Indicators and trends

Monitoring climate change adaptation

climate change
Scotland's centre of expertise connecting climate change research and policy

Is Scotland's natural environment resilient to climate change?	Version
	16/05/16

Our natural environment is changing and will continue to change due to the direct and indirect impacts of climate change. The exact nature of this change is uncertain because of the complex interactions between climate and other pressures on the web of species and habitats that make up our ecosystems. In turn these pressures affect the ability of ecosystems to provide services such as flood management, food and timber resources, carbon sequestration, landscapes of cultural, recreational and tourism value and helping to regulate air and water quality.

Direct impacts of climate change include the loss of some coastal habitats such as machair, one of the rarest habitats in Europe, due to sea level rise. Projected warmer, drier springs and summers are expected to lead to an increased wildfire risk and reduced water levels and flows in lochs and rivers. The projected increased frequency of intense, heavy rainfall events will result in more frequent flooding and soil erosion. Impacts that are indirectly related to climate change include an increased threat from some pests and diseases such as Dothistroma needle blight and invasive species such as rhododendron.

Apart from climate change, the natural environment is subject to a range of other pressures. Many of these are related to land use, land management and demand for resources. The warming climate is likely to lead to more land in Scotland being suitable for intensive cultivation (arable farming). Together with projected increases in global food demand, this is likely to drive intensification of agricultural activity. Scotland's native woodlands are under pressure from multiple sources including non-native tree planting, habitat fragmentation, invasive non-native plants and animals, plant pests and diseases, deer browsing and atmospheric pollution.

Any of these pressures may impair the ability of habitats and the species they support to withstand the impacts of climate change. To build their resilience to this threat it is important to manage those pressures that we can influence. Ecosystems, habitats and species that are in good condition will be better able to withstand climate change. Larger and better connected areas of habitat are often more resilient and can help enable some species to move location in order to find suitable areas of habitat in a changing climate.

Climate projections indicate significant areas where active peat formation may no longer occur. Therefore it is important to protect existing peat resources and ensure appropriate hydrological conditions are created. Deep peat soils represent a very significant carbon store. Losing just 1% of our deep peat would release over 16 megatonnes of carbon to the atmosphere; more than Scotland's total annual carbon emissions. The main threat for release of carbon from peatlands arises from degradation of these soils due to factors like erosion, drainage, fire, afforestation, over-grazing, pollution and peat extraction. While land management is often at the root of these factors, this degradation can also be a 'natural 'process impacted to some extent by more recent shifts in climate.

The resilience of the terrestrial environment is closely linked to our water environment; for example land management practices can influence water quality and flood risk. Management actions need to be undertaken at a large enough scale to capture a complex web of ecosystem interconnections, such as landscape scale conservation or river catchment scale management.

Different views exist on the concept of resilience of the natural environment to climate change and what it means, e.g. how much resilience is enough? 'Resilience' is described by SNH as 'a property which allows an ecosystem to maintain its characteristics under the impacts of novel processes and shocks'[1].

Climate projections provide us with an indication of how Scotland's climate may change in future. As mentioned above, there is much greater uncertainty surrounding the response of natural systems to these changes. The complex interactions within ecosystems, future development of pressures such as pests and diseases and land use changes (for example associated with climate change mitigation such as renewable energy) make it inherently difficult to predict responses to climate change. So it is difficult to know whether a species, habitat or system is resilient to climate change. There is a clear need to better understand the responses of natural systems to climate change. We know that healthy, biodiverse systems in good condition are more likely to withstand external pressures. To tackle some of these fairly intractable issues, a good starting point is to identify what is known about the condition of our natural environment now, the changes or trends that have been observed and what factors might have contributed to these changes. The indicators presented here gather that knowledge together to help build our understanding.

Adaptation options: What can be done: what are the policy levers?

Better management of the pressures that we are able to influence is likely to improve our natural environment's resilience to the impacts of climate change.

Related policies and legislation include:

- Scottish Biodiversity Strategy 2020 Challenge
- Land Use Strategy
- Scottish Planning Policy
- Scotland's Wild Deer: a National Approach
- Adaptive management in NNRs
- Pilot use of SNH Wildlife Management Framework
- EU Habitats Directive
- EU Common Agricultural Policy (CAP)
- Scottish Forestry Strategy
- Scottish Biodiversity Action Plan

<u>Land Use Planning and Management</u>

Land use planning policy plays a central role in building a resilient natural environment as, in order to succeed; adaptation needs to be embedded into wider land use planning.

Scotland's Land Use Strategy, reviewed every five years, is a key commitment of the Climate Change (Scotland) Act 2009. The first strategy was published in 2011 and the second in March 2016. The second strategy retains the framework and vision of the first strategy; with three primary objectives relating to economic, environmental and community sustainability together with ten principles for sustainable land use. It also sets out priority actions across agriculture, forestry, uplands and land use decision making at the local level for the next five years to help meet these objectives. This

[1] Valluri-Nitch and Stone, 2015 http://www.snh.gov.uk/docs/A1744865.pdf

should build on the experience of two Regional Land Use pilots that have been carried out in Aberdeenshire and the Borders[2].

