased from 23% to 33% and dwarf shrub cover from 49% to 64%. Two

severely burnt sites were excluded from the analysis. A trial of the effects of burning and flailing for heather management showed that heather regenerated more rapidly after burning, but both methods gave satisfactory results.

Other upland habitats

The Scottish ESA reports give areas for other types of habitat in comparison with national trends. These are summarised in Table 2.3. Results varied. In Argyll Islands, Cairgorm Straths and Loch Lomond, result for dwarf shrub heath compared favourably with national trends, but in Breadalbane and the Western and Southern Uplands, there were large decreases, greater than expected from national data. There was little change in the area of bog in the Argyll Islands and increases in the Western and Southern Uplands and Stewartry, compared to substantial decreases predicted from national trends. However, the reverse situation pertained in Breadalbane and the Cairngorm Straths. Differences from the national trend were less marked for bracken, but increases were observed in Cairngorm Straths and the Western and Southern Uplands in contrast to decreases predicted by national data.

Table 2.3 Observed changes in upland habitats in Scottish ESAs, compared to those indicated by national trends on equivalent land (*c* = estimated from graph).

	Dwarf shrub heath		Bog		Bracken	
ESA	**Observed**	**Indicated**	**Observed**	**Indicated**	**Observed**	**Indicated**
Argyll Islands	-870	-*c*2610	0	-2575	-*c*500	-*c*600
Breadalbane	-5768	-1984	-124	+178	-223	-75
Cairngorm Straths	+402	-2409	-479	+172	+ 490	-279
Loch Lomond	+48	-397	-106	-84	-123	+94
W & S Uplands	-10600	-2500	+5250	-7000	+200	-*c*20
Stewartry	-344	+562	+49	-660	+*c*100	+*c*50

Lowland heathland

A survey of lowland heath SSSIs in 1994/5 showed clear benefits of agri-environment schemes. Around 25% of the site units studied were in favourable condition and 26% in unfavourable condition but recovering, i.e. 59% in total (Brown *et al*., 1998). However, more than 70% of units within schemes were in favourable or recovering condition, compared to only 40% of units outside schemes. Also, units outside schemes had the highest proportion of heaths in unfavourable condition (58%).

Hewins *et al*. (2007) reported the outcome of a sample condition survey of non-statutory lowland heathland sites in England. Approximately half the sites monitored were in agreements under agri-environment schemes, mostly CS, otherwise ESA agreements, except for one that was in the Wildlife Enhancement Scheme. Grazing management and bracken control were observed on 31% and 18% respectively of sites with agri-environment agreements, compared to only 9% and 3% respectively of outside agri-environment schemes. However, no significant differences were found between agreement and non-agreement land in terms of condition assessment pass rates for dry heath sites. No stands were considered to be in favourable condition. There were only eight stands of wet heath, so differences between scheme and non-scheme sites could not be analysed, but none achieved all targets. However, information on the objectives of most of the agri-environment scheme agreements

was not available, so it was not known to what extent heathland management was being addressed. Recommendations included targeting agri-environment initiatives to lowland heathland sites, seeking to increase uptake of agreements, and ensuring that options are appropriate for heathland maintenance and restoration.

In Tir Gofal lowland and coastal heaths, the heather building phase and height had increased and bare ground had decreased, suggesting reduced grazing, but with other signs suggesting increased grazing (Jackson, 2007).

2.5.3.3.2 Plants

Dale (2002) presented the results of a five year monitoring programme to determine the impact of a Countryside Stewardship agreement on a range of plant communities on Bodmin Moor. Vegetation was assessed annually between 1997 and 2001 inside and outside grazing exclosures in four semi-improved and eight unimproved communities. Comparison was made with control areas on adjacent common land with year round grazing. In the semi-improved grassland, ryegrass declined and other grasses and rushes increased. The most improved swards were more resistant to change. All unimproved swards also changed, though this was generally least marked in the control areas. There was some increase in *Calluna* heather, though this was limited. However, other desirable species had also increased, including *Erica tetralix, Vaccinium, Deschampsia flexuosa* and *Eriophorum vaginatum*. In some cases *Molinia* had spread, and small scale burning and a more flexible grazing regime were proposed to manage this species and prevent further spread over wider areas. It was concluded that entry into CS had resulted in a substantial recovery of many of the upland plant communities, but responses had varied between sites even for initially similar vegetation. The targets for *Calluna* cover had not been reached, but it was considered that these had been unrealistic for most of the area in any case.

Toogood *et al*. (2006) report on the results of botanical monitoring of the rough land management tier in the West Penwith ESA between 1993 and 2005. Over the twelve years between surveys there was a 12% increase in scrub, an 8% increase in acid grassland, a 12% reduction in heathland, 4% loss of mires and 4% loss of improved grassland. However, some individual plots had shown positive changes. None of the 21 sites that were assessed for condition were in a favourable condition, and only two could be classed as recovering. Nutrient levels had generally declined, but this was not associated with changes in vegetation. Overall, 38% of sampled plots had deteriorated, and it was concluded that abandonment or neglect were responsible for the observed changes. Increased grazing or other management methods to reduce vegetation height and prevent invasion by bracken and bramble were required to prevent further loss of conservation value and allow recovery.

On the acid peatlands surveyed during monitoring of Tir Gofal, dwarf shrubs and other desirable species had increased in frequency and abundance (Jackson, 2007). However, there had also been a corresponding increase in undesirable species and *Molinia caerulea*. There was some scrub encroachment and evidence of a possible rise in the water table. Lowland and coastal heaths showed an overall decrease in dwarf shrubs, little change in mean abundance but an increase in frequency of desirable species, and little change in heathland grasses.

In the West Fermanagh and Erne Lakeland ESA, results of monitoring were mainly positive (McAdam *et al*., 2004a). Plant diversity was maintained between 1993 and 2003, though there was a decrease in the number of higher plant species recorded per transect. The total number of higher plant species remained the same, but there

were more bryophyte species in 2003. Occurrence of *Nardus stricta* decreased from 60% to 30% of sites, though mean cover of *Molinia caerulea* increased from 6% to 12%. The proportion of species in each CSR[14] group had not changed, and there was a high proportion (60%) of stress-tolerating species. Mean cover of Sphagnum mosses increased from 6% to 12%.

2.5.3.3.3 Invertebrates

There were no significant differences in numbers of carabid beetles caught in heather moorland in West Fermanagh and Erne Lakeland ESA in Northern Ireland between 1993 and 2003 (McAdam *et al*., 2004a). More spider species and individuals were caught in 2003, though differences were not statistically significant. Changes in the species composition of the community were recorded, with an increase in heathland specialists and a decrease in species preferring open grassy conditions.

Monitoring of the other ESAs in Northern Ireland took place between 1994 and 2004 (McAdam *et al*., 2005). There were no changes in mean number of carabid individuals, species or diversity on heathland in Antrim Coast, Glens and Rathlin, Rathlin Island, or Sperrins ESAs, but in Slieve Gullion there was a significant decrease in mean number of carabid species and individuals, though the diversity index did not change. No results were reported for spiders in these ESAs.

2.5.3.3.4 Birds

Assessments of bird populations in Exmoor and the North Peak were carried out covering the period 1993-1996. On Exmoor, populations of moorland birds had been maintained or, for some species, increased. Some bird species (curlew, wheatear and meadow pipit) also increased on moorland in the North Peak.

Geary (2002) reported on follow-up a survey of moorland birds on Exmoor, after previous whole moor surveys in 1978 and 1992/3, and a sample survey in 1996. Trends varied between species, with declines, stable populations and increases all recorded. It was concluded that ESA moorland management prescriptions were having a positive effect on most moorland bird populations, but localised overgrazing, swaling and scrub encroachment may be affecting tree pipit, whinchat and ring ouzel. It was suggested that higher grazing pressure on Dartmoor may explain why the whinchat population was lower than on Exmoor, and Dartford warbler was not more widespread.

Calladine *et al*. (2002) compared numbers and breeding success of black grouse, a declining BAP priority species, in ten areas with reduced grazing treatments (<1.1 sheep/ha in summer and <0.l5 sheep/ha in winter) under the Countryside Stewardship scheme (or equivalent private initiatives) in the north of England with paired sites that had 2-3 times higher grazing densities. On sites with reduced grazing, numbers of displaying male black grouse increased on average by 4.6% per annum, compared to an average 1.7% reduction on control areas. Summer hen densities showed the greatest rate of increase where grazing was restricted on small areas of ground, and declined where such areas exceeded around 1km^2, suggesting that access to some short vegetation may be important during the breeding season. On reduced grazing sites, 54% of hens retained broods during the late chick-rearing period, compared to 32% at normally grazed reference areas.

[14] Competitor-Ruderal-Stress Tolerator

2.5.3.4 Summary and Conclusions

A very high proportion of the upland heather moorland UK priority habitat is within agri-environment schemes. However, evidence for benefits of ESA management is mixed, with little or no improvement in the quantity or condition of heather found in many of the evaluation surveys carried out. There have however been some marked successes reported in all parts of the UK. A consistent theme emerging from the large number of evaluations carried out is that success or failure in terms of targets for heather condition is related strongly to grazing pressure. It is clear that change in heather amount and condition is related to stocking rate, and that high stocking rates invariably lead to deterioration in status of the heather. However, the vulnerability of habitats varies, and schemes work best when targeted closely to areas and situations so that (grazing) prescriptions closely fit the needs of each individual site. Other factors encouraging higher levels of grazing are high levels of grass in the vegetation, supplementary feeding, and the presence of tracks or roads. In response to these results, more recent schemes have incorporated measures to support shepherding, fencing, and complete removal of stock in winter, to allow greater control of stocking rates. Where degradation has been severe, complete stock removal for a period may be required for recovery. However, in some circumstances undergrazing can also be detrimental. For example, deterioration in the West Penwith ESA was linked to insufficient grazing.

Botanical monitoring of species other than heather in CS agreements on Bodmin Moor, Tir Gofal in Wales and West Fermanagh and Lakeland ESA in Northern Ireland showed positive results in terms of increases in desirable species and/or diversity.

Increases in some bird species were recorded in Exmoor and the North Peak ESAs in England, and reduced grazing under CS had positive effects on the numbers and breeding success of black grouse in northern England.

Condition monitoring of lowland heaths showed that SSSIs were in favourable or recovering condition on more than half of sites, and there was a clear benefit of agri-environment scheme support, with over 70% of sites in schemes being in one of these categories, compared to only 40% of those outside schemes. The condition of lowland heathland outside SSSIs was however generally unfavourable. More grazing management and bracken control appeared to be occurring in land under agri-environment scheme agreements, but there is insufficient information to assess their effectiveness.

2.5.4 Boundaries, trees, woodland

2.5.4.1 Background

There was a range of habitat options in the ESA scheme relating to woodland, trees or boundaries. These tiers include woodland, hedgerow, wall restoration, as well as grass margins. Actual prescriptions for these then vary between ESAs in all UK countries. Occurrence of prescriptions for these habitats in English ESAs is shown in Table 2.4.

Table 2.4 Summary of tiers relating to boundaries, trees and woodland in English ESAs (from Ecoscope, 2003).

Stage	ESA	Woodland	Hedgerow	Wall restoration	Grass margin
I	Broads				√
	Pennine Dales	√		√	
	Somerset Levels & Moors				√
	South Downs				
	West Penwith				√
II	Breckland	√			
	Clun	√	√		
	North Peak	√	√	√	
	Suffolk River Valleys	√	√		√
	Test Valley	√			√
III	Avon Valley	√			√
	Exmoor	√	√		
	Lake District	√	√	√	
	North Kent Marshes	√			√
	South Wessex Downs	√			
	South West Peak	√		√	
IV	Blackdown Hills	√	√		
	Cotswold Hills		√	√	
	Dartmoor	√	√	√	
	Essex Coast				
	Shropshire Hills	√	√		
	Upper Thames Tributaries		√		√

For woodland, ESA prescriptions usually refer to a grazing plan to exclude livestock from sensitive areas. This is because livestock grazing can threaten the natural regeneration of trees and hinders the development of the understorey. There are also some prescriptions for tree management, such as thinning, inter-planting and control of invasive species.

For field boundaries, ESA prescriptions usually refer to the maintenance of existing boundaries and hedges, as well as prohibiting the removal of any hedge, bank, wall or dyke without permission.

Countryside Stewardship (CS) in England provided support for hedgerow restoration (laying, coppicing) and planting, restoration of stone walls, earth banks, ditches, dykes and rhynes, repair and restoration of stone-faced hedgebanks and tree planting and management as capital works, but did not provide any options for ongoing annual management of these features (except for small upland woodlands). Annual payments were however available for two and six metre wide grass margins around arable fields, beetle banks, and six metre wide buffer strips and wildlife strips (tall/tussocky grass) in margins of intensive grassland.

Environmental Stewardship in England has prescriptions for boundaries, trees and woodland. Under ELS, options cover management of hedgerows, stone-faced hedgebanks, ditches, stone walls, protection of in-field trees, maintenance of woodland fences and management of woodland edges. There are also options for combined hedge and ditch management.

There are also a number of options that cover boundaries, trees and woodland under HLS in England. For hedges, there is a prescription (HB12) for maintenance of hedgerows of very high environmental value, to maintain hedgerows that support target species of farmland birds, insects or mammals, or which make a significant contribution to the local landscape character and/or are historically important boundaries. Woodland trees and scrub options under HLS include: ancient trees in arable and intensively managed grass fields; maintenance, restoration or creation of woodland, wood pasture, or successional areas and scrub, and a woodland livestock exclusion supplement.

Under Tir Cymen in Wales, farmers were obliged to follow management guidelines for all broadleaved woodland (except woodland in other planting and management schemes) and for selected stone walls, hedges and slate fence boundaries. In addition, farmers could also choose to enter other land into the scheme as arable field margins managed for wildlife, as well as to make other improvements including tree and shrub planting, laying or planting of hedges, rebuilding or building new stone walls, cloddiau and fencing (for environmental management).

Tir Gofal contains prescriptions for semi natural broadleaved woodland under its mandatory management guidelines, as well as introducing the establishment of New Broadleaved Woodland as a voluntary option. Voluntary options for field boundaries remain similar to those under Tir Gofal. Tir Cynnal requires that the area of land classed as semi-natural wildlife habitat must form at least 5% of the total area under agreement on participating farms. This includes broadleaved woodland. A relevant general habitat prescription is not to undertake supplementary feeding in broadleaved/mixed woodlands. A number of habitat creation prescriptions relate to woodland and also field boundaries/margins. These are: creating wildlife corridors alongside water courses; leaving uncropped margins on cereal land; creating grass margins on cereal land and small scale broad-leaved tree planting.

In Scotland the Countryside Premium Scheme (CPS) also had some prescriptions relating to field boundaries and trees. For field boundaries, these included the creation of extended hedge (creating wider and taller hedges that provide a better wildlife habitat), building and restoration of dry stone walls and dykes and planting, replanting, coppicing or laying of hedges.

Under the Rural Stewardship Scheme in Scotland there were general requirements for dyke and hedge protection and hedge trimming, under ‘Good Farming Practice’. Specific prescriptions for field margins and boundaries referred to management of grass

margins or beetle banks in arable fields, management of hedgerows, and management of extended hedges.

Capital payments for Rural Stewardship in Scotland under 'designed landscapes' included various options relating to field boundaries. These were: the restoration of dry stone or flagstone dykes or walls or ha-has; replanting, coppicing or laying of hedge; building or restoration of traditional dry stone or flagstone dykes; planting, replanting, coppicing or laying of a hedge.

Woodland management and scrub control for RSS in Scotland came under 'general environmental conditions'. Prescriptions for woodland and scrub refer to management of scrub (including tall herb communities), management of native or semi-natural woodland, and management of ancient wood pasture

Generally, this involved the exclusion of grazing and the conservation of the understorey. Control of invasive species such as *Rhododendron* or non-native tree species was prescribed, as well as the conservation of key species such as the pearl-bordered fritillary butterfly. Other woodland management measures included selective coppicing or thinning work.

In Northern Ireland, the Countryside Management Scheme and ESAs have whole farm requirements for field boundary management and farm scrub and woodland (if present), and there are also optional choices for field boundary restoration, grass margins planted with trees, and ungrazed grass margins. In addition, there are capital works payments for field boundary restoration and tree and shrub planting and management.

2.5.4.2 Key sources of evidence

The impacts of ESAs on field boundaries in England were evaluated for all English ESAs by Catherine Bickmore Associates (2004a) and in the Broads ESA, Somerset Levels & Moors ESA by McLaren *et al.* (2002). Catherine Bickmore Associates (2004b) evaluated field boundaries in CS. Critchley *et al.* (2006) evaluated sown grass margins in arable fields under CS, covering 116 sites across eight regions, and examined the plant species composition of four types of margin: basic grass >2 years old, basic grass 2 years old or less, diverse grass + forbs and cereal headlands. The same authors also conducted an earlier, similar study in 2004 examining options for cultivated arable margins (see section 2.5.1.3.2). In addition, there have been several studies of the utilisation of CS grass margins by invertebrates and birds, including Field *et al*. (2005, 2006); Field & Mason (2005); Shore *et al*. (2005) and Marshall *et al*. (2006).

In Wales, field boundaries and hedges were more commonly evaluated in each separate ESA report than woodland. A series of studies by ADAS were made for the Welsh Assembly, comparing a baseline survey of samples of 500 x 500 m squares made in the early 1990s (survey years vary) with a resurvey approximately five years later (ADAS, 1999; 2000; 2000a; 2000b; 2000c; 2000d; 2001; 2002; 2002a). Two smaller reports evaluate Tir Gofal for trees and plants in field margins (Law, 2004; Woodman, 1998). A large report covering evaluations between 1988-1997 of Tir Gofal, all ESAs, Tir Cymen, The Habitat Scheme and the Moorland Scheme is also available (Medcalf *et al.*, 1998), providing a summary evaluation of detailed monitoring programmes.

A series of reports to the Scottish Executive Environment and Rural Affairs Department treated each ESA separately as part of a coordinated evaluation

between 1995 and 2004 (Bell *et al.*, 2007; Cummins *et al.*, 2007; Nolan *et al.*, 2007, 2007a; Scott *et al.*, 2007, 2007a). In addition, a single combined study was made covering the Habitat Scheme, ESA, CPS and RSS schemes, based on case studies of 10 habitats included in agri-environment schemes, with three sites selected for each habitat (30 sites total) (Hall & Chapman, 2004). Only the combined study and the report for the Stewartry ESA (Scott *et al*., 2007) evaluate field boundaries, the rest only evaluate woodland

In Northern Ireland, studies covering the Countryside Management Scheme, and ESA agri-environment schemes, evaluated both woodland and field boundaries (McAdam *et al*, 1997; 2004; 2004a; 2004b; 2005; 2006). Baseline studies in 1995 for the ESAs covered all ESAs in a single study, using a stratified random sampling technique. These are detailed and compared with a summary of 2003/4 studies in McAdam *et al.*, 2006. A total of 183 quarter kilometre (25ha) squares were surveyed, including participant and non-participant farms. When sites were re-visited in 2003 and 2004, the survey was split into two (splitting West Fermanagh and Erne Lakeland ESA from the others). Only sites under ESA agreement were surveyed in this second survey. The surveys cover both woodland and field boundaries.

2.5.4.3 Key findings

2.5.4.3.1 Habitat

According to the Ecoscope report, the length of arable margin under agreement in England increased greatly throughout the 1990s, so that in 2000 it measured 21,933 km (split approximately equally between the creation of permanent grass margins of greater than six metres width, and creation of grass margins or beetlebanks of two metres width). A similar pattern of increase occurred for work undertaken under capital grants for conservation plans, such as hedgerow restoration.

Catherine Bickmore Associates (2004a) surveyed hedgerows in English ESAs. It was considered that most agreements would meet the ESA objectives. A similar study was carried out of hedges in CS (Catherine Bickmore Associates, 2004b). In this instance, 80% of agreements were considered on course to meet wildlife objectives.

Studies both in Northern Ireland and Wales observed significant increases in the length of boundaries (ADAS, 2000; 2002; McAdam *et al.*, 2006). However, these tend to be fences rather than hedges. The total length of field boundaries in Northern Ireland ESAs had either been maintained, or increased, except Slieve Gullion ESA, where it had decreased (McAdam *et al.*, 2006). In Northern Ireland, hedges were removed in all ESAs and replaced with fences (McAdam *et al.*, 2006). This was not the case in Wales, where it was found that traditional boundaries were well maintained or enhanced in some ESAs (Ynys Môn ESA: ADAS, 2002; Cambrian mountains ESA: ADAS, 2000a; Radnor ESA: ADAS, 2000d), with no change in others, although some hedge removal was still evident on a smaller scale (ADAS, 2002). Knightbridge *et al*. (1998) stated that 53% of monitored boundaries restored by Tir Cymen were in good condition on a second visit.

Changes in grazing levels as a result of agri-environment schemes have had important effects on woodland. These have mostly been positive under the ESA scheme; in Northern Ireland reduced grazing led to decreased poaching, and observations in both Wales and Scotland showed increased sapling and tree density and condition, notably the regeneration of oak seedlings in the Cambrian Mountains in Wales (ADAS, 2000a), as well as increased regeneration of ash and rowan under

Tir Cymen (Reaston & Knightbridge, 1997). A second evaluation by Knightbridge *et al*. (1998) showed that under Tir Cymen, good tree regeneration in 20% of all woodland parcels was observed.

In Northern Ireland, the proportion of woodlands that were grazed fell from 37% to 26% between 1994 and 2004 (McAdam *et al.*, 2004). Under ESA rules, livestock should be totally excluded, but many were not and some fences were not stock proof.

2.5.4.3.2 Plants

In the West Fermanagh and Erne Lakeland ESA in Northern Ireland, there was no significant change in mean number of higher plant species in woodlands, though there was a decrease in the total number of species recorded on all sites between 1993 and 2003 (McAdam *et al*., 2004a). Increases in cover of bramble, ivy, celandine, bluebell, wood sorrel, wood anemone and herb robert were noted. Cover of bare ground decreased, probably as a result of reduced poaching by cattle. The reduced levels of disturbance resulted in a decrease of stress-tolerating species between evaluations.

In the Antrim Coast, Glens and Rathlin ESA there was some evidence of a decrease in species number and diversity in woodlands between 1994 and 2004 (McAdam *et al.,* 2005). Cover of bare ground decreased, but ground cover of woodland herbs did not increase.

Under Tir Cymen in Wales, increased diversity of ground flora in woodland has been observed (Medcalf *et al*., 1998).

In the study of hedgerows in ESAs carried out by Catherine Bickmore Associates (2004a), no comparisons were made with hedges not in the scheme, but comparison with other data suggested a relatively high proportion of species-rich hedges (38% compared to 26%; Churchward *et al*. 1999) and diverse basal flora (particularly on taller banks) in the scheme. However, in CS, there was a similar proportion of species rich hedges (21%) to that found by Churchward *et al*. 1999 (26%; Catherine Bickmore Associates, 2004b).

Critchley *et al.* (2006) studied the vegetation development of sown grass margins under Countryside Stewardship. Sown margins had more grass and fewer weeds than naturally regenerating margins. Grass margins had greater species richness and more bird, butterfly larva and bumblebee food plants than cropped margins. Species composition was related to seed mixture, region and soil properties. Mixtures containing mesotrophic forb species were recommended because they enhance the botanical diversity of sown grass margins.

Marshall *et al*. (2006) found that the herbaceous flora of pre-existing boundaries adjacent to CS 6m sown grass strips was significantly more species-rich than comparable boundaries with no sown strip, suggesting a buffering effect with the strip protecting the boundary from the effects of agrochemicals.

A study of five European countries concluded that overall, plant species density has been significantly enhanced by agri-environment options (probably as a result of reduced agrochemical inputs and the buffering effect of margins) (Kleijn *et al.*, 2006). However, in studies of REPS in Ireland, little difference was observed between agreement and non-agreement margins in terms of plant species richness and abundance. This led to the conclusion by Feehan *et al.* (2005) that there has been no significant benefit of the scheme to enhance field margins.

2.5.4.3.3 Birds

In Wales, statistical analysis of winter data showed that thickness of hedge influences the number of birds, the restoration of which is encouraged under Tir Gofal (Williams, 2003).

Marshall *et al*. (2006) found no significant effect of CS sown margins on numbers of bird territories. However, Clarke *et al*. (2007) found higher bird and territory densities in fields with sown grass margins, especially if there were also undrilled patches in the fields.

2.5.4.3.4 Invertebrates

There were no significant differences in numbers of carabid beetles caught in woodland habitats in West Fermanagh and Erne Lakeland ESA in Northern Ireland between 1993 and 2003 (McAdam *et al*., 2004a), or in the Antrim Coast, Glens and Rathlin ESA between 1994 and 2004 (McAdam *et al*., 2005). Fluctuations in spider species and their abundance in West Fermanagh and Erne Lakeland ESA were not significant, indicating no change in woodland quality.

Marshall *et al*. (2006) found no effect of sown grass strips under CS on carabids or spiders, although lycosid spiders were more abundant in boundaries of small fields with 6m strips. However, numbers of bees were higher in boundaries with 6m margin strips than in control boundaries, and were also higher in the centres of fields with 6m margins than in control fields. The presence of grass margins also increased bee diversity. Also, abundance and species richness of Orthoptera (grasshoppers and crickets) was significantly higher in boundaries with grass margins.

Field & Mason (2005) investigated the effect of 2m wide CS grass margins on the gatekeeper butterfly. There were no significant effects of the presence of grass margins, but numbers of gatekeepers were higher where hedgerows were present. However, Field *et al*. (2005) found significantly higher total numbers butterflies on 6m wide CS margins than in control boundaries, and more individuals of meadow brown, though not of gatekeeper or skipper butterflies. Field *et al*. (2006) investigated the effects of 2 and 6m wide margins on butterfly species richness. Species richness was greater on the 2m margins than on control sections, and greater when a higher number of grass species was included in the seed mixture. It was suggested that CS grass margins would be improved as butterfly habitats if linked to existing habitats such as hedgerows, and sown with a wider range of native grasses and herbs.

Clarke *et al*. (2007) found that a typical CS margin grass seed mix provided a good resource for those invertebrate species that are dependent on sward architectural complexity; however, it was a poor resource for phytophagous species, particularly where their host plants are wildflowers. A tussocky grass mix containing forbs was better than both the grass-only mixture and a fine-leaved grass mix with forbs for a range of non-pollinator invertebrates. Inclusion of wildflowers in the seed mixture resulted in the largest increases in abundance and diversity of pollen and nectar resources, bumblebees and butterflies. The abundance and diversity of soil- and litter-feeders did not respond to seed mix.

2.5.4.3.5 Mammals

Shore *et al*. (2005) compared the abundance and biomass of small mammals in 3 and 6m wide grass margins with control margins cropped up to the edge. In autumn, bank vole and common shrew were more abundant on grassy margins than

conventional field edges, and bank vole numbers were positively related to margin width. Total small mammal biomass increased between spring and autumn on the 3 and 6m margins, but decreased on control margins. Total biomass in autumn was three times higher on the 6m margins than controls.

2.5.4.4 Summary and Conclusions

In Wales, Scotland and Northern Ireland, prescriptions to reduce grazing of woodlands have resulted in positive impacts on tree regeneration and the ground flora. Woodland has not been a major objective of English schemes.

Most monitoring of boundaries in agri-environment schemes has been in relation to changes in extent. Large amounts of hedges and other boundaries are now managed under agri-environment schemes, but in Northern Ireland, the length of hedgerows in ESAs decreased, with removed hedges being replaced by fences. In Wales, traditional boundaries were well maintained or enhanced in several ESAs, and over half of boundaries restored under Tir Cymen were in good condition on a second visit.

Evaluation of hedgerows suggested that most ESA and CS agreements in England would meet objectives, but comparative evaluations with non-scheme hedges have not been carried out, nor have biodiversity benefits been directly measured. However, comparison with other datasets indicated a relatively high proportion of species-rich hedges in English ESAs.

Grass margins generally enhanced plant diversity at field edges, and were most effective when sown with a diverse grass/wildflower mixture. Effects on invertebrates depend on seed mixture; grass mixtures benefit phytophagous species such as grasshoppers, plant bugs and larvae of certain butterflies, but nectar feeding insects (e.g. adult butterflies, bees) require the addition of forbs to the mixture.

There is also evidence that grass margins may increase bird territory numbers, and increase numbers of small mammals.

2.5.5 Wetland & coastal

2.5.5.1 Background

A number of English ESAs had prescriptions relating to wet grassland (see Table 2.2). Other wetland habitats within English ESAs included bogs and mires (South West Peak, Dartmoor), fen (Broads), marsh (Suffolk River Valleys, North Kent Marshes) and grazing marsh (Broads, Somerset Levels and Moors, Essex Coast, North Kent Marshes) as well as wetlands including open water (Lake District).

Countryside Stewardship (CS) included options for managing fen and reedbeds, and creating and managing inter-tidal habitats. There was also a range of funding for capital works to create or restore ponds, create scrapes and manage water levels.

Environmental Stewardship in England does not have any specific options at Entry Level for wetlands or coastal areas. Buffer strips and grazing prescriptions refer to the protection of wetland areas but are not directly designed to protect or enhance wetlands.

Higher Level Stewardship in England has a range of specific inter-tidal coastal options and wetland options. For inter-tidal coastal areas, there are options for maintenance or restoration of coastal saltmarsh or sand dunes, and creation of inter-tidal and saline habitat or coastal vegetated shingle and sand dunes on arable and grassland (or, in the case of inter-tidal habitat, by unmanaged breach or regular inundation). There are two supplements, for extensive grazing and livestock exclusion on saltmarshes.

HLS options for wetlands are available for maintenance of high wildlife value ponds, creation, maintenance or restoration of reedbeds or fen, and maintenance or restoration of lowland raised bog. Supplements are available for wetland cutting and wetland grazing.

In Wales, Tir Cymen prescriptions for coastal land included cliff top grazing, grazing marsh, sand dunes and salt marshes. Under Tir Gofal, there are Whole Farm Section and mandatory prescriptions relating to wetlands, encompassing upland bog, reedbeds and grazing marsh. The aim of management is to maintain the distinctive fauna and flora through low levels of stocking, or stock exclusion in some cases, by maintaining or increasing water levels and avoiding burning or drainage. Coastal habitat options also exist under Tir Gofal. These include saltmarshes, sand dunes and coastal cliffs and slopes. Here the aim is to agree a suitable grazing regime (usually between 0.4 and 1.0 LSU per ha/yr), though it is recognised that in some cases, such as on exposed coastal cliffs and slopes, grazing may not be necessary or practicable.

In Scotland, the Countryside Premium Scheme (CPS) had management options to enhance inbye wetland areas in agricultural use, including lowland raised bog and reedbeds, for birdlife and to encourage botanical diversity, which would in turn help invertebrates. The prescriptions referred to livestock exclusion, grazing levels and the application of pesticides and fertiliser. There was also an option for wetland creation.

The Rural Stewardship Scheme (RSS) in Scotland had prescriptions for management of wetland, management of lowland raised bog, the creation and management of wetland,

management of water margin and the management of flood plain. There was also provision for the management of coastal heath under prescriptions for species-rich areas. In addition, there were capital payments covering creation or restoration of ponds. The RSS defined "wetland" as inbye ground which is normally saturated with water for a significant proportion of the year. The aim of the management measures was to enhance inbye wetland areas, including salt marsh and reedbeds, for birdlife and to encourage botanical diversity that would in turn benefit invertebrates.

In Northern Ireland, in addition to the maintenance and enhancement of species-rich wet grassland, there are options to provide suitable habitat for wetland wildlife (particularly BAP species) in fens, swamps and reedbeds, and lowland raised bogs.

2.5.5.2 Key sources of evidence

Studies covering wetlands have been conducted in all four countries, with at least five good studies for each of England, Northern Ireland, Scotland and Wales, in addition to those reviewed by Ecoscope (2003).

In England, McVey (2005) presented results from breeding wader surveys conducted in the Upper Thames Tributaries ESA (UTTESA) in 1994, 1997 and 2005. 5171 hectares of agreement land (19% of the UTTESA) comprising 61 sites and involving 91 landowners were surveyed. Manchester *et al.* (2005) conducted vegetation surveys in Avon Valley, Somerset Levels and Moors and Upper Thames Tributaries ESAs, with baseline surveys in 1993, 1995 and 1998. A resurvey took place in 2003.

Welsh studies also focus on separate ESAs with wetland prescriptions. Surveys were conducted at the scale of a 500 x 500 m square using a stratified random sample strategy within the Lleyn Peninsula (ADAS, 2000b) and the Ynys Môn ESAs (ADAS, 2002a). For other studies a variety of sample units and strategies were used.

In Scotland a number of studies of separate ESAs with wetland prescriptions have been conducted (Bell *et al.*, 2007; McAdam *et al*., 2005; Scott *et al.,* 2007, 2007a; Truscott *et al.,* 2007).

A baseline study of all Northern Ireland CMS by McAdam *et al.* (2004c) considered the most significant influences on habitat, and concluded that in general, the greatest influence on semi-natural habitat condition was level of grazing. McAdam *et al.* (2004a; 2005) evaluated wetland habitats in ESAs in Northern Ireland.

2.5.5.3 Key findings

2.5.5.3.1 Habitat

Ecoscope (2003) suggested that simple wetland management prescriptions may be ineffective because appropriate water level regimes are complex and vary depending on site conditions and specific objectives. Agreements need to be based on site specific management plans or integrated with statutory Water Level Management Plans.

Dutt (2004), in a survey of grazing marshes, assessed 149 fields from 45 agreements in several ESAs and CS, between late April and late June 2004. In total, 60% of the applicable fields or 4,687 hectares nationally were judged to be of sufficient quality to contribute towards the HAP targets for coastal and floodplain grazing marsh.

2.5.5.3.2 Plants

Wetlands

Within the Upper Thames Tributaries ESA, wetland vegetation characteristic of wet grassland had been maintained (Manchester *et al*., 2005). In the Somerset Levels and Moors ESA however, land managed under the raised water level tier was increasingly characterised by species adapted to conditions of high soil moisture content. In common with other surveys of wet grassland in Somerset, the results of this survey suggested that raised water levels were encouraging the formation of more species-poor inundation and rush pasture communities, accompanied by a decline in species richness in some cases. This suggests that options involving raised water levels were being inappropriately implemented at some sites, implying a need for clearer objectives for sites and targeting of options.

Botanical diversity was maintained and there was a general increase in the cover of rushes (*Juncus* species) recorded on wet pasture under agreements in the West Fermanagh and Erne Lakeland ESA in Northern Ireland (McAdam *et al.*, 2004b). Also on ESA land in Northern Ireland, changes in spider populations in wet pasture indicated a more diverse vegetation structure (McAdam *et al.*, 2005).

In Scotland, there was evidence from all ESAs that Tier 1 measures had achieved their aims. In the Cairngorms Straths ESA, the Tier 1 measures had maintained the area of wetland vegetation and avoided damage on in-scheme land. (Bell *et al.*, 2007). In the Central Borders, Shetland Islands and Stewartry ESAs, Tier 1 measures were also successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land, but showed no clear advantage compared with out-scheme land (Scott *et al.,* 2007, 2007a; Truscott *et al.,* 2007). There were no significant changes in wetland botanical diversity in any of these ESAs.

In contrast, Tier 2 schemes in Scotland were less successful. In the Cairngorms Straths and Stewartry ESAs, increased cover of tall rushes and purple moor grass plus plant litter associated with exclusion of stock resulted in a decrease in plant species number and diversity (Bell *et al.*, 2007; Scott *et al.,* 2007). Similar results were found in the Central Borders and Shetland Islands ESAs, though in this case sedges and a range of competitive grasses increased, again probably due to reduced grazing (Scott *et al.,* 2007a; Truscott *et al.,* 2007).

Wetlands in the CPS and RSS in Scotland were evaluated by Hall and Chapman (2004). These are presented as individual site case studies, so give a very localised evaluation of schemes. On all three wetland sites they found that wetland plants had increased in abundance in 2004. However, drier parts of the sites studied did not improve, as undergrazing has led to areas of overgrown vegetation.

Studies in the Ynys Môn and Lleyn Peninsula ESAs in Wales (ADAS, 2000b; 2002a), overall recorded few changes in the vegetation composition of wetlands. In the Ynys Môn ESA, the relevant Performance Indicator 2.2 was thus partially achieved, in that the composition and structure of Tier 1A vegetation had not deteriorated, but the aim of improving the composition and structure of Tier 2A vegetation was not achieved (ADAS, 2002a). Similarly, in the Lleyn Peninsula ESA, there were no statistically significant changes to occur on Tier 1A stands. There was one statistically significant sign of improvement on Tier 2A stands, namely a drop in soil phosphorus levels (ADAS, 2000b). Also evaluated in the ADAS (2002a) report, the monitoring of wetland in Radnor ESA has revealed changes in both the composition and structure of vegetation between 1994 and 2000. In this case species composition declined

under Tier 1, but Tier 2 vegetation was of high quality and that quality had been maintained.

Initial results from ESA monitoring by Medcalf *et al.,* (1998) demonstrated an increase in species diversity on Tier 2 sites with the most stringent prescriptions aimed at habitat enhancement. This study also examined water margins in the Radnor and Preseli ESAs, where, on re-survey after restoration, a total of seven out of ten ponds showed an increase in diversity which suggested that water quality had also increased. The same study also showed significant increases in wetland species from botanical monitoring of sites in Tir Cymen.

Coastal habitats

The English Habitat Scheme included an option for creation of saltmarsh. Ecoscope (2003) summarised the outcome of the scheme. Uptake was low, but more than 54ha of new saltmarsh were established, and monitoring suggested that establishment of saltmarsh communities was progressing, though not achieved at the time of the survey.

Studies conducted in Welsh ESAs showed no deterioration in habitat quality of coastal grasslands, and signs of improvement were noted on both Tier 1 and Tier 2 sites (Lleyn Peninsula ESA: ADAS, 2000b; Ynys Môn ESA: ADAS, 2002a; Medcalf *et al.* 1998). Medcalf *et al.* (1998) also studied a range of other coastal vegetation including coastal heaths with western gorse and bell heather. Re-survey was carried out in 1997 and showed an increase in species diversity within the heathland stands. This is particularly encouraging, since without active management such areas can easily develop into species-poor scrub dominated by common gorse. Lowland heath monitoring in the West Penwith ESA covered in section 2.5.3.3.2.

In Scotland, Hall and Chapman (2004) provided evidence from localised studies based on individual sites. They also found evidence of improved conditions of coastal heaths and maritime grassland vegetation under CPS and habitats schemes. This was attributed to the change in grazing regime. However, an increase in taller bracken gave cause for concern.

2.5.5.3.3 Birds

The provision of habitat for waders has been a key objective of agri-environment schemes containing wet grassland, and much monitoring and evaluation work has been directed towards assessing the success of such management.

In the Cairngorms Straths ESA, Scotland, there was evidence of declines in breeding pairs of curlew and oystercatcher. Numbers of lapwing declined significantly on Tier 2 land but remained stable on Tier 1 land. Redshank were scarce (Bell, 2007). In the Shetland Islands ESA however, there was evidence of an increase in the total numbers and density of breeding pairs of oystercatcher and curlew (Truscott *et al.,* 2007).

The localised case studies of Hall and Chapman (2004) showed that CPS and RSS in Scotland had contributed to the return of snipe as a breeding species in 2004 on one site. However, on another site, taller sward height had made the site less suitable for breeding lapwings.

In Wales, all 20 Tier 2 wetland sites in the Ynys Môn ESA that were monitored during the 1995/96 winter season were found to support wading birds. This baseline

suggested that the sites had an important role in providing suitable habitat for overwintering wading and other birds on Ynys Môn. Only two out of the 20 sites surveyed supported breeding wading birds but all sites supported at least one species of targeted wetland bird. This suggests that, at the time of survey, the majority of sites were suitable for the smaller songbirds associated with wetlands rather than for wading birds (ADAS, 1999).

Since this baseline monitoring, further surveys in the Ynys Môn and Lleyn Peninsula ESAs showed similar trends. Overall numbers of individuals and species of wintering waders and wildfowl had not increased in either ESA, though both common snipe and woodcock increased as wintering species (ADAS, 2005; Shepherd, 2002). There were very few recorded breeding waders in Ynys Môn (ADAS 2005), and none in the Lleyn Peninsula (Shepherd, 2002). There was no recorded significant change in the number of breeding wader territories in Ynys Môn between 1996 and 2004 (ADAS, 2005). However, it is likely that many of the sites were too small to support large increases in wader populations. The fact that there had been a significant change in the number of breeding waders in the Ynys Môn ESA indicated that as a minimum, conditions were being maintained. Nevertheless, it was apparent that the more exacting objective to 'enhance' numbers had not been achieved (ADAS, 2005).

Comparison of ESA data with national data, demonstrated that with the notable exception of curlew (for which indices increased within Wales but decreased within the ESA), general increasing trends in ESA 'site usage' for breeding species of waders echo those observed in national data. This indicates that changes in the trends of ESA indices may be due (at least in part) to factors operating outside ESA management (ADAS, 2005).

In England, the study of the Upper Thames Tributaries ESA between 1994-1997 suggested a decline in lapwing, redshank and snipe. However, curlew appeared to be more stable (Manchester *et al*., 2005). Since 1997, lapwing, redshank and curlew populations increased, while snipe populations remained unchanged. However, the increases in lapwing and redshank populations were due to the high numbers of pairs on the RSPB's Otmoor Nature reserve, which accounted for 54 pairs (40%) and 24 pairs (82%) respectively and did not represent the entire ESA. Only curlew increased uniformly across all the catchments (McVey, 2005). Lack of response of wader populations was considered to be due to effective drainage and intensive management of a large proportion of the grassland in the ESA. Land in the higher tiers supported higher densities of waders, but these had the lowest uptake. The survey showed that there was potential for success once farmers were engaged, and it was recommended that a more robust and effective farmer support structure should be put in place to enable HLS to realise its potential for breeding waders.

Ausden and Hirons (2002) found that lowland wet grassland nature reserves managed by the RSPB had been successful at conserving breeding lapwings and redshank but habitat management usually only produced short-term increases in numbers of breeding snipe. Within ESAs, populations of breeding wading birds fared better on land managed under high tiers than on land managed under low tiers. Land managed under high tiers also supported more pairs of breeding wading birds per pound of ESA grant received than land managed under low tiers.

A similar conclusion was reached by Wilson *et al*. (2005), in a study of changes in numbers of waders in key English ESAs between 1982 and 2002. Wader populations tended to be higher, and to have declined less, in designated areas (ESAs, SSSIs or nature reserves), than in the wider countryside (Wilson *et al*., 2005). Nature reserves may be generally more effective at maintaining wader populations

than ESAs. For the five ESAs considered there were 12 cases of species decreases of more than 25% and seven with little change (less than 25%) or increases. Wader numbers declined in six of the eight ESAs surveyed, the North Kent Marshes and Essex Coast ESAs being the exceptions. It is important to note that not all land within the ESA was managed under ESA agreement, and that land management was not studied in detail. Also, the ESAs were designated after the initial (1982) survey, between 1987 and 1993. However, the authors considered that the efficacy of these site designations in conserving and enhancing breeding wader populations required a more detailed study. Comparing breeding population trends of lapwing, redshank and snipe, on scheme and non-scheme land, trends were most favourable (increasing or declining less rapidly) in the more expensive ESA options aimed at enhancing habitat; the less expensive, habitat maintenance options, appeared to have little benefit for lapwing and snipe, although redshank has benefited (Wilson *et al*., 2007).

Dutt (2004), suggested that a wide variability of habitat condition exists within the schemes and that the current prescriptions are too generalised to achieve ideal conditions for the desired breeding wader habitat. Unsatisfactory water level and sward condition were found to be the major cause of failure. It was also concluded that the targeting of fields for entry to the scheme could be improved. Recommendations for ES included:

- The initial selection of sites entered into agri-environment schemes needs to be more critically assessed or at least targeted for the desired result.
- There is a need to provide detailed supporting guidance for the new Environmental Stewardship Scheme.
- Follow-up visits are essential to maintain the quality of the managed land.
- A repeat survey of habitat quality should be considered after 3-5 years of the new scheme.

2.5.5.3.4 Invertebrates

ADAS (1999a) surveyed ten ponds in Welsh ESAs, seven of which were in Radnor and three in Preseli in 1996, 1997 and 1998. Eight out of the ten ponds showed an increase in number of invertebrate taxa between 1996 and 1998, whilst seven out of ten showed an increase in Shannon-Wiener Diversity Index over the same period.

In Northern Ireland, invertebrate species richness of sampled habitats under ESA agreement has been maintained. In many cases the range of species on target habitats has increased (McAdam *et al.*, 2004b).

2.5.5.4 Summary and Conclusions

Most monitoring of wetland habitats has focused on wet grassland. There has been very little monitoring of fens, lowland raised bogs or reedbeds. In general, evaluations of wet grasslands showed that condition had been maintained or improved, but in the Somerset Moors and Levels, raised water levels were leading to more species-poor inundation and rush pasture communities, implying a need for better targeting of options, and in some Scottish ESAs and CPR/RSS sites, deterioration had resulted from reduced grazing levels.

Far fewer studies have been made on the vegetation of coastal areas, including coastal grasslands and heaths. However, the evidence available in Wales and Scotland indicates improved conditions of coastal heaths and maritime grassland vegetation under agri-environment schemes.

Improving habitat for wading bird populations has been a key objective of many schemes. There have been some positive outcomes (e.g. increases in breeding oystercatcher and curlew in the Shetland Islands ESA and wintering snipe and woodcock in the Ynys Môn ESA), but for most agri-environmental schemes monitoring has shown little evidence of increases, or even decreases, in wader populations. Where positive effects have been observed, these have been associated with the presence of nature reserves or higher tier management in ESAs. Unsatisfactory water level and sward condition were found to be the major cause of failure, and prescriptions more specifically tailored to the needs of specific sites are required, along with better targeting and advisory support. The increased emphasis on these elements in HLS, and the linkage of options to indicators of success, should help to ensure more favourable outcomes of agreements with objectives including habitat provision for waders.

Invertebrates have not been studied in great detail, however two studies (one in Wales and one in Northern Ireland) indicate some positive impacts of wetland agri-environment schemes.

2.6 Historic Environment

2.6.1 Background

Across the UK the importance and value attributed to the historic environment in rural areas is widely recognised in policy. An important role for agri-environment schemes is to maintain and enhance the protective management of all historic resources on farmland. This role embraces all the main UK agri-environment schemes (Dwyer and Kambites, 2005). On farmland the key components of the historic environment resource comprise archaeological sites, historic features such as traditional buildings, historic field boundaries and ancient trees and designed landscapes (Defra *et al.*, 2005):

- **Archaeological sites** survive in different forms including above ground monuments and structures, undulations in the ground, remains which have been ploughed flat but survive below the cultivation level and remains which are deeply buried beneath river valley silts or hill wash. The value of archaeological sites is in the story they can tell.
- **Traditional farm buildings** are by far the most numerous type of historic structure in the countryside. They are a fundamental and ubiquitous feature in the rural environment and help to define its character and historic interest and provide an important contribution to a sense of place for rural communities and visitors alike.
- **Field patterns and field boundaries** are often of great historic importance. They provide time-depth evidence of the development of farming techniques and customs, which can stretch back thousands of years.
- **Ancient trees** are key features of the historic environment, where they survive on commons, in hedges, in wood pasture and coppiced woodland and isolated in fields. It is estimated that 80% of Northern Europe's ancient trees are in the UK.
- **Designed landscapes** are a quintessential part of the UK countryside and are considered to be one of the UK's most significant contributions to European culture.

All of these components feature strongly within agri-environment schemes with the exception of ancient trees. There is, of course, a very close relationship between the historic environment and the broader landscape as both are intertwined. Although many agri-environment schemes distinguish between the historic environment and landscape, all of the key historic components traverse both categories, apart from archaeological sites, which are not usually considered in landscape terms by the schemes. The evidence presented in this section relates to those studies that have specifically included an analysis of *historic environment benefits.* The evidence relating to *landscape benefits* is considered in Section 2.6.

Ranges of measures have been designed to maintain and enhance the protective management of the historic environment. These include arable reversion to protect buried features, preservation and management of historic field boundaries, reduced stocking rates on grassland to prevent erosion by livestock trampling, scrub clearance on sites that do not receive enough grazing to prevent this otherwise,

fencing around sensitive sites, restoration of neglected features and monuments, and so on (Dwyer and Kambites, 2005).

2.6.2 Key sources of evidence and quality

The key sources of evidence for the provision of historic environment benefits by UK agri-environment schemes are the individual agri-environment scheme evaluations commissioned by the relevant authorities in each of the four countries, and a number of more overarching reviews that evaluate the environmental impacts of multiple schemes. The latter type of study includes, for example, Medcalf *et al.* (1999), Ecoscope (2003), Catherine Bickmore Associates (2004a; b), Kirkham *et al*. (2007) and Dwyer and Kambites (2005). Additional evidence is provided by a number of case studies of specific agri-environment scheme options within limited geographical areas, for example, Roberts *et al.* (2005), Courtney *et al.* (2007) and Humble and Allen (2007).

Dwyer and Kambites (2005) found that monitoring data on the protective management of the historic environment were less complete than was the case for either landscape or biodiversity interest in the countryside. There was also an uneven distribution in the volume and quality of evidence available for the provision of historic environment benefits across the different agri-environment schemes.

The monitoring and evaluation programmes for ESAs in each of the four countries have provided the greatest volume of evidence. Time-series data are provided for samples of archaeological sites and historic features. Changes in the condition of sites and features are compared between agreement and non-agreement land. However, Ecoscope (2003) identify a number of limitations of the ESA monitoring evidence base in England. A particular limitation for monitoring the impact of the ESA scheme on the historic environment was small site samples and the generally low uptake of higher tier options. This limitation also applies to ESA monitoring programmes in the other countries.

The Ecoscope study also identified a number of limitations with the approach taken to monitor the environmental performance of CS. For CS, scheme performance was evaluated by subjective appraisals of agreement negotiations, appropriateness, environmental effectiveness, compliance and side effects. Ecoscope concluded that this approach meant that it was not possible to evaluate CS in terms of achievement of objectives or quantity and quality of environmental benefits.

The Ecoscope study concluded that the selection of ESAs and targeting of CS tended to focus measures towards land that was already of high environmental value in terms of historic interest but it was difficult to quantify the actual impact of the schemes on the historic environment.

In Wales, the Wales Audit Office (2007) report on performance of Tir Gofal found that there was no routine monitoring and evaluation of the impact of Tir Gofal on the maintenance and restoration of the historic environment. Features of interest are identified during the application appraisal process and the archaeological trusts make judgements about their importance. However, the condition of each feature is not formally assessed and thus there are no baselines against which to measure changes in condition.

In Scotland, the Mid-term Evaluation of the RDP (SEERAD, 2004) concluded that the lack of a monitoring programme for the CPS, the Organic Aid Scheme and the RSS meant that there was very little relevant data available to fully assess the

environmental impacts that have occurred as a result of the implementation of the schemes. However, anecdotal case-study evidence suggested that at the local level there were tangible benefits and that the schemes could in the future lever increased environmental gain.

Swales *et al*. (2005) found that in Northern Ireland there are no substantive results yet from environmental monitoring and evaluation studies of CMS, due to its relatively short lifespan.

2.6.3 Key findings

2.6.3.1 Archaeological sites

Evidence from ESA monitoring reports suggests that the scheme has been successful in maintaining the protective management of archaeological sites on agreement land throughout the UK. There was however, little evidence to suggest that the number of protected archaeological sites was being being increased through enhanced management. In England, time-series data from the monitoring of Stage I and Stage II ESAs showed that the level of damage to archaeology was reduced when land was under agreement. Performance Indicators relating to the protection of archaeological sites from loss or increased risk were largely achieved (Ecoscope, 2003).

The monitoring evidence in Scotland produced very similar results. From the draft monitoring reports that have been prepared for nine ESAs there is a broad consensus that Tier 1 has been effective in maintaining the protective management of archaeological sites. It was also concluded that the scheme had resulted in little enhanced management of the resource due to the low level of uptake of Tier 2 (see Bell *et al*., 2007; Cummins *et al*., 2007, 2007a; Nolan *et al*., 2007, 2007a; Pearce *et al*., 2007; Scott *et al*., 2007, 2007a; Truscott *et al*., 2007).

ADAS undertook archaeological and historical monitoring in each of the six Welsh ESAs. A baseline survey was undertaken when each ESA was launched and resurveys were subsequently undertaken to create time-series data. Where appropriate and practicable, comparisons were also made between agreement and non-agreement land. The evidence from these surveys shows that the overall ESA wide objective '*to maintain sites of archaeological and historical significance*' has been broadly met for those sites within the sample on agreement land. The monitoring reports show that sites on agreement land were protected to a greater extent than those on non-agreement land in two ESAs.

McAdam *et al.* (2004) reviewed the monitoring evidence for ESAs in Northern Ireland between 1993 and 2003. They report that a survey of archaeological sites in Mournes and Slieve Croob ESA and Antrim ESA carried out in 1994 found that of 87 sites, 51% showed recent damage and livestock grazing was the major concern, with 23% damaged by cattle and sheep. Landscape monitoring between 1995 and 1998 assessed condition of historic features within ESAs. Results indicated that recent disturbance due to livestock had occurred but that it was not sufficient to cause further deterioration in the condition of monuments. Most disturbance or damage was noted on sites not under ESA agreement.

A review of monitoring evidence for ESAs between 1995 and 2005 (McAdam *et al.* 2006) found that there was no change in the number or condition of historic monuments or features. There was no change in the condition of historic and archaeological sites since the baseline survey and most were classified as having

either ‘substantial remains’ (35%) or ‘some remains’ (26%). 31% of sites displayed evidence of recent damage, with the majority being caused by livestock activities (47%).

A study by Kirkham *et al*. (2007) evaluated the environmental outcomes generated by Arable Reversion agreements within CS and ESAs. One of the objectives of the study was to identify the extent to which these agreements had afforded protection to the archaeological resource. The study involved the analysis of management agreement files, interviews with agreement holders and field survey of a representative sample of 112 sites. The principle conclusion arising from the study for the historic environment was that a high proportion of sites (77%) showed benefits involving the protection of the historical resource. The study also concluded that in affording protection of archaeological features, the reinstatement of a type of land use that fits the historic character of an area can be of enormous value, and all of the Arable Reversion sites fell into this category to a greater or lesser degree.

English Heritage collected time-series data in 2001, 2005 and 2007 on the condition and management of 1,515 scheduled Ancient Monuments (SAMs) in the East Midlands Region (see Case Study Box 5). The data showed that over the study period there was a reduction in the number of SAMs at high or medium risk, with a concomitant increase in the number of SAMs at low risk. The study reported that the majority of SAMs assessed as being at high risk in 2007 were also at significant risk in 2001 and 2005 because of inappropriate long-term farm management. Many of these were under arable cultivation and they had been identified as candidates for ES management agreements. Between 2005 and 2007 the risk banding had been reduced for 30 SAMs in the East Midlands and analysis of the funding streams that have been responsible for implementing the change showed that Environmental Stewardship was the most important single scheme (44%). Between 2005 and 2007, 56 SAMs improved in condition and analysis of the funding streams showed that ES was responsible for the majority of this enhanced management (78%) (Humble & Allen, 2007).

Current Defra research on the conservation of the historic environment in England (project BD1706) will be completed later in 2008 and seeks to review current knowledge of the impacts of widely practised vegetation management on the historic upland environment and to identify evidence based examples of best practice.

In Wales Medcalf *et al.* (1998) found that the ESA and Tir Cymen schemes were generally successful in protecting individual archaeological and historic features. Prescriptions were designed to maintain existing SAMs, USAMs and other features of historic value identified on the agreement farms. Time-series monitoring of sample sites on and outside ESA agreement land showed that the majority of archaeological sites were retained whilst there was a greater level of site damage on land outside agreements. For Tir Cymen, Medcalf *et al*. (1998) reported that assessment and monitoring of 10 farms within the scheme had identified 147 archaeological sites and that most were under benign management regimes, mainly upland livestock grazing, and no significant damage to historic features was evident.

BOX 5. CASE STUDY: MAINTENANCE AND ENHANCEMENT OF SCHEDULED MONUMENTS IN THE EAST MIDLANDS REGION OF ENGLAND

Scheduled Monuments (SMs) are monuments that have been designated because of they are the very best examples of their type and are considered to be of national archaeological and historic importance. Although protected by law, SMs in the countryside are vulnerable to changes in agricultural land management practices, which can cause damage and decay. Significant damage has been caused to field monuments and buried archaeology by the soil-tillage operations carried out during arable cultivation. This includes the conversion of grassland to arable, the encroachment of ploughing onto isolated field monuments and the erosive effect of continuous cultivation. Changes in livestock management on grassland can also cause significant damage to field monuments and earth works. Increased stocking can lead to overgrazing, poaching and the removal of vegetation cover, which in turn can lead to erosion. Decreased stocking can lead to under grazing which encourages the spread of scrub vegetation and tree growth. This can cause damage to the archaeological resource through root penetration and can also damage visual amenity by hiding sites from view.

English Heritage has collected time-series data (2001, 2005 and 2007) on the condition and management of 1,515 SMs in the East Midlands region in England. In 2001, the majority of SMs (73%) were located on agricultural land or woodland. A third of SMs (35%) were classified as being at high (13%) or medium (22%) risk from deterioration, damage or loss. Of those SMs in the high-risk category, 84% were under threat from agriculture. Arable cultivation (71%) was identified as the major threat to high-risk SMs with damage being caused by soil tillage. As a result of the 2001 survey, the most vulnerable SMs on agricultural land have been targeted for inclusion in agri-environment schemes, mainly through Countryside Stewardship Scheme, and latterly Environmental Stewardship (ES). A resurvey of SMs in 2007 found that there had been a reduction in the number of SMs at high or medium risk with a concomitant increase in the number of SAMs at low risk. Between 2005 and 2007 the risk banding has been reduced for 30 SMs and analysis of the funding streams that have been responsible for implementing the change show that ES was the most important single scheme (44%). Between 2005 and 2007, 56 SMs improved in condition and analysis of the funding streams showed that ES was responsible for the majority of these improvements (78%).

Uptake data for the archaeology options under ES (Entry Level, Higher Level and Organic Entry Level) in the East Midlands show that by February 2008, 6,741ha had been entered into the scheme under the arable options. The majority of the land (79.5%) was entered under the option for the management of archaeological features on grassland. This option is used to retain permanent grassland, which is considered the best form of management for agricultural sites. The remaining 20.5% of the land was entered under options for the management of archaeological sites on arable land. A total of 767ha of land containing archaeological sites had been taken out of arable production. Cultivation depth had been reduced on 521ha on land to reduce the risk of damage to buried archaeological sites. A small amount of land (68ha) had been entered under the option for arable reversion by natural regeneration. The purpose of this option is to protect sub-surface archaeological features from damage due to cultivation, by establishing permanent grassland on arable, set-aside or grass leys through natural regeneration. It is targeted at protecting features at risk of damage through the standard method of grassland establishment, which would involve some form of cultivation such as ploughing. Finally, a total of 17ha was being managed to prevent the expansion of scrub on archaeological sites.

The division of land between grassland and arable options in the East Midlands mirrored the situation at the national level, where 61,064ha was entered under the option for the management of archaeological features on grassland (79.1%).

2.6.3.2 Historic features

2.6.3.2.1 Traditional farm buildings

The impact of ESA Conservation Plans and CS Special Projects on traditional farm buildings has been the focus of three separate research projects (ADAS, 2003; Roberts *et al*., 2005; Courtney *et al.*, 2007). Research carried out by ADAS (2003) to determine the effectiveness of ESA and CS traditional farm building restoration projects found that agreement holders had a high level of satisfaction with the schemes and a significant number of buildings would have either continued to deteriorate or have been lost in the absence of the schemes. Only nine of the 106 agreement holders interviewed in the study would have restored their buildings in the absence of the scheme while 46 of the 120 buildings surveyed would have had some first aid, low-cost repairs. ADAS also concluded that existing assessment procedures were insufficient to enable the value of the building and the gains from restoration to be fully understood, and that restoration projects should be more selective and targeted in future.

Work by Roberts *et al.* (2005) and Courtney (2007) also found that agreement holders had a high level of satisfaction with the ESA scheme and that in the absence of the scheme very little restoration work would have been undertaken. In the Lake District ESA, Roberts *et al.* (2005) found that during the period 1998 to 2004, conservation plan expenditure on traditional farm building restoration projects totalled over £6.2 million and involved the repair of 655 buildings. Data on the impacts of the scheme were collected through file analysis, interviews with agreement holders and field survey. The study concluded that without the ESA scheme, two-thirds of the buildings were likely to become derelict and the remainder repaired to a lower standard not in keeping with local character. The study also concluded that a significant pool of historically significant buildings remained within the ESA, which would benefit from entry into the ESA or the successor ES scheme.

A similar study was undertaken in the Yorkshire Dales National Park, which found that between 1998 and 2004, £2.8m in grants was paid for the restoration of 327 farm buildings within that part of the Pennine Dales ESA that fell within the National Park. According to a survey of agreement holders 74% of the buildings would not have been maintained in the absence of the restoration grant. It was also found that the remaining buildings would have been repaired to a lower standard which was not in keeping with local character.

In Wales, the 2005 socio-economic evaluation of Tir Gofal found that 46% of farmers who had made capital investments in traditional buildings (the main form of restoration activity funded by Tir Gofal) would not have done so without the financial support provided by the scheme, and at least another 19% said that they had invested sooner and/or on a greater scale as a result of the scheme (Wales Audit Office 2007).

2.6.3.2.2 Field pattern and field boundaries

A study to assess the environmental benefits brought by ESA and CS to the hedgerow network was undertaken by Catherine Bickmore Associates (2004a; b). The study covered a 10-year period to 2002 and had a particular focus on ancient and/or species rich hedges, and those with recognised biodiversity, landscape, and/or historic value. The study analysed data collected from a representative

sample of 200 management agreements made between 1998 and 2000 (CS), and 1993-2002 (ESA). The study involved CS and ESA agreement file analysis, a survey of agreement holders and a field survey of a sample of 1,252 hedges, to assess the benefits that planting and restoration work under the schemes brought to the historic value of the hedgerow network on agreement land.

In terms of historic value, the objectives of CS stated that hedge restoration works should, where possible, target those hedges which are 'long established or form historic features.' The field survey found that 84% of hedges were either historic or pre-enclosure. The review of agreement files found that historic objectives directly relating to hedges were provided for 55% of the CS sample agreements. However, there was no reference to the retention of vernacular features directly associated with hedges. At a generic level, the study found that the historic network of pre-enclosure and historic hedges was being maintained through the ESA scheme. However, for both schemes the omission of severely degraded hedges and hedgerow banks from restoration programmes was detrimental to the historic landscape framework.

2.6.3.2.3 Designed landscapes

The review of CS undertaken by Ecoscope (2003) found that CS Special Project funding had made a significant contribution to the restoration of historic parkland. Law (2004) evaluated the contribution of Tir Gofal to the Parkland and Wood-pasture Habitat Action Plan in terms of scheme outputs (number and area of relevant agreement options and capital works). The focus of the study was on habitats but it also recognised the contribution of Tir Gofal to the maintenance and enhancement of value. The historical importance of parkland is recognised by the scheme and there are voluntary options as well as capital works to restore and enhance their historical qualities. However, payments made under Tir Gofal are based on the management of parkland as a habitat.

2.6.4 Overview of monitoring

Much of the quantitative evidence collected on the historic environmental benefits supplied by the agri-environment schemes focuses on archaeological sites. There is much less quantitative evidence available on the impact of the schemes on the historic value of other features and designed landscapes.

The evidence shows that archaeological value was being maintained, by the UK agri-environment schemes. The Ecoscope study concluded that of the three main environmental objectives of the ESA scheme, the maintenance and enhancement of wildlife, landscape and historic environment values, ESAs performed best in maintaining historic values. "These were maintained in almost all ESAs, with the exception of one where the monitoring was inconclusive. However, there was little evidence of positive management of the resource and limited attainment of the relevant Performance Indicators." (Ecoscope, 2003, p8). This pattern of maintenance but not enhancement is repeated for ESA schemes in the other countries.

After reviewing the monitoring evidence for the impact of CS on the historic environment, Ecoscope concluded the performance of CS was less effective than ESAs in terms of the maintenance of historical value. However, Ecoscope also concluded that CS was achieving, in the main, its stated objectives of protecting and maintaining important historical and archaeological features and landscapes. On average over 70% of CS agreements had been effective in at least maintaining historic environment value. Overall it was concluded that there was little

enhancement of historical value but CS Special Project funding was considered to make a significant contribution to the restoration of historic parkland and traditional buildings.

In Wales the review by Medcalf *et al.* (1998) found that the ESA and Tir Cymen schemes were generally successful in protecting individual archaeological and historic features. The Welsh Audit Office found that, although little monitoring and evaluation has been carried out, the available evidence suggests that Tir Gofal is protecting the historic environment.

