CAP Greening Review – Part 1 – Trends in Environmental Indicators

A brief overview of recent trends in key environmental indicators in Scotland, covering biodiversity, water quality, land, including soils and climate change.

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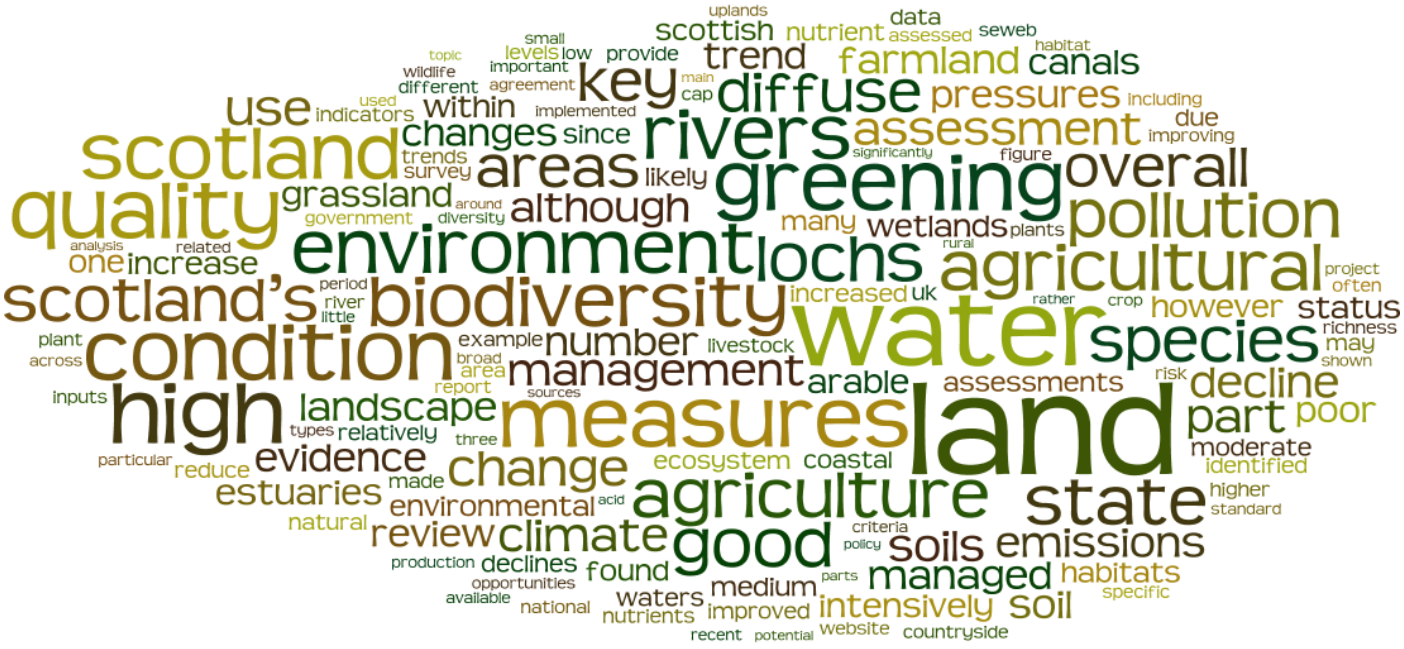
The James Hutton Institute
25th August 2017
Version 1.5
Final Version



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THE CAP GREENING REVIEW

This review was commissioned by the Cabinet Secretary for Rural Affairs, Food and Environment as part of the policy development process for the Common Agricultural Policy (CAP) Greening measures to be implemented from 2015. The scope of the review was agreed within government with the review managed by the Natural Heritage Management Team within the Environment and Forestry Directorate and supported by analysts from the Rural and Environment Science and Analytical Services Division. The particular focus of the review was on the use of *equivalence* measures. These are the measures designed and implemented within member states as alternatives or supplements to the standard mandatory measures prescribed in the EU Regulations. The review was conducted by staff of the James Hutton Institute between February and May 2015 with interim results used by policy makers (and stakeholders) in decisions announced by the Minister in June 2015. Given the freedom for member states to revise and update Greening equivalence measures this document is intended to provide a record of the evidence base provided by the Greening Review and to contribute to subsequent phases of policy development and implementation. It reflects the state of play in June 2015 and does not consider later revisions to Greening.

The report of the Greening Review comes in four parts.

Part 1 (this document) is an overview of the recent trends in key environmental indicators in Scotland, covering soils, biodiversity, water quality and climate change. In addition to outlining the state and trend of each component of the environment, Part 1 also identifies current and potential future pressures. Where any of these pressures are likely to stem from agricultural practices, they are specifically identified.

Part 2 is a technical report of the distribution of measures providing definitions of the standard and proposed equivalence measures as they stood when the review was commissioned. The report provides a sectoral and regional analysis of the distribution of businesses whose pattern of land use mean they would need to undertake one or more of the three Greening requirements. For these businesses, the report also identifies (as far as possible) if their pattern of land use already meets the criteria contained in the Greening measures. This analysis is based on business returns made through the Single Application Form (SAF) for 2014.

Part 3 is a series of map books that are a product of the analysis contained in the distribution of measures technical report. These define the spatial distribution of the greening requirements. National maps for each of the three standard greening requirements are followed by maps for each of the 14 agricultural regions. In addition, data currently collected allows an assessment of the degree to which the crop diversification requirement is currently being met.

Part 4 is an Expert Review of the three standard Greening measures, and where relevant the (then) proposed draft equivalence measures. This draws on research in five fields of study: agro-ecology; biodiversity and landscape ecology; climate change adaptation and mitigation; soils, and waters and catchments. Questions addressed within the Expert Review include: localised and landscape effects, trade-offs, the consequences of implementation factors not specified in the regulation; context specific factors that should be included in guidance to ensure the measure is effective and opportunities for cooperation between businesses and coordinating types and locations of measures.

Part 1 thus provides the wider context, Part 2 the numbers, types and locations of businesses affected and thus the potential scope for benefits or burdens, Part 3 the spatial distribution of the measures, and Part 4 assessments of the (then) proposed equivalence measures set against the counterfactual of the standard greening measures that would otherwise have been implemented.

SUMMARY

This overview has used Scotland's Environment website (SEweb) as the main source of information to conduct analysis of trends in environmental indicators. SEweb represents the outcome of the most comprehensive analysis and synthesis of knowledge available in a single source. Twelve environmental indicators have been summarised here; six relate to water, five to land and one climate.

Key findings

- The water environment is mainly in good condition and improving. 80% of rivers and canals and 63% of lochs are in high or good condition;
- Nevertheless diffuse pollution from agriculture is recognised as a key pressure on water quality and 252 water rivers and lochs are affected by diffuse pollution pressures;
- The land components are in poorer condition, some are in decline and farm land biodiversity is of particular concern;
- Between 1961 and 2011, the climate has warmed by at least 1 degree C, rainfall has increased by 27% with seasonal and spatial variation and snow cover has decreased;
- From 1990 to 2012, there has been a 26.7 % reduction in GHG emissions from the Agriculture and related land use sector. However, agriculture and related land uses still contribute almost a quarter of Scotland's GHG emissions. These falls are often associated with reduced production rather than increased efficiency.

