SCOTTISH POLICY GROUP

BRITISH ECOLOGICAL SOCIETY

Environment, Climate Change and Land Reform Committee
Stage 1 call for evidence

Climate Change (Emissions Reduction Targets) (Scotland) Bill

A response from the British Ecological Society Scottish Policy Group

23rd August 2018

The British Ecological Society: 'A world inspired, informed and influenced by ecology'

Founded in 1913, we are the world's oldest ecological society, with over 6,400 members worldwide. As the voice of the UK's ecological community, we communicate the value of ecological knowledge to policymakers and promote evidence-informed solutions.

The Scottish Policy Group (SPG) is a group of British Ecological Society (BES) members promoting the use of ecological knowledge in Scotland. We act as a focal point to provide robust ecological evidence to the Scottish Government, Scottish Parliament and wider society.

The BES Scottish Policy Group welcomes the opportunity to submit evidence to the ECCLR committee on the Climate Change (Emissions Reduction Targets) (Scotland) Bill. Our approach is to provide context in terms of the likely impacts of climate change on Scotland's natural environment. This shows why urgency is required to reduce greenhouse gas emissions and why adaptation as part of the Climate Change Plan is as important as mitigation to protect Scotland's biodiversity, ecosystems and habitats.

Key messages

- Scotland has an internationally important representation of ecosystems and communities that are determined by, and dependent upon, its particular climate.
- There is strong evidence that species across a range of taxa are shifting their distribution poleward in response to climate change, and the assemblages of species found in different habitats are altering as a response to climate change.
- A climate change vulnerability assessment for around 3000 species in Britain predicted that such changes in species distribution will become the norm, not the exception in the coming years.
- Bryophytes and vascular plants contained the greatest proportion of vulnerable species, and upland species adapted to cool, wet conditions are also particularly vulnerable to climatic changes as they have 'nowhere else to go.'
- Future conservation measures need to account for the inherent uncertainty resulting from climate change and, as part of adaptation plans, help with species movement as well as ensuring other human-induced pressures are reduced to both improve habitat condition, and to ensure the outcomes of change are the best they can be for biodiversity and ecosystem service provision.
- Even by acting now, a response in the natural environment may not be seen for many decades as biodiversity takes time to adapt to new conditions[1].

Below we provide evidence of potential impacts on organisms (including pests and diseases), habitats and ecosystems from a changing climate.

Habitats and ecosystems

Long term studies of vegetation in Scotland

Long-term surveys of vegetation in Scotland conducted by The James Hutton Institute showed that climate change was one of the major drivers of change in vegetation in moorland, grassland and alpine plant communities over the last c 40 years (explanation of change for each habitat is given below). This work illustrates the importance of long-term datasets for providing a baseline against which changes can be measured, including the rate of change. It also highlights the need to invest in, and maintain, long-term ecological monitoring (for example the UK Countryside Survey) so that, as climate change progresses, action can be targeted towards those systems where it is most needed[2].

Case study - moorlands

Scotland is an internationally important stronghold of dwarf shrub moorland dominated by ericaceous plants, such as heather. A long-term study has found that the species diversity and vegetation composition of moorlands in Scotland has changed significantly over time resulting in a reduced biodiversity value [3]. There was an increase in common species and a loss in abundance of specialist species, especially those associated with higher altitudes (such as dwarf willow, bearberry and alpine lichens). Climate change, along with nitrogen pollution and grazing, was identified as a key driver of these changes.

Case study - grassland plant communities

The responses from six different grassland habitats - ranging from calcareous to acidic and wet grasslands - to a combination of pollution, climate change and grazing, are complex and compounded by uncertainties over lag-time effects[4]. Changes in climate (i.e. becoming warmer and wetter[5]) were related to significant changes in vegetation composition, but the relationships differed between plant species groups and different grassland habitats. Overall, common grassland species become more common, while rarer species become less common resulting in a change in the species composition of the grasslands.

Case study - alpine vegetation

Scotland's alpine vegetation includes elements of both arctic and alpine floras. Bryophytes and lichens are an important component and many of these communities are recognised as internationally important both in their own right and as habitat for significant breeding bird assemblages[6].

A long-term study, investigating the impacts of human-induced pressures (climate change, nitrogen pollution and grazing) found that common species are becoming more abundant, resulting in decreasing diversity within and between different alpine communities. For instance, key northern and alpine specialists such as bearberry, Iceland moss (a lichen) alpine azalea, Bigelow's sedge, declined while lowland generalist species, such as heather, increased. This change was consistent with predicted impacts of climate change, although the decline in lichen richness was also consistent with effects of nitrogen pollution. These results accord with a comparative study across Europe that found a change in alpine plant assemblages that was attributed to an upward shift in the altitudinal limit of an increasing number of species and local extinctions; slow-growing, stress-tolerant alpine species were replaced by more vigorous generalists[7].

In recognition of the sensitivity of specialist montane species, such as snow-bed bryophytes, to climate change, Scottish snow-beds are acting as an early case study for understanding climate change impacts. Trends for specialist bryophyte species in snow-beds are incorporated as a National Adaptation Indicator[8].

There may be little that can practically be done to protect nationally-rare Sites of Special Scientific Interest (SSSIs) designated for their snow-beds from global climate change, as projections indicate a trend to warmer winters[9] and less snowfall overall (so there is likely to be less snow fall and late lying snow to support snow-bed communities). Therefore, the Government should consider, as part of its adaptation strategy, how to continue protecting such SSSIs even if the features for which they were designated (in this case snow-beds) deteriorate or disappear due to climate change.

Scotland's temperate rainforests

Scotland's globally-rare temperate rainforests, found along its oceanic west coast, are characterised ecologically by a unique assemblage of moisture-demanding epiphytic (i.e. growing on the surface of plants) bryophytes and lichens[10]. However, the impact of a changing climate on Scotland's temperate rainforests is highly uncertain: the predicted future climate and habitat-type for this ecosystem is unlike any other currently found in Europe[11] and it is not possible to predict – based on current examples – what plant and animal communities might occupy this habitat in the future. Ecological modelling indicates that the negative effects of climate change can partially be offset by extending the area of the habitats and improving their quality. However, additional stresses causing a decline in habitat quality, such as pests and diseases like Ash dieback (a recently arrived non-native tree disease), that affect keystone species (a species that has a disproportionately large effect on its ecosystem relative to its abundance), can exacerbate the impacts of climate change and rapidly increase rates of species decline and extinction[12]. Therefore, improving the extent of habitat through strategic restoration within ecological networks and land management to improve habitat quality, such as controlling invasive non-native species, may enhance the resilience of assemblages of species to climate change - especially for ecosystems such as Scotland's rainforest that have 'nowhere else to go' because they are at the edge of their range.

Blanket peatland

Climate warming in peatlands can cause changes in vegetation composition resulting in a decrease in *Sphagnum* mosses and an increase in grass-like species and dwarf shrubs such as heather. This leads to a greater proportion of vascular plants being present which have been shown to increase greenhouse gas emissions from peat, because of plant-induced peat respiration, which is faster in vascular plants than moss species. Therefore, a switch in species composition in blanket peatlands can lead to an active decomposition of soil carbon, potentially causing significant carbon loss from peatlands[13].

Marine ecosystems

The UK's marine and coastal ecosystems are being affected by rising sea levels and temperatures, oxygen loss and rising acidity, other climate driven changes to salinity, wind, waves and currents as well as human-induced pressures from overfishing[14,15,16,17].

The effects on biodiversity of rising sea temperatures include: a decrease in breeding success of fulmars; Atlantic puffins; common, Arctic and little terns; as well as black-legged kittiwakes – that is strongly linked to changes in fish prey populations such as sand eel. Over the coming century, there will be a continuing shift northward in habitat suitability and prey availability for many bird species. Leach's storm petrel, great skua and Arctic skua could become extremely rare or even extinct in the UK[18]. In addition, severe summer storms are having strong negative effects on breeding performance of some species, especially razorbills[19].

In response to warming seas, cold water fish species are moving northwards, at estimated rates that are up to three times faster than terrestrial species, as well as moving deeper, at an average rate of ~3.6 m per decade (which may make commercial exploitation more difficult) whilst cephalopod (squid, cuttlefish and octopus) populations around the UK are expanding[20]. Other organisms such as jellyfish are increasing in abundance which has been linked to both rising sea temperatures and ecosystem instability caused by past overfishing[21]. In terms of impacts on marine species important to commercial fisheries, for the past ten years, the number of juvenile cod entering the population has remained very low despite dramatic decreases in fishing, in part this is related to shifts in the ranges of copepod species that larval cod feed on [22]. Fish species are also expected to shrink in size[23], as their metabolism accelerates with increasing temperature they need more oxygen to sustain body functions, which is limited by the surface area of gills.

Acidification in UK seas over the last 30 years has been happening at a faster rate than for the wider North Atlantic, with the overall effect of increased acidification being negative for biodiversity. For instance, there is a risk of a significant reductions in shellfish growth (and opportunities for commercial harvest) within 50 years, although some micro-algae and seagrasses may benefit from increased availability of CO_2[24]. Algal blooms caused by human-induced fertilization (excess nitrogen) of marine coastal systems can lead to oxygen depleted 'dead zones' forming that are also hotspots for acidification[25,26]. Areas of dead zones are expected to increase as sea temperatures rise and this could further threaten coastal fisheries[27].

Organisms

Distribution trends

There is strong evidence that species across a range of taxa are shifting their distribution poleward[28], and their communities are reshuffling in response to climate change[29]. A climate change vulnerability assessment for around 3000 species in Britain across 17 taxa predicted that such changes in distribution will become the norm, not the exception in the coming years[30]. Bryophytes and vascular plants contained the greatest proportion of vulnerable species, and upland species adapted to cool, wet conditions were also particularly vulnerable to climatic changes as they had 'nowhere else to go'. Although many other species could potentially expand their range, such opportunities will not occur where there are barriers to dispersal (e.g. habitat fragmentation, low populations sizes or lack of suitable plant partners – some insect species may face local extinction if the plant species they depend on are not present [31]). Future conservation measures need to deal with the inherent uncertainty resulting from climate change and, as part of adaptation plans, help with species movement (e.g. by making systematic assessments of spatial ecological network (connectivity) performance under conditions of climate change, and safeguarding the nature reserve network which facilitates species' range expansion and protection[32]) as well as ensuring other human-induced pressures are reduced. In addition, species translocations may become an increasingly important conservation tool to be considered as part of adaptation plans.

Bird populations and distributions

There is strong evidence for impacts on climate change on a range of British bird species, including internationally important breeding seabird and wintering waterbird communities[33]. Projected future impacts are likely to produce both winners and losers, with upland species, breeding seabirds and red- and amber-list species, most vulnerable to future decline, the risk of which will increase with the projected magnitude of climate change[34,35,36].

Case study - golden plover

One of the key mechanisms by which climate change affects birds is through impacts on key prey species. For example, hot, dry summer weather reduces the abundance of craneflies, a keystone organism of peatland systems. This limits the breeding success of golden plovers and other upland birds that feed on craneflies the following spring, threatening their populations. Management to restore peatlands by blocking drainage ditches and raising water levels is a priority for climate change adaptation and can contribute to making these systems resilient to 2°C warming[37,38,39].

Case study - red grouse

Red grouse is a heavily managed wild bird species important to Scotland's rural economy. It is also vulnerable to the effects of climate change through direct impacts on breeding success, impacts on cranefly prey (see above), as well as the condition of heather (which depends on climate) and disease. For instance, the incidence of strongylosis, being greater in warm, wet springs, as well as the prevalence of ticks, which can cause louping ill virus[40].

Spread of pests and diseases

Climate change will also affect the presence or absence of viruses which may have economic impacts as well as affecting biodiversity. Two examples are given below.

Case study - spread of the Xiphinema diverscaudatum virus

Some virus-carrying nematodes which presently have a restricted distribution could spread further north. For example, *Xiphinema diverscaudatum*, which is a vector of Strawberry Latent Ringspot Virus (SLRV) has a geographical distribution up to the Tay estuary, which means strawberries grown in the north of Scotland are currently not subjected to possible infections with this virus. However, a 1^{o} C rise in temperature would permit the virus to extend into north-east Scotland[41].

Case study - the spread of viruses affecting common frogs
The viruses of the genus *Ranavirus*, family *Iridoviridae* have been introduced to the UK on multiple occasions and have caused major declines of common frogs in south-east England following recurrent disease outbreaks among adult frogs. Disease incidents were more frequent and more severe (i.e. a greater proportion of the frog population died) at higher temperatures. Projections using future emissions scenarios showed that the disease could spread to Scotland and possibly threaten some frog populations' capacity to persist[42].

Conclusion

Scotland's natural environment has already been altered by climate change, and future changes are inevitable but come with uncertainty regarding outcomes. Mitigation is absolutely needed as there is no other option than reducing emissions to avoid a massive loss of local biodiversity. In addition, conservation efforts need a greater focus on adaptation measures and monitoring as this will help address changes happening now and future uncertainty.

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