2.6.5 Summary and conclusions

There is clear evidence from monitoring of ESAs in all four UK countries, as well as Countryside Stewardship, Environmental Stewardship and Tir Cymen, that entry into these schemes produces benefits in respect of the *protection of archaeological features*, compared to what would have happened in the absence of the scheme. In addition, there is evidence from CS and ESA schemes in England that arable reversion options under the schemes have greatly improved the protection afforded to archaeological features, on this land. In both these cases the evidence of scheme additionality is strong. There is also a growing body of evidence concluding that ESA, CS and Tir Gofal schemes involving the restoration of historic buildings provide clear additionality compared to what would have happened in the absence of the scheme. In most cases, buildings would either have continued to decline, or repair work would have been done in less sensitive ways which would have reduced the historic value of these assets. These conclusions are based upon farmer interviews, as the principal means of establishing the counterfactual.

In respect of historic field boundaries in ESAs and CS in England, there is evidence that the schemes targeted this resource well (output), and that management under the schemes was mainly appropriate for achieving protection (results). However this monitoring lacked an earlier baseline and was thus unable to demonstrate significant beneficial impacts, and the exclusion of the most severely degraded boundaries from some scheme agreements was detrimental to the historic landscape.

For historic designed landscapes, there is evidence from CS and Tir Gofal that the schemes have made a significant positive contribution to the protection and restoration of these sites.

2.7 Landscape

2.7.1 Background

The Dwyer and Kambites (2005) review of UK agri-environment measures found that all the general schemes (ESAs, CS, RSS, CMS, Tir Gofal and their predecessors) targeted landscape protection and enhancement, and the organic schemes usually made reference to the potential benefits to the landscape as a by-product of organic conversion. Loss of overall landscape diversity and both loss and poor management of landscape features were recognised as problems in all countries, although comparatively greater emphasis was given to these issues in England and Scotland. In Wales, specific problems were identified in the context of historic landscapes but this may reflect greater awareness of the issue rather than a more severe problem. In Northern Ireland, landscape change was emphasised in relation to changes in habitats and the specialisation of farming, especially in lowland areas.

Dwyer and Kambites (2005) found that scheme contributions to landscape protection and enhancement were made at a variety of 'levels':

- Some schemes target particular kinds of measure in 'packages' related to broad 'landscape types' for which they are primarily designed to be applied. For example, the CS scheme in England was designed around enhanced management of the following landscape types: uplands, waterside landscapes, lowland meadow and pasture, historic landscapes, arable landscapes and lowland heaths. Similar approaches were also evident in RSS.
- At the level of the competitive assessment of applications and the promotion of suitable applications in each region, the scoring system against which applications are assessed may include additional scores for applications that fit well with locally-devised 'targets' for the area. Commonly, these include particular actions that are seen as a priority for landscape protection and/or enhancement. For example, in a local landscape suffering from decline in character due to neglect and degradation of traditional field boundaries, the management and restoration of these particular features may be identified as a local 'target'. In this area, if this action is included in an application to join the scheme, that application will score more highly than another which has not picked up this local target, and thus it will have a greater chance of being accepted into the scheme.
- At the level of individual agreements and work undertaken, any management or restoration work on features must always be designed to be in keeping with local landscape character. For example, field boundaries should be of a traditional type for the area and buildings should be restored using traditional local materials. This is a standard requirement in all the 'general' agri-environment schemes in the UK.

2.7.2 Key sources of evidence and quality

The key sources of evidence for the provision of landscape benefits by UK agri-environment schemes are the individual agri-environment scheme evaluations commissioned by the relevant authorities in each of the four countries and a number of more overarching reviews that evaluate the environmental impacts of multiple schemes. Case study evidence is provided for specific agri-environment scheme options within limited geographical areas.

Ecoscope (2003) in its review of these scheme evaluations stated that, compared to monitoring the impacts of agri-environment schemes on biodiversity and habitats, monitoring impacts upon landscape character and quality is less straightforward to achieve objectively. "Landscape impacts can be considered to be changes in the fabric, character, and quality of the landscape, through changes in the elements and features that afford a visual impact upon the landscape character. Detection of such changes requires interpretation and professional judgement with reference to a baseline character assessment or landscape guidance produced by local authorities." (Ecoscope, 2003, p10).

Dwyer and Kambites (2005) noted that the UK is particularly advanced in the field of landscape character assessment. This has enabled landscape protection and enhancement objectives to be defined fairly clearly with reference to specific 'character areas' or 'zones' in both Scotland and England, and for more local landscape assessments to be available to guide scheme design and targeting in both Wales and Northern Ireland. A number of the UK schemes (e.g. ESAs in England, Tir Cymen) have included landscape character assessments as a baseline for monitoring and/or management purposes. There is little published research that uses landscape character assessment to determine the landscape benefits of UK agri-environment schemes. However, the short-term assessment of scheme results in CS evaluations in England during the 1990s involved expert judgement of field survey findings in the context of local landscape character assessments.

Rather than taking a holistic view of landscape, as with the landscape character approach, much of the impact evidence relating to landscape benefits has been presented in the form of output measures for key landscape components. Examples of such output measures include figures on length of linear boundaries, area of different land cover types and the number of point features, such as hedgerow trees, that have been maintained or enhanced. This approach has been adopted for monitoring ESAs and rationalized in the following way: "As a rule, where the key characteristics are strong the landscape quality is high and, conversely, where they have been weakened the landscape quality is lower. It follows, therefore, that changes that strengthen landscape character are usually beneficial, whereas those that weaken the character are detrimental. Thus, the landscape assessment provides a benchmark for evaluating the impact of change occurring to the landscape elements, enabling judgements to be made about the performance of the scheme in maintaining and enhancing landscape value. Changes to the landscape elements and, therefore, to key characteristics of the landscape types, were monitored by various surveys that looked at land cover, point and linear features." (ADAS, 2000b).

These types of output measure are widely reported as evidence of landscape benefit across all the main schemes. What this means is that there is a substantial amount of evidence on the maintenance and enhancements of individual landscape components but little information about the juxtaposition of these elements and how they interact.

There are no published studies of the landscape benefits of Tir Gofal in Wales, CPS and RSS in Scotland or CMS in Northern Ireland.

2.7.3 Key findings

2.7.3.1 Land cover

The pattern of land cover is recognised as an important factor that helps to define landscape character and the monitoring programmes that accompany the UK agri-

environment schemes have collected data on changes in land cover. However, there is considerable variation in the extent to which these data have been analysed in relation to landscape character. This can be seen in the different approaches taken to the interpretation of land cover data collected by the ESA scheme monitoring programmes.

In Wales, changes in land cover within ESAs were explicitly related to their impact on the landscape. Overall it was concluded that land cover change had been small during the monitoring period, but where change had taken place, it was generally on land that was not in agreement, and generally had a negative impact on the landscape. For example, in the Radnor ESA the results showed that land cover changes, although small, were generally negative and related to the on-going intensification of agriculture and the improvement of grassland which had not entered the scheme. In the Ynys Môn ESA it was reported that very few land cover changes occurred during the re-survey period, but the small scale, piecemeal improvement and development of semi-natural rough land that is not in the scheme is gradually weakening the landscape character. In the Lleyn Peninsula ESA, land cover changes had a greater impact on the landscape and it was reported that the overall quality and integrity of all landscape types in the ESA has declined because of this. By contrast, land cover changes and trends were considered to be generally insignificant in the Preseli ESA but the replacement of worn out fences to protect Coastal Heath would lead to the enhancement of this feature in future years.

In Scotland, land cover change was monitored and evaluated in terms of Broad Habitats and was not assessed in terms of its impact on the landscape. The monitoring programme found that, in general, the main Broad Habitat types had been maintained although there was some variation between ESAs. For example, the Stewartry ESA scheme was seen to have had beneficial effects on four of the seven semi-natural Broad Habitats by increasing areas or at least slowing down the rates of decrease (Scott *et al.*, 2007). In the Shetland Islands ESA, the area of two out of four semi-natural Broad Habitats had increased, one was stable and one declined. There were no statistically significant changes in the areas of any Broad Habitats and it was concluded that the areas of all the more natural Broad Habitats had been maintained (Truscott *et al.,* 2007). In the Machair ESA, monitoring showed that the area of all the semi-natural Broad Habitats had been maintained or increased, whereas arable and fallow land had decreased significantly (Pearce *et al.,* 2007).

Changes in land cover types in ESAs in Northern Ireland were monitored between 1995 and 2005 (McAdam *et al.,* 2006). The results showed that for the ESA scheme as a whole, changes in broad land cover types such as grassland, heather moorland and woodland were relatively small indicating that large-scale change had not occurred over the 10 years of monitoring. The only exception to this was in Slieve Gullion ESA where there was a significant loss of grassland due mainly to losses of unimproved species-poor grassland to buildings and amenity grassland. This indicates a possible trend towards increased development affecting the landscape character of this ESA, on land which did not enter the scheme. From this it was concluded that the main landscape resources had not undergone major changes in any of the ESAs between 1995 and 2005, except in the Slieve Gullion ESA.

The Reaston and Knightbridge (1997 and 1998) evaluation of the Tir Cymen scheme found that the scheme had been effective in maintaining and enhancing land cover types that contributed to landscape character and value. The study identified 196 landscape character areas and 137 holdings as a basis for assessing the schemes landscape objectives. The study concluded that Tir Cymen was wholly addressing significant management issues and enhancing opportunities on 29% of these

landscape character areas, resulting in a maintained and enhanced landscape, partly addressing issues and opportunities on 68% of these and in 3% of areas was not addressing these at all.

Medcalf and Pawson (1999) in their evaluation of first generation agri-environment schemes in Wales assessed land cover change in terms of major habitat types. They did not analyse the impact of land cover change in term of landscape character.

2.7.3.2 Boundaries

The maintenance and enhancement of traditional field boundaries was a feature of the ESA scheme throughout the UK. The objective of the scheme focused on the maintenance and restoration of traditional field boundaries and field patterns, which were considered to by key contributing components of landscape character. The success of the scheme was measured against a number of Performance Indicators, which varied between ESAs but generally related to retention and maintenance of stockproof boundaries and the restoration of non-stockproof boundaries – i.e. generally reporting scheme results, rather than directly assessing landscape impacts.

ADAS (2002) undertook a survey of the condition of walls on 171 case-study agreement holdings in six ESAs, with complementary data on farmer attitudes, behaviour and costs. The quality of wall renovation work was also assessed on 89 case-study holdings in five ESAs. The survey found substantial variation in the wall maintenance commitment within and between the ESAs. For example, less than a fifth of all walls in the Cotswold Hills were identified as stockproof, and holdings had on average only three walls to maintain under ESA prescriptions. In contrast over four-fifths of all walls in West Penwith were identified as stockproof, with holdings having on average 59 walls to maintain under ESA prescriptions. The report concluded that these substantial variations had implications for the costs of wall maintenance incurred between different holdings and between different ESAs. In most ESAs, a 'good' level of wall renovation was recorded for at least two-fifths of walls, with most of the remainder of the work being considered to be 'acceptable'.

Ecoscope (2003) made qualitative judgements of impact, based upon the individual scheme data, and concluded that significant landscape enhancement had taken place in some of the English ESAs. For example, in the Lake District ESA there had been considerable enhancement of field boundaries, while in the Cotswolds ESA there had been an increase in the maintenance and total length of dry stone walls.

The ESA monitoring programme in Wales recorded positive boundary protection in all ESAs apart from the Lleyn Peninsula, where the standard of traditional boundary management had declined over the monitoring period. By contrast, in the Cambrian Mountains ESA the scheme was seen to have brought some beneficial changes to linear features through improved management of traditional boundaries. This has resulted in more hedges becoming laid, trimmed and stockproof in their own right. Likewise in the Radnor ESA there had been a number of beneficial changes in the management of boundaries over the monitoring period. The monitoring report noted that a substantial proportion of traditional hedges were being managed by laying, particularly on agreement land, thus renewing and sustaining the strong pattern of field boundaries that is so characteristic of the Radnor ESA landscape (ADAS 2000d). However, there was little evidence of boundary enhancement in some ESAs. For example, in the Ynys Môn ESA an increase in fencing along traditional boundaries serves to protect rather than enhance them. Thus the ESA was considered to be maintaining rather than enhancing the historic pattern of field

boundaries, and did not appear to be encouraging a significant improvement in the standard of management (ADAS, 1999).

In Scotland, the ESA monitoring programme found that the scheme had a positive impact in maintaining traditional boundaries on agreement land and that there was also a limited degree of boundary enhancement. There was a general decline in the condition of traditional boundaries on non-scheme land, indicating scheme additionality. There was also a general increase in fencing on both agreement and non-agreement land. These changes were not evaluated in terms of their impact on landscape character or quantity. In the Stewartry ESA, for example, the length of dykes remained stable on agreement land but decreased on non-agreement land, although neither change was statistically significant. It was concluded that there was some indication the ESA measures have had some success at maintaining the overall length of dykes and show benefits over the decreases recorded on non-agreement land (10% decline in the length of dykes and 20% in the length of hedges, while the length of stockproof dykes decreased by 11%). Hedges were generally in a neglected condition, with three-quarters (75%) showing no signs of recent management. There were also increases in the lengths of restored dykes and hedges on agreement land, which were greater than those on non-agreement land (Scott *et al.,* 2007). In the Shetland Islands ESA the scheme was judged to have been successful at maintaining the overall length and condition of dykes but not to have achieved significant boundary enhancement (Truscott *et al*., 2007). In the Machair of the Uists and Benbecula, Barra and Vatersay ESA, it was concluded that the schemes had been successful, as boundaries within the ESA had been retained and showed an improvement in overall quality (Pearce *et al*., 2007).

In Northern Ireland, baseline landscape surveys took place in all five ESAs in 1995, with resurveys in 1998 and in 2005. Data were compared between 1995 and 2005 to determine changes in the distribution and abundance of land cover and boundary landscape elements with respect to the ESA scheme. The review of landscape monitoring evidence undertaken by McAdam *et al.* (2006) found that there had been no significant losses in the length of traditional field boundaries but the length of fencing had increased. This increase in fencing had taken place within predominantly upland areas such as the Sperrins ESA and may have an important impact on the visual landscape. Around three quarters of field boundaries were not actively managed, including those on agreement land. A comparison of changes on agreement and non-agreement land found that the maintenance and restoration of traditional field boundaries had taken place to a greater extent on agreement land, while non-agreement land had experienced greater removal of boundaries. This suggests that the ESA scheme was aiding the maintenance and enhancement of traditional field boundaries and helping to reinforce landscape character in a context where active management of field boundaries was not common practice.

Ecoscope (2003) concluded from the evidence in short-term evaluation studies that for CS, the field boundary option was the most successful in landscape terms, with nine out of ten agreements being judged as effective in both maintaining and enhancing the landscape within agreements.

Courtney *et al.* (2007) evaluated the impact of ESA and CS capital works on dry stone walls within the Yorkshire Dales National Park. The study found that 354 agreement holders used the ESA and CS schemes to renovate 128 km of dry stone wall and were paid £1.9m. A survey of agreement holders found that in the absence of the restoration grant, half of these would have carried out no restoration work at all. It was frequently mentioned that it would have been too expensive to restore the walls without the grant assistance, and where a stock proof boundary was required a

post and wire fence would have been used instead. The study concluded that the schemes helped to maintain and enhance the historic character and special qualities of the Yorkshire Dales National Park. This study provides evidence of scheme additionality, albeit based upon farmer surveys to judge what would have happened without the schemes.

A similar survey of Tir Gofal agreement holders carried out for the 2005 socio-economic evaluation of Tir Gofal found that 36% of respondents would not have invested in new field boundaries in the absence of the scheme. This was less than the proportion for other capital works, and might reflect the agricultural benefits farmers accrue from carrying out boundary improvements. However, of the 64% who said that they would have invested in the absence of Tir Gofal, 56% said that they had brought forward the timing of investment and 71% said that they had increased the scale of their investment, compared to what they would have done without the scheme. This suggests that at least 81% of respondents acknowledged that the payments under Tir Gofal for field boundary work had had some form of additionality, in respect of scheme results (Wales Audit Office, 2007).

The Wales Audit Office (2007) report on Tir Gofal states that most farms in the scheme had undertaken hedgerow management and there has been significant investment in stone walls and other boundaries. However, it was also noted that there was no reliable baseline information available on the overall length and condition of traditional boundaries in Wales, nor on trends over time, which would enable these achievements to be put into context.

Monitoring the results of maintenance and enhancement of field boundaries in the Tir Cymen scheme found that suitable capital works programmes had been initiated and that the restoration and/or maintenance of existing boundary features in 92% of sites sampled had been successful. The standard of capital works was also assessed and it was found that 84% of agreement holders had carried out works to an acceptable standard (Medcalf & Pawson, 1999).

BOX 6. LANDSCAPE CASE STUDY: MAINTENANCE AND ENHANCEMENT OF FIELD BOUNDARIES

Traditional field boundaries, which includes hedges, dry stone walls, earth banks, slate fences and ditches, are key components of agricultural landscapes across the UK. The materials of construction and the patterns of enclosure help to define the character of local landscapes reflecting farming history, crafts and traditions. The concentration and specialization of agricultural production onto fewer but larger farms which employ less labour has resulted in the rationalisation of field patterns and the removal of traditional field boundaries across the UK. This has often been accompanied by a reduction in the level of maintenance of the remaining traditional boundaries and their replacement by post and wire fencing.

All the main agri-environment schemes recognise the contribution that traditional field boundaries make to landscape character and contain prescriptions for their maintenance and options for their enhancement. According to Dwyer and Kambites (2005) perhaps the most obvious landscape impact of the schemes is where they have been used to enhance the condition of traditional field boundaries and a range of monitoring reports have shown that there has been a substantial uptake of management options for traditional field boundaries across the UK. An impressive array of output statistics has been recorded.

In England, the ESA and CS schemes have funded the planting of over 740 km of new hedgerows and the restoration of nearly 10,000 km of existing hedgerows by 2003. Over 1,100 km of dry stone walls have been restored with commitments under CS for a further 1,500 km. Over the 20 year period 1991 to 2012 Defra will have funded CS restoration works or new planting on some 27,000 km of hedgerow, while ESAs funded some 8,600 km for a shorter period from 1998 to 2004. Between the two schemes, over 40,000 km of hedgerows have been protected and/or restored. This represents around 12% of the estimated total hedgerow stock in England

In Wales, by January 2007, the Tir Gofal scheme had funded the management of 3,739km of hedgerows and 478km of dry stone walls, stone faced earth banks, earth banks and slate fences. In Scotland, RSS has funded a range of traditional field boundary management operations including the restoration of 427km of hedgerows. In Northern Ireland, between 2004 and 2008 over 1,760km of traditional field boundaries were restored under the ESA and CMS schemes. Of this total, CMS accounted for 1,536km (87.3%). In the winter of 2007/2008 around 600km of field boundaries were restored by over 6,100 participants.

Agri-environment scheme monitoring reports and evaluations have generally assumed that landscape character will be reinforced by the maintenance and restoration of traditional field boundaries. Output statistics, in the form of the length of boundaries entered under different management options, have often served as a proxy measure for the success of the schemes. These studies generally conclude that the schemes have been successful in maintaining traditional boundaries and field patterns on agreement land but enhancement has been limited. These studies also report that there has been an increase in the length of post and wire fencing on both agreement and non-agreement land and this is considered to have a detrimental impact on landscape character. A study of the landscape benefits provided by the ESA and CSS hedgerow measures in England concluded that both schemes have been instrumental in facilitating hedgerow restoration works throughout England and in particular enhancing the hedgerow network through planting, and through encouraging laying (Catherine Bickmore Associates, 2004).

2.7.4 Overview of monitoring

Dwyer and Kambites (2005) concluded that despite the rather piecemeal collection of evidence in some of the UK's regions, landscape protection and enhancement was likely to be achieved to a relatively high degree within UK AES because the great majority of scheme agreements have resulted in the strengthening of landscape components, compared to what has happened on land outside the schemes. However, they also concluded that this had to be set in context when considering the extent and pattern of scheme uptake in different regions. The pattern of uptake was an issue that was also raised in the Ecoscope (2003) review of ESAs and CS. Where ESAs showed a high degree of uptake with a large proportion of land entered into agreements, this may provide additional value through the provision of large blocks of contiguous managed land and connected landscape components. This was seen as an important advantage of ESAs in comparison with CS, where agreement land may suffer from dispersion across a farmed landscape.

Ecoscope (2003) concluded that the agri-environment schemes in England (ESA and CSS) had been successful in relation to their principal landscape objectives of maintaining valued landscapes. Nine ESAs were judged to be successful in maintaining and enhancing landscape value, whilst all (13) others were either partly successful or at least maintained landscape value. Twelve ESAs were considered to have had a positive programme of maintenance implemented and on this basis it was likely that overall landscape quality has been enhanced for these ESAs. The main landscape benefits of the scheme were the maintenance of landscape features and the prevention of deterioration due to changes in management. The comparison of agreement and non-agreement land provided evidence that without the scheme the landscape would have been detrimentally affected by changes in land use management. It was concluded that the ESA scheme had contributed to the maintenance of characteristic landscape components and also contributed to the maintenance and enhancement of landscape character.

In Wales, the monitoring programme for the ESA scheme conducted by ADAS found that landscape character, in terms of land cover and field boundaries, had been maintained in five of the six ESAs. Evidence of widespread enhancement of landscape character was not found in any of the ESAs. Comparison of land cover and field boundary change between agreement and non-agreement land found that there was a higher degree of detrimental change on non-agreement land in two ESAs.

McAdam *et al*. (2006) concluded that the main landscape benefits of the ESA scheme in Northern Ireland have been the maintenance of key land cover and boundary components that contribute to landscape character and the prevention of deterioration due to changes in land use management. This has been shown by a comparison of agreement and non-agreement land. There has also been landscape enhancement in some ESAs through increases in characteristic landscape features. In general the scheme was considered to be positively contributing to the overall maintenance of landscape resources.

For CS, the monitoring studies indicate that the scheme was successful in achieving its landscape objectives on the basis of scheme results assessed by expert judgement, with a high proportion of agreements being judged as potentially effective in maintaining and enhancing the landscape. In total, 74% of sample agreements were judged to be meeting the objectives relating to landscape conservation and

enhancement, and 93% of sites with capital works were judged as meeting objectives relating to local landscape character (Ecoscope, 2003).

The Wales Audit Office (2007) report concluded that the evidence about Tir Gofal's actual impact on the environment relative to other factors was inconclusive. Only limited data was available about the scheme's impact, and output data were used as a proxy indicator of the scheme's success. The report stated that while landscape beauty is a subjective judgement, Tir Gofal had made a significant contribution towards features that were generally accepted as enhancing the visual appeal of the landscape. Under the scheme, £7.5 million has been spent on restoring traditional boundaries, and the creation of new woodland and arable land under the scheme will help to create a more diverse landscape.

2.7.5 Summary

The ESA monitoring excercises for all four UK countries give robust evidence of positive scheme results in respect of landscape protection and (to a lesser extent) enhancement, indicating clear additionality in most cases.

The short-term results monitoring for CS indicates that this scheme was appropriately designed to encourage positive landscape impacts in the overwhelming majority of agreements, but longer term monitoring and appraisal in respect of individual character areas would be required in order to assess actual impacts in context. In respect of other AES in the UK, evidence for landscape benefits so far rests mainly upon the scale of scheme outputs in respect of landscape feature management and restoration, but proper assessments of landscape impacts are lacking (athough there was some attempt to look at this in the thematic studies of e.g. hedgerow management).

2.8 Access

2.8.1 Background

A feature from the outset of agri-environment schemes in the UK (notably England and Wales) has been the inclusion of options to improve the provision and quality of access to farmland. The key components of access provision (in England and Wales) include general public access, and educational access[15].

- **General public access** is most often through the creation of permissive access routes or areas that connect with the public footpath network, or the upgrading of facilities for existing access provision through Public Rights of Way (PRoW). Management of PRoWs is excluded from AES as this is a legal requirement of landowners.
- **Educational access** requires farmers to open their farms to visits from school children and adult groups of all sorts and to develop suitable interpretive information, often delivered by the farmers themselves.

An increasingly wide range of government departments have highlighted the benefits of walking and it remains the most popular recreational activity within the UK. The quality of the countryside is seen as a keen motivator for both residents and visitors to spend time and money in the countryside, but this requires that the countryside is accessible, with the right amenities and resources to facilitate public enjoyment.

The Countryside Premium Scheme was the first agri-environment scheme to offer farmers payments for access on set-aside land. This was run as a pilot scheme by the Countryside Commission and closed in 1991, being replaced by a national scheme, the Countryside Access Scheme. This closed in 1999 and provisions were included in Countryside Stewardship (CS) for both linear and open access and as an option in ESAs as early as 1992. Within Wales, enhancing access provision was a core part of Tir Cymen and subsequently Tir Gofal, as well as ESAs. Tir Gofal also offers educational access. In Scotland and Northern Ireland, payments for access provision are referred to as part of the ESA provision.

In the last few years different legislation has been developed for the various UK countries, for England and Wales the Countryside Rights of Way Act was introduced in 2000, while in Scotland the Land Reform (Scotland) Act was passed in 2003. This has implications for what would be appropriate to fund under agri-environmental schemes. For example in Scotland the legislation grants a right of responsible access to most land and water, so permissive agreements are generally not required.

2.8.2 Key sources of evidence and quality

Within England, the review by Ecoscope (2003) summarised the evidence gathered regarding impact of the ESA and CS schemes on access in England up to 2000-01. This study highlights the wide variability in benefits derived from access options and the fact that little work on usage had been undertaken. The review focused on educational access within CS and access options within ESAs.

[15] This distinction is not made in Scotland.

Bentley (2001, 2002 & 2003) undertook a detailed analysis of 30 access agreements, looking at the files and interviewing the farmers, under CS and ESA in Shropshire, Staffordshire, and Derbyshire/Peak District. This analysis was followed up with a postal survey of PRoW officers, countryside staff and FRCA agri-environment managers.

ADAS (2007) completed a study reviewing the educational and disabled access in England through telephone interviews with agreements holders, both current and lapsed. ADAS also provided a review of access within both CS (Finch & Slater, 2003) and ESA (Slater, 2003) largely based on centrally gathered figures but with some interview based material.

There have been no other new studies assessing the access provision of agri-environment schemes (AES) in England since the introduction of the Countryside Rights of Way (CRoW) Act in 2000, which provides access to 'open countryside', deemed to be downland, heathland, moorland and mountain and registered common. This has clearly reduced the need to offer farmers and landowners access options within AES where there are large areas of CRoW land, because there is a plentiful supply of available access land as the figures from the mid-term review of ESAs and CS suggest (Slater, 2003; Finch & Slater, 2003). There remains a need to consider accepting linear access in areas where CRoW land is less plentiful and this can help link up these areas to the existing network. The CRoW Act also requires all local authorities to submit Rights of Way Improvement Plans (RoWIPs), which should highlight the condition and suitability of the public rights of way network. This is similar to the work undertaken in Scotland, outlined in the case study (Box 7).

Within Wales, the first scheme to offer access provision was Tir Cymen, and this was a basic condition of scheme entry, on any areas defined as 'open country'.

The Welsh Audit Office (2007) report, based on a review of scheme information, concluded that Tir Gofal had increased the public's opportunities for access to the countryside, but problems remain about partnership working, permissive access and educational access. The most extensive survey of rights of way in the UK was undertaken by Exegesis (2003) in Wales. The core survey assessed the condition of 3,283 km of rights of way within 225 randomly selected survey squares. The length of paths surveyed was calculated to provide statistically reliable and representative information about path condition within each authority area. It was therefore able to assess the condition of access within and outside AES agreements as they appered within the grid squares. The research team were only able to ascertain farms within the grid square that were involved in AES schemes and those that were not. Therefore, apart from the need to meet legal requirements regarding access, it could not be ascertained whether access was a specific part of the AES agreement for those farms within such a scheme.

As has been noted earlier, there are substantially fewer PRoW over farmland in Northern Ireland compared to England and Wales. As a result, although both ESAs and the Countryside Management Scheme (CMS) offer access provision as a management option (for example offering payments for stiles and footpaths), there are no actual figures within the evaluations in relation to access provision by AES. However, the McAdam *et al.* (2006) survey noted that a 1998 survey indicated that 50% of those in ESAs would be willing to consider access provision compared to 35% of non-participants.

BOX 7. ACCESS CASE STUDY: PROVISION OF PERMISSIVE ACCESS IN PEMBROKESHIRE AND FIFE.

The case study focuses on Wales, where before and following the introduction of the CRoW Act, there was an attempt to 'link' areas of open access, which were largely on the higher slopes, with the RoW network, which was predominately focussed on the lower slopes and valley bottoms. This is contrasted with a non-AES scheme in Scotland.

Recent data (December 2007) indicate that 516km of new linear permissive access routes have been created by Tir Gofal and 4,187km have been maintained within agreement land. Through a Tir Gofal agreement, an agreement holder has developed a two kilometre permissive footpath, which links into the existing public rights of way network, including two circular walks (Nine Wells, Ogof Castell and Solva, Segor Rock) and the Pembrokeshire Coast National Trail near Solva within the Pembrokeshire Coast National Park. The route created extends existing access provision in a tourist 'honey-pot' and provides users with an additional route to explore coastal farmland and view features of wildlife importance. Appropriate signage has been produced; a Tir Gofal Permissive Access board at the farm has been installed and Pembrokeshire Coast National Park has displayed signs on site near the route at Solva. The route will also link to the All-Wales Coastal Path, which is a Welsh Assembly Government commitment.

While the above is a good example of what can be achieved within AES, Swales *et al* (2005) provide some very interesting counter-evidence of what can be achieved outside of AES. However, the model could easily be included within AES and may provide a stronger model in areas where there are few PRoW. The report into the environmental priorities of the rural development schemes notes that as in the other parts of the UK, facilitating public access to the countryside and maintaining the existing network were considered as important environmental issues by stakeholders in Scotland. However, unlike the rest of the UK, there are complications across Scotland with community land rights.

The 2003 Land Reform (Scotland) Act was the result of a lengthy consultation during the 1990s. Following the passing of the Act, the Scottish Outdoor Access Code was approved in July 2004, with both coming into effect in February 2005 to create a framework for responsible access to land and inland water for recreation and passage. The Act gave everyone a right of responsible access over most land in Scotland on foot, cycle, horseback and canoe. Local authorities and National Park Authorities also had new duties to:

- Prepare a Core Paths Plan to provide a good network of paths for all users;
- Uphold access rights;
- Establish at least one local access forum in each of their areas with a balanced membership representing recreational and land management interests; and
- Publicise the Scottish Outdoor Access Code.

Following the passing of the new legislation Fife Council invited all stakeholders (as required by the legislation) to comment on the Core Path Network for Cupar and the surrounding area. The aim was to integrate access with the needs of landowners and residents. Little use has been made of AES to fund either access provision or management in the Fife area. However, across Scotland there are suggestions that the uptake of the LMC access options have been increasing but from a low base. Within 6 months the Fife initiative had resulted in 328 participants taking 2,064 walks (Swales *et al* 2005)

In the view of Swales *et al* (2005) as this new system becomes embedded it should provide a framework for the access options of AES to be used to assist in local authorities in the delivery of their responsibilities in this area.

An extended version of this case study is provided in Appendix 4.

2.8.3 Key findings

2.8.3.1 General public access

It seems clear that most of the agri-environment schemes in the UK have provided increased amounts of public access to the countryside, either through new or enhanced paths or area-access sites, or through supporting the provision of 'access events' including educational access. In England about 15% of agreements include access options. In some schemes (notably England) this provision has involved the creation of new permissive rights of access while in others it has more to do with facilitating access via the enhancement of access facilities (stiles, gates, resurfacing or clearing obstructions, signage and accompanying directional materials).

For example, the CCW and FRCA evaluation (1999) of the first three years of Tir Cymen concluded that after only three years, some 27.6 square kilometres of farmland (primarily moorland and upland grassland) was available for new public access. This constituted some 8.6% of the total area of secured access within Wales. In addition, a further 700 kilometres of PRoW were incorporated into agreements, along with 43 kilometres of new permissive paths. Taken together these totals comprised some 2% of the total length of linear access provision within Wales. Whilst the monitoring discovered some isolated instances of obstruction on PRoW, these tended to occur on routes that were perceived by farmers as not being used anyway.

The Ecoscope (2003) review in England noted that the Countryside Access Scheme closed in 1999 with 141 agreements providing 84.2 hectares of access routes and 1627 ha of open access. By 2000, CS agreements included 1,172,146 m of PRoW, 13,126 ha of open access, 719,216 m of bridleway and 22,247 m of disabled access routes. The report notes that there was a greater level of take up within CS and early evaluations by LUC (1995 and 1996) suggested that two-thirds of these agreements provided good value for money (judgments made on the basis of expert opinion during site visits). However, these earlier evaluations were criticized and the approach changed. Within ESAs by 2002 there were access agreements in 16 of the 22 English ESAs. Of the 104 agreements, 27 were in the Lake District. The overall target for ESA access provision was very small, at only 119 hectares. Ecoscope reported in 2002 that Defra was not promoting access as an option in ESAs, although it was still available as part of the scheme menus. The fact that many ESAs were designated on land which was already well used for public access (e.g. national parks, coastal areas) could be one reason why new access was not prioritised, within agreements.

The latest figures provided as part of the mid-term review of the England Rural Development Programme (Slater, 2003; Finch & Slater, 2003) suggest limited targeting for access. The general approach for AES has been to target, in discussion with local access authorities, where new access was likely to yield good value for money. The provision of new access within ESAs was noted as very low. Notably, they found that scheme participants were wary of the access options following the introduction of the CRoW Act. Rather than the provision of new permissive access, the key concern within schemes had changed to ensuring or facilitating the appropriate management of open access.

The SEERAD mid-term evaluation (2004) notes that ESAs offered access over Scottish farmland in the past as a voluntary option, but there was very little take up.

Access has not featured strongly in agri-environmental measures in Scotland until relatively recently. The law on public access within Scotland has been changed considerably by the Land Reform (Scotland) Act 2003, and means that schemes cannot pay for the right of access, only its appropriate management, facilitation and promotion. The uptake from farmers for the access options of the LMC Menu Scheme introduced in 2005 was high, with 406 involved in hosting farm and woodland visits (£100 per visit) and 4,145 farmers developing 2,400 km of new access paths (£2.75 per metre). For example, the *LMC Menu Scheme Policy Analysis Research Project* says that 474.6 kilometres of paths will be maintained on land throughout the country under the scheme for five years. This report recomends the clarification of 'eligible paths' so that the evidence of public benefits is clearer (e.g. links with wider path networks, but including local and informal networks as well as core paths).

The clear evidence of outputs and results in respect of UK AES access (with the notable exception of Northern Ireland schemes, which do not promote access) does not always reflect equally strong impacts. One of the biggest obstacles to assessing the value of access benefits provided from the schemes is the lack of studies examining access demand, and considering the quality of the public access experiences provided through schemes, in comparison with what would have existed without them. In the evaluations of CS and ESA access, there were no figures on the usage of new access, making value for money assessment uncertain (Ecoscope, 2003). In the few studies where wider aspects of value are considered, the evidence to support scheme benefits is less clear.

From the supply side, there is some evidence of additionality: the economic review of CS (Crabb *et al.* 2000) asked agreement holders what would happen to the different parts of their agreement if it was not renewed. With regard to permissive access routes established under CS, 45% indicated that the access created under the 10-year scheme would stop when the scheme ended.

In a review of access provisions within CS and ESAs, Garrod *et al.* (1998) concluded that the 'value for money' for access provision was low because too few agreements effectively linked into the existing network and provided access routes that met public demand. Given the 10 year timeframe for the agreements, there was too little time for the routes to become established and known among users, and therefore only a few schemes delivered excellent value for money, in their view.

Bentley (2001) developed a similar critique to that put forward by Garrod *et al.*, (1998), but set within the wider context of local area provision of access, viewed from the perspective of rights of way work. He concluded that the general access provision under AES did not fit into the work programme of PRoW officers within local authorities, and thus offered little value for money. This was partly because the discussions with farmers and land owners were conducted with an AES project officer who may not be in contact with the access staff in the local authority and has very little knowledge or experience of the mechanisims as they only do one or two agreements every couple of years. He also concluded that provision under AES was generally supply-driven rather than demand-led, meaning that there is also little connection between, and calculation of, supply and demand for access, in many cases. Nevertheless, he reviewed some good practice in a number of case studies which highlighted the benefits of, and need for, a more targeted approach that integrates schemes into the existing network.

The Exegesis (2003) study, based upon a sample of 12% or 76km of the rights of way in Tir Gofal areas, found that the condition of paths on Tir Gofal farms was

generally no better than the average for all of Wales, and the signposting of paths from roads was slightly poorer. These figures suggest low or no additionality in respect of the quality of access, as a result of AES. The Welsh Audit Office report (2007) also noted that permissive access areas in Tir Gofal are not monitored, but evidence suggested that such areas are not widely or clearly promoted.

It would appear from the findings in England and to some extent Wales that there is a case for schemes having improved the management of existing access. This is largely in the form of enhanced facilities and quality of provision, such as the re-grading of an existing access route so that it is suitable for disabled access. The situation in Scotland is broadly positive, with the potential benefits of the new funding being welcome by access interests, but ongoing efforts may be needed to integrate this provision with that provided by other routes.

2.8.3.2 Educational access

The Welsh Audit Office (2007) report found that some 4,200 educational visits had taken place as a result of the Tir Gofal scheme.

Curry and Short (1998) reviewed 50 CS agreements, through assessment of the agreement and by interviewing the farmer, that included the educational access option, and found that only a few had a strategic approach to offering educational visits. Therefore the level of additionality (i.e. offering something not available before) was questionable in 50% of agreements.

The Ecoscope report (2003) reviewed the above report and other internal Defra documents and presented a mixed picture for educational access under CS. They concluded that the option provides new educational access opportunities, but the demand from schools and colleges was low and their experiences were apparently mixed.

ADAS (2007) reviewed the educational access provisions available under Environmental Stewardship (ES) and found that teachers valued the opportunity that ES offered, through educational access. However, the study also highlighted that increasing transport costs and a lack of awareness about the Countryside Educational Visit Accreditation Scheme reduced the potential value of the trips for all concerned. Interviews with farmers whose educational access option had lapsed found that in nearly all cases the main reason for not continuing with this option was that they could not secure the required number of visits from schools. The Welsh Tir Gofal evaluation (Welsh Audit Office, 2007) found a similar phenomenon in respect of educational access in Wales. The ADAS report concluded that the future of educational access is strong, once the perceptions of high risk associated with outdoor activity can be overcome. Health and safety is an issue that concerns teachers, but recent changes to the ES scheme to emphasise careful planning of this aspect had been welcomed by agreement holders.

Educational access has not been available in AES in Northern Ireland. Within Scotland, educational visits linked to the natural or cultural heritage fall within access rights. As a result, there is no need for educational access within the AES options. Grants are offered to farmers for farm visits and talks.

One common recommendation from the evaluation studies is that AES need to develop strategies that make better use of information regarding both access supply and demand, within the surrounding area, in order to maximise the benefits of this provision within schemes. The SEERAD (2004) report concludes that the

development of a core plan by local authorities that looks at demand as well as the condition of supply, as outlined in recent legislation, would be a sensible way to assess the value of access provision within schemes. Where new access is concerned, the evaluations appear to suggest that one of two criteria should be demonstrated.

- AES project officers should make use of local authority information regarding access provision, such as the RoWIPs in England and Core Path Plans in Scotland. Access within an AES agreement can then be used to implement these plans; or
- where new access is included with an AES application in England, there would need to be strong local support for the initiative from local residents and/or businesses, on the grounds that the proposals would improve facilities in the area.

Finally, it would seem worthwhile to develop clearer targets and guidance on what AES are looking for within the access provision elements of the schemes. There also needs to be more rigorous and wide-ranging evaluation, to test the user benefits of access within AES.

2.8.4 Summary and Conclusions

It is clear from the monitoring evidence that UK AES have given rise to a significant number of new permissive access routes and open access opportunities in England and Wales, and to some degree of enhanced accessibility to farmland in Scotland. Limited evidence suggests that these opportunities provide additionality in respect of access options for the public, compared to what would exist without the schemes. These studies indicate positive outputs and results from the schemes, therefore, but no evidence of actual scheme impacts.

There is good evidence from case studies that in some situations, well-designed and targeted new access routes and areas can offer good value from a user perspective, linking existing routes to create new paths or facilities in areas which are already well-known and enjoyed by high numbers of users. However, these case studies contrast with broader evaluation work suggesting that this is not 'the norm' in respect of access within agreements, generally. The implication is therefore that the schemes' impact upon public enjoyment from access to the countryside is much lower than it could be if it were planned more strategically and with more reference to local access needs and opportunities in the context of existing access provision outwith the schemes.

The biggest challenge in attempting to assess the impacts of access provision within UK AES is the lack of monitoring or evaluation which assesses the demand for new access and the level of use and quality of the access experience, for sites and routes once created.

2.9 Resource protection

The objectives of agri-environment schemes have traditionally been focussed on protecting and enhancing biodiversity, habitats, landscapes and historic features rather than soil and water quality, partly because other policy mechanisms (e.g. Nitrate Vulnerable Zones) exist to address resource protection. Nonetheless, some measures taken to protect habitats etc. can also play a role in resource protection. In England, resource protection is now a primary objective of Environmental Stewardship (ES), and the descriptions of ES options explicitly state resource protection as a likely benefit for 25% of the options in ELS, over half of which are attributable to buffer strip options alone. The equivalent figure in HLS is 15%. Indirect benefits (i.e. where implementing the option is likely to be beneficial to resource protection, but this is not the primary aim of the option, as specified in the Handbook) may be achieved by a further 27% of ELS options and 39% of HLS options. Overall, therefore, around 50% of all ES options are likely to have some benefit for resource protection, although the extent of the benefit may be very small. Similarly, the objectives of Tir Gofal are to protect habitats, the historic environment, rural landscapes and to promote public access to the countryside; only the recent Tir Cynnal gives protecting water and soil quality as one of its objectives. As part of Tir Cynnal agreements resource, manure and nutrient plans have to be completed. However, to be accepted in Tir Cynnal farmers only have to make plans, they do not have to implement them.

The absence of resource protection as an objective in most previous agri-environment schemes means that there has been no evaluation of the schemes in relation to the protection of soil and water, hence data in this area are lacking. Water quality was an objective of the Water Fringe option of the Habitat Scheme, but the water quality assessment was based on desk review and relied on anticipated benefits rather than measured impacts (McLaren, 1998). A review of agriculture as a source of phosphorus in Northern Europe concluded that it was too early to detect trends in the impact of catchment sensitive farming in the UK and Ireland (Ulen *et al*., 2007). Perhaps the best evidence of the resource protection benefits of managing farmland more sympathetically is that provided by the Countryside Survey (2000). This recorded a 25% improvement in biological condition of streams and small rivers from 1990-1998, with only 2% of sites deteriorating. In order to evaluate the performance of agri-environment schemes on resource protection more specifically, it has been necessary to draw on research underlying the processes through which protection may be achieved and to determine the likely benefits of the schemes. Accordingly, this section is differently structured from preceding sections, where the emphasis has been on reviewing evidence from evaluations of agri-environment scheme impacts.

The agri-environment schemes in the different countries of the UK propose similar land management techniques in order to reduce diffuse pollution, where this is addressed. Because it has the widest range of options to address this issue, England's Environmental Stewardship has been taken as an example in the following discussion of the impact of agri-environment schemes on soil and water quality. Those explicitly linked to resource protection in the ES Handbook are listed in Table 2.5. Buffer strips account for over half the ELS options with a 'direct' benefit to resource protection and these are considered separately in the case study (see Box 8 and Appendix 5). Although other schemes such as Scotland's Rural Stewardship Scheme and Northern Ireland's Countryside Management Scheme do not highlight resource protection as a benefit of the agri-environment schemes, many of the advocated land management practices are similar between schemes in the different countries, thus the overall impact will be comparable.

Table 2.5 ELS and HLS options designed to protect resources as stated in the Handbooks

Code	Option title	Benefit 1 – Reduction of:	Benefit 2
EE01	2m buffer strips on cultivated land	Agrochemical/manure input	Buffer
EE02	4m buffer strips on cultivated land	Agrochemical/manure input	Buffer
EE03	6m buffer strips on cultivated land	Agrochemical/manure input	Buffer
EE04	2m buffer strips on intensive grassland	Agrochemical/manure input	Buffer
EE05	4m buffer strips on intensive grassland	Agrochemical/manure input	Buffer
EE06	6m buffer strips on intensive grassland	Agrochemical/manure input	Buffer
EE07	Buffering in-field ponds in improved grassland	Agrochemical/manure input	Buffer
EE08	Buffering in-field ponds in arable land	Agrochemical/manure input	Buffer
EF07	Beetle banks	Agrochemical/manure input	Buffer
EG01	Under sown spring cereals	Agrochemical/manure input	
EJ01	Management of high erosion risk cultivated land	Risk of erosion	
EJ02	Management of maize crops to reduce soil erosion	Risk of erosion	
EK02	Permanent grassland with low inputs	Agrochemical/manure input	
EK03	Permanent grassland with very low inputs	Agrochemical/manure input	
EL02	Manage permanent in-bye grassland with low inputs	Agrochemical/manure input	
HC09	Creation of woodland in the LFA	Agrochemical/manure input	
HC10	Creation of woodland outside of the LFA	Agrochemical/manure input	
HC15	Maintenance of successional areas and scrub	Agrochemical/manure input	
HC16	Restoration of successional areas and scrub	Agrochemical/manure input	
HC17	Creation of successional areas and scrub	Agrochemical/manure input	
HD07	Arable reversion by natural regeneration	Agrochemical/manure input	
HD08	Maintaining high water levels to protect archaeology	Runoff	
HJ03	Arable reversion to unfertilised grassland to prevent erosion or run-off	Risk of erosion & runoff	Reduced agrochemical /manure input
HJ04	Arable reversion to grassland with low fertiliser input to prevent erosion or run-off	Risk of erosion & runoff	Reduced agrochemical /manure input
HJ05	In field grass areas to prevent erosion or run-off	Agrochemical/manure input	Buffer
HJ06	Preventing erosion or run-off from intensively managed improved grassland	Stocking density	Reduced agrochemical /manure input
HJ07	Seasonal livestock removal on grassland with no input restriction	Stocking density	
HJ08	Nil fertiliser supplement	Agrochemical/manure input	
HL13	Moorland re-wetting	Runoff	
HL16	Shepherding	Stocking density	

BOX 8. RESOURCE PROTECTION CASE STUDY: BUFFER ZONES

Buffer strips can include grass margins, field margins, filter strips, and streamside corridors, and they have been the subject of a substantial amount of published research in recent years. Buffer strips are considered to be a key management tool for delivering the objective of reducing water pollution, and enhancing the status and preventing further deterioration of aquatic ecosystems as required by the Water Framework Directive. They are supported under a number of agri-environment schemes including ES in England, Tir Gofal in Wales, and CMS/ESAs in Northern Ireland.

The uptake of 6m buffer strips on arable and grassland in England increased from *c* 1300 and 250 respectively in CS to *c*. 5500 and 1300 in ELS. There has been an increase in uptake of buffer strips in ELS of *c* 20% in arable areas and *c* 60% in grasslands since September 2007. The area covered by 4m and 6m buffers in England is nearly ten-times larger in arable land than on grassland, whereas in Northern Ireland there are larger areas of ungrazed grass margins than rough grass crop margins. This may reflect the different dominant farming types in the two countries.

There are two main types of buffer strips - riparian and in-field. The benefit of in-field buffers along existing features such as hedges or stonewalls may be limited as the feature already creates some barrier to the movement of soil and pollutants therein. However, there are no data on the impact of non-riparian buffers along existing features in the field. A single study on in-field buffers introduced away from existing features demonstrated that these could reduce nitrate losses to watercourses and are likely to reduce sediment and P losses, but more work would be required to extrapolate the findings more widely.

Riparian buffer strips have been investigated more thoroughly. Riparian buffer strips have the potential to protect watercourses in a number of ways. First, they distance farming activities from the watercourse (with the exception of buffers on grassland in England). On the whole, the use of fertilisers, manures, and pesticides is prohibited on buffer strips thus direct losses to the watercourse during application will be reduced. Where livestock are concerned, restricting access to the watercourse by using a fenced buffer will prevent direct defecation into the watercourse, and poaching of the stream bank. The second mode of action for buffer strips is that they can filter out sediment and pollutants contained in runoff from upslope – this is influenced by the vegetation type.

The scientific evidence has demonstrated that the effectiveness of buffer strips in protecting watercourses varies according to the prevailing conditions, and the location of a buffer strip in relation to the pollutant source or pathway is of paramount importance in determining its performance in protecting water quality. Although buffer strips can retain sediment and thus prevent further soil erosion they do not serve to protect the soil from which it came; i.e. buffer strips attempt to address the impacts of pollution rather than the causes. Buffer strips should therefore be considered as a secondary conservation practice, after controlling the generation of pollutants at their source. Buffer strips are only effective if they are carefully designed, installed and maintained, and accumulated sediment must be removed occasionally to maintain effectiveness. It has been proposed that the maintenance of buffers at specific locations, e.g. where flow converges, may be more effective than the widespread distribution of buffers. A further issue to be considered is that of pollution swapping. If buffers are effective at reducing nitrate losses to watercourses, unless the vegetation on the buffer is harvested, nitrogen losses from the system will still occur via denitrification and the production of nitrous oxide, a greenhouse gas.

Designing the size, nature, and location of a buffer strip in relation to requirement will provide the greatest potential protection of soil and water. The primary benefit of generic buffers will be to limit direct losses to watercourses during application and to prevent poaching and direct defecation, where applicable. There is evidence for pesticides that the reduction in direct losses increases with increasing width of buffer.

Options in both ELS and HLS designed to protect resources other than buffers, achieve this protection primarily from a simple reduction in initial inputs (pesticides, inorganic fertilisers, organic manures), either because the prescription requires lower inputs, or there is a change of 'crop type', thus inputs are intrinsically lower (e.g. from arable to grassland, or scrub). Similarly, benefits to soil quality arise from changes in land use (e.g. no maize on high risk land), or a reduction in stocking density (either a direct prescription, or greater restriction in grazing times/frequencies). Soil and water quality are, on the whole, intrinsically linked. Preventing soil erosion reduces sedimentation of water and the transfer of pollutants such as pesticides and phosphorus that may be bound to sediment. Compaction of the soil reduces infiltration rates and increases the likelihood of runoff which then has the potential to cause soil erosion elsewhere and transfers pollutants. The discussion below does not therefore attempt to address soil and water quality separately.

The evidence of the resource protection benefits of beetle banks and undersowing spring cereals is limited and can be conflicting. With the exception of the Defra-funded MOPS project (Field testing of mitigation options; PE0206), there has been little research specifically into the effect of beetle banks on reducing soil and water pollution, and the evidence of their performance is necessarily derived from research conducted on in-field grass strips. The findings of PE0206 demonstrated great variability between the in-field replicates so that any observed benefit of beetle banks (in conjunction with contour ploughing) was not statistically significant, and the effect of disturbing tramlines (or having no tramlines) was substantially more successful at reducing runoff and associated phosphorus (P) and sediment losses than beetle banks. Blackwell *et al* (1999) have demonstrated that in-field grass strips can be more effective at reducing erosion and leaching compared to riparian buffers. Moreover, it is noted in the ES Handbook that the beetle banks must be very carefully positioned to avoid creating preferential pathways for runoff, thus exacerbating pollution issues. It may be that the effectiveness of beetle banks in protecting resources is site-specific, hence generic conclusions may not be drawn with any confidence.

It is suggested in the ELS Handbook that undersowing spring cereals with a grass ley containing legumes will reduce the requirement for agro-chemical inputs, as the legumes should provide a source of nitrogen. Whilst there has been research in to the benefits of forage legumes (e.g. Anon, 2005a; Anon, 2005b), there has been little specific published research into the impact of legumes in undersown spring cereals on soil and water quality. Legumes are not as effective as non-legumes at removing soil water nitrate, and they can add substantial amounts of nitrogen (N) to the system (Thourp-Kristensen *et al*., 2003). Hansen *et al*., (2000) reported that destroying a rye cover crop undersown in spring wheat resulted in a 25% increase in nitrate leaching compared to land without a cover crop (for a sandy soil, thus results may not necessarily be extrapolated to other soil types). Nevertheless, the presence of a cover crop on soils vulnerable to nitrate leaching (i.e. sandy) can reduce nitrate leaching (Shepherd, 1999; Askegaard *et al*., 2005). On other soil types, the benefit of cover crops is variable, and cannot necessarily be proven (e.g. Richards *et al*., 1996; Shepherd and Webb, 1999; McDonald *et al*., 2005) with other factors (e.g. rainfall, previous cropping practices) potentially being more influential in determining nitrate losses. Indeed, a cover crop can be ineffective if it is not well established prior to early/mid September (Lord *et al*., 1999) and the timing of incorporation significantly influences nitrate leaching, with losses being greater if cover crops are incorporated rather than removed (Thomsen, 2005).

The Defra-funded study SP0404: Soil erosion control in maize (Anon, 2001) highlighted the importance of soil type in the effectiveness of mitigation measures to reduce runoff. Although a clover understorey in maize did reduce runoff by around 80%, yields were also reduced by 40%. Creating a rough surface by chisel-ploughing reduced runoff by at two experimental sites, but sowing a cover crop enhanced erosion at the same sites. Conversely, chisel-ploughing on a lighter soil at a third site greatly increased runoff. Thus the measures outlined in the option for 'Management of maize crops to reduce soil erosion' (EJ2) do have the potential to reduce runoff and erosion, but they must be carefully chosen in relation to individual sites.

There is a reasonable assumption that restricting N input to a maximum quantity of 100 kg total N/ha on permanent grassland (EK2) and in-bye (EL2) will lessen water pollution, as there is evidence that nitrate leaching from grasslands increases with N input, and for inputs above around 250 kg N/ha nitrate losses can exceed those from arable areas (Lord et al., 1999). A reduction from high fertiliser rates to 100 kg N/ha would therefore reduce the potential for nitrate leaching and benefit water quality. The average field application rate on grassland is already around 100 kg N/ha (2003-2007 average < 108 kg N /ha with a continuing decline to 99 kg N/ha in 2007; British Survey of Fertiliser Practice, 2007). The potential for a reduction in nitrogen leaching is very small when inputs are less than 100kg N/ha (ADAS, 2007a; D3) and a study that investigated the impact of lower rates of fertilisation found that there was no significant difference in N loss between mown grass when it was unfertilised, or when it received a low (60 kg N/ha) fertilisation rate (Malisauskas *et al*., 2005). Moreover, nitrate losses from unfertilised set-aside grassland (*c.*4 kg/ha/yr) were twice that of the mown grass (*c*. 1.7 kg/ha/yr), even though the latter received a low fertiliser application rate (60 kg/ha); nitrate losses from set aside were attributed to mineralisation of residues whereas the removal of vegetation from the mown grass could have contributed to lower nitrate losses in drainage water. The benefit of ES options that reduce fertiliser inputs to grasslands will therefore largely be restricted to those areas where current inputs prior to scheme entry were higher than 100 kg N/ha/yr.

The general consensus is that grazing intensity is a more significant factor in relation to nitrate leaching, and the general decline in fertiliser use on grasslands may be attributed to a decline in stocking numbers. However, there is no specific requirement to reduce grazing intensity in the grassland ELS options. A reduction in fertiliser input to grasslands without a concurrent reduction in stock numbers could result in the need to import feed, which could counteract any reduction in nitrate leaching (ADAS, 2007; D3).

Cuttle *et al*., (2006) estimated that losses of N from arable and dairy farming were similar (50 kg/ha) but only 20kg/ha from beef, and losses of P are 3.8, 2.2 and 1.6 kg/ha for arable, dairy and beef farming respectively. As a rule, nitrate losses from arable land are greater than from grassland (Lord, 2006) thus reverting to grass, particularly low input grassland, from arable is likely to be beneficial to water quality. In addition to the change of land use as a means of reducing inputs, HJ3-6 options require that areas of soil compaction are removed, which will serve to reduce runoff and erosion. The extent of the benefit will be case specific, but it is reasonable to assume that the combination of actions in the 'HJ' options will be particularly beneficial to both soil and water. The in-field grass area is analogous to an in-field buffer which may offer more protection to water courses than a riparian buffer (Blackwell *et al*., 1999).

The creation of woodland is advocated as protecting both soils and watercourses. There has been little research to quantify the extent to which introducing woodlands benefits soil and water quality although it is known that trees can protect soils by maintaining a root structure that enhances infiltration/reduces soil erosion (Broadmeadow & Nisbet, 2004), the physical impact of rainfall is lessened, particularly with a full canopy, less water is available for runoff due to transpiration and the absence of machinery minimises the potential for compaction. The lack of fertiliser input and the utilisation of nutrients by the trees also reduces the potential for pollution of water courses. The siting of woodland along watercourses will be beneficial in distancing farming activities from surface water and retaining nutrients and water entering the woodland from upstream.

It is proposed in the HLS Handbook that moorland re-wetting could assist in reducing diffuse pollution by reducing runoff from the re-wetted area, but there have been no specific studies to support this theory; if anything, rewetting may increase the release of dissolved organic carbon and iron, with potentially adverse effects on water quality (Fenner *et al*., 2001). Manganese may also be released from re-wetted moorlands (Heal *et al*., 2002). There has been more research on re-wetting on fenlands (*cf* moorlands), but, again, it has been demonstrated that peatlands can become a source of nutrients on re-wetting. Kieckbusch & Schrautzer (2007) found that a re-wetted fen retained nitrate, but exported organic N and phosphate; Blackwell *et al* (2004) reported a 100-fold increase in ammonium when land was inundated and a reduction in redox potential (conventionally resulting in an increase in phosphate concentrations), and Rupp *et al* (2004) also reported an increase in P concentrations (which were inversely related to redox potential) on re-wetting. Meissener *et al*. (2008) propose that site-specific knowledge and management of the water table is required to develop re-wetting programmes in order to prevent P pollution occurring. There is therefore little evidence to date to support the theory that moorland re-wetting can reduce diffuse pollution, although it is possible that studies conducted to date have not been of sufficient duration to monitor any long-term benefits.

The Defra-funded project MA01041 (Boatman *et al*., 2007b) is one of the few studies that has attempted to assess the impact of agri-environment schemes on water quality. In this study, losses of N and P for the different options within ELS were estimated using values of N and P losses due to (analogous) mitigation options provided by Cuttle *et al*. (1996). Cuttle *et al*.'s rates of N and P losses (kg/ha) were multiplied by the area affected using ELS uptake data (to September 2007) in order to provide an estimate of total N and P losses for different lowland farming types; the results of which are shown in Table 2.6 and Table 2.7.

The study identified that ELS was likely to provide greater percentage reductions in P losses compared to N, and also that the overall impact of ELS was likely to be quite small, mainly due to the much larger areas of land not covered or affected by ELS options. Although the percentage reductions in N losses for cereal and general cropping were lower than farming involving livestock, the actual reductions were still substantial due to the large area of land covered by cereal and general cropping.

Table 2.6 Total N losses for lowland farm types, with relevant ELS options and without (baseline) excluding Management Plans.

Farm type	N total (kg)			% reduction	
	baseline	ELS min	ELS max	ELS min	ELS max
Cereals	76,183,267	74,854,238	73,241,787	1.74	3.86
General Cropping	32,758,923	32,225,085	31,613,450	1.63	3.50
Pigs/Poultry	515,985	508,581	503,683	1.43	2.38
Dairy	559,857	552,961	536,837	1.23	4.11
Lowland Beef & sheep	3,080,521	2,610,711	2,578,898	15.25	16.28
Mixed	10,349,770	10,113,773	9,699,651	2.28	6.28
Total	123,448,322	120,865,348	118,174,305	2.09	4.27

Source: Defra project MA01041

Table 2.7 Total and mean (kg/ha) P losses for lowland farm types, with ELS and without (baseline) excluding Management Plans.

Farm type	P total (kg)		% reduction	Mean P loss kg/ha	
	baseline	ELS		baseline	ELS
Cereals	4,687,450	4,488,439	4.25	3.08	2.95
General Cropping	2,003,868	1,919,295	4.22	3.07	2.94
Pigs/Poultry	19,403	18,737	3.43	3.35	3.24
Dairy	22,463	21,353	4.94	2.01	1.91
Lowland Beef & sheep	209,937	199,853	4.80	1.69	1.60
Mixed	572,889	564,895	1.40	2.77	2.73
Total (average)	1,136,832	830,877	4.04	(2.66)	(2.56)

Source: Defra Project MA01041

ES supports current good practice as well as stimulating changes to more environmentally beneficial management. In some cases therefore, particularly in grassland and upland farming areas, there may be little change in management practices on scheme entry, where existing practices are similar to those required by scheme prescriptions. For example, 80% of farmers who chose low and very low input grassland options in the uplands (EL2 & EL3) already met the option requirements (Bishop *et al*., 2007), thus whilst it will be beneficial to maintain such practices, there will not necessarily be an improvement in environmental conditions. Similarly, a recent

evaluation of Management Plans reported that for the Manure Management Plan (ELS) "no change had been recorded in the majority of cases, as good practice was already being implemented" (ADAS, 2007b). Agri-environment schemes will however offer an incentive to ensure that these standards are maintained.

Project MA01041 found that Management Plans (now excluded from ELS) specifically aimed at protecting soil and water rather than enhancing biodiversity were substantially more beneficial than other ELS options (Table 2.8). Moreover, the reduction in nutrient losses could be attributed to a small number of key management practices, namely:

- Reduce field stocking rate when wet
- Time N application to crop requirements
- Do not apply slurry at high risk times
- Integrate fertiliser and manure (i.e. account for nutrient content of manure)

Table 2.8 Summary of estimated percentage reductions in N losses from management plans (MP) and non-management plan options

Farm type	% N reduction from non-MP options		% reduction from management plans (medium uptake)		
	ELS min	ELS max	Soil	Nutrient	Manure
Arable	1.69	3.68	11.2	19.5	20.0
Dairy	1.23	4.11	12.0	8.0	6.0
Lowland Beef & sheep	15.25	16.28	31.8	18.8	17.5
Mixed	2.28	6.28	41.8	43.5	43.5

Source: Defra Project MA01041

2.9.1 Agri-environment vs other initiatives

It has been suggested above that resource protection has largely been a secondary role of agri-environment schemes, and other policies are in place to help protect soil and water quality. These include The Nitrates Directive, Catchment Sensitive Farming, and cross-compliance. In this section, the potential impact of agri-environment schemes is compared with these other measures.

2.9.1.1 Nitrates Directive

The Nitrates Directive was introduced at the EU level in order to address the serious threat of nitrate pollution to both surface and groundwater bodies from agricultural activities. The Directive requires the Environment Agency/SEPA, as the competent authorities, to designate Nitrate Vulnerable Zones (NVZ) in polluted areas. Within a NVZ, farmers must observe an Action Programme of measures that are specifically aimed at addressing nitrate pollution. Generalising, these include restricting the timing and application of fertilisers (no applications between September and February) and high organic-matter-content manure (no applications Aug/Sept/Oct), keeping accurate

records, and having adequate slurry storage capacity. The Action Programme is currently under review, with changes to be announced later in summer 2008.

All these measures are designed specifically to reduce the production of excess nitrate at source, and thus address the *cause* of the problem. Moreover, the area of land that will be required to abide by the measures (i.e. falls within a NVZ) is substantial in England. In theory, The Nitrates Directive has a greater potential to protect watercourses from nitrate pollution than agri-environment schemes. However, this potential has not been realised to date, and even though there is a current NVZ action programme, nitrate concentrations are high in many areas (Anon, 2007). It is likely that advice and incentives to action the objectives of the Nitrates Directive will be required to achieve the potential benefits.

2.9.1.2 Cross-compliance

Cross-compliiance refers to conditions that farmers have to comply with in order to recieve Single Farm Payments under the CAP. In addition to reinforcing the regulations on ground water and the use of sewage sludge through Statutory Management Requirements (SMRs) 2 and 3, there is a requirement under Good Agricultural and Environmental Conditions (GAEC) to undertake a soil protection review (GAEC1), and there are also requirements relating to the post-harvest management of uncropped land to prevent run-off and soil erosion (GAEC 2), and waterlogged soil, to maintain soil structure and prevent compaction (GAEC 3). These provisions will help to reduce erosion and movement of pollutants to water, this helping to prevent pollution at source. Thus they will work in conjunction with agri-environment scheme measures such as buffer strips, which aim to intercept pollution before it reaches watercourses and other sensitive habitats.