Most Greening measures apart from those applying to permanent grassland (including rough grazings) are relevant to a relatively small part of Scotland, namely that land used for arable cropping and improved grasslands; respectively these account for 11% and 24% of the total agricultural area of Scotland (Scottish Government statistics 2015[1]). Even for this area not all farmland is included within Greening, only those businesses in receipt of CAP payments. In areas where these land cover types are predominant, a different picture emerges of the environmental indicators.

- Lochs and rivers are predominantly in moderate condition with some poor; there has been a recent decline particularly in the Central Belt. 23% of rivers and canals (5753 sq km) and 11% of lochs (109 sq km) are in poor and bad condition; these are found primarily in the more intensively managed land.
- Agricultural nutrient, livestock and soil management, and the resultant diffuse pollution, is identified as one of the key pressures on water quality; there are programmes of measures in place to reduce their impacts but their effectiveness is variable and context specific
- The more intensively managed land has more artificial fertilisers applied, more land is ploughed on an annual basis and livestock production is more intensive; these activities all release GHGs to the atmosphere
- Farmland biodiversity has shown serious declines in habitat diversity and species numbers; many of these changes are a result of changes in arable and grassland management including the use of pesticides, change from spring to autumn sown cereals, timing of grass cutting, loss of diversity of crops and the overall frequency of agricultural operations.
- Wetlands on the lower ground, although small, are important biodiversity components of the farmed landscape, and are at risk from diffuse pollution.

Both the Scotland section of the UK National Ecosystem Assessment (NEA) and the Countryside Survey 2007 reports also provide evidence that broadly speaking, the lowland, more intensively farmed landscape is in poorer condition than other parts of Scotland. Overall, the trends in condition of the environment reflect contrasts in intensity of management, with higher intensity systems in many cases having poorer and in some cases declining condition. The CAP Greening requirements will therefore apply, in the main, within those areas where the environment is in poorer or declining condition.

[1] http://www.gov.scot/Resource/0048/00488075.pdf

1 INTRODUCTION:

This overview draws primarily on Scotland's Environment website (SEweb)[2], particularly the content in the State of Environment reports section[3]. SEweb provides an up to date summary of the key components of Scotland's environment and, in most cases, has enough detail to support the CAP Greening Review's requirement to provide for a brief overview of their condition. SEweb represents the outcome of the most comprehensive analysis and synthesis of knowledge available in a single source. An individual or group of individuals, recognised as being experts in that field, authored each topic on SEweb and earlier drafts were scrutinised by a committee drawn from across the Scottish Government and beyond. Further information on authorship can be found on SEweb[4]. In addition, Scottish Government policy teams were kept aware of progress on these reports with sign off on their key points before publication on the website. The salient points from these reports are summarised in this document and where other sources were used to provide additional detail these are also identified.

1.1 SE web criteria, classifications and caveats

A key part of SEweb is the State and Trend assessments for each topic. They have been made using the following criteria:

- State: Excellent, Good, Moderate, Poor, Bad
- Trend: Improving, Stable/Improving, Stable, Stable/Declining, Declining, Assessment not made
- Agreement: high, medium or low agreement
- Evidence base: high, medium or low evidence

Further information on how they were compiled, and who carried them out, can be found on SEweb[5].

These assessments all include caveats which are worth restating here in full, for clarity on how they should be interpreted.

- These assessments provide a comprehensive review of the state of the Scottish environment and make use of the available evidence and expertise. However, any overall assessment is necessarily a simplification.
- Assessments are of the current "average state"; some aspects of the environment covered by a topic will be in a better state, and others worse. Equally, the condition of some areas is improving, while others are worsening or staying the same.
- We have taken account of the scale of any damage to the environment in these assessments; impacts can be locally damaging, but may have little effect on a national scale.
- The assessments are based on the agreement between the specialists who took part; other specialists may have different opinions.

2 STATE AND TRENDS IN SCOTLAND'S ENVIRONMENT

The overall State and Trend assessments on the Scotland's Environment website is summarised in Table 1 and each topic has been reviewed briefly in turn. More attention has been given to those topics that agricultural management has more impact on and where the proposed Greening measures are most relevant.

[2] http://www.environment.scotland.gov.uk/
[3] http://www.environment.scotland.gov.uk/get-informed/
[4] http://www.environment.scotland.gov.uk/get-informed/state-of-the-environment-summary/who-wrote-this/
[5] http://www.environment.scotland.gov.uk/get-informed/state-of-the-environment-summary/state-and-trend-assessments/

Table 1: Summary of State and Trend Assessments from Scotland's Environment website

Water	State	Agreement	Evidence base	Trend	Agreement	Evidence Base
Coastal waters	Good	High	High	Stable/declining	Medium	Medium
Estuaries: quality	Good	High	Medium	Improving	High	Medium
Estuaries: biodiversity	No assessment made					
Freshwater Lochs	Good	High	High	Stable/improving	Medium	High
Rivers and Canals: quality	Moderate	Medium	High	Stable/improving	High	High
Rivers and Canals: biodiversity	Good	High	High	Stable/improving	High	High
Land						
Landscape	No assessment made					
Soils	Good	Medium	Low	No assessment made: insufficient data		
Wetlands	Poor	High Medium		Stable/declining	High	Low
Biodiversity						
Farmland: biodiversity	Moderate	High	Medium	Stable/declining	High	Medium
Farmland: mountains and uplands	Moderate	High	Low	Stable/declining	High	Low
Climate						
	Not assessed in the standard way					

2.1 Water: Quality

Different types of water body have been described and assessed under the headings of Coastal Waters, Estuaries, Freshwater Lochs and Rivers and Canals. A key policy driver for water quality is the EU Water Framework Directive which has a standard 5 class classification system; this has been a powerful lever both to classify the existing state of our water bodies and to set explicit targets for improvement. As a result, the state and trend assessments for water are more consistent than for land, have more evidence and higher levels of agreement.

2.1.1 Coastal Waters

Coastal waters are defined as extending from the 3 mile limit up to the limit of the highest tide, extends to approximately 48, 000 km^2 and includes sheltered sea lochs to exposed coastline; Scotland possesses 8% of Europe's coastline. However agriculture has relatively little impact on this environment compared to other pressures such as fishing, aquaculture, climate change and litter. There is some concern over nitrogen and faecal remains from agricultural activity; the latter was a particular issue around ten years ago in relation to bathing water quality, but in 2013 no sites failed. In 2014, only two of the 84 designated bathing waters failed bathing water quality standards.

Almost all (97%) of Scotland's coastal waters are in good or high condition, only 3% rated as moderate or poor, notably in the Firths of Clyde and Lorne. The overall state is good, with a trend of stable/declining due to the potential for the pressures suggested above to become more critical.

2.1.2 *Estuaries*

There are 49 estuaries assessed as part of the Water Framework Directive (WFD), including nine salt-water lagoons, covering an area of approximately 1,000 km^2.

Overall, half of Scotland's estuaries are in good environmental condition, with generally clean water and little evidence of human alteration. A further third are at high status; overall, over 85% of our estuaries have a high or good status. The condition of the remaining seven of Scotland's estuaries is affected by high levels of nutrients entering the water, or factors (such as damaged habitats and invasive non-native species (INNS)).

Six of Scotland's estuaries have a status of moderate because of relatively high concentrations of nutrients that can harm wildlife. Of particular relevance to this review is the Solway estuary, the Montrose basin and the Ythan estuary are all at moderate status because of high nutrient inputs from agriculture. The Montrose basin and the Ythan estuary are small estuaries on the east coast, but the Solway accounts for 30% of the total area of estuaries in Scotland.

