STATE OF NATURE

2019

state of nature PARTNERSHIP

SCOTLAND

THE HEADLINES

In this report we have drawn on the best available data on Scotland's biodiversity, produced by partnerships between conservation non-governmental organisations (NGOs), research institutes, UK and national governments, and thousands of dedicated volunteers. We have focused on the trends in species as the key evidence of how nature is faring.

The collection of systematic data on species' trends often does not fully cover timescales relevant to ecological changes. Widescale data collection only began 20–50 years ago. The results should be interpreted in that context and viewed against a backdrop of profound historic human influences on nature in Scotland. Scotland makes a very significant contribution to UK biodiversity; it has a high proportion of the UK's upland habitats, including its most mountainous terrain, and has species found nowhere else in the UK. Some of Scotland's species, such as the White-script Lichen and Scottish Primrose, are found nowhere else in the world. Historic deforestation, intensified livestock grazing since the 18th century, widespread sporting management since the 19th century and large-scale commercial forestry during the 20th century have all had significant effects on upland wildlife.

Photo: Drew Buckley

Our data show that the abundance and distribution of Scotland's species has on average declined over recent decades and most measures indicate this decline has continued in the most recent decade. There has been no let-up in the net loss of nature in Scotland.

Red squirrel

Photo: Kevin Sawford

24%
decline in average species' abundance.
Our indicator of average species' abundance of 352 terrestrial and freshwater species has fallen by 24% since 1994. There has been very little change in the rate of decline in the last 10 years.

14%
decline in average species' distribution.
Our indicator of average species' distribution, covering 2,970 terrestrial and freshwater species over a broad range of taxonomic groups, has fallen by 14% since 1970, and is 2% lower than in 2005.

49%
of species have decreased in abundance.
Of the species showing either strong or moderate changes in numbers, 49% have decreased and 28% have increased. Likewise more species have decreased in distribution (33%) than increased (20%) since 1970.

62%
of species show strong changes.
Our wildlife is undergoing rapid change, the proportion of species defined as showing strong changes in abundance, either increasing or decreasing, rose from 45% since 1994 to 62% over the last 10 years.

11%
of species are threatened.
Of the 6,413 species found in Scotland that have been assessed using Regional Red List criteria, 11% have been classified as threatened with extinction from Great Britain.

38%
decline in the Scottish breeding seabird indicator between 1986 and 2016.
However, the abundance indicators for fish species, both pelagic and demersal, show some signs of recovery from deep historic lows in the Celtic and North Seas.

Though some pressures on nature,

notably freshwater pollution, have reduced in recent decades, the pressures that have caused the net loss of biodiversity continue collectively to have a negative effect.

- Agricultural productivity, linked to the intensification of land management and the decline in farmland nature, is still increasing, although some farmers have adopted wildlife-friendly farming techniques.
- Average temperatures in Scotland have increased by nearly 1°C, with widespread impacts on nature evident already.
- Legislation has driven marked reductions in emissions of some harmful pollutants, although negative impacts remain.
- The need for more homes in response to changing human population demographics means that thousands of hectares (ha) of habitat including farmland, woodland and wetland are built on every year, although woodland cover has increased and new wetland habitat has been created.

Gannet

Photo: Andrew Parkinson

The impacts of fishing and climate change

on species' abundance and distribution are evident throughout Scottish seas. At the base of the food web, plankton communities have changed in response to warming seas. While fish stocks are showing signs of recovery, the impacts of unsustainable fishing persist. The ramifications of other pressures on the marine environment, such as noise and plastic pollution, are of concern but remain less clear.

Photo: Oliver Smart

This report showcases just a few of the exciting conservation initiatives,

involving thousands of people, intended to help nature flourish across Scotland, delivered through partnerships of individuals, landowners, NGOs and government.

Photo: Peter Cairns

Scotland has a long history of love for, and fascination with, our natural heritage.

Thanks to this, thousands of volunteers collect data on our wildlife every year. Without their dedication this report would not be possible; we thank them all.

#STATEOFNATURE

KEY FINDINGS

We are able to present trends in status for more species than ever before in *State of Nature 2019*. This is due to new datasets becoming available and the development of analytical tools which enable a much broader range of taxonomic groups to be represented.