2.9.1.3 Catchment Sensitive Farming (CSF)

Phosphorus is also a significant pollutant of water bodies and measures in the Nitrates Directive will not necessarily reduce P pollution, partly due to the different dynamics of production and transportation of the two nutrients. The England Catchment Sensitive Farming Delivery initiative (ECSFDI) (2006) was implemented to address issues of P losses in particular, as a means of complying with the Water Framework Directive. CSF is, as its name implies, focussed around specific catchments (40 in total), and one of its key advantages is that it identifies and then addresses the cause of the pollution in order to focus remedial practices appropriately. Dedicated CSF “officers” have advised farmers on how best to reduce soil and water pollution. This commonly utilised options within ES, but these would be targeted to where most needed, with the aim of reducing pollution rather than to attain the required number of points for payment. Similar schemes have also been run in Scotland (e.g. the Ugie Wetland project and the Ythan project).

There are several case studies where there have been noted improvements in water quality due to implementing CSF (Table 2.9). These benefits were achieved through implementation of agri-environment options, in conjunction with additional measures as appropriate in each case. The positive feedback, and the fact that there was a higher uptake of ELS options in ECSFDI catchments than England as a whole (Defra, 2008) indicates that it is unlikely that the same benefits would have arisen in the absence of a CSF officer.

Table 2.9 Examples of CSF successes

River	Main pollutant	Main cause of pollutant	Mitigation technique
Frome	Sediment; P	Animal and machinery poaching	Create sediment trap using blind ditch
		Mixing of dirty & clean water	Divert clean water away from yard
Itchen,	Sediment; P; N	Runoff down farm track	Divert clean water away from yard
			Create sediment trap using blind ditch
			Re-siting of barn door to reduce faeces on track
Test	Sediment	Outdoor pigs	Reduced stocking density & re-siting on farm
		Runoff down farm track	Large buffers > 10m
Galven	Sediment	Outdoor pigs; potatoes	Re-site pigs
		Runoff down farm track	Improve soil structure with muck & straw
			Grass set-aside on high risk areas

Other practices that may be advocated in CSF include minimum tillage (where appropriate to the soil type), phase feeding of livestock, avoiding winter tramlines and exporting surplus manure. These practices do not fall within the scope of agri-environment schemes *per se*, but they could contribute substantially to the protection of resources. Cuttle *et al*. (1996) estimated N and P losses from different farm types when implementing methods to control diffuse water pollution. If it is assumed that the maximum area that can be covered by an option within an agri-environment scheme is one-fifth of the farmed land, then the benefit of the agri-environment scheme would need to be substantial to be more effective than implementing other beneficial management practices. For example, reducing fertiliser application rate is a common theme in ES. Using data from Cuttle *et al* (1996), this could reduce N and P losses by up to 3 kg per year (assuming a reduction in N application of 15kg/ha/yr, and 1/5 of land in agri-environment scheme). If minimal cultivation systems were implemented on the remaining land, losses could be reduced by up to 4 kg per year. This calculation is very basic, but it serves to illustrate that, whilst agri-environment schemes may assist in reducing water pollution, to achieve maximum benefit they need to be implemented in association with land management practices not currently supported through AE schemes, that are specifically aimed at protecting resources and affect a much larger area of land.

The ECSFDI provides a good example of how diffuse water pollution can be reduced through a combination of measures, but whatever the regulation or incentive, if resource protection is to happen in practice, then 1) the mitigation options must be targeted appropriately, and 2) this is best achieved by offering practical advice to the farmer. Indeed the ECSFDI Evaluation Report (Defra, 2008) commented that farmers were motivated to implement beneficial practices for reasons such as the provision of soil analysis, advice and expertise; help with development of nutrient and fertiliser management plans, keeping up with regulatory requirements or keeping one step ahead of future potential requirements, and advice and financial support for changes they already planned to make. Similarly, in Scotland the success of the Ugie Wetland project was attributed to providing practical advice and properly targeted cash incentives (SNH, 2000).

2.9.2 Conclusions

There is a general paucity of evaluation data on the benefits of AES for resource protection, as historically this role has been secondary. Extrapolation of data relating to the processes underlying pollution and/or modelling indicates that the potential for policies such as NVZs and cross-compliance to protect soil and water may be greater than AES due to the scale of the land involved and the fact that they aim to address the cause of pollution. However, in reality, it is apparent that regulation alone will not necessarily achieve resource protection and additional targeted measures will be required and supported through the financial incentives available via AES, supported by initiatives such as the ECSFDI to offer advice on the implemnentation and integration of best practice techniques to address specific problems. Thus the combined approaches of regulation, incentive (through AES payments) and advice offer the best way forward in terms of addressing resource protection issues.

A fundamental factor that will determine the effectiveness of any land management practice or mitigation method in protecting soil and water quality is its relevance to the situation. There is a tendency for small areas of land to produce a disproportionately large amount of pollution, thus it is necessary to identify and target these critical sources in order to locate appropriate management options (Strauss et al., 2007). Generic prescriptions could take land out of production with no benefit to the environment if the source of pollution is not addressed. Johnes *et al*. (2007) propose a two-tiered approach to nutrient management to protect resources, where broad regional policies are combined with targeted management in high risk areas at both the catchment and farm scale. Similarly, a study to predict the outcome of adopting a wide range of mitigation options concluded that it would be necessary to form catchment-specific plans in order to achieve a substantial reduction in diffuse losses of nutrients (Anthony, 2006). This has, in part, been demonstrated by the ECSFDI.

Agri-environment schemes are tools that can be used to protect soil and water, but they must be used appropriately in a targeted manner to be effective. It might be expected that schemes that identify environmental features which require protecting and then introduce appropriate management (e.g. HLS, Tir Gofal) would have more success than generic schemes such as ELS and Tir Cynnal. Moreover, it is possible that the benefits of the schemes to water and soil quality may take many decades to have any discernible effect (Anon, 2004a) and, even with mitigation options in place, it may not be possible to reduce mean nitrate concentrations from agriculture to below 50 mg/L (ADAS, 2007a).

2.10 Flooding

Flood management is only stated as an objective under the English HLS. There are only two HLS options (HQ13 Inundation grassland supplement; HL13 Moorland re-wetting supplement). However, options that are specifically designed to prevent erosion and runoff (HJ3-HJ8) and/or otherwise protect resources may also contribute to the management of flooding.

The evidence to support the benefits of options HQ13 in relation to flooding is relatively sparse. Modelled predictions of restoring floodplains on the River Cherwell suggest that this could reduce peak flow by ~ 10–15% (Acreman *et al*., 2003; 252). However, other modelling work (Acreman *et al*., 2007; 251) has suggested that restoring floodplain wetlands can reduce the storage capacity during floods, which could have a negative impact. Similarly, Lane *et al*., (2003b) noted that it may be necessary to ensure disconnection between the wetland and surface water during medium and low flows in order to ensure sufficient storage for high flow, flood events. There is some evidence that targeting specific grips (moorland re-wetting, HL13) may help to reduce flooding from upland areas (Lane et al., 2003a).

Evidence of the impact of land management practices on flood risk in rural areas, illustrates the complexity and local nature of the issue (Anon, 2004b), but in terms of evaluating the impact of agri-environment schemes specifically on flooding, ES schemes have not been implemented for sufficient time to monitor any effect. However, on-going work is attempting to address this using farm-scale pilot schemes to investigate land management practices and flood risk (Defra/EA 'Making Space for Water' programme.)There has been little integration of flood defence and biodiversity functions in the past, thus wetland areas serving to maintain biodiversity would not necessarily have an efficient flood defence role (Morris *et al*., 2004). The potential for integration does exist, although it would require careful management. Morris *et al* (2004) also concluded that a range of options, and not just those associated with management agreements and annual payments, is required for the management and administration of washland areas.

2.11 Genetic conservation

Little information is available on the impact of agri-environment schemes in terms of genetic conservation. The following information was extracted from Dwyer & Kambites, (2005)

According to the mid-term evaluation of agri-environment schemes, “1063 ha of land are managed specifically as historic landscapes through the restoration and management of old orchards, restoration of ancient irrigated water meadows, restoration of historic parks, restoration of historic features in the upland landscape and restoration of old meadow and pasture.’ However, the MTE was unable to find any data concerning the success of these initiatives in preserving threatened breeds and varieties

Tir Gofal has recently been adapted to include bonus payments for use of traditional Welsh breeds. It also supports Welsh Black Cattle because they graze the rough vegetation in a more appropriate way to maintain its biodiversity interest than continental breeds do. In addition, the ‘orchards and parkland’ measure is relevant to the preservation of endangered varieties of fruit. In Northern Ireland, account is taken of whether or not the applicant had any Irish Moiled cattle, the only indigenous domestic livestock on the Rare Breeds Register. However, there do not appear to be any data on the impact of these measures.

Dwyer and Kambites (2005) concluded: “The UK schemes collectively achieve little in relation to this goal, reflecting its perceived relative low priority in this country. Where some inducements are present they may help to maintain existing rare breeds or varieties but on their own they are unlikely to encourage significant change in the keeping of these breeds or varieties. In the case of old orchards it is however likely that the schemes have played a significant role in alerting farmers to the potential value of traditional varieties of fruit tree and thus encouraging their preservation and replacement or extension with similar varieties, wherever possible.”

The inclusion of genetic conservation as an objective of HLS in England may raise its profile, but it is too early to comment on how significant its impacts will be.

3. DISCUSSION AND CONCLUSIONS –

3.1 How good is the evidence for environmental benefits?

3.1.1 Overview

This review has encompassed a wide range of direct and less direct evidence for the environmental benefits provided by agri-environment schemes in the UK. Unlike the bulk of formal scheme evaluations, our emphasis here has been on capturing the fullest appreciation of likely scheme impacts, rather than focusing much attention upon scheme outputs and results in themselves. Outputs and results have only been used where they provide useful contributory indicators of likely scheme impacts. As such, we have been able to assemble an overview of the strength and reliability of the accumulated evidence of environmental benefits.

In respect of the accepted protocol of formal scientific evaluations, the monitoring results from UK ESAs provide the main source of ecological and landscape impacts data. These studies largely include baseline and control samples and can thus distinguish scheme additionality, which is important in seeking to understand the difference that schemes have made, in environmental terms. However, with regard to the ESAs, the data are now rather out-of-date. This is both because they relate to changes in the first 5-10 years of scheme agreements, and because these schemes themselves represented a 'first attempt' to pursue agri-environment benefits in the UK. Thus many of their lessons have now been learned and improvements applied, in the new schemes which have superseded ESAs in all four countries.

3.1.2 ESA evidence

With respect to the ESA monitoring data, we can sum-up its findings as follows. There is robust evidence that the schemes made a significant contribution to the protection of historic features in all four countries (mainly archaeology and historic field boundaries – sections 2.5.3.1 and 2.5.3.2). This is largely because there were lower or no significant declines in condition on land under agreement, whereas non-agreement land showed significant declines, over a similar period. The same can be said in respect of the preservation of characteristic land cover types and landscape features (sections 2.6.3.1 and 2.6.3.2). The monitoring confirms that when land entered the schemes, key landscape features and land-cover types were preserved and in some cases, grew in extent, over the period of monitoring, while on land outside agreements, net losses were frequently recorded. With regard to preventing the destruction of important habitats, there is also evidence that land which entered agreements maintained its broad habitat type during the monitoring period (although some declines in condition were noted for a few habitats), whereas land outside agreement was generally subject to more negative change. For example, the review of grassland management prescriptions for all UK ESAs by Critchley *et a*l (2003) shows good evidence of additionality in respect of habitat condition, in most ESAs (see section 2.4.2.3). Thus the evidence indicates that had these schemes not existed, the quality and extent of these attributes would very likely

have declined, within the areas that were designated under the scheme. With the schemes, both extent and quality were largely maintained, for all land under agreement. In those few ESAs where overall scheme uptake was relatively low (e.g. Upper Thames Tributaries, Wessex Downs), the net impact of these positive changes may be small. However for ESAs as a whole, uptake levels were generally sufficient to ensure that these schemes made a significant difference to the quality of these environmental assets, in the areas designated.

At the same time, there is also some evidence to suggest that the schemes were insufficiently ambitious and/or tailored to local circumstances, in relation to their provisions for habitat quality maintenance, as well as the enhancement of biodiversity and landscape quality. For example, some deterioration in grassland managed under the scheme was recorded in a few ESAs in England and Wales due to both undergrazing and overgrazing, and undergrazing was a consistent feature of tier 2 ESA land in Scotland. With respect to the restoration of grassland and other grazed habitats from former arable, the species richness and quality of the resulting swards were often limited by soil fertility and appropriate seed sources. This means that the objectives in relation to biodiversity and habitat goals were often not achieved for example, where habitat degradation continued on moorland and grassland sites, due to insufficient linking of stocking densities and grazing management to specific local needs – see section 2.4.2.4). In relation to invertebrates, birds and mammals, the evidence for positive impacts from ESAs is thin or inconclusive in many instances. However, where schemes were specifically designed to provide for the needs of particular species, such as the corncrake in Scotland substantial positive impacts were recorded within a relatively short timescale. These results suggest that there was significant potential to enhance the performance of schemes with regard to biodiversity and landscape benefits.

In relation to access and public enjoyment, it is probably fair to say that the ESA experience is not particularly informative, since the uptake of this option in those ESAs where it was available was small. However, evidence from the menu-based schemes, particularly CS in England, suggests that the provision of new access was likely to be delivering additionality mainly in those cases where it was carefully tailored to local needs and co-ordinated with pre-existing access networks and opportunities. However, the evidence also suggests that there were many cases where these conditions were not fulfilled and thus there was significant scope for improvement.

3.1.3 Later scheme developments and additional evidence

By the mid-to-late 1990s these broad patterns of impact were understood and widely accepted among the policy-making community. As a result, attempts were made in all parallel and subsequent schemes, to incorporate:

- A greater range of scheme management options, and more scope for linking precise management prescriptions to the varied environmental needs and in particular, the biodiversity potential of individual sites. This is evident for CS and ES (HLS) schemes in England from 1998 onwards; also Tir Gofal in Wales from 1999 and Rural Stewardship in Scotland (2001-7).
- An increased emphasis (in both financial terms, and in relation to scheme targeting and promotion) upon using schemes to pursue environmental enhancement, over and above the basic protection of existing value. This generally led to a greater use

of capital payments within scheme agreements (the proportion within CS rose during the late 1990s, for instance), to enable more investment in enhancement actions. It also led, in English ESAs (where scheme entry became discretionary after 1996), Tir Gofal, and CS and HLS in particular, to a requirement for applications to include a higher proportion of more ambitious and expensive management prescriptions, if they were to be awarded funding under the schemes.

Whilst these developments can be expected to give rise to greater levels of environmental benefit from schemes, the evidence on this point to date is more limited. To a large extent, in the absence of long-term monitoring of these more complex and ambitious schemes to measure environmental impacts, the review of their benefits relies upon a combination of the results of independent evaluations of the management options that they use, and short-term evaluation studies which mainly give information on scheme outputs and results. Taken independently, neither of these two basic sources provides robust evidence of scheme impacts. However, when assessed in combination, they provide some strong indications of the likely quality and extent of agri-environment schemes benefits, across the UK.

There are also some important exceptions to this general picture of incomplete evidence. These include the ASPS monitoring results, which give clear evidence of positive scheme impacts on biodiversity within 5 years of land entering agreements. The outcomes of the CS special projects for cirl bunting and stone curlew, and management under AES for corncrake, also indicate the potential for what can be achieved with targeted application of research-based options. For all three of these species, Biodiversity Action Plan targets for population size have been exceeded as a result of such targeted action. In addition, the results of evaluations of field boundaries, traditional farm buildings, designed landscapes and other landscape feature restoration within menu-based schemes including CS, Tir Cymen and Tir Gofal (sections 2.5 and 2.6) show early evidence of positive change for both feature extent and condition, as a result of scheme uptake.

From our combined review of these sources (in addition to the ESA evidence already discussed), we conclude the following main points.

- There is good evidence that the much increased coverage, and the kinds of management option now being used within the UK agri-environment schemes, will deliver significant benefits to biodiversity. This is particularly in respect of the vegetation and birdlife of a range of habitat types including: arable, species-rich grasslands, hedgerows, moorland and lowland heaths, and some types of wetland. There is less evidence for mammals and invertebrate species, but there are cases of measured benefits in respect of, for example, butterflies, bumblebees, sawflies and plant bugs, and some mammal species (e.g. brown hares and voles), especially in arable habitats. In general, the higher level schemes are likely to deliver significantly more benefits per hectare of land than the entry-level schemes, but the extent of the latter is clearly much more significant at the landscape scale. In respect of higher tier schemes, it was clear that by 2005, a large proportion of priority habitat for grassland and upland heathland, was under some form of agri-environment schemes which was targeting its protection and enhancement. Further, as a result of the lessons from ESA monitoring and academic research, the tailoring of scheme prescriptions to enhance their biodiversity benefits was much improved, relative to the position a decade earlier.

- There is also good evidence to indicate that UK agri-environment schemes are contributing positively to the protection and enhancement of landscape quality and the wider historic fabric of the countryside (including buildings, parkland/designed landscapes and monuments). Again, the higher level schemes are likely to be contributing much more per hectare than the entry level ones, at this stage, both due to design and to the much more recent development of the latter. However, this situation could change quite rapidly as more land enters the entry level tiers, in locations which have not previously benefited from any agri-environment support.
- With regard to public enjoyment of the countryside from new or enhanced access opportunities, it seems that schemes may have secured a significant amount of new or enhanced access but that the value of this access in relation to demand for, and use of, the sites provided, is likely to be much lower than is indicated from simple statistics of output (km of paths, hectares of open access). As a result of wider policy changes, there is now broader recognition that scheme access should be more carefully co-ordinated with other access provision, in order to realise benefits and maximise value for money.

For resource protection, the evidence of environmental benefits from schemes is much weaker than it is for biodiversity and landscapes. Mostly, it is indirect and must be inferred from a combination of independent research and modelling studies and critical appraisal of agreement contents and uptake patterns. Analysis of the available evidence from such sources indicates that as currently constituted, agri-environment schemes form a useful adjunct to other policy measures for addressing specific soil and water protection issues, but that they need to be seen as part of a suite of approaches for resource protection, which also includes measures based on regulation (e.g. NVZs) and conditionality (cross-compliance), to achieve maximum benefit. The approach used in the Catchment Sensitive Farming initiative is particularly attractive, as this allows the integration of appropriate scheme and non-scheme options through targeted advice to address specific issues at a farm scale.

3.2 Monitoring of agri-environment schemes

There has been some criticism of both the effectiveness of agri-environment schemes and their evaluation, particularly in relation to biodiversity (e.g. Kleijn *et al*., 2001; Kleijn & Sutherland, 2003). Kleijn e*t al.* (2001) showed that specific options in a Dutch scheme were not effective in protecting species richness of plants and birds, though they did find effects for hoverflies and bees. They suggested that there was a pressing need for scientifically sound evaluation of agri-environment schemes. A subsequent review of the effectiveness of agri-environment schemes in Europe concluded that "the lack of robust evaluation studies does not allow a general judgement of the effectiveness of European agri-environment schemes". However, they further state: "Only the Netherlands and the United Kingdom have made any significant effort to evaluate the effects of agri-environment programmes on biodiversity". Kleijn and Sutherland (2003) set out a protocol for the evaluation of schemes: "Studies should include the collection of baseline data, should incorporate control sites that are similar to scheme sites in every respect but the change in management, and both control sites and scheme sites should be sufficiently replicated". Whilst laudable as an ideal, this proposal does not address the many difficulties inherent in adopting such an approach, not least the implication that farmers on "control" sites would either be barred from entering the scheme during the full period of monitoring or could otherwise be untypical and thus not valid as indicators of

the counterfactual. Nevertheless, the collection of baseline data and a robust approach to establishing the counterfactual (i.e. trends in the absence of agri-environment schemes agreements), and thus measuring additionality with some confidence, should be included in evaluations wherever possible.

Most evaluations of ESAs in the UK included baselines and controls to some degree, and provided valuable information on the performance of agreements. Where the anticipated benefits were not fully realized, the studies provided pointers for potential improvements to the operation and/or prescriptions within the schemes. In many cases these pointers confirmed weaknesses in scheme prescriptions and approaches that were already recognised by project officers and those stakeholders with the greatest interest in scheme outcomes (notably environmental agencies and NGOs, and farming organisations). Nevertheless, stakeholder opinions may be influenced by vested interests, and the Government's 'evidence based policy approach' requires robust scientific evidence as a basis for action.

Comparison of scheme with non-scheme areas was also a feature of the evaluation of the Arable Stewardship Pilot Scheme, though in this case baseline data were not available. A difficulty with both these sets of evaluations was the length of time required before impacts could be discerned: the initial evaluation of ASPS after three years showed little effect, but much greater impacts were evident after five years of the scheme operation. Evaluations of ESAs in England and Wales were intended to be carried out after five years but evaluation programmes for some ESAs have extended beyond this and all ESAs in Scotland and Northern Ireland have been evaluated over a ten year period.

Policy imperatives have generally required scheme reviews over a much shorter timescale, hence short-term indications of scheme performance are required. The need to wait 5 years after scheme changes were implemented, before results could be demonstrated, combined with the perception that experts and stakeholders already understood much about potential scheme improvements long before that process could be completed, meant that this formal science approach to monitoring and evaluation was increasingly seen as something of an obstacle to development, during a period of intense experimentation with these schemes (c.1992-2003). Hence, policy-makers shifted their attention and resources into shorter-term and dynamic monitoring and experimentation with scheme prescriptions, and early, indicative performance measures. The available evidence as reviewed in this study suggests that this has reduced our ability to actually measure scheme impacts for UK agri-environment schemes. However, at the same time it has probably accelerated scheme learning, in respect of refining and developing potential management options and delivery approaches.

This shift in approach has resulted in less reliance on the repeat survey approach that was adopted in the ESAs, and greater use of expert judgement and other predictive methodologies in some cases, such as the evaluation of Countryside Stewardship in England. Rather than measuring actual impacts, this produced an assessment of 'likely impacts' which were assessed in holistic manner (e.g. overall benefits for biodiversity, or landscape), such that the potential success or failure of the scheme in terms of single issues such as specific wildlife objectives could not be readily ascertained (Carey *et al*., 2005). In a separate exercise, baseline data on botanical characteristics and quality of land under agreement were obtained (Carey *et al*., 2002), but despite this having been

the initial plan, no follow-up survey was actually carried out before the scheme closed to new entrants, in 2005.

We suggest that, whilst the short-term indicative evaluation methods are undoubtedly useful for the policy review cycle as well as directing ongoing learning and experimentation, they should be used in conjunction with, and not as replacements for, direct and longer-term evaluation of scheme impacts on the ground.

The new 'entry-level' type schemes raise issues in this regard with respect to monitoring methodology. Care will need to be taken with the use of control sites in the assessment of broad and shallow schemes as a means of attempting to assess the counterfactual, since a large proportion of land will be in the schemes and that which remains outside may have different characteristics from land in the scheme. Some comparative evaluation will still be possible, especially at a field scale within farms, but also between farms where controls are carefully chosen. This could be particularly productive where specific options or combinations of options can be identified that would be expected to lead to specific outcomes for particular indicators, e.g. skylark scrapes. However, for more general objectives, such comparative methods will need to be supported by additional approaches to assess the counterfactual and the degree of additionality provided by the scheme, such as examining long-term trends in environmental variables and then comparing the trends since most land came within a broad and shallow scheme, to trends before this. For this purpose, more generic environmental monitoring exercises could well be useful, such as the Countryside Survey and Breeding Birds Survey (BBS). In undertaking such analyses however, it is important to identify what land is or is not in schemes and how it is being managed. The recording of such information has not previously been a focus of such surveys, and needs to be built into future work, as is already being done with bird monitoring using additional BBS squares.

Over recent years, there has been an increasing programme of research underpinning the development of agri-environment scheme options and testing them prior to, or during, implementation within schemes. This research serves to give confidence that the options will be effective prior to the results of full evaluations appearing. It is still important, however, that such evaluations are carried out, in order to confirm that the scheme is working, as implemented on 'real' commercial farms in the wider countryside.

For example, Kleijn and Sutherland (2003) acknowledge the success of UK agri-environment schemes initiatives to conserve cirl buntings, stone curlews, corncrakes and black grouse through targeted action incorporating agri-environment schemes, but question whether such results can be reproduced wherever intensive support is not available. Whilst such support is likely to continue to accompany higher level schemes in future, it will be important to obtain good quality monitoring data on the impact of the new 'broad and shallow' entry-level-type schemes now operating in England, Wales and Scotland, for which intensive support is clearly not envisaged or provided for by public funding. Current plans incorporate broad-scale monitoring to detect general differences in, for example, bird densities on scheme and non-scheme land through the British Trust for Ornithology's Breeding Bird Survey, but the evidence base could be considerably strengthened by inclusion of studies of the impact of specific options targeted at particular species or taxonomic groups (e.g. skylark patches).

Whittingham (2006) has suggested on theoretical grounds that a 'landscape approach' to agri-environment agreements, whereby groups of farms enter schemes and undertake

management towards a common objective, might yield enhanced dividends, at least in terms of biodiversity conservation. In Wales, just such an approach has already been earmarked for development within a higher-level scheme. The opportunity to assess such groups of agreements could be usefully incorporated into an evaluation programme. In particular, it could help to shed light on the oft-debated pros and cons of having more ambitious higher-level scheme agreements scattered across the countryside rather than concentrated in a few 'priority' zones, as originally advocated by the European Commission.

One valuable feature of UK agri-environment schemes' design and monitoring since their inception is the element of active learning and experimentation that has been evident throughout. Lessons from early schemes have clearly informed the design and evaluation of later schemes. Thus, more recent Higher Level Schemes incorporate baseline farm surveys, a greater level of targeting, more flexibility in tailoring options to local conditions linked to indicators of success and an increasing role for advisory input to provide support in achieving the scheme objectives. It is therefore possible to have confidence that the successes of similar, earlier schemes can be replicated and increased through efficient use of resources to achieve specific, geographically targeted, objectives.

Looking ahead, one major challenge will be to respond to early evidence of the functioning of the new 'broad and shallow' UK schemes to ensure that their broader strategic goals can be achieved, in the absence of intensive extension support from the Government departments and agencies delivering the schemes. This process is already under way as a result of the recent review of progress which has examined the operation of ES over the first two years and proposed a range of modifications to the scheme in response to its findings.

3.2.1 Recommendations

For future monitoring we recommend continuing short-term assessment of potential environmental benefits for those indicators where adequate research has already been conducted, to provide a good basis for the prediction of impacts using a combination of spatially differentiated output and result data. These should as far as possible use robust models populated with data from the literature, supplemented if necessary by expert opinion.

At the same time, we believe it is essential that baseline environmental data on a suitably representative sample of farmland entering agreements should be obtained and a programme of repeat surveys planned, in order to provide direct measurement of scheme impacts, over time. The selection of indicators for collection of this baseline data should cover all the key objectives of the scheme, and also take account of the likelihood of measurable changes being achieved within the periods between repeat survey. The hypothesis-led approach used in the ASPS evaluation provides a good model for so doing in respect of biodiversity benefits, although slightly different approaches would doubtless be required to cover benefits such as landscape and public enjoyment. The relatively modest investment that such a programme would require, in support of the projected agri-environment schemes expenditure over the coming 5 to 10 years (e.g. £3 billion in England alone, by 2013), would seem to be amply justified by the need to convince a wider audience of UK and international actors that these schemes are delivering in accordance with their goals and at reasonable cost to the public.

The broad and shallow ELS-type schemes raise issues for monitoring in terms of the use of controls to establish the counterfactual. In this context the acquisition of baseline data becomes even more important, but it is likely that a range of approaches will be needed, including the use of controls where feasible but also other survey data to assess the wide-scale impacts.

3.3 Conclusion

The forgoing text chronicles a range of outcomes from many different approaches to achieving environmental goals within agri-environment schemes. There have been some notable successes, but in other areas where there is considerable room for improvement. A key feature is the incorporation of lessons learnt from earlier experiences into the revision of schemes at review points, and the design of new schemes. A recurring theme is the need for targeting of options, based on farm audits set in the context of local priorities, coupled with the flexibility to tailor prescriptions to suit the needs of individual sites. The role of advisory support is a key element in this process

The ability to learn from the outcomes of scheme implementation is reliant on the availability of high quality information monitoring and evaluation studies, and whilst many excellent evaluations have been carried out, the prioritisation of certain objectives in this regard has meant that there are still areas where little information exists on scheme performance. This is particularly the case for those objectives that have tended to be considered as secondary, or have only become priorities more recently, such as access and resource protection, though even for the longest standing objectives, biodiversity and landscape, there is still a dearth of data in some areas.

This report comes at an exciting and dynamic stage in the development of agri-environment schemes in the UK. Major changes in the structure of these schemes have taken place in recent years, set in a new policy context but building on many years experience from the successes and failures of earlier schemes and a sound and ever expanding research base. The re-structuring of agri-environment schemes has been accompanied by an increase in funding to higher levels than ever before, at least in England, with the potential for further increases over the next few years if the level of modulation rises[16]. Whilst these enhanced funding levels create the potential for greater achievements in terms of environmental enhancement, they also carry an increased obligation to demonstrate delivery in terms of public benefit and value for money. At the same time, there are concerns that in the face of ever-increasing pressures on the environment resulting from climate change and the need to feed and accommodate an expanding population, even these enhanced funding levels may be insufficient to prevent further declines in biodiversity and environmental quality.

The impacts of these changes are only just beginning to emerge, and the next few years will reveal the extent to which these new initiatives are achieving their goals. In a very real sense, the forthcoming period will truly test the ability of agri-environment schemes to deliver major environmental benefits, and designing and implementing an evaluation strategy capable of measuring the outcomes, is a major challenge. Already, the review

[16] Modulation levels to 2012 are currently being discussed among EU member states, along with the other proposals forming part of the 'CAP Health Check' package of reforms.

of progress for Environmental Stewardship has produced a range of responses to early evaluation results, in order to improve scheme performance, and such flexibility and rapidity of response will need to be continued if the scale of expenditure and the associated effort involved is to be maintained.

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APPENDIX 1: CIRL BUNTING AND SKYLARK CASE STUDY, EXTENDED VERSION

Background

The cirl bunting and the skylark are bird species that are dependent on farmland habitats in the UK, and have some similarities in their ecology. Both eat seeds and other vegetable matter in the winter and feed their chick on invertebrates during the breeding season. However, they differ in that cirl buntings breed in hedgerows whilst skylarks nest on the ground and prefer open ground well away from hedgerows and trees. They also differ greatly in their distribution, skylarks being widely distributed across the majority of the UK, whilst cirl buntings are currently confined to a small area of Devon coastline between Plymouth and Exeter, though they were formerly much more widely distributed. Skylarks have also declined in England, but have not experienced any significant contraction of range. On the basis of these declines, both cirl bunting and skylark are red-listed species of conservation concern. The status of the cirl bunting has been improved by the targeted implementation of tailor-made agri-environment scheme options; can the same be achieved for widely distributed species such as the skylark?

Cirl bunting

Status

Cirl buntings first colonised England in 1800, but by the mid 1930s they were widely distributed across southern England and parts of Wales (Evans, 1997; Wotton *et al*; 2004). However they declined between the 1930s and the 1960s, and the population collapsed in the 1970s to around 252-319 pairs in the period 1968-1972, and 167 pairs in 1982 (Sitters, 1982, 1985). By 1989, there were only 118-132 pairs, almost all of which were in South Devon (Evans, 1992).

Ecological requirements

Research into the requirements of cirl buntings was carried out by Andy Evans and colleagues during the late 1980s and early 1990s (Evans & Smith, 1994; Evans *et al*., 1997). In winter, cirl buntings foraged preferentially in stubble or fallow fields (Evans & Smith, 1994), with the largest numbers observed in fields with a higher incidence of broad-leaved weeds (Evans, 1997). In summer, most losses of chicks were due to starvation or predation, but growth rates and survival were higher later in the season when Orthoptera (grasshoppers and bush crickets) became more important in the diet.

As a result of this research programme, it was concluded that important factors in the decline of cirl buntings included the reduction in mixed farming, fewer winter stubbles as a result of a switch from spring to autumn sowing of cereals, and intensification of grassland producing swards that were unsuitable as habitat for grasshoppers.

Agri-environment scheme options

In 1994, the cirl bunting became the subject of a ‘Special Project’ under the Countryside Stewardship (CS) scheme, which included options for maintenance of low-intensity grassland, overwinter stubbles following low-input barley, and grass field margins. The

low-input barley prescription allowed the use of fungicides, growth regulators and specific graminicides, but prohibited the use of insecticides and broad-spectrum herbicides. Between 1991 and 2004, over 214 CS agreements were established in the area of Devon where cirl buntings were still present, at least 152 of which had special project options. In total, over 1000ha of special project land was entered into the scheme over this period. The impact of the introduction of the Special Project on uptake can be seen in Figure CBS 1.

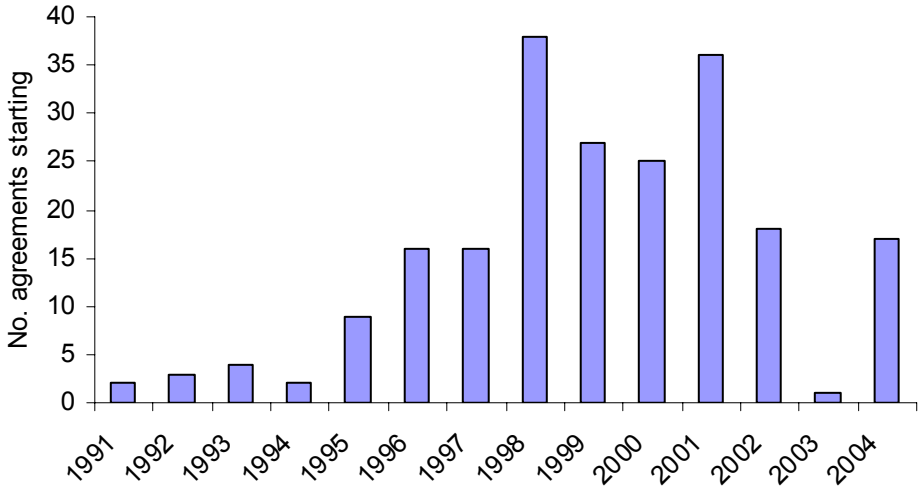

Figure CBS 1 Number of Countryside Stewardship agreements starting each year within the range of cirl bunting.

Cirl buntings showed a rapid response to the provision of options under CS, with numbers increa sing to an estimated 453 pairs in 1998 (Wotton *et al*., 2000) and 697 in 2003 (Wotton *et al*., 2004). Although set-aside stubbles probably contributed to the recovery, Peach *et al*. (2001) showed that numbers had increased by 83% in tetrads with land entering CS between 1992 and 1998, compared to only 2% on adjacent land with no CS.

Bradbury *et al*. (2008) compared the use by cirl buntings of 'special project (SP)' stubbles with conventional stubbles. Cirl buntings, and also yellowhammers and reed buntings, used SP stubbles to a significantly greater extent than the conventional stubbles. SP stubbles also contained greater densities of broad-leaved weeds. Bradbury *et al* emphasize the importance of maintaining the availability of prescriptions that provide seed-rich stubbles for cirl bunting and other declining granivorous species.

Countryside Stewardship closed in 2004, and the Special Project came to an end. CS agreements last for ten years, and a large proportion of those established under the Special Project arrangements are still in place at the time of writing, but numbers will decline rapidly over the next few years. With the demise of set-aside, the conservation status of cirl buntings is therefore likely to be determined by uptake of relevant options under Environmental Stewardship. There are no Special Projects under the new scheme, so progress is reliant on establishing agreements containing appropriate options through advice by NE project officers and other advisers.

Table CBS 1 Numbers and areas of holdings with ELS and HLS options likely to benefit cirl buntings, and area of options in the three JCAs where cirl buntings are found (South Devon, Dartmoor and Devon Redlands), May 2008.

Scheme	Option code	Option description	No. holdings	No.as % total	Area of holdings (ha)	holding area as % total	Area of option (ha)
ELS	EF6	Over-wintered stubbles	84	9.2	10488	14.2	778
HLS	HF15	Reduced herbicide, cereal crop management preceding overwintered stubble and a spring crop (rotational)	11	1.2	1401	1.9	84
	HG7	Low input spring cereal to retain or re-create an arable mosaic	5	0.5	954	1.3	26
	HK6	Maintenance of species-rich, semi-natural grassland	12	1.3	1711	2.3	61
	HK7	Restoration of species-rich, semi-natural grassland	44	4.8	5045	6.9	301
	HK8	Creation of species-rich, semi-natural grassland	0	0.0	0	0.0	0
	HK15	Maintenance of semi-improved or rough grassland for target species.	12	1.3	1965	2.7	419
	HK16	Restoration of semi-improved or rough grassland for target species.	6	0.7	1344	1.8	42
	HK17	Creation of semi-improved or rough grassland for target species	7	0.8	1277	1.7	44

Table CBS 1 shows the uptake of ELS and HLS options likely to benefit cirl buntings, as at May 2008. Currently, only a small proportion of holdings have relevant options under HLS, but the number with ELS stubbles Is considerably greater, and the area of ELS option EF6 is over nine times greater than the area of the HLS stubble options HF15. Option HF15 is equivalent to the SP stubble option, whereas option EF6 does not currently restrict pre-harvest herbicides, though pre-harvest desiccant and post-harvest herbicides are prohibited.

Skylark

Status

Common Bird Census data suggest a decline in England of 59% in skylark numbers between 1967 and 2005, and Breeding Bird Survey data show a decline of 15% in England and 23% in Northern Ireland since 1995, though there is little evidence of any change in status in Scotland or Wales (Baillie *et al*., 2007).

Ecological requirements

The highest densities have been found on set-aside (Wilson *et al*. 1997, Chamberlain *et al*. 1999, Donald *et al*. 2001b), but cereals are an important habitat for skylarks, due to the large land area covered (Donald & Vickery 2000). With the likelihood of set-aside being abolished under the forthcoming 'CAP Healthcheck', skylarks will be even more reliant on cereals as a nesting habitat.

Skylarks prefer to nest in low vegetation, and their decline is thought to be largely due to the change from spring to autumn-sown crops, coupled with increased intensity of production resulting in taller, denser crops which have restricted the number of breeding attempts and lowered breeding productivity per year as a result (Wilson., 1997; Donald & Vickery, 2000, Donald *et al*. 2001b). As the season progresses, nests in cereals are often situated near tramlines and as a result suffer high levels of predation (Odderskær *et al*. 1997, Donald & Vickery, 2000).

Winter habitat can also influence skylark breeding abundance. Skylarks show a preference for set-aside and stubble fields in winter (Buckingham *et al*. 1999; Donald *et al*. 2001a, Gillings & Fuller, 2001). Gillings *et al*, (2005) showed that there were more skylarks in Breeding Bird Survey 1km squares with stubbles, and that the presence of stubbles influenced population trends. Skylarks declined by 34% on squares with no stubble, compared with only 13% on squares with stubble present. Where stubbles exceeded 20ha/km^2, skylark population trends were stable or increasing. However, this result could be at least partly explained by the association of stubble with set-aside and spring-sown crops, both of which are known to support higher densities of breeding Skylarks than autumn-sown crops.

Agri-environment scheme options

Research undertaken during the SAFFIE" project showed that breeding success and productivity of Skylarks in winter wheat fields could be increased through the adoption of

small undrilled patches. Where these were implemented, Skylark territory densities were higher (particularly in the crucial late-season nesting period) and the number of Skylark chicks reared was nearly 50% greater than in fields without undrilled patches (Clarke *et al*., 2007; first year results were also reported by Morris *et al*. (2004)). The patches appear to work by enabling access to dense crops, so that the birds are no longer obliged to nest near tramlines and hence avoid the associated high nest failure rates through predation and machinery damage. Undrilled patches are available as 'Skylark plots' in Entry Level Stewardship.

Overwinter stubbles were first introduced to CS as one of the 'arable options' added to the scheme in 2002. There was no prohibition on pre-harvest desiccants, thought the application of agrochemicals to the stubble was not allowed. Stubbles are currently available as option EF6 under ELS, and stubbles following a cereal with reduced herbicide use as HLS option HF15. Several other ELS and HLS options may benefit through providing similar resources (see table ??).

Uptake of ES options likely to benefit skylark is summarized in Table CBS 2. With the exception of EF6 (overwintered stubbles), uptake of all options is very low (less than 2% of holdings in all cases). Skylark plots were only taken up by 1.5% of agreement holders. At the recommended density of 2/ha, the number of plots in the scheme would be equivalent to 6921ha of wheat, equivalent to 0.4% of the 1.7million ha grown in England in 2007 (data from the June Agricultural Survey.

The amount of overwinter stubble is equivalent to 6.4% of the area of the holdings on which this option is situated. The analysis carried out by Gillings *et al*, (2005) suggested that 20% of the area needed to be in stubble for skylark populations to be stable or increasing.

Conclusions

Set-aside stubbles have occupied more than 10% of the area of land eligible for CAP subsidies since 1999, most of which has been rotational set-aside, thus providing the benefits of stubbles throughout the winter. It is possible that the advent of large-scale set-aside has been at least partly responsible for the slowing in the rate of decline of the skylark population since the late 1980s (Baillie *et al*., 2007), but if so, the imminent demise of set-aside as a policy tool may herald a further period of steeper decline in this species. Whether this is the case or not, it is clear that even with a large proportion of the landscape occupied by 'conventional' stubbles, the decline of skylarks and other species that use stubbles has at best been slowed.

Agri-environment schemes are never likely to be able to achieve the same areas of stubble as existed under set-aside. However, Robinson (2001) found that skylark densities were greater where seed densities were higher; similar responses have been found for other species by Moorcroft *et al*. (2002) and Bradbury *et al*. (2008). It seems likely that if agri-environment schemes are going to be able to substitute for the loss of set-aside stubbles as winter feeding areas, they will need to provide seed-rich areas similar to those provided for cirl buntings in the CS 'Special Project'.

Table CBS 2 Numbers and areas of holdings with ELS and HLS options, and area of options likely to benefit skylarks, May 2008.

Scheme	Option code	Option description	No. holdings	No.as % total	Area of holdings	Holding area as % total ES area	Amount of option	Units
ELS	EF6	Over-wintered stubbles	3942	12.29	907228	20.70	57935	ha
	EF7	Beetle banks	408	1.27	139474	3.18	103	ha
	EF8	Skylark plots	500	1.56	113949	2.60	13841	plot
	EG1	Under sown spring cereals	322	1.00	66115	1.51	2318	ha
	EG4	Cereals for whole crop silage followed by over-wintered stubbles	181	0.56	29754	0.68	783	ha
	EG5	Brassica fodder crops followed by over-wintered stubbles	550	1.72	126087	2.88	6722	ha
HLS	HF13	Fallow plots for ground-nesting birds (rotational or non-rotational)	339	1.06	94529	2.16	1912	ha
	HF15	Reduced herbicide, cereal crop management preceding overwintered stubble and a spring crop (rotational)	76	0.24	16112	0.37	805	ha
	HF17	Fallow plots for ground-nesting birds as an enhanced setaside option (rotational or non-rotational)	59	0.18	13675	0.31	258	ha
	HF18	Reduced herbicide, cereal crop management preceding enhanced set-aside (rotational)	15	0.05	3942	0.09	129	ha
	HG07	Low input spring cereal to retain or re-create an arable mosaic	151	0.47	30964	0.71	1513	ha

It is not yet clear whether the restrictions on herbicide use in the ELS option EF6 will be sufficient to achieve this; as Bradbury *et al*. (2008) point out, "the degree to which the ELS can deliver for farmland birds, in those areas not covered by HLS, will depend crucially on the relative importance of pre-harvest desiccant and reduced herbicides in determining weed and seed density in stubbles". One of the outcomes of the recently published 'Review of Progress' of ES is that the possibility of introducing a new ELS option for weed-rich stubble will be investigated.

Cirl buntings have undoubtedly been a success story for agri-environment schemes. However, if the EF6 option does not provide adequate seed densities, as suggested by the data presented by Bradbury *et al* (2008), continued recovery may depend on sufficient HLS agreements being formulated with option HF15 and suitable grassland or field margin options to ensure that survival and productivity are maintained.

Although stubbles are important in providing overwinter food resources for skylarks, research indicates that the decline in this species has been largely driven by reduced productivity. The SAFFIE results suggest that it is possible to substantially boost productivity by the implementation of 'skylark patches', but to date uptake of this option has been slow, and the challenge for the future is to find ways to encourage greater uptake of this and other 'mid-field' options for skylarks and other ground-nesting species.

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APPENDIX 2: HAY MEADOWS CASE STUDY, EXTENDED VERSION

Background

The area of semi-natural, or unimproved grasslands has declined dramatically during the twentieth century. Fuller (1987) concluded that 97% of enclosed unimproved grassland was lost between 1932 and 1984. Blackstock *et al*. (1998), reviewing the results of surveys carried out during 1978-1996, concluded that semi-natural grasslands covered only 1-2% of permanent lowland grassland in England and Wales. As a result, Habitat Action Plans were drawn up for five semi-natural grassland types, of which two include hay meadows: "Upland hay meadows" and "Lowland meadows" (Anon., 1998).

Upland hay meadows are defined as the National Vegetation Classification (NVC) community MG3 (*Anthoxanthum odoratum – Geranium sylvaticum* grassland). They occur mainly in the upland valleys of the north Pennines, with outliers in Scotland. They are absent from Wales and southern England. It is estimated that there are currently less than 1000ha in England and 100ha in Scotland (Anon., 1998). Upland hay meadows are found in the Pennine Dales and Lake District ESAs (Swash, 1997).

The Lowland meadow priority habitat includes three NVC communities: MG5 *Cynosurus cristatus - Centaurea nigra* Lowland hay meadow and pasture, MG4 *Alopecurus pratensis – Sanguisorba officinalis* Flood meadow, and MG8 *Cynosurus cristatus – Caltha palustris* Flood pasture. It is estimated that there are 5-10,000ha of MG5 grassland in England and Wales and 2-3,000ha in Scotland. It was found in the majority of English ESAs and in the Anglesey, Cambrian Mountains, Preseli and Radnor ESAs in Wales (Swash, 1997); it is also found in West Fermanagh and Erne Lakeland ESA in Northern Ireland. There are estimated to be less than 1500ha of MG4 flood meadow in the Thames Valley, the midlands, Welsh borders and Yorkshire, but it was only found in one ESA, the Upper Thames Tributaries ESA in England. MG8 flood pasture is even rarer, covering less than 1000ha in England and Wales, and 6-800ha in Scotland, but it occurred in a number of ESAs including the Avon Valley, Broads, Lake District, Pennine Dales, Somerset Levels & Moors, South Wessex Downs, Test Valley, Clwydian Range, Lleyn Peninsula and Radnor, with the Pennine Dales and Somerset Levels & Moors containing important quantities (Swash, 1997). Lowland Meadow grassland was also found in Argyll Islands, Cairngorm Straghs, Central Borders, Shetland and Stewartry ESAs in Scotland (Critchley *et al*., 2003).

Agri-environment scheme options

Uptake

Options incorporating hay meadow management vary between countries and schemes, and in some cases may incorporate management for hay and/or grazing. For the purposes of this case study, only options designed to promote the creation, restoration or favourable management of species-rich hay meadows are considered. Some schemes also have prescriptions to manage hay meadows for the benefit of other organisms, especially birds. The uptake figures presented are those for the options considered most appropriate in each case. For schemes that have now closed, the projected areas under existing agreements are also included where available.

Table HM 1 shows the area of options specific to meadow management in the English ESAs. These vary in their titles and specific details between ESAs. The maximum total area under these options coincided with the closure of the scheme in 2004, when they covered over 10,000ha. Two thirds of this area was in the Pennine Dales, with much of the rest in the Peak District. In the same year, around 6,400ha were under the lowland meadow, and *c*. 6,800 under the upland hay meadow options of Countryside Stewardship (CS) Scheme in England (Figure HM 1).

Table HM 1 Area of specific hay management options in English ESAs (ha).

Year	ESA and option code*									Total
	Black-down Hills	Cotswold Hills	Dart-moor	Lake District*	North Peak	North Peak	Pennine Dales	Shropshire Hills	South West Peak	
	OO2	1BM	O2A	O2A	MMS	O2B	1BM	MMS	O2B	
1997								8.2	5.3	13.5
1998		5.7	3.5	14.4	74.5		307.7	78.4	46.1	530.3
1999	133.1	4.8	134.8	650.0	240.6		6143.1	249.9	843.5	8399.8
2000	147.5	4.8	150.0	712.3	307.4		6422.6	274.1	881.6	8900.3
2001	155.1	4.6	168.0	776.8	319.9		6768.0	335.3	972.0	9499.7
2002	163.0	5.4	199.5	908.1	334.9	0.6	6695.4	408.8	1050.2	9765.9
2003	166.3	5.4	209.7	781.9	439.3	3.7	6692.1	441.1	1210.6	9950.1
2004	175.4	0.8	213.1	797.2	450.9	4.1	6834.5	487.2	1309.8	10273.0
2005	162.9	0.8	167.2	769.2	445.2	4.1	6692.5	480.7	1182.6	9905.2
2006	145.6	0.8	137.4	756.8	403.4	4.1	6585.7	415.6	1095.5	9544.9
2007	130.3	0.8	134.3	737.0	390.5	4.1	5914.2	378.5	1059.9	8749.6
2008	115.7	0.8	128.1	723.2	315.1		5582.3	306.6	1000.2	8172.0
2009	111.2	0.8	126.9	713.3	297.2		5357.9	305.2	961.3	7873.8
2010	102.7	0.8	110.1	679.6	288.6		5116.4	302.3	924.3	7524.8
2011	101.3	0.8	110.1	617.5	271.4		4713.3	282.8	847.0	6944.2
2012	96.1		105.2	527.7	250.9		1069.8	258.6	738.2	3046.5
2013	91.4		100.7	145.1	54.9		446.0	234.3	188.8	1261.2

*Option descriptions:

Blackdown Hills OO2: Species-rich hay meadows
Cotswold Hills 1BM: All IPG managed as hay meadow
Dartmoor O2A: Species-rich hay meadows
Lake District O2A: Meadows (including herb-rich meadows)
North Peak MMS: Hay meadow supplement
North Peak O2B: Traditional hay meadows
Pennine dales 1BM: Meadows
Shropshire Hills MMS: Hay meadow management supplement
South West Peak O2B: Traditional hay meadows.

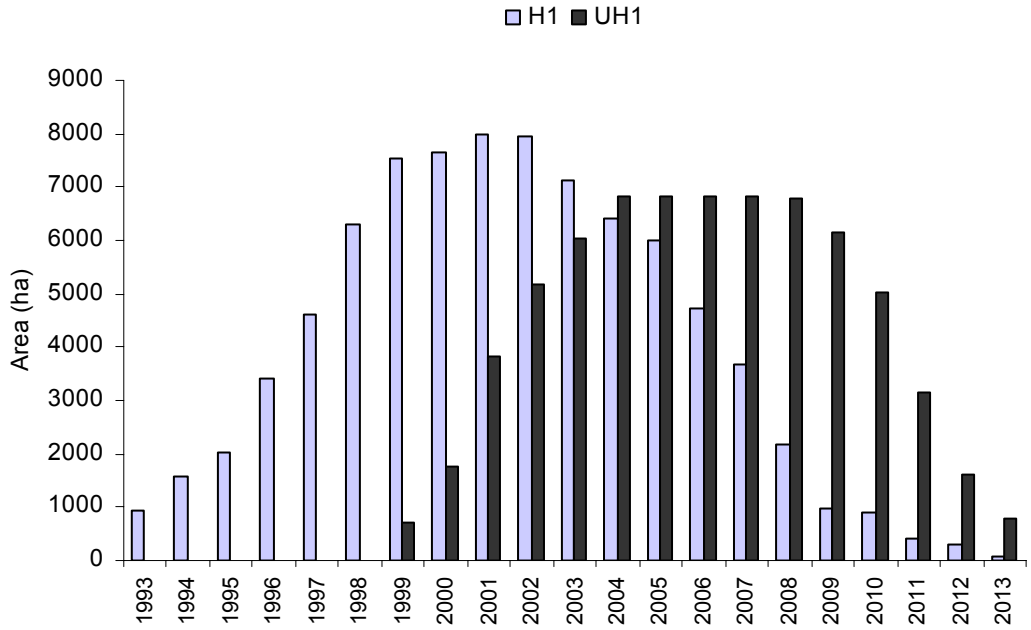

Figure HM 1 Area of Lowland meadows (H1) and Upland hay meadows (UH1) in Countryside Stewardship agreements in England (including projected future area.

The Entry Level scheme in England does not contain any prescriptions for hay-meadow management, though there are general prescriptions for permanent grassland management with low or very low inputs, which are mainly concerned with restricting the level of Nitrogen use. Table HM 2 shows the area in appropriate options of the Higher Level Scheme in England in 2008. Although all the options can include hay management, the hay-making supplement was claimed on only just over 2000ha.

Table HM 2 Area of options for species-rich grassland, and number and area of holdings with these options in Higher Level Stewardship in England, May 2008.

Option code	Option description	Amount of option (ha)	No. holdings	Area of holdings
HK6	Maintenance of species-rich, semi-natural grassland	4712.1	471	74912.6
HK7	Restoration of species-rich, semi-natural grassland	9049.8	763	124648.6
HK8	Creation of species-rich, semi-natural grassland	1359.9	136	38244.8
HK18	Hay-making supplement	2037.7	277	33939.9

In Wales there were 1,711ha of unimproved neutral grassland in Tir Gofal in January 2007, and 561.56 ha of hay meadows and 614.47 ha of reversion to hay meadows under ESA agreements in spring 2008.

In Scotland, prescriptions for herb-rich pasture in the ESAs cover management for hay where appropriate. Prescriptions for management of Species-Rich Grassland (SRG) in the Countryside Premium Scheme (CPS) and Rural Stewardship Scheme (RSS) involve leaving the sward uncut for three months in the summer, though the RSS allows for a grazing plan to be agreed where this is felt to be more appropriate to the conservation interest of the site..

Table HM 3 Area of Herb-rich pasture options in Scottish ESAs (ha).

Year	Argyll Islands	Cairngorm Straths	Central Borders	Central Southern Uplands	Loch Lomond	Shetland Islands	Stewartry	W. Isles Machair	Western Southern Uplands	Total
1993	0.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	18.0
1994	43.2	23.0	8.1	1.3	37.4	54.8	66.6	0.0	0.0	234.3
1995	481.5	106.6	59.9	1.3	47.9	182.6	364.2	78.9	14.2	1337.1
1996	833.5	197.8	82.7	2.0	95.3	442.8	699.1	164.3	46.9	2564.4
1997	1198.0	311.4	199.4	48.2	123.1	839.7	809.7	218.2	170.5	3918.0
1998	1336.8	364.0	269.6	62.4	149.2	1331.7	936.5	265.9	222.5	4938.5
1999	1646.8	471.0	387.1	232.9	177.5	2284.4	1121.1	464.4	501.6	7286.7
2000	1654.9	467.1	404.7	245.7	181.4	2365.6	1114.6	492.4	499.6	7425.8
2001	1637.8	473.3	415.2	283.5	167.3	2609.4	1116.1	549.2	533.5	7785.3
2002	1650.3	565.6	419.6	292.5	162.3	2693.2	1119.0	550.4	500.6	7953.5
2003	1634.6	555.4	413.2	307.5	126.2	2647.5	1122.3	547.8	500.1	7854.7
2004	1584.7	539.3	393.7	255.3	104.5	2571.7	980.8	530.9	449.9	7410.9
2005	937.4	380.0	296.4	244.2	93.1	2408.7	721.5	380.7	444.7	5906.7
2006	626.6	283.4	287.4	244.2	30.4	2079.3	370.7	277.9	411.8	4611.7
2007	345.8	206.3	172.6	213.5	28.7	1575.0	258.8	261.5	283.9	3346.1
2008	234.8	158.1	117.6	184.2	25.3	1103.2	136.5	220.3	263.0	2443.0
2009	51.9	55.0	10.0	17.1	0.1	147.0	33.6	27.4	38.2	380.3
2010	45.5	55.0	10.0	17.1	0.1	146.8	33.6	16.6	38.2	363.0
2011	0.0	50.7	0.0	0.0	0.0	0.0	11.0	7.0	5.0	73.7

The total area of land in options for herb-rich pasture in Scottish ESAs peaked at over 7,900ha in 2002, with the largest amounts found in the Shetland Islands, followed by the Argyll Islands and Stewartry ESAs (Table HM 3).

The area under the option for SRG management in the CPS was highest in 2001 at around 5,300ha, with a further 520 under the creation and management option (Figure HM 2). From 2001, the CPS was replaced by the RSS, in which the area under SRG management eventually reached over 11,000ha in 2006, when the scheme closed. An additional 2,000ha were under options involving the creation of SRG (Figure HM 2).

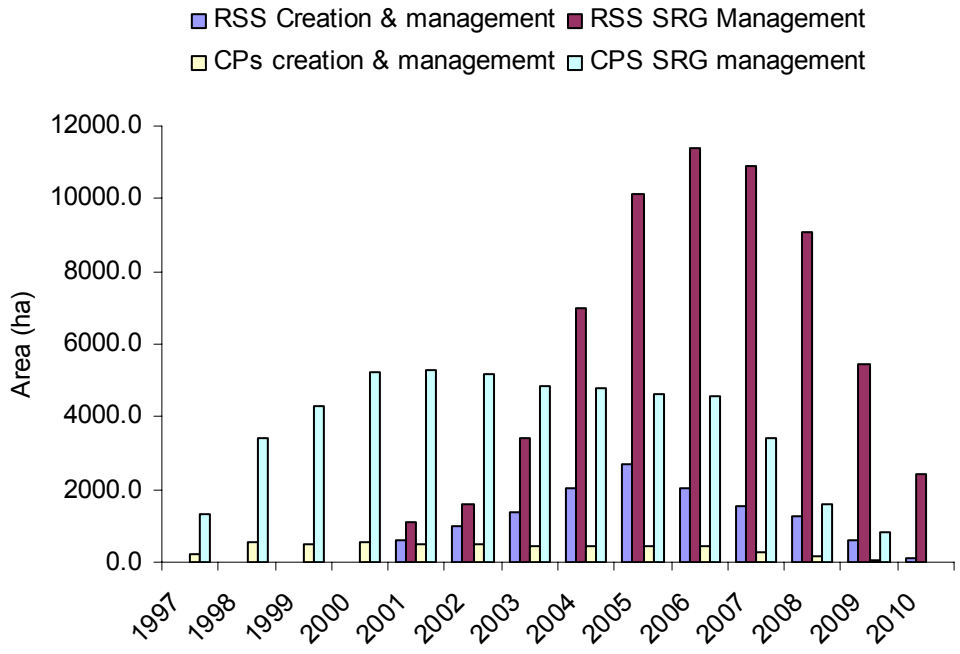

Figure HM 2 Areas of species-rich grassland (SRG) management, or creation and management (including sowing, arable and improved grassland) in the Countryside Premium Scheme and Rural Stewardship Schemes in Scotland.

Data for the SRG hay management prescription for in the Countryside Management Scheme and ESAs in Northern Ireland are only available for the sum of all schemes. Areas managed as hay meadows are shown in Table HM 4. No breakdown as to the location of this area was available.

Table HM 4 Area of land under option 'species-rich grassland cut for hay' in agri-environment schemes in Northern Ireland

Year	Area (ha)
2004	317
2005	438
2006	438
2007	546

Outcomes of agri-environment scheme options

A number of evaluations have investigated the effect of agri-environment agreements on the botanical composition of grasslands, including hay meadows.

Critchley *et al*. (2003) reviewed botanical monitoring results for semi-natural grasslands from agri-environment schemes throughout the UK, in terms of their contributions to HAP targets. Only two samples included upland hay meadows

(UHM), both in the Pennine Dales, one of which was being maintained and the other rehabilitated (i.e. maintained but with the quality being enhanced). Among six lowland samples in English ESAs classified as existing (as opposed to potential) LM, three were being maintained, two rehabilitated, and two (both on the Somerset levels) had deteriorated. Of two LM sites in Northern Ireland (both in West Fermanagh and Erne Lakeland), one was being rehabilitated and one maintained, and of five in Scotland, four were maintained but one had deteriorated. One LM sample in Radnor, Wales had deteriorated, but another was being rehabilitated. In one of the samples in Northern, where land in the scheme was being rehabilitated, no changes was observed in land not in the scheme, and in Radnor, deterioration was observed in non-scheme land whereas land under agreement was rehabilitated.

Out of eighteen samples in England with potential to develop into LM from improved grassland, only five showed sings of restoration to HAP status. The one site in Northern Ireland showed no restoration, but three of four sites in Wales did show signs of restoration.

A key factor determining outcomes was the use of inorganic fertiliser. Most instances of rehabilitation of existing HAP sites, or of restoration from improved grassland, occurred where no fertiliser was allowed or applications were reduced on scheme entry.

Hewins *et al*. (2005) surveyed the condition of BAP priority grasslands in England and compared sites within and outside agri-environment schemes. UHM and LM were in the poorest condition of the priority grassland types, with only 7% and 18% respectively of grassland in these categories in favourable condition. In general, grassland in agri-environment scheme agreements was almost twice as likely to be in favourable condition as that outside schemes. When individual priority habitats were considered, pass rates were higher for LM and UHM in agreements than for those not in agreements, though the difference was not significant for these habitats. Upland hay meadows were also less likely to show similarity to NVC types indicative of neglect or agricultural improvement than those not in agreements. There was a significant positive relationship between presence of agri-environment agreements and increased cover of herbs for both LM and UHM, and there were more positive indicator species in UHMs in agreements, though this relationship was not significant.

The authors stressed that these results do not necessarily indicate that the condition of grasslands improved under agri-environment scheme management, as there were no pre-agreement baseline data on condition with which to compare, but they did suggest particularly for UHM that the schemes are either successfully selecting and/or protecting these meadows.

Critchley *et al*. (2004) reported on vegetation change in the Pennine Dales ESA between 1987 and 2002. They found that species richness increased up to 1995, but re-survey in 2002 showed a decline to levels similar to those observed in baseline surveys. Herb species richness declined in a sample of unimproved swards, but few changes were detected in semi-improved grasslands. In contrast, improved swards showed increases albeit small ones, in total, herb and grass species richness. There were clear relationships between vegetation change and management practices. Detrimental practices included cutting before 15 July, spring grazing, and application of inorganic nitrogen. Sites under Tier 2 management fared better between 1995 and 2002 than those in Tier 1.

Kirkham *et al*. (2004) re-surveyed 18hay meadows in 2003 within the Dartmoor ESA, that had previously been surveyed in 1995. In contrast the results of Critchley *et al*.

(2004), most sites increased in conservation value between the surveys, with the greatest increases at sites that were initially more agriculturally improved. Soil samples also revealed a general trend of declining soil fertility. However, all sites failed to reach a 'favourable' conservation status in terms of SSSI criteria in an English Nature Condition Assessment.

Manchester *et al*. (2005a) presented results of a resurvey in 2003 of upland grassland in the Shropshire Hills, Blackdown Hills, and South West Peak ESAs, first surveyed in 1994. For the most part, presentation of the results does not allow hay meadows to be readily distinguished from pastures, However, declines in numbers of species were noted particularly in the unimproved hay meadows of the Shropshire Hills and South West Peak ESAs. In the Shropshire Hills, a trend towards more acid conditions was noted, but the changes in the South West Peak were more difficult to interpret.

Manchester *et al*. (2005b) surveyed wet grassland in the Avon Valley, Upper Thames Tributaries and Somerset Levels and Moors ESAs. Results suggested that the ESA scheme was functioning to at least maintain the extensively managed permanent pastures and hay meadows within the Avon Valley, and the Upper Thames tributaries but in the Somerset Levels and Moors ESA, land managed under the raised water level tier was increasingly characterised by species adapted to conditions of high soil moisture content.

Discussion and Conclusion

Uptake data indicate that areas under agri-environment schemes exceed the estimated areas of BAP priority habitats, though it is not known what proportion of grassland that corresponds to priority habitats is within agri-environment agreements. However, Carey *et al* (2005) estimated that there were 1053ha of Lowland Meadow priority habitat and 183ha of Upland Hay Meadow priority habitat in English ESAs. Carey *et al* (2002, 2005) found that land in CS and ESAs had a much higher proportion of high value grassland than English countryside as a whole. Hewins *et al*. (2005) found that grassland in agri-environment scheme agreements was almost twice as likely to be in favourable condition as that outside schemes, suggesting that agri-environment schemes are selecting and/or protecting higher quality grass swards.

Critchley *et al*. (2003) discuss factors influencing the botanical composition of lowland semi-natural grasslands, and Jefferson (2005) recently reviewed the conservation management of upland hay meadows. Evidence that use of fertilisers is associated with decrease, or lack of increase in species richness is supported by a number of studies in the literature (Marrs, 1993). For example, Kirkham *et al*. (1996) showed a decline in species richness of hay meadows on the Somerset Levels ESA with fertiliser use, and Kleijn *et al* (2001) found that Dutch agri-environment schemes did not increase botanical richness because fertiliser inputs were not reduced sufficiently.