Diffuse inputs of nitrates from agriculture are regulated by the Nitrates Directive (91/676/EEC). Areas where the nitrate concentration in groundwater is high are designated as nitrate-vulnerable zones and action is being taken to reduce the inputs of nitrates from agriculture in these areas. The catchments of the Solway estuary, the Montrose basin and the Ythan estuary all contain nitrate-vulnerable zones. Sources of nitrate entering the River South Esk, which drains into the Montrose Basin and the River Ythan, are also being studied as part of SEPA's diffuse-pollution monitoring programme, aiming to reduce diffuse pollution by encouraging best practice in land management.

Several initiatives, primarily funded through the SRDP are in place to encourage, and contribute to the costs of, better land use practices to reduce diffuse pollution from agriculture. Nutrient enrichment remains a problem in some catchments although inputs are reducing. The overall quality assessment for estuaries is good and that it is improving.

2.1.3 Freshwater Lochs

There are over 25,500 lochs in Scotland although the WFD criteria only apply to the 334 lochs that are bigger than 0.5 km^2. The quality of nearly 63% of assessed lochs has been assessed as 'good' or 'high'. Many lochs are relatively unaffected by human activity.

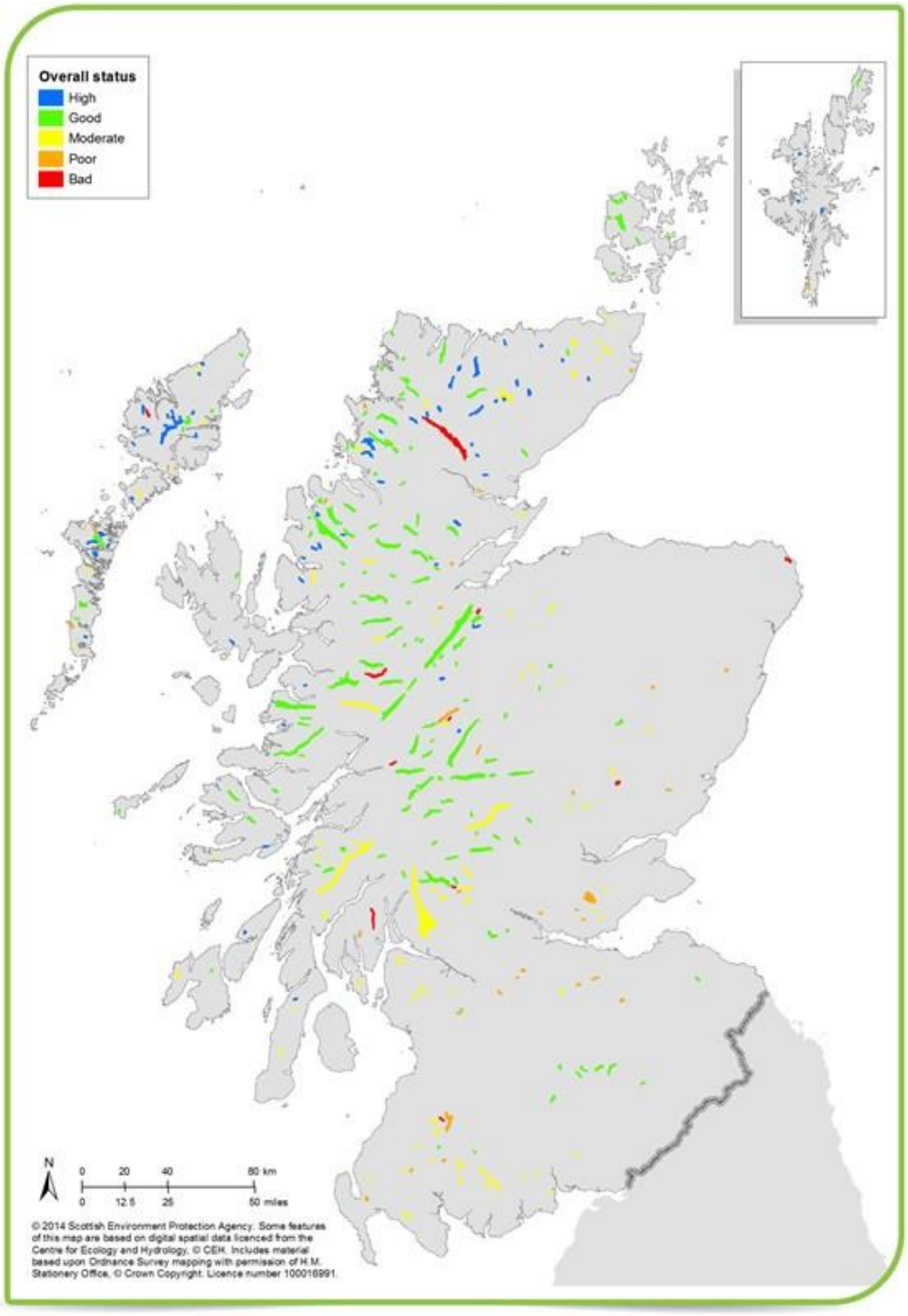

Figure 1: Overall status of lochs, 2012 data

Land management, both forestry and agriculture has been identified as one of the key pressures on Scotland's lochs through diffuse pollution of applied nutrients to land into water. Figure 1 illustrates the broad relationship between those lochs within the zone of improved agricultural land and poor quality. To quote the text from the website 'Lochs in the more intensively farmed areas are often polluted by nutrients through run-off from fields, and are affected by changes to their habitats'. Excessive inputs of nutrients can boost the growth of algae and other water

plants, causing oxygen depletion and major changes in the balance between the plants and animals living in the loch. This rather than direct toxicity is the key water quality concern in most of these lochs.

These problems are being tackled in a number of ways, notably through the River Basin Management Plan, working directly with farmers and other land managers to reduce diffuse pollution from a range of land-management activities (e.g. concerted work in priority catchments) and the creation of a Diffuse Pollution Advisory Group. Part of the work of the group has been to set up a project based on partnerships between SEPA and farmers to work towards reducing diffuse pollution in 12 catchment areas where it was a particular problem. The project uses a combination of approaches, including monitoring water quality and carrying out 1,270 farm visits, with a further 2,500 planned before the end of 2015. SEPA estimates that around 75% of the farms visited have taken steps to reduce diffuse pollution, and believes that working with land managers and other stakeholders to identify pollution risks and agree on the best way to reduce them is the best way to ensure that effective action is taken.

Although the overall state of Scotland's lochs is good, there is a significant number that are not and they occur within the broad zone where the Greening Measures will be implemented. They are also considered to be in a generally stable/improving state.

2.1.4 Rivers and Canals:

Scotland has approximately 125,000 km of rivers, of which 25,000 km are subject to the WFD's quality criteria. Of Scotland's rivers and canals, 9% are in the poorest condition, although these are in general on upward trend in condition. Like lochs, rivers and canals are classified under four criteria, overall status, beds and banks, water quality and water flow. These vary considerably, for example, only 52% of rivers are classified as high or good for overall status but 78% as high or good for water quality. Significantly, there has been a decline in condition of rivers and canals in the Central Belt, and in more intensively farmed areas. Diffuse pollution from agriculture is the single biggest pressure that adversely affects the largest number of rivers and canals in Scotland (Natural Scotland 2008). The problems it causes include excessive inputs of nutrients, run-off of harmful chemicals, such as pesticides, and too much sediment. Excessive inputs of nutrients and organic matter can reduce oxygen levels in the water, which harms aquatic animals.