Using multispecies indicators, our goal is to communicate a clear, objective assessment of the state of biodiversity in Scotland. The metrics we present show how measures of average species' status have changed over time as well as showing the variation in trends between species.

For full methods see *State of Nature 2019* at www.nbn.org.uk/stateofnature2019.

Our species' status metrics make use of two broad types of data:

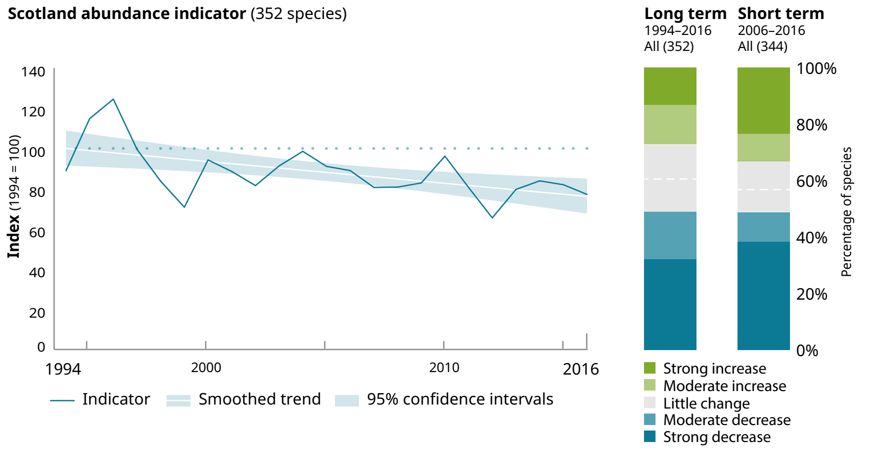
Abundance data from a number of well-established monitoring schemes in Scotland and the UK encompassing 352 species (birds, mammals, butterflies and moths). Many of these species are popular to record, and are relatively easy to identify and to observe, making it possible to count individuals to get a measure of relative abundance. Our abundance metrics report the average change in relative abundance across these species.

Occupancy data from large-scale biological records datasets from which we can now calculate trends for 2,970 species across a wider range of taxonomic groups (including mammals, vascular plants, lichens, bryophytes and a number of invertebrate groups). These trends measure the change in the proportion of occupied sites in Scotland, so our metrics effectively report the average change in distribution for these species.

We focus on measuring change over two periods: from 1994 through to 2016 for abundance data and from 1970 to 2015 for occupancy data. Our short-term period covers the final 10 years of these time series, telling us how Scotland's nature is doing now.

Photo: Laurie Campbell

SCOTLAND-SPECIFIC COMBINED ABUNDANCE INDICATOR BASED ON TRENDS OF MOTHS (175 SPECIES), BIRDS (143 SPECIES), BUTTERFLIES (25 SPECIES) AND MAMMALS (9 SPECIES)



The abundance indicator for 352 terrestrial and freshwater species, for which Scotland-specific trends are available, shows a statistically significant decline in average abundance of 24% (95% confidence intervals (CI) -33% to -15%) between 1994 and 2016. Over this long-term period the smoothed indicator fell by 1.2% per year. Over our short-term period, the decline was a statistically non-significant 12%, a rate of 1.3% per year. There was no significant difference in the rate of change between the long and the short term.

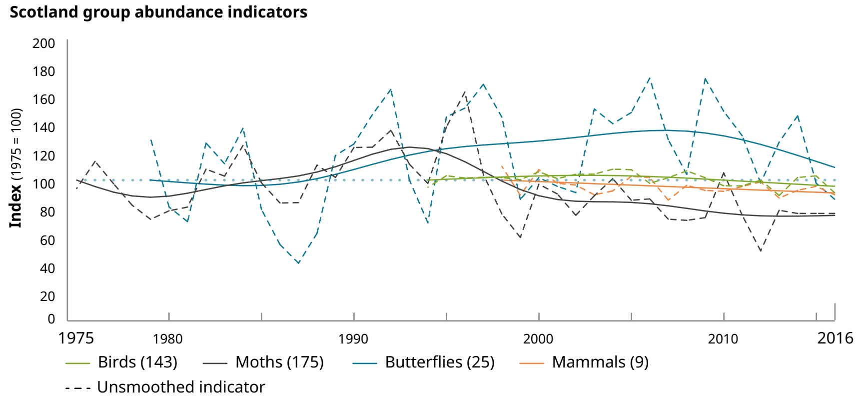
The white line with shading shows the smoothed trend and associated 95% CI, the blue line shows the underlying unsmoothed indicator. The bar chart shows the percentage of species within the indicator that have increased, decreased (moderately or strongly) or shown little change in abundance. Within multispecies indicators like these there is substantial variation between individual species' trends. To examine this, we have allocated species into trend categories based on the magnitude of population change, over the long- and the short-term periods.