The impact of grazing management is complex, with grazing intensity, duration, timing and type of stock all having an influence. Critchley *et al*. (2003) note that until recently, many UK agri-environment schemes included generalised management prescriptions, but that mow many schemes include a requirement for the development of site-specific grazing plans.

Other important factors can be hydrology (for wet meadows) and the availability of propagules (where restoration or rehabilitation are objectives). In relation to the

latter, Critchley *et al*. (2003) emphasize the long-term nature of such processes, and indicate that full restoration is unlikely within the ten year period of most agri-environment agreements.

Overall, Critchley et al. (2003) conclude that the quality of semi-natural grassland as a whole is likely to be maintained under agri-environment agreements, but that successful rehabilitation, restoration and re-creation will depend on appropriate fertiliser, grazing and hydrological regimes, with re-introduction of target species where they are absent after sward conditioning by harrowing etc. This will require a pro-active approach, which may need significant input from an adviser. With respect to meadows, they conclude that agri-environment schemes are probably making a substantial contribution to the UK target area for maintenance of lowland meadows, and that the UK target area for restoration and re-creation of lowland meadows is possibly being met, but that there was insufficient information for upland hay meadows. The subsequently published surveys by Critchley *et al*. (2004) and Manchester *et al*. (2005)give some cause for concern, though the results obtained by Kirkham *et al*. (2004) in Dartmoor are more encouraging.

Critchley *et al*. (2007) described how the results of the evaluation of the Pennine Dales hay meadows were taken into account in developing options in the HLS in England. The prescriptions under the new scheme are closer to the more successful Tier 2 prescriptions under the ESA, for example no inorganic fertiliser is allowed, the default cutting date is 15th July, with the potential to set a later date (earlier cutting dates had resulted in a reduction in forb richness), and livestock are excluded for seven weeks before cutting. HLS is more outcome driven than previous schemes, and 'Indicators of Success' are defined for each agreement, describing the targe state of the feature being managed.

For the benefits achieved to be maintained, and hopefully enhanced, it is essential that a substantial proportion of sites, including the best examples, are transferred to new schemes when previous schemes come to an end. For this reason, gaps in scheme availability, such as occurred between 2006 and 2008 in Scotland, need to be kept to a minimum to avoid loss or deterioration in swards of high conservation value.

In England, the data in Table HM 1 indicate a reduction in area of hay meadows in ESAs and CS of 2,100ha and 4260ha respectively between 2004 and 2008. In contrast, Table HM 2 shows areas of around 4712, 9050 and 1360ha in HLS options for maintenance, restoration and creation of SRG respectively, but only 2038ha with hay meadow supplement. There must be some question therefore whether uptake of relevant options under HLS is keeping pace with the amount of land leaving agri-environment schemes as agreements come to an end. On the other hand, the high level of adviser input should ensure that HLS agreements target the best sites, and there is little doubt that some of the grassland under earlier schemes, particularly Tier 1 ESA agreements, was not of high quality. Nevertheless, an early re-assessment of those sites previously identified as of high quality in previous surveys would provide a valuable indication of the extent of re-entry into the current scheme.

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APPENDIX 3: HEATHER MOORLANDS CASE STUDY, EXTENDED VERSION

Background

Upland heathland, as defined in the Habitat Action Plan for this habitat, is characterised by the presence of dwarf shrubs at a cover of at least 25%, and defined as lying below the alpine or montane zone (at about 600-750 m) and usually above the upper edge of enclosed agricultural land (generally at around 250-400 m, but descending to near sea-level in northern Scotland). There have been considerable losses of heather moorland in recent decades. It has been estimated that 27% of heather moorland was lost in England and Wales between 1947 and 1980, and 18% was lost in Scotland between the 1940s and 1970s, with a continuing downward trend (Anon., 1998a).

Currently there are around 270,000 ha of heather moorland in England, 80,000 ha in Wales, up to 69,500 ha in Northern Ireland and between 1,700,000 and 2,500,000 ha in Scotland. Although there are in total 2-3 million ha of this habitat, it has international importance because it largely confined within Europe to the British Isles and the western seaboard of mainland Europe. It has also been estimated that 440,000 ha of land in the uplands in England and Wales consist of grassland containing suppressed dwarf shrubs, with than 25% cover of heather. There is likely to be further significant loss of heather moorland to acid grassland if current grazing levels and pressures continue.

Upland heathland encompasses a number of National Vegetation Classification (NVC) plant communities. These including *Vaccinium myrtillus - Deschampsia flexuosa* (H18), which is generally widespread in the uplands, *Ulex gallii - Agrostis curtisii* (H4) and *Calluna vulgaris - U. gallii* (H8) in southern Britain, *Calluna - V. myrtillus* (H12) especially in the east, *Calluna - E. cinerea* (H10), *Calluna - V. myrtillus - Sphagnum capillifolium* (H21) and *Scirpus cespitosus - E. tetralix* (M15) particularly in western margins. Other more locally distributed communities include *Calluna - D. flexuosa* (H9)*, Calluna - Arctostaphylos uva-uri* (H16) and *E. tetralix - Sphagnum compactum* (M16) (Anon., 1998a). The distribution of these communities is influenced by climate, altitude, aspect, slope, maritime influences and management practices including grazing and burning.

Upland heath in 'favourable condition' is typically dominated by a range of dwarf shrubs such as heather, bilberry and crowberry, and be structurally diverse, with heather at different stages of growth including areas of mature heather. Losses or degradation of heather moorland have occurred through agricultural land improvements, including ploughing, reseeding, liming and fertilisation at lower elevations, drainage and moorland 'gripping', heavy grazing by sheep (and, in certain areas, red deer and cattle), poorly managed burning and afforestation. Encroachment by bracken also causes loss in biodiversity. Other threats are acidification and nitrogen enrichment caused by deposition of atmospheric pollutants, and climate change. The time of year and length of grazing period, stock shepherding, supplementary feeding, heather management by burning or swiping, and control of scrub and bracken are all important management factors influencing the vegetation composition and condition of heather moors.

ESAs with prescriptions for heather moor management include the Lake District, North Peak, South West Peak, Exmoor, Dartmoor, the Shropshire Hills, the Cambrian Mountains, Radnor, Preseli the Central Southern Uplands and Western

Southern Uplands of Scotland and the Sperrins in Northern Ireland. The national schemes in all four countries including Countryside Stewardship (CS) Scheme and more recently Environmental Stewardship in England, the Countryside Premium Scheme (CPS) followed by the Rural Stewardship Scheme (RSS) in Scotland, Tir Cymen and more recently Tir Gofal in Wales, and the Countryside Management scheme in Northern Ireland, also had or have options for managing heather moorland.

Agri-environment scheme options

Uptake

A number of options existed in most schemes relating to heather moorland. For this reason, where data were available for multiple years, uptake data are only presented for the year in which the scheme closed (or the preceding or following year where uptake maxima appear in that year. For most options, uptake areas increased throughout the life of the scheme and so were at a maximum in the years presented, but there are some exceptions to this generalisation.

In ESAs and the CS in England in 2004/5 there were total around 150,000ha in moorland management options, 128,000ha in moorland enhancement options and 19,000ha in recreation, reversion and regeneration options (Table M 1,

Table M 2). The area in management options alone was equivalent to over half the estimated area of the Upland Heath priority habitat in England. Whilst not all the land in these options will qualify as priority habitat, it appears that a high proportion of heather moorland was being managed under one or other of the schemes. Carey *et al*. (2002) estimated that there were 1,700ha of upland heathland priority habitat, including mosaics containing the priority habitat, under CS agreement in England in 1998-1999. To put this in perspective, in 1999 there were 3340ha under prescriptions for regenerating suppressed heather moor, 12,137ha in the enhanced heather moorland tier, and 9,175ha in the 'management of heather moorland habitat' tier of CS. Carey *et al*. (2005) estimated, from survey work carried out in 2002-2003, a total of 24,812ha of upland heath priority habitat in ESAs, with a further 7,951 ha in mosaics where it was the primary component and 17,232 ha where was the secondary or tertiary component. As for CS, this is considerably less than the area under relevant prescriptions in the ESAs as a whole (see Table M 1).

ESAs and the CS closed in 2004, but by 2008 there were over 61,000ha in the moorland option of Entry Level Stewardship (ELS), and 53,000ha in maintenance or restoration options of Higher Level Stewardship (HLS)

Table M 3). However, as agreements under the classic schemes terminate, it will be important to achieve continued transfer to the new scheme if the area under sympathetic management is to be maintained or increased.

There were 35,423 ha of high mountain and upland heath in Tir Gofal in January 2007. Data are not available for Welsh ESAs, however it appears that a lower proportion of the heather moorland stock is in agri-environment schemes.

Table M 1 Area (ha) of options relating to heather moorland in English ESAs in 2004 and 2005

ESA	Option code	Long description	Area (ha) 2004	Area (ha) 2005
Dartmoor	O1E	Moorland	33,233	32,893
Dartmoor	O2B	Heather Moorland (Existing Agreement Holders only)	1,192	1,032
Exmoor	O1D	Moorland	5,121	4,866
Exmoor	O1E	Heather moorland and coastal heath	9,212	9,222
Lake District	O1E	Heather fell	49,830	48,803
Lake District	O2B	Intermediate heather fell	1,416	1,449
North Peak	O1C	Moorland	3,929	2,907
Shropshire Hills	O1D	Moorland	2,790	2,790
Shropshire Hills	OO2	Heather Moorland	299	299
South West Peak	O1D	Moorland	948	796
Total			**107,969**	**105,057**
Dartmoor	2BR	Moorland Enhancement (Revised Tier)	5,530	5,146
Exmoor	OO2	Enhanced heather moorland and coastal heath	1,690	1,690
Lake District	O2C	Enhanced heather fell	7,802	7,841
North Peak	O2A	Moorland enhancement - extensification	27,287	26,719
North Peak	O2B	Moorland enhancement - exclosure	10,936	10,696
South West Peak	O2E	Enhanced moorland	3,700	3,754
Total			**56,944**	**55,845**
Dartmoor	O2C	Moorland Re-creation	147	144
Exmoor	O2A	Reversion of land to heather moorland and coastal heath	12	12
South West Peak	MRS	Moorland regeneration supplement	685	684
Total			**844**	**840**
Dartmoor	CRS	Winter Cattle Removal Supplement (on Tier O1E)	30,093	30,094
Dartmoor	EWS	Early Winter Stocking Level Supplement (on Tier O1E)	7,490	7,409
Exmoor	LHS	Winter Livestock Removal Supplement (on Tier O1D)	7	7
Lake District	SRS	Supplement for removal of stock in winter	13,595	14,337
Shropshire Hills	LHS	Supplement for Off-wintering 100% of moorland stock	197	197
Shropshire Hills	LLS	Supplement for Off-wintering 50% of moorland stock	2,275	2,275
Total			**53,658**	**54,320**
Dartmoor	PGS	Summer Purple Moor-grass Grazing Supplement (on Tiers O1E,O2B)	3,577	3,017
Exmoor	PGS	Purple moor-grass grazing supplement	1,299	1,298
Total			**4,876**	**4,315**
Dartmoor	CCS	Commons Supplement	31,137	31,711
Exmoor	CCS	Commons Supplement	3,374	3,372
Lake District	CCS	Commons Supplement	52,138	52,863
Shropshire Hills	CCS	Commons Supplement	2,215	2,215
Total			**88,864**	**90,161**

Table M 2 Area (ha) of options in the Countryside Stewardship Scheme in England in 2005

Option code	Description	Area (ha)	
		2004	2005
UM1	Regenerating heather on improved land	632	632
UXA	**Supplement for up to 10 years** Regenerating suppressed heather moor	602	543
UM2	**First 300 ha**	15,266	15,293
UM5	*thereafter*	2,542	2,542
UXB	*Supplement for up to 10 years*	14,323	13,582
UM3	Enhanced heather moorland	71,699	72,042
UM4	Management of heather moorland habitat	43,995	44,063
UA	**Supplement for additional temporary stock removal**	20,208	20,288
UB	*Supplement for introducing heather burning*	338	337
UC	*Supplement for upland commons management*	42,657	43,719

Table M 3 Area of options relating to heather moorland, and number and area of holdings with these options in Environmental Stewardship in England, May 2008.

Option code	Option description	Amount of option	No. holdings	Area of holdings
EL6	Moorland and rough grazing	61,430	371	131,040
HL9	Maintenance of moorland	7,509	33	15,095
HL10	Restoration of moorland	45,655	134	67,947
HL11	Creation of upland heathland	558	6	2,232
HL12	Supplement for management by burning, cutting or swiping	18,025	29	2,362
HL13	Moorland re-wetting supplement	1,728	19	12,557
HL15	Seasonal livestock exclusion supplement	19,607	78	37,383
HL16	Shepherding supplement	9,649	18	14,589

In 2000, over 3,500ha were receiving payment for bracken control and over 41,000ha for muirburn under ESA or CPS options in Scotland (Table M 4, Table M 5), and by 2006 the area under bracken control options had increased to over 5,700ha under RSS (Table M 5). No separate uptake data were available for muirburn under RSS, though payments can be made for this if part of the moorland management plan. The option covering the largest area of ESAs was stock control, peaking at over 122,000ha in 2001 (Table M 4). Nearly 200,000ha were receiving payment for moorland management in the RSS in 2006, equivalent in area to the great majority of the area of the upland heath priority habitat in Scotland. However, the scheme closed that year so the area is now declining (down to 134636ha in 2008).

Table M 4 Area (ha) of options for heather moorland in Scottish ESAs in 2001

ESA	Item	Area (ha)	
		2000	2001
Argyll Islands	Bracken Control	73	32
Breadalbane	Bracken Control	124	71
Cairngorm Straths	Bracken Control	10	6
Central Southern Uplands	Bracken Control	369	429
Loch Lomond	Bracken Control	52	104
Stewartry	Bracken Control	13	51
Western Southern Uplands	Bracken Control	110	252
Total		**2,751**	**2,945**
Argyll Islands	Bracken Control (Secondary Treatment)	0	0
Breadalbane	Bracken Control (Secondary Treatment)	0	6
Cairngorm Straths	Bracken Control (Secondary Treatment)	0	0
Central Southern Uplands	Bracken Control (Secondary Treatment)	0	25
Stewartry	Bracken Control (Secondary Treatment)	0	0
Western Southern Uplands	Bracken Control (Secondary Treatment)	0	30
Total		**0**	**61**
Breadalbane	Bracken Control (Small Areas)	25	67
Loch Lomond	Bracken Control (Small Areas)	0	0
Total		**25**	**67**
Argyll Islands	Muirburn	758	763
Breadalbane	Muirburn	1,717	1,767
Cairngorm Straths	Muirburn	1,682	1,682
Central Southern Uplands	Muirburn	12,046	13,161
Loch Lomond	Muirburn	75	99
Shetland Islands	Muirburn	10	0
Stewartry	Muirburn	436	436
Western Southern Uplands	Muirburn	5,733	6,302
Total		**22,457**	**24,210**
Argyll Islands	Stock Control	530	492
Breadalbane	Stock Control	1,180	1,356
Cairngorm Straths	Stock Control	770	808
Central Southern Uplands	Stock Control	61,117	60,158
Loch Lomond	Stock Control	813	763
Shetland Islands	Stock Control	19,729	32,294
Stewartry	Stock Control	1,351	1306
Western Southern Uplands	Stock Control	22,884	25,211
Total		**108,375**	**122,388**
Argyll Islands	Stock Disposal	62	62
Breadalbane	Stock Disposal	63	0
Cairngorm Straths	Stock Disposal	0	0
Central Southern Uplands	Stock Disposal	458	458
Shetland Islands	Stock Disposal	172	114
Stewartry	Stock Disposal	14	11
Western Southern Uplands	Stock Disposal	292	269
Total		**1,062**	**914**

Table M 5 Area (ha) of options for heather moorland in the Countryside Premium Scheme (CPS) in 2000, and the Rural Stewardship Scheme (RSS) in 2005 in Scotland.

Scheme	Item	Area (ha)
CPS (2000)	Bracken Control	791
	Moorland - Muirburn	18,931
Total		**19,723**
RSS (2006)	Bracken Eradication Programme (Moorland)	4,110
	Bracken Eradication Programme (Species-rich)	521
	Bracken Treatment	1,105
	Moorland Management	199,627
	Stock Disposal	31,945
Total		**237,308**

Data for the heather moorland prescription for in the Countryside Management Scheme and ESAs in Northern Ireland are only available for the sum of all schemes (Table M 6). No breakdown as to the location of this area was available. Over 50,000ha of heather moorland were being managed under agri-environment schemes by 2007, equivalent to nearly three quarters of the estimated area of priority habitat in the province.

Thus, it appears that throughout the UK, a high proportion of upland heather moorland is under agreement in agri-environment schemes.

Table M 6 Area of land under heather moorland option in agri-environment schemes in Northern Ireland

Year	Area (ha)
2004	43,721
2005	41,838
2006	52,421
2007	50,375

Outcomes of agri-environment scheme options

Ecoscope (2003) reported on the results of assessments in all six of the English ESAs containing heather moorland. In Dartmoor, it was concluded that in the period up to 1997 the quality of the moorland vegetation had continued to decline, and levels of uptake were well below target for the scheme. In Exmoor, an assessment covering the period 1993-1996 indicated that the amount of heather moorland in the scheme was substantial, but condition appeared likely to be deteriorating, and the extent of heather remained threatened. However, populations of moorland birds had been maintained or, for some species, increased. In the Lake District, target uptake for heather moorland was not achieved, but the quality of the vegetation was not assessed. The North Peak was assessed over the period 1993-1996. Uptake targets for moorland were almost achieved, and there was evidence that moorland vegetation was beginning to re-establish on some sites. Grazing levels were substantially reduced, and the proportion of suppressed heather decreased. Heather

burning increased, but there was little regeneration of heather at bracken control sites. Some bird species (curlew, wheatear and meadow pipit) also increased. The Shropshire Hills were monitored between 1994 and 1997. The monitoring indicated that heather was suppressed at the start of the scheme, but lack of repeat survey data meant that a full assessment of the impact of the scheme could not be made. In the South West Peak, an assessment between 1993 and 1996 revealed that the uptake target for moorland had been achieved, and grazing pressure had declined, but the condition of heather was not assessed.

Overall, Ecoscope (2003) concluded that "some ESA grazing prescriptions may not maintain moorland habitats in favourable condition, and may not be effective in enhancing condition when habitats are in unfavourable condition. Grazing rates therefore need to be fixed on a flexible basis, which takes into account the type of habitats involved, their condition, conservation and landscape objectives and farming business".

Since the Ecoscope report, upland heath appears to have received less attention in terms of evaluation in relation to its area than grassland in English agri-environment schemes. Kirkham *et al*. (2005) reported on monitoring of moorland vegetation between 1994 and 2003. Grazing pressure on heather increased over the survey period, particularly between 1994 and 1997, and *Calluna* cover declined. Grazing pressure was too high to prevent decline of heather due to suppression, and there was little evidence of enhancement from a degraded starting point. It was concluded that maintenance management under Tier 1 prescriptions may not bring about restoration, and that Tier 2 or even off-wintering of stock may be necessary.

Darlaston & Glaves (2004) assessed the effects of the Exmoor ESA moorland restoration tier on heather at Winsford allotment between 1993 and 2003. In contrast to the results from Dartmoor, stocking rates were substantially reduced in summer and no stock were grazed in winter. Heather grazing index (percentage grazed shoots) had fallen from 88% in 1993 to 29% in 2003, and heather cover and height had also increased. Mean heather cover increased from 5% in 1993 to 29% in 2003. However, it was noted that even with good regeneration, recovery was slower than scheme targets allowed for, and this would need to be taken into account in setting indicators for success under the Higher Level Scheme.

A follow-up survey of moorland birds on Exmoor was also undertaken by the RSPB (Geary, 2002). Trends varied between species, with declines, stable populations and increases all recorded. It was concluded that ESA moorland management prescriptions were having a positive effect on most moorland bird populations, but localised overgrazing, swaling and scrub encroachment may be affecting tree pipit, whinchat and ring ouzel. It was suggested that higher grazing pressure on Dartmoor may explain why whinchat population was lower than on Exmoor, and Dartford warbler was not more widespread.

In the first generation of agri-environment schemes in Wales (ESAs and Tir Cymen), monitoring of both the Cambrian Mountains ESA and Tir Cymen monitoring showed a rapid overall improvement in heather condition on existing heathland under agreement in response to reductions in stocking density (Anon, 1998b). Heather (*Calluna vulgaris*) on non-agreement land was grazed significantly more than that on land under ESA agreement. There was a significant increase in the amount of heather grazed near to tracks and paths and when there was more grass in the sward. This was also found in the later assessment in the Cambrian Mountains (see below). A quarter of heathland sites in Tir Cymen recorded increases in Calluna cover of between 15-20%. On some sites, however, these beneficial changes were

accompanied by an increase in less palatable vegetation, especially purple moor grass and bracken. Lessons from this early monitoring were taken forward in the design of the Tir Gofal scheme. A greater range of habitat types was recognised, and greater discretion ws given to project officers to allow for the development of site specific grazing regimes. Provisions were also made for bracken control and scrub management, and increased emphasis was placed on the need for controlled burning and away-wintering of stock.

In 2000, a re-survey of 20 heather moorland sites previously surveyed in 1997 was undertaken in the Cambrian Mountains ESA in Wales (ADAS, 2000). Half the sites were under ESA agreement and half were not. Grazing index was lower on agreement land than on non-agreement land; however, although grazing index had not increased between 1993 and 1997, it had increased between 1997 and 2000. Grazing index was correlated with the number of stock. It was lower on dominant heather than sub-dominant, and was negatively related to the cover of heather. It was concluded that sheep are drawn to graze where grass is present among the heather, and grazing of the adjacent heather leads to suppression. Therefore, more precision may be needed in setting stocking rates for different areas according to their vulnerability, through the use of shepherding or additional fencing. In cases of severe overgrazing, complete removal of stock was recommended to allow recovery.

Despite the conclusions of the two reports cited above, a further re-survey of the Cambrian Mountains in 2004 found that heather had deteriorated on a number of Tier 1 sites, with high or very high grazing indices being recorded (Ardeshir, 2005). However, the performance indicators did appear to have been met on two of the three Tier 2 sites recorded. Once again, it was concluded that stocking rates were too high and more precision ws needed in controlling sheep in vulnerable areas. Levels of heather grazing were found to be higher when heather levels in the vegetation were low, there were patches of grass, tracks and paths within the heather, and stocking levels were higher.

Habitats surveyed in Tir Gofal in 2001-2 were re-surveyed in 2006-7 (Jackson, 2007). On Upland Heaths, the mean abundance of dwarf shrubs increased, the desirable species increased in frequency and mean abundance, the height of the heather and the building and mature heather phases all increased. However, only three upland heath sites were monitored, so the results need to be treated with caution.

Monitoring of Scottish ESAs was carried out between 1995 and 2004. Tier 1 land was monitored in all ESAs, but Tier 2 land was only monitored in what were considered to be the most important habitats ('Focus habitats') in each ESA. Tier 2 monitoring of heather moorland was carried out in Argyll Islands, Breadalbane, Cairngorm Straths, Central Southern Uplands and Western Southern Uplands, Loch Lomond, and Shetland Islands ESAs. Results differed between the ESAs

Among these, the largest areas of upland heath occur in the Western Southern Uplands and Central Southern Uplands (known in combination as the Southern Uplands). The area of dwarf shrub heath in these ESAs decreased during the monitoring period by 10,600ha, or 13% of its original area, in contrast to a national increasing trend (Cummins *et al*., 2007). There was also a general decline in the quality and area of dwarf shrub heaths on land in the scheme, even though 75% was subject to Tier 2 measures. Furthermore, this decline was greater than on land outside the scheme. Although the tier 2 measures reduced grazing pressure, cover of Calluna still decreased considerably, and changes in other species indicated a general decline in condition. It was concluded that the grazing levels on tier 2 sites were not suitable for conserving or enhancing heather.

In Loch Lomond, there was a 9% decrease in the area of heather vegetation between 1996 and 2003, but an increase in the percentage cover of heather, resulting in an overall decrease of 8% in the index of heather cover (Nolan *et al*., 2007b). In contrast, on out-scheme land there was a 4% increase in heather vegetation, but a reduction in percentage cover leading to an overall 51% decline in the heather cover index. Tier 1 management was however successful in maintaining heather condition, showing a reduction in suppressed heather on land in the scheme compared to little change on land outside the scheme. There was little evidence of enhancement arising from tier 2 measures, indicating that grazing levels were still too high.

In contrast to the Southern Uplands, results were much more positive in the Breadalbane ESA (Nolan *et al*., 2007a). There was little change in area of dwarf shrub heaths and Tier 1 requirements maintained heather condition and reduced the amount of suppressed heather, compared to an increase in areas outside the scheme. In addition, grazing intensity was reduced on land in Tier 2 measures, and height and cover of heather increased, indicating that the aim of enhancement had been achieved.

In Cairngorm Straths, only three holdings were available for monitoring. Cover, height and condition of heather was improved on land 100m away from the moorland or holding edge, but the scheme was less successful on land nearer the edge (cf. results of 1998 survey in Cambrian Mountains above) (Bell *et al*., 2007).

In the Argyll Islands ESA, the area of heather on Tier 1 land was maintained but heather condition declined due to a decrease in mean height (Cummins *et al*., 2007b). There was a slight decrease in area and little change in height or condition of heather on tier 2 land, indicating that stocking levels were probably too high, even though cover was low on some sites to start with.

In the Shetland Islands ESA, the area of heather vegetation on land in the scheme changed little, but heather cover within that area increased slightly, compared to a decrease on non-scheme land (Truscott *et al*. 2007). The number of sites in the scheme with suppressed heather decreased, and the mean height of heather increased, compared with a small decrease on out-scheme land. The tier 2 measures were therefore judged successful in the cover, height and condition of C*alluna* in comparison with land outside the scheme.

Only Tier 1 moorland was monitored in the Stewartry ESA. there was a 16% decrease in heather vegetation within the ESA compared to a 23% decrease outside the scheme (Scott *et al*., 2007). Cover of *Calluna* decreased by 22% on land in the scheme.

In Northern Ireland, monitoring of the West Fermanagh and Erne Lakeland ESA was carried out between 1993 and 2003 (McAdam *et al*., 2004), and four other ESAs were monitored between 1994 and 2004 (McAdam *et al*., 2005). McAdam *et al*. (2004) found that there had been a significant increase in mean cover of heather from 41% to 50%, and that dwarf-shrub cover had increased or been maintained on 85% of sites. On the remaining sites, where cover remained below 25%, it was thought that further reductions in stocking rates would be needed if condition was to improve.

There was no significant change in heather cover between 1994 and 2004 in the Antrim Coast, Glens and Rathlin or the Sperrins ESAs. Grazing levels ranged from none through light to heavy in these two ESAs. On two sites in the Antrim Coast, Glens and Rathlin ESA where grazing levels were high, heather cover was low and

condition poor in both surveys. In Slieve Gullion ESA, where grazing levels were recorded as none on half the sites with the rest subject to light grazing, mean heather cover increased from 23% to 33% and dwarf shrub cover from 49% to 64%. Two severely burnt sites were excluded from the analysis. A trial of the effects of burning and flailing for heather management showed that heather regenerated more rapidly after burning, but both methods gave satisfactory results.

The new ESA scheme in Northern Ireland classifies heather moorland into blanket bog, wet heath, dry heath or degraded heather, each of which has separate prescriptions and maximum grazing levels. These should help to achieve positive management and contribute to the delivery of BAP targets.

Discussion and Conclusion

Agri-environment schemes throughout the UK have achieved good levels of uptake for the heather moorland habitat. Unfortunately however, the results have been mixed, with little or no improvement in the quantity or condition of heather found in many of the evaluation surveys carried out. There have however been some marked successes, and the conclusions of the reports reveal a number of common principles which have emerged independently from the evaluations.

Firstly, it is clear that change in heather amount and condition is related stocking rate, and that high stocking rates invariably lead to deterioration in status of the heather. However, the vulnerability of habitats to degradation varies, with dry heath able to withstand higher levels of grazing pressure than wet heath, and blanket bog being the most susceptible. Where mosaics of vegetation occur, the stocking rate may need to be set in relation to the most sensitive habitat present.

Another factor is the amount of grass present in the vegetation. A positive feedback operates whereby heavy grazing leads to invasion of heather stands by grass, which attracts the sheep and so encourages increased grazing, which in turn leads to further increases in grass cover. Thus, increasing heather cover is most difficult where it is already low, and in such sites complete withdrawal of grazing for a period may be the only way to achieve recovery. Other factors encouraging higher levels of grazing are supplementary feeding, and the presence of tracks or roads. Key principles for managing heather are set out in the Upland Management Handbook (Backshall *et al*., 2001), which recommends maximum stocking rates for different habitats in summer and winter.

A number of reports conclude that measures are necessary to control grazing levels according to the sensitivity of the habitat concerned, and this has led to the introduction of measures to allow shepherding and fencing in more recent schemes (e.g. the HLS), as well as allowing for complete removal of stock in winter. It remains to be seen how effective these measures are, but the successes reported for example in the Exmoor ESA, early results from Welsh schemes, Breadalbane, Shetland, West Fermanagh and Erne Lakeland, and Slieve Gullion ESAs, show what can be achieved.

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APPENDIX 4: ACCESS CASE STUDY, EXTENDED VERSION

The case study focuses on Wales, where before and following the introduction of the CRoW Act, there was an attempt to 'link' areas of open access, which were largely on the higher slopes, with the RoW network, which was predominately focussed on the lower slopes and valley bottoms. This is contrasted with a non-AES scheme in Scotland.

Bentley (2003) reported that Snowdonia National Park saw that a 'portfolio of links would facilitate access to areas of statutory open countryside' created under CRoW. In the event, such an approach has not been easy to achieve as the Exegesis (2003) report highlights. However, the most recent data (December 2007) indicate that 516km of new linear permissive access routes have been created by Tir Gofal and 4,187km have been maintained within agreement land. These routes are designed to complement existing rights of public access, improve opportunities to appreciate the countryside and contribute to improved health and well being among users.

The Welsh Assembly provided the Tir Gofal permissive access route near Solva, in Pembrokeshire as an example to highlight the type of development that Snowdonia National Park proposed.. Through a Tir Gofal agreement, the voluntary option to create a new permissive linear access route has been entered into, where the agreement holder has developed a two kilometre permissive footpath for locals and tourists alike, which links into the existing public rights of way network, including two circular walks (Nine Wells, Ogof Castell and Solva, Segor Rock) and the Pembrokeshire Coast National Trail near Solva within the Pembrokeshire Coast National Park (see Figure A 1).

The route created extends existing access provision in a tourist 'honey-pot' and provides users with an additional route to explore coastal farmland and view several features of wildlife importance, including skylarks and peregrines, as well as rare arable weeds such as weasel snout and stone parsley.

Appropriate signage has been produced; a Tir Gofal Permissive Access board at the farm has been installed and Pembrokeshire Coast National Park has displayed signs on site near the route at Solva. The route will also link to the All-Wales Coastal Path, which is a Welsh Assembly Government commitment.

While the above is a good example of what can be achieved within AES, Swales *et al* (2005) provide some very interesting counter-evidence of what can be achieved outside of AES. However, the model could easily be included within AES and may provide a stronger model in areas where there are few PRoW. The report into the environmental priorities of the rural development schemes notes that as in the other parts of the UK, facilitating public access to the countryside and maintaining the existing network were considered as important environmental issues by stakeholders in Scotland.

In Scotland management and provision of access has been funded and provided outside agri-environmental schemes, for example through local authorities, land managers and various organisations such as The Paths for All Initiative set up by Scottish Natural Heritage.

The Scottish Executive (2001) report 'A Forward Strategy for Scottish Agriculture' recognises that the land managed by farmers is a considerable asset to the rural economy, and this included the contribution from walking.

Historically, Scotland has a long tradition of access to land and inland water for recreation.

In 2003 the Land Reform (Scotland) Act was introduced after a lengthy consultation during the 1990s. The Act was driven by a range of reasons, such as needing to clarify uncertainty in the legislation, addressing poor access provision in some largely lowland areas and providing more practical ways for land managers to support access and help rural economies.

Following the passing of the Act, the Scottish Outdoor Access Code was approved in July 2004, with both coming into effect in February 2005 to create a framework for responsible access to land and inland water for recreation and passage. Local authorities also had new powers and duties to:

- Prepare a Core Paths Plan to provide a good network of paths for all users including walkers, cyclists, horse-riders and users of inland water) ;
- [Uphold access rights
- Establish at least one local access forum in each of their areas with a balanced membership representing recreational and land management interests
- and publicise the Scottish Outdoor Access Code

Following the passing of the new legislation Fife Council invited all stakeholders to comment on the Core Path Network for Cupar and the surrounding area. The aim was to integrate access' with the needs of landowners and residents. Little use has been made of AES to fund either access provision or management in the Fife area, as with much of Scotland.

In the view of Swales *et al* (2005) as this new system becomes embedded it should provide a framework for the access options of AES to be used to assist in access authorities in the delivery of their responsibilities in this area. The State of Scotland's Farmed Environment report (2005) notes that despite the 2003 Scottish Land Reform Act, which gives statutory rights for non-motorised access over most areas, there remains a demand for improved access provision over agricultural land.

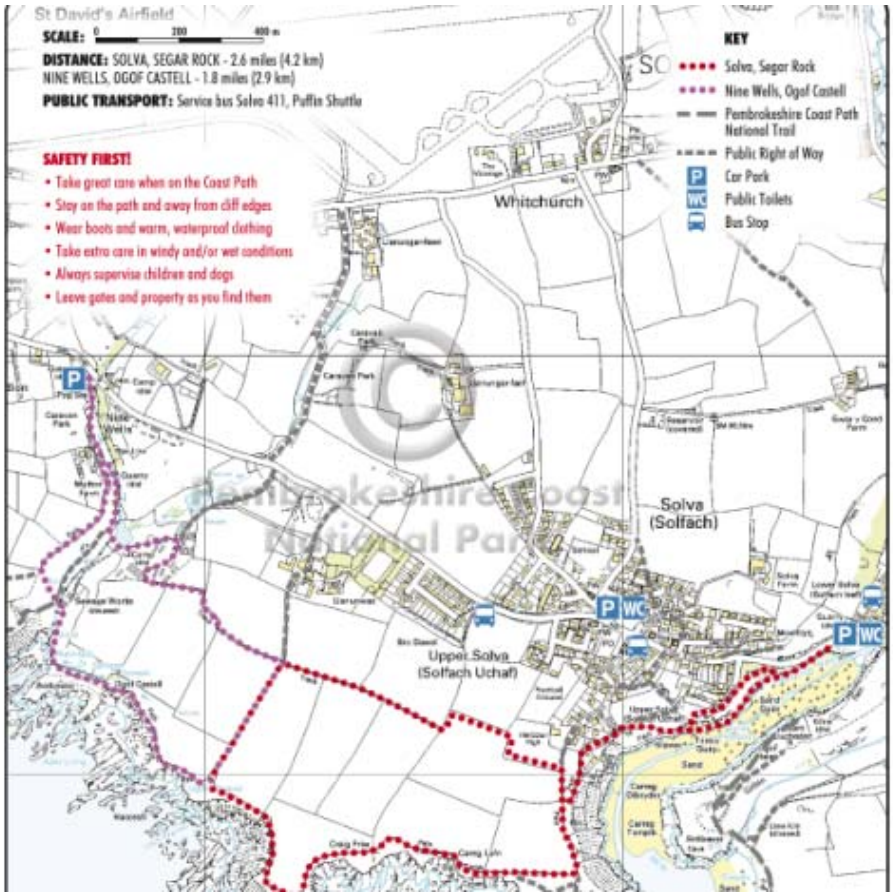

Figure A 1 Map of permissive access routes at Solva, Pembrokeshire.

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APPENDIX 5: RESOURCE PROTECTION CASE STUDY: BUFFER ZONES

In terms of the impact of agri-environment schemes on water and soil quality, much of the supporting evidence is derived from studies that were not specifically designed to investigate the performance of these schemes, and any impacts are therefore inferred from aspects of the studies that are relevant to management practices prescribed in the scheme. A notable exception to this is buffer strips, where there has been considerable interest over the last decade or more, and hence a substantial amount of published research. Buffer strips exist under a number of guises, including grass margins, field margins, filter strips, and streamside corridors. Buffer strips are considered to be a key management tool for delivering the objective of reducing water pollution, and enhancing the status and preventing further deterioration of aquatic ecosystems as required by the Water Framework Directive. As such, buffer strips have been, and continue to be supported under a number of schemes, and advocated under the Catchment Sensitive Farming Programme (CSF), whilst narrow buffer zones are required under cross-compliance. Examples of the different buffer strips in different schemes are given in Table RP 2.

The use of fertilisers, manures or pesticides is generally forbidden, except for the control of injurious weeds. One of the main differences is that in England grazing is allowed on the buffers whereas in the rest of the UK it is largely prohibited. The areas covered by buffer strips in the different schemes are summarised in Table RP 1. Data were not available for Scotland.

Table RP 1 Buffer strip areas in England, Wales and N Ireland

Scheme	Buffer type	Area covered (ha)
England ELS	2m arable	1663.59
	4m arable	6261.19
	6m arable	13402.12
	2m grass	463.6
	4m grass	658.57
	6m grass	1385.26
	pond grass	147.52
	pond arable	266.88
	beetle bank	103.44
Wales - Tir Gofal	Buffer	368
	Ungrazed grass margins	339.06
	Ungrazed grass margins (watercourse)	176.83
Northern Ireland	planted with trees	592.24
	planted with trees (water course)	32.36
	Rough grass crop margin	343.45

Table RP 2 Examples of buffer strips in different schemes in the UK

Country	Scheme	Required?	Description	Prescription
UK	ESA		Buffer strip 6m	No inorganic fertiliser
	ESA		Arable grassland margin 6m	No fertiliser or pesticide
	Cross-compliance	Mandatory	2m margin, at least 1m from water's edge	
England	CSS	Optional	2-6m riparian buffer/field margins	No fertiliser or manure, spot treat or wipe to control injurious weeds
	ELS	Optional	2-6m riparian buffer/field margins	No fertiliser or manure, spot treat or wipe to control injurious weeds; no access or storage.
		Optional	Beetle bank	2m wide 0.4m high
Wales	Tir Gofal	Mandatory	1m buffer round all field boundaries	No cultivation, fertilisers, lime, pesticides (except to control injurious weeds)
		Optional	Streamside corridor	Fence off land either side of stream; no livestock grazing
	Tir Cynnal	Optional	5m unploughed; uncultivated strip at bottom of slope	
NI	Countryside Management Scheme	Optional	Ungrazed grass margin 2 - 25 m	No grazing; supplementary feeding, storage, fertiliser, lime pesticides
		Optional	Ungrazed grass margin planted with trees 2m - 0.2 ha	No grazing; 90% native trees with at least 5 species; no drainage, fertiliser, lime pesticides
		Optional	Rough grass margin arable fields 2 - 12m	No grazing; not used as a headland or access; no feeding, storage, fertiliser, lime pesticides
Scotland	Rural Stewardship Scheme	?	Grass margin of beetlebank arable 1.5 - 6m	Grazing allowed after harvest; no fertiliser or manure; pesticides require written agreement
			Management of water margin 6 - 12m; 12 - 24m	Inbye land; no fertiliser or manure; no supplementary feeding; no grazing; restricted pesticide use

The uptake of buffer strips in England has increased from their introduction in CS. The maximum number of holdings having 6m buffers on arable and grassland has increased from *c* 1300 and 250 respectively in CS to *c*. 5500 and 1300 in ELS. There has been an increase in uptake of buffer strips in ELS of *c* 20% in arable areas and *c* 60% in grasslands since September 2007. The area covered by 4m and 6m buffers in England is nearly ten-times larger in arable land than on grassland, whereas in Northern Ireland there are larger areas of ungrazed grass margins than rough grass crop margins. This may reflect the different dominant farming types in the two countries. The proportion of ungrazed grass margins adjacent to watercourses in N. Ireland (52%) is greater than that of all buffer strips under ELS in England (37%; Boatman *et al*., 2007).

The benefits of buffer zones

Buffer zones may occur either along the edge of a water feature (riparian), or other features such as stonewalls, hedges, and woods. The benefit of buffer strips to soil and water along features other than water bodies may be limited, as the hedge, stone wall, or similar, could already create a barrier to the movement of soil by water or wind erosion, and any pollutants contained therein. Although there has been some research on the impact of creating in-field grass buffers where there was previously no cultivation-break in the field (Blackwell *et al*., 1999), there are no supporting data as to the impact of non-riparian buffers along *existing* features in the field. It is reasonable to assume that potential benefits may arise along non-riparian buffers from reduced inputs, no cultivation and a continuous vegetative cover, but there is no available data to support this assumption and/or to quantify the magnitude of the benefit.

Riparian buffer strips have greater potential to reduce water pollution as the farming activity is distanced from the water's edge (with the exception of grassland buffers in England). There have been a number of reviews that have collated existing literature on riparian buffer strips (e.g. Muscutt *et al*., 1993;Dosskey, 2001; Krutz *et al*., 2005; Lovell & Sullivan, 2006; Reichenberger *et al*., 2007). The majority of the work reviewed was conducted in the US, although Muscutt *et al* (1993) do consider its relevance to UK agriculture. A commonality of the reviews (and other studies) is the variability in the findings – buffers can reduce nutrient and sediment transport to water courses (Addy *et al*., 1999; Borin & Bigon, 2002; Patty *et al*., 1997), but they can also be ineffective (Leeds-Harrison *et al*., 1996), and/or act as a source of pollutants (Parkinson *et al*., 2000; Borin *et al*., 2005). Buffers are more effective at trapping coarse, sand-sized sediment, than the finer fractions that may be enriched with phosphorus (Abu-Zreig, 2001; Owens *et al*., 2007). Other research has demonstrated that buffer strips do not appear to reduce concentrations of soluble reactive P, and/or the effect is inconsistent, but they are more effective at reducing losses of total P (Borin *et al*., 2005; Uusi-Kamppa *et al*., 2000). Similarly, strongly-sorbing pesticides may be retained within buffers (Reichenberger *et al*., 2007; Patty *et al*., 1997), but buffers can be less effective at retaining weakly sorbing compounds (Reichenberger *et al*., 2007; Lovell & Sullivan, 2006). Nitrate concentrations may be reduced in the order of 50% (Lovell & Sullivan, 2006), but where the land is under-drained, water can by-pass the buffer zone rendering it ineffective (Muscutt *et al*., 1993); Domburg *et al*, (2002) consider that knowledge of the location of artificial field drains is essential to the appropriate siting of a buffer. The effectiveness of a buffer can depend on the vegetation cover, and forested buffers may remove more nitrate than grass buffers (Fennessy & Cronk, 1997; Hefting et al., 2005), but vice versa for particulate P (Osborne & Kovacic, 1993). Cutting vegetation can increase the uptake of nitrate from buffer strips (Bedard-Haughn *et al*., 2005) and harvesting the

vegetation can remove significant quantities of N and P from systems (Toet *et al*., 2005), although this could counteract habitat objectives.

The variable effectiveness of buffers is reflected in the conclusions of several researchers that the siting of the buffer in relation to the pollutant source or pathway is essential to the performance of buffers in protecting water quality (Owens *et al*., 2007; Lovell & Sullivan 2006; Leeds-Harrison *et al*., 1996) and their generic placement will not necessarily serve to protect watercourses from pollutants with the exception of pesticide drift and incidental losses of fertiliser and manure. Moreover it is necessary to maintain buffers (Lovell & Sullivan 2006) and to remove accumulated sediment occasionally (Dosskey *et al*., 2002) in order to maintain their effectiveness. Haycock *et al*., (1997; Cited in Owens *et al*., 2007) also concluded that maintenance of buffers at specific locations, e.g. where flow converges, may be more effective than the widespread distribution of buffers. This is in accord with work in Scotland that has demonstrated a slight reduction in sediment loading to Loch Leven in some places, but there is also evidence that concentrated flows are unaffected by the 20m buffer strip and TP loads are not reduced accordingly (Vinten *et al*., 2007).

The discussion above applies to land where the farming activity is distant from the protected feature, and thus excludes buffer strips on intensive grassland in England where there is no requirement to fence buffers. The benefits of these buffer strips will be limited to reducing pesticide contamination of surface waters by drift in particular, and incidental losses of fertilisers and inorganic manures during application (although the latter should not be spread within 10m of water anyway). Whilst there are supporting data to illustrate that buffer strips reduce pollution of surface water via drift (e.g. de Snoo & Wit, 1998; Zande *et al*., 2001), there are no data quantifying losses when accounting for pesticide application via spot treatment or weed wiping, although as less herbicide should fall off-target, potential losses to surface and groundwater should also decrease (assuming that weed density, and therefore treatment, does not increase in the buffer zone). Although the total quantity of pesticides (primarily herbicide) used on permanent pasture represents only 4% of the weight of active ingredient used on wheat and barley alone (Pesticide Usage Survey Grasslands 2005; Arable 2006), MCPA accounts for 45% of that applied to permanent pasture and this compound has consistently been detected in surface water above 0.1 µg L^{-1} between 1998 and 2006 (as has 2,4-D and mecoprop) (Environment Agency data[17]); usage of MCPA in arable crops is one-tenth of that in permanent pasture, thus grasslands could be a significant source of MCPA and any effort to reduce pollution could be beneficial to the environment.

Grazing intensity is reported as being a significant factor influencing water quality (Anon, 2007; D3). There is no requirement to amend grazing intensities on buffer strips in England and, in terms of nutrient losses, any benefits of buffer strips on intensive grassland would arise solely from a reduction in direct losses to the water course during fertiliser application, but there are no data to provide an indication of the relative importance of this source.

Although buffer strips can retain sediment and thus prevent further soil erosion (and protect water courses from saltation), they do not serve to protect the soil from which it came. Indeed, buffer strips attempt to address the impacts of pollution rather than the causes. Barling and Moore (1994) proposed that buffer strips should be

[17] http://www.environment-agency.gov.uk/commondata/103196/132012?referrer=/yourenv/eff/1190084/business_industry/agri/pests/915588/

considered as a secondary conservation practice, after controlling the generation of pollutants at their source, as buffer strips are only effective if they are carefully designed, installed and maintained. A field-based evaluation tool for riparian buffer zones in agricultural catchments, the Buffer Zone Inventory and Evaluation Form (BZIEF), has recently been developed as part of a Defra-funded project (PE0205) to target appropriate locations for buffer zones.

The effectiveness of buffers against pesticide contamination from spray drift is likely to be less variable compared to their impact on nutrients and sediment, and many data indicate that buffer zones reduce the potential for direct losses of pesticides into surface waters during application. However, the quantity of drift is influenced by a number of factors irrespective of a buffer zone, including formulation of the product, application rate, wind speed and direction, crop type, and nozzle type (spray quality) and it has been estimated through modelling that drift losses account for only 1% of the total load of pesticides into surface waters, even with no buffer zone present; this compares to 22% to 70% for other point sources such as leaks, cleaning spray equipment, and waste water plants (Holvoet *et al*., 2008). So although buffer strips could offer some benefit in terms of reducing water pollution from pesticides, greater benefits may be accrued by preventing drift at source (e.g. low drift nozzles; end nozzles), maintaining and calibrating sprayers, and cleaning sprayers responsibly.

A further issue that must be considered is that of pollution swapping. If buffers are effective at reducing nitrate losses to watercourses, unless the vegetation on the buffer is harvested, the nitrogen losses from the system will still occur via denitrification and the production of nitrous oxide, a greenhouse gas. The reduction in water pollution could therefore be offset by an increase in air pollution.

APPENDIX 6: TABULATED SUMMARY OF STUDIES.

Biodiversity and habitats

Table A 1 Biodiversity Results: Prescription development and testing

Study No.[1]	Indicator(s)	Key findings	Reference
A258	Hawthorn	Results are preliminary, as not all cutting treatments have yet been applied. However, berry yields of all cut plots were substantially lower than uncut control plots, and yields in 2006 were markedly lower than in 2005. Individual berry weights from recently cut plots were also lower than those from uncut plots, though this difference just failed to achieve significance.	Sparks, T, H. & Croxton, P. J. (2007) The influence of timing and frequency of hedgerow cutting on hawthorn flowering and berry yields: preliminary results. *Aspects of Applied Biology* **82**, Vegetation Management pp.103-106.
A232	Higher plants Invertebrates	The longer hedges were left uncut, the greater the production of fruits on woody shrubs, which provide winter food for birds, though some climbers were unaffected by cutting frequency. September cutting removed berries produced that year, but February cutting adversely affected some invertebrates. Some invertebrate groups were more abundant on annually-cut hedges compared with biennially-cut hedges. The results indicate that not all hedges on a holding should be cut at the same time and that not cutting annually would benefit biodiversity.	Marshall, E. G., Causley, E. G.., West, T. M. & Radcliff, H. E. R. (2001) Effects of management on the biodiversity of English hedgerows. *Hedgerows of the World: their ecological functions in different landscapes.* Proceedings of the 2001 Annual IALE (UK) Conference, held at the University of Birmingham, 5-8th September 2001 (eds C. Barr & S. Petit), pp. 361-365.
A233	Higher plants	For expt. 1, the number of emergent aquatic and riparian species decreased over four years but the magnitude of the decrease was negatively correlated with mowing frequency; it was greatest in unmown plots. For expt. 2, the turnover of emergent aquatic and riparian species did not differ between the treatments but more floating and submerged species colonised ditches mown twice a year. The number of floating and submerged species per ditch tended to increase following dredging. A dredging cycle of at least 3 years is necessary for the maintenance of diverse assemblages of floating and submerged aquatic species. The maintenance of diverse assemblages of emergent and riparian species on ditch banks relies on frequent mowing carried out annually and no less than once every 2 years. Mowing regimes for floating and submerged species should incorporate an annual spring cut.	Milsom, T. P., Sherwood, A. J., Rose, S. C., Town, S. J. & Runham, S. R. (2004) Dynamics and management of plant communities in ditches bordering arable fenland in eastern England. *Agriculture, Ecosystems and Environment* **103,** 85-99.
A6	Small mammals Higher plants	Seven species of small mammal were captured, and the total number increased by 38% between the study years. Wood mice, common shrews and bank voles were the most abundant species caught, so results relate to these species only. In both years, the greatest numbers of mammals were trapped in 2 m field margins followed by 6 m margins, farm woodland and set-aside. Total number captured was strongly positively correlated with sward height in 2 m field margins in 2004; this habitat has the highest numbers of potential prey for barn owls. In this habitat, significantly greater numbers were captured in taller swards. This suggests that areas cut every 2 or 3 years supported more individuals and species than areas cut annually.	Askew, N.P., Searle, J. B. & Moore, N. P. (2007) Agri-environment schemes and foraging of barn owls *Tyto alba*. *Agriculture Ecosystems & Environment* **118,** 109-114.

Study No.[1]	Indicator(s)	Key findings	Reference
A62	Butterflies Higher plants	Butterfly species richness was significantly greater on the 2 m margins than on the control sections, and was greater when a higher number of grass species were included in the original seed mixture. Plant species richness was greater on the 6 m margins when established by natural regeneration. The study suggests that there was little difference in butterfly and plant species richness between 2 and 6 m grass margins. It also concludes that these margins as established under the rules of CSS (1996) were often no better than having no grass margins at all (there should be more nectar sources included in the seed mixtures). The management, particularly of 6 m margins (a summer cut with the cuttings removed) is not beneficial to butterflies.	Field, R. G., Gardiner, T., Mason, C. F. & Hill, J. (2006) Countryside stewardship scheme and butterflies: A study of plant and butterfly species richness. *Biodiversity and Conservation* **15,** 443-452.
A61	Gatekeeper	Overall, there was no significant difference in gatekeeper abundance on CSS 2 m grass margins and the control sections of field edges without margins. However, significantly more of these butterflies were seen on the margins at the end of the study than at the beginning. Also, there was a strong relationship between gatekeepers and the presence of adjacent hedgerows. It is suggested that gatekeepers would benefit most from grass margins sown with a seed mixture of fine-leaved grasses and wildflowers, next to a hedgerow and managed in accordance with the scheme.	Field, R. G. & Mason, C. F. (2005) The utilization of two-metre Countryside Stewardship Scheme grass margins by the gatekeeper Pyronia tithonus (L). *Journal of Natural History* **39,** 1533-1538.
A134	Small mammals	Six mammal species were trapped; most were bank voles, wood mice and common shrews so the influence of margin width and vegetation structure was determined only for these species. Numbers of bank voles and common shrew numbers were higher on the grass margins than conventional field edges, and margin width was positively associated with bank vole abundance. Numbers of wood mice did not differ with margin type. Total small mammal biomass increased between spring and autumn on the CS margins but decreased on the conventional field margin. Results suggest that hte creation of grassy margins up to 6 m wide may benefit some small mammal species. However, it may take several years for a suitable ground cover to develop.	Shore, R. F., Meek, W. R., Sparks, T. H., Pywell, R. F. & Nowakowski, M. (2005) Will Environmental Stewardship enhance small mammal abundance on intensively managed farmland? *Mammal Review* **35,** 277-284.
A59	Butterflies Higher plants	Butterfly abundance was significantly higher on the 6 m grass margins than on the control sections but butterfly species richness was higher on the control sections. There were significant differences in butterfly abundance depending on the method used to establish the margins and their position; the lack of nectar sources, the use of agricultural cultivars, the position of the margins and their management did not benefit the abundance of common butterflies on farmland. Positioning margins adjacent of set-aside may be most beneficial for butterflies.	Field, R. G., Gardiner, T., Mason, C. F. & Hill, J. (2005) Agri-environment schemes and butterflies: the utilisation of 6 m grass margins. *Biodiversity and Conservation* **14,** 1969-1976.
A101	Higher plants Birds Bees Grasshoppers Ground beetles	The sown 6 m margins had positive impacts on diversity or abundance for the flora, bees and grasshoppers. The flora of the pre-existing boundary adjacent to the sown margins was significantly more species rich than controls. Grasshoppers were found only in the field boundary. They, and bees, were more abundant were strips were sited, reflecting additional habitat resources. There were no significant effects of sown strips on numbers of birds, spiders or Carabidae, but also no negative impacts. Some taxa, e.g. spiders, showed statistically significant influences of field size and thus landscape structure. Results confirm benefits to biodiversity of introducing new margin strips, but successes of agri-environment schemes will vary between taxa and species, and can be dependent on landscape structure.	Marshall, E. J. P., West, T. M. & Kleijn, D. (2006) Impacts of an agri-environment field margin prescription on the flora and fauna of arable farmland in different landscapes. *Agriculture Ecosystems & Environment* **113,** 36-44.
A120	Bees Higher plants	Bumblebee abundance in July and August was significantly higher on pollen and nectar margins compared with wildflower margins, mature grass margins and recently sown margins. Bees were virtually absent from the cereal crop. Bumblebee species richness was significantly higher on margins sown with either wildflowers or the pollen and nectar mix.	Pywell, R. F., Warman, E. A., Hulmes, L., Hulmes, S., Nuttall, P., Sparks, T. H., Critchley, C. N. R. & Sherwood, A. (2006) Effectiveness of new agri-environment schemes in providing foraging resources for bumblebees in intensively farmed landscapes. *Biological Conservation* **129,**

Study No.[1]	Indicator(s)	Key findings	Reference
			192-206.
A200	Invertebrates Higher plants	Beetle banks make a valuable contribution to game habitat on farmland, providing useful densities of chickfood invertebrates and nesting shelter to arable fields, where such resources may be lacking. However, they cannot substitute for suitably managed field margins.	Thomas, S.R., Goulson, D. & Holland, J.M. (2001) Resource provision for gamland gamebirds: the value of beetle banks. *Annals of Applied Biology* **139,** 111-118.
A177	Skylark	Undrilled patch treatments supported more breeding skylarks for longer, probably by aiding accessibility of food. Winter wheat planted in wide-spaced rows did not improve abundance of favoured food items over conventional crops.	Morris, A. J., Holland, J. M., Smith, B. & Jones, N.E. (2004) Sustainable Arable Farming for an improved environment (SAFFIE): managing winter wheat sward structure for Skylarks *Alauda arvensis*. *Ibis* **146,** 155-162.
A199	Higher plants	The main components of the resulting vegetation were annuals and dicotyledons. The number and cover of monocotyledons increased over the study period, though the increase was always greatest after shallow cultivations. Perennials always increased irrespective of depth. These increases, especially of crop weeds, might be of concern to farmers and intervention might be necessary to control them. Obligate autumn germinators tended to increase after September cultivations and spring germinators after March cultivations. Timing and depth of the most recent cultivation had the strongest effect on species composition, with a small residual effect from the previous cultivation.	Critchley, C. N. R., Fowbert, J. A. & Sherwood, A. J. (2006) The effects of annual cultivation on plant community composition of uncropped arable field boundary strips. *Agriculture, Ecosystems and Environment* **113,** 196-205.
A13	Harvest Mice Higher plants	Harvest mouse nest density was greater in beetle banks than in field margins. Nests were constructed where the vertical structure of the vegetation was significantly denser than average. The creation of beetle banks and grassy field margins provide suitable nesting sites for harvest mice. The management of no annual cutting provides the right botanical structure for nests.	Bence, S. L., Stander, K. & Griffiths, M. (2003) Habitat characteristics of harvest mouse nests on arable farmland. *Agriculture Ecosystems & Environment* **99,** 179-186.
A161	Beetles Higher plants	In the first year of establishment, no differences in the structure of beetle communities found between the tussock grass and the CSS margins. However, the fine grass margins supported lower overall abundance and species richness of beetles. This was probably due to small-scale architectural differences between fine and tussock grasses rather than plant composition. A greater abundance of large beetles were found in fine grass margins, though this was attributed to a small number of species or taxonomic group. All three margin types included beetle species of conservation importance. It is likely that the structure of the beetle community will change as the margins develop and more forbs become established. All margins contribute to an improvement in invertebrate biodiversity in agricultural landscapes.	Woodcock,B.A., Westbury,D.B., Potts,S.G., Harris,S.J. & Brown,V.K. (2005) Establishing field margins to promote beetle conservation in arable farms. *Agriculture, Ecosystems and Environment* **107,** 255-266.
A223	Bees Higher plants	Bumblebee abundance was closely linked to successional changes in availability of suitable forage plant species. Field margin treatments sown with a 'grass and wildflower' mixture had the highest bumblebee abundance, and provided a consistent supply of forage species, with different components of the seed mixture flowering in each year. The unsown natural regeneration treatment attracted foraging bees only in the second year due to the local abundance of thistles, an agriculturally unacceptable weed.	Carvell, C., Meek, W. R., Pywell, R. F. & Nowakowski, M. (2004) The response of foraging bumblebees to successional change in newly created arable field margins. *Biological Conservation* **118,** 327-339.
A224	Bees Higher plants	Very few bumblebees were recorded on intensively managed cereal margins (controls) due to a lack of dicot species. Conservation headlands supported a significantly greater number of flowering dicots, but the majority were annuals which did not provide good forage for bees. The removal of field margins from the cropping system was the best strategy for providing foraging habitat for bumblebees. Non-crop habitat from natural regeneration gave a good	Pywell, R.F., Warman, E.A., Carvell, C., Sparks, T.H., Dicks, L.V., Bennett, D., Wright, A., Critchley, C. N. R. & Sherwood, A. (2005) Providing foraging resources for bumblebees in

Study No.[1]	Indicator(s)	Key findings	Reference
		foraging habitat but most of the key forage species were pernicious weeds of agriculture. Sowing non-crop field margins with wildlife seed mixtures for providing the best foraging habitat, so long as preferred forage species such as *Trifolium pratense* were introduced.	intensively farmed landscapes. *Biological Conservation* **121,** 479-494.
A152	Higher plants	Species diversity including rare species was highest on uncropped cultivated margins, followed by spring fallow and cropped conservation headlands without fertilisers. Diversity generally lower on cropped margins due to competition from the crop. Fertilised cropped conservation headlands were the least diverse option and were similar to cereal crop controls. AE management accounted fro more variation in species composition than habitat context, physical/climatic variables, soil properties or region. AE schemes shown to be effective in conserving arable plants, including rare species, across a variety of landscape types	Walker, K. J., Critchley, C. N. R., Sherwood, A. J., Large, R., Nuttall, P., Hulmes, S., Rose, R. & Mountford, J. O. (2007) The conservation of arable plants on cereal field margins: An assessment of new agri-environment scheme options in England, UK. *Biological Conservation* **136,** 260-270.
A227	Spiders Ground beetles True bugs Higher plants	Total abundance of each study group was highest in uncropped strips but also higher in conservation headlands than in fully sprayed headlands. Species diversity for spiders and true bugs was significantly higher in uncropped strips and conservation headlands than in fully sprayed headlands. Species richness for both these groups and ground beetles was higher in all fields in uncropped headlands and conservation headlands than in the fully sprayed controls. The community structure of carabids and spiders was altered by headland management and also changed with the age of the uncropped strips.	Hassall, M., Hawthorne, A., Maudsley, M., White, P. & Cardwell, C. (1992) Effects of headland management on invertebrate communities in cereal fields. *Agriculture, Ecosystems and Environment* **40,** 155-178.
A186	Grey partridge Invertebrates	Mean brood size in each of the three areas was significantly higher on plots with unsprayed headlands; it can be assumed that chick survival is higher on these unsprayed areas. Leaving unsprayed strips along cereal fields is potentially useful for grey partridge conservation. The edges of cereal fields are most appropriate as this is the preferred feeding habitat of young partridges.	Rands, M. R. W. (1985) Pesticide use on cereals and the survival of grey partridge chicks: a field experiment. *Journal of Applied Ecology* **22,** 49-54.
A228	Butterflies	Results show clear within-season differences in behaviour patterns. Spring emerging butterflies in sprayed field margins were mainly associated with the field boundary habitat (the hedgerow), whilst those in fields with conservation headlands were mainly associated with the headland. In normally sprayed field margins, the main activity was flight, whilst in field margins with conservation headlands, there were increases in foraging activity on headland flora. Butterflies that emerged in the summer were less strongly associated with the headland than those that emerged in the spring. Conservation headlands improve field margins as habitat for butterflies by increasing resources.	Dover, J.W. (1997) Conservation headlands: effects on butterfly distribution and behaviour. *Agriculture, Ecosystems and Environment* **63,** 31-49.
A225	Higher plants	Beetle banks had lower species richness and *H'* diversity than field margins, but these characteristics increased with the age of the bank until those over 10 years of had approximately equal diversity. Few individual plant species were found exclusively in either habitat. Beetle banks provided more grass cover, especially tussock grass, but less herbaceous cover and fewer nectar-providing plants compared with field margins. Weed cover was not significantly different between habitat types. Overall, beetle banks retain a dense vegetation structure despite increase botanical diversity, and are of value as a refuge habitat for predatory invertebrates. Increasing floral diversity may benefit invertebrates.	Thomas, S. R., Noordhuis, R., Holland, J. M. & Goulson, D. (2002) Botanical diversity of beetle banks: effects of age and comparison with conventional arable field margins in southern UK. *Agriculture, Ecosystems and Environment* **93,** 403-412.
A30	Bees	Pollen & nectar mixture more effective in providing bumble bee forage than sown margins (range of mixtures) natural regeneration, conservation headlands. Pollen & nectar mix attracted highest total abundance and diversity of bees (including rare long-tongued species). However, there were differences between species and sexes in responses to margin management over time. Diverse mix of wildflowers attracted more shorter-tongued species and provided greater continuity of forage resources.	Carvell, C., Meek, W. R., Pywell, R. F., Goulson, D. & Nowakowski, M. (2007) Comparing the efficacy of agri-environment schemes to enhance bumble bee abundance and diversity on arable field margins. *Journal of Applied*