The maps on Scotland's Environment website illustrate the broad relationship between water quality, the intensity of agricultural production and those areas where the Greening measures are implemented. In Figure 2, the majority of rivers in the poor and bad categories are in the more intensively managed agricultural areas. There are remarkably few rated high or good in these areas, and they are almost exclusively in the Highlands and the higher parts of the Southern Uplands.

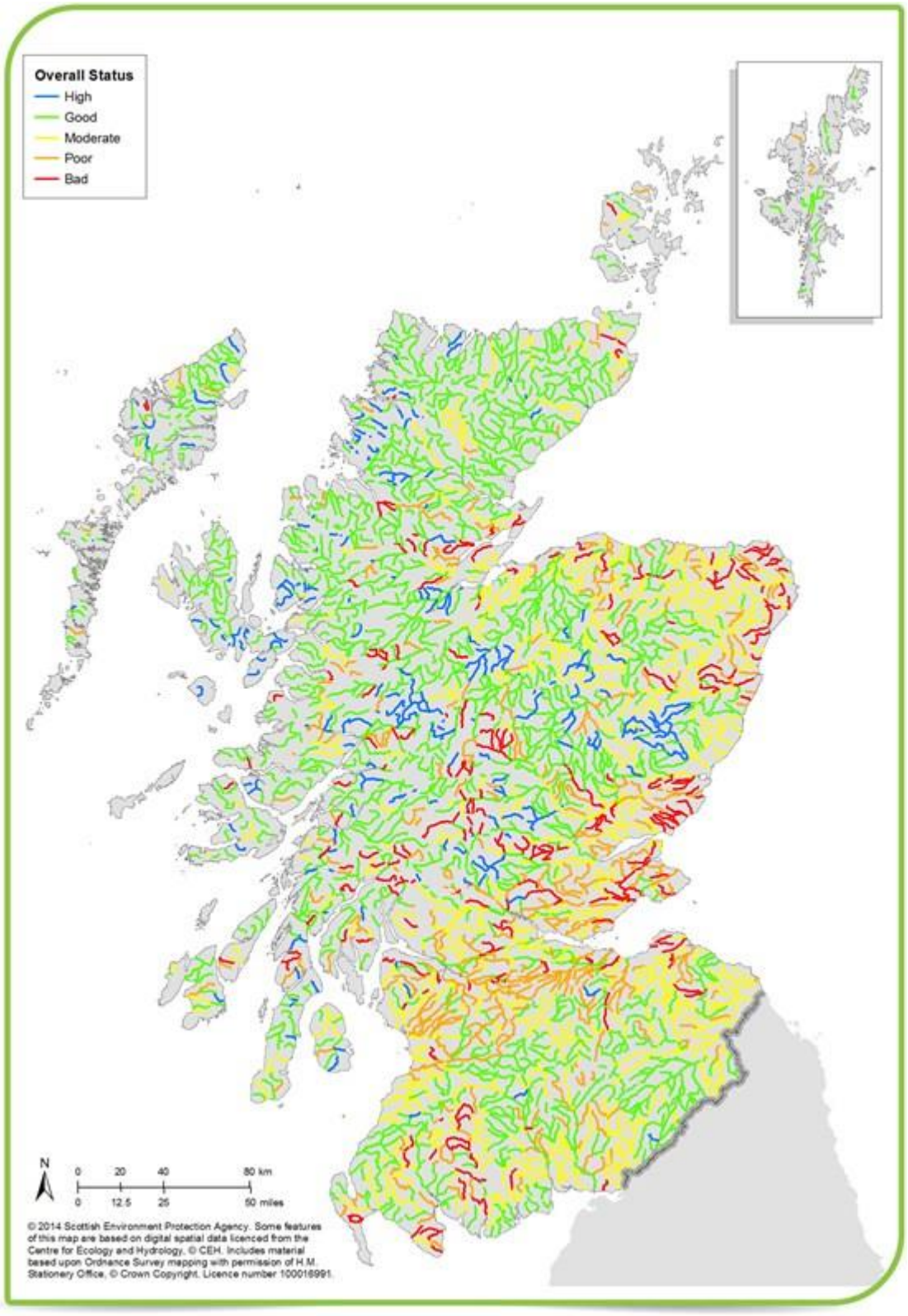

Figure 2: Overall status of rivers and canals, 2012 data

Water-quality status gives a representation of the condition of a river using a combination of chemical and biological pollution indicators (Figure 3). The map shows a distinctive pattern of High and Good quality rivers in the extensively managed parts of the Highlands and Southern Uplands, and Moderate and Poor in the agricultural lowlands. Many rural areas, distant from large settlements and industry, have rivers of moderate quality, for example, Aberdeenshire, the Merse of Berwickshire and the Solway coastal regions.