- Over the long term, 49% of species showed strong or moderate declines and 28% showed strong or moderate increases; 24% showed little change.
- Over the short term, 48% of species showed strong or moderate declines and 33% showed strong or moderate increases; 18% showed little change.
- Over the long term, 45% of species showed a strong change in abundance (either increase or decrease). Over the short term this rose to 62% of species.

Using a different, binary categorisation:

- Over the long term, 60% of species showed negative trends and 40% showed positive trends; over the short term, 56% of species showed negative trends and 44% showed positive trends.

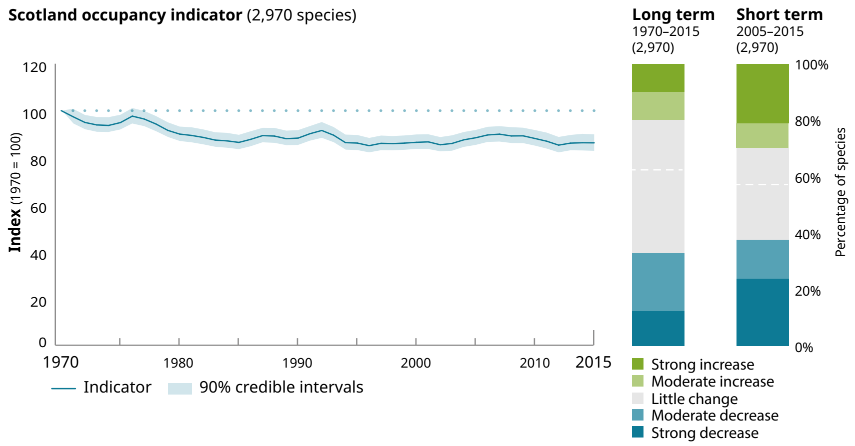
TRENDS IN ABUNDANCE FOR BIRDS, MOTHS, BUTTERFLIES AND MAMMALS



Based on smoothed trends:

- The abundance indicator for 175 moth species starts in 1975 and shows a statistically significant decline in average abundance of 25% (CI -49% to -1%). Over the short term, the indicator was 10% lower in 2016 compared to 2006.
- The abundance indicator for 143 bird species starts in 1994 and has been broadly stable since, with a statistically non-significant decline in average abundance of 4% (CI -9% to 0%). The indicator was 7% lower in 2016 compared to 2006.
- The abundance indicator for 25 butterfly species starts in 1979 and shows a slight but statistically non-significant increase in average abundance of 9% (CI -27% to +45%). The indicator was 19% lower in 2016 compared to 2006.
- The abundance indicator for nine mammal species starts in 1998 and overall shows a statistically significant decline in average abundance of 9% (CI -14% to -4%). The indicator was 5% lower in 2016 compared to 2006.

CHANGE IN SPECIES' DISTRIBUTION IN SCOTLAND



The occupancy indicator for 2,970 terrestrial and freshwater species shows a decline in average distribution of 14% between 1970 and 2015, and 2% between 2005 and 2015. Because species tend to decline in abundance before they disappear from a site, declines could reflect more severe underlying abundance declines.