Study No.[1]	Indicator(s)	Key findings	Reference
		Allowing Cirsium spp. to flower also increased their attractiveness to male bumble bees. Legum-based mixtures can quickly provide attractive forage, but issues of flowering phenology and longevity of the mixture need to be addressed.	*Ecology* **44,** 29-40.
A118	Bees Higher plants Butterflies Invertebrates	Removing land from production proved the most practical and effective means of providing habitat for most taxa studied. Annually cultivated margin effective in the conservation of rare arable plant populations. Pollen & nectar mix was highly effective in providing foraging resources for bumblebees and butterflies and also enhanced the diversity of beetles and bugs. Prescriptions most effective where targeted at requirements of declining taxa.	Pywell, R. F., Meek, W. M., Carvell, C., Hules, L. & Nowakowski, M. (2007) The Buzz project: biodiversity enhancement on arable land under the new agri-environment schemes. *Aspects of Applied Biology 81, Delivering Arable Biodiversity,* pp. 61-68.
A226	Birds Butterflies Bees Higher plants	Eighty times as many birds were recorded from game crops as nearby conventional crops. Butterflies and bumblebees were, respectively, up to 15 and 40 times more abundant in the game crops. Game crops contained on average 90% more weed species due to an increase in the number of broad-leaved weeds in game compared to other crops. Game crops also contained more important bird-food weeds. Game crops therefore provide an attractive habitat for several forms of wildlife and provide valuable resources for songbirds, some of which are in decline on modern farmland.	Parish, D. M. B. & Sotherton, N. W. (2004) Game crops as summer habitat for farmland songbirds in Scotland. *Agriculture, Ecosystmes and Environment* **104,** 429-438.
A151	Birds Higher plants Seeds	Densities of wintering skylarks were higher on arable reversion fields, where the sward was above 10 cm than on ones with shorter sward and decreased with sward closure. Such conditions existed in the first 2 years after reversion and also resulted from low or intermittent grazing pressure, especially by cattle. Higher densities of skylarks foraged on cereal stubbles than on arable reversion grass, reflecting availability of broad-leaved weed seeds. Only short-term benefit for birds from experimentally opening the sward on established arable reversion fields. These results led to reviews of the management prescriptions for these two ESAs, with grazing requirements being relaxed and fertiliser allowances on permanent grassland AR to be increased, which allow farmers to maintain a taller sward for foraging skylarks. Also a new arable tier introduced in the South Downs ESA encouraging farmers to retain cereal stubbles over the winter period.	Wakeham-Dawson, A. & Aebischer, N. J. (1998) Factors determining winter densities of birds on Environmentally Sensitive Area arable reversion grassland in southern England, with special reference to skylarks (*Alauda arvensis*). *Agriculture Ecosystems and Environment*, 70(2-3):189-201.
A33	Invertebrates Higher plants Birds	Increased activity densities of Arionidae slugs, heteropteran bugs and homopteran bugs were recorded in the conservation headlands compared to the conventional headlands. Despite an increase in potential prey conservation headlands were no richer in bird species. However, the vegetation on these headlands was longer and denser than on conventional headlands, which could have made accessibility to prey and foraging conditions more difficult for birds. The activity density of ground beetles in general was found to be lower in conservation headlands. It is suggested that additional measures are undertaken to open the vegetation structure of such headlands.	Cole, L. J., McCracken, D. I., Baker, L. & Parish, D. (2007) Grassland conservation headlands: Their impact on invertebrate assemblages in intensively managed grassland. *Agriculture Ecosystems & Environment* **122,** 252-258.
A190	Black grouse Higher plants	The composition of vegetation did not differ between grazing treatments, but vegetation height was greatest were grazing was restricted. Numbers of black grouse males displaying increased (average 4.6%) at the ten sites with reduced grazing; at the normally grazed control sites, numbers declined annually (average 1.7%). Summer black grouse hen densities showed the greatest rate of increase where grazing restricted on smaller areas of ground ($0.4km^2$). Declines occurred at sites where the area of restricted grazing exceeded 1 km^2; hens avoid extensive areas of tall sward for breeding. A higher proportion of females retained broods during the late chick-rearing period compared to normally grazed sites though there was no difference in brood size between treatments.	Calladine, J., Baines, D. & Warren, P. (2002) Effects of reduced grazing on population density and breeding success of black grouse in northern England. *Journal of Applied Ecology* **39,** 772-780.
A234	Higher plants Invertebrates	Extensively managed fields tended to be more structurally diverse and potential seed resources were higher as were potentially important bird prey items such as beetles and spiders. Some soil invertebrates, such as earthworms, were	Atkinson, P. W., Asteraki, E. J., Conway, G. J., Fuller, R. J., Goodyear, J., Smith, R. E. N.,

Study No.[1]	Indicator(s)	Key findings	Reference
	Birds	more abundant in intensively managed fields. During winter 1999/2000, avian species diversity (predominantly invertebrate-feeding species) was higher on intensively managed fields. The intensification of grassland may benefit ground-feeding birds though a higher biomass of invertebrate prey items (both dung and soil-dwelling) and also by making prey more available. Few seed-eating birds were recorded and these would be expected to occur more on seed-rich, extensively managed sites. The effects of intensification on breeding birds are likely to be more deleterious.	Tallowin, J. R. B. & Vickery, J. A. (2002) Use of grassland by wintering birds: effects of management on their food resources. (BGS Occasional Symposium No.36). Conservation pays? Reconciling environmental benefits with profitable grassland systems. Proceedings of the joint British Grassland Society/British Ecological Society Conference, University of Lancaster, 15-17 April, 2002. British Grassland Society (BGS), Reading, UK: 2002, pp. 61-64.
A197	Cirl bunting Higher plants Seeds	Cirl buntings and several other species, including yellowhammer and reed bunting, used special project stubbles significantly more than conventional stubbles. Seed densities, especially those of broadleaved weeds, were higher on special project stubbles. HLS option HF15 Reduced herbicide, cereal crop management preceding over-wintering stubble and a spring crop should benefit cirl and other buntings if deployment is targeted enough. ELS option EF6 prohibits pre-harvest desiccant and post-harvest herbicide but there is not restriction on pre-harvest herbicides. This option should be an improvement on CSS stubbles.	Bradbury, R. B., Bailey, C. M., Wright, D. & Evans, A. D. (2008) Wintering Cirl Buntings *Emberiza cirlus* in southwest England select cereal stubbles that follow a low-input herbicide regime. *Bird Study* **55,** 23-31.
A132	Lapwing	Nests on fields managed under Option 1B had a greater chance of survival than nests on conventionally managed fields. Overall, the main causes of nest loss were predation and agricultural operations. Crop type, nest status and distances to field boundary and predator perches had a significant effect on nest survival. Conclusion that lapwing nest survival on arable land can be enhanced with prescriptions than promote spring/summer fallow and consideration of the timing of agricultural operations.	Sheldon, R. D., Chaney, K. & Tyler, G. A. (2007) Factors affecting nest survival of Northern Lapwings *Vanellus vanellus* in arable farmland: an agri-environment scheme prescription can enhance nest survival. *Bird Study* **54,** 168-175.
A238	Higher plants Heather	A reduction in stocking rate can lead to changes within semi-natural plant communities, but heather cover was not enhanced under the Tier 2A stocking rate, although it was maintained under the Tier 1A stocking rate.	Hetherington, S.L., McLean, B.M.L., Gardner, S.M., Wildig, J. & Griffiths, B. (2002)(BGS Occasional Symposium No.36). Conservation pays? Reconciling environmental benefits with profitable grassland systems. Proceedings of the joint British Grassland Society/British Ecological Society Conference, University of Lancaster, 15-17 April, 2002. British Grassland Society (BGS), Reading, UK: 2002, pp.85-88.
A283	Corn Bunting	Corn buntings were found to be less likely to decline when farmland was subject to management intervention designed to benefit the species. This management is primarily the FBL, it is not clear the input from RSS schemes. Between 2002 and 2004 Corn Bunting numbers showed no significant change in tetrads with targeted management intervention, but declined by 43% in tetrads with no intervention. By contrast, population changes did not differ significantly for results comparing 2000 to 2002, before management was implemented.	Perkins, A. J., Maggs, H. E., Wilson, J. D., Watson, A. and Smout, C. (2008) Targeted management intervention reduces rate of population decline of Corn Buntings *Emberiza calandra* in eastern Scotland. *Bird Study* **55** 52-58

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 2 Biodiversity study characterisation: prescription development and testing

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
A258	England	Hedgerow management	Hawthorn	Experiment	Factorial	Eight hedgerow blocks each containing four 15 m long plots. Each plot was allocated at random to one of four combinations of cutting frequency (annual vs. biennial) and timing of cutting (harvest time or winter). In autumn of 2005 and 2006 berry yields determined in each of the 32 plots from ten quadrats (0.5 m) per plot, five each side of the hedge. In autumn 2006, control yields taken from an uncut hedge plot. Berry size assessed from 50 berries and control berry size in 2006 only. Cover of hawthorn blossom assessed in May 2006, again using 10 quadrats divided into 25 smaller cells (10 cm).	Yes	2005-2006
A232	England	Hedgerow management	Higher plants Invertebrates	Experiment		Seven hedges in different areas of southern Britain selected. Individual hedges treated as independent replicated experiments with factorial combinations of timing (September v. February) and frequency (annual, biennial or triennial) of cutting. All sites included an unmanaged control and additional laying and coppice treatments included at one site. Physical dimensions of the hedge and botanical composition of hedge and herbaceous flora assessed in May and July. Berry abundance assessed in autumn. Vacuum samples of invertebrates taken in May and July using a D-vac sampler.	Yes	1996-1997
A233	England	Ditch management	Higher plants	Experiment		Two experiments carried out on ditches on arable farmland. Expt 1: evaluated effects of four mowing regimes on ditch banks. Treatments covered: unmown control; two cuts a year in March and November; one annual cut in November; one cut every second year in November. Carried out on two adjacent ditches, split into 20 m sections separated by 5 m discards. Treatments and control assigned to these sections in a randomised design with three replications. Ditches dredged once before start. Abundance of plant species scored by recording presence or absence in each of 10 contiguous 2 m sections in each plot. Repeated every 6 weeks April-September. Species classified by their growth habit. Expt. 2: compared effects of two mowing regimes at a larger scale - two cuts/year in November and March; one cut every two years in November. Treatments paired on 16 ditch sections, each 50 m long. One ditch section from expt retained for comparison. Ditches dredged twice during expt. Cover of individual species estimated using DAFOR scores. Each section visited in May and August.	Yes	1988-1992 and 1992-1997
A6	England	CSS 2 m & 6 m field margins	Small mammals Higher plants	Survey		Small mammal live-trapping using Longworth traps was undertaken on farm woodlands, permanent set-aside and both 2 m and 6 m CSS field margins. Twenty sampling units were used for each habitat. Twelve traps were set in each unit during each of 2 trapping period, 1m from the habitat boundary.	Yes	2003-2004

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
						Mammals were fur-clipped and released. Sward height at each trap point was measured at each trapping point using a drop-disk.		
A62	England	CSS 2 m & 6 m field margins	Butterflies Higher plants	Survey		Undertaken on three farms. A number of grass margins were established using a range of different grass mixtures and establishment methods. Numbers of margins varied with site, and although all available 6 m margins were included, control sections were limited at each site to a few suitable fields with no grass margins. Vegetation monitored during summer, by recording all species present in each grass margin and allocating an abundance classification. Butterfly species richness was measured using the transect method, and recording butterfly observations at the height of the flight period.	Yes	1997-2000
A61	England	CSS 2 m grass margins	Gatekeeper	Survey		Study undertaken on three farms in CSS. Thirteen margins (including both established and sown margins) were monitored for gatekeepers between July and August each year, using a transect method. At least three control sections of field edges without grass samples were also monitored.	Yes	1997-2000
A134	England	CSS 2 m & 6 m field margins	Small mammals	Survey		Study conducted on one farm in CSS. The 2 m margins had been voluntarily widened to 3 m. Small mammals were live-trapped using Longworth traps in spring and autumn of both years. In each year, trapping was carried out on 0 m (conventional field), and the two margins, with four replicates of each. The margins were sown with a CS field margin grassland conservation mix. The same margins were used in both years, but different conventional fields were used due to crop rotations. Twenty traps were set in two parallel rows of 10, one at the edge of the margin furthest from the crop, the other 2 m into the margin or field.	Yes	1999-2000
A59	England	CSS 6 m grass margins	Butterflies Higher plants	Survey		Undertaken on two arable farms, and eight sections of margin investigated; three established using natural regeneration and five by sowing a range of grasses. Parts of these margins were monitored for butterflies. Both sites had one control section: an arable field edge with no margin. The grass margins were managed as outlined in the CSS regulations. The vegetation on the margins was also monitored each year, with all species being identified and given a classification using the DAFOR scale. All butterflies observed on the field margins were recorded with special note for the 'key' species that use grasses in the larval stage. Monitoring was undertaken weekly during the summer, when weather conditions suitable.	Yes	1997-2000
A101	England	CSS 6 m grass margins	Higher plants Birds Bees Spiders Grasshoppers Ground	Survey	Paired field	A total of 42 arable fields were evaluated comprising 21 field pairs; one field with a sown 6 m CSS margin and one a control, non-scheme field with no margin. Each pair matched as far as possible for environmental factors and grouped on the basis of average field size to examine landscape structure effects. Flora assessed by quadrat in the pre-existing boundary, crop edge, crop centre and margin strips where present, with percentage ground cover being recorded. Bird observations made to assess numbers of nesting birds	Yes	2003

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
			beetles			using a standard territory mapping approach. Bee fauna assessed by using a butterfly net to catch flying bees and a sweep net in the vegetation. Spiders and carabidae were collected in pitfalls in the field boundary and crop centre. Grasshoppers were caught using a sweep net in the field boundary and crop.		
A120	England	6 m sown margins & pollen and nectar mix.	Bees Higher plants	Survey		Bumblebee richness and abundance compared on five management treatments: 1) conventional cereal crop - control; 2) 6 m margin sown with grasses 2002-03; 3) 6 m margin sown with grasses 1993-2000; 4) 6 m margin with grasses and wildflowers between 1999-2003; 5) 6 m margin with pollen and nectar- rich species between 200-03. Sampling carried out in 32 10km squares - each square contained a sample agreement of all 5 margin treatments, with the exception of wildflower margin which was absent from 9 squares, to give a total of 151 field margin agreements. On each field margin 100 m transect randomly located and counts made of foraging bumblebees across margin. The diversity and abundance of flowering dicotyledons along the transect recorded to give a measure of the forage resource availability. Also all flowering dicots identified in the field and an approximate abundance of single and multi-flowered stems made. The vegetation composition of each field margin recorded in 20 quadrats within each transect. The presence of rooted vascular plants noted.	Yes	2004
A200	England	Beetle banks	Invertebrates Higher plants	Survey		Beetle banks compared with adjacent grassy hedgerow bottoms or non-shrubby margins. In 1998, 9 beetle banks/margins sampled for invertebrates, extended to 22 in 1999, in order to assess chickfood provision. To determine vegetation cover and food plant provision plant species presence and percentage cover assessed at the same sites within 20 random quadrats.	Yes	1998-1999
A177	England	Skylark plots	Skylark	Experiment	Randomised block	Three treatments: conventional winter wheat (control); winter wheat in wide-spaced rows; undrilled patches. Each treatment minimum of 5 ha. Vegetation (percentage cover of plant species, vegetation height and density), invertebrate (suction sampling, sweep netting and pitfall traps) and skylark (territories, nests, nest productivity nestling body condition and foraging locations) collected.	Yes	2002-2003
A199	England	6 m uncropped cultivated margin	Higher plants	Experiment	Randomised block	Three experimental sites, and at each site 36 experimental plots set up in the tilled headland zone of a single arable field. Twelve treatments representing different combinations of cultivation timing (September or March) and depth (deep or shallow) were allocated to the plots and replicated three times. Botanical data was collected from 32 quadrats located centrally in each plot with the presence of all rooted plant species recorded, along with estimates of top cover.	Yes	1997-2000
A13	England	Buffer strips and field margins	Harvest mice Higher plants	Survey		Work conducted on one farm on field margins and beetle banks. Field margins at least 1 m wide, adjacent to hedgerows and generally uncut. Beetle banks sown with tussock forming grasses and uncut since 1992/94. Total of 1800 m	Yes	1998

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
						of beetle bank and 9800 m of field margin searched by hand for harvest mouse nests, Sept-Nov. Percentage cover of each plant species estimated visually within a 0.25 m^2 quadrat positioned around nest. Vegetation structure also measured. Species composition, percentage cover and vertical structure also recorded at a comparison site chosen randomly along same length of habitat. Nest height and nearest nest also measured.		
A161	England	Field margins (equivalent to buffer strips and field corner management on cultivated land)	Beetles Higher plants	Experiment		Non-cropped field margins established at one site. Five replicate blocks each containing nine experimental plots were sown with one of three seed mixtures: CSS mix, tussock grass and forbs, fine grass and forbs (3 plots each in each block). Botanical assessments made using 10 replicate quadrats in each plot., with species and percentage cover recorded along with cover of bare ground and litter. Vegetation structure also assessed. Suction sampling used to sample beetle communities within the plots before and after cutting; five samples taken in each plot for each sampling date.	Yes	2001-2002
A223	England	Field margins (equivalent to buffer strips and field corner management on cultivated land)	Bees Higher plants	Experiment		Three cereal field margins were selected and each margin was divided into five contiguous plots, and each plot was subject to one of five different treatments: natural regeneration, unsown, 6 m wide; sown 'tussocky' grass mixture, 6 m wide; sown 'grass and wildflower' mixture, 6 m wide; split treatment with 3 m 'tussocky' grass mixture adjacent to hedge and 3 m sown 'grass and wildflower' mixture adjacent to the crop; cropped to the edge, which received conventional management as per the rest of the field. Bumblebee activity was recorded on transects along the central line of all three margin replicates, on warm, dry days using an adapted form of standard 'bee walk' methodology. The flowering plant species which each bee was first seen to visit was also noted. To gain a measure of forage availability and to assess successional change in flowering on the different treatments, the number of flowers/inflorescences of each plant species present in each plot was estimated using a 5 point scale. Flower abundance scores were measured on every sampling date after bumblebee transects.	Yes	1999-2002
A224	England	Arable Stewardship Pilot Scheme conservation headlands, uncropped margins, sown field margins	Bees Higher plants	Survey		A total of 36 farms which had ASPS management agreements in place in 1999 were chosen. Sample field margins selected using proportional random sampling: 16 conservation headlands with no fertilisers, 18 naturally regenerated field margins and 28 field margins sown with a wildlife seed mixture. Nearby, conventionally managed cereal field margin with similar aspect and boundary type acted as controls. Bumblebees recorded at each field margin along 100 m linear transects in the centre for options established as strips. For shorter strips, counts taken along two parallel 50 m transects. Crop edge and hedge base avoided. Note made of the plant species on which each bee was foraging. Vegetation sampling undertaken in 20 quadrats and the presence of all vascular plant species rooted in the quadrat recorded. The flowering dicotyledon component of the vegetation along the transect recorded	Yes	2003

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
						to give a measure of the forage resource availability.		
A152	England	Uncopped cultivated margins, spring fallow, cropped conservation headlands with or without fertiliser inputs	Higher plants	Survey		Diversity of arable plants compared on four cereal field margin options available under CSS and ESA: spring fallow following over-winter stubble; uncropped cultivate margins; conservation headlands; no-fertiliser conservation headlands. Sampling carried out in 39 random 20 x 20 km squares in 8 regions of England, with number in each proportional to uptake of targeted options. A conventionally managed cereal crop visited as a control. Total sample of 195 field margins surveyed simultaneously. On each field, a sampling zone adjacent to field boundary set up. Vegetation composition recorded in 30 quadrats on 3 transects parallel to field margin, at 1 m, 3 m and 5 m. Presence of all vascular plants recorded along with top-cover estimates of plants, bar ground, bryophytes and litter taken. Entire field margin searched for the presence of 86 rare arable plants. Soil samples collected from each quadrat. Management details for each margin compiled and a variety of landscape context and environmental variables measured.	Yes	2005
A227	England	ESA Uncropped wildlife strips & conservation headlands	Spiders Ground beetles True bugs Higher plants	Survey		Study sites on two farms within the Breckland ESA, with 8 fields used (3 conservation headland, 3 uncropped wildlife strips, 2 fully sprayed headlands). Ground beetle and spider sampling undertaken using pitfall trapping in a sampling grid on the 6 m headlands (35 traps/field site). Bugs sampled with a D-vac along 5 transect lines at intervals from 0 m (verge/field boundary) to 15 m into crop. Two sets of samples taken 3 weeks apart. Vegetation structural complexity measured at each site. Percentage cover and relative humidity at ground level recorded in 10 random quadrats/points at each site.	Yes	1988
A186	England	Conservation headland	Grey partridge Invertebrates	Experiment		One farm was split into three areas and a total of 37 fields split into six trial plots (2 plots per area). A 6 m strip around every field in one plot per area was left unsprayed with pesticides, whilst in the other plots the entire fields were sprayed as normal. The size and composition of family parties of partridges were recorded by field counts. Insects available to chicks in the sprayed and unsprayed headlands were sampled in June, (the main hatching period for chicks), using a sweep net. One headland in each of the 37 fields was sampled, 3 m from the field boundary.	Yes	1983
A228	England	Conservation headland	Butterflies	Survey		Observations made on one large farm, where no insecticides used after 1984. Therefore any differences in butterfly distribution would primarily reflect the cessation of broadleaved herbicide applications on outer 6 m of cereal crops. Field boundaries with conservation headlands and fully sprayed headlands paired according to orientation. Number of plots of field margins changed each year. Observations of butterfly behaviour made in middle of day, and different behaviour activities noted e.g. feeding, flying, resting. Location recorded either as hedgerow or headland.	Yes	1985-1987

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
A225	England	Beetle banks	Higher plants	Survey		The flora of nine beetle banks within arable fields at one site was assessed in summer 1998 and winter 1999. These ranged from 1 to 13 years old and had been sown with *D. glomerata*. In summer 1999, 22 banks from 5 locations were assessed; these were aged from <1 to 14 years old and 20 had been sown. In both years other randomly selected field margin, usually a grassy hedgerow bottom or non-shrubby edge, were used as controls for each beetle bank. Vegetation on each bank or margin was assessed in quadrats placed at 10 m intervals; species recorded as % cover. Twenty quadrats positioned across the width of each strip and plants classified as 'tussock', 'other grasses', 'herbaceous', 'woody', 'nectar providers', 'grass weeds' and 'broad-leaved weeds'.	Yes	1998-1999
A30	England	Pollen & nectar mix Sown field margins Conservation headlands Uncropped wildlife strips	Bees	Experiment	Randomised block	6 treatments in contiguous 50 x 6m plots established along two replicate (N-S) margins. 5 trts, with conventional crop management as a control. Assessments = abundance of flowering units (May - Aug). Bumble bee activity (counts visiting flowers) (May - Aug)	Yes	2001-2005
A118	England	Pollen & nectar mix Sown field margins Conservation headlands Uncropped wildlife strips	Bees Higher plants Butterflies Invertebrates	Experiment	Randomised block	6 treatments in contiguous 50 x 6m plots established along two replicate (N-S) margins. 5 treatments, with conventional crop management as a control. Assessments: % cover plant species. Abundance of flowering units (May - Aug). Abundance and diversity of bumblebees and butterflies. Pitfalls - activity & density of ground-dwelling inverts. Vortis suction - abundance and diversity of inverts.	Yes	2001-2005
A226	Scotland	Game crops (equivalent to wild bird seed mixture)	Birds Butterflies Bees Higher plants	Survey		Twenty-one arable fields visited with game crops present at all sites. The outer 20 m of a random sample of conventional crops (either barley or wheat) within 250 m of the game crops were also surveyed. Songbirds counted by walking around or through the crops so as to pass all area to within 10 m. Numbers of butterflies and bumblebees also recorded. Counts made from June to September each year with an average of 3 visits per farm. Weeds sampled using 10 random quadrats per field; in conventional crops, these were within 20 m of the field edge. Weeds identified and Domain scale used to estimate cover.	Yes	2001-2002
A151	England	ESA arable reversion	Birds Higher plants Seeds	Experiment & survey		Survey of grassland birds made over three winters on over 200 fields in the South Downs and South Wessex Downs ESAs. As well as permanent grassland (at least 70 fields each survey) and chalk downland (14-22 fields) both of which are types of ESA arable reversion, some fields of intensively managed grass, winter wheat, and cereal stubbles also surveyed for comparison. Each field walked and numbers of grassland birds recorded, together with livestock present. Sward closure in each AR field estimated from 4 random quadrats and height of vegetation averaged from 16 measurements	Yes	1994-1996

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
						of maximum vegetation height at four random points in each quadrat. Plant surveys carried out in a sample of the fields in the South Downs ESA on two summers by using 4 random quadrats and counting species present. In two winters, seeds lying on the ground in 31 permanent grassland AR, chalk grassland AR and stubble fields sampled from two quadrats 50 m from field margin. Effects on skylarks and downland plants of opening up the sward investigated on 14 permanent grassland AR fields - 7 treated and 7 controls. Numbers of skylarks present recorded in three visits. Sward closure in all fields recorded by estimating average ground cover in 10 random quadrats in each field.		
A33	Scotland	Grassland conservation headlands (equivalent to field corners on lowland grassland)	Invertebrates Higher plants Birds	Experiment	Split plot	Five grassland fields in three locations selected for study. In each field, one of the headlands randomly divided into two areas: conventional headland and 6 m grassland conservation headland. Pitfall trapping undertaken along five transects (open field and field edge and headland of each treatment) in each field. Key bird food invertebrates, agricultural pests and ground beetles counted. Vegetation sampling also undertaken at four points along each pitfall transect, with % bare ground, number and relative abundance of plant species and frequency of key weed species recorded. Vegetation height and density also measured at ten points. Bird surveys conducted annually on three occasions, with number and species of birds using the backing habitat and both types of headland being recorded.	Yes	2000, 2002-2003
A190	England	Grassland options in the uplands	Black grouse Higher plants	Survey		Numbers of black grouse and their breeding success were monitored at 20 sites in the north of England. Ten treatment sites included areas where grazing was reduced <1.1 sheep/ha in summer and <0.5 sheep/ha in winter. Each was paired with a control site that held sheep at two (summer) to three times (winter) the density on the treatment sites. The reduced grazing sites ranged varied in size and most were part of existing agri-environment schemes. Point sampling was used to assess vegetation height and dominant species composition in summer 1999 only. Measurements were taken at a minimum of 100 evenly spaced transects traversing each site (between 1 and 4 transects per site)	Yes	1996-2000
A234	England	Grassland options outside the LFA	Higher plants Invertebrates Birds	Survey		Forty-eight fields selected and stratified into 3 levels of management intensity using nitrogen input as the indicator variable. Fields with less than 50 kg N/ha classed as 'extensively managed' and those greater than 250 kg N/ha as 'intensively managed'. Those in between classed as 'moderately intensively managed'. Visits made in summer an autumn to record cover of plants in 5 quadrats on a transect across field: 2 close of field boundary, 1 in field centre and 2 midway between. Vegetation structure measured at intervals along transects and standing crop by cutting quadrats at ground level along transect and drying. Slugs sampled using 6 refuge traps in autumn and spring. Soil macro-invertebrates extracted from 9 soil cores taken from each field. Birds	Yes	1999-2000

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
						counted using two 1 minute point counts and a perimeter walk around field during 6 survey visits during the winter.		
A197	England	CSS Special Project: Cirl Buntings	Cirl bunting Higher plants Seeds	Survey		Study undertaken on 186 cereal stubble fields. Conventional stubbles created under CSS arable options or in rotational set-aside with no slurry spreading or silage storage. SP stubbles followed a barley crop grown under a low-input herbicide regime. Each field selected at random but was within 2 km of a cirl bunting territory. Plant and bird surveys undertaken at the same time on each stubble field, plants using random quadrats within 30 m of boundary, and birds with a single 'complete area search' by walking transects across each field. A paired sub-sample of 20 SP and 20 conventional fields were used to collect 10 surface soil samples from each field to determine seed availability.	Yes	2003-2004
A132	England		Lapwing	Survey		Data collected over two field seasons from 28 farms, ten of which were Arable Stewardship farms that had Option 1B as part of their agreement. Lapwing nests were located by the presence of territorial adult birds and incubating females. Nests checked regularly to obtain information on breeding success and the timing of hatching. Nest site and habitat variables, such as nearest active nest, field size, crop type and nearest field boundary and predator perch also recorded.	Yes	1999-2000
A238	Wales	Cambrian Mouintains ESA Tier 1A and 2A	Higher plants Heather	Experiment		Undertaken in the Cambrian Mountains ESA on two 'farmlets' (153 ha and 148 ha), with approximately equal areas of semi-natural plant communities and improved land. Aim to assess the effectiveness of ESA prescriptions in maintaining (Tier 1A) and enhancing (Tier 2A) the cover and condition of heather. The larger farmlet had a stocking rate to meet the Tier 1A prescription and the smaller farmlet had a lower stocking rate for Tier 2A. Vegetation composition assessments undertaken in each plant community at 1 m permanent quadrats, which were repeatedly sampled.	Yes	1990-1997
A283	Scotland	Rural Stewardship Scheme and Farmland Bird Lifeline.	Corn Bunting	tetrad	Survey	Counts made of territorial male Corn Buntings in the breeding seasons of 2002 and 2004 were compared across 53 tetrads. 19 of these were subject of management intervention designed to benefit Corn Buntings, effective from 2003.	Yes	2002, 2004

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 3 Biodiversity Results: Evaluations

Study No. [1]	Indicator(s)	Key findings	Reference
A180	Field boundary/hedges Higher plants	Relatively high proportion of species-rich hedges (38% compared to 26%, Churchward *et al*. 1999) and diverse basal flora (particularly on taller banks) in the scheme. Potential for BAP species noted for dormice, bats, hares through physical characteristics and network attributes. It was considered that most agreements would meet the ESA objectives.	Catherine Bickmore Associates (2004) *Hedgerow management and restoration in agri environment schemes: Part II Environmentally Sensitive Area Scheme*. Report to Defra.
A175	Breeding Waders	No regionalised analysis. Wader populations tend to be higher, and have declined less in designated areas (ESAs, SSSIs or nature reserves) than in the wider countryside. The efficacy of these site designations in conserving and enhancing breeding wader populations requires a much more detailed study. Nature reserves may be generally more effective at maintaining wader populations than ESAs. For the five ESAs considered (excluding Oystercatcher) there were 12 cases of species decreases of more than 25% and seven with little change (less than 25%) or increases. It is important to note that not all land within the ESA is managed under ESA agreement (i.e. land management not studied in detail).	Wilson, A.M., Vickery, J.A., Brown, A., Langston, R.H.W., Smallshire, D., Langston, R.H.W., Smallshire, D., Wotton, S. & Vanhinsbergh, D. (2005) Changes in the numbers of breeding waders on lowland wet grasslands in England and Wales between 1982 and 2002 *Bird Study* **52** 55-69
A220	Higher plants	10% of plots had changed NVC community type 1993-2005. Increase in scrub communities and in acid grassland, resulting from a loss in heathland, mires and improved grassland. Of the 21 sites assessed for condition, none were in favourable condition [but this assessment relates to SSSIs]. Changes in pH and soil nutrients were not directly associated with changes in vegetation. Trends in community composition suggested that overall grazing was decreasing and fertility and acidity increasing.	Toogood, S., Hewins, E., Mellings, J., Lush, M., Goodger, B., Anthwal, V. & Glaves, D. J. (2006) *Resurvey of rough land monitoring plots in West Penwith ESA, 2005*. Report to Defra.
A103	Ditches	Ditches classified into 14 classes, based on features relating to ESA management. Variability of ditch classes present within an area varied. 5 sites were varied and represented effective management, providing features required for aquatic and marginal vegetation and invertebrates. However at 3 sites, there were large geographic clusters of similar ditch classes, therefore these sites represent less effective management.	McLaren, R., Riding, A. & Lyons-Visser, H. (2002) *The effectiveness of ditch management for wildlife in the Broads and Somerset Levels and Moors ESAs*. ADAS report to Defra.
A84	Hay meadows Higher plants	Most fields increased in conservation value (and decreased in soil fertility), particularly where sites were initially more improved. Changes characterised by increases in species richness, decreases in Ellenberg N index and greater similarity to MG5a. Also, at sites that were initially more improved, stress tolerator scores increased over time. No sites reached favourable condition (with respect to SSSI criteria). ESA management has improved the conservation value of poorer quality sites and at least maintained the conservation value of better quality sites.	Kirkham, F.W., Fowbert, J. A. & Parkin, A. B. (2004) *Hay-meadow vegetation monitoring in the Dartmoor ESA 1995-2003*. Report to Defra.
A174	Hay meadows Higher plants	Species richness increased under ESA management to 1995, but subsequently declined (to same level or slightly above baseline levels). Several species characteristic of hay meadows peaked in abundance in 1995. In the unimproved sample (MG3) herb richness declined and grass richness increased (1995-2002). Few changes in semi-improved sample (MG3a, MG6b) but similarities to unimproved and there may be potential for re-establishment of unimproved communities. Small increases in species richness on the improved sample. The most important relationship between 2002 data and management practices were N application and early cutting vs no N application and late cutting. There was also an effect of reduced grazing intensity as a result of FMD. Clear relationships between vegetation change and management practices. Herb richness most strongly related to cutting date; deterioration most common where sites were cut before 15 July, and there was some enhancement 1987-2002 if cut after 22 July. Herb richness also declined more at sites with high soil pH levels. Spring grazing was associated with declines in herb richness. Reduced grazing due to FMD and cattle grazing had a detrimental effects although the effects of cattle grazing were often in interaction with other practices.	Critchley, C. N. R., Fowbert, J. A., Wright, B. & Parkin, A. B. (2004) *Upland hay meadows in the Pennine Dales Environmentally Sensitive Area: Vegetation changes between 1987 and 2002 and its relation with management practices and soil properties*. Report to Defra

Study No.[1]	Indicator(s)	Key findings	Reference
		1987-2002 changes in vegetation were similar under both Tier 1 and 2 agreements, although 1995-2002 Tier 2 sites fared better.	
A85	Heather moorland Higher plants	Grazing pressure (indicated by grazing index) on *Calluna* increased under ESA management, but little difference between different management tiers. Species suited to grazing declined on heath sites *Calluna* age suggested that burning frequency reduced under ESA. ESA objectives mostly met, but *Calluna* condition not enhanced when start point is degraded.	Kirkham, F. W., Fowbert, J. A, Parkin, A B., Darlaston, M. & Glaves, D. J. (2005). *Moorland vegetation monitoring in the Dartmoor ESA 1994-2003*. ADAS Report to Defra.
A214	Heather moorland	No stand passed all attribute targets (either standard or species-poor sites CSM targets) and hence none could be considered to be in favourable condition. Stands passed an average of 69% of standard CSM targets and 73% of the species-poor sites CSM targets. Even when less stringent targets developed for the Higher Level Stewardship (HLS) Scheme were applied, less than 5% of the dry heathland sample was considered to be in favourable condition (although this figure rose to 43% if the targets for dwarf shrub structural diversity were excluded). The results showed relatively low pass rates for a wide range of attribute targets. A high proportion of dry heathland stands (41%) failed to even meet the basic target of 25-90% cover of dwarf shrubs and many failed targets for cover of such species as *Rubus* species, *Pteridium aquilinum* and other negative indicators. Agri-environment agreements appeared to facilitate positive conservation management, though such positive action was not restricted to agreement stands. However, the interpretation of differences between agri-environment groups was limited by the coarseness of the agreement groupings used and by the lack of detailed information on length of time under agreement. Public ownership of land was also associated with greater levels of conservation management. Such management may, overtime, lead to recovery towards good/favourable condition.	Hewins, E., Toogood, S., Alonso, I., Glaves, D.J., Cooke, A. & Alexander, R. (2007) *The condition of lowland heathland: results from a sample survey of non-SSSI stands in England*.
A222	Birds	Moorland management prescriptions under the ESA scheme having a positive effect on most moorland bird population where they are in operation. However localised overgrazing, swaling and scrub encroachment is causing habitat change within some combes, which may be contributing to declines in the breeding populations of some species.	Geary, S. (2002) *Exmoor moorland breeding bird survey 2002.* Report to Defra.
A213	Breeding Waders	1994-1997 results suggested a decline in lapwing, redshank and snipe however, curlew appeared to be more stable. Lapwing, redshank and curlew populations have increased since 1997 while snipe populations have remained unchanged. However, the increases in lapwing and redshank populations are due to the high numbers of pairs on the RSPB's Otmoor Nature reserve, which accounts for 54 pairs (40%) and 24 pairs (82%) respectively and does not represent the entire UTTESA. Only curlew have increased uniformly across all the catchments. The effective drainage across much of the UTTESA was demonstrated by a 45% reduction of the area of 'wet' fields and standing water between the first two visits. This, together with the intensive management of a large proportion of grassland in the survey area, remains the largest limiting factor to all the wader species, particularly snipe and redshank in the UTTESA. The UTTESA has had a limited impact on the population and distribution of breeding waders, due to varying uptake. Land in the higher tiers (tier 2 - wet grassland management and tier 3b - arable reversion to wet grassland) has been able to support waders at high densities. However, these two tiers remain the tiers with the lowest uptake in the UTTESA.	McVey, D. (2005) *Upper Thames tributaries breeding wader survey*. RSPB report to Defra.

Study No.[1]	Indicator(s)	Key findings	Reference
A218	Higher plants	Between the two surveys, at the scale of the plot, the mean number of species recorded was similar in the Blackdown Hills and Shropshire Hills ESAs, but had declined in the South West Peak ESA. At the scale of the nest, there was a reduction in the mean number of species between years for all of the ESAs. Although declines in the numbers of species were observed in all community types, the losses of species from the unimproved hay meadow communities of the Shropshire Hills and South West Peak are of greatest concern. Declining species richness in the Blackdown Hills may have been due to a lack of management or abandonment of land marginal for agriculture. However, direct evidence of this is difficult to acquire. In the Shropshire Hills, losses of mesotrophic species were accompanied by an increase in species suited to acidic soil conditions. This suggests that conditions are becoming more suitable to support calcifugous vegetation communities. Numbers of species did increase on some monitoring sites within each ESA sampled. These increases were observed to occur most commonly within vegetation approximating to the NVC community MG6, which is to be expected as this is the predominant permanent pasture type in lowland England.	Manchester, S. J., Carey, P. D. & Pywell, R. F. (2005*) Botanical survey of upland grassland in the Shropshire Hills, Blackdown Hills and South West Peak ESAs*. Report to Defra.
A219	Higher plants	Vegetation sampled within the Avon Valleys and Upper Thames Tributaries was the most diverse in terms of the number of different grassland communities present, with 12 and 11 communities or sub-communities present respectively, compared to just seven in the Somerset Levels and Moors. The Upper Thames Tributaries vegetation was the most species-rich (147 species), followed by the Avon Valleys (129) and the Somerset Levels and Moors (94). At the scale of the plot, the mean number of species recorded had increased since the baseline survey in both the Avon Valley and Upper Thames Tributaries ESA, but remained the same in the Somerset Levels and Moors. At the scale of the nest, numbers of species had increased in the Avon Valley, remained unchanged in the Upper Thames and declined in the Somerset Levels and Moors. Neither gains nor losses of species were confined to one particular community type in any of the ESAs sampled. Results suggest that the ESA scheme is functioning to at least maintain the extensively managed permanent pastures and hay meadows within the Avon Valley. Within the Upper Thames Tributaries ESA, vegetation that is characteristic of extensive permanent grassland and wet grassland has been maintained. In the Somerset Levels and Moors ESA, land managed under the raised water level tier is increasingly characterised by species adapted to conditions of high soil moisture content. In common with other surveys of wet grassland in Somerset, the results of this survey suggest that raised water levels are not maintaining species-rich wet grassland, but are encouraging the formation of more species-poor inundation and rush pasture communities.	Manchester, S. J., Carey, P. D. & Pywell, R. F. (2005*) Botanical survey of wet grassland in the Avon Valley, Upper Thames Tributaries and Somerset Levels and Moors ESAs*. Report to Defra.
A216	Higher plants	This study has demonstrated that the ecological quality of land in ESA agreement is generally higher than the countryside as a whole and is broadly similar to that of the CSS. The targeting of ESAs at particular areas has clearly resulted in greater success in protecting some habitats than the CSS; notably Lowland Heathland, Upland Heathland, and Coastal & Floodplain Grazing Marsh. Like CSS, the ESAs have included large areas of infertile grassland that are either already of high conservation quality or, importantly, may have the potential to achieve high conservation value with appropriate management. There are, therefore, significant opportunities to target restoration or re-creation of priority habitats. In general, the schemes have been well targeted and are effectively run as shown by parallel appraisals of management agreements for both CSS and ESA.	Carey, P. D., Hulmes, S., Nuttall, P., Large, R., Hulmes, L., Croxton, P., MacFarlane, W., Holder, R., O'Shea, R., Spence, D., Pinches, C., Garbutt, R. A., Burrows , A. & Wadsworth, R. A. (2005) *Ecological characterisation of the environmentally sensitive areas of England*. Report to Defra.

Study No.[1]	Indicator(s)	Key findings	Reference
A215	Birds	The densities of nine species of farmland bird (blackcap, chaffinch, dunnock, pheasant, pied wagtail, robin, whitethroat and wren) appear to have changed between 1997 and 2002; these changes are in line with short-term national population trends. • All finches appear to have increased in density; yellowhammer and marsh tit, both red-listed species, appear to be stable in the ESA. • Five species (including red-listed birds linnet, bullfinch, grey partridge and house sparrow) appear to be increasing within the ESA, even though they are declining nationally. • Starling, lapwing, corn bunting and skylark are all birds of conservation concern that appear to be declining within the ESA as in the rest of England. • Lapwing, tree sparrow and corn bunting populations in the ESA are extremely vulnerable and require targeted conservation effort in order to be maintained. • The Cotswold Hills ESA now holds nationally important populations of sixteen bird species, including five red- and two amber -listed species. In 1997 it was found to hold nationally important populations of 21 species, including 2 red and 4 amber-listed species. • It is likely that the future agri-environment scheme operating within the current ESA will provide the most effective means of influencing land management over much of the area.	Dodd, S. & Meadows, K. (2003) *Breeding bird survey of the Cotswold Hills ESA 2002*. RSPB report to Defra.
A29	Biodiversity	Appropriateness of agreements significantly lower for both schemes and the predicted environmental effectiveness of the ESA scheme was also lower when scored by the ecologist alone.	Carey, P. D., Manchester, S. J. & Firbank, L. G. (2005) Performance of two agri-environment schemes in England: a comparison of ecological and multi-disciplinary evaluations. *Agriculture Ecosystems & Environment* **108,** 178-188.
A86	Grassland Higher plants	Few sites met definitions of Lowland Calcareous Grassland or Lowland Meadows, but many were equivalent to poorer examples of semi-natural grasslands. Wet grassland sites more likely to be acting as a buffer for existing habitats rather than becoming valuable habitats for ground nesting birds.	Kirkham, F., Parkin, A. B., Fowbert, J. A. & Sherwood, A. J. (2007) Appraisal of grasslands re-created under arable reversion agreements in the countryside stewardship and environmentally sensitive area schemes. *Aspects of Applied Biology; Delivering arable biodiversity* **81**:285-292.
A221	Higher plants	Arable reversion sites much less species-rich than semi-natural grasslands. A significant proportion of sites were comparable with poorer examples of semi-natural grasslands and may develop further over time, relatively few sites met the BAP definitions for Lowland Calcareous grassland or Lowland meadow. Plant communities were more species rich in calcareous habitats, with a greater richness of plant food sources for farmland birds and butterfly larvae and greater richness of nectar sources. Establishment method, seed mix and vegetation management all affected aspects of vegetation quality. Quality of sites from areas noted for the high quality of their neutral grasslands did not differ from those selected from other areas. Many of the wet grassland sites were not suited to many ground nesting birds, but will provide a valuable buffer for existing sites. Inconsistent targeting of suitable land with respect to vegetation.	Kirkham, F. W., Davis, D., Fowbert, J. A., Hooke, D., Parkin, A. B. & Sherwood, A. J. (2006) *Evaluation of arable reversion agreements in the Countryside Stewardship and Environmentally Sensitive Areas Schemes*. Report to Defra.
A28	Biodiversity	Most CSS agreements should maintain or enhance biodiversity (and other objectives). 36% and 38% indicated high and medium additionality respectively suggesting that CSS should provide benefits to society. Agreement negotiation, predicted environmental effectiveness and predicted compliance all improved between 1996 and	Carey, P. D., Short, C., Morris, C., Hunt, J., Priscott, A., Davis, M., Finch, C., Curry, N., Little, W., Winter, M., Parkin, A. & Firbank, L.

Study No.[1]	Indicator(s)	Key findings	Reference
		1998.	G. (2003) The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management* **69,** 71-91.
A26	Biodiversity	The field survey (randomly placed quadrat) identified Priority Habitats on 37% of agreements and accounted for >20% of the total area under agreement including mosaics. Calcareous grassland and heathland most common. Cereal field margin priority habitat was found on the greatest number of agreements but accounted for only a small area. Results indicated that CSS has been successful in targeting Broad and Priority Habitats.	Carey, P. D., Barnett, C. L., Greensdale, P. D., Hulmes, S., Garbutt, R. A., Warman, E. A., Myhill, D., Scott, R. J., Smart, R. J., Manchester, S. J., Robinson, J., Walker, K. J., Howard, D. C. & Firbank, L. G. (2002) A comparison of the ecological quality of land between an English agri-environment scheme and the countryside as a whole. *Biological Conservation* **108,** 183-197.
A182	Field boundary/hedges Higher plants	Similar proportion of species rich hedges (21%) to Churchward *et al*. 1999 (26%). One third of hedges linked to other strong landscape features (e.g. woodland, large hedgerow trees). Although trees were recorded in half hedges surveyed, only 17% of hedges included mature trees (>1m at chest height). 80% of agreements were considered on course to meet wildlife objectives.	Catherine Bickmore Associates (2004). *Hedgerow management and restoration in agri environment schemes: Part I Countryside Stewardship Scheme*. Report to Defra.
A91	Higher plants Invertebrates Birds	In all countries, the schemes had a marginal to moderately positive effect on biodiversity. Uncommon/Red Data Book species rarely benefited, but few of the options studied targeted rare species and the study was not designed to detect rare species. Plant species density and abundance of one of the arthropod groups were significantly enhanced by AE options (plants - probably a result of reduced agrochemical inputs and buffering effect of margins). Species density of birds not enhanced by the AE options in any country. Abundance of observed birds significantly higher at the field scale in CH and DE.	Kleijn,D., Baquero, R. A., Clough, Y., Diaz, M., De Esteban, J., Fernandez, F., Gabriel, D., Herzog, F., Holzschuh, A., Johl, R., Knop, E., Kruess, A., Marshall, E. J. P., Steffan-Dewenter, I., Tscharntke, T., Verhulst, J., West, T. M. & Yela, J. L. (2006) Mixed biodiversity benefits of agri-environment schemes in five European countries. *Ecology Letters* **9,** 243-254.
A41	Higher plants	Sown perennial vegetation (including forbs where sown) established in all types of margin. Sown margins developed different communities to naturally regenerated and cereal margins. Perennial forbs characteristic of semi-natural habitats did not colonise margins sown with basic grass mixtures, but competitive and ruderal species colonised all grass margin types. Community composition varied, partly as a result of soil properties and region, but not due to management and habitat context.	Critchley, C. N. R., Fowbert, J. A., Sherwood, A. J. & Pywell, R. F. (2006) Vegetation development of sown grass margins in arable fields under a countrywide agri-environment scheme. *Biological Conservation* **132,** 1-11.
A40	Higher plants	Creation of simple habitats on arable land is relatively straightforward, because results are predictable, particularly when the habitat is sown. Vegetation development under natural regeneration can vary between regions, landscapes and soil types. In naturally regenerated options, the option had an effect on the vegetation, due to cultivation, and successional changes. In sown options the method of establishment was more important and had a greater impact than soil, landscape and geographic factors. The best options to conserve annual arable species were uncropped wildlife strips, wildlife seed mixtures (absence of agro-chemical inputs and open structure of the cover) and conservation headlands without fertiliser. Some of the most abundant species are important for higher trophic groups.	Critchley, C. N. R., Allen, D. S., Fowbert, J. A., Mole, A. C. & Gundrey, A. L. (2004) Habitat establishment on arable land: assessment of an agri-environment scheme in England, UK. *Biological Conservation* **119,** 429-442.
A22	Brown hare Grey partridge	Densities of both species higher in EA than WM. In EA brown hare density increased (1998-2002) on agreement farms (+35%) and decreased on control farms (-18%), however densities remained stable on both agreement and control farms	Browne, S. J. & Aebischer, N. J. (2003) *Arable Stewardship: impact of the Pilot Scheme on*

Study No.[1]	Indicator(s)	Key findings	Reference
		in WM. Adult grey partridge densities fell by half (1998-2002) in both regions. However, breeding productivity improved (x2) on agreement farms compared to control farms resulting in an improved young-to-old ratio (x4) and brood size (x2) compared to control farms. This improved productivity resulted in densities dropping much less on agreement than control farms in EA. Additional forms of game and land management (questioning farmers) had no detectable effect on results. Results from 2000 had not allowed agreements sufficient time to improve biodiversity; further improvements are anticipated over time.	*the brown hare and the grey partridge after five years*. Report to Defra.
A138	Birds	At the field scale, ASPS options affected presence/absence of nesting birds reflecting nest site provision and abundance/access to food resources. Spring-summer fallow positive for skylarks, lapwings, yellow wagtails. Skylarks also selected legumes, lapwings also selected legumes, set-aside and sugar been/root crops. Reduced pesticide options (conservation headlands and low input cereals) highly selected by several species, but had a negative association for reed buntings. Grass margin option highly selected by boundary nesters and skylarks. Wildlife seed mixtures or winter stubble strongly selected by skylarks and linnets. However for most species there was no response at the farm scale. Area of options (and frequency in the landscape) required to benefit birds needs to be determined.	Stevens, D. K. & Bradbury, R. B. (2006) Effects of the Arable Stewardship Pilot Scheme on breeding birds at field and farm-scales. *Agriculture Ecosystems & Environment* **112,** 283-290.
A18	Birds	Most species or groups showed no significant response, possibly because of the short timescale. Winter birds. Higher numbers of granivorous passerines on scheme sites vs. controls in both years in the West Midlands (benefit from stubbles and game cover strips - equivalent to wildlife seed mixtures). However plovers and skylarks showed significant negative associations with the scheme in East Anglia. Breeding birds. Positive effect of the scheme on lapwing (benefit from spring cropping and spring/summer fallow) across both pilot areas although the effect was much stronger in East Anglia. No effect on skylarks. Starlings positive response probably as a result of length of time some options were uncultivated - this may help to increase soil-dwelling invertebrate populations relative to other habitats. Positive effects on a group of 3 granivorous passerines probably because of the provision of weed seeds in field margins and wildlife strips and wildlife seed mixtures plus lack of spraying in conservation headlands. These options also provide enhanced invertebrate populations (nestling food) plus nest sites for reed bunting. Concluded the pilot scheme had been relatively successful at delivering some targets.	Bradbury, R. B. & Allen, D. S. (2003) Evaluation of the impact of the pilot UK Arable Stewardship Scheme on breeding and wintering birds. *Bird Study* **50,** 131-141.
A20	Birds	Grey partridge: In EA autumn densities decreased less 98-02 on scheme farms, but not for adults only. In WM there was no difference in between year change between scheme and control farms. In EA, by 2002, Young:Old ratio was much higher on scheme farms than control and brood size higher. In WM there were no significant differences. Winter birds: Farm-scale assessment - Farm type had few effects on winter birds. Field-scale assessments - granivorous passerines responded to options. Densities higher on stubbles than other field types and were high on fields with wildlife seed mixtures. Skylark densities higher on stubbles, but responses to other variables differed between regions.	Bradbury, R. B., Browne, S. J., Stevens, D. K. & Aebischer, N. J. (2004) Five-year evaluation of the impact of the Arable Stewardship Pilot Scheme on birds. *Ibis* **146,** 171-180.
A210	Breeding Waders	Although 86% of fields complied with the agri-environmental scheme prescriptions (combined ESA and Countryside Stewardship data), only 35% complied with a set of ideal breeding wader habitat criteria. A total of 60% of the applicable fields or 4,687 hectares nationally were judged to be of sufficient quality to contribute towards the HAP targets for Coastal and Floodplain Grazing Marsh. This study suggests that a wide variability of habitat condition exists within the schemes and that the current prescriptions are too generalised to achieve ideal conditions for the desired breeding wader habitat. Unsatisfactory water level and sward condition were found to be the major cause of failure. It was also concluded that the targeting of fields for entry to the scheme could be improved.	Dutt, P. (2004) *An assessment of habitat condition of coastal and floodplain grazing marsh within agri-environmental schemes*. RSPB report to Defra.

Study No.[1]	Indicator(s)	Key findings	Reference
A217	Birds	Baseline survey only: 1. Additional surveys on the same squares should be carried out in 2008 and 2011 in order to assess the broad-scale impacts of the Entry Level Scheme on bird populations. 2. Spatially referenced data is required on Entry Level Scheme uptake in order to assess: (i) differences in bird population trends between ELS and non-ELS squares; (ii) the effects of different Entry Level Scheme options on bird population trends, and (iii) the influence of scale of uptake at a landscape scale (e.g. 3x3km centred on the survey square) on bird population trends.	Chamberlain, D., Noble, D. & Vickery, J. (2006) *Assessment of the impacts of the Entry Level Scheme on bird populations: results from the baseline year, 2005*. Draft report to Defra.
A198	Woodland Heather moorland Grassland Blanket bog Wetland Water margins Butterflies Hay meadows	Detailed monitoring programmes have been set up in the ESAs and on land under agreement in the Habitat, Moorland and Tir Cymen schemes. This report uses the results of the monitoring programmes, and achievements against the Performance Indicator to evaluate the existing WOAD and CCW schemes. **Woodland** Monitoring of broadleaved woodland to record the impact of stock exclusion has taken place in the Cambrian Mountains ESA and Tir Cymen areas. Both programmes showed a significant increase in the number of tree seedlings following stock exclusion. The Tir Cymen monitoring looked at changes in the ground flora. An increase in extent and species diversity was noted. **Heather moorland** Both the Cambrian Mountains ESA monitoring and the Tir Cymen monitoring showed a rapid overall improvement in heather condition on existing heathland under agreement. **Grassland** Monitoring of lowland grasslands has taken place in the Cambrian Mountains and Radnor ESA hay meadows, and on calcareous grasslands in the Clwydian ESA. both ESA and Tir Cymen programmes demonstrated that there had been no deterioration in species diversity over the period of the surveys (1994-1997). Reductions in nutrient input as part of ESA, Habitat Schemes and Tir Cymen agreements have maintained and enhanced the quality of hay meadows and pasture sites. **Butterflies** Within the Clwydian Range ESA, the ecological significance of large areas of limestone grassland led to the establishment of a monitoring programme designed to record changes in butterfly numbers over time. The work on butterflies demonstrates that species diversity and population levels are dependent on factors other than vegetation type. **Wetlands I**nitial results from ESA monitoring demonstrated an increase in species diversity on those sites with the most stringent prescriptions aimed at habitat enhancement (Tier 2A). **Water margins** On re-survey a total of seven ponds showed an increase in diversity which suggested that water quality had also increased. Tir Cymen botanical monitoring recorded significant increases in wetland species. Monitoring of forty ESA sites within Ynys Môn covered a diversity of sites ranging from coastal heaths with western gorse and bell heather through to exposed cliff top grasslands. The latter sites possessed generally low-growing vegetation and were very diverse in terms of species. Re-survey was carried out in 1997 and showed an increase in species diversity within the heathland stands. This is particularly encouraging, since without active management such areas can easily develop into species-poor scrub dominated by common gorse.	Medcalf, K., Pawson, B., Horton, C., Rugg, I., Davis, J. & Jones, E. (1998) *ANNEX 1 An Interim Evaluation of the First Generation of Agri-Environment Schemes in Wales In the Context of Tir Gofal*. Report to Welsh Office Agricultural Department (WOAD)
A162	Birds	Underpinning research to advise schemes rather than an evaluation.	Woodhouse, S. P., Good, J. E. G., Lovett, A. A., Fuller, R. J. & Dolman, P. M. (2005) Effects of land-use and agricultural management on birds of marginal farmland: a case study in the Lleyn peninsula, Wales. *Agriculture, Ecosystems & Environment* **107**, 331-340.
A235	Birds	The results suggest that the Lleyn ESA may have benefited birds as higher tiers supported significantly higher species densities than lower tiers. Higher tiers also tended to support a wider variety of species than lower tiers.	Williams, I., Gibbons, D., Kelly, E., Owen, M. and Watts, C. (1997) Ornithological Survey of

Study No.[1]	Indicator(s)	Key findings	Reference
			the Lleyn ESA April-July 1996
A236	Birds	Long term overgrazing in the ESA has resulted in a depleted natural bird population. The nature conservation measures in the ESA are justified, providing feeding areas for important bird species and nest site opportunities.	RSPB (1988) Bird Communities in the Cambrian Mountains ESA. A report to WOAD.
A230	Higher plants	74% of habitat areas managed well. Beneficial changes in vegetation due to reductions in grazing recorded in these areas include: Increased heather cover, increased regeneration in woodlands of oak, ash and rowan, increased cover in the grass/herb layer under hedge The 26% of habitat areas not managed well showed problems of over/under grazing attributed to: The farmer not complying with the agreement, poor quality work, the Tir Cymen prescription being inappropriate.	Reaston, R. and Knightbridge, R. (1997) Tir Cymen monitoring and evaluation: first evaluation report. ENTEC Technical Report to CCW
A209	Marsh Fritillary	No adult marsh fritillaries were seen. There could be a number of reasons for this: - i) Marsh fritillaries don't use the site (most years). ii) The adult survey was conducted late in the season. iii) The adults were missed during the search (which could be as short as 1 hour). iii) 1997 was generally a poor year for marsh fritillaries in Glamorgan (Vice county 41). Of the sites that were surveyed for larval webs only three farms produced positive results, but the numbers of larval webs seen were very small despite the extent of suitable vegetation at these sites. This is probably a reflection of the poor year the adults had in 1997 throughout Glamorgan. Many of the sites appeared to be managed sympathetically usually pony and/or cattle grazed. Some of the fields at Wern fawr were very closely horse grazed and at Cwm-nant-isaf the small patch of vegetation that could be suitable for breeding marsh fritillaries was very closely grazed.	Woodman, J. (1997) Tir Cymen marsh fritillary (*Eurodryas aurinia*) survey, Gower, 1997.
A231	Higher plants	Of the 869 habitat parcels on the 137 sample holdings, 305 (35%) were managed in a wholly appropriate manner. Beneficial changes seen included: Increase in the number or abundance of desirable species present (11% of parcels) Good tree regeneration in 20% of all woodland parcels. Tir Cymen maintaining high nature conservation and landscape value. 53% of monitored boundaries restored by Tir Cymen were in good condition on second visit. Of the remaining 564 (65%) habitat parcels on the sample holdings, management required adjustment: compliance problems on 25% of parcels, inadequate or inappropriate management prescriptions (58% of parcels), undesirable vegetation changes as a result (29%)	Reaston, R. and Knightbridge, R. (1998*) Tir Cymen monitoring and evaluation: second evaluation report*. ENTEC Technical Report to CCW
A237	Arable weeds Biodiversity	When correctly applied in Swansea/Gower farms options 6b,c,d were found to support strong and moderately diverse weed communities. In Dinefwr the 6E option was successful in recovering a sparse but diverse mixed community of broad-leaved arable weeds. Colonisation of rough-grass margins by wild plants could be better facilitated. Stubble needs to be kept open to permit utilisation by ground-feeding birds. Need to prevent ploughing of species-rich unimproved grassland.	Kay, Q. (1997) *Tir Cymen Stewardship scheme: arable land management. Arable weed communities and wildlife: a survey and evaluation of the effects of arable option schemes at selected Tir Cymen sites in Swansea/Gower and Dinefwr*. Report to CCW
A229	Birds	Too small a sample for significant results! No conclusions made in the study despite 3 years of surveying.	Thomas, N., Humphries, M., Pickup, T. & Williams, Iolo (2000) *Ornithological monitoring of arable land in the Dinefwr Tir Cymen Scheme RSPB Cymru* Report to CCW
A207	Higher plants	The two most frequent prescriptions looked at were uncropped wildlife margin, 6B, and unsprayed cereal crops, 6C.	Woodman, J. (1998) A sample survey of

Study No.[1]	Indicator(s)	Key findings	Reference
		There appeared to be little difference in species richness or species type between the two prescriptions. The average level of species richness at each farm was between 20 - 40 species, with extremes of 10 species at one farm to 76 species at another. A number of species that are uncommon in the British Isles were seen during this survey. Many of these species have declined due to intensive farming practices. Generally a wide variety of species were seen in the Tir Cymen prescription areas including some species which are considered uncommon or rare in Wales and/or the British Isles as a whole	arable weeds on farms with arable options under the Tir Cymen scheme, Gower, 1997.
A208	Higher plants	During this survey and with recent records included 3 of the farms can be considered of national importance and 6 of county importance. The arable options have probably increased the frequency of some of these scarcer plants in the county and are hopefully 'bouncing back' after the declines of the 60's & 70's. Some of the higher scoring species on these farms include shepherds needle, corn buttercup, cornflower, corn chamomile and corn marigold. Moderately highly scoring species that turned up quite commonly depending on the soil type were corn spurrey, stinking chamomile, dwarf spurge, field woundwort. Of the lower scoring but still very interesting (especially for Wales) were both sharp & round leaved fluellen, treacle mustard, field madder, many seeded & fig-leaved goosefoot and corn parsley. Some oddities and high scoring species that were recorded at Home farm were false cleavers (*Galium spurium*) and rye brome (*Bromus secalinus*).	Woodman, J. (1997) *Vale of Glamorgan arable weed survey 2006*. Preliminary summary.
A204	Lapwing	The results of the Survey were very disappointing. On Section 34A land there were breeding pairs of Lapwings at only 2 of the 30 sites i.e.Morfa Madryn in Gwynedd where there were 15 pairs and Llwyn Berriad in Powys,where there were 2 pairs. Adjoining Section 34A land there were 9 pairs of Lapwings on recently sown Maize at Shordley Hall (Flintshire),and on damp, rough pasture 1 pair at Dyffryn Nedd (Powys),2 pairs at Penrhiw (Powys) and 2 pairs on an adjoining Common at Gelliwarog (Swansea). On the 4 additional Tir Gofal sites the results were more encouraging, as follows. At Ty Isa (Flintshire) there were 2 pairs, both of which produced 2 young. At Llwydfaen (Conwy) there were initially at least 3 pairs but on the subsequent visit no sign of birds and the grass was very rank in the absence of grazing. At Tai'n y Foel(Conwy) the rough damp grassland ,grazed by sheep, was ideal for Lapwings and at least 7 pairs nested successfully. At Domencastell there was a single feeding bird. With the notable exception of the Local Nature Reserve at Morfa Madryn, the contribution of the scheme is somewhat limited.	Williams, G. (2002) *Baseline Survey of Numbers of Breeding Lapwing (Vanellus vanellus) on Tir Gofal Farms*. CCW Report.
A206	Lapwing	Unfinished study - simply presents the data. **Tythegston** Four pairs bred in field B, and one pair in field C. This is significantly less than in 2004, possibly because Field A was unsuitable, reducing available nesting habitat. By the end of May, the birds had dispersed, with pairs either leading young onto adjacent marshy grassland (two pairs), remaining on the arable fields (two pairs) or leaving the site altogether (possibly 1 pair). This suggests that between two and four pairs were successful in raising young, at least to the pre-flight stage. **Llampha**Ten pairs in total bred or attempted to breed. Five pairs bred on field A and two each on field B and C. An additional pair bred at an unknown location and, by the time of the first visit had already lead young onto nearby grassland. By mid May, one pair had led young onto nearby marshy grassland in field D, whilst another had moved to field E	Lucas, A. (2005) *Breeding Lapwing at Tythegston and Llampha farm in 2005*. CCW Report
A203	Trees	6,238 orchard and parkland trees have been, or will be, planted as part of a five-year capital works programme	Law, A. (2004) *The Contribution of Tir Gofal to the Parkland and Wood-pasture Habitat Action Plan.* CCW Staff Science Rep. No 04/7/1