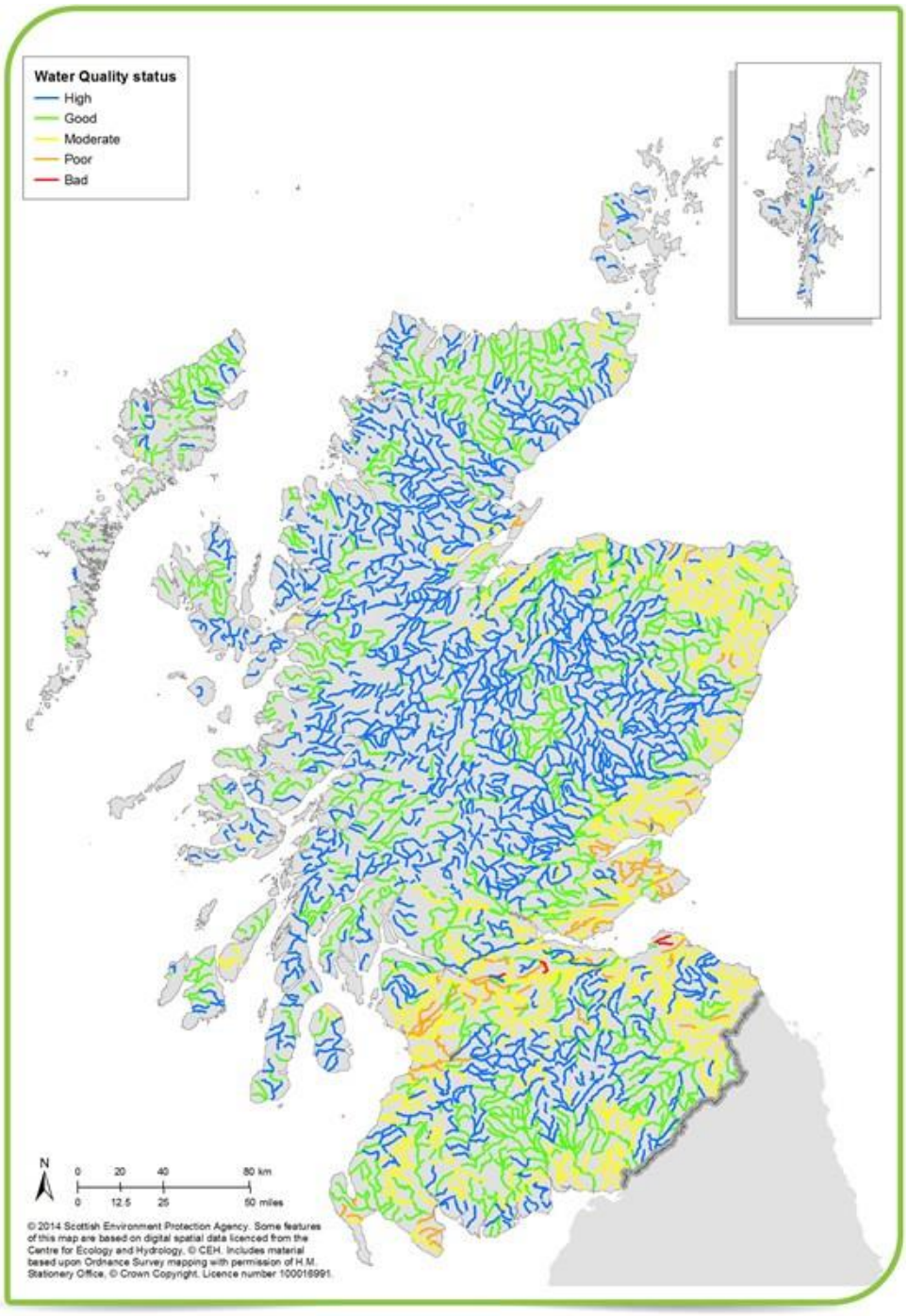

Figure 3: Water quality status of rivers and canals in 2012

Where agriculture is practiced, if soil, livestock and/or organic or inorganic fertilizers are not managed properly, then this can lead to diffuse pollution. Such diffuse pollution arises across a river catchment, rather than entering the water from a single identifiable pipe or discharge making the identification of the source(s) of pollutants more challenging ('source apportionment'). It is highly likely, that a substantial proportion of diffuse pollution results from agricultural management. River straightening widening and dredging carried out in the past to help agricultural land

drainage has caused modification to the bank-side environment as well as the in-river ecology. Such morphology changes can also increase incidence and severity of flooding.

Agriculture has been identified as one of the three main pressures on the rivers and canals environment along with sewage disposal and hydropower.

Efforts to reduce and eventually minimise diffuse pollution from agriculture are similar to those described under the Lochs topic. The establishment of the Diffuse Pollution Advisory Group promotes partnership working and adopts a carrot rather than a stick approach. With regards to the three greening measures, there are likely to be opportunities to locate Ecological Focus Areas adjacent to vulnerable water courses to help reduce the risk of diffuse pollution.

2.2 Water: Biodiversity

2.2.1 Estuaries and Coastal

Scotland's coastal waters are among the world's most biologically diverse. There are many concerns about Scotland's inshore sea life due to the pressures on their habitats and their supporting food webs. The overall assessment within Scotland's Marine Atlas for species and habitats shows the poor state of marine biodiversity. On the whole, Scotland's inshore biology has suffered a decline in status and is continuing to decline.

Although it is likely that impacts on this environment from agriculture are less serious than from other threats such as aquaculture, development and litter, in some contexts it could be one of the main contributors to wildlife damage. 'Pollution' is one of six identified threats to biodiversity in this environment and on balance, the contribution from agriculture is relatively probably small although on the east coast run-offs from agriculture and urban wastewater discharges are identified as the main sources of nutrients.

No overall assessment has been made on the State and Trend of the biodiversity of the Estuaries and Coastal environment.

For 20% of bathing waters, rural diffuse pollution is contributing significantly (in combination with other pressures) to actual or potential poor status. Of 84 bathing waters in 2015, 14 are poor with a further three having a status of sufficient and at risk of being classified poor with a rural diffuse pollution pressure.

2.2.2 Rivers and Lochs

The overall ecological condition of Scottish rivers is generally good, with healthy populations of many mammal, bird, fish, invertebrate and plant species. The condition has improved over the last few decades, but some problems remain.

Freshwater wildlife is largely in a good condition, but a number of individual species are declining.

Some high-profile species are still struggling (e.g. pearl mussels), although others are recovering well (e.g. otters). High nutrient concentrations threaten plants like river jelly lichen and slender naiad.

Although the overall state of the ecology in Scotland's rivers and loch is good and improving, this is likely to be masking differences between the upper and lower reaches of rivers; nutrient levels in Scotland's rivers usually naturally increase as they flow downstream. Consequently, the lower reaches tend to support a higher abundance of aquatic plants that can have deleterious consequences for other wildlife. Of the five pressures affecting river and loch biodiversity, nutrient enrichment by nitrogen and phosphorus is one and although agricultural inputs are not specifically mentioned, it is likely that they are part of the problem, particularly in predominantly rural locations. This is implicitly recognised where diffuse (rather than point) pollution is the issue, and action needs to be taken at a

catchment level. For example in response to a threat from nutrient enrichment to rare loch plants in Tayside, SEPA initiated a lochs partnership, with funding from the Tayside Biodiversity Fund for measures to protect the plants. The project included an audit of farms in the catchment, soil nutrient budgets, advice to land managers, and funding to create buffer strips around lochs to trap nutrients.

2.3 Land: Quality

2.3.1 Landscape

This topic is somewhat peripheral to the subject of the review. However over a number of decades there has been an intensification of land use and management in the lowlands aimed at maximising yields and producing food more cheaply. This has prompted a move towards monoculture, where only the most profitable and productive crops are grown, at the expense of a more diverse landscape of field types and hedgerows. This intensification is viewed as one of the two main direct pressures that will influence and change the character of the landscape (and presumably the associated biodiversity) and is a key factor driving the cropping rules within the Greening proposals i.e. to create a more diverse cropping structure across a predominantly arable landscape. The cropping areas of Scotland, in general, although intensively cropped, do have a relatively diverse cropping regime and the relevance of the crop diversification measure to Scotland is limited. Areas that are affected are Highland and North-east Scotland where spring barley is widely grown to meet the malting market.

2.3.2 Soils

A key factor in the assessment of a 'good' soil is that it is dependent on what use and function is required from different soils; compare arable soils in east Scotland with the blanket peats of Caithness for example. Both may well be healthy for their desired uses, but they are radically different from each other in terms of properties and function. Another point to consider is the relevant lack of trend data for soils due to the resources required and the difficulties in obtaining comparative samples from different visits to the same site.

Nevertheless, soils are considered to be mainly in a good state and there is no evidence of a Scotland-wide problem. Two surveys have shown only a very modest decline in soil carbon in arable soils – probably the key soil property for the delivery of ecosystem services - over the period from the late 1970s until the present day. Other important factors such as pH and nutrient concentrations likewise show little change over the full sampling period (1978-2007) on arable soils, although soil pH on improved grassland has significantly increased over this period to a level more appropriate for this farming system. Phosphorus concentrations in agricultural soils available for plant growth have remained relatively stable in the last 10 years, and are generally satisfactory. In some fields, however, very low, or excessively high, levels are found. If there is more phosphorus available than plants require, it can find its way into watercourses and lead to environmental harm. Although sulphur deposition from airborne pollution has declined markedly in recent decades, N deposition has not and these are harmful to upland soils and their above ground vegetation structure and won't be addressed by the greening measures.