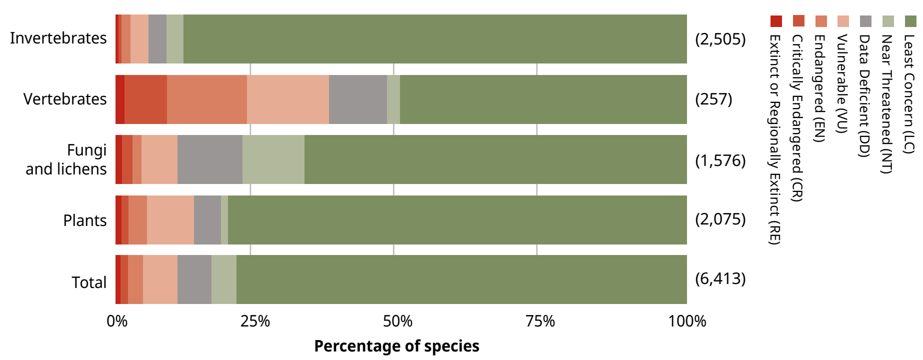
To examine the variation in species' distribution trends, we allocated trends into categories based on the magnitude of distribution change.

- Over the long term, 33% of species showed strong or moderate declines and 20% showed strong or moderate increases; 47% showed little change.
- Over the short term, 37% of species showed strong or moderate declines and 30% showed strong or moderate increases; 33% showed little change.
- Over the long term, 23% of species showed a strong change in distribution (either increase or decrease). Over the short term this rose to 45% of species.

Using a different, binary categorisation:

- Over the long term, 62% of species showed negative trends and 38% showed positive trends in distribution; over the short term, 57% of species showed negative trends and 43% showed positive trends.

NATIONAL RED LIST ASSESSMENT BY TAXONOMIC GROUPS



Of the 6,413 species found in Scotland that have been assessed against the International Union for Conservation of Nature (IUCN) Regional Red List Criteria, 642 (11%) of the extant species, for which sufficient data are available, are formally classified as threatened (Critically Endangered, Endangered or Vulnerable) and therefore at risk of extinction from Great Britain (the scale at which assessments are made). The bars show the percentage of assessed species, by broad taxonomic group and overall, which fall into each of the IUCN Red List categories.

Of the extant terrestrial and freshwater species found in Scotland, assessed using modern IUCN Regional Red List criteria, 265 plants (13%), 153 fungi and lichens (11%), 92 vertebrates (37%) and 132 invertebrates (5%) are classified as being at risk of extinction from Great Britain.

In addition to the *State of Nature* report's metrics of change in abundance and distribution of terrestrial and freshwater species, and of extinction risk, Scottish Natural Heritage (SNH) publishes biodiversity indicators for birds and butterflies on an annual basis[1].

- Between 1994 and 2017, the woodland bird index (23 species) showed an increase of 69%. The smoothed farmland bird index (27 species) increased steadily up to the late 2000s, peaking at 23% above the 1994 index value. It is currently 14% higher than in 1994, although range changes between 1970 and 1990 suggest a decline in farmland birds over that period. The smoothed upland bird index (17 species) shows a statistically significant decline of 17%.
- Between 1979 and 2017, the long-term trend for generalist butterflies (14 species) was classed as stable. Some species show climate-driven, significant long-term population increases including northwards range expansion. Scotland's specialist butterflies (six species) also show little change since 1979; however, some species (such as Grayling) show statistically significant declines, while others (such as Small Pearl-bordered Fritillary) have increased significantly.

MARINE KEY FINDINGS

Marine status assessments have been made for the Greater North Sea and Celtic Seas (except for seabirds). Here we present examples to summarise changes around the Scottish coast, but for more details on each group see *State of Nature 2019* UK report, Marine key findings section.

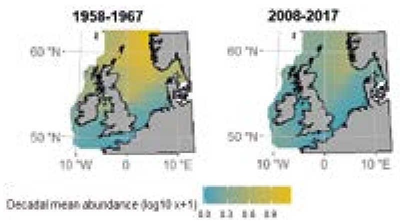
PLANKTON

The base of the marine food web is formed by a wide variety of organisms, including phytoplankton (photosynthetic plant-like microscopic organisms) and zooplankton (animal plankton including copepods and larvae of some larger species). These groups are sensitive to changes in nutrients, salinity and temperatures. Plankton communities respond rapidly to environmental changes, making them a good indicator of change in marine ecosystems. In recent years, profound and important changes have been identified in some components of the plankton communities around the UK coast, including Scotland.