Study No.[1]	Indicator(s)	Key findings	Reference
A201	Moss	The results suggest that there is an assemblage of bryophytes that can be considered typical of arable in the region. Five Nationally Rare or Scarce species and a few other uncommon arable specialists occur occasionally, although the reasons for their patchy occurrence have not yet been clarified. Three of the nationally rare or scarce species were discovered new to South Wales' arable during the present survey, and further fieldwork is required to establish their distribution. In some fields, certain members of the main assemblage drop out, and the remainder are joined by various nutrient-tolerant species. This change may be a result of farming activities but further work is required to determine this.	Bosanquet, S. D. S. (2003) *The bryophyte flora of arable fields in South Wales a preliminary assessment.* CCW Report
A202	Birds	Many bird species were too rare to allow informative analysis of the individual species. For analysis species were therefore grouped into nine ecological or taxonomic guilds, with four individual species. Statistical analysis of the winter results showed that the five habitat variables which were of most significance in explaining bird numbers were the abundance of broad-leaved weeds with flowers/seeds in mid field, size of field, thickness of hedges, crop type and farming characteristics. A comparison with a previous survey in Wales, covering the winters of 1993/94 and 1994/95, gave similar densities of birds feeding on stubble fields; given that there has been a decline in many, but not all, farmland species in the intervening years this is an encouraging result for the Tir Gofal farms. Similarly the preliminary results of the BTO Winter Farmland Bird Survey of England, Scotland and Wales showed that the densities of key guilds/species were far greater on the Tir Gofal farms than the averages for the BTO survey.	Williams, G. (2003) *A study to evaluate Tir Gofal root crop and winter stubble options in enhancing farmland bird populations*. CCW Report contract FC 73-03-16
A37	Machair Heather Woodland	Although enhancement not demonstrated by studies, there has been maintenance and no decline of the habitats in their current state. **Breadalbane** Heather utilisation maintained but greater outside area. Woodland regeneration increase in sapling height. **Loch Lomond** Heather utilisation maintained but greater outside area. Woodland regeneration no increase in sapling height. **Machair** Species composition of grassland maintained.	Crabtree, R. & Milne, J. (1998) Applications of actions for environmentally sensitive areas: Examples in Scotland. *Annales de Zootechnie* **47**, 491-496
A171	Grassland Woodland Heather moorland	The area of three out of five semi-natural Broad Habitats had been maintained or increased and the rate of decline in the other two was below national trends. **Grassland** the Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have been achieved. However, the Tier 2 aims of conserving, enhancing or extending areas of herb-rich grasslands, were apparently not achieved, mainly due to many sites being under-grazed. **Woodland** Overall, the results suggest that the Scheme was successful in protecting the area of broadleaved woodland. However, Tier 1 management measures seemed ineffective in avoiding damage to woodland, while results for Tier 2 sites indicate success in increasing the overall density and condition of saplings and trees, and in extending the areas of broadleaved woodland and woodland regeneration. **Heather moorland** Tier 1 had apparently not been successful in maintaining the overall area or condition of heather vegetation generally, or the condition of heather as a species (*Calluna*). The Tier 2 prescriptions had not achieved their overall aim of improving the cover, height and condition of *Calluna*. **Wetland** Tier 1 measures were broadly successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land in the sample of 1-km squares. Under Tier 2 prescriptions there was a decrease in botanical diversity. **Farmland birds** There was strong evidence of a decline in the number of breeding pairs of all four species of wading birds, in line with national trends. This was reflected by a decrease in the number of farms with breeding birds present.	Cummins, R. P., Nolan, A. J., Scot,t D., French, D. D., Hewison, R. L., Henderson, D. J., Bell, J. S., Pearce, I. S. K., Ellis, C., Mills, C., Marquiss, M., Picozzi, N., Bacon, P. J., Elston, D.A. & Palmer, S. C. F. (2005) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 1: Argyll Islands ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A172	Grassland Woodland Heather moorland	In the Breadalbane ESA, changes in the area of Broad Habitats were variable and not statistically significant. **Grassland** The Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have been achieved. While the Tier 2 aim of conserving the area of herb-rich grasslands also appears to have been achieved, there was little evidence of enhancement. Indeed, there were indications of a general decline in the species richness and quality of such grasslands on nearly two-thirds of Tier 2 sites, most likely due to many sites being under-grazed.	Nolan, A.J., Cummins, R.,P., Scott, D., French, D.,D., Hewison, R.,L., Bell, J.,S., Henderson, D.,J., Acton, A., Ellis, C., Mills, C., Elston, D.,A. & Palmer, S. C. F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland*

Study No.[1]	Indicator(s)	Key findings	Reference
		Woodland Overall, the results suggest that the Tier 1 target of maintaining the area of woodland and tree regeneration was achieved. However, while sapling density increased, the additional benefits of the Tier 2 measures, over and above the Tier 1 requirements were apparently not large, nor clearly evident. **Heather moorland** The standard requirements of Tier 1 were almost successful in maintaining the area of heather vegetation and were very successful in maintaining the condition of heather. Tier 2 prescriptions had achieved their aim of 'enhancement' based on the height and cover of heather, also in relation to a reduction in grazing, as compared to Tier 1 and out-scheme areas.	*Vol. 2: The Breadalbane ESA Monitoring Report 1995-2004.* Report to the Scottish Executive Environment and Rural Affairs Department
A173	Grassland Woodland Dwarf shrub moorland	In the Cairngorms Straths ESA, changes in the area of Broad Habitats were variable and not statistically significant. **Grassland** The Tier 1 aims of maintaining the area of semi-natural grasslands and moorland grass appear to have been achieved. The richness and diversity of grasslands on in-scheme land appeared to be declining, which did not meet the Tier 1 aims. **Woodland** successful in increasing the area of scattered trees and the area of regeneration, as well as increasing sapling heights. These increases were probably as a result of reduced grazing under Tier 1 management measures. Tier 2 measures were apparently successful in increasing the overall density and condition of saplings and trees in coniferous woodlands, but in broadleaf woodlands, Tier 2 sites achieved no better results than out-scheme sites. **Dwarf shrub moorland** The Tier 2 aim of improving the cover, height and condition of *Calluna* was achieved on land 100m away from the moorland or holding edge. However, on land nearer the edge, the Scheme was less successful. **Wetlands** The Tier 1 measures have apparently achieved the aims of maintaining the area of wetland vegetation and avoiding damage on in-scheme land. However, the Tier 2 prescriptions were not successful in conserving botanical diversity. **Farmland birds** There was strong evidence of declines in breeding pairs of curlew and oystercatcher. Numbers of lapwing declined significantly on Tier 2 land but remained stable on Tier 1 land. Redshank, were scarce in the ESA.	Bell, J. S., Cummins, R. P., Nolan, A. J., Scott, D., French, D. D., Hewison, R. L., Henderson, D. J., Pearce, I. S. K., Ellis, C., Mills, C., Bacon, P., Marquiss, M., Picozzi, N., Elston, D.A. & Palmer, S. C.F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 3: The Cairngorms Straths ESA Monitoring Report 1995-2004.* Report to the Scottish Executive Environment and Rural Affairs Department
A178	Grassland Woodland Wetland	In the Central Borders ESA, monitoring indicates the areas of semi-natural Broad Habitats appear to have been maintained and changes were similar to national trends. **Grassland** The Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear not to have been achieved. Similarly, the Tier 2 aims of conserving, enhancing or extending areas of herb-rich grasslands, were apparently not achieved, mainly due to many sites being under-grazed. **Woodland** Overall, the results suggest that the Scheme was successful in maintaining the area of broadleaved and mixed woodland and the area of tree regeneration. **Wetland** Tier 1 measures were successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land, but showed no clear advantage compared with out-scheme land. Under Tier 2 prescriptions there was a significant decrease in botanical diversity, probably due to reduced grazing.	Scott, D., Cummins, R. P., French, D. D., Hewison, R. L., Ross, L., Ellis, C., Mills, C., Elston, D.A., Duff, E. I. & Palmer, S. C. F.(2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 4: The Central Borders ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A179	Grassland Woodland Heather moorland	In the Loch Lomond ESA, changes in the area of Broad Habitats were variable and not statistically significant. **Grassland** the Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have been achieved. However, while the Tier 2 aim of conserving the area of herb-rich grasslands also appears to have been achieved, there was little evidence of enhancement or increase in area. **Woodland** successful in maintaining the area of broadleaved woodland and exceeded the target for woodland regeneration. Tier 1 requirements were considerably less effective in avoiding damage to woodland, while the Tier 2 prescriptions were reasonably successful at increasing the overall density and condition of saplings and trees. **Heather moorland** Tier 1 barely maintained the area of heather vegetation, but had been very successful in maintaining the condition of heather. Overall, there was no clear evidence that the Tier 2 prescriptions had achieved their aim of 'enhancement'.	Nolan, A.J., Cummins, R.P., Scott, D., French5, D.D., Hewison, R.L., Bell, J.S., Henderson, D.J., Pearce, I.S.K., Ellis, C. Mills, C., Elston, D.A., Palmer, S.C.F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 5: The Loch Lomond ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department

Study No.[1]	Indicator(s)	Key findings	Reference
A193	Grassland Machair	In the Machair ESA, results indicate that the area of all the semi-natural Broad Habitats had been maintained or increased, whereas arable and fallow land decreased significantly. **Grassland** The Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have generally been achieved. However, the Tier 2 aims of conserving, enhancing or extending areas of these grasslands that were herb-rich were not achieved. **Machair** The Tier 1 aims of avoiding damage and maintaining the area of machair grasslands appear to have mostly been achieved. Tier 2 measures have generally been successful in conserving overall diversity but not in enhancing it and showed no clear benefit over Tier 1. The Tier 1 aim for maintaining the area of croppable machair does not appear to have been achieved. Species diversity was maintained but there was a small decline in botanical quality of the habitat. On plots subject to Tier 2 measures, crop rotation was maintained. Although species diversity decreased significantly on both cropped and fallow sites.	Pearce, I.S.K., Cummins, R.P., Nolan, A.J., French, D.D., Hewison, R.L., Henderson, D.J., Bell, J.S., Acton, A., Crawford, I.C, Ellis, C., Mills, C., Elston, D.A., Palmer, S.C.F (2007*).Monitoring Environmentally Sensitive Areas in Scotland Vol. 6: The Machair of the Uists and Benbecula, Barra and Vatersay ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A194	Grassland Lapwing Oystercatcher Curlew Redshank Dwarf shrub moorland Wetland	Two out of four semi-natural Broad Habitats had increased, one was stable and one declined. **Grassland** At least some increase in the area of herb-rich grasslands but showed no clear advantage over non-agreement areas. Species composition generally declined and so the Scheme had apparently not achieved its Tier 2 aims of enhancing, or conserving, species diversity in herb-rich grasslands, probably due to a lack of grazing. In contrast, species diversity had generally been maintained on out-scheme areas. **Dwarf shrub moorland** Tier 2 prescriptions were broadly successful in improving the cover, height and condition of *Calluna* and there were clear benefits compared to out-scheme areas. **Wetland** maintained the area of wetland vegetation but showed no clear benefits compared with out-scheme land. Under Tier 2 prescriptions there was a significant decrease in the mean number of species. **Farmland birds** There was strong evidence of an increase in the total numbers and density of breeding pairs of oystercatcher and curlew. Lapwing showed a tendency towards a decline whilst for redshank little change was observed.	Truscott, A.M., Cummins, R.P., Nolan, A.J., Scott, D., French, D.D., Hewison, R.L., Bell, J.S., McGowan, G., Ellis, C., Mills, C., Bacon, P.J., Picozzi, N., van der Wal, R., Elston, D.A., Palmer, S.C.F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 7: The Shetland Islands ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A195	Woodland Dwarf shrub moorland Heather Heather moorland	In the Southern Uplands ESA, three out of seven semi-natural Broad Habitats increased in area, in contrast to declines for these habitats on equivalent land in Scotland as a whole. Another two habitats were almost unchanged but dwarf shrub heaths decreased considerably in the ESA compared to an increase recorded elsewhere. **Woodland** On balance there appeared to be no clear benefit from the Tier 1 requirements. An overall 'success index' showed that the enhancement aims of the Tier 2 woodland measures had been attained at 14 of the 30 monitoring sites but were not successful on 8 sites that were unchanged or on the other 8 sites that continued to decline. **Dwarf shrub moorland** At the plant community level, mapping data indicate a general decline in the quality and area of dwarf shrub heaths on in-scheme land. The overall decline here was generally greater than on out-scheme land. *Calluna* cover was so low on half of the stock reduction plots and one-quarter of the stock management plots that any regeneration there was unlikely. Both of the Tier 2 measures reduced overall grazing pressure but the cover of *Calluna* still decreased considerably, possibly due to rapidly growing graminoids out-competing the *Calluna.* ***Calluna*/Heather moorland** the combined Tier 1 and Tier 2 measures were apparently successful in maintaining *Calluna* height and in preventing an increase in the occurrence of suppressed *Calluna* on these plots where the heather vegetation was initially in reasonable condition. However the measures were not successful in conserving the cover of *Calluna* or the general condition of heather moorland. Even so, the measures showed some benefit compared to the declines recorded on out-scheme plots.	Cummins, R.P., Scott, D., French, D.D., Hewison, R.L., Bell, J.S., Henderson, D.J., Ellis, C., Mills, C., Hawker, D., Elston, D.A., Palmer, S.C.F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 8: The Combined Western and Central Southern Uplands ESAs Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A196	Grassland Wetland	In the Stewartry ESA, the area of three out of six semi-natural Broad Habitats increased, with the decrease in two others less than national trends. Only dwarf shrub heaths and broadleaf woodland did less well in the ESA when compared to national trends.	Scott, D., Cummins, R.P., French, D.D., Hewison, R.L., Pearce, ISK, Ross, L., Ellis, C., Mills, C., Crawford, I.C., Hawker, D., Elston,

Study No.[1]	Indicator(s)	Key findings	Reference
	Woodland Water margins Dwarf shrub moorland Field boundary/hedges	**Grassland** The Tier 1 aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have been achieved. However, the Tier 2 aims of conserving, enhancing or extending areas of herb-rich grasslands were apparently not achieved, mainly due to many sites being under-grazed. **Wetland** Tier 1 measures were successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land, but showed no clear advantage over out-scheme areas. The Tier 2 prescriptions appear to be inappropriate for conserving botanical diversity. **Water margins** The Tier 1 measures were successful in decreasing the area of bare ground and maintaining the canopy cover of trees and bushes. The Tier 2 prescriptions were also successful in decreasing bare ground, caused by stock, and increasing tree and shrub cover. **Woodland** The tier 1 measures were successful in maintaining the area of woodland, but appeared to be ineffective at preventing damage within areas of tree regeneration. Tier 2 prescriptions were only partially successful in reducing damage and encouraging tree regeneration. **Dwarf shrub heaths** The Tier 1 aims of maintaining the area, cover and condition of heather moorland were not achieved, although decreases were less than on out-scheme land. **Boundaries** The rate of decline in the length of dykes in the ESA was less than the national trend. The length of hedges declined in the ESA, compared with an expected slight increase, based on national figures. In summary, the combined effects of Tier 1 and Tier 2 measures was an increase in the length of dykes, whereas hedge length was stable. These results indicate success, at least at the Tier 1 level.	D.A., Palmer, S.C.F. (2007) *Monitoring Environmentally Sensitive Areas in Scotland Vol. 9: The Stewartry ESA Monitoring Report 1995-2004*. Report to the Scottish Executive Environment and Rural Affairs Department
A76	Grassland Wetland Woodland Dwarf shrub moorland Water margins Field boundary/hedges	**Grasslands (ESA,CPS)** **SITE 1:** Greater butterfly orchids have increased in numbers as a result of the change in management. However, other wildflowers have declined in abundance and the vegetation is becoming rank. **SITE 2:** Plant species diversity is thought to have increased, and a more varied sward structure has improved the site for invertebrates such as small heath, meadow brown and common blue butterflies. There has been some limited expansion of Juniper. However, there are a few localised signs of undergrazing with increases in heather and birch seedlings. **SITE 3:** There has been an increase in flowering plants, but these are generally tall competitive species such as hogweed. Undergrazing has shaded out the smaller flowering plants. There is also a problem of invasive species, with rosebay willowherb and giant hogweed growing on the site. **Wetland (RSS,CPS)** **SITE 1:** Snipe returned as a breeding species in 2004. Flowering plants (particularly marsh cinquefoil and marsh lousewort) have increased in abundance in the wetter parts of the site. However, the drier, rush dominated areas around the edge of the site remain quite rank and overgrown. **SITE 2:** One of the shallow ponds does not hold water well and has rapidly been colonised by a diverse range of wetland plants, greatly increasing the botanical value of the site. However, the original rushy vegetation around the ponds has become very rank and overgrown due to undergrazing, **SITE 3:** Cotton grass, cross-leaved heath, sedges, pale butterwort and bog myrtle have increased in abundance and spotted orchids, birdsfoot trefoil and yellow rattle have increased on drier parts of the site. However, taller sward height has made the site less suitable for breeding lapwings and there is concern that bog orchids may have reduced in numbers following grazing exclusion. **Woodland (ESA)** **SITE 1:** Steep, north facing bank with sparse woodland flora, unaffected by previous stock grazing has regenerated well, with dense regeneration of ash, hazel, willow, birch, oak, rowan, and elder. However, In the remainder of the woodland natural regeneration has been less successful. **SITE 2:** The woodland was entered into the ESA in order to encourage natural regeneration of birch and juniper. Overall the amount of regeneration has been disappointing, with none at all occurring in areas of *Holcus* grass and no juniper regeneration.	Hall, C. & Chapman P (2004) *Agri-environment case studies – improving advice on practical habitat management*. SAC Conservation Services. http://www.scotland.gov.uk/Publications/2005/03/20737/53136

Study No.[1]	Indicator(s)	Key findings	Reference
		SITE 3: Livestock exclusion has been very successful at protecting ground flora within the wood (much more so than a simililar nearby wood without an agri-environment scheme. However, the principal aim of tree regeneration has been unsuccessful. **Shrub (RSS, CPS)** **Site 1:** Stock exclusion has resulted in the regeneration of pockets of hawthorn, blackthorn, dog rose, elder and considerable areas of gorse. The main problem associated with the site since the removal of stock grazing, is the increase in ragwort. **Site 2:** Following stock exclusion, birch regeneration has increased, and there has also been oak, ash, rowan, hazel and willow regeneration. However, Rhododendrons have been a huge problem on the site. **Site 3:** Established juniper bushes have increased in size since sheep grazing stopped and the juniper have been able to produce fruit in recent years. However, there has been no regeneration of new juniper plants, perhaps due to a build up of plant litter or the lack of viable seed. **Water Margins (ESA, CPS)** **Site 1:** Since entering into the ESA, a few alder and willow have regenerated. The tall herb communities are in good condition as a result of the restricted grazing option. **Site 2:** Since the exclusion of livestock, iris, meadowsweet, knapweed, tufted hair grass and cocksfoot grass have grown to an average height of 1m to provide ideal cover for otters. Alder is regenerating within the margin. There is concern that the water margin may eventually become too overgrown for otters. Bramble is dense and appears to be spreading. **Site 3:**The grass seed mix was sown in May, and established quickly to provide excellent tussocky grassland habitat for brown hare, grey partridge, small mammals and a wide range of other wildlife. However, there has been no spread of tall herbs from the original margin into the sown grass margins. **Coastal Heath (CPS, Habitats scheme)** **Site 1:** With the new grazing regime, the condition of the heath vegetation has improved, and there are fewer weeds. Taller braken a concern. **Site 2:** There has been a noticeable improvement in the coastal heath and maritime grassland vegetation with the grazing regime adopted under the scheme. **Site 3:**Under this grazing regime, the condition of the site has improved significantly. Taller bracken a concern. **Grass margin (RSS, CPS)** **Site 1:** The margin is now standing at 50-65 cm in height and its composition is 50% grasses (cocksfoot, timothy and ryegrass) and 50% white clover with few weeds present. **Site 2:** The margins are generally in excellent condition. However, Creeping thistle and docks occur in the margins **Site 3:** Good site preparation and careful attention to sowing has resulted in good establishment and a good structure.	
A98	Biodiversity	A significant proportion of all participants believed that there had been an increase in biodiversity, and that the schemes had increased their environmental knowledge. The positive impacts of participation on the appearance of the landscape were limited to RSS and CPS only, with no discernible pattern evident from OAS. A high proportion of RSS participants responded to the question about an increase in species abundance (n= 182) with over half (118) answering 'no' or variations on the negative. A third of participants (64) answered positively to varying degrees. Those who perceived an increase in species variety frequently cited higher profile species including songbirds, game birds and raptors. Mammals such as rabbit and hare were also cited. Not all increases were viewed in a positive light, for example one respondent cited an increase in docks and couch grass. A comparatively lower proportion of CPS participants (total responding n = 158) answered 'no' or variations on the negative (26) for increase in species abundance. A very high proportion (130) answered positively to varying degrees, with a perceived increase in species abundance frequently cited for higher profile species including songbirds, lapwings, buzzards, and hares, as well as heather and wildflowers. Similarly to RSS, not all increases are viewed in a positive light, with a number (7) citing undesirable weeds including thistles and ragwort.	Manley, W. and Smith, G. (2007) *Agri-environment schemes in Scotland: a survey of participants and non-participants.* Report produced by Royal Agricultural College for Scottish Government Social Research.

Study No.[1]	Indicator(s)	Key findings	Reference
		The responses from OAS participants (n = 53) are evenly spread between 'no' or variations on the negative (18) and those answering positively to varying degrees (22). Those who perceived an increase in species abundance more frequently cited higher profile species including a variety of birds (13). RSS (n = 68), CPS (n = 73) and OAS (n = 25) participants generally provided additional positive responses but concerns were also raised in respect of weed problems. Non-participants (n = 52) were also asked for comment to an adapted question. A number perceived no or little environmental impact, but some recognised that there might be environmental improvements like increased bird numbers. Many were evidently proud of and recognised the environmental value of their land, that scheme participation was not a prerequisite, and managing the environment had been and was a part of their farming.	
A166	Higher plants Invertebrates Ground beetles Spiders Chough	Overview report summarises and evaluates the main results of the ESA monitoring programme to 2003. Plant and invertebrate species richness of sampled habitats under ESA agreement has been maintained. In many cases the range of species on target habitats has changed to include more desirable species from a conservation point of view. Management prescriptions are having a positive effect on heather moorland with an increase or maintenance of heather cover. The scheme has been successful in maintaining the condition of semi-natural grasslands. At present there are both positive and negative effects of grazing exclusion on woodlands. Agri-environment scheme farmland management on the north Antrim coast is providing the best hope for survival of the chough in Northern Ireland (Chough monitoring refers to Cameron et al, 2004).	McAdam, Cameron, A. Flexen, M, and Johnston, R.J. (2004) *Environmentally Sensitive Areas in Northern Ireland: Monitoring and evaluation of the ESA scheme between 1993 and 2003 Report*. Faculty of Agriculture, University College Dublin, Dublin, Irish Republic (Cameron, A., Flexen, M., Johnston, R.J. & McAdam, J.H. (2004). *Monitoring of the Chough Option in the Antrim Coast, Glens and Rathlin Environmentally Sensitive Area 1998-2002*. Report to DARD. Queen's University of Belfast.)
A165		A comprehensive baseline map based database was established for each ESA. The areas of land under agreement are highest in the two longest running ESA schemes, the Mournes & Slieve Croob and the Antrim Coast, Glens & Rathlin ESA.	McAdam, J.H., Hoppé, G., Millsopp, C.A., Cameron, A. and Mulholland, F. (1997) *Landscape monitoring of Environmentally Sensitive Areas in Northern Ireland*. Faculty of Agriculture, University College Dublin, Dublin, Irish Republic
A170	Grassland Woodland Heather moorland Field boundary/hedges	Little change in terms of overall broad land cover types (i.e. grassland, woodland and heather moorland) in ESAs over 10 years of monitoring. The total length of field boundaries had either been maintained, or increased, in all ESAs except Slieve Gullion ESA, where it had decreased. Hedge removal had occurred in all ESAs, totalling an estimated 280km over 10 years. Increased levels of fencing as opposed to more desirable hedge planting, rare instances of hedge removal and lack of diversity in hedge shrub planting.	McAdam, J.H., Flexen, M, McEvoy, P.M. and O'Mahony, D. (2006*) Environmentally Sensitive Areas in Northern Ireland: Landscape monitoring of the ESA scheme 1995-2005.* Report to Defra. Queen's University Belfast.
A122	Rabbit Red fox Irish hare	Rabbits and Foxes: results show ESA management greatly enhances abundance. Not the case for hares. Foxes indicate greater biodiversity, but this is mainly common species rather than those of conservation interest such as hares.	Reid,N., McDonald, R. A. & Montgomery, W. I. (2007) Mammals and agri-environment schemes: hare haven or pest paradise? *Journal of Applied Ecology* **44,** 1200-1208.
A169	Higher plants Invertebrates Ground beetles	With the exception of sites in Slieve Gullion, plant species diversity of heather moorland had been maintained under ESA management. On wetter sites (i.e. blanket bog or wet heath) where heather cover was low at baseline due to overgrazing prior to management under ESA agreement, vegetation often remained in poor condition with low heather cover and a lot	McAdam, J.H., Flexen, M, McEvoy, P.M. and Johnston, R.J. (2005*) Environmentally Sensitive Areas in Northern Ireland: Monitoring of Antrim Coast, Glens and Rathlin ESA*

Study No.[1]	Indicator(s)	Key findings	Reference
	Spiders	of bare ground. However with the introduction of the new ESA scheme, stocking rates on these habitats should be reduced. Reduction in grazing has reduced the effects of poaching (woodlands). The increase in dwarf-shrub cover on dry heath sites in Slieve Gullion, due to reduced grazing under ESA management, may have led to the loss of plant and carabid species diversity	*Sperrins ESA Slieve Gullion ESA Biological evaluation of the ESA scheme between 1994 and 2004*. Report to Defra. Queen's University Belfast.
A167	Higher plants Invertebrates Ground beetles Spiders	Monitoring indicates that after ten years the plant and invertebrate species richness of habitats under ESA agreement is being maintained. There were signs of enhancement of plant species composition. There was a general increase in the cover of rushes (*Juncus* species) recorded on unimproved grassland, wet pasture and hay meadows. There was a significant increase in the mean cover of heather (*Calluna vulgaris*) on heather moorland and there was a notable decrease in the frequency of several grass species on heather moorland. The ground beetle, *Carabus clatratus*, identified as an indicator species on hay meadows, increased in frequency. The species *Carabus nitens* identified as an indicator on heather moorland maintained its presence. Changes in spider populations on heather moorland and wet pasture indicate a more diverse vegetation structure. The mean number of plant species recorded in woodland under ESA agreement did not change significantly.	McAdam, Cameron, A. Flexen, M, and Johnston, R.J. (2004) *Environmentally Sensitive Areas in Northern Ireland: Monitoring of the West Fermanagh and Erne Lakeland ESA Biological evaluation of the ESA scheme between 1993 and 2003* Report to Defra. Queen's University, Belfast.
A168	Higher plants Invertebrates Ground beetles Spiders	Baseline study. In general the greatest influence on semi-natural habitat condition was level of grazing.	McAdam, Cameron, A. Flexen, M, and Johnston, R.J. (2004) *Baseline Biological Monitoring of the Countryside Management Scheme in Northern Ireland 2002 / 2003* Report to Defra. Queen's University Belfast.
A58	Field boundary/hedges Higher plants Beetles	Non-agreement farms had greatest variability: the most species-rich and species-poor farms were non-agreement. Factors largely independent of recent management, such as hedge age and gappiness, were most important in explaining observed variation. Few differences between average species richness and abundance on agreement and non-agreement farms were revealed. The study concludes that the scheme has not significantly benefited the group surveyed.	Feehan,J., Gillmor, D. A. & Culleton, N. (2005) Effects of an agri-environment scheme on farmland biodiversity in Ireland. *Agriculture Ecosystems & Environment* **107**, 275-286.
A262	Winter Waders Higher plants	The overall numbers of wintering waders and wildfowl, have increased since baseline monitoring was undertaken in 1995/96. Numbers of individual species of waders and wildfowl have not increased since baseline. However, there has been a significant increase in species numbers between the first and second resurvey. Looking at waders in isolation, common snipe have increased as a wintering species. Botanical survey: On Tier 2A sites, there has not been any recorded change in the ecological criteria. Similarly, species suited to coastal conditions have not increased. Reinforcing this is the fact that apart from potassium, soil nutrient levels have actually increased. Tier 1A sites have recorded an increase in species suited to grazing and a decrease in species suited to saline soil conditions. This is qualified by the fact that, in spite of a rise in soil phosphorus levels, species suited to high nutrient levels have actually decreased. There has been no change in species suited to coastal locations.	Environmental monitoring in the Ynys Môn ESA 1993 – 2000

Study No.[1]	Indicator(s)	Key findings	Reference
A262	Hay meadows Wetland	Changes to a number of other features were also analysed and described: soil descriptors, Hay meadow indicator species (Hay meadows only), rush species (Wetlands only), agricultural improvement indicator species and National Vegetation Classification community. The wildlife value of Hay meadows under Tiers 1A, 2A and 2B is being maintained and enhanced. The wildlife value of Tier 1 and non-agreement Hay meadows is degrading. The monitoring of wetland in Radnor ESA has revealed changes in both the composition and structure of vegetation between years 1994 and 2000. Environmental Objective 2 has not been fully met, as measured by Performance Indicator 2.2. Species composition has declined under Tier 1 agreement. This is highlighted by a rise in Nu scores and a fall in A scores for the Tier 1 stands. Short-term changes in vegetation composition can be summarised as having substantially deteriorated under Tier 1, and largely maintained under Tier 2. Vegetation communities categorised as Tier 2 are of high quality and this quality has been largely maintained. There may have been a slight decline in species composition in Tier 2 stands. This is signalled by a rise in the frequency of white clover.	Environmental monitoring in the Radnor ESA 1993 – 2000
A262	Hay meadows	The changes in recorded hay meadow reversion vegetation diversity and composition were in accord with the Environmental Objective 2 and the associated Performance Indicator 2.2, with a single exception; lack of grazing of one stand has had a detrimental affect on botanical diversity and composition; species richness and numbers of hay meadow indicator species are higher and vegetation diversity and composition recording larger increases on less improved land; soil fertility is generally decreasing, and may be reflected in the increasing botanical diversity and composition of the stands. Decreases in soil fertility are larger in more improved stands.	Environmental monitoring in the Preseli ESA 1993 – 2000
A262	Waders Higher plants	The overall numbers of individuals and overall numbers of species, of wintering waders and wildfowl, have not increased since baseline monitoring was undertaken in 1995/96. However, looking at waders in isolation, both common snipe and woodcock have increased as wintering species. There were no recorded breeding waders. Changes in recorded coastal grassland vegetation composition indicate that in the main Environmental Objectives 1 and 2 and Performance Indicator 1.3 are being met, but that further re-surveys are needed to confirm the trends highlighted here. There have been few recorded changes in the vegetation composition of wetlands. Performance Indicator 2.2 is thus being partially achieved, in that the composition and structure of Tier 1A vegetation is not deteriorating, and partially not fulfilled in that it has not been demonstrated that the composition and structure of Tier 2A vegetation is improving.	Environmental monitoring in the Lleyn Peninsula ESA 1993 – 2000
A262	Biodiversity	No results given	Environmental monitoring in the Clwydian Ranges ESA 1993 – 2000

Study No.[1]	Indicator(s)	Key findings	Reference
A262	Woodland Hay meadows Higher plants Heather moorland	During the period between the baseline survey and the resurvey land cover, within sample squares, has remained generally stable. There have been small losses of more diverse habitats such as Moorland grass, Scrub and Semi-improved grassland and small increases in the areas of less diverse habitats such as Coniferous woodland and Buildings and non-farmed land. This reflects the general pattern found in other ESAs in Wales. Regeneration of oak seedlings increased between 1995 and 1999. A total of 10 species of tree seedlings and eight species of saplings were located within the sample plots. Of these, Sessile oak seedlings were the most common, and had increased significantly. However, no other species was found to have increased at any height class since the baseline survey. Recruitment into the sapling population was not apparent. Hay meadows surveyed were in general less diverse and of higher soil fertility than the 'traditional' Cambrian Mountains hay meadow, which is now rare. Species suited to low nutrient levels were significantly different on Tier 1A and Tier 2A land. There were more species suited to lower nutrient levels on Tier 2A land. Tier 1A hay meadows had significantly higher species diversity, than Tier 2A hay meadows. The survey methodology concentrated on grazing level assessments of heather:· It appears that the grazing of sheep sets into motion a system of positive feedback if there is at least some grass amongst the heather. The more grass there is, the more the sheep draw towards it and the more they graze the adjacent heather, thus suppressing it. As the heather becomes suppressed, the proportion of grass increases and the sheep graze it ever more heavily.	Environmental monitoring in the Cambrian Mountains ESA 1993 – 2000
A265	Field boundary/hedges Woodland Heather moorland Hay meadows	The results indicate that traditional boundaries on agreement land are being retained and enhanced. Traditional boundaries on non-agreement land have also been retained and enhanced although there were two detrimental changes on non-agreement land involving the loss of a hedge and a hedge becoming non-stockproof. Regeneration of oak seedlings increased between 1995 and 1999. Hay meadows surveyed were in general less diverse and of higher soil fertility than the 'traditional' Cambrian Mountains hay meadow, which is now rare. · One performance indicator can be assessed from this element of the monitoring programme. This is that 'Diversity of those species characteristic of species-rich grassland cut for hay does not deteriorate on land under Tier 1 and improves on land under Tier 2 agreement'. It is unclear at this stage whether it has been met, in that some aspects of hay meadow composition have improved, whilst others have declined. Grazing index of heather was lower on agreement land than on non-agreement and was lower on dominant heather than on sub-dominant;· The levels of grazing index on sites under Tier 1 agreement were found not to have increased between 1993 and 1997, but there was an increase between 1997 and 2000. This suggests that the Performance Indicator 1.3 has been met in terms of grazing index for the first resurvey but not the second.	ADAS (2000) *Environmental Monitoring in the Cambrian Mountains ESA 1995 – 1999*. ADAS report for NAW
A266	Field boundary/hedges Grassland Wetland	Coastal grassland: There were no signs that habitat quality had deteriorated on Tier 1A sites and some signs that it was improving. There were signs that the habitat quality of Tier 2A sites had improved, but these signs are not great enough to be certain. Wetland: There were no statistically significant changes to occur on Tier 1A stands, there was nothing to indicate that the wetland vegetation had in any way deteriorated. There was one statistically significant sign of improvement on Tier 2A stands, namely a drop in soil phosphorous levels. The results of the linear feature monitoring present a somewhat mixed picture of the effect of the ESA scheme on field boundaries within sample squares on the Lleyn Peninsula. In summary, there does appear to be some difference between agreement and non-agreement land in terms of changes to traditional boundaries, and the majority of the changes identified involve free-standing fences. Therefore, the suggestion is that the ESA scheme has not had a significant impact in terms of the maintenance and enhancement of traditional field boundaries within sample squares over the period 1991	ADAS (2000) *Environmental Monitoringin the Lleyn Peninsula ESA1989–1998*. ADAS report for NAW

Study No.[1]	Indicator(s)	Key findings	Reference
		to 1998.	
A267	Field boundary/hedges Hay meadows	Hay meadows: The changes in recorded hay meadow reversion vegetation diversity and composition were in accord with the Environmental Objective 2 and the associated Performance Indicator 2.2, with a single exception; lack of grazing of one stand has had a detrimental affect on botanical diversity and composition; species richness and numbers of hay meadow indicator species are higher and vegetation diversity and composition recording larger increases on less improved land; soil fertility is generally decreasing, and may be reflected in the increasing botanical diversity and composition of the stands. Decreases in soil fertility are larger in more improved stands. The overall length of field boundaries within sample squares increased. The total length of traditional boundaries decreased, while the total length of fences increased. Data suggests that traditional boundaries on agreement land have been protected under the ESA scheme. The resurvey data also shows that traditional boundaries have been restored under Tier 2C on ESA agreement land.	ADAS (2000) *Environmental Monitoring in the Preseli ESA1994–1999*. Report for NAW
A268	Field boundary/hedges Woodland Hay meadows Higher plants	Baseline study. Baseline results show that within the sample the dominant field boundaries surveyed were free-standing fences. Traditional field boundaries are key features to be protected under the ESA scheme. The relatively low occurrence of such boundaries highlights the importance of the ESA scheme to this area. The 40 hay meadow stands were assigned to a National Vegetation Classification (NVC) community with the aid of the computer program MATCH. The hay meadow stands were predominantly mesotrophic grasslands of a transitional nature in terms of their NVC community classifications. The majority of the woodlands contained a mixture of oak, ash, birch and rowan seedlings and saplings in varying amounts. The ESA prescriptions are succeeding in encouraging the production of seedlings within woodlands. Further re-surveys are required to investigate whether these seedlings, particularly oak, go on to establish as saplings.	ANON (2001) Cambrian Mountains ESA Baseline monitoring report
A269	Heather moorland	Heather on a number of Tier 1 Agreement sites has deteriorated and the relevant PI has not been met. The fact that by 2004, after a number of years of agri-environment agreement, half of the Tier 1 sites have high or very high GI levels highlights that something is wrong. Presuming that the appropriate agri-environment stocking levels are being abided by it is likely that due to the selective behaviour of sheep the mandated stocking levels are too high and leading to over-grazed heather. There are only three Tier 2 Agreement sites in the sample. Of these the relevant PI appears to have been met for the two sites with 'dominant heather' but has not been met for the site with 'sub-dominant' heather. The destruction of one of the Non-agreement heather sites by ploughing highlights one of the greatest benefits of Agri-environment Schemes in that under ESA management this could not 'legally' have happened. To summarise while some positive benefits of the ESA Scheme for SNRG have been demonstrated, the PIs have in general not been met and the status of heather in the Cambrians ESA appears to, on balance, have markedly deteriorated. The principle reason for this may be the grazing behaviour of sheep, on moorlands with open heather swards.	Ardeshir, D (2005) *Monitoring of Semi Natural Rough Grazings in the Cambrian Mountains ESA:* Third And Final Re-survey 2004. ADAS report for NAW

Study No.[1]	Indicator(s)	Key findings	Reference
A270	Field boundary/hedges	For linear and point features, a total of 113 changes were identified within the 35 sample squares monitored, 60% of which occurred in just two landscape types, the Clwydian Edge and the Vale of Clwyd and 54% of these within two sample squares. Between 1994 and 2001, the total length of boundaries increased slightly, Over the monitoring period the proportion of hedges in the sample decreased to 63.3%, the length of trimmed hedges decreasing by 0.3% and untrimmed hedges by 1.2%. Little evidence for traditional boundary restoration was noted over the survey period; just two hedges were recorded as having been laid. A total of 12 linear and point feature changes were identified on agreement land over the survey period. Beneficial changes include hedge trimming and the restoration of a hedge but detrimental changes include hedges becoming untrimmed, hedges becoming unfenced, the replacement of a hedge with a fence, a hedge being removed to leave a treeline and new free-standing fencing being erected. The overall length of stockproof boundaries increased on agreement land but only as a result of land coming into agreement over the survey period. Due to the detrimental changes noted, the overall objective for point and linear features has not been fully met.	ADAS (2002) *Environmental Monitoring in the Clwydian Range ESA 1994 – 2001*. ADAS report for NAW
A271	Field boundary/hedges Butterflies	There is a high percentage of traditional field boundaries (77%) present within the sample area compared to wire fences or other non-traditional boundaries. Traditional field boundaries are again key features to be protected under the ESA scheme and their dominance within the sample is encouraging. This result was common to Radnor, Ynys Môn and Preseli ESAs. The results indicate that butterflies were present in greater numbers on unimproved grassland and least on improved grassland. However, the results also indicate that there is no difference between species richness and abundance when each grassland type was examined in proportion to its length. Factors which are beyond the control of ESA management are also important in affecting butterfly populations. These include weather, exposure and aspect, and these need to be accounted for in subsequent surveys.	ADAS (2000) Clwydian range Environmentally Sensitive Area baseline monitoring report March 2000.
A272	Field boundary/hedges Hay meadows	The changes in recorded hay meadow reversion vegetation diversity and composition were in accord with the Environmental Objective 2 and the associated Performance Indicator 2.2, with a single exception; lack of grazing of one stand has had a detrimental affect on botanical diversity and composition; species richness and numbers of hay meadow indicator species are higher and vegetation diversity and composition recording larger increases on less improved land; soil fertility is generally decreasing, and may be reflected in the increasing botanical diversity and composition of the stands. Decreases in soil fertility are larger in more improved stands. There has been a move from unmanaged to managed hedges on land within sample squares between 1994 and 1997 The data suggests that traditional boundaries on agreement land have been protected under the ESA scheme. The resurvey data also shows that traditional boundaries have been restored under Tier 2C on ESA agreement land. The overall length of field boundaries within sample squares increased. The total length of traditional boundaries decreased, while the total length of fences increased.	ADAS (2001*) Environmental Monitoring in the Preseli ESA1994 – 1999*. ADAS report for NAW
A273	Field boundary/hedges Hay meadows	The monitoring results suggest that the ESA is meeting the objective for field boundaries by maintaining and restoring the historic pattern of field boundaries, including walls, banks and hedges and encouraging an improvement in the standard of their management. The evidence gathered by this programme indicates that farmers are protecting and enhancing the best Hay meadows (Tier 2) on a farm. However, it appears that the poorer partially degraded 'Hay meadows' (Tier 1) on a farm are further degrading. This provides evidence that because the ESA Scheme considerably restricts management of Tier 1A and Tier 2 sites, landowners may be targeting resources at Tier 1 sites where few management restrictions exist.	ADAS (2000*) Environmental Monitoring in the Radnor ESA 1993 – 2000*. ADAS report for NAW

Study No.[1]	Indicator(s)	Key findings	Reference
A274	Field boundary/hedges Higher plants	Overall the 2000 re-survey shows that linear features on agreement land within the Ynys Môn ESA have been retained and a limited number restored (a low proportion under Tier 2C) thereby retaining existing field patterns. The monitoring results suggest that the ESA is only partly meeting the objective for field boundaries. Although the historic pattern of field boundaries is being maintained with some limited enhancement the increase in free-standing fencing is having a negative impact and in addition there is no real evidence that the Scheme is encouraging an improvement in the standard of field boundary management. It is clear that traditional boundaries are being maintained primarily by the use of protective fencing, rather than active traditional management (hedge laying, bank maintenance, stone wall rebuilding). Without substantial restoration and improved management of traditional boundaries it is questionable whether the existing historic pattern of field boundaries can be maintained in the future. On Tier 2A sites, there has not been any recorded change in the ecological criteria. Similarly, species suited to coastal conditions have not increased. Reinforcing this is the fact that apart from potassium, soil nutrient levels have actually increased. Tier 1A sites have recorded an increase in species suited to grazing and a decrease in species suited to saline soil conditions. This is qualified by the fact that, in spite of a rise in soil phosphorus levels, species suited to high nutrient levels have actually decreased. There has been no change in species suited to coastal locations. Grazing levels may still be too high and there may be a need examine grazing intensities.	ADAS (2002) *Environmental Monitoring in the Ynys Môn ESA 1993 – 2000*. ADAS report for NAW
A275	Waders	The overall numbers of individuals and overall numbers of species, of wintering waders and wildfowl, have not increased since baseline monitoring was undertaken in 1995/96. However, looking at waders in isolation, both common snipe and woodcock have increased as wintering species. There were no recorded breeding waders. Anticipated ecological changes are only likely to occur over the long-term. It is likely that since baseline, there has been insufficient time for significant changes to occur. Results from ESA monitoring need to be considered in tandem with national trends before firm conclusions can be drawn on the success or otherwise of the ESA management prescriptions.	Shepherd, S (2002) *Wader Monitoring in the Lleyn Peninsula ESA 1995 – 2002*. ADAS report for NAW
A276	Grassland Wetland	The survey provided a baseline with which to compare future surveillance data and thus monitor possible long-term change.	ADAS (2000) *Lleyn Peninsula ESA Baseline monitoring report*. ADAS report for NAW
A277	Invertebrates	Eight out of the ten ponds showed an increase in number of invertebrate taxa between 1996 and 1998, whilst seven out of ten showed an increase in Shannon-Wiener Diversity Index over the same period; These increases appear to be in accordance with Environmental Objective 3 for both ESAs but there is no specific performance indicator to be addressed	ADAS (1999*) Biological Monitoring of Pond Restorationin Radnor and Preseli ESAs 1996-1998.* ADAS report for the Welsh Office Agricultural Department
A278	Heather Hay meadows Field boundary/hedges	Baseline results show that within the sample the dominant field boundaries surveyed were untrimmed hedges and hedgebanks. Overall, the percentage of traditional boundaries compared to wire fences was encouraging. The majority of all traditional field boundaries sampled (85%) were supplementary fenced, either to form a stockproof barrier or to protect already stockproof traditional boundaries. All the monitoring sites were different from one another in terms of heather biomass utilisation. In general terms, sites in private ownership were more heavily bioutilised than common land and furthermore, grazing units with sub-dominant heather were more heavily bioutilised than dominant heather sites. The base-line survey recorded two NVC communities (MG6 and MG7) of five sub-communities. This reflected the fact that the reversion sites occurred on agriculturally improved land. There was no significant relationship recorded between NVC and environmental variables. The MG7 communities displayed the lowest values of species richness, in keeping with all other research. These stands also showed the highest values of soil phosphorus and potassium, presumably due to inorganic fertiliser inputs. Inorganic	ADAS (2001*) Preseli ESA Baseline Monitoring Report*. ADAS report for NAW

Study No.[1]	Indicator(s)	Key findings	Reference
		fertiliser is known to depress species richness. The highest recorded species richness in this survey was from two stands originating from arable reversion. Though not targeted, eight known hay meadow indicator species were recorded in the stands, and others were noted in the vicinity. Thus local seed sources of these indicator species will not be limiting. Three ecological criteria were recorded during the baseline survey: grazing (G), nutrient status (Nu) and water availability (W). The G scores were predominantly positive showing that more species suited to high levels of grazing are present than those suited to low levels of grazing. The Nu scores were low to negative; showing that a higher proportion of species was present suited to low levels of nutrient availability. The W scores are predominantly negative, showing that there is generally a higher proportion of species present that are suited to low water availability.	
A279	Higher plants Hay meadows Field boundary/hedges	The majority of the stands surveyed were very species rich, although none proved to be outstanding examples of the habitats. The baseline results of the point and linear feature survey showed that within the sample, the dominant field boundaries surveyed were trimmed and untrimmed hedges. Overall, the percentage of traditional boundaries compared with wire fences was encouraging.	ADAS (1999*) Radnor ESA Baseline Monitoring Report*. ADAS report for NAW
A280	Field boundary/hedges Higher plants Waders	All 20 Tier 2 wetland sites that were monitored during the 1995/96 winter season were found to support wading birds. This suggests that the sites have an important role in providing suitable habitat for overwintering wading and other birds on Ynys Môn. Only two out of the 20 sites surveyed supported breeding wading birds but all sites supported at least one species of targeted wetland bird. This suggests that, at the time of survey, the majority of sites were suitable for the smaller songbirds associated with wetlands rather than for wading birds.. The majority of the stands surveyed were very species-rich. A good representative sample of heath and maritime cliff habitats was obtained as part of this survey. The baseline results of the point and linear feature survey showed that within the sample, the dominant field boundaries surveyed were untrimmed hedges, hedgebanks and hedgewalls. Overall, the percentage of traditional boundaries compared with wire fences was encouraging.	ADAS (1999) *Ynys Môn ESA Baseline Monitoring Report*. ADAS report for NAW
A281	Breeding Waders	The fact that there has not been a significant change in the number of breeding waders indicates that as a minimum, conditions are being maintained. Nevertheless, it is apparent that the more exacting objective to 'enhance' is not as yet being achieved. There were very few recorded breeding waders. There was no recorded significant change in the number of breeding wader territories between 1996 and 2004. However, it is likely that many of the sites are, in any event, too small to support large increases in wader populations. Comparison of ESA data with national data, demonstrate that with the notable exception of Curlew (for which indices have increased within Wales but decreased within the ESA), general increasing trends in ESA 'site usage' for breeding species of waders, echo that of national data. This indicates that changes in the trends of ESA indices may be due (at least in part) to factors operating outside of ESA management.	ADAS (2005) *Breeding Waders Monitoring in the Ynys Môn ESA 1996 – 2004*. ADAS report for NAW
A282	Corncrake	The area of land within the core the Corncrake range that is affected by management schemes intended to benefit Corncrakes increased almost five-fold between 1992 and 2003. The proportion of male Corncrakes within the area of such management schemes increased in the time period. Different management regimes had different rates of increase. Reversal of the population decline of Corncrakes coincided with the introduction of the recovery plan. Overall, the analysis indicates that conservation management has occurred on a scale sufficient to account for the change in trend of the Corncrake population.	O'Brien, M., Green, R.E. and Wilson, J. (2006) Partial recovery of the population of Corncrakes Crex crex in Britain, 1993-2004. *Bird Study* **53** 213-224

Table A 4 Biodiversity study characterisation: evaluations

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
A180	England	All English ESAs	Field boundary/hedges Higher plants	sub-field	Survey	100 ESA agreements which include hedgerow restoration from 7 ESAs. Farmer perceptions assessed. Total of 774 hedges surveyed.	No	No	No	2003
A175	England	ESAs	Breeding Waders	varied	Survey	986 sites (1393.5 km2) in 2002. 794 have comparable data for 1982.	Yes	Yes	Yes	1982 and 2002
A220	England	West Penwith ESA	Higher plants	km2	Survey	26 permanent stratified randomly located plots (8 x 4 grid of 1 x 1 m quadrats). Sampled using the ADAS plot method, condition assessment of vegetation stands of BAP priority habitats. Success in meeting objectives assessed against specific performance indicators. Analysis of vegetation change over time for: whole sample, stratified by habitat and for individual plots.	Yes	Yes	No	1993-2005
A103	England	Broads ESA, Somerset Levels & Moors ESA	Ditches	km2	Survey	1516 ditches surveyed from a total of 12 areas (100-300 ha) within the 2 ESAs (in different Tiers). 210 were not in an ESA agreement.	No	No	Yes	1999
A84	England	Dartmoor ESA	Hay meadows Higher plants	field	Survey	16 nested (1 x 1 m) quadrats per plot. 1 plot per field. Random selection of 20 (18 in 2003 due to loss of sites) sites entered into Tier 2a.	Yes	Yes	No	1995-2003
A174	England	Pennine Dales ESA	Hay meadows Higher plants	sub-field	Survey	Species recorded in 1 x 1 m quadrats. 164 sites resurveyed (5 quadrats per field) in 2002 as part of 3 separate monitoring programmes, 2 of which considered fixed quadrats.	Yes	Yes	No	1987-2002
A85	England	Dartmoor ESA	Heather moorland Higher plants	km2	Survey	32 nested quadrats (1 x 1 m) per plot, 1 plot per sampling area. Baseline and up to 9 years under ESA management for c. 60 randomly selected sampling areas (one sample per 30 ha)	Yes	Yes	No	1994-2003
A214	England	ESAs, CS & WES	Heather moorland	varied	Survey	A random sample of English non-SSSI lowland heathland stands, both inside and outside of agri-environment agreements, was surveyed during 2005 and 2006 to provide baseline information on condition. Approximately equal numbers of sites were selected from within agri-environment agreements and outside of such agreements (although only 22% of sites in the total population were under agreement). However, it was not known in all cases which options applied within	Yes	Yes	Yes	2005-2006

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						the agreements (i.e. sites did not always have heathland options).				
A222	England	Exmoor ESA	Birds	km2	Survey	Survey of breeding birds (23 target species) repeating a survey carried out in 1992/3.	No	Yes	No	2002 baseline from 1992/3
A213	England	Upper Thames Tributaries ESA	Breeding Waders		Survey	Breeding wader survey of 20% of ESA area (61 sites) and compared with 1994 and 1997 surveys of same sites (large proportion was re-sampled). Bird counts plus land use and some habitat estimates (tussocky vegetation, sward height, ditch levels). Sample of farmers questioned about their perceptions.		Yes		1994-2005
A218	England	Shropshire hills, blackdown hills and south west peak ESAs	Higher plants	8m x 4m stand / plot	Survey	In the Blackdown Hills ESA, the baseline survey was carried out during 1994 and 1995, in the Shropshire Hills during 1995 and in the South West Peak during 1994. Resurvey 2003. In total, 89 sites were monitored during 2003: 22 in the Blackdown Hills, 29 in Shropshire Hills and 38 in South West Peak ESA. Botanical data were collected by recording vegetation within an 8x4m stand (or plot) consisting of 32 nests (1m2 quadrats), with each nest further subdivided into a series of cells.	Yes	Yes	No	1994-1995. Resurvey 2003
A219	England	Avon Valley, Somerset Levels and Moors and Upper Thames Tributaries ESAs	Higher plants	8m x 4m stand / plot	Survey	In the Avon Valley ESA, the baseline survey was carried out during 1993; in the Somerset Levels and Moors monitoring occurred in 1993, 1995 and 1998 and, in the Upper Thames Tributaries, baseline monitoring was completed in 1995. At each monitoring site, a plot was permanently located and vegetation recorded using nested quadrats. Resurvey 2003. Botanical data were collected by recording vegetation within an 8x4m stand (or plot) consisting of 32 nests (1m2 quadrats), with each nest further subdivided into a series of cells.	Yes	Yes	No	1993-2003
A216	England	BAP Broad and Priority Habitats under ESA agreement, all England.	Higher plants	200x200 m	Survey	A stratified random sample of 450 agreements was selected for survey covering an area of approximately 70,000 ha, representing approximately 12.5% of the land under ESA agreement in England. A random 200 m2 vegetation quadrat was recorded within each agreement surveyed using Countryside Survey methods. In addition, a quadrat was recorded in each Priority Habitat identified at the site, excluding any that had been recorded by the random quadrat. The quadrat positions were mapped and permanently marked in the field to allow precise relocation. Each quadrat was classified in terms of the National Vegetation Classification (NVC) and the Countryside Vegetation System (CVS); the number of species and the presence of rare and scarce species were also quantified. The quadrats were co-located with the spatial data in the field and database by using GPS and the software POCKET GIS.	No	No	No	2002-2003

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						In total 470 holdings with agreements were surveyed; 92 in 2002 and 378 in 2003				
A215	England	Cotswold hills ESA	Birds	km2	Survey	The Cotswold Hills ESA covers approximately 857 km2, so sixty-nine randomly selected 1 km squares were chosen for surveying, representing about 8% of the total area or c.10% of land eligible for ESA agreements. Each 1 km square was surveyed by walking two parallel lines across the area, each approximately 250 metres in from the edge of the square.	Yes	No	Yes	1997-2002
A29	England	ESA, CSS	Biodiversity	farm	Survey	598 agreements (455 CSS; 143 ESA) scored (see A28). Scores from full appraisal team (multidisciplinary panel) and ecologists (wildlife objectives) were compared.	Yes	No	Not applicable	Agreements with start dates 1996-1998
A86	England	CSS, ESA	Grassland Higher plants	field	Survey	112 arable reversion fields, 6-12 years old. Grouped (not stratified) by potential habitat type based on geographic location. 20-30 'quadrats' (2 m diameter semi-circle). Survey based on EN rapid condition assessment. Habitat characteristics. Species list but not exhaustive, included analysis of plant species valuable for higher trophic groups.	Yes	No	No	2004
A221	England	ESA, CSS	Higher plants	field	Survey	112 randomly selected agreements with arable reversion between 6 and 12 years old. Sample stratified on the basis of potential to develop 3 habitat types based on BAP habitats: lowland calcareous grassland, lowland meadow, coastal/floodplain grazing marsh. One field assessed from each agreement. Rapid assessment method based on EN Rapid Condition Assessment for grassland SSSIs. 20-30 samples; 1 m radius semicircle. Percent cover of all readily visible species. Soil samples.	Yes	No	No	2004
A28	England	CSS	Biodiversity	farm	Survey	484 CSS agreements evaluated by experts to assess: agreement negotiation - appropriateness, environmental effectiveness, compliance and side effects, plus additionality. To assess the degree to which CSS agreements have met their objectives. Included surveys, desk study, interview with agreement holder.	No	No	No	Agreements with start dates 1996-1998
A26	England	CSS	Biodiversity	farm	Survey	Random sample of 451 agreements from start dates between 1991 and 1997 (excluding boundary feature only agreements) BAP Broad and Priority Habitats mapped. Vegetation in random nested quadrats (4 quadrats from 4m2 to 200m2) on land under agreement on each holding	No	No	No	1997-2000?
A182	England	CSS	Field boundary/hedge	sub-field	Survey	100 CSS agreements which include hedgerow restoration. Random sample stratified by Government Office Region and by total length of	No	No	No	2002-2003

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
			s Higher plants			hedgerow work undertaken under the agreement. Farmer perceptions assessed. Total of 751 hedges surveyed.				
A91	England	CSS	Higher plants Invertebrates Birds	sub-field	Survey	Selected AE options in 5 European countries. In England - 6 m wide grass field margin strips along arable fields. Response of: a) all species, b) uncommon plant and arthropod species, c) Red Data Book species. Compared species density and abundance (no. of sp or individuals per sampling unit) fields with AE schemes and controls. Paired similar sized fields with similar environmental conditions. 7 field pairs in each of 3 areas in each country.	Yes	No	Yes	2003
A41	England	CSS	Higher plants	sub-field	Survey	116 sites across 8 regions. 4 types of margin: basic grass >2 yrs old; basic grass 2 yrs or less; diverse grass + forbs; cereal headlands. 1 of each margin in 32 10x10km squares; 4 squares in each of 8 administrative regions. 11 sites subsequently found to be established by natural regeneration. 30 quadrats 0.5x0.5m. Species composition.	Yes	No	Yes	2004
A40	England	ASPS	Higher plants	sub-field	Survey	Options: overwinter stubble, spring fallow, undersown cereals, grass leys, wildlife seed mixtures, conservation headlands, no-fertiliser conservations headlands, sown grass margins, naturally regenerated grass margins and uncropped cultivated margins. All farms in pilot areas with these options. Sites within farms selected at random. In each pilot area, 20 sites per option or all sites if <20 under agreement. 294 sites surveyed.	Yes	No	No	1999-2000
A22	England	ASPS	Brown hare Grey partridge	farm	Survey	Brown hare and grey partridge Sample of c. 40 scheme and control farms. Hares - winter density; Grey partridge - autumn density and productivity. Compared 1998 and 2002.	Yes	Yes	Yes	1998-2002
A138	England	ASPS	Birds	sub-field	Survey	Most sites which entered the scheme which were of sufficient size surveyed. Plus control sites selected close to ASPS sites. Study conducted at field and farm scales. Impact on breeding birds assessed. Transect method similar to BBS used for farm scale bird counts. Territory mapping for option scale effects.	Yes	No	Yes	1999-2003
A18	England	ASPS	Birds	farm	Survey	Winter birds. 54 scheme and 48 control sites censused in 2 winters across the 2 pilot areas. Counts of feeding birds in each field. Breeding birds. 50 scheme and 48 control sites surveyed in the two years. Analysed for change over time, to test whether a difference between treatments already existed in year 1 and was maintained in yr 2 and for differences between scheme and control sites using multiple log-	Yes	No	Yes	1998-2001

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						linear regression.				
A20	England	ASPS	Birds	farm	Survey	Baseline data sampled during the winter after options were implemented, therefore the management could have had some impact on some species. Grey partridge counts done in autumn 1998 and 2002; 40 scheme and 36 control sites split between the 2 pilot areas. Winter bird surveys (feeding bird counts) conducted in 98/99 and 02/03 on 37 scheme and 37 control farms across the 2 pilot areas. Grey partridge density and productivity analysed. Winter bird counts analysed in groupings of taxonomic or ecological guilds. Changes in bird numbers over 5 years compared between scheme and control farms.	Yes	Yes	Yes	1998-2003
A210	England	ESAs & CS.	Breeding Waders	field	Survey	A total of 149 fields from 45 agreements were assessed between late April and late June 2004 in relation to the UK Habitat Action Plan (HAP) for Coastal and Floodplain Grazing Marsh in Avon, Broads, Essex, North Kent, Somerset, Suffolk, Test Valley Upper Thames ESAs & CS.	No	Yes	No	2004
A217	England	ELS all Britain	Birds	km2	Survey	This provides the opportunity to assess the impact of the Entry Level Scheme on farmland bird populations by monitoring bird abundance coincident with implementation of the Entry Level Scheme (in 2005) and post-implementation (2008 and 2011). A total of 975 additional sample survey squares (referred to as 'ASS squares') and 1,474 standard BBS squares were surveyed in lowland farmland landscapes in 2005.	Yes	Yes	Yes	2005
A198	Wales	All Wales Tir Gofal: ESAs Tir Cymen The Habitat Scheme The Moorland Scheme	Woodland Heather moorland Grassland Blanket bog Wetland Water margins Butterflies Hay meadows	undefined	Survey	**Woodland** monitoring in the Cambrian Mountain ESA compared the number of germinating tree seedlings from sites which were on agreement and non-agreement land between 1988 and 1993. Tir Cymen examined vegetation change in the woodlands over the three-year period from 1993-1996 and in 1996-1997. **Heathland** Cambrian Mountains ESA, heather has been examined over a four-year period between 1993 and 1997. Preseli ESA which was surveyed in 1994 and will be resurveyed in 1998. Moorland Scheme which has had baseline surveys over the last two years. Tir Cymen Meirionnydd, where monitoring involved 36 heathland and 81 acid grassland sample sites drawn from a range of farms. **Grassland** Monitoring of lowland grasslands has taken place in the Cambrian Mountains and Radnor ESA hay meadows, and on calcareous grasslands in the Clwydian ESA. Within Preseli ESA land entered into the reversion to haymeadow category has been monitored. The Tir Cymen monitoring programme examined hay meadows and pasture in 112 sample sites from the three pilot areas. **Wetland** The ESA monitoring programme concentrated on Radnor	Yes	Yes	Yes	1988-1997

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						and the Lleyn Peninsula, with re-surveys either carried out in 1997 or due for 1998. The Tir Cymen monitoring looked at a range of sites drawn from farms in each of the three pilot areas. Re-survey was completed in 1996 and 1997, a period of three years after the initial baselines. **Water margins** Ten pond sites in the Radnor and Preseli ESAs were baseline monitored just before restoration in 1996 and immediately afterwards in 1997. Tir Cymen baseline monitoring surveys were carried out in 1993 or 1994 with a re-survey in either 1997 or 1998.				
A162	Wales	general study	Birds	2 hectares	Survey	45 sites in marginal upland on the Lleyn peninsula. Not specifically analysed whether in scheme or not	Yes	No	Yes	2000
A175	Wales	ESAs	Breeding Waders	varied	Survey	65 sites (115 km2) in 2002. 57 sites have comparable data for 1982.	Yes	Yes	Yes	1982 and 2002
A235	Wales	Lleyn ESA	Birds	km2	Survey	61 randomly selected 1km squares surveyed on the Lleyn peninsula. 10 were within tier 2 of ESA, 32 were within tier 1 of the scheme and 19 were not yet entered into the scheme.	No	No	Yes	April-June 1996
A236	Wales	Cambrian Mountains ESA	Birds	km2	Survey	131 squares were selected within the northern and southern sectors of the ESA. (104 in North, 27 in South). Squares were selected on basis of existing vegetation cover. Continuous areas of semi-natural rough grazing given priority. Line transects at 250m separation, visited twice.	No	No	No	April-July 1988
A230	Wales	Tir Cymen	Higher plants	farm	Survey	Field survey results presented are based on a sample of 70 farms, 50% of the total of 140 farms that were monitored.	No	No	No	1993 and 1996
A209	Wales	Tir Cymen	Marsh Fritillary	field	Survey	Farms with no previous records were visited in June to search for adult butterflies and again in September for larval webs (unless the site vegetation appeared unsuitable for breeding during the adult survey). Sites with previous records were only surveyed for larval webs to assess their present status. All 11 sites surveyed are on Tir Cymen agreement land.	No	Yes	No	1997
A231	Wales	Tir Cymen	Heather moorland	farm	Survey	137 sample holdings.	No	No	No	1994 and 1997 as well as 1993 and 1996 reported in A230
A237	Wales	Arable land	Arable weeds Biodiversity	farm	Survey	Swansea/Gower 6A sites on 2 farms and 6B,C,D sites on 3 farms in each case. Total of 8 Tir Cymen farms included in the study. 6E	No	No	No	Summer and

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
		options in Tir Cymen: 6A,6B,6C, 6D,6E,6F				and 6F sites only in Dinefwr, on two farms in each case (total 4 farms).				autumn of 1997
A229	Wales	Dinefwr district Tir Cymen arable options	Birds	field	Survey	Monitoring of birds on seven fields on seven farms in Dinefwr. This is compared to birds on seven fields on the same farms which were not entered into the arable options, for comparison.	No	No	Yes	1997-2000
A207	Wales	Tir Gofal	Higher plants	field	Survey	10 farms, all implementing options. A total of 33 sites were surveyed (The term 'site' here represents a field or field margin under a Tir Cymen management option, within one of the ten farms).	No	No	No	1997
A208	Wales	Tir Gofal	Higher plants	field	Survey	18 farms looked at 15 in the Vale, 2 in Cardiff, and 1 in Bridgend	No	No	No	1996
A204	Wales	Tir Gofal	Lapwing	farm	Survey	30 Tir Gofal farms	No	Yes	No	2002
A206	Wales	Tir Gofal	Lapwing	farm	Survey	2 farms. Both sites were visited for about three hours each on two occasions during May.	No	No	No	2005
A203	Wales	Tir Gofal and the UK Habitat Action Plan (HAP)	Trees	national	Review	All areas under Tir Gofal	No	No	No	2004
A201	Wales	Tir Gofal arable options (South Wales only)	Moss	tetrad	Survey	Thirty fields in 23 tetrads were covered during the current survey.	No	No	Yes	2001-2003
A202	Wales	Tir Gofal root crop and stubble options	Birds	farm	Survey	70 farms were covered in the winter survey, with two counts on each farm, and 13 farms in the summer survey, also with two counts. In addition to the bird counts, habitat, farming characteristics and landscape variables were measured.	Yes	Yes	Yes	Winter 2002/3 and 2003 summer
A37	Scotland	ESAs all scotland	Machair Heather Woodland	national	Review	Unspecified	No	No	Yes	1988-1993