Although the overall state of Scotland's soils is generally good, a key aspect of soils and environmental quality is the influence of soil management and the downstream effects; a good quality soil can still cause harm to the environment as a whole. Current initiatives to gather more comprehensive data on soil erosion are ongoing through catchment walks carried out by SEPA staff and a CREW project on soil structural degradation (which is often caused by soil compaction) and its contribution to increasing flooding risk is due to report in the summer of 2016. Soil erosion and compaction often contribute to poor water quality and GHG emissions as well as degrading the soil itself. In a sense, seeking to improve water and air quality directly can be an 'end of pipe solution' as the problems are not initiated, but manifest themselves there.

2.3.3 Wetlands

Wetlands are one of the most extensive land covers in Scotland, comprise a number of habitats, and are found in a wide range of geographical and landscape contexts (Figure 4). Wetlands include a number of our most extensive peat bogs, which although not likely to be directly influenced by Greening, are globally important.

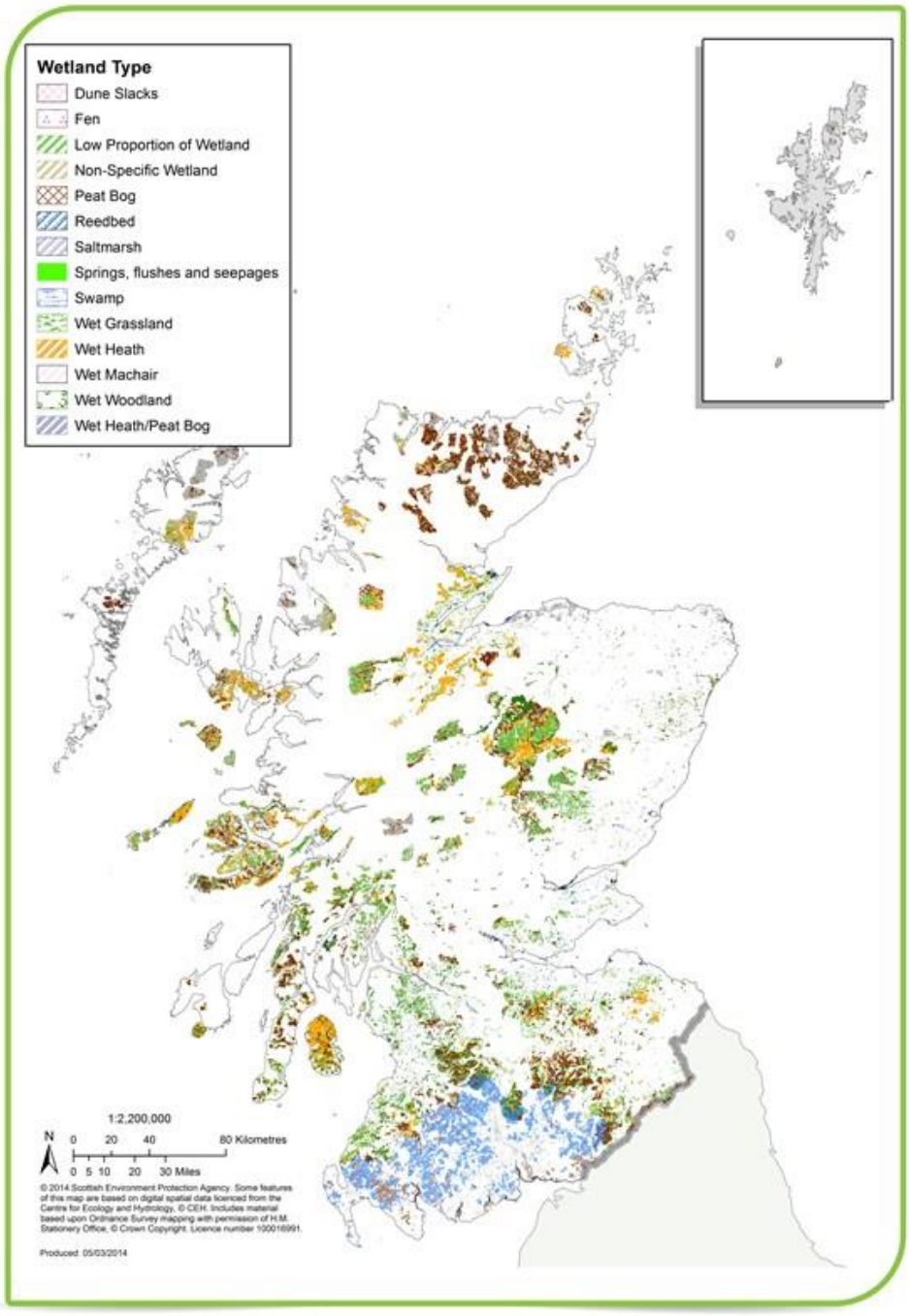

Figure 4: Locations and extent of wetlands (areas not yet surveyed have been left blank; they may contain wetlands).

The overall assessment for the state of our wetlands is that it is poor and on a stable to declining trend although it must be acknowledged that this judgement is made on scant evidence. Wetlands are under a number of pressures including some associated with agriculture such as land management practices, drainage from adjacent nutrient rich farmland and grazing livestock. Much of the area of wetland lies well outside the region where Greening measures will be implemented. There are, however, many small areas scattered throughout the agricultural lowlands which provide important pockets of biodiversity (and in many instances high carbon stocks) in an otherwise highly managed landscape. Their rarity increases their potential local value. Most wetlands within protected sites are in

favourable condition, with the exception of lowland raised bogs where 59% of sites are in unfavourable condition. These are the wetlands most likely to benefit from Greening. The EFA Greening measure may provide opportunities for more sympathetic management of land immediately adjacent to them; though wetlands themselves would not be eligible.

Funds are available currently for peatland restoration projects through the Green Stimulus Peatland Restoration project and SRDP; these areas don't fall into the Greening Measures in any case. Additionally there are similar schemes to encourage the construction of farm wetlands to treat agricultural water pollution and to enhance biodiversity; Ecological Focus Areas may provide opportunities for these types of activities.

2.4 Land: Biodiversity

2.4.1 Farmland

In the lowland biogeographic zone (that coincides with the areas where most Greening measures will apply) there are a number of important habitats - lowland heath (wet and dry), natural grasslands (acid, neutral and calcareous) and fen meadows. The landscape is, however, dominated by intensively managed and therefore highly altered arable, grassland and horticultural systems. In designated areas, around two-thirds of habitats and species have been assessed as being in either recovering or favourable condition, with the remaining third in unfavourable condition. Little is known about the condition of non-designated sites but it is likely that a higher proportion of the area is in unfavourable condition. The wildlife found in this ecosystem is highly influenced by changes in land use and land-management practices, such as the losses of set-aside land and applications of herbicides and pesticides.

There are many datasets available for this ecosystem from surveys such as the Countryside Survey and the Breeding Bird Survey. Some of the key findings include:

- Of 61 farmland bird species, nine have declined greatly between 1995 and 2011, with some now so scarce that they have almost disappeared.
- In more detail, these declines are kestrel (-57%); oystercatcher (-30%); lapwing (-56%); swift (-57%); rook (-34%); skylark (-19%) starling (-40%); and meadow pipit (-29%).
- The smoothed long-term (1979-2010) butterfly population trend for all species was classed as stable. However, butterfly species that are restricted to specific and often isolated habitats (known as specialists) declined to 51% of their 1979 populations, although this decline may have levelled off since 2000. Moth numbers among 185 of the more common species fluctuated between 1975 and 2004. There is emerging evidence from the Rothamsted Insect Survey of long-term declines in common moth species in Britain.

Additional information on the state and trend in farmland biodiversity can be found in Countryside Survey reports.

The Countryside Survey has been conducted every 8-10 years since 1978 and to date there have been four surveys across the UK comprising revisiting specific one kilometre squares. A large number of data types are collected and as they are repeat visits, this allows some trends to be identified. Although the number of squares has increased since the project first started, the protocols for data collection have, wherever feasible, remained similar to allow valid comparisons.

In the Enclosed Farmland habitat it was found in a general sense that plant species richness in the Arable and Horticulture and Improved Grassland Broad Habitat remained stable between 1990 and 2007. However this masks two important and more specific points:

- Plant species richness and plant cover were higher in crop edges than in arable fields or managed arable margins in 2007.

- Plant species richness in Improved Grassland decreased by 8% in Scotland between 1998 and 2007.

Given that land under set aside was more similar to arable margins and more diverse than the majority of the field that is under crop, the removal of compulsory set aside in 2009 is likely to cause a decline in overall species diversity that has not yet been picked up by survey. On the other hand, certain SRDP measures may help to compensate for this change.

The Enclosed Farmland habitat contains many examples of the Boundary and Linear Features Broad Habitat; these often provide the haven for wildlife within an intensively managed landscape. In Scotland, these broadly have shown declines both in their length and their species richness. The total length of woody linear features declined by 5% from 1998 to 2007 (reversing a period of increase in the previous fourteen years) and their management has shown similar declines. A decline of 22% in hedge plant species richness was recorded between 1998 and 2007. This has coincided with the reduction in the number of species used as food for farmland birds or butterfly caterpillars over the same period.

The Semi-Natural Grasslands: Neutral, Calcareous and Acid Grassland Broad Habitats are only subject to the Permanent Grassland measure that provides no more protection than existing regulations and no options for enhanced management. The EFA measure might, however, depending on implementation, have a role in in the restoration or (re)creation of these habitats. Acid Grassland increased in extent by 8% between 1998 and 2007 but no significant changes in area were found in the other habitats. The condition of both Neutral and Acid Grasslands is in decline, in terms of species richness and loss of key species. Plant species richness decreased by around 17% in Neutral Grassland in Scotland since 1998 and by 9% in Acid Grasslands and species losses included Bird and Butterfly larvae Food Plants.

More detail can be found in Norton et al 2009.

The three crop and EFA components of the Greening measures are intended to help address declines in biodiversity by providing nesting areas and increasing the proportion of the ground that is not intensively managed thereby providing the opportunities to increase insect numbers for example.

Many of these changes are a result of changes in arable and grassland management including the use of pesticides, change from spring to autumn sown cereals, timing of grass cutting and the frequency of agricultural operations. Additionally, in a Knowledge Scotland briefing[6] on continuing declines in farmland biodiversity, SRUC identify landscape simplification (or homogenisation) as the key driver of biodiversity declines. It is also clear that this cannot be addressed at the scale required solely by using only farm-level agri-environment schemes; measures need to be at an appropriate scale to be effective and there perhaps needs to be better funding mechanisms for more co-operative measures to deliver biodiversity benefits.

2.4.2 Mountains and Uplands

In Scotland most of the mountain and uplands biogeographic zone is outside the areas where the Greening measures will be implemented, but does make up a large proportion of Scotland's landscape. Semi-natural land covers with varying proportions of grasses, heather and other dwarf shrubs dominate the region. It should be recognised that these areas are dynamic systems subject to a number of pressures some attributable to their use as "rough grazings" by agriculture or as sporting estates. Others such as atmospheric deposition are anthropogenic in origin but are not a direct consequence of land use/management. Significant changes in these systems are thus not solely the consequence of change in land use, improvement or ploughing, which is the focus of the Greening measures.

[6] http://www.knowledgescotland.org/briefings.php?id=230

At a macro-scale, Rough (or acid) Grassland has shown an increase in area from 1998 to 2007 of 72,000 square kilometres (8%) according to Countryside Survey 2007 with grasses replacing the original cover of heather and other dwarf shrubs. This overall increase is possibly due to levels of grazing pressure encouraged by CAP headage payments at that time. Despite expansion in area terms, the 2005 assessment of rough grasslands found that their condition was a particular concern. Only approximately 20% were in favourable condition. More recent results from 2010, and 2014, show a marked improvement with 35% in 2010, and 60% in 2014 in favourable condition.

Both over- and under-grazing can produce undesirable consequences and appropriate stocking rates can vary considerably between habitats and locations. Key pressures on dwarf shrub heath that encourage the growth of grasses are the overgrazing of sheep and deer, poorly managed muirburn, and improved drainage. The removal of livestock in some areas has, however, in some instances, resulted in more vigorous and dense vegetation grown, leading to a decline in the richness of invertebrates that are an important diet for some nesting birds. None of these issues is particularly addressed by the proposed Greening measures.

2.5 Climate

Climate cannot easily be assessed in terms of terms like 'good', 'bad', 'better' or 'worse', but one thing is increasingly certain is that it is changing globally at an unprecedented rate largely due to human activity.

2.5.1 Mitigation of greenhouse gas emissions

Since the baseline year of 1990 until 2012, there has been a 26.7 % reduction in emissions from the Agriculture and related land use (defined as net emissions from cropland, grassland livestock, agricultural soils, stationary combustion sources and off-road machinery). This is slightly below the overall 29.8% reduction across all sectors. Agriculture and related land use, however, remains the second biggest emitter of greenhouse gasses in Scotland in 2012 (11.2 Mt CO2e, 21.2 % of Scottish total). If forestry is combined with agriculture as an aggregated land use sector then the current emissions from agriculture are substantially offset by the sequestering effect of forestry (9.9 Mt CO2e, 19%). Sequestration by forestry has since 1990 (Scottish Government 2012) increased by 41.9%, a reflection of the maturing of the woodland resource over time. Rates of sequestration are expected to decline in the coming years due to timber harvesting, reduced (and below target) planting rates compared to the second half of the 20th century and an overall younger growing stock.

Agriculture differs from most other sectors in that the contribution from nitrous oxide exceeds that of methane which in turn exceeds that of carbon dioxide; with the exception of waste management, this is the reverse of all the other sectors. The fall in carbon dioxide emissions from the agriculture and related land use sector has partly been due to the effects of historic land use changes. The process of land being converted to cropland releases carbon dioxide from soils. Between 1990 to 2013, the rate at which land has been converted into cropland has fallen. Also the contribution to emissions of historic land use change is lower since the rate of emission declines with the time elapsed since the change occurred. Methane emissions from agriculture have fallen from 1990 to 2013 due to a decline in cattle and sheep numbers - with a corresponding fall in emissions from enteric fermentation and animal wastes. Nitrous oxide emissions have also fallen due to improvements in practices on agricultural soils and a decline in livestock numbers. Since agriculture contributes 90% of the nitrous oxide emissions (Scottish Government 2012) – the greatest impact of Greening measures for climate change mitigation would be in reducing rates of nitrous oxide emissions most likely through increasing the efficiency of fertiliser utilisation.