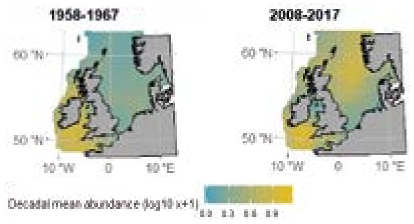
Copepods (small planktonic crustaceans) make up a large proportion of the zooplankton biomass and play a key role in converting energy from primary producers up the food web; however, the composition of these communities is changing. Warming temperatures have driven northward shifts in the distribution of zooplankton in the North East Atlantic, from the 1960s to the late 1980s, bringing smaller warm-water copepod species into certain regions around the UK.

An example of this has been the shift in the relative proportions of two closely related copepod species, with the cold-water *Calanus finmarchicus* being replaced by the warmer-water relative *C. helgolandicus* in some areas[2,3] (see maps below). These shifts have the potential to impact higher trophic levels, not least because of changes to community composition but also because seasonal patterns of production and overall abundance vary among species. This has consequences for the predators of plankton, including fish[4], which in turn can impact on species at higher trophic levels, such as seabirds[5,6,7].

Colder-water species, *Calanus finmarchicus*, moving polewards



Being replaced by warmer-water species, *Calanus helgolandicus*, moving northwards

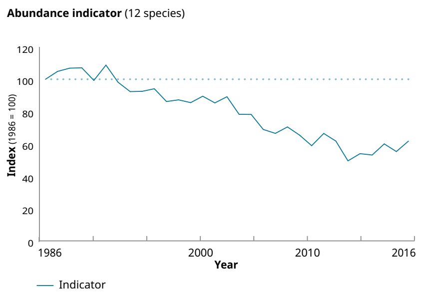


SEABIRDS

Seabirds sit at the top of the food web and are susceptible to changes in the distribution and phenology of the plankton and fish species they rely on for food. They have undergone substantial declines in Scotland over the last 30 years.

- From the start of the time series in 1986 to the most recent estimate in 2016, the average numbers of 12 species of breeding seabirds in Scotland have declined by 38%.
- Surface feeding seabirds such as Kittiwake, or species that depend on them, such as Arctic Skua, have been particularly affected, with declines of 72% and 77% respectively since 1986. Sandeels are a key prey species for fish and seabirds. There is now good evidence that declines in the abundance and nutritional quality of Sandeels has reduced the breeding success and populations of seabirds such as Kittiwakes[8,9,10]. The cascade of mechanisms involved are still being investigated but include the impact of fishing on Sandeel populations as well as increasing sea surface temperature, the timing and strength of ocean stratification, and a mismatch in reproductive timings with availability of prey[11,12].

Index of seabird numbers in Scotland, 1986 to 2016



MARINE MAMMALS

- Scotland hosts over 30% of the world breeding population of Grey Seals. Between 2012 and 2016, populations were largely stable in the west and north, and increased by 4% in the North Sea[13].
- Since 1994, Harbour Seal abundance has decreased in colonies on the north and east coasts of Scotland but increased in west Scotland (an area that holds over 20% of UK Harbour Seals)[13].

Photo: Chris Gomersall

FISHERIES

Marine fish and shellfish are harvested around the UK, representing the most widespread direct human pressure in UK waters[14]. Fish stocks of commercial interest span international boundaries. When fish communities are fished more heavily, the larger, more profitable fish are removed and the size-mix of the fish stocks is changed. Smaller, less commercially valuable, less reproductive individuals become more dominant, affecting the structure and stability of the ecosystem[15].

The UK has a legal commitment to fish sustainably by 2020.

The Scottish Government indicator for sustainability of commercial fish stocks reports the percentage of key Scottish fish stocks fished sustainably. From 2015 to 2017 the indicator increased from 46% to 54%[16].

The UK administrations' latest assessment of progress towards Good Environmental Status (GES) under the Marine Strategy Regulations[17] confirmed GES will not be met by 2020 for fish, commercial fish and shellfish, and benthic habitats.