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
A171	Scotland	Argyll Islands ESA	Grassland Woodland Heather moorland Lapwing Oystercatcher Curlew Redshank	km2	Survey	33 1 km OS squares sampled. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB. A different sampling approach was used for farmland wading birds due to the patchy distribution of their habitats. Here a random sample of farms was taken.	Yes	Yes	Yes	1995-2004
A172	Scotland	Breadalbane ESA	Grassland Woodland Heather moorland	km2	Survey	26 sampling units which incorporated 29 1-km O.S. squares. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB. The units were usually single 1 km OS squares but two adjacent squares were used if the original square contained less than 50 ha of eligible land.	Yes	Yes	Yes	1995-2004
A173	Scotland	The Cairngorms Straths ESA	Grassland Woodland Heather moorland Lapwing Oystercatcher Curlew Redshank	km2	Survey	28 sampling units which incorporated 32 1-km O.S. squares. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB. The units were usually single 1 km OS squares but two adjacent squares were used if the original square contained less than 50 ha of eligible land. A different sampling approach was used for farmland wading birds due to the patchy distribution of their habitats. Here a random sample of farms was taken.	Yes	Yes	Yes	1995-2004
A178	Scotland	The Central Borders ESA	Grassland Woodland Wetland	km2	Survey	26 1-km O.S. squares sampled. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB.	Yes	Yes	Yes	1995-2004
A179	Scotland	The Loch Lomond ESA	Grassland Woodland Heather moorland	km2	Survey	26 sampling units which incorporated 30 1-km O.S. squares. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB. The units were usually single 1 km OS squares but two adjacent squares were used if the original square contained less than 50 ha of eligible land.	Yes	Yes	Yes	1995-2004
A193	Scotland	The Machair of the Uists and Benbecula, Barra and	Grassland Machair	km2	Survey	26 1-km O.S. squares sampled. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB.	Yes	Yes	Yes	1995-2004

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
		Vatersay ESA								
A194	Scotland	The Shetland Islands ESA	Grassland Lapwing Oystercatcher Curlew Redshank Dwarf shrub moorland	km2	Survey	26 sampling units which incorporated 30 1-km OS squares. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB. The units were usually single 1 km OS squares but two adjacent squares were used if the original square contained less than 50 ha of eligible land. A different sampling approach was used for farmland wading birds due to the patchy distribution of their habitats. Here a random sample of farms was taken.	Yes	Yes	Yes	1995-2004
A195	Scotland	The Southern Uplands ESA	Woodland Dwarf shrub moorland Heather	km2	Survey	26 1-km O.S. squares sampled. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB.	Yes	Yes	Yes	1995-2004
A196	Scotland	The Stewartry ESA	Grassland Wetland Woodland Water margins Dwarf shrub moorland Field boundary/hedges	km2	Survey	26 1-km O.S. squares sampled. Stratified random sample, each stratum being an amalgamation of similar land classes from the 32 classes in CEH's Land Classification of GB.	Yes	Yes	Yes	1995-2004
A76	Scotland	The Habitat Scheme, ESA, CPS and RSS	Grassland Wetland Woodland Dwarf shrub moorland Water margins Field boundary/hedges	varied	Survey	Case Studies covering 10 habitats included in agri-environment schemes, with 3 sites selected for each habitat (30 sites total).	No	No	No	2004
A98	Scotland	RSS, the now closed CPS, and the OAS.	Biodiversity	farm	Review	Postal questionnaires sent to each farmer. Total number of participants surveyed 1231 Responses 486 % Response 39.5 Total number of non-participants surveyed Responses 353 % Response 20.1%	No	No	Yes	2004

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
A166	Northern Ireland	All NI ESAs	Higher plants Invertebrates Ground beetles Spiders Chough Grassland Woodland Heather moorland Field boundary/hedges	25 hectare square	Review	Refers to A165. A total of 183 squares of 25ha sampled.	No	Yes	No	1993-2003
A165	Northern Ireland	All NI ESAs	Grassland Woodland Heather moorland Field boundary/hedges Bracken	25 hectare square	GIS	Stratified random. The sampling unit was a 25 hectare square. Sampling intensity of 1.5%-2.0% by ESA area. Total replicates: 183	No	Yes	No	1995-1998
A170	Northern Ireland	All NI ESAs	Grassland Woodland Heather moorland Field boundary/hedges	25 hectare square	Review	Baseline landscape surveys were carried out in all five ESAs in 1995, using a stratified random sampling technique. A total of 183 quarter kilometre (25ha) squares were surveyed. This survey was repeated in 2005	Yes	Yes	No	1995-2005
A122	Northern Ireland	ESA	Rabbit Red fox Irish hare	km2	Survey	200 survey squares. Road transects used to survey km square using night-driven, spotlight surveys. 150 squares were ESA and 50 were non-ESA (matched for characteristics such as land class, altitude, category of bisecting road and distance from ESA boundary).	Yes	No	Yes	2005? Not stated clearly.
A169	Northern Ireland	Antrim Coast, Glens and Rathlin ESA Sperrins ESA	Higher plants Invertebrates Ground beetles Spiders Heather moorland	field	Survey	A total of 108 heather moorland and 28 woodland sites were surveyed in 1994, including participant and non-participant farms. In 2004 only sites under ESA agreement were surveyed giving a total of 89 sites for botanical monitoring. Invertebrates were monitored on a sub-sample of these sites using pitfall traps. Traps were placed 20 m apart in a line through the centre of each site. Heather moorland = 60m transect (20m interval quadrats 1 x 1 m).	Yes	Yes	No	1994-2004

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
		Slieve Gullion ESA	Woodland			Woodland = 14 x 14 m permanent quadrats				
A167	Northern Ireland	West Fermanagh and Erne Lakeland ESA	Higher plants Invertebrates Ground beetles Spiders Grassland Heather moorland Woodland	field	Survey	A total of 188 field sites were surveyed in 1993. In 2003 96 plant sites were surveyed and 32 invertebrate sites. Invertebrates were monitored using pitfall traps. Traps were placed 20 m apart in a line through the centre of each site. Grassland/wetland = 5 2 x 2 m permanent quadrats along a diagonal transect in field (1 x1 m sub-samples). Heather moorland = 60m transect (20m interval 2 x 2 m permanent quadrats along a diagonal transect in field (1 x1 m sub-samples)). Woodland = 200 x 200 m permanent quadrats	Yes	Yes	No	1993-2003
A168	Northern Ireland	All NI CMS	Higher plants Invertebrates Ground beetles Spiders Grassland Wetland Heather moorland Woodland Field boundary/hedges	field	Survey	Stratified by county. At least a 5% sample of each habitat. No. of plant sites surveyed: 380 No. of invertebrate sites surveyed: 133 Grassland/wetland = 5 x 1m^2 quadrats along a diagonal transect in field. Heather moorland = 100m transect (20m intervals). Woodland = 200 x 200 m permanent quadrats Scrub = 4 x 4 m permanent quadrats Field margin = 30m long sampling zone located. At two distances along this three quadrats were positioned at certain distances from the boundary. These were generally 2m, 8m and 16m. Ground beetles and spiders = pitfall traps in field	Yes	Yes	No	2002-2003
A58	Ireland	REPS	Field boundary/hedges Higher plants Beetles	sub-field	Survey	Field margin flora and carabidae fauna were surveyed on 60 paired agreement and non-agreement farms.	Yes	No	Yes	1999-2000
A262	Wales	Ynys Môn ESA	Winter Waders Higher plants	500 x 500 m square	Survey	87, 500m × 500m squares within the ESA surveyed and re-surveyed for waders. The 2000 botanical re-survey was carried out on 40 fixed monitoring stands in the Ynys Môn coastal belt.	Yes	Yes	No	1993-2000
A262	Wales	Radnor ESA	Hay meadows Wetland	500 x 500 m square	Survey	Botanical surveys of Hay meadows and Wetlands were undertaken in 1994, 1997 and 2000 within 70 fixed monitoring stands (35 in each habitat).	Yes	Yes	No	1993-2000
A262	Wales	Preseli ESA	Hay meadows	500 x 500 m square	Survey	Botanical surveys of Hay meadow reversion were undertaken in 1996 and 1999 within 10 fixed monitoring stands.	Yes	Yes	No	1994-1999
A262	Wales	Lleyn	Waders	500 x 500	Survey	Botanical surveys of coastal grasslands and wetlands were carried out	Yes	Yes	Yes	1995-2002

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
		Peninsula ESA	Higher plants	m square		in 1995 and 1998 within 37 fixed monitoring stands (20 coastal grasslands and 17 wetlands). Ten sites had Tier 1A agreements, twenty-three had Tier 2A agreements and four were Non-agreement.				
A262	Wales	Clwydian Range ESA	Biodiversity	500 x 500 m square	Survey	No ecological monitoring took place in 2001 due to the Foot and Mouth outbreak, the Butterfly monitoring survey planned for 2001 will now take place in 2002/03. Of the 35 sample squares surveyed approximately 10% of land was under ESA agreement and 90% was land not under agreement in 1997; these figures had risen to 21% and 79% respectively by 2001.	No	Yes	Yes	1994-2001
A262	Wales	Cambrian Mountains ESA	Woodland Hay meadows Higher plants Heather moorland	500 x 500 m square	Survey	In 1999 a re-survey of land cover within a sample of 100 500 m × 500 m squares was carried out in the Cambrian Mountains ESA. During 1999, all 22 woodlands that were originally surveyed in the 1995 baseline survey were re-surveyed. In 1999, a botanical re-survey was carried out of hay meadows	Yes	Yes	Yes	1995-2000
A265	Wales	Cambrian Mountains ESA	Field boundary/hedges Woodland Heather moorland Hay meadows	500 x 500 m square	Survey	In 1999 a re-survey of land cover and points and linear features, within a sample of 100 500 m × 500 m squares was carried out in the Cambrian Mountains ESA. Each sample square was revisited and changes and trends in land cover recorded. Copies of the baseline maps and photographs were taken into the field and compared with the present appearance and condition of land cover. During 1999, all 22 woodlands that were originally surveyed in the 1995 baseline survey were re-surveyed. Botanical surveys of hay meadows were undertaken in 1995 and 1999 within 40 fixed monitoring stands. In the spring of 2000 a resurvey was carried out on heather moorland within semi-natural rough grazings in the Cambrian Mountains ESA. This resurvey involved revisits to the same 20 sites that had been assessed in the first resurvey undertaken in 1997. These 20 sites were based on the 16 baseline survey sites chosen in 1993 with a few additions to make up the sample size. Ten of the sites were under ESA agreement and 10 were non-agreement thus allowing comparisons to be made.	Yes	Yes	Yes	1995-1999/2000
A266	Wales	Lleyn Peninsula ESA	Field boundary/hedges Grassland Wetland	500 x 500 m square	Survey	The monitoring system for land cover was based upon detailed field survey of a stratified random sample. In the Lleyn Peninsula ESA, 65 sample units (500 m x 500 m squares, i.e. each 25 ha in area) were selected and stratified by the landscape types defined in the landscape assessment (ADAS 1992). The sample units covered c.3.5% of the total ESA area. The baseline survey of point and linear features on the Lleyn Peninsula was carried out in 1989. The system adopted was a stratified random sample of 65 survey units (sample squares), each	Yes	Yes	Yes	1989-1998

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						occupying 25 ha (i.e. 500 m ´ 500 m). In 1991, an interim survey was carried out of point and linear features using the 1989 classification.				
A267	Wales	Preseli ESA	Field boundary/hedges Hay meadows	500 x 500 m square	Survey	In Preseli ESA, 100 sample units (500 m ×500 m squares, ie each 25 ha in area) were selected and stratified by the landscape types defined in the landscape assessment. The sample units covered approx. 2% of the total ESA area. Each sample square was resurveyed in 1997 For hay meadows, the baseline survey took place during the summer of 1996, with the resurvey undertaken during the summer of 1999	Yes	Yes	Yes	1994-1999
A268	Wales	Cambrian Mountains ESA	Field boundary/hedges Woodland Hay meadows Higher plants	varied	Survey	A baseline survey of land cover, point and linear features, historic sites and the botanical component of two habitat types. The point and linear feature survey involved the sampling of one hundred units (each 25 ha in area) which were selected and stratified by the landscape types defined in the landscape assessment. A survey of the botanical composition of 40 hay meadow stands and 20 stands of broadleaved woodland was carried out.	Yes	Yes	No	1995-1996
A269	Wales	Cambrian Mountains ESA	Heather moorland	varied	Survey	The basic unit used for monitoring is an area of semi-natural rough grazing land that contains some heather moorland and is normally ring-fenced so that stocking levels can be managed. Between 40 and 50 farms were chosen with areas of semi-natural grazing land containing heather. The areas of heather were surveyed using quadrats and a transect.	Yes	Yes	Yes	2004
A270	Wales	Clwydian Range ESA	Field boundary/hedges	500 x 500 m square	Survey	The monitoring system for point and linear features was based upon detailed field survey of a stratified random sample. In Clwydian Range ESA, 35 sample units (500 m x 500 m squares, i.e. each 25 ha in area) were selected and stratified by the landscape types defined in the landscape assessment.	No	Yes	Yes	1994-2002
A271	Wales	Clwydian Range ESA	Field boundary/hedges Butterflies	500 x 500 m square	Survey	The point and linear feature survey involved sampling 35 units (each 25 ha in area) which were selected and stratified by the landscape types defined in the landscape assessment. The sample units covered c.3% of the total ESA area. A survey of the botanical composition and butterfly populations at six sites was carried out. Three habitat types were included throughout the six sites; improved, semi-improved and unimproved calcareous grassland, the latter being sub-divided into areas of gorse, bracken and rock outcrop. The transect methodology for the butterfly survey used was developed at the Institute of Terrestrial Ecology (ITE) Monks Wood, Huntingdon. Each transect was walked at an even pace, and only the butterflies which came within 5 m in front of the recorder were counted. Butterflies were noted by 'scoring' in the appropriate square. Totals were entered in the appropriate square as each section was	Yes	Yes	Yes	not clear from report: says it is baseline therefore roughly 1994?

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
						completed.				
A272	Wales	Preseli ESA	Field boundary/hedges Hay meadows	undefined	Survey	In 1997 a resurvey of point and linear features within sample squares was carried out in Preseli ESA Botanical surveys of Hay meadow reversion were undertaken in 1996 and 1999 within 10 fixed monitoring stands.	Yes	Yes	Yes	1994-1999
A273	Wales	Radnor ESA	Field boundary/hedges Hay meadows	500 x 500 m square	Survey	In 2000 a re-survey of point and linear features within a sample of 103, 500 m × 500 m squares was carried out in Radnor ESA	Yes	Yes	Yes	1993-2000
A274	Wales	Ynys Môn ESA	Field boundary/hedges Higher plants	500 x 500 m square	Survey	In 2000 a re-survey of point and linear features within a sample of 87, 500m × 500m squares was carried out in Ynys Môn ESA. In 2000 a botanical re-survey was carried out on coastal belt in the Ynys Môn ESA. The survey was carried out on 40 fixed monitoring stands in the Ynys Môn coastal belt.	Yes	Yes	Yes	1993-2000
A275	Wales	Lleyn Peninsula ESA	Waders	landscape	Survey	A random selection of 17 sites was made from a list of all wetland sites over 4 hectares (a few are below this as not all 4 ha sites gave permission) and under Tier 2A agreement on the Lleyn Peninsula.	Yes	Yes	No	1995-2002
A276	Wales	Lleyn Peninsula ESA	Grassland Wetland	undefined	Survey	A survey of the botanical composition of 20 coastal grassland stands and 20 stands of wetland was successfully carried out. In 1989 and 1991 baseline data was collected from hay meadow, wetland and coastal belt sites. The survey was repeated in 1993, but only for wetland and coastal grassland. A new baseline was set up in 1995.	Yes	Yes	No	1995
A277	Wales	Radnor and Preseli ESAs	Invertebrates	Pond	Survey	Ten ponds were surveyed, seven of which were in Radnor and three in Preseli in 1996, 1997 and 1998.	Yes	Yes	No	1996-1998
A278	Wales	Preseli ESA	Heather Hay meadows Field boundary/hedges	varied	Survey	The monitoring system for point and linear features is based upon detailed field survey of a stratified random sample. In Preseli, one hundred sample units (500 m × 500 m squares, i.e. each 25 ha in area) were selected and stratified by the landscape types defined in the landscape assessment. 20 field sites for heather moorland of varying size. The hay meadow monitoring was conducted on five farms within the ESA, a total of ten stands were surveyed.	Yes	Yes	No	1996
A279	Wales	Radnor ESA	Higher plants Hay meadows Field boundary/hedges	varied	Survey	A survey of the botanical composition of 35 hay meadow stands and 35 stands of wet pasture was successfully carried out. The point and linear feature survey involved sampling one hundred and three units (each 25 ha in area), which were selected and stratified by the landscape types defined in the landscape assessment. The sample units covered c.3% of the total ESA area.	Yes	Yes	No	1993? (not clearly specified!)

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
A280	Wales	Ynys Môn ESA	Field boundary/hedges Higher plants Waders	varied	Survey	The point and linear feature survey involved the sampling of 87 units (each 25 ha in area), which were selected and stratified by the landscape types defined in the landscape assessment. The sample units covered c.3% of the total ESA area. A survey of the botanical composition of 70 stands of coastal belt was successfully carried out.	Yes	Yes	No	1995-1996
A281	Wales	Ynys Môn ESA	Breeding Waders	landscape	Survey	A list of all wetland sites over 4 ha under Tier 2A agreement on the Ynys Môn ESA was drawn up by the ADAS Cartographic Unit in Aberystwyth in 1995. From this list a random selection of 20 sites was made. Due to permission not been given on enough sites from the original list, sites were then randomly chosen from a list drawn up of sites between 3 ha and 4 ha and then of between 2 ha and 3 ha. 1. On arrival at the site, the area to be surveyed was scanned with binoculars for wader/targeted bird activity. The site was then walked to within 100 m of each part of the site.	Yes	Yes	Yes	March to June 2004 (This follows on from previous breeding surveys that were carried out during 1996, 1998 and 2002)
A282	England	Britain - all schemes conserving Corncrake habitat	Corncrake	km2	Review	Counts made of singing male Corncrakes in 1km squares.	No	No	Yes	1992-2003

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 5 Biodiversity Reviews

Study No.[1]	Indicator(s)	Key findings[1]	Reference
A164	Biodiversity	Evaluates the effects on Scottish biodiversity of changes in the use of traditional breeds and varieties. The livestock component concentrated on rare and traditional Scottish breeds of sheep and cattle as there are no distinctly Scottish pig breeds. The crop component of the project concentrated on barley and oats with a brief overview of other crops. Special attention was paid to Scots Bere. An overview of the size and complexity of the genetic resource of Scottish breeds of sheep and cattle is given. A case study of the Blue Grey cow revealed that although considerable information is available on the performance of this genotype in relation to other breeds and crosses, little is known as to whether it contributes to wider biodiversity in a way which is different to other breeds. **Virtually no research has been conducted on the role of rare and traditional breeds in farming systems or the extent to which these breeds contribute to biodiversity. The role of traditional Scottish cultivars on wider biodiversity is not well documented, although cereal crops provide a habitat and food for a range of taxa.**	Wright, I. A., Dalziel, A. J. I., Ellis, R. P. & Hall, S.J.G. (2002) The state of traditional Scottish animal breeds and plant varieties and the implications for biodiversity. Report produced by the Macaulay Institute and Scottish Crop Research Institute for Scottish Executive Social Research. http://www.scotland.gov.uk/Publications/2002/12/15947/15078
A55		Need to complete	Ecoscope Applied Ecologists (2003) *Review of agri-environment schemes – monitoring information and R&D results.* Final report for Defra
A97	Mammals	Reviews how some management options and set-aside might affect habitat resources for mammals e.g. conservation headlands increase plant and invertebrate resources within the crop edge for species such as wood mice, grassy field margins can support communities of smaller mammals and hedgerows act as important commuting and hunting routes. Their potential will depend on factors such as seed mixtures used, timing and severity of cutting and length of time they have been in place. Organic agriculture is supported by some schemes and studies suggest significant benefit to species such as wood mice and bats. However, solutions should also be sought at the landscape scale, addressing such issues as habitat connectivity between farms. Mammal monitoring programmes need to be developed to assess the effects of schemes.	MacDonald,D.W., Tattersall, F. H., Service, K. M., Firbank, L. G. & Feber, R. E. (2007) Mammals, agri-environment schemes and set-aside - what are the putative benefits? *Mammal Review* **37,** 259-277.
A149	Birds	AE scheme and less intensive farming practices essential to reversing Farmland Bird Index declines. ELS will meet the quantity issue (which is considerable) but specialist prescriptions are required (especially for sedentary species) and should be targeted through HLS.	Vickery,J.A., Bradbury, R. B., Henderson, I. G., Eaton, M. A. & Grice, P. V. (2004) The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England. *Biological Conservation* **119,** 19-39. (Nigel's copy)
A141	Birds	Game crops used more than other farmland habitats by a wide range of bird species. Kale, quinoa, and cereals such as triticale and millet were used by many species, whilst maize was used by very few. Differences in the rate of seed shedding helped to provide seed food throughout the winter. Crop location influenced their use by some bird species. The use of nitrogen fertiliser influenced seed yield. If managed and sited correctly, a combination or two or three crop species can provide a valuable winter food resource for many declining farmland bird species.	Stoate,C., Henderson, I. G. & Parish, D. M. B. (2004) Development of an agri-environment scheme option: seed-bearing crops for farmland birds. *Ibis* **146,** 203-209.
A156	Waders	Conservation of waders in wider countryside can only be achieved through successful implementation of agri-	Wilson ,A. M., Ausden, M. & Milsom, T. P.

Study No.[1]	Indicator(s)	Key findings[1]	Reference
	Wet grassland	environment schemes, and opportunities are present in several schemes. Several studies appear to show the apparent failure of some ESAs to protect breeding wader populations outside nature reserves. There may be several possible reasons for this; the possibly that prescriptions might have unintended side-effects cannot be ruled out. More information on wader productivity and meta population dynamics is needed. On ESA land outside of nature reserves, socio-economic factors could be inhibiting the uptake of beneficial prescriptions such as raised water levels. However, it has been shown that higher tier management options within the ESA scheme (those that enhance the landscape) are more cost-effective than lower tier options (those that maintain the landscape).	(2004) Changes in breeding wader populations on lowland wet grasslands in England and Wales: causes and potential solutions. *Ibis* **146,** 32-40.
A205	Lapwing	Arable options within agri-environment schemes can be used to provide breeding habitat through their UK range, and ESA prescriptions have been shown to be successful in maintaining or increasing numbers of breeding lapwings on lowland wet grassland. A lack of similar success in arable habitats may be due to a lack of suitable prescriptions. However, more arable options have been incorporated into CSS, and ELS will be introduced across a much wider area of agricultural land. The farming community needs to be made aware of the requirements of lapwing.	Sheldon, R., Bolton, M., Gillings, S. & Wilson, A. (2004) Conservation management of Lapwing *Vanellus vanellus* on lowland arable farmland in the UK. *Ibis* **146,** 41-49.
A142	Cirl bunting Stone-curlew	Breckland breeding population of stone-curlew almost doubled between 1991 and 19989. The proportion breeding on ESA agreement land increased from 18% in 1991 to 29% in 1998. The Wessex population remained stable although there is no breeding population in the ESA. CS special project in Devon and Cornwall for cirl bunting. 320 territories in 1992 increased to 453 by 1998 of which 24% were associated with CS agreement land. CB numbers in tetrads containing agreement land increased by 70% compared with only 2% in tetrads with no agreement land.	Swash, A.R.H., Grice, P. V. & Smallshire, D. (2000) The contribution of the UK Biodiversity Action Plan and agri-environment schemes to the conservation of farmland birds in England. *Ecology and Conservation of Lowland Farmland Birds* 36-42.

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Protection of the historic environment

Table A 6 Historic environment results: Evaluations

Study No.[1]	Indicator(s)	Key findings	Reference
B01	Historic environment: historic features, parkland, archaeological sites	**ESAs:** were judged to be successful in maintaining and enhancing landscape Best performance, however, appears to be with respect to historic environment values. These were maintained in almost all ESAs, with the exception of one where the monitoring was inconclusive. However, there was little evidence of positive management of the resource and limited attainment of the relevant PIs. **CSS**: Performance of CSS with respect to the maintenance of historical value has been less effective than ESAs. This was most evident in upland landscapes, where no maintenance or enhancement was judged to be occurring on 47% of sites. Nevertheless, CSS is achieving, in the main, its stated objective of protecting and maintaining important historical and archaeological features and landscapes. On average more than 70% of agreements were judged to be effective in at least maintaining historic value. CSS Special Project funding made a significant contribution to restoration of historic parkland and traditional buildings.	Ecoscope (2002) Review of Agri-Environment Schemes – Monitoring Information and Research and Development Results
B02	Historic environment: historic features, parkland, archaeological sites	Although little monitoring and evaluation has been carried out, available evidence suggests that Tir Gofal is protecting the historic environment. At 31 July 2006, Tir Gofal protected 16,382 historic features and 3,449 hectares of historic parks and gardens, and at 31 March 2007 had funded restoration work on 487 farms. Routine compliance visits suggest that there has been no obvious deterioration of such features, but there is no formal monitoring of their condition. There is no routine monitoring and evaluation of the impact of Tir Gofal on the maintenance and restoration of the historic environment. Features of interest are identified during the application appraisal process and the archaeological trusts make judgements about their importance. However, the condition of each feature is not formally assessed and thus there are no baselines against which to measure changes in condition.	Wales Audit Office (2007) Tir Gofal Report presented by the Auditor General for Wales to the National Assembly for Wales
B05	traditional field boundaries Traditional farm buildngs	Traditional field boundaries: Low additionality - 64 per cent of respondents stated that they would have invested in new field boundaries in the absence of the scheme, but the scheme had brought forward the investment or increase intended scale of the work. Traditional Farm Buildings: 46 per cent of farmers who had made capital investments in traditional buildings (the main form of restoration activity funded by Tir Gofal) would not have done so without the financial support provided by the scheme, and at least another 19 per cent said that they had invested sooner and/or on a greater scale as a result of the scheme.	Agra CEAS Consulting (2005) *Socio-economic evaluation of Tir Gofal*. Final Report for Countryside Council for Wales and Welsh Assembly Government
B06	Historic or archaeological sites: Historic monuments including tombs, burial sites, stone circles, forts	The most commonly recorded historic monuments in the ESAs were raths and kilns. There was no change in the number or condition of historic monuments or features recorded since 1995. There was no change in the condition of historic and archaeological sites since baseline with most classified as having either 'substantial remains' (35%) or 'some remains' (26%). Only 31% of sites displayed evidence of recent damage, with the majority being caused by livestock activities (47%). Any recent damage is likely to have been influenced by the fact that only 19% had specific enclosures for protection.	McAdam, J. H., Flexen, M, McEvoy, P.M. and O'Mahony, D., (2006). *Environmentally Sensitive Areas in Northern Ireland: Landscape monitoring of the ESA scheme 1995-2005* (Report to Defra. Queen's University Belfast).
B07	Historic or archaeological sites: Historic	There are approximately 3,000 recorded historic monuments and archaeological sites occurring within ESAs. A survey of archaeological sites in Mournes and Slieve Croob ESA and Antrim ESA was carried out in 1994 (McErlean, 1994). The survey of 87 sites included those on land of participants and non-participants of the ESA scheme. Of the	McAdam, J. H., Cameron, A. Flexen, M, and Johnston, R.J. (2004*) Environmentally Sensitive Areas in Northern Ireland: Monitoring and evaluation of the ESA*

Study No.[1]	Indicator(s)	Key findings	Reference
	monuments including tombs, burial sites, stone circles and forts	sites, 51% showed recent damage and livestock grazing was the major concern, with 23% damaged by cattle and sheep. Landscape monitoring between 1995 and 1998 (Cameron et al, 1999) assessed condition of historic features within ESAs. Results indicated that recent disturbance due to livestock had occurred but that it was not sufficient to cause further deterioration in the condition of monuments. Most disturbance or damage was noted on sites not under ESA agreement. A pilot survey of condition and management of the archaeological resource in an area of north-east Antrim was carried out in 2001/2 by QUB (Gormley *et al*., 2002). A sample of 200 sites was surveyed and the main threat identified as gradual damage caused to monuments by livestock. Results showed that of 20 sites on land under ESA management agreement, 75% were in fair/good condition and 25% were in poor condition.	*scheme between 1993 and 2003* Report. Faculty of Agriculture, University College Dublin, Dublin, Irish Republic
B08	Archaeological sites	Background and prescription monitored sites predominantly exhibited stability of vegetation cover and overall condition. A minority of background and prescription monitored sites showed negative and/or positive changes, with respect to long term preservation of archaeological sites. The ESA scheme appears to have slowed the rate and/or reduced the incidence of negative change (increasing bracken and scrub cover) on in-scheme sites. On prescription-monitored sites, there was less damage due to stock feeding, dumping or storage of materials, wild animals and active vehicular tracks than on background sites. Results indicate that while Tier 1 can be generally regarded as successful in maintaining the condition of sites, the outcome for Tier 2, which was designed to enhance sites, is less clear. While there are a number of individual sites where Tier 2 measures did.	R.P. Cummins, A.J. Nolan, D. Scott, D. D. French, R. L. Hewison, D.J. Henderson, J.S. Bell, I. S. K. Pearce, C. Ellis, C. Mills, M. Marquiss, N. Picozzi, P.J. Bacon, D. A. Elston, S. C. F. Palmer (2005) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 1: Argyll Islands ESA*. Report to the Scottish Executive Environment and Rural Affairs Department
B09	Archaeological sites	Background and prescription monitored sites predominantly exhibited stability of vegetation cover and overall condition. A minority of prescription monitored sites showed negative and/or positive changes, with respect to the condition of archaeological sites. The main objective of the mandatory Tier 1 measures, protection and maintenance of condition of the archaeological resource, was generally successfully met. There was no clear evidence of enhancement for the parameters addressed by adoption of specific Tier 2 measures. Erosion emerged as the most pressing archaeological management issue in the Breadalbane ESA and, despite the improvements in erosion status in the prescription sample, there was a continuing high incidence of erosion principally caused by livestock, indicating poor compliance with Tier 1 requirements for stock control. Uptake of erosion- and livestock-related Tier 2 measures was far too low in the circumstances.	A. J. Nolan, R. P. Cummins, D. Scott, D. D. French, R. L. Hewison, J. S. Bell, D. J. Henderson, A. Acton, C. Ellis, C. Mills, D. A. Elston and S. C. F. Palmer (2007) *MONITORING ENVIRONMENTALLY SENSITIVE AREAS IN SCOTLAND, Vol. 2: The Breadalbane ESA, Monitoring Report, 1995-2004*
B10	Archaeological sites	Background and prescription monitored sites predominantly exhibited stability of vegetation cover and overall condition. A minority of background and prescription monitored sites showed negative and/or positive changes, with respect to long term preservation of archaeological sites. The Tier 1 measures were generally well adhered to on both in-scheme background sites and prescription monitored sites. In particular, there was a notable reduction in the number of sites with dumped material. Adoption and implementation of the wide range of Tier 2 archaeological management measures available to participants was very limited in Cairngorms Straths. The Tier 2 measure grazing plan was selected for 6 sites but appears not to have been effective in controlling erosion. There is no evidence for enhancement in the Tier 2 sample as a whole. Even though the Tier 2 results are equivocal, this should not be seen as undermining the design or potential effectiveness of the Tier 2 measures if taken up more widely and appropriately applied.	J. S. Bell, R. P. Cummins, A.J. Nolan, D. Scot, D.D. French, R. L. Hewison, D. J. Henderson, I.S.K. Pearce, C. Ellis, C. Mills, P. Bacon, M. Marquiss, N. Picozzi, D.A. Elston, S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 3: The Cairngorms Straths ESA Monitoring Report 1995-2004*
B11	Archaeological sites	Background and prescription monitored sites predominantly exhibited stability of vegetation cover and overall condition. A minority of background and prescription monitored sites showed negative and/or positive changes, with respect to long term preservation of archaeological sites. Tier 1 was broadly successful in maintaining the *status quo*, for example in scrub and bracken, where cover levels were low, and in tree cover which had a wider range of classes represented. There was a statistically significant reduction in the number of background and prescription sites subject to ploughing. Several other improvements were statistically evident in the background sample but not in the prescription sample (erosion condition, dumping, drains and other disturbance). However, changes in the prescription	D.Scott, R. P. Cummins, D. D. French, R. L. Hewison[1], L. Ross, C. Ellis, C. Mills, D. A. Elston, E.I. Duff, S. C .F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 4: The Central Borders ESA*. Report to the Scottish Executive Environment and Rural Affairs Department

Study No.[1]	Indicator(s)	Key findings	Reference
		sample were also in a positive direction for erosion, dumping and drains, even though not statistically significant. Occasional Tier 1 compliance issues were evident in the persistence of dumping and stock-feeding on a few sites, and more generally in managing stock levels to avoid erosion. There was no clear evidence for enhancement in the Tier 2 sample as a whole.	
B12	Archaeological sites	Background and prescription monitored sites predominantly exhibited stability of vegetation cover and overall condition. A minority of background and prescription monitored sites showed negative and/or positive changes, with respect to long term preservation of archaeological sites. It is difficult to comment on the efficacy of Tier 1 protection measures in Loch Lomond ESA because many background monitoring sites subsequently came into scheme. Furthermore, no statistically significant changes were observed, probably due to small sample sizes. The results were broadly similar for background and Tier 1 prescription sites, although generally bracken cover was at higher levels on prescription sites and remained so. The erosion results also appear to differ, with apparently more negative change in the prescription results, indicating that the Tier 1 measure of maintaining grazing but avoiding erosion was often not successful on these particular sites. The results do not give conclusive evidence regarding whether the scheme met the Tier 1 objective of protecting the archaeological resource. The Tier 1 measure of not allowing dumping or storage of any material upon an archaeological site appears to have been well adhered to on both in-scheme background sites and prescription monitored sites. Adoption and implementation of the wide range of Tier 2 archaeological management measures available to participants was very limited in Loch Lomond. In many cases, selected Tier 2 measures had not been implemented within the monitoring period. There is no evidence for enhancement in the Tier 2 sample as a whole. Even though the Tier 2 results are equivocal, this should not be seen as undermining the design or potential effectiveness of the Tier 2 measures if taken up more widely and appropriately applied.	Nolan, A. J., Cummins, R. P., Scott, D., French, D. D., Hewison, R. L., Bell, J. S., Henderson, D. J., Pearce, I. S. K., Ellis, C. Mills, C., Elston, D. A., Palmer, S. C. F. (2007*) Monitoring Environmentally Sensitive Areas in Scotland Vol. 5: The Loch Lomond ESA Monitoring Report 1995-200*4. Report to the Scottish Executive Environment and Rural Affairs Department
B13	Archaeological sites	A mixed picture of condition emerges for the prescription monitored sites, with no change, decline or improvement variously indicated. Where there were improvements, they also occurred in the background sample, which was entirely of out-scheme sites, and so are not necessarily a result of the ESA scheme. The principal management issue in this ESA is erosion, with the prescription sites being especially susceptible and with rabbits and domestic livestock recorded as the most frequent causes. There was no statistically significant reduction in rabbits or livestock as the cause of erosion on either prescription or background monitored sites. In fact, erosion worsened on a majority of prescription monitored sites over the monitoring period, while improving in the latter part of the monitoring period on background sites. As a consequence Tier 1 cannot be seen as successful in maintaining site condition. The primary objective of Tier 1, to maintain site condition, was exceeded in the categories of ploughing and drains, although similar improvements were also seen in the background sample. Adoption and implementation of the wide range of Tier 2 archaeological management measures available to participants was extremely limited in the Machair ESA.	I. S. K. Pearce, R. P. Cummins, A. J. Nolan, D. D. French, R. L. Hewison, D. J. Henderson, J. S. Bell, A. Acton, I. C. Crawford, C. Ellis, C. Mills, D. A. Elston, S. C. F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 6: The Machair of the Uists and Benbecula, Barra and Vatersay ESA.* Report to the Scottish Executive Environment and Rural Affairs Department
B14	Archaeological sites	Erosion emerged as the principal archaeological management issue in the Shetland Islands ESA. The erosion results indicate that Tier 1 exceeded the aim of maintenance, with 53% of 'Tier 1 only' sites having reduced erosion levels over the prescription monitoring period. Similarly, 58% of Tier 2 sites, mostly with erosion-related Tier 2 measures, also improved in erosion condition. Livestock were a frequent cause of erosion. While background sites showed more decline in condition, the final incidence of erosion by livestock was higher for prescription sites (74%). Thus the Tier 1 requirement of managing stock to avoid erosion was often not met. Tier 2 uptake was limited in both numbers of sites and in the range of management issues addressed.	A. M. Truscott, R .P. Cummins, A. J. Nolan, D. Scott, D. D. French, R. L. Hewison, J. S. Bell, G. McGowan, C. Ellis, C. Mills, P.J. Bacon, N. Picozzi, R. van der Wal, D. A. Elston, S. C. F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 7: The Shetland Islands ESA.* Report to SEERAD
B15	Archaeological sites	Some positive changes occurred in both background and prescription monitoring samples, indicating Tier 1 was successful in maintaining condition for these factors, although the improvements cannot be directly attributed to the ESA scheme's measures. Some statistically significant positive changes occurred in the prescription sample only,	R. P. Cummins, D. Scott, D. D. French, R. L. Hewison, J. S. Bell, D. J. Henderson, C. Ellis, C. Mills, D. Hawker, D. A. Elston & S. C .F. Palmer (2007)

Study No.[1]	Indicator(s)	Key findings	Reference
		indicating the scheme was successful in maintaining and possibly enhancing condition. Background results also improved but were not statistically significant. Tier 1 was successful in maintaining the *status quo* in scrub, bracken and tree cover where there was largely no change. Tier 2 was not generally successful in enhancing condition; uptake was limited, some sites were inappropriately selected and mostly the results showed no change.	Monitoring Environmentally Sensitive Areas in Scotland. Vol. 8: The Combined Western and Central Southern Uplands ESA. Report to SEERAD
B16	Archaeological sites	Background and prescription sites predominantly exhibited stability of vegetation cover and overall condition. Tier 1 measures were generally well adhered to and were largely successful. This is supported statistically for several Tier 1 issues. While there was Tier 2 selection over a wide range of measures, the number of sites involved was low. The outcome was frequently one of no change.	D. Scott, R. P. Cummins, D. D. French, R. L. Hewison, I. S. K. Pearce, L. Ross, C. Ellis, C. Mills, I. C. Crawford, D. Hawker, D.A. Elston & S. C. F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 9: The Stewartry ESA*. Report to SEERAD
B21	Lowland parkland, wood pasture, Orchards	Focus on habitats but recognises contribution to historic value. The historical importance of parkland is recognised by the Scheme and there are voluntary options as well as capital works to restore and enhance their historical qualities. However, payments made under TG are based on the management of parkland as a habitat. The Tir Gofal Scheme is making a significant contribution to the attainment of the targets listed in the HAP. Some 2,390 hectares (ha) of parkland and 90ha of orchard in Wales are under agreement (Feb 04), which is of particular relevance to the HAP targets that pertain to the protection and maintenance of these habitats. The Scheme is also contributing towards the restoration of parkland habitats, with 114 ha of improved park being reverted to a less improved state. The planting of 6,238 new parkland or orchard trees and the pruning or pollarding of 1,313 trees, can also be taken to provide an accurate measure of how the Scheme is contributing to the restoration or expansion of parkland, wood-pasture and orchards.	Law, A. (2004) The Contribution of Tir Gofal to the Parkland and Wood-pasture Habitat Action Plan, .CCW Staff Science Rep. No 04/7/1
B23	Historic features and archaeological sites	Arable reversion options in ESA and CSS afforded protection to archaeological features. 77% of sites showed benefits.	Kirkham, F. et al. (2006*) Evaluation of Arable Reversion Agreements in Countryside Stewardship and Environmentally Sensitive area Schemes*, Defra Project MA01015/RMP 1982
B24	Historic features	The 1997 resurvey of historic features for Ynys Mon ESA looked at a stratified sample of 24 Ancient Monuments, assessing any change since baseline survey in 1994. Out of the 8 monuments on ESA agreement land, there was no loss of recorded archaeological or historic features. In Radnor ESA, 28 historical monuments were examined during the interim resurvey. Ten of these features were on agreement land. Changes that occurred to monuments were not necessarily detrimental. On non-agreement land, 5 monuments had encountered changes. Of the 35 Unscheduled Historical Monuments on Preseli ESA, the 9 on agreement land had not been lost. This compares to non-agreement land where two monuments had been completely removed since baseline survey. Of the 9 sites on agreement land 3 had recorded some damaging operations. On non-agreement land 11 of the 26 sites had suffered changes. In the Clwydian Range ESA 3 USAMs were examined on agreement land and 14 on non-agreement land at resurvey. No alterations to the sites on agreement land were found. On non-agreement land 3 sites showed signs of detrimental change. Tir Cymen monitoring examined ten farms in Meirionnydd and Dinefwr, representing a variety of landscapes, terrain and historical value. The monitoring showed that only isolated cases of stone removal were recorded in both Meirionnydd and Dinefwr. No significant damage to historic features was revealed.	Medcalf, K. & Pawson, B. (1999) An Interim Evaluation of the First Generation of Agri-Environment Schemes in Wales In the Context of Tir Gofal, WOAD
B42	Field boundary hedges	At a generic level the study found that the historic network of pre-enclosure and historic hedges was being maintained through the ESA scheme. However, the omission of severely degraded hedges and hedgerow banks from restoration programmes was detrimental to the historic landscape framework.	Catherine Bickmore Associates (2004). *Hedgerow management and restoration in agri environment schemes: Part II Environmentally Sensitive Area Scheme*. Report to Defra.

Study No.[1]	Indicator(s)	Key findings	Reference
B43	Field boundary hedges	The field survey found that 84 per cent of hedges were either historic or pre-enclosure. The review of agreement files found that historic objectives directly relating to hedges were provided for 55 per cent of the CSS sample agreements. However, there was no reference to the retention of vernacular features directly associated with hedges. The omission of severely degraded hedges and hedgerow banks from restoration programmes was detrimental to the historic landscape framework	Catherine Bickmore Associates (2004*). Hedgerow management and restoration in agri environment schemes: Part I Countryside Stewardship Scheme.* Report to Defra.
B44	Archaeological sites	Detailed monitoring programmes have been set up in the ESAs and on land under agreement in the Habitat, Moorland and Tir Cymen schemes. This report uses the results of the monitoring programmes, and achievements against the Performance Indicator to evaluate the existing WOAD and CCW schemes. Archaeological sited on ESA agreement land had been retained. There was evidence of a loss of sites on non-agreement land. Tir Cymen monitoring examined ten farms in Meirionnydd and Dinefwr, representing a variety of landscapes, terrain and historical value. The monitoring showed that only isolated cases of stone removal were recorded in both Meirionnydd and Dinefwr. No significant damage to historic features was revealed.	Medcalf, K., Pawson, B., Horton, C., Rugg, I., Davis, J., & Jones, E. (1998). ANNEX 1 An Interim Evaluation of the First Generation of Agri-Environment Schemes in Wales In the Context of Tir Gofal (Report to Welsh Office Agricultural Department (WOAD)).
B49	Field boundary dry stone walls	Survey of the condition of walls on 171 case-study agreement holdings in six ESAs, with complementary data on farmer attitudes, behaviour and costs. The quality of wall renovation work was also assessed on 89 case-study holdings in five ESAs. The survey found substantial variation in the wall maintenance commitment within and between the ESAs. For example, less than a fifth of all walls in the Cotswold Hills were identified as stock-proof, and holdings had on average only three walls to maintain under ESA prescriptions. In contrast over four-fifths of all walls in West Penwith were identified as stockproof, with holdings having on average 59 walls to maintain under ESA prescriptions. The report concluded that these substantial variations had implications for the costs of wall maintenance incurred between different holdings and between different ESAs. In most ESAs, a 'good' level of wall renovation was recorded for at least two-fifths of walls, with most of the remainder of the work being considered to be 'acceptable'	
B54	Archaeological sites	Changes occurred on four out of 45 sites. Apart from one change on agreement land, the changes and trends since the baseline survey were small. No monuments were lost either on agreement land or non-agreement land within the sample. The overall ESA wide objective '*to maintain sites of archaeological and historical sites*' has been broadly met for those sites within the sample on agreement land. On non-agreement land there have been detrimental changes to archaeological and historic features but these have been fairly minor and relatively insignificant.	ADAS (2000) *Environmental Monitoring in the Cambrian Mountains ESA 1995 – 1999*, Report to National Assembly For Wales Agriculture Department
B56	Archaeological sites	A considerable proportion of the historical sites chosen for the monitoring could not be located. Of the 17 sites chosen, seven (41%) proved impossible to find. Of the 10 sites located and visited in 1997, changes were only identified on three, none of which were located on agreement land. No monuments were lost either on agreement land or non-agreement land within the sample. Of the sites on non-agreement land there were small detrimental changes to archaeological and historic features. Due to the lack of sites on agreement land and the high proportion of features that could not be located at baseline or first re-survey a decision was made in 2000 to discontinue further re-surveys of historical sites in the Clwydian Range ESA.	ADAS (2002) *Environmental Monitoring in the Clwydian Range ESA 1994 – 2001*, Report to National Assembly For Wales Agriculture Department
B58	Archaeological sites	Overall the results of the historical monitoring resurvey suggest that, in general, historical features are afforded more protection when the land they are on is under ESA agreement. No monuments were lost on ESA agreement land but two monuments were completely removed on non-agreement land between the baseline survey and the resurvey. Of the monuments on agreement land, five (63%) were unaltered since the baseline survey while on non-agreement land 15 (58%) were unaltered since the baseline. On non-agreement land there were changes and trends to six out of the 26 monuments.	ADAS (2001) *Environmental Monitoring in the Preseli ESA 1994 – 1999,* Report to National Assembly For Wales Agriculture Department

Study No.[1]	Indicator(s)	Key findings	Reference
B60	Archaeological sites	The overall objective to maintain sites of archaeological and historical interest has not been met on agreement land. Of the 28 archaeological and historical sites re-surveyed in 2000 16 were now located on ESA agreement land, an increase of six since the previous re-survey in 1996. Overall, changes were identified on 11 out of 28 sites surveyed, five on agreement land and six on non-agreement land. The changes and trends since the baseline survey were generally small. No features were lost on agreement land. On non-agreement land no features were lost, although detrimental changes were recorded.	ADAS (2002) *Environmental Monitoring in the Radnor ESA 1993 – 2000*, Report to National Assembly For Wales Agriculture Department
B62	Archaeological sites	Overall, despite some increased threats to features on agreement land, the ESA wide objective '*to maintain sites of archaeological and historical sites*' has been broadly met for those sites within the sample on agreement land. On non-agreement land the changes recorded reflect a gradual piece meal deterioration in the condition of archaeological and historical features. Over the period 1996 – 2000 changes were noted on seven out of the 24 sites monitored, two on agreement land and five on non-agreement land. Of the monuments on agreement land, two were identified as having altered since the previous survey, On non-agreement land a number of sites were subject to changes.	ADAS (2002) *Environmental Monitoring in the Ynys Môn ESA 1993 – 2000*, Report to National Assembly For Wales Agriculture Department
B64	Archaeological sites	Of the 270 monuments were surveyed and of these 92 are located on land now in ESA agreement. For all monuments the proportion that were assessed as being visible has decreased from 53% to 51%. Of the 29 monuments assessed as becoming visible since the baseline, it would appear that 20 are due to the fact that the 1997 air photos were much clearer than the 1988 photographs used for the baseline assessment. Comparing the changes on agreement and non-agreement land shows that in terms of the visibility of features, the proportion of visible features increased on agreement land but decreased on non-agreement land. In terms of land cover changes, there were a greater proportion of positive changes to monuments on agreement land than non-agreement land.	ADAS (2000) *Environmental Monitoring in the Lleyn Peninsula ESA 1989–1998*, Report to National Assembly For Wales Agriculture Department
B66	Traditional farm buildings	Research carried out to determine the effectiveness of ESA and CSS traditional farm building restoration projects found that agreement holders had a high level of satisfaction with the schemes and a significant number of buildings would have either continued to deteriorate or have been lost in the absence of the schemes. Only nine of the 106 agreement holders interviewed in the study would have restored their buildings in the absence of the scheme while 46 of the 120 buildings surveyed would have had some first aid, low-cost repairs. ADAS also concluded that existing assessment procedures were insufficient to enable the value of the building and the gains from restoration to be fully understood, and that restoration projects should be more selective and targeted in future.	ADAS (2003) *Traditional Farm Building Restoration on ESA and CSS Agreements*, MA01004, Report to Defra

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 7 Historic environment study characterisation: evaluations

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
B01	England & Wales	ESA & CSS	Historic environment: historic features, parkland, archaeological sites	farm	Monitoring	N/A		No	
B02	Wales	Tir Gofal	Historic environment: historic features, parkland, archaeological sites	farm	Monitoring	All agreements	No		1999 - Sep 2007
B05	Wales	Tir Gofal	Not reviewed yet PTG	scheme	Socio-economic monitoring	Face to face interviews with 20% of beneficiaries, stratified by farm type and size.		No	
B06	N. Ireland	All NI ESAs	Historic or archaeological sites: Historic monuments including tombs, burial sites, stone circles and forts	25 ha sq	Review	Baseline landscape surveys carried out in all five ESAs in 1995, using a stratified random sampling technique. Total of 183 quarter kilometre (25ha) squares were surveyed.	Yes	Yes	1995-2005
B07	N. Ireland	All NI ESAs	Historic or archaeological sites: Historic monuments including tombs, burial sites, stone circles and forts	Not specified	Review	Not specified	No	Yes	1993-2003
B08	Scotland	Argyll Islands ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1995-2003
B09	Scotland	Breadalbane ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (7 squares)	Yes	Yes	1996-2003
B10	Scotland	Cairngorms Straths ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1996-2003
B11	Scotland	Central Borders ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1996-2004
B12	Scotland	Loch Lomond ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1996-2004

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
B13	Scotland	Machair of the Uists & Benbecula, Barra & Vatersay ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1996-2003
B14	Scotland	Shetland Islands ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1995-2003
B15	Scotland	Combined Western and Central Southern Uplands ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1995-2004
B16	Scotland	Stewartry ESA	Archaeological sites	landscape	Survey	Stratified random sampling using 1 km OS squares. Subset of squares used for botanical monitoring (8 squares)	Yes	Yes	1995-2003
B21	Wales	Tir Gofal	Lowland parkland, wood pasture, Orchards	farm	Review of agreements	No	No	No	Feb-04
B23	England	ESA & CSS	Historic features and archaeological sites	farm	Review of agreements	Stratified random sampling of management agreements	No	No	?
B24	Wales	ESA & Tir Cymen	Historic features	farm	Survey	No	No	Yes	1994-1997
B42	England	All English ESAs	Historic hedges	sub-field	Survey	100 ESA agreements which include hedgerow restoration from 7 ESAs. Farmer perceptions assessed. Total of 774 hedges surveyed.	No	No	2003
B43	England	CSS	Historic hedges	sub-field	Survey	100 CSS agreements which include hedgerow restoration. Random sample stratified by Government Office Region and by total length of hedgerow work undertaken under the agreement. Farmer perceptions assessed. Total of 751 hedges surveyed.	No	No	2002-2003
B44	Wales	ESA Tir Cymen	Archaeological sites	landscape farm	Survey	ESA: Sample of ancient monuments Tir Cymen: 10 farms selected to represent different conditions	No	ESA: yes Tir Cymen	ESA: 1994-1997

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
								no	
B49	England	ESA	Dry stone wall	farm	Survey	Survey of the condition of walls on 171 case-study agreement holdings in six ESAs, with complementary data on farmer attitudes, behaviour and costs. The quality of wall renovation work was also assessed on 89 case-study holdings in five ESAs.	No	No	1999-2000
B54	Wales	ESA	Archaeological sites	landscape	Survey	45 sites were monitored, 29 on agreement land, 16 on non-agreement land in 1995. Resurveyed in 1999	No	Yes	1995-1999
B56	Wales	ESA	Archaeological sites	landscape	Survey	17 sites selected for monitoring on agreement and non-agreement land in 1994. Survey discontinued due to difficulty in finding sites	No	Yes	1994-1997
B58	Wales	ESA	Archaeological sites	landscape	Survey	35 sites selected for monitoring on agreement and non-agreement land in 1994. Resurveyed in 1997	No	Yes	1994-1997
B60	Wales	ESA	Archaeological sites	landscape	Survey	28 sites selected for monitoring on agreement and non-agreement land in 1993. Resurveyed in 2000	No	Yes	1993-2000
B62	Wales	ESA	Archaeological sites	landscape	Survey	24 sites selected for monitoring on agreement and non-agreement land in 1993. Resurveyed in 2000	No	Yes	1993-2000
B64	Wales	ESA	Archaeological sites	landscape	Air photo survey	270 sites selected for monitoring on agreement and non-agreement land in 1988. Resurveyed in 1997	No	Yes	1988-1997
B66	England	ESA CSS	Traditional farm buildings	farm	Survey	The study involved the surveying of 120 buildings, with the sample drawn across the various ESA grant rates and from CSS agreements to gain an overall impression of the range of situations and project types.	No	No	2002/03

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 8 Historic environment results: Expert opinion

Study No.[1]	Indicator(s)	Key findings	Reference
B17	Archaeological sites and historic features	Multidisciplinary evaluation of CSS using a an appraisal team The results of this appraisal process suggest that in the majority of cases the CSS agreements should maintain or enhance the environment in terms of ecology, landscape, and landscape history and increase public enjoyment of the countryside. 36% of agreements showed high additionality and 38% medium additionality. There were missed historical opportunities in 25% of agreements	P. D. Carey,, C. Short, C. Morris, J. Hunt, A. Priscott, M. Davis, C. Finch, N. Curry, W. Little, M. Winter, A. Parkin, L. G. Firbank (2003) The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management* **69**, 71–91
B22	Archaeological sites	Scotland has more than 250,000 known archaeological sites. 2004, 478 archaeological sites were managed under the Rural Stewardship Scheme. The lack of monitoring information makes it difficult to determine the influence of management prescriptions on environmental outcomes as there is no direct evidence available, yet.	State of Scotland's farmed environment 2005 (no date)
B25	Historic features	Much of the evidence received asserted that Tir Gofal has made significant improvements to the farmed environment in Wales. But effectiveness is currently measured in terms of *outputs* such as the number of agreements, areas covered by prescriptions and the number of traditional buildings and historic features protected, rather than in terms of environmental outcomes11. Many contributors highlighted the need for better monitoring and evaluation of the environmental effects of the scheme	The National Assembly for Wales, Agriculture and Rural Development Committee (2003) The Future of Agri-environment schemes in Wales.

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 9 Historic environment study characterisation: Expert opinion

Study No.[1]	Country	Scheme &/or prescription	Indicator(s)	Type of study	Consultees	No. consultees	Stats?	Baseline?	Study date(s)
B17	England	CSS	expert appraisal scores allocated for each of five criteria: agreement negotiation; appropriateness, environmental effectiveness, compliance and side effects.		Multi-disciplinary: desk study, interviews, field survey; and contextual data were collected all data was appraised by MD team	A stratified random sample of 500 CSS Agreements	N/A	N/A	
B22	Scotland	RSS	Archaeological sites	State of Scotland's farmed environment	?	?	N/A	N/A	2004
B25	Wales	A-E schemes in Wales prior to 2003	Historic features	review of stakeholder submissions	Stakeholders	?	N/A	N/A	?

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 10 Historic environment results: Case studies

Study No. [1]	Indicator(s)	Key findings	Reference
B26	Scheduled monuments	The data have been analysed to provide time series information at three points: 2001 2005 and 2007. These data record an overall steady reduction in the numbers SMs at high or medium risk, with a concomitant rise in the numbers of SMs at low risk. Grant schemes that can deliver SMs at Risk objectives have been of particular importance – particularly Defra's Environmental Stewardship programme. Between 2005 and 2007, the risk banding has been reduced for 30 SMs in the East Midlands – and analysis of the funding streams that have been responsible for implementing change demonstrates the particular importance of Environmental Stewardship, EH grant-aid and the Heritage Lottery Fund. Between 2005 and 2007, 56 SMs had their condition improved (a low risk SM can undergo improvements without a change in risk banding), and analysis of the funding streams demonstrates that Environmental Stewardship is responsible for the majority of these enhancements. Frequently these enhancements will have been a consequence of other, non-cultural heritage ES scheme objectives – such as scrub clearance to improve biodiversity. When compared with the previous pie chart, the smaller proportion of EH grant aid on the chart below indicates that EH grant aid is being targeted effectively at risk reduction – not to enhancements to SMs already in reasonable condition	Humble, J. & Allen T. (2007) Scheduled Monuments at Risk: East Midlands Region Time-series data 2001-2007, English Heritage
B28	Traditional farm buildings and boundaries	This report evaluates the social and economic impacts of grant-funded traditional farm building and dry stone wall restoration in the Yorkshire Dales National Park. The research examines six schemes, under which landowners and farmers were eligible to apply for grant funding over the period 1998 - 2004. The schemes considered in the research include Defra's Pennine Dales Environmentally Sensitive Areas Scheme, the Countryside Stewardship scheme and the Rural Enterprise Scheme, as well as the National Park Authority's Barns and Walls Conservation and Farm Conservation Schemes, and the Yorkshire Dales Millennium Trust Scheme. The major source of funding for barns and walls in the study was the Defra grant schemes, which accounted for more than 80% of building and 85% of walling grants. The project sought to rigorously define the benefits delivered by this repair programme in addition to the important heritage conservation work which was its primary objective. These collateral benefits include the creation of employment, inputs to the local economy, support for craft skills, advantages to farm businesses and landscape enhancement from the perspective of both residents and visitors. During the study period over 517 traditional farm buildings and 191 km of dry stone walls were restored. Without the injection of funding over three quarters of the traditional farm buildings repaired were otherwise likely to become derelict. Allowing for direct, indirect and induced effects, the building and walling schemes have resulted in a total injection of between £7.08 million and £9.12 million to the local economy, with every £1 expenditure on repair work on buildings resulting in a total output within the wider local area of £2.48 (£1.92 for walling).	Courtney, P, Gaskell, P, Mills, J, & Roberts, E. (2007) *A Socio-economic study of grant-funded traditional drystone wall and farm building restoration in the Yorkshire Dales National Park*. Final Report to English Heritage
B29	Traditional farm buildings	The evaluation project focused on the period 1998 to 2004, during which Defra's investment in grants has totalled over £6.2 million. The project sought to rigorously define the benefits delivered by this repair programme in addition to the important heritage conservation work which was its primary objective. These collateral benefits include the creation of employment, inputs to the local economy, support for craft skills, advantages to farm businesses and landscape enhancement from the perspective of residents and visitors. During the study period over 450 conservation plans covering more than 655 buildings, including 35 listed buildings were agreed. Without the ESA scheme, two thirds of these buildings were likely to become derelict and the remainder repaired to a lower standard not in keeping with local character. Grant recipients contributed £1.62 million towards the cost of the repairs. Allowing for direct, indirect and induced effects, the scheme has resulted in a total injection of between £8.5 million and £13.1 million to the local economy, with every £1 expenditure on repair work resulting in a total output within the ESA of £2.49. The retention of revenue generated by these repair projects in the local economy is substantial, reflecting the fact that local building contractors are carrying out the work, a significant proportion of their staff and supplies are sourced locally, and that local households spend a fair proportion of their disposable income in the immediate area. A significant pool of historically significant buildings remains	Roberts, E, Gaskell, P, Courtney, P and Mills, J. (2005) *Social and Economic Impacts and Benefits of Traditional Farm Building Repair and Re-use in the Lake District ESA*. Final Report to English Heritage

Study No.[1]	Indicator(s)	Key findings	Reference
		within the National Park which would benefit from entry into the ESA or its successor Environmental Stewardship scheme	
B67	Archaeological sites	he study quantified the threat from arable cultivation to a sample of the archaeological resource in the East Midlands The study also developed and tested a robust and integrated risk assessment and mitigation model for archaeological sites in arable cultivation. Out of a proposed sample of 159 Scheduled sites identified as being at moderate or high risk from cultivation damage and 39 non-scheduled sites (198 in total), permission was granted to undertake the survey and subsequent fieldwork on 77 and 39 sites respectively. In total, fieldwork investigations were carried out on 116 sites. The study found that scheduling and agri-environmental schemes do not always provide sufficient protection to the archaeological resource. Many farmers were found to be breaking the terms of their Class Consent as 25% of the Scheduled sites were being subsoiled. 10% more Scheduled sites (22%) than non-scheduled sites (12%) were under root and tuber crops. 3% more Scheduled sites (7%) than non-scheduled sites (4%) were subject to clod separation or de-stoning operations. The majority of sites tested were at risk from cultivation, with Scheduled sites being at slightly higher risk (79% at moderate, high or serious risk) than nonscheduled sites (75% at moderate, high or serious risk). Approximately 3000 Scheduled sites are reported to be under arable cultivation. If the results from the East Midlands are used as a direct parallel, c 79% of these sites are at moderate/high and serious risk of damage from agricultural activities, a total of c 2,370 Scheduled sites. Some 39% of the Scheduled sites in the COSMIC survey are at serious risk: if projected nationally this percentage would mean that c 1170 out of the 3000 sites are at serious risk. This risk to the Scheduled resource is much higher than any other form of risk to Scheduled Monuments	Oxford Archaeology (2006) Conservation of Scheduled Monuments in Cultivation (COSMIC), Report to English heritage and Defra

Table A 11 Historic environment study characterisation: Case studies

Study No.[1]	Country	Region/ area	Scheme	Indicator(s)	Scale	Type of study	Baseline?	Control site(s)?[6]	Study duration
B26	England	East Midlands	Environmental Stewardship	Scheduled monuments	region	Survey	Yes	No	2001-2007
B28	England	Yorkshire Dales National Park	ESA, CSS	Traditional farm buildings and boundaries	National Park	Survey	No	No	1998-2004
B29	England	Lake District National Park	ESA	Traditional farm buildings	National Park	Survey	No	No	1998-2004
B67	England	East Midlands		Archaeological sits	Region	Survey	Yes	No	2003-2005

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 12 Historic environment Reviews

Study No.[1]	Indicator(s)	Key findings	Reference
B27	Historic features and archaeological sites	In all four regions of the UK, the importance and value attributed to the historic environment in rural areas is widely recognised in policy. This includes both the more obvious built structures and ancient monuments and other more integral aspects of landform and structure such as ridge and furrow undulations from mediaeval ploughing techniques that have been preserved under permanent pasture, pre-enclosure and enclosure traditional field boundaries and historic water meadows with their drainage and flooding systems still intact or visible, even where no longer functioning. However, it is also probably true to say that these aspects have only really received thorough research attention in policy circles within the past 10-20 years and, as a result, the 'baseline data' on the historic environment and in trends relating to its condition, is less complete than is the case for either landscape or biodiversity interest in the countryside.	Dwyer, J. and Kambites, C. (2005) AGRI-ENVIRONMENTAL MEASURES EVALUATION AGRI/ G4/ 2004, CCRU
B35	Historic features and archaeological sites	Information was generally lacking on the state of the historic environment in all four countries although some data for England and Wales shows that agriculture constitutes a specific threat to archaeological sites and monuments and historic landscapes. There appear to be no strategies or targets relating to the protection of the historic environment in any of the four countries. Stakeholders in England and Wales raised concerns about agriculture's impact on the historic environment.	Swales, V., Dwyer, J., and Farmer, M. (2005). *Environmental priorities in the UK Rural Development programmes* Report to LUPG. (LUPG).

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Maintenance of landscape quality and character

Table A 13 Landscape results: Prescription development and testing

Study No.[1]	Indicator(s)	Key findings	Reference
B3	Landscape features	Maintenance of landscape features (£537) commanded the highest Willingness to Pay amount by Welsh Households surveyed.	Hyde & Christie (2002)
B20	Dry stone walls	The perceived benefits of dry stone walls by visitors to these ESAs appeared to be relatively low compared to other features supported by ESA policy and below average ratings amongst the general public.	Gourlay. D and Slee, B (1998) Public Preferences for Landscape Features: A Case Study of Two Scottish Environmentally Sensitive Areas. *Journal of Rural Studies,* Vol. **14**, No. 2, pp. 249-263

Table A 14 Landscape study characterisation: Prescription development and testing

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
B3	Wales	Tir Gofal – landscape features		Choice Experiment valuation				
B20	Scotland	Stewarty and Loch Lomond ESA	Dry stone walls	Choice experiment – ranking and qualitative assessment		Face-to-face interviews with *ca* 350 visitors to each of the ESAs, 400 residents in each area and 250 members of the general public outside the areas.		