The Land Use Strategy acknowledges the need for integration across a range of other policies affecting land use, although it remains to be seen how this will be achieved. Scottish planning policy includes large scale land management initiatives such as green networks and River Basin Management Plans.

The Scottish Planning Policy, published in 2014, includes adaptation to climate change as a key planning outcome. The policy underpins development planning and development management activities such as peat extraction, deep peat, priority peatland interests and carbon rich soil.

Scottish Natural Heritage (SNH) has developed a set of adaptation principles to guide them and others in helping nature adapt to climate change. They are demonstrating these within the National Nature Reserves (NNRs) that they own and manage, and in their partnership working in these and other protected areas and nature reserves[3]. The principles address land use planning and management issues including reducing existing pressures such as habitat fragmentation, invasive non-native species, pollution and unsustainable land use. They seek to improve habitat management by addressing issues such as overgrazing, burning and drainage and improve resilience to climate change, for example by increasing habitat diversity. The Principles also recognise the need for a flexible, adaptive approach to planning land and conservation management, such as planning for unavoidable habitat change and consideration of species translocation where feasible and appropriate.

Habitat Restoration - Peatland

Peatland restoration can contribute to both climate change adaptation and mitigation by improving the ability of our natural environment to withstand a changing climate while simultaneously helping achieve the continued sequestration of large amounts of carbon dioxide (CO_2) that could otherwise be released to the atmosphere. The Scottish Government has emphasised the importance of restoring peat-forming habitats which have been drained or damaged. Their lead advisor in peatland restoration is the National Peatland Group chaired by SNH. The Peatland ACTION project funded by Scottish Government has been tackling the restoration challenges laid out in Scotland's National Peatland Plan. Restoration is also incentivised through various programmes including options within the SRDP, the Heritage Lottery Fund and EU-LIFE. However the process of restoration will take time to bring about a permanent change, while climate change is projected to increase the urgency of the restoration programme.

What do the indicators tell us?

The suite of indicators on resilience of the natural environment cover:

RISKS and OPPORTUNITIES associated with the resilience of the natural environment

Extent of key semi-natural habitats: terrestrial

[2] http://www.gov.scot/Topics/Environment/Countryside/Landusestrategy/regional

[3] http://www.snh.gov.uk/climate-change/taking-action/adapting-to-change/helping-nature-adapt/turning-principles-into-practice/

This indicator includes data for native and ancient woodland from the Native Woodland Survey of Scotland (NWSS), and for Broad Habitats from the Countryside Survey. The NWSS provides baseline data for the woodland habitats but comparable historic data is not available. For broad habitats, comparison with earlier Countryside Surveys enables quantification of changes over time. There has been an increase in acid grassland and broad-leaved, mixed and yew woodland, a decrease in fen, marsh and swamp, and no significant change in bog, neutral grassland or dwarf shrub heath between 1990 and 2007. No trend was available for other habitats included.

Extent of key semi-natural habitats: coastal habitats

This indicator measures the extent of coastal habitats in Scotland and reports on the five coastal priority habitats recognised by the UK Biodiversity Action Plan. While data (or best estimates) are provided for extent of habitats, limitations of the data available, together with the intrinsic difficulty of measuring some dynamic coastal habitats, mean it has not been possible to identify trends over time.

Extent of key habitats: deep peat

This indicator focuses on the extent of three key types of deep peat habitat: lowland raised bogs, blanket bogs and fens, which are identified as priority habitats within the UK Biodiversity Action Plan. Latest figures are 1653kha of blanket bog, 34.9kha of raised bog and 8.6kha of fen. The extent of blanket bog is currently stable, raised bog is decreasing in extent and the trend for fen is not known.

Condition of key habitats: Proportion of notified habitats in unfavourable condition

Scottish Natural Heritage (SNH) operates a Site Condition Monitoring programme to monitor the condition of nature conservation features of special interest on designated sites in Scotland. This indicator identifies the proportion of notified habitats that are classified as unfavourable with no clear indication that they are in recovery ('Unfavourable No Change' and 'Unfavourable Declining'). Such habitats are potentially more susceptible to the additional pressures that will be exerted by climate change. In 2014, around 24% of notified habitat features were in unfavourable condition; this proportion has decreased by approximately 2.5% since 2011, however this is not uniform across habitat types. Also some habitat types are more vulnerable to climate change than others.

Condition of key habitats: Area of modified deep peat soils

The area of modified deep peat soils includes cultivated (3.6kha), intensive grassland (43.9kha), drained (732kha), regularly burnt (43.1kha), afforested (235kha), bare (268kha) and under extraction (3kha). These areas however are not known with certainty and some of the assessments were made over thirty years ago. For some types of modified peat soils the trend is unknown; there has been some decrease in the extent of drained and afforested peat soils due to drain blocking and tree removal as part of ongoing peatland restoration programmes, but accurate data is not available.