2.5.2 Climate change risks

In Scotland as a general summary, the climate over the last century has become warmer, with drier summers, wetter winters and more frequent heavy rainfall. There is a lot of data describing Scotland's climate and changes to it on Scotland's Environment website. Over the period 1961-2011, some of the key findings are:

- Across Scotland the mean annual temperature has increased by 1.3 °C, with the biggest seasonal change found in spring which has warmed by 1.5 °C on average. The mean temperature has also increased for all seasons in all regions by at least 1 °C.
- There has been a decline in the number of days a year on which there is air or ground frost, with a reduction of 21 days of air frost and 29 days of ground frost.
- Since 1961 there has been a clear increase in sunshine hours for all regions of Scotland in the spring. There has also been an increase in sunshine hours in autumn, but summer and winter have seen little change.
- There has been an overall increase in rainfall (27%) with variations most marked in winter with a 24% increase in total rainfall in the east and an increase of 45% and 51% in the west and north respectively.
- All parts of Scotland have seen an increase in the number of days of heavy rain in a year but with variations across the country.
- All regions have seen a decline in snow cover from 1971-2011, however autumn is the only season for which there is a clear trend. In recent winters there has been an increase in the number of days of snow cover, following a period of winters with relatively little snow.

Looking into the future, the key climate change trends expected for Scotland are hotter, drier summers and milder, wetter autumns and winters. We can also expect to see:

- an increase in summer heatwaves, extreme temperatures and drought;
- increased frequency and intensity of extreme rainfall;
- reduced frost and snowfall;
- rising sea levels.

The impacts of climate change on this scale present both risks and opportunities to Scotland's land, the way it is used and we cannot be certain on any of these. The UK Climate change risk assessment provides a good summary of potential impacts; those presented below are not intended to be exhaustive. Some are also very location specific dependent on local climate and soil conditions:

- Higher incidence of drought conditions
- Conversely, reduced access to the land at key times due to wetter soils
- Longer growing season
- More risk of disease and pests
- Wider range of agriculture and tree crops
- Increased risk of flash floods
- Higher yields if moisture availability is not limiting

Our natural environment will be likewise impacted with more risks than opportunities identified, for example:

- Reduced water levels in rivers and lochs
- Conversely potential higher levels at specific times
- Increased prevalence of invasive non-native species, pests and pathogen
- Warmer rivers, lakes and seas impacting on biodiversity
- Changes in timing of seasonal events and migration patterns can result in mismatches between species such as predator-prey/host relationship

3 OTHER SOURCES OF EVIDENCE

3.1 UK National Ecosystem Assessment (NEA)

The UK National Ecosystem Assessment (NEA) overview of the state and trend of Enclosed Farmland provides a comprehensive review of the state of the UK countryside and a trend assessment of how well the countryside provides a suite of ecosystem services after consideration of the impact of changes in different habitats since 1990. This assessment is based on information and evidence documented within the NEA and on expert opinion. Like all such judgements, there is an element of uncertainty associated with them. The text below refers specifically to Scotland.

Fifteen ecosystem services are assessed and Enclosed Farmland is considered of high or medium-high importance in the delivery of thirteen of them; for only Fish and Noise is it of low importance. Of the thirteen, the following assessments have been made (number of services):

- Crop production and Environmental Settings: Landscape are improving (2)
- Trees, standing vegetation, peat and air quality show signs of improvement (2)
- Livestock/Aquaculture, Environmental Settings: Local places and Water Quality show no net change (3)
- Water supply, Climate, Hazard and Soil Quality show signs of deterioration (4)
- Wild species diversity and pests and diseases have deteriorated (2)

Overall the state of Enclosed Farmland is indicating a deterioration in state with some (for example crop production and wild species diversity) having, at least in part, having a direct impact on the other. In other words, the focus on enhancing yields, based on the evidence in Section 2.4.1, has had a detrimental effect on biodiversity. Perhaps worthy of note is the differences between these and some of the assessments above, for example water quality (in this habitat) and soil quality. This is indicative of the difficulties associated with making broad judgements of this type, based often on scanty evidence. Significantly perhaps, there is more agreement on 'biodiversity' issues.

3.2 SNH's Natural Capital Asset Index (NCAI)

This was first published in 2011 by Scottish Natural Heritage with the aim 'to raise awareness of the drivers of change in the nation's natural capital assets and to facilitate enhanced methods for assessing natural capital'. Much of the information in this report is also included in the NCAI. We were advised (SNH pers comm) that because of some methodological issues, the NCAI is being revised significantly with a recommendation that it should not be used as a pivotal example.

4 CONCLUSIONS

Scotland's environment and land use pattern demonstrates very stark contrasts; extensive agricultural and other land management activities over the hills and uplands (about 55%), woodland (18%) and relatively intensively managed arable and improved grassland (25%). To an extent, the condition of the environment reflects these contrasts.

Twelve environmental indicators have been reviewed; six relate to water, five to land and one climate. Scotland-wide, the key findings are:

- The water environment is mainly in good condition and/or improving. 80% of rivers and canals and 63% of lochs are in high or good condition;
- Nevertheless diffuse pollution from agriculture is recognised as a key pressure on water quality and 252 water rivers and lochs are affected by diffuse pollution pressures

- The land components are in poorer condition, some are in decline and farmland biodiversity is of particular concern.
- The balance or risks from weather patterns are changing and extreme event s are more likely.
- Since the baseline year of 1990 until 2012, there has been a 26.7 % reduction in GHG emissions from the Agriculture and related land use sector. However, agriculture and related land uses still contribute almost a quarter of Scotland's GHG emissions. These falls are often associated with reduced production rather than efficiency.

The Greening measures are relevant to a relatively small part of Scotland – the improved agricultural land and a different picture emerges of the environmental indicators here. The key points are:

- Lochs and rivers in the arable and grassland zone of Scotland are predominantly in moderate condition with some poor; there has been a recent decline in the Central Belt and improved agricultural areas. 23% of rivers and canals (5753 sq km) and 11% of lochs (109 sq km) are in poor and bad condition; these are found primarily in the more intensively managed land.
- Agricultural nutrient, livestock and soil management, and the resultant diffuse pollution, is identified as one of the key pressures on water quality on this land; there are programmes of measures in place aimed at reducing their impacts.
- Farmland biodiversity has shown some serious declines in habitat diversity and some wildlife species; many of these changes are a result of changes in arable and grassland management including the use of pesticides, change from spring to autumn sown cereals, timing of grass cutting, loss of diversity of crops and the overall frequency of agricultural operations.
- The more intensively managed land has more artificial fertilisers applied, more land is ploughed on an annual basis and livestock production is more intensive; these activities all release GHGs to the atmosphere
- Wetlands on the lower ground, although small, are at risk from diffuse pollution.

The evidence presented here on the State of the Environment in the more intensively managed parts of Scotland's agricultural land indicates that improvements are still required in how that land is managed; declines in water quality and biodiversity, in large part, are directly attributed to specific agricultural management systems. On the other hand greenhouse gas emissions have shown a steady decline between 1990 and 2012 significantly for the agricultural sector of nitrous oxide for which the agricultural sector is most responsible. The decline of around 20% is welcome but further decreases are required. The Greening measures are intended to address these issues and help create a better environment within what will remain an intensively managed agricultural landscape.

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