Table A 15 Landscape results: Evaluations

Study No.[1]	Indicator(s)	Key findings	Reference
B1	Landscape features	Nine ESAs were judged to be successful in maintaining and enhancing landscape value, whilst all others were either partly successful or at least maintained landscape value. Not possible to assess the level of additionality achieved by the schemes. For CSS out of the sites where an assessment was possible and where there was some potential for landscape enhancement, a high proportion (74% of the sample), were meeting the objectives relating to landscape conservation and enhancement, with 93% of sites with CSS funded capital works meeting the objectives relating to appropriateness to local landscape character. The most successful of all CSS options were for field boundaries, with over 94% of agreements being effective in both maintaining and enhancing the landscape within agreements. Upland was the only landscape type showing poor performance in this respect, where only 35% of agreements were judged to be maintaining and enhancing the landscape. Agri-environment schemes throughout England have been successful in relation to their principal landscape objectives of maintaining valued landscapes.	Ecoscope (2003)
B2	Field boundaries	Most farms in Tir Gofal restored or created hedgerows, and significant investment in stone walls and other boundaries, but no baseline information on the overall length and condition of traditional boundaries, nor on trends over time. Most agreement holders were likely to invest in boundaries whether or not they were in Tir Gofal, but the scheme helped them to increase the amount of work they were able to fund and enabled them to do it more quickly.	Welsh Audit Office (2007) Report presented by the Auditor General for Wales to the National Assembly for Wales
B5	Field boundaries	Low additionality - 64 per cent of respondents stated that they would have invested in new field boundaries in the absence of the scheme, but the scheme had brought forward the investment or increase intended scale of the work.	Agra CEAS Consulting (2005) Socio-economic evaluation of Tir Gofal. Final Report for Countryside Council for Wales and Welsh Assembly Government
B6	Field boundaries	Landscape enhancement in all ESAs through maintenance or increases in characteristic landscape features eg. increase in estimated hedge length and new dry stone walls due to establishment and restoration, except Slieve Gullion ESA, where it had decreased. 285km of hedge planting over 10 years the majority (c. 63%) on participants land. An estimated 280km of hedge removal was recorded since baseline with most (c. 70%) occurring on non-participant land. Suggests that the ESA scheme had benefited both the establishment and retention of hedges on land under agreement having an overall net positive affect on the landscape. The majority (around 75%) were not actively managed including those under agreement. Across ESAs changes in broad land cover types such as grassland, heather moorland and woodland were relatively small, except in Slieve Gullion ESA where there was a significant loss of grassland due mainly to losses of unimproved species-poor grassland to buildings and amenity grassland.	McAdam, J. H., Flexen, M, McEvoy, P. M. and O'Mahony, D. (2006) Environmentally Sensitive Areas in Northern Ireland: Landscape monitoring of the ESA scheme 1995-2005. Report to Defra. Queen's University Belfast.
B7	Land cover elements Field boundaries	The ESA scheme instrumental in maintaining the characteristic landscape of each ESA by encouraging farmers to maintain major landscape elements and preserve vulnerable habitat. Lengths and numbers of boundaries increased in all ESAs except Slieve Gullion and this increase mainly due to increases in fences. Dry stone walls increased in the Mournes & Slieve Croob and the Sperrins ESAs. Some boundary removal (mainly hedges) noted in all ESAs except the Antrim Coast Glens & Rathlin. Removal occurred almost	McAdam, J. H., Cameron, A. Flexen, M, and Johnston, R.J. (2004) *Environmentally Sensitive Areas in Northern Ireland: Monitoring and evaluation of the ESA scheme between 1993 and 2003* Report. Faculty of Agriculture,

Study No.[1]	Indicator(s)	Key findings	Reference
	Heather moorland Woodland	exclusively on non-ESA farms with the exception of the West Fermanagh & Erne Lakeland ESA where some removal was noted on an ESA participant farm. Estimates of complete, stockproof boundaries increased in the Mournes & Slieve Croob, Fermanagh and Sperrins ESAs. Levels of boundary management increased in all ESAs except Slieve Gullion over the three-year period. Areas of heather moorland under ESA agreement increased considerably over period. Areas of all woodland types remained the same over the three-year period. Woodland area under ESA agreement increased	University College Dublin, Dublin, Irish Republic
B8	Broad habitats cover Grassland cover Broadleaved woodland cover Dwarf shrub heath cover Heather Moorland cover Wetland cover	Across the ESA as a whole, the areas of semi-natural grassland and broadleaf/mixed woodland Broad Habitats increased by amounts considerably in excess of the national trends. Decreases in areas of bogs, dwarf shrub heaths and bracken-dominated vegetation were considerably less than on equivalent land elsewhere in Scotland. The area of fen/marsh/swamp had apparently decreased more than predicted by national figures but the results are difficult to interpret Aims of avoiding damage and maintaining the area of semi-natural grasslands appear to have been achieved. However, aims of conserving, enhancing or extending areas of herb-rich grasslands, were apparently not achieved, mainly due to many sites being under-grazed. Scheme was successful in protecting the area of broadleaved woodland, increase across whole of ESA by 5% of area in 1995, mostly on in-scheme land. Across the ESA as a whole, general pattern of loss of dwarf shrub heath land cover types, especially dense dry heaths and wet heaths in general. This was predominantly due to changes on out-scheme land. Not been successful in maintaining the area or condition of heather vegetation, both of which had declined slightly more on in-scheme than on out-scheme land. The Tier 2 prescriptions had not achieved their overall aim of improving the cover, height and condition of *Calluna.* Broadly successful in maintaining the area of wetland vegetation	R.P. Cummins, A.J. Nolan, D. Scott, D.D. French, R.L. Hewison, D.J. Henderson, J.S. Bell, I.S.K. Pearce, C. Ellis, C. Mills, M. Marquiss, N. Picozzi, P.J. Bacon, D.A. Elston, S.C.F. Palmer (2005) Monitoring Environmentally Sensitive Areas in Scotland. Vol. 1: Argyll Islands ESA. Report to the Scottish Executive Environment and Rural Affairs Department
B09	Broad habitats	In the Breadalbane ESA, changes in the area of Broad Habitats were variable and not statistically significant. The general pattern was that three out of six semi-natural Broad Habitats showed positive trends in area compared to national trends, in line with the aims of the Scheme, and three showed negative trends, the latter due to a large increase in the area of native plantation woodland on out-scheme land within the boundary of the ESA.	Nolan, Cummins, R., Scott, D., French, D., Hewison, R., Bell, J., Henderson, D., Acton, A., Ellis, C., Mills, C., et al. (2007). Monitoring Environmentally Sensitive Areas in Scotland. Vol. 2: The Breadalbane ESA, Monitoring Report, 1995-2004 (Report to the Scottish Executive Environment and Rural Affairs Department).
B10	Broad habitats cover Grassland Woodland	Five out of seven semi-natural Broad Habitats (Grasslands, Fen/Marsh/Swamp, Broadleaf/Mixed woodland, Dwarf Shrub Heaths and Bracken) showed positive trends in area, the latter two in contrast to declines indicated by national trends. Two Broad Habitats (Bogs and Conifer woodland) showed an apparent decrease in area, but considerably less so than that indicated by comparisons elsewhere. Aims of maintaining area of semi-natural grasslands and moorland grass appear to have been achieved although on	J. S. Bell, R. P. Cummins, A.J. Nolan, D. Scot, D.D. French, R. L. Hewison, D. J. Henderson, I.S.K. Pearce, C. Ellis, C. Mills, P. Bacon, M. Marquiss, N. Picozzi, D.A. Elston, & S.C.F. Palmer (2007) *Monitoring Environmentally*

Study No.[1]	Indicator(s)	Key findings	Reference
	Dwarf shrub moorland Wetland cover Boundary features	out-scheme land the area of semi-natural grasslands actually increased Increased area of scattered trees and the area of regeneration, but area of woodlands decreased. Aim of improving the cover, height and condition of *Calluna* was achieved on land 100m away from the moorland or holding edge. However, on land nearer the edge, the Scheme was less successful, although slightly better than the out-scheme land Aim of maintaining area of wetland vegetation achieved Aim of maintaining the condition of dykes was not achieved	*Sensitive Areas in Scotland. Vol. 3: The Cairngorms Straths ESA* Report to the Scottish Executive Environment and Rural Affairs Department
B11	Broad habitats cover Grasslands Wetlands Woodlands Boundary features	Areas of semi-natural Broad Habitats appear to have been maintained and changes were similar to national trends. Only semi-natural grasslands showed any marked decrease in area in the ESA. Aims of avoiding damage and maintaining the area of semi-natural grasslands appear not to have been achieved. Similarly, the Tier 2 aims of conserving, enhancing or extending areas of herb-rich grasslands, were apparently not achieved, mainly due to many sites being under-grazed. Measures were successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land, but showed no clear advantage compared with out-scheme land Successful in maintaining the area of broadleaved and mixed woodland Length of hedges increased in the ESA, compared with a national trend of a small loss	D.Scott, R.P. Cummins, D.D. French, R.L. Hewison[1], L.Ross, C. Ellis, C. Mills, D.A. Elston, E.I. Duff, & S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 4: The Central Borders ESA.* Report to the Scottish Executive Environment and Rural Affairs Department
B12	Broad habitats	In the Loch Lomond ESA, changes in the area of Broad Habitats were variable and not statistically significant. The general pattern was that five out of six semi-natural Broad Habitats showed positive trends in area, in line with the aims of the Scheme and in contrast to declines indicated by national trends, notably in relation to dwarf-shrub heath and semi-natural grasslands.	Nolan, A. J., Cummins, R.P., Scott, D., French, D.D., Hewison, R.L., Bell, J.S., Henderson, D.J., Pearce, I.S.K., Ellis, C. Mills, C., Elston, D.A. & Palmer, S.C.F. (2007). *Monitoring Environmentally Sensitive Areas in Scotland Vol. 5: The Loch Lomond ESA Monitoring Report 1995-2004* (Report to the Scottish Executive Environment and Rural Affairs Department).
B13	Broad Habitats cover Herb-rich Grasslands Herb-rich Machair Grasslands Croppable machair	Area of all the semi-natural Broad Habitats had been maintained or increased, whereas arable and fallow land decreased significantly. Aims of avoiding damage and maintaining the area of semi-natural grasslands appears to have generally been achieved. However, the Tier 2 aims of conserving, enhancing or extending areas of these grasslands that were herb-rich were not achieved Aims of avoiding damage and maintaining the area of machair grasslands appear to have mostly been achieved Am for maintaining the area of croppable machair does not appear to have been achieved	I.S.K. Pearce, R.P. Cummins, A.J. Nolan, D.D. French, R.L. Hewison, D.J. Henderson, J.S. Bell, A. Acton, I.C. Crawford, C. Ellis, C. Mills, D.A. Elston, & S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 6: The Machair of the Uists and Benbecula, Barra and Vatersay ESA*. Report to the Scottish Executive Environment and Rural Affairs Department
B14	Broad Habitats cover	Areas of all the more natural Broad Habitats had been maintained	A.M. Truscott, R.P. Cummins, A.J. Nolan, D. Scott, D.D. French, R.L. Hewison, J.S. Bell, G.

Study No.[1]	Indicator(s)	Key findings	Reference
	Grasslands	Some increase in the area of herb-rich grasslands but showed no clear advantage over non-agreement areas	McGowan, C. Ellis, C. Mills, P.J. Bacon, N. Picozzi, R. van der Wal, D.A. Elston, S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 7: The Shetland Islands ESA.* Report to the Scottish Executive Environment and Rural Affairs Department
	Dwarf shrub Heaths	Broadly successful in improving the cover, height and condition of *Calluna* and there were clear benefits compared to out-scheme areas.	
	Wetlands	Successfully maintained the area of wetland vegetation but showed no clear benefits compared with out-scheme land	
	Boundaries	Successful at maintaining the overall length and condition of dykes.	
B15	Broad Habitats cover	3 out of 7 semi-natural Broad Habitats increased in area, in contrast to declines elsewhere. Two habitats were almost unchanged but dwarf shrub heaths decreased considerably in the ESA compared to an increase recorded elsewhere	R.P. Cummins, D. Scott, D.D. French, R.L. Hewison, J.S. Bell, D.J. Henderson, C. Ellis, C. Mills, D. Hawker, D.A. Elston, S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 8: The Combined Western and Central Southern Uplands ESA.* Report to the Scottish Executive Environment and Rural Affairs Department
	Woodlands	Woodland broad picture was one of general stability	
	Dwarf Shrub Heaths	General decline in quality and area of dwarf shrub heaths on in-scheme land. The overall decline here was generally greater than on out-scheme land.	
B16	Broad Habitats cover	Three out of six semi-natural Broad Habitats increased, with the decrease in two others less than national trends. Only dwarf shrub heaths and broadleaf woodland did less well in the ESA when compared to national trends.	D. Scott, R.P. Cummins, D.D. French, R.L. Hewison, I.S.K. Pearce, L. Ross, C. Ellis, C. Mills, I.C. Crawford, D. Hawker, D.A. Elston, S.C.F. Palmer (2007) *Monitoring Environmentally Sensitive Areas in Scotland. Vol. 9: The Stewartry ESA.* Report to the Scottish Executive Environment and Rural Affairs Department
	Wetlands	Successful in maintaining the area of wetland vegetation and avoiding damage on in-scheme land, but showed no clear advantage over out-scheme areas	
	Woodlands	Successful in maintaining the area of woodland.	
	Dwarf shrub heaths	Aims of maintaining the area, cover and condition of heather moorland were not achieved, although decreases were less than on out-scheme land.	
	Boundaries	Increase in the length of dykes, whereas hedge length was stable.	
B41	Landsape	Over 92% of farms in Tir Cymen were substantially addressing the issues of landscape management by identifying capital works.	Reaston, R., and Knightbridge, R. (1998). Tir Cymen monitoring and evaluation: second evaluation report (ENTEC Technical Report to CCW).
B42	Field boundary hedges	The CSS scheme have been instrumental in facilitating hedgerow restoration works throughout England and in particular enhancing the network through planting, and through encouraging laying. CSS has increased agreement holder's awareness of the environmental benefits of hedgerows and improved ongoing management with associated wildlife and landscape benefits.	Catherine Bickmore Associates (2004). *Hedgerow management and restoration in agri environment schemes: Part II Environmentally Sensitive Area Scheme*. Report to Defra.
B43	Field boundary hedges	The ESA scheme has been instrumental in facilitating hedgerow restoration works throughout England and in particular enhancing the network through planting, and through encouraging laying.	Catherine Bickmore Associates (2004). Hedgerow management and restoration in agri environment schemes: Part I Countryside Stewardship Scheme. Report to Defra.
B44	Field boundaries	Field boundaries have been monitored in all ESA areas with Baseline and Resurvey results available for four ESAs: Radnor, Ynys Mon, Preseli and Clwydian Range. The features were monitored using a stratified random sample of	Medcalf, K., Pawson, B., Horton, C., Rugg, I., Davis, J., and Jones, E. (1998). ANNEX 1 An

Study No.[1]	Indicator(s)	Key findings	Reference
		field boundaries within sample squares, distributed throughout the ESA. The baseline results for the four ESAs were broadly similar: Within the sample area, the ESA scheme has been successful at maintaining traditional field boundaries and has encouraged their positive management, compared to land which has not entered ESA agreement. However, positive management works have been noted on land not in ESA agreement, though not to the same extent. The level of change within the sample areas has been small. No changes to traditional boundaries have taken place on land in ESA agreement which represent breaches of ESA management prescriptions. However, removal or degradation of traditional field boundaries has taken place on land not in ESA agreement. Land in ESA agreement has shown an increase in the amount of hedgerow management. Tir Cymen: The Tir Cymen monitoring examined landscape change and the quality of field boundary restoration work on 140 farms under agreements, within the three pilot areas. Baseline surveys were carried out in either 1993 or 1994 with re-surveys three years later in 1996 or 1997. Results of the monitoring suggest that suitable capital works programmes had been initiated. Also, the restoration and/or maintenance of existing boundary features in 92% of sites sampled had been successful. Monitoring also assessed the standard of capital works, carried out on traditional boundaries. 84% of agreement holders had carried out works to an acceptable standard.	Interim Evaluation of the First Generation of Agri-Environment Schemes in Wales In the Context of Tir Gofal (Report to Welsh Office Agricultural Department (WOAD)).
B49	Field boundary dry stone walls	Survey of the condition of walls on 171 case-study agreement holdings in six ESAs, with complementary data on farmer attitudes, behaviour and costs. The quality of wall renovation work was also assessed on 89 case-study holdings in five ESAs. The survey found substantial variation in the wall maintenance commitment within and between the ESAs. For example, less than a fifth of all walls in the Cotswold Hills were identified as stock-proof, and holdings had on average only three walls to maintain under ESA prescriptions. In contrast over four-fifths of all walls in West Penwith were identified as stockproof, with holdings having on average 59 walls to maintain under ESA prescriptions. The report concluded that these substantial variations had implications for the costs of wall maintenance incurred between different holdings and between different ESAs. In most ESAs, a 'good' level of wall renovation was recorded for at least two-fifths of walls, with most of the remainder of the work being considered to be 'acceptable'	ADAS (2002) Environmentally Sensitive Areas Scheme: Dry Stone Walls on ESA Agreement Holdings, ADAS report to Defra
B54	Land cover, Linear features	During the monitoring period the landscape character of the ESA was generally maintained rather than being enhanced. Thus Objectives 1/2/3 have not been fully achieved. Land cover changes have generally been negative in terms of landscape, although small. The scheme has brought some beneficial changes to linear features particularly in the Rolling hill land and valleys landscape type through improved management of traditional boundaries. This has resulted in more hedges becoming laid, trimmed and stockproof in their own right. In this respect, Objective 4 has only partly been met.	ADAS (2000) Environmental Monitoring in the Cambrian Mountains ESA 1995 – 1999, Report to National Assembly For Wales Agriculture Department
B56	Land cover, Field boundaries	Landcover changes between 1994 and 2001 were small. ESA scheme maintaining land cover by preventing detrimental change, but it is not enhancing the landscape character. Total length of traditional boundaries reduced between1994 and 2001 by 1.1%, mainly non-stockproof hedges, although decrease is less than on non-agreement land and also less new inappropriate fencing has occurred. Whilst there is an increase in hedge trimming there is little evidence of hedges being improved or enhanced through hedge laying or coppicing.	ADAS (2002) Environmental Monitoring in the Clwydian Range ESA 1994 – 2001, Report to National Assembly For Wales Agriculture Department
B58	Landscape character, Land cover, Linear features	During the monitoring period the landscape character of the ESA was generally protected and the status quo maintained. Land cover changes and trends are generally insignificant, however the replacement of worn out fences to protect Coastal heath will lead to the enhancement of this feature in future years, which is beneficial. There is evidence that new side fencing to protect traditional boundaries is being carried out on agreement land and as a result there will be longer-term benefits to the landscape due to the protection of hedgebanks. However fencing will only prolong the life of the banks if maintenance work is carried out. Maintaining these features is a requirement of all ESA agreements, however, there has been no evidence of such boundary maintenance. Until such evidence is collected there must be some concern as to the effectiveness of the scheme in providing long-term protection. Overall, the ESA	ADAS (2001) Environmental Monitoring in the Preseli ESA 1994 – 1999, Report to National Assembly For Wales Agriculture Department

Study No.[1]	Indicator(s)	Key findings	Reference
		has prevented significant detrimental changes on agreement land. However, the extent of activity to manage, enhance or restore field boundaries by traditional practices remains small.	
B60	Landscape character, Land cover, Linear features	Overall, the landscape character of Radnor ESA has been generally maintained, rather than enhanced both in the period 1996 – 2000 and over the full monitoring period between 1993 and 2000. Land cover changes in the period 1996 – 2000, although small, were however generally negative and related to the on-going intensification of agriculture and the improvement of grassland, albeit mostly on non-agreement land. A substantial proportion of traditional hedges are being managed by laying, particularly on agreement land, thus renewing and sustaining the strong pattern of field boundaries that is so characteristic of the Radnor ESA landscape, No firm conclusions can be drawn from the overall effects of fencing changes on the landscape, however the small increase in the length of free-standing fences may result in a weakened network of traditional field boundaries. Objective 4 ('To maintain and restore the historic pattern of field boundaries and encourage the improvement in the standard of management') is directly related to landscape. This performance indicator has been met based on monitoring results over the period 1996 – 2000 and since the baseline in 1993.	ADAS (2002) Environmental Monitoring in the Radnor ESA 1993 – 2000, Report to National Assembly For Wales Agriculture Department
B62	Land cover, Linear features	Very few land cover changes to agreement and non-agreement land occurred during the re-survey period, however minimal negative change occurred on agreement land. The small scale, piecemeal improvement and development of semi-natural roughland is evident outside of agreement land, and is gradually weakening the landscape character. The ESA scheme is therefore maintaining rather than enhancing the diverse landscape character of Ynys Môn. There was a substantial increase in free-standing fences on both agreement and non-agreement land. Traditional boundaries such as banks and walls generally remained intact on agreement land, however only a few have been restored, and some trimming of hedges has taken place, in some landscape types inappropriately. The increase in fencing along traditional boundaries serves to protect rather than enhance them, and renders them useless rather than useful cultural and landscape features. Thus the ESA is only maintaining rather than enhancing the historic pattern of field boundaries, and does not appear to be encouraging a significant improvement in the standard of management. As a result Objective 4 is only being partly fulfilled on agreement land within the Ynys Môn ESA.	ADAS (2002) Environmental Monitoring in the Ynys Môn ESA 1993 – 2000, Report to National Assembly For Wales Agriculture Department
B64	Land cover Field boundaries	Changes on agreement land have been small but spread across seven of the 12 land cover classes. Changes have resulted in the loss of more valuable vegetation classes or habitats and this has been particularly obvious in one sample square where 60% of the total amount of negative change in area terms occurred, including the ploughing of part of an area under agreement as Tier 2A wetland. This change was directly related to a change in ownership of the land involved. ESA scheme has not had a significant impact in terms of the maintenance and enhancement of traditional field boundaries within sample squares over the period 1991 to 1998.	ADAS (2000) Environmental Monitoring in the Lleyn Peninsula ESA 1989–1998, Report to National Assembly For Wales Agriculture Department

Table A 16 Landscape study characterisation: Evaluations

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
B01	England & Wales	ESA, CSS	Landscape		Review			No	
B02	Wales	Tir Gofal	traditional boundaries, woodlands		Review	All agreements	No		1999 - Sep 2007
B05	Wales	Tir Gofal	landscape	scheme	Socio-economic monitoring	Face to face interviews with 20% of beneficiaries, stratified by farm type and size.		No	
B06	N. Ireland	All NI ESAs (Mournes & Slieve Croob ESA, Antrim Coast, Glens & Rathlin ESA, West Fermanagh & Erne Lakeland ESA, Sperrins ESA and Slieve Gullion ESA.)	Field boundary/ hedges	25 ha sq	Review	Baseline landscape surveys carried out in all five ESAs in 1995, using a stratified random sampling technique. Total of 183 quarter kilometre (25ha) squares were surveyed.	Yes	Yes	1995-2005
B07	N. Ireland	All NI ESAs as B6	Land cover elements	25 ha sq	Review	Refers to B6. Random 25 ha squares selected in proportion to the land class group areas. Total of 183 square	No	Yes	1993-2003
B08	Scotland	Argyll Islands ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 33 squares	Yes	Yes	1995-2004
B09	Scotland	Breadalbane	Land cover elements	landscape	Survey		Yes	Yes	1995-2004
B10	Scotland	Cairngorms Straths ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 32 squares	Yes	Yes	1995-2004
B11	Scotland	Central Borders ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 26 squares	Yes	Yes	1995-2004
B12	Scotland	Loch Lomond	Land cover elements	landscape	Survey		Yes	Yes	1995-2004
B13	Scotland	Machair of the Uists & Benbecula, Barra & Vatersay ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 40 squares	Yes	Yes	1995-2004
B14	Scotland	Shetland Islands ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 30 squares	Yes	Yes	1995-2004

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
B15	Scotland	Combined Western & Central Southern Uplands ESA	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 20 squares.	Yes	Yes	1995-2004
B16	Scotland	Stewartry ESA.	Land cover elements	landscape	Survey	Stratified random sampling using 1 km OS squares. Total of 26 squares.	Yes	Yes	1995-2004
B41	Wales	Tir Cymen	landscape	farm	Survey	Survey of 170 farms.	No	No	1993-1996
B42	England	All English ESAs	Hedges	sub-field	Survey	100 ESA agreements which include hedgerow restoration from 7 ESAs. Farmer perceptions assessed. Total of 774 hedges surveyed.	No	No	2003
B43	England	CSS	Hedges	sub-field	Survey	100 CSS agreements which include hedgerow restoration. Random sample stratified by Government Office Region and by total length of hedgerow work undertaken under the agreement. Farmer perceptions assessed. Total of 751 hedges surveyed.	No	No	2002-2003
B44	Wales	ESA Tir Cymen	Landscape elements	landscape farm	Survey	ESA: Sample of ancient monuments Tir Cymen: 10 farms selected to represent different conditions	No	ESA: yes Tir Cymen no	ESA: 1994-1997
B49	England	ESA	Field boundary dry stone wall	farm	survey	Survey of the condition of walls on 171 case-study agreement holdings in six ESAs.	No	No	2001
B54	Wales	ESA	Land cover field boundaries	landscape	Survey	45 sites were monitored, 29 on agreement land, 16 on non-agreement land in 1995. Resurveyed in 1999.	No	Yes	1995-1999
B56	Wales	ESA	Land cover field boundaries	landscape	Survey	17 sites selected for monitoring on agreement and non-agreement land in 1994. Survey discontinued due to difficulty in finding sites.	No	Yes	1994-1997
B58	Wales	ESA	Land cover field boundaries	landscape	Survey	35 sites selected for monitoring on agreement and non-agreement land in 1994. Resurveyed in 1997.	No	Yes	1994-1997
B60	Wales	ESA	Land cover field boundaries	landscape	Survey	28 sites selected for monitoring on agreement and non-agreement land in 1993. Resurveyed in 2000.	No	Yes	1993-2000
B62	Wales	ESA	Land cover	landscape	Survey	24 sites selected for monitoring on agreement	No	Yes	1993-2000

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Study duration
			field boundaries			and non-agreement land in 1993. Resurveyed in 2000			
B64	Wales	ESA	Land cover field boundaries	landscape	Air photo survey	270 sites selected for monitoring on agreement and non-agreement land in 1988. Resurveyed in 1997	No	Yes	1988-1997

Table A 17 Landscape results: Expert opinion

Study No.[1]	Indicator(s)	Key findings	Reference
B17	Ecology Landscape Historic features	Multidisciplinary evaluation of CSS using a an appraisal team The results of this appraisal process suggest that in the majority of cases the CSS agreements should maintain or enhance the environment in terms of ecology, landscape, and landscape history and increase public enjoyment of the countryside. Thirty-six percent of agreements showed high additionality and 38% medium additionality, which demonstrates that the CSS is likely to provide a benefit to society. Agreement negotiation, predicted environmental effectiveness and predicted compliance all improved significantly over the period 1996–98.	P.D. Carey, C. Short, C. Morris, J. Hunt, A. Priscott, M. Davis, C. Finch, N. Curry, W. Little, M. Winter, A. Parkin, & L.G. Firbank (2003) The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management* **69**, 71–91.
B18	Wildlife objectives	In a repeat of the Carey et al 2003 study (B17) 598 CSS and ESA scheme agreements were re-scored by an ecologist alone and compared to the scores of the multidisciplinary panel. The appropriateness of agreements was significantly lower for both schemes and the predicted environmental effectiveness of the ESA scheme was lower as well, when scored by the ecologist alone. They conclude that the results from Carey et al 2003 cannot be used to indicate the success/failure in terms of the wildlife objectives alone.	Peter D. Carey, Sarah J. Manchester, Les G. Firbank (2005) Performance of two agri-environment schemes in England. *Agriculture, Ecosystems and Environment* **108** 178–188

Table A 18 Landscape study characterisation: Expert opinion

Study No.[1]	Country	Scheme &/or prescription	Indicator(s)	Type of study	Consultees	No. consultees	Stats?	Baseline?	Study date(s)
B17	England	CSS	expert appraisal scores allocated for each of five criteria: agreement negotiation; appropriateness, environmental effectiveness, compliance and side effects.		Multi-disciplinary: desk study, interviews, field survey; and contextual data were collected all data was appraised by MD team	A stratified random sample of 500 CSS Agreements as taken and this represented approximately 10% of the expected total of 5000 agreements predicted to be signed between 1996 and 1998.			
B18	England	CSS and ESA			Comparison of ecological and multi-disciplinary evaluations	As above			

Table A 19 Landscape results: Case studies

Study No.[1]	Indicator(s)	Key findings	Reference
B19	Landscape assessment	Case studies of ESAs (West Penwith, Exmoor, The Cotswold Hills and South Wessex Downs) are described demonstrating how landscape assessment and scheme design has lead to landscape protection and enhancement	Bolton (2003) *Agri-Environment Schemes and Landscape Character Assessment in Practice*. In: The Countryside Character Network (CNN) workshop Landscape character assessment and agri-environment schemes 2003.

Table A 20 Landscape study characterisation: Case studies

Study No.[1]	Country	Region/ area	Scheme	Indicator(s)	Scale	Type of study	Baseline?	Control site(s)?[6]	Study duration
B19	England		ESA			Review			

Table A 21 Landscape Reviews

Study No.[1]	Indicator(s)	Key findings	Reference
B27	Historic features and archaeological sites	Despite the rather piecemeal collection of evidence on this aspect of scheme performance in some of the UK's regions, the overwhelming impression is of a range of agri-environment schemes in which landscape protection and enhancement are likely to be being achieved to a relatively high degree. However, this has to be set in context when considering the extent and pattern of schemes' uptake, in different regions. Thus for the ESA schemes, those with a high overall uptake level are likely to have been able to achieve potentially significant landscape benefits within their areas while those with much lower uptake relative to the total designated area will have performed less well, all else being equal. Similarly for the whole suite of schemes, the higher overall uptake of AES in Scotland, Wales and Northern Ireland (as expressed relative to total UAA) may mean that the schemes in these regions have made a clearer impact upon landscapes than those in England where uptake is relatively scattered and less significant as a proportion of total farmland	Dwyer, J. and Kambites, C. (2005) AGRI-ENVIRONMENTAL MEASURES EVALUATION AGRI/ G4/ 2004, CCRU
B35	Historic features and archaeological sites	Loss of overall landscape character and diversity and both loss and poor management of landscape features were referred to as problems in all countries although greater emphasis appears to be given to these issues in England and Scotland. In Wales, problems were identified in the context of historic landscapes but this may reflect greater awareness of the issue rather than a more severe problem. In Northern Ireland, landscape change was emphasised in relation to changes in habitats and the specialisation of farming, especially in lowland areas. There appear to be no overall Government targets or strategies for landscapes outside of designated areas, suggesting it is given lower priority than other environmental issues. Stakeholders in all four countries did however raise concerns about landscape change, often in relation to biodiversity issues.	Swales, V., Dwyer, J., and Farmer, M. (2005). *Environmental priorities in the UK Rural Development programmes* Report to LUPG. (LUPG).

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Promotion of public access

Table A 22 Access results: Evaluations

Study No. [1]	Indicator(s)	Key findings	Reference
B01	Access	Early reviews highlight the wide variability in benefits derived from access options and little work on usage had been undertaken. The review focused on educational access in CSS and access options within ESAs. Curry and Short (1998) reviewed 50 agreements; few had a strategic approach to offering educational visits. The level of additionality was questionable in 5o% of agreements. In ESAs it was noted that there has been limited take up and low levels of usage by 2002.	Ecoscope/CPM/CJC Consulting (2003) Review of agri-environment schemes - monitoring information and R&D results (RMP/1596)
B30	Access	Detailed analysis of 30 access agreements under CSS and ESA in Shropshire, Staffordshire, Derbyshire/Peak District. Followed up with postal survey of Rights of Way officers, countryside staff and FRCA agri-environment managers. He concludes that the access provision under agri-environment schemes does not fit into the work programme of ROW officers and offers little value for money. He also concludes that provision under AES is supply driven rather than demand-led [There is also little connection between, and calculation of, supply and demand. Three good case studies were identified and he suggests a more targeted approach that integrates the schemes into the existing network.	Bentley J (2001) Countryside access: strategic planning, coordination and agri-environment schemes, *Countryside Recreation* 9 (2) Summer 8-13. Bentley J (2002) *The contribution of access agreements under agri-environment schemes towards the provision of new access in the countryside* RICS research paper Vol 4 No 6. RICS London. Bentley J (2001) *Countryside access: strategic planning, coordination and agri-environment schemes,* RICS research paper Vol 4 No 19. RICS London.
B31	Access	In a review of access provisions within CSS and ESAs, Garrod concluded that the 'value for money' (VFM) with too few schemes effectively linking into the existing network and providing access routes that meet public demand. A few schemes delivered excellent value for money.	Garrod W, Willis K, Raley M and Rudden M (1998) *Economic evaluation of the access provisions in the MAFF agri-environment programmes* Final report to MAFF, Newcastle upon Tyne.
B32	Educational access	Teachers value the opportunity but transport costs and lack of awareness about the Countryside educational visit accreditation scheme and the information this contains reduce the potential value of the trip. Health and safety is an issue. Recent changes to the scheme had been welcomed by agreement holders. Lapsed farmers could not secure the required number of visits in nearly all cases.	ADAS (2007) *Review of educational access under Defra agri-environment schemes* Report to Defra
B02	Access	The report concluded that Tir Gofal increase the public's opportunities for access to the countryside but problems remain about partnership working, permissive access and educational access. Quoted the B21 to note that rights of way within Tir Gofal are not better than elsewhere in Wales. Permissive access areas are not monitored but evidence suggested that such areas are not widely or clearly promoted. Some 4,200 educational visits have taken place but some farmers struggle to reach the 6 /year required to claim the £500.	Welsh Audit Office (2007) Report presented by the Auditor General for Wales to the National Assembly for Wales

Study No.[1]	Indicator(s)	Key findings	Reference
B05	Access	Permissive access areas are not monitored but evidence suggested that such areas are not widely or clearly promoted. Some 4,200 educational visits have taken place but some farmers struggle to reach the 6 /year required to claim the £500.	Agra CEAS Consulting (2005) Socio-economic evaluation of Tir Gofal. Final Report for Countryside Council for Wales and Welsh Assembly Government
B33	Access	The core survey assessed the condition of 3,283 km of rights of way within 225 randomly selected survey squares. The length of paths surveyed was calculated to provide statistically reliable and representative information about path condition within each authority area. In total 12% or 76km of the rights of way in Tir Gofal areas was included in the sample survey of agreements from 2000-02. Paths in Tir Gofal farms were generally no better than the average for all of Wales and signposting of paths from roads was poorer.	Exegesis (2003) *Wales Rights of Way Condition Survey 2002* Final Report for Countryside Council for Wales, May 2003
B24	Access	The report evaluates the performance of the first generation of agri-environment schemes in Wales. Monitoring of the first three years of the Tir Cymen access provisions was carried out during 1996 and 1997. The study concluded that after only three years some 27.6 square kilometres of farmland (primarily moorland and upland grassland) was available for new public access. This constituted some 8.6% of the total area of secured access within Wales. In addition a further 700 kilometres of Public Right of Way were incorporated into agreements, along with 43 kilometres of new permissive paths. Taken together these totals comprised some 2% of the total length of linear access provision within Wales. Whilst the monitoring did discover some isolated instances of obstruction on Public Rights of Way, these tended to occur on routes that were perceived by farmers as not being used. Since the most recent data obtained by CCW indicates that approximately 20% of PRoW in Wales are either impassable or usable only with great difficulty, the survey suggests a significant improvement in accessibility had taken place on the 556 study farms. Monitoring has not been carried out on ESA agreement land.	CCW and FRCA (1999) *An Interim Evaluation of the First Generation of Agri-Environment Schemes in Wales In the Context of Tir Gofal* report to WOAD.
B34	Access	Large areas that have potential for quiet enjoyment through the scheme. Farmers are becoming more accepting of access.	CEI (1997) *Evaluation of the access provisions of the Tir Cymen scheme* report to Welsh Assemply CEI, Manchester Metropolitan University.
B06	Access	No actual figures reported but noted that RoW in NI are less frequent than in England and Wales. A survey in 1998 noted that 50% of those in ESAs would be willing tom consider access provision compared to 35% of non-participants.	McAdam, J. H., Flexen, M, McEvoy, P .M. and O'Mahony, D. (2006) Environmentally Sensitive Areas in Northern Ireland: Landscape monitoring of the ESA scheme 1995-2005. Report to Defra. Queen's University Belfast.
B07		No actual figures reported but noted that RoW in NI are less frequent than in England and Wales. A survey in 1998 noted that 50% of those in ESAs would be willing tom consider access provision compared to 35% of non-participants.	McAdam, J. H., Cameron, A. Flexen, M, and Johnston, R. J. (2004) Environmentally Sensitive Areas in Northern Ireland: Monitoring and evaluation of the ESA scheme between 1993 and 2003 Report. Faculty of Agriculture, University College Dublin, Dublin, Irish Republic

Table A 23 Access study characterisation: Evaluations

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base-line?	Study duration
B01	England & Wales	ESA, CSS	Access	N/A	Review	Evaluation reports	limited	No	2002 or earlier
B30	England	CSS and ESA	access	Agreement	Survey and questionnaire	30 agreements in Shropshire, Staffordshire, Derbyshire/Peak District	No	No	1995-2000
B31	England	CSS and ESAs	access	Agreement and wider GIS analysis in 4 case study areas.	Desk study, interviews with land managers and project officers, user survey and focus groups	Desk study, interviews with land managers and project officers, user survey and focus groups	Yes (economic)	Yes	Pre 1998
B32	England	CSS and ESAs	Educational access	scheme	Review	Stratified sample including Agreement holders, users of the sites, 'lapsed' agreement holders and stakeholders	No	No	2006 or earlier
B02	Wales	Tir Gofal	Permissive access, educational access	scheme	Review	All agreements	No	No	1999 - Sep 2007
B05	Wales	Tir Gofal	Access	scheme	Socio-economic monitoring	Face to face interviews with 20% of beneficiaries, stratified by farm type and size.	N/a	No	N/a
B33	Wales	Tir Gofal	access	Rights of way survey	Survey and questionnaire	Condition of 3,283 km of rights of way within 225 randomly selected survey squares. In total 12% or 76km of the rights of way in Tir Gofal areas was included	Yes	Yes	2000-2002
B24	Wales	Tir Cymen, ESAs	access	scheme	Other evaluation and monitoring reports	All monitoring reports	Yes	Yes	Pre 1999
B34	Wales	Tir Cymen	Access	scheme	Review	File searches, Interviews with Tir Cymen officers, and farmers. Field survey of all 45 permissive paths in the scheme. Field survey of all 45 permissive paths in the scheme.	No	No	1997 or earlier
B06	N. Ireland	All NI ESAs (Mournes	access	25 ha sq	Review	Baseline landscape surveys carried out in all five	Yes	Yes	1995-2005

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base-line?	Study duration
		and Slieve Croob ESA, Antrim Coast, Glens and Rathlin ESA, West Fermanagh and Erne Lakeland ESA, Sperrins ESA and Slieve Gullion ESA.)				ESAs in 1995, using a stratified random sampling technique. Total of 183 quarter kilometre (25ha) squares were surveyed.			
B07	N. Ireland	All NI ESAs as B6	access	25 ha sq	Review	Refers to B6. Random 25 ha squares selected in proportion to the land class group areas. Total of 183 square	No	Yes	1993-2003

Table A 24 Access results: Expert opinion

Study No.[1]	Indicator(s)	Key findings	Reference
B17	Ecology, landscape, historic features and access	Multidisciplinary evaluation of CSS using a an appraisal team The results of this appraisal process suggest that in the majority of cases the CSS agreements should maintain or enhance the environment in terms of ecology, landscape, and landscape history and increase public enjoyment of the countryside. Thirty-six percent of agreements showed high additionality and 38% medium additionality, which demonstrates that the CSS is likely to provide a benefit to society. Agreement negotiation, predicted environmental effectiveness and predicted compliance all improved significantly over the period 1996–98.	P.D. Carey, C. Short, C. Morris, J. Hunt, A. Priscott, M. Davis, C. Finch, N. Curry, W. Little, M. Winter, A. Parkin, L.G. Firbank (2003) The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management* **69**, 71–91
B18	Wildlife objectives only, excluding access	In a repeat of the Carey et al 2003 study (B17) 598 CSS and ESA scheme agreements were re-scored by an ecologist alone and compared to the scores of the multidisciplinary panel. The appropriateness of agreements was significantly lower for both schemes and the predicted environmental effectiveness of the ESA scheme was lower as well, when scored by the ecologist alone. They conclude that the results from Carey et al 2003 cannot be used to indicate the success/failure in terms of the wildlife objectives alone.	P. D. Carey, S. J. Manchester , L. G. Firbank (2005) Performance of two agri-environment schemes in England. *Agriculture, Ecosystems and Environment* **108,** 178–188
B35	access	Facilitating public access to the countryside and maintaining the existing network were considered as important environmental issues by stakeholders. There are variations across the UK in the number of RoW, for example there are less in NI and East England and in Scotland there are issues with community land rights. However, they note that at government level there are few explicit targets relating to public access provision in agri-environment schemes. There is a good case study of public access in Fife.	Swales V, Dwyer J and Farmer M (2005) *Environmental priorities in the UK Rural Development programmes* Report to LUPG.

Table A 25 Access study characterisation: Expert opinion

Study No.[1]	Country	Scheme &/or prescription	Indicator(s)	Type of study	Consultees	No. consultees	Stats?	Baseline?	Study date(s)
B17	England	CSS	Expert appraisal covering all scheme aims including access Scores allocated for each of five criteria: agreement negotiation; appropriateness, environmental effectiveness, compliance and side effects.	Agreement review	Multi-disciplinary: desk study, interviews, field survey; and contextual data were collected all data was appraised by MD team	A stratified random sample of 500 CSS Agreements as taken and this represented approximately 10% of the expected total of 5000 agreements predicted to be signed between 1996 and 1998.	Limited	Yes, partial	1997-2002
B18	England	CSS and ESA	Wildlife objectives	Re-evaluation of data	Comparison of ecological and multi-disciplinary evaluations	As above	Limited	No	1997-2002
B35	UK	All schemes	Access	Review of monitoring reports	LUPG	Not specified	No	No	Pre 2004

Table A 26 Access results: Case studies

Study No.[1]	Indicator(s)	Key findings	Reference
B04	Access	By 1998, 61km of permissive paths had been created and 700km of maintained permissive rights of way (not sure of the difference between these two). Also access to 35,000 ha of open moorland.	CCW (2003) LANDMAP Case Study 13. Agri-Environment Planning[18]

Table A 27 Access study characterisation: Case studies

Study No.[1]	Country	Region/ area	Scheme	Indicator(s)	Scale	Type of study	Baseline?	Control site(s)?[6]	Study duration
B04	Wales	Wales	Tir Cymen	access	region	Evaluation using Landmap	No	No	2001-03

[18] http://landmap.ccw.gov.uk/files/CaseStudy_13.pdf

Table A 28 Access results: Reviews

Study No.[1]	Indicator(s)	Key findings	Reference
B36	access	Commenting on the 1998 review of Tir Cymen Banks and Marsden note that while conservation improvements were found the benefits were just as great in areas where access had been improved or introduced.	Banks J and Marsden T (2000) Integrating agri-environmental policy, farming systems and rural development: Tir Cymen in Wales *Sociologia Ruralis* 40 (4) 466-480
B37	access	In the agreement holder questionnaire 45% indicated that the access created under the scheme would stop when the scheme ended	Crabb J, Short C and Temple M (2000) *Economic evaluation of Countryside Stewardship* report to MAFF CCRU and ADAS.
B31	access	In a review of access provisions within CSS and ESAs, Garrod concluded that the 'value for money' (VFM) with too few schemes effectively linking into the existing network and providing access routes that meet public demand. A few schemes delivered excellent value for money.	Garrod W, Willis K, Raley M and Rudden M (1998) *Economic evaluation of the access provisions in the MAFF agri-environment programmes* Final report to MAFF, Newcastle upon Tyne.
B38	access	Mid term review of ESAs revealed that only 11 out of the 22 English schemes had any take up for access and this covered only 47 hectares.	Slater J (2003) *Mid-term review of the ERDP: ESAs* ADAS report to Defra
B39	access	The report notes that CSS has no target framework for access as participants are very wary of the access options since CROW was introduced. Management of open access a key issue.	Finch C and Slater J (2003) *Mid-term review of the ERDP: CSS* ADAS report to Defra
B22	access	The reports notes that despite the Scottish Land Reform Act (2003), which gives statutory rights for non-motorised access over most areas, there is still a demand for access over agricultural land. ESAs have offered this in the past as a voluntary option but there has been very little take up because of issues with community land rights. The development of a core plan by local authorities that looks at demand as well as the condition of supply is an interesting development. The uptake from farmers for the access options of the LMC Menu Scheme introduce in 2005 is high with 406 involved in farm and woodland visits (£100 per visit) and 4,145 farmers developing 2,400 km of new access paths (£2.75 /m).	Unknown (2005) *The state of Scotland Farmed Environment* Report to SEERAD

Natural resource protection

Table A 29 Resource protection results: Prescription development and testing

Study No.[1]	Indicator(s)	Key findings	Reference
A243	Sediment Phosphorus	No consistent effect of the buffer zones on suspended solids in the stream was observed during the study. It was noted that the study was conducted over a short time period and that site-specific sizing of buffers may be required.	Leeds-Harrison, P.B., Quinton, J.N., Walker, M.J., Harrison, K.S., Tyrrel, S.F., Morris, J., Mills & Harrod T. (1996). Buffer zones in headwater catchments. MAFF/English Nature report Project CSA 2285.
A261	Nitrate	Nitrate losses from winter barley were greater than from areas with cover crops, but only during wet periods and more so from a sandy loam; otherwise nitrate losses were similar.	Macdonald, A.J., Poulton, P.R. Howe, M.T. Goulding, K.W.T. & Powlson, D.S. (2005) The use of cover crops in cereal-based cropping systems to control nitrate leaching in SE England. *Plant and Soil* **279**, 355-373.
A255	Nitrate Phosphorus	Redox potential in the peat indicated potential for N mineralisation in the summer and the reduction of Fe-bound P in the winter and the production of ammonium, which could have implications for water quality although this was not specifically measured during this study.	Kieckbusch, J.J. & Schrautzer, J. (2007). Nitrogen and phosphorus dynamics of a re-wetted shallow-flooded peatland. *Science of the total Environment* **380**, 3-12.
A239	Runoff Phosphorus	Results variable and site specific (soil type/slope). Site 1, understorey halved runoff compared to conventional and chisel ploughing reduced runoff by 90%. Conversely, at another site chisel ploughing increased the incidence of runoff. Sowing a winter cover crop also increased runoff at one site. The clover understorey reduced overland flow and suspended solids by > 50%, but yield was reduced by almost the same!	Anon (2001) Soil erosion in maize. Defra report SP0404
A242	Soil compaction Organic matter Runoff	Organic matter in the top 7cm of the soil was lower where grazing intensity was higher; bulk density was higher in the surface soil. It was suggested that runoff occurred more rapidly on the land subject to higher grazing pressures. This was largely attributed to the change in vegetation structure and the soil moisture content, rather than the grazing per se.	Meyles, E.W., Williams, A.g>, Ternan, J.L., Anderson, J.M., & Dowd, J.F. (2006). The influence of grazing on vegetation, soil properties and stream discharge in a small Dartmoor catchment, southwest England, UK. *Earth surface Processes and Landforms*, **31**, 622-631.
A150	Phosphorus Sediment	The very limited data set indicates a reduction in sediment load to the Loch due to the buffer strip, BUT, there is also evidence that concentrated flows are unaffected by the 20m buffer strip and TP loads are not reduced accordingly.	Vinten,A.J.A., Crawford, C., Cole, L., McCracken, D. I., Sym, G., Duncan, A. & Aitken, M. N. (2004) *SAC and SEPa Biennial Conference, Edinburgh, 24-25 March 2004* (eds D.Lewis & L.Gairns), pp. 42-50.
A259	Nitrate	Comparing N leaching losses from stubble vs. winter barley, losses were significantly greater from stubble in the first year, but lower in the second year, so no effect could be determined.	Vinten, A. J. A., Ball, B. C., O'Sullivan, M. F., Henshall, J. K., Howard, R., Wright, F., & Ritchie, R. (2002) The effects of cultivation method and timing, previous sward and fertilizer level on subsequent crop yields and nitrate leaching following cultivation of long-term grazed grass and grass-clover swards

Study No.[1]	Indicator(s)	Key findings	Reference
			Journal of Agricultural Science **139,** 245-256
A241	Soil compaction	The results were contrary to most published research and there was no definitive relationship between stocking density and soil compaction as measured by bulk density or infiltration rate. It was recommended that more research, particularly with peaty soils would be required to determine recovery from reduced stocking rates.	Carrol, Z.L., Reynolds, B., Emmett, B.A., Sinclair, F.L., Ruiz de Ona, C. & Williams, P. (2004). The effect of stocking density on soil in upland Wales. Countryside Council for Wales Contract Science Report No. 630.
A248	Pesticide Nitrate Phosphorus Runoff	Results were variable. Reductions compared to no-grass strip varied in the ranges: Runoff 43% to ~ 100%, Suspended solids 87% to 100%; pesticides 44% to 100% (compound-dependent); nitrate 47% to 100%; phosphate 22% to 89%.	Patty, L, Benoit, R. & Gril, J.J. (1997) The use of grassed buffer strips to remove pesticides, nitrate and soluble phosphorus compounds from runoff water. *Pesticide Science* **49,** 243-251.
A240	Pesticide	At a wind speed of 4.5m/s no drift was detected in the ditch regardless of nozzle type for the 6 m buffer.	de Snoo, G.R., & Wit, P.J. (1998) Buffer zones for reducing pesticide drift to ditches and risks to aquatic organisms. *Ecotoxicology and environmental safety* **43,** 112-118.
A240	Pesticide	At a wind speed of 4.5m/s drift deposition is reduced by > 90% with a 3 m buffer regardless of nozzle type.	de Snoo, G.R., & Wit, P.J. (1998) Buffer zones for reducing pesticide drift to ditches and risks to aquatic organisms. *Ecotoxicology and environmental safety* **43,** 112-118.
A253	Nitrate Phosphorus Sediment	Sediment deposition was a major source of N and P in all floodplain communities. Highest deposition rates were found where water velocity was reduced (reed beds; pond). There was no significant difference between deposition in woodlands and grasslands.	Olde Venterink, H., Vermaat, J.E., Pronk,M., Wiegman, F., van der Lee, G.E.M., van den Hoorn, M.W., Higler, L.W.G. & Verhoeven, J.T.A. (2006) Importance of sediment deposition and denitrification for nutrient retention in floodplain wetlands. *Applied Vegetation Science* **9,** 163-174.
A249	Nitrate	Riparian buffers were on average effective at reducing nitrate whilst increasing ammonium in groundwater. Soil type (drainage and parent material) had a strong influence on groundwater nitrate in both cropland and riparian buffer soils.	Young E.O. & Briggs R.D. (2005) Shallow groundwater nitrate-N and Ammonium-N in cropland and riparian buffers. *Agriculture Ecosystems & Environment* **109**, 297-309.
A246	Sediment	Soil loss was reduced in 1993, 1994 & 1995 by 42, 66, 72% (conventional till); 20, 64, 57% (no-till); 65, 84, 88% (bare-fallow) in the presence of a grass strip.	Raffaelle, J.B., McGregor, K.C., Foster, G.R. & Cullum, R.F. (1997). Effect of narrow grass strips on conservation reserve land converted to cropland. *Transactions of the ASAE* **40** (6), 1581-1587.

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 30 Resource protection study characterisation: prescription development and testing

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
A243	England	6m buffer strip on cultivated land	Sediment Phosphorus	Experiment		Suspended sediment measured (mg/L) from 3 catchments containing buffered and un-buffered sites	No	
A261	England	Cover crop/under-storey	Nitrate	Experiment		Field experiments compared bare fallow followed by spring barley, cover crops followed by spring and winter barley, all followed by further winter barley for nitrate leaching losses on 2 sites (sandy loam & chalk loam).	Yes	
A255	England	floodplains/wet meadows	Nitrate Phosphorus	Experiment		A lowland wet grassland restored from intensive agriculture in Somerset fens was monitored for water moisture and redox at 10, 30, 60, & 90 cm depth on a daily basis.	Not applicable	2001
A239	England	Management of maize crops to reduce soil erosion	Runoff Phosphorus	Experiment		3 study sites had 4.5 x 10m hydrologically isolated plots. Surface water, particulates and P monitored. Treatments were conventional bare stubble, chisel ploughed stubble, Italian ryegrass understorey, ryevron winter cover crop, cultivation across slope, cultivation along slope.	No	1998/89; 1999/00; 2000/01
A242	England	Shepherding supplement	Soil compaction Organic matter	Experiment		Rainfall and runoff were monitored in a 61ha catchment in Dartmoor. Antecedent precipitation index was used to relate rainfall to soil moisture data; the latter was monitored using time domain reflectometry. 151 measurements wre made on 19 occasions. Physical soil characteristics were made at 23 locations. GIS was used to create a vegetation map. Grazing pressures were estimated from observation on 15 site visits, noting the location of the animals.	Yes	Dec 1998 - June 2000
A150	Scotland	6m buffer strip on cultivated land	Phosphorus Sediment	Experiment		Monitoring of water en route to an in loch during storm events using automatic water sampler after the implementation of a 20m buffer strip. Results are compared to water quality parameters before the buffer strip. There is little detail on this previous data, and no detail on analysis.	No	2002-2004
A259	Scotland	overwinter stubble	Nitrate	Experiment		A 3-year field experiment investigated the fate of N released after cultivation of previously long-term grass and grass-clover swards. The effects of timing of cultivations (autumn and spring), tillage methods (no tillage, ploughing to 200 mm and ploughing to 300 mm) and fertilizer N for spring (0, 40, 80 and 120 kg N/ha) and winter barley (0, 60, 120, 180 kg N/ha) on yield, N uptake and nitrate leaching were measured	Yes	1996-1998
A241	Wales	Shepherding supplement	Soil compaction	Experiment		3 plots on 3 sites in upland Wales were monitored for bulk density, infiltration rate and other soil properties at different grazing densities	No	2000
A248	France	Beetle banks	Nitrate Phosphorus Pesticide	Experiment		Cultivated plots (250m2) were bordered by a 20-m long ryegrass strip. Runoff was collected via galvanised metal sheet feeding to a collection tank at 0, 6, 12 or 18 m from the edge. Crops were corn or winter wheat.	Not applicable	May 94-March 95
A240	Netherlands	4m buffer strip on cultivated	Pesticide	Experiment		50 m length of field sprayed with 7 collectors measuring drift in the sprayed field, in the ditch and the adjacent field. Different nozzles were tested under		

Study No.[1]	Country	Prescription	Indicator(s)	Type of study	Design	Sampling approach	Stats?	Study duration
		land				various wind speeds and 3-m and 6-m buffer zones		
A240	Netherlands	6m buffer strip on cultivated land	Pesticide	Experiment		50 m length of field sprayed with 7 collectors measuring drift in the sprayed field, in the ditch and the adjacent field. Different nozzles were tested under various wind speeds and 3-m and 6-m buffer zones		
A253	Netherlands	floodplains/wet meadows	Nitrate Phosphorus Sediment	Experiment		Five communities (reed bed, woodland, pond, semi-natural grassland, agricultural grassland) with 5 plots on each on the floodplains of two rivers were monitored for sediment, nutrients, denitrification and productivity.	Yes	2 flood events
A249	US	6m buffer strip on cultivated land	Nitrate	Survey	Paired field	Samples of shallow ground water, tile drainage and stream water from cropland, grass, Salix grass and native forest riparian buffers were taken approximately monthly over 6-9 months and analysed for nitrate and ammonium. Buffers averaged 9 m width.	Yes	2003
A246	US	Beetle banks	Runoff Sediment	Experiment		Duplicate plots 10m x 3.7m on a 10% slope with grass strips 0.6 - 0.8 m at the base, Corn planted above. Tests: Conventional till, no-till, bare fallow all with and without grass strip. Rainfall applied at successive intervals to give varying antecedent moisture conditions. 1h rain, 4h dry, 30 min rain, 30min dry, 30 min rain. intensity ~ 50-65 mm/h.	Yes	1993-1995

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 31 Resource protection results: Evaluations

Study No.[1]	Indicator(s)	Key findings	Reference
A257	ammonium	There was a 100-fold in crease in ammonium levels following the inundation of the land, a decrease in pH and a reduction in soil redox potential. These have implications for water quality, but this was a short-term study.	Blackwell, S.A., Hogan, D.V. & Maltby, E. (2004) The short-term impact of managed realignment on soil environmental variables and hydrology. *Estuarine, Coastal and Shelf Science* **59**, 687-701.
A256	Phosphorus	There was an increase in soluble P in the river draining the fen area when a programme of re-wetting was introduced (~ 30% of the catchment). P dynamics were inversely related to redox potential which in turn is influenced by water level fluctuations.	Rupp, H., Meissner, R, & Leinweber, P. (2004) effects of extensive land use and re-wetting on diffuse phosphorus pollution in fen areas - results from a case study in the Dromling catchment, Germany. *Journal of Plant Nutrition and Soil Science* **167**, 408-416.

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 32 Resource protection study characterisation: Evaluations

Study No.[1]	Country	Scheme	Indicator(s)	Scale	Type of study	Sampling approach	Stats?	Base line?	Control?	Study duration
A257	England	saltmarshes	ammonium	km2	Survey	Agricultural land that had been historically-reclaimed from saltmarsh was flooded by allowing the defence to be breached. Water level, conductivity, redox potential and ammonium were monitored in top soil water.	N/A	Yes	N/A	2000
A256	Germany	floodplains/ wet meadows	Phosphorus	km2	Survey	The impacts of a re-wetting programme were monitored. Redox potential and water level were monitored in peat areas, alder woods, and re-wetted intensive grassland. The river was monitored for P. Time series analysis was used to illustrate water fluctuations and river-P content in relation to land use change (including re-wetting) over 7 years.	N/A	No	n	2000-2003

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 33 Resource protection results: Case studies

Study No.[1]	Indicator(s)	Key findings	Reference
A254	Nitrate Phosphorus	Nitrate was retained in both fens, but phosphate and organic N was exported. It was proposed that the speed of inundation (a few years) and lack of continuous flow may have contributed to this.	Kieckbusch, J.J. & Schrautzer, J. (2007). Nitrogen and phosphorus dynamics of a re-wetted shallow-flooded peatland. *Science of the total Environment* **380**, 3-12.

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 34 Resource protection study characterisation: Case studies

Study No.[1]	Country	Region/ area	Scheme	Indicator(s)	Scale	Type of study	Baseline?	Control site(s)?	Study duration
A254	Germany	N. Germany - fen	HSL	Nitrate Phosphorus	km2	Survey	No	No	May 1999 - Dec 2001

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 35 Resource protection: Reviews

Study No.[1]	Indicator(s)	Key findings	Reference
A245	Pesticide Nitrate Phoshporus Sediment	Direct reduction of nutrients and pesticides by distancing application from watercourse. Long-term performance not guaranteed - several studies demonstrate the buffer can become a source of pollutants. Limited work conducted at catchment scale. Linear buffer may be restrictive - need larger buffer area around site-specific pollutant pathways/sources. Buffers can reduce nitrate losses if no underdrainage. Fine sediment unlikely to be removed from buffer < 5m. Variable results for reduction in P, some studies demonstrated increase in soluble P	Muscutt A.D., Harris, G.L., Bailey, S.W. & Davies, D.B. (1993). Buffer zones to improve water quality: a review of their potential use in UK agriculture. *Agriculture, Ecosystems and Environment* **45**, 59-77.
A247	Phoshporus Pesticide Nitrate Sediment	Buffers need to be maintained and sediment removed to remain effective. Nitrate can be reduced by ~ 50%. Phosphorus can be reduced but effectiveness highly variable. Buffers highly effective at removing strongly-sorbing pesticides but performance more variable for moderately-sorbing compounds.	Lovell S.T. & Sullivan W.C. (2006) Environmental benefits of conservation buffers in the United States: Evidence, promise, and open questions. *Agriculture Ecosystems & Environment* **112**, 249-260.
A244	Pesticide Sediment	Buffer width - substantial increase in sediment retention up to 5m, but little additional retention > 5m. Retention a function of particle size - finer particles may not be retained. Regardless of width. No conclusive evidence as to the influence of area ratio (contributing area: strip area). Indirect evidence that vegetation type may affect herbicide retention efficacy - promoting infiltration is important. Buffer efficiency may decrease with age as sediment builds up - BUFFER SHOULD BE INSPECTED AFTER LARGE STORMS - if sediment accumulates at buffer/edge of field interface, could divert sheet flow into rill flow.	Krutz, L.J., Senseman, S.A., Zablotowicz R.M. & Matocha, M.A. (2005) Reducing herbicide runoff from agricultural fields with vegetative filter strips: a review. *Weed Science* **53**, 353-367.
A250	Pesticide	The effectiveness of grassed buffer strips at the lower edges of fields is very variable and the variability cannot be explained by strip width alone. Riparian buffer strips are most probably less effective than edge-of-field. Subsurface drains are an effective mitigation measure for reducing runoff losses from slowly permeable soils with frequent water logging. Constructed wetlands are promising but their effectiveness still needs to be demonstrated fro weakly and moderately sorbing compounds.	Reichenberger, S., Bach, M., Skitschak, A., and Frede, H.G. 2006. State-of-the-art review on mitigation strategies and their effectiveness, Report DL#7 of the FP6 EU-funded FOOTPRINT project http://www.eu-footprint.org/downloads/FOOTPRINT_DL7.pdf
A260	Nitrate	A meta-analysis was performed on experiments comparing crop yield, nitrate leaching, or soil nitrate between conventional (receiving inorganic fertilizer with a winter bare fallow) and diversified systems managed using either a non-legume over-wintering cover crop (amended with inorganic fertilizer) or a legume over-wintering cover crop (no additional N fertilizer). Only studies with rotations designed to produce a cash crop every year were included in our analysis. Many yield comparisons were found in the literature, but only a limited number of nitrate leaching or soil inorganic N studies met the criteria for inclusion in a meta-analysis. Long-term studies were also uncommon, with most data coming from experiments lasting 2-3 years. Yields under non-legume cover crop management were not significantly different from those in the conventional, bare fallow systems, while leaching was reduced by 70% on average. Relative to yields following conventional N-fertilization, the legume-fertilized crops averaged 10% lower yields. However, yields under green manure fertilization were not significantly different relative to conventional systems when legume biomass provided >= 110 kg N ha(-1). On average, nitrate leaching was reduced by 40% in legume-based systems relative to conventional fertilizer-based systems. Post-harvest soil nitrate status, a measure of potential N loss, was similar in conventional and green manure systems suggesting that reductions in leaching losses were largely due to avoidance of bare fallow periods. Mainly US data.	Tonitto, C., David, M.B., & Drinkwater, L.E. (2006) Replacing bare fallows with cover crops in fertilizer-intensive cropping systems: A meta-analysis of crop yield and N dynamics. *Agriculture Ecosystems & Environment* **112**, 58-72

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Flooding

Table A 36 Flooding results: Modelling

Study No.[1]	Indicator(s)	Key findings	Reference
A251	Flooding	Increasing the area of land that has a high water table reduces the storage of potential flood water and therefore risk of flooding is enhanced.	Acreman, M.C., Fisher, J., Stratford, C.J., Mould, D.J. & Mountford, J.O. (2007) Hydrological science and wetland restoration: some case studies from Europe. *Hydrology and Earth System Sciences* **11**, 158-169.
A252	Flooding	Embanking the river could increase peak flows by 50-150%. Restoring floodplain connection to rivers could reduce peak flow by 10-15%.	Acreman, M.C., Riddington, R. & Booker, D. (2003). Hydrological impacts of floodplain restoration. *Hydrology and Earth System Sciences* **7***, 75-26.*

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI

Table A 37 Flooding study characterisation: Modelling

Study No.[1]	Model Name	Country	Indicator(s)	Scheme	Model units	Stochastic or deterministic?	Mathematical or behavioural?	Spatial or aspatial?	Spatial scale
A251		England	Flooding	HLS			mathematical	spatial	km2
A252	CLASSIC; iSIS	England	Flooding	HLS			mathematical		catchment

[1] Preceded by letters indicating reviewing organisation: A = CSL, B = CCRI