Monitor and measure the IMPACT of changes in the resilience of the natural environment

Natural Capital Asset Index

'Natural Capital' provides a means to account for nature within a national balance sheet and capture the contribution of services provided in national accounts. The impacts of climate change constitute a threat to Scotland's natural capital.

Scotland's Natural Capital Asset Index (NCAI) developed by SNH is an attempt to quantify changes in its natural capital. This indicator uses the first version of the NCAI published in 2012. SNH published a revised version of the NCAI in late 2015. The NCAI is an aggregate index based on an analysis of the ecosystem area and ecosystem quality of seven broad habitats. There was no significant change in Scotland's NCAI between 2000 and 2010, following a significant decline from the 1950s to the 1990s. The NCAI can monitor the status of our natural capital but cannot always show the impact of

individual policies; and it is not sensitive to how changing levels of natural capital might result in ecological thresholds or 'tipping points' being crossed (not a linear relationship). For the most part, data availability has been limited and proxy indicators have therefore been used within the NCAI.

Annual greenhouse gas (GHG) emissions from degraded peatlands

This indicator uses annual GHG emissions to calculate the total GHG emissions in CO_2 equivalents for each peatland category. This will then indicate where carbon losses are coming from and in which categories this is most serious. These figures also permit calculation of the carbon benefits of restoration, or, conversely, the consequences of permitting a peatland area going into a category of greater emissions. Current estimates show that bare and drained land accounts for the majority of annual emissions from degraded peatlands. Current estimates of GHG emission factors are uncertain as present values are based on few relevant studies. However, evidence is increasing making annual updates both feasible and warranted.

Number and area of reported wildfires in forests and key habitats

This indicator provides a proxy measure to help monitor the impact of wildfire on forests and other key habitats.

In 2012/13 the area of forest affected by wildfire was 267.6 hectares and in total 479 forest wildfires were recorded. In the same period, other key habitats affected by forest wildfire include 383.9 hectares of mountain, heath and bog; and 684.5 hectares of semi-natural grassland. A general upward increase in wildfires is expected, however it is not possible to detect trends at present. The combination of attributing factors makes it difficult to determine causality and to identify trends due to an individual factor such as changing climate.

Monitor what ACTION is being taken to adapt by improving the resilience of the natural environment

Proportion of notified habitats and species in 'positive' condition

In March 2015, 73.4% of notified habitat features and 71.9% of notified species features were in positive condition (favourable or recovering), as recorded by Scottish Natural Heritage's (SNH) Site Condition Monitoring (SCM) programme. Over the last 10 years there has been an increase in the number of notified features, both habitats and species, to be classified as favourable. Features that are in good condition are likely to be better able to withstand the pressures of climate change.

Peatland restoration area

In 2012, 30.9 kha of peatland was restored; the annual average area restored between 1990 and 2012 was 1.4 kha. However, recently the area restored has rapidly increased and the current figure is really unknown, but is likely to be in the region of 3 to 6 kha per year. The total number of sites within Peatland Action is 105 compared to the total for 1990-2012 of 47 sites, although the actual area restored may be greater than this.

Amount of natural regeneration in native woodlands

This indicator monitors the amount of natural regeneration in native woodlands. In 2014, 21% of the total cover in native woods was in regeneration stages, comprising 17% established regeneration and 4% visible regeneration. It is estimated that 15-35% is the minimum average cover of established regeneration required to sustain native woodlands, therefore the current average cover of 17% established regeneration is likely to be too low. The data source is the Native Woodland Survey of Scotland (NWSS), the most complete survey of its kind providing quality assured, comprehensive data for every area of native woodland over 0.5 ha in area.

Possible future indicators for which data is not currently available or suitable

For the existing indicators *Extent of key semi-natural habitats: coastal habitats* and *Extent of key semi-natural habitats: terrestrial* , Scotland's Coastal Change Assessment, which is being produced by the University of Glasgow for the Scottish Government (2016) and SNH's Habitat Map of Scotland (2019) will provide a baseline against which to measure future trends.

Condition of climate sensitive species: Number of species identified as under pressure from climate change (a knowledge document 'Climate change pressure on Scotland's notified species' is available).

Ecosystem Health Indicators

Area of Priority terrestrial habitats under restoration / Area of new habitat creation

Wetland restoration area

Key habitats (woodland, grassland, peatland) at high risk of wildfire

Wildfire prevention and management strategies

Other relevant indicators

The resilience of the natural environment is interconnected with all of the natural environment narratives (and associated indicators) and particularly with land use, which is likely to change in response to the direct and indirect impacts of climate change.

Area of land under landscape scale conservation

Narratives: Tracking suitable space in a changing climate; Pests, diseases and invasive species (forestry); Sustainable agriculture; Water quality and availability