MARINE FISH ABUNDANCE IN THE CELTIC AND GREATER NORTH SEAS

Abundance indicators for demersal marine fish species, those that live on or near the sea floor (e.g. Cod, Haddock, Saithe), for the Celtic Seas and the Greater North Sea, show signs of recovery following improved fisheries management, from very low baselines and a history of overexploitation.

Data for pelagic fish species that live in the water column (e.g. Herring, Blue Whiting and Mackerel) indicate increases in average abundance in both the Celtic and the Greater North Seas over the same period. Groundfish surveys are less reliable for schooling pelagic species and therefore the direction of trend is more appropriate to report than the average magnitude of change.

The abundance indicator for demersal marine fish, for the Celtic Seas (based on 11 species) and the Greater North Sea (based on nine species) show increases in average abundance as follows:

CELTIC SEAS

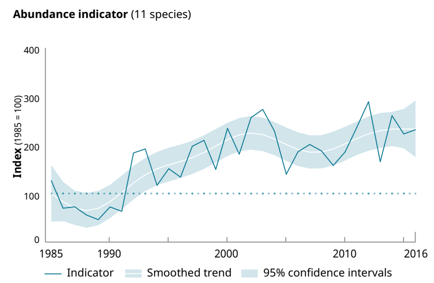
- The demersal species indicator shows a statistically significant increase of 133% over the long term (1985–2016) and a non-significant 22% over the last 10 years.
- Over the long term, 27% of species showed strong or moderate decreases and 64% showed strong or moderate increases; 9% showed little change.

GREATER NORTH SEA

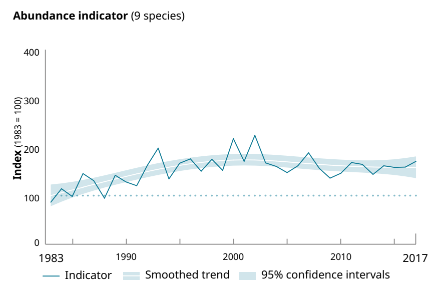
- The demersal species indicator shows a statistically significant increase of 58% over the long term (1983–2017) and a non-significant decrease of 6% over the last 10 years.
- Over the long term, 11% of species showed strong or moderate decreases and 78% showed strong or moderate increases; 11% showed little change.

Photo: Laurie Campbell

Change in average species' abundance – Celtic Seas demersal fish



Change in average species' abundance – Greater North Sea demersal fish



Very little is known about the vast majority of unmonitored and unregulated fish populations. These trends are based on a tiny proportion of the hundreds of demersal fish species present in UK waters.

DRIVERS OF CHANGE

The following pages explore the key pressures acting on nature in Scotland; agricultural management, climate change, hydrological change, urbanisation, woodland management, pollution, invasive non-native species (INNS), upland management, marine climate change and fisheries.

AGRICULTURAL MANAGEMENT

Photo: David Woodfall

Agriculture is the dominant use of land, covering over 70% of Scotland, and some of the most important wildlife habitats, such as the Hebridean machair, are intrinsically linked to farming systems.

As a result, farming practices influence how nature fares, with the power to either support or endanger wildlife and ecological life-support systems. Agriculture and associated land uses are deeply related to the twin climate and biodiversity crises, while farmers and crofters are frequently on the frontline of environmental change. At both a UK and global scale, farmland management has been identified as one of the most significant pressures on biodiversity[1,2].

Historically, intensification of agriculture has been one of the major causes of biodiversity decline due to loss of traditional farming practices and changes in management. For example, Corncrakes bred in all Scottish counties in the mid-19th century; by the 1980s they were almost entirely restricted to some Hebridean and Orkney islands[3]. The changes in farmland management over the past 50 years that have had the greatest impact on Scotland's nature include the increased use of pesticides and fertilisers, continuous cropping, changed sowing seasons and the loss of non-cropped habitats[3,4,5]. Changes in food production patterns can cause invertebrate declines, with conversion to more intensive agriculture and agrochemical pollutants the key drivers[6]. Moreover, changes to ploughing, crop rotations, fertiliser use and livestock numbers have negatively impacted soil and water quality, carbon storage and led to increasing greenhouse gas emissions, which contribute to climate change[7]. While these are changes that have been seen in lowland agriculture, much of Scotland's uplands are also managed for food production; we discuss this on page 15.

However, compared to other UK countries, some species groups such as butterflies and moths, especially generalists, show greater stability in Scotland. Scottish agri-environment schemes (AES), in which subsidies support wildlife-friendly farming methods, have delivered some positive outcomes, in particular in addressing declines in some farmland birds[8,9]. Efficient food production can demonstrably be decoupled from ecological damage with the right incentives and advice. The terrestrial breeding bird index farmland section, incorporating trends from 27 species, has shown a 14% long-term increase (1994–2017)[10], and more specifically trends in abundance of seed-eating birds in Scotland have become more stable[11]. In some areas targeted AES have arrested declines and even enabled partial recovery, such as for Corncrakes in the Hebrides and Corn Buntings in northeast Scotland[12,8]. Despite the issues related to intensification, as outlined above, areas with a high proportion of semi-natural vegetation and low-intensity agriculture make up 40% of Scotland's agricultural area, and are classified as High Nature Value farmland[13].

FARMERS HELPING NATURE TO PROSPER

Many farmers and crofters are managing their land with nature and the environment in mind and show how biodiversity can benefit with the right support. Leaving space for nature with wildlife-friendly practices such as enhanced field margins, good grazing management, reduced inputs of pesticides and fertilisers, and mowing and cutting at the right time can have major benefits.

At Williamwood farm in Dumfriesshire, for example, farmers Michael and Shirley Clarke have Highland-cross cattle and breeding sheep that they farm with nature in mind. They maintain wet rushy areas for wading birds, reducing their stock in the breeding season, manage species-rich grassland to maintain plant diversity, sow wild-bird cover to help farmland birds and have created margins to protect watercourses. They have also planted more than 11,000 trees, 3.5km of new hedgerows, created a new lake and put up numerous bat and bird boxes. Farming with nature is at the heart of what they do, which is why Michael was one of the founding steering group members of the Nature Friendly Farming Network (NFFN) in Scotland[14]. He is now chair of the Scottish Steering Group of NFFN, working alongside a growing network of support for nature among Scottish farmers and crofters.

CLIMATE CHANGE

Climate change is a key driver of change in Scotland's habitats and species, from mountain tops to seabeds, interacting with the effects of other drivers[1].

Climate influences the landform processes directly shaping mountains, rivers and coasts, and underpins our habitats, ecosystems and landscapes[2]. Climate change and extreme weather events have already impacted on many aspects of our natural and human environment, including agriculture, forestry, transport, water resources, energy demand and human health[1,3]. Some habitats will be affected directly, but often climate change will alter intricate ecological balances, as in the marine environment (see page 16). Many of Scotland's species are adapted to specific climatic conditions, meaning that climate change is projected to have strong effects[4].

Climate change is driving the range of some species northward, including butterflies (Small Skipper, Ringlet and Orange-tip)[5]; birds (Nuthatch, Reed Warbler)[6]; dragonflies (Hairy Dragonfly)[7] and moths (Thistle Ermine and Gold Triangle)[8]. On the trailing edge of ranges, climate change is putting pressure on species that have their southern limits in Scotland. Modelling predicts that species associated with cold montane habitats are likely to see continued contraction of their ranges to the most northerly and high-altitude locations[9]. Snow cover and its duration are projected to decrease further, with the possibility of no snow cover below 900 metres by the 2080s[10]. This could lead to the loss of snow-bed communities through the increased dominance of generalist species from lower altitudes.

A recent project mapped the best places for nature across the UK and calculated the amount of carbon contained in the vegetation and top 30cm of soil, showing that nature-rich areas secure carbon, benefit species and provide vital ecosystem services[11]. It is increasingly well documented that habitat degradation means stored carbon is lost to the atmosphere[12].

The frequency of fires in uplands and woodlands is predicted to increase, leading to direct damage to habitat and indirect impacts through nitrate deposition[10]. Across many sites in Scotland, peatlands and blanket bog play a crucial role in carbon storage, flood alleviation and water quality, while delivering significant biodiversity benefits. The global importance of peatlands for carbon storage and biodiversity is increasingly recognised – the Scottish Government Peatland Action Fund[13] has funded extensive restoration and conservation work on more than 19,000ha across the country.

Scotland's coastal habitats are also seeing pressure from climate change, through the acceleration in the rise of sea levels and larger storm-surges causing erosion and reduced connectivity of some beach, dune and machair habitats. These factors have led to changes in species composition[14]. Saltmarshes and some dune systems, which increase the resilience of coastlines to these pressures by attenuating wave energy and providing a buffer for sensitive inland habitats, may be adversely affected by higher seasonal rainfall, increasing variation in groundwater, and freshwater run-off[15].

A further risk from climate change is the spread of INNS and pathogens which may benefit from the changing conditions.

SCOTLAND'S UPLANDS AND CLIMATE CHANGE

Scotland's uplands are of international importance. Long-term monitoring of snowbeds has revealed the effects of climate change. Mean snow cover duration from October to May in the central Scottish Highlands decreased between 1979 and 2003[16], during which time both mean temperature and mean precipitation increased. This is affecting the composition of montane vegetation, with the decline of some arctic-alpine species. Repeat surveys of snow-bed vegetation over the past 50–60 years show a shift towards more homogeneous communities, with an increase in generalist species such as the Three-leaved Rush and declines in specialist species such as snow-bed liverworts[16]. As a result, the species richness of dwarf-shrub heath and oceanic-montane liverwort-rich heath habitats is declining. These changes are thought to be due to a combination of increasing temperatures, shifts in precipitation patterns, and changes to grazing regimes[16]. Shifts in the ranges of species and changes in phenology will have implications for the ecological composition of communities and habitats, with both winners and losers.

Photo: Steve Knell

Hairy Dragonfly

HYDROLOGICAL CHANGE

Humans have been managing the subsurface and surface hydrology of catchments for thousands of years.

Land has been drained for agriculture and development, and streams and rivers have been diverted, straightened, deepened, embanked, dammed and reinforced to allow navigation, provide flood defence, create reservoirs for power generation and agricultural, industrial and domestic use, prevent erosion and protect infrastructure[1,2,3]. The industrial revolution brought a significant increase in water management and the current hydrological functioning of watercourses is often a legacy of this period. An assessment of the status of Scotland's surface waters in 2017 found that 13.4% were in poor or bad condition regarding barriers to fish migration, while 8% were adversely affected by flow rates[4]. Latterly, streams and rivers have been subjected to a number of often individually minor, but collectively significant, alterations designed to improve recreational fishing.

Many of these modifications have had adverse effects on wetland and freshwater habitats and species[5]. Historic losses due to drainage have been very significant; although not well quantified, the extent of lowland wetlands is much smaller now than in the early 20th century, and losses extend much further back historically. Of the remaining wetlands that are protected by law, 30% of designated wetland features are classed as unfavourable or unfavourable recovering due to management. 29% of freshwater features are unfavourable or unfavourable recovering due to management[6]. Soil sealing (the process of covering soil in impervious substances such as concrete or tarmac) has compounded the rate and extent of wetland loss, and changes in farming practices have led to the disappearance of many lowland ponds formerly used to water livestock[5,7].

Recently, rewetting peatlands, the creation of ponds and river restoration have led to some improvements[8,9,10]. Green infrastructure, such as sustainable urban drainage systems, has created new wetlands in urban areas. These developments offer opportunities for wildlife and can reduce the risk of flooding or pollution locally[11]. However, further pressures on hydrological networks are arising from climate change (e.g. increased flood risk and prolonged droughts), pollution (particularly diffuse pollution from agriculture) and INNS. The latter have considerable impacts on freshwater ecosystems that are known to be intensifying[12], and will, without increased biosecurity action, precipitate further losses.

MOUND ALDERWOODS

This formerly tidal area, designated as a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC), was once part of the Loch Fleet estuary but was largely isolated from it in 1816 when a causeway was constructed to convey what is now the A9. Following this separation, the area was gradually colonised by Alder and willows to form the present mosaic of dense wet woodland, open fen and saline lagoon. The qualifying interest of the SAC is "Alder woodland on floodplains"; "wet woodland" is one of the notified natural features of the SSSI.

By 