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# BIODIVERSITY AND ECOSYSTEM RESILIENCE

## KEY CONSEQUENCES

Effects of a changing climate observed in Scotland's nature indicate some of the likely future effects. Warming has already caused earlier timing of spring events such as leaf unfolding, bird migration and egg laying. Where species adapt at different speeds this may impact on their populations. For example, caterpillars may emerge earlier than birds' eggs hatch, leading to a lack of food for some bird chicks. Shifts in ranges in plant and animal species have been recorded, particularly northwards, and there may be new species moving to Scotland, such as the comma butterfly. Movements may also occur up hillsides, and species already confined to high mountains in Scotland may be lost as conditions become unsuitable or other species replace them. In the seas, the ranges of some plankton and fish abundance are moving.

Effects on biodiversity are likely to be severe with species potentially becoming extinct in Scotland as a result of their being unable to adapt to a rapidly changing environment. There will also be physical effects on habitats, including loss of saltmarsh and machair to coastal erosion, loss of salmon spawning beds to flash floods, and peat erosion from drying out of wetlands. There will be new risks from non-native species including pests and diseases. These effects, when combined with human responses such as land-use change to grow bioenergy crops or new forests, can cause major changes to ecosystems and the relationships between species.

Ultimately, the effects of the changing climate and the loss of species diversity could degrade ecosystem function to the extent that they cannot maintain the level of services, such as flood mitigation, productive land capacity and water supply that are of value to people. The *Millennium Ecosystem Assessment* and recent EU studies show that this is exactly what is happening: ecosystems are degrading as a result of human activities, and so is their capacity to provide the services on which people depend. There are international examples of ecosystem failure, which should serve as a warning of the extreme losses in biodiversity and natural services that can result.

Soils are extremely important to biodiversity and many other sectors. For example, soil quality affects food and biomass production, it regulates water flow and quality, it acts as a natural carbon store and gas balance, provides habitats, raw material and a platform for building. All of these vital functions will be impacted by climate change and better understanding how soils may be adapted for such change will underpin the resilience of many sectoral responses. Where soil is concerned, adaptation strategies and mitigation strategies are inextricably linked. Soil also has a direct role in regulating climate via the uptake and release of greenhouse gases and by storing carbon. These processes determine in part the composition of the atmosphere and thus the Earth's climate.

## THE BIG CHALLENGES

The key challenge is to manage the natural environment, and the human activities that affect it, so that, as far as possible, biodiversity can adapt to a changing climate and ecosystems are resilient enough to continue to supply the ecosystem services that underpin our economy and communities.

### Freshwater ecosystems

Freshwater ecosystems will be affected by higher temperatures, increased variability in rainfall causing flooding or drought, decreasing snowfall and changing water quality. Developing flood management schemes to work with and utilise natural processes will be important. Climate change is also envisaged to exacerbate the effects on biodiversity of other anthropogenic effects (e.g. eutrophication, acidification, habitat fragmentation) and therefore adaptation strategies should seek to also reduce those effects.

### Upland ecosystems

Upland ecosystems are likely to see changes as some habitats and species are affected by changing snowfall and rain patterns. In addition the climate space where certain habitats and species can exist is likely to shift. Some of these habitats and species are already at the edge of their ranges, with mainly northern or montane distributions, or they occur in habitats such as snowbeds. These species may have nowhere they can move to as their climate space in Scotland disappears. The challenge is to develop appropriate management for the uplands to increase the resilience of habitats, species and soil to climate change.

### Woodland ecosystems

We can expect changes in woodland ecosystems, with different species reacting in different ways to the changes in climate. It is likely that enlarging remnant native woods and developing habitat networks around them will help woodland ecosystems and individual species to adapt to climate change, by building resilience and allowing dispersal to more suitable areas. Improving the condition of existing native woodlands, e.g. by managing grazing impacts, will be important.

### Farmland and urban

In farmland and urban ecosystems, some species will be 'losers' as their range is predicted to contract. However, many farmland and urban species could be 'winners' as their range expands northwards, such as peacock butterflies. Biodiversity will better adapt to climate change by maintaining the extent and diversity of habitat types and landscape features, by enlarging existing areas of habitat to build resilience, and by strengthening habitat networks that allow dispersal to more suitable areas.

### Increasing knowledge and understanding

There is considerable uncertainty over the likely effects of climate change on Scotland's biodiversity and ecosystems, and how these changes or trends can be influenced or managed. A greater understanding of this is required.

### The need for action across many sectors

A major challenge in protecting the health of biodiversity and ecosystem services in the face of climate change is the need to reach across many sectors to achieve effective actions. The ecosystem approach promotes the involvement of those who use the environment in decisions about its management. This challenge will be even greater as there will be a need to ensure that other sectors actions to mitigate or adapt to climate change do not have significant impacts on ecosystems. The planning system will be an important mechanism to work across sectors, given its influence over land use change.



## PLANNING FOR BIODIVERSITY AND ECOSYSTEM RESILIENCE IN SCOTLAND

### Scottish Biodiversity Strategy

Scotland has a *Biodiversity Strategy*, setting objectives for conserving our biodiversity and linked to a duty on all public bodies to further biodiversity conservation. Responsibility for priority habitats and species previously coordinated at a UK level, is now devolved to Scotland. Implementation Plans supporting the *Scottish Biodiversity Strategy* ensure delivery is integrated with actions for priority habitats and species, utilising an ecosystems approach to conservation. Actions under the *Strategy* are overseen by the five *Scottish Biodiversity Forum Ecosystem Groups*: Upland, woodland, marine/coastal, freshwater/wetland, and lowland/farmland. Climate change has been identified as a pressure on biodiversity in all five of the Ecosystem Groups. Some of these will be considered in greater detail in other Sector Action Plans under the Adaptation Framework.

The *Scottish Biodiversity Strategy* has identified some actions to assist in adaptation to climate change, and more will be described as understanding increases. Many actions to assist in adaptation have been identified in the Scottish Natural Heritage publication *Climate change and natural heritage – SNH’s approach and action plan*. Some broad areas for action include:-

- Promotion of natural flood management in catchment planning;
- Adaptive coastal management including managed coastal realignment;
- Using natural features in urban environments to assist adaptation, for example through use of shade from trees and shrubs to reduce demand for cooling or use of living roofs to improve habitat connectivity, reduce heat gain and slow the movement of rainwater drainage into the urban drainage system;

- Management of nature conservation sites to take account of changing climate, and to consider the place of the sites in the wider ecological network;
- Managing species conservation priorities to take account of changing climate;
- Reducing pressures on habitats vulnerable to climate change, e.g. managing grazing in woodlands, restoring water tables in wetlands, reducing pollution in rivers and lochs, managing activities in coastal waters;
- Promoting ecological connectivity to assist in species movement in response to climate change, and as a means of building larger, resilient species populations and habitats; and
- Continuing pressure on invasive non-native species that impact on native biodiversity, some of which may be even more successful in a warmer climate, and a considered response to the gradual movement of species from the South.

### Scottish Soil Framework

Also of importance is the Government’s *Scottish Soil Framework* which sets out the vision for soil protection in Scotland, and formally acknowledges the important services soils provide to society. The *Soil Framework* recognises that climate change and loss of organic matter are the most significant threats to Scottish soils. It promotes the sustainable management and protection of Scotland’s soils and identifies several key outcomes of direct relevance to climate change adaptation. These include enhancing the soils capacity to adapt to a changing climate.



## SECTOR ACTIONS

	Description	Who Delivers	When
<b>Understand the consequences of a changing climate</b>			
1	Increase knowledge and awareness of state of ecosystem health and services on land and in the sea, and the trends for change.	SG, SNH and partners	Ongoing
<b>Equip decision makers with skills and tools</b>			
2	Publish further guidance on establishing habitat networks and adaptive management of protected sites.	SNH	Ongoing
3	Assess and manage vulnerable coasts, promoting adaptive coastal management that works with natural processes.	SNH, local authorities, SEARS partners	Ongoing
4	Identify those species that are most sensitive and vulnerable to climate change and prioritise options for future management and adaptation strategies.	SG, SNH and partners	Ongoing
5	Develop the ecosystem approach into a usable set of tools for use by decision makers.	SG, SNH and partners	Ongoing
<b>Integrate adaptation into public policy and regulation</b>			
6	Promote restoration of natural processes and promotion of wetland networks in catchments as a means of increasing resilience.	SNH, SEPA and partners	Ongoing
7	Guide the management of soils to reduce erosion and greenhouse gas emissions including prioritising peat bog management.	SG, SNH and partners	Ongoing
8	Increase the resilience of habitats and species in the wider countryside by developing habitat networks, increasing habitat patch size where possible, and improving habitat condition, through agri-environment schemes and land-use planning.	SG, SNH, Local authorities and partners	Ongoing
9	Identify invasive species whose behaviour will change as climate changes. Develop appropriate management techniques for their control/management.	SG, SNH and partners	Ongoing

SG = Scottish Government; SNH = Scottish Natural Heritage; SEPA = Scottish Environment Protection Agency; SEARS = Scotland's Environment and Rural (Delivery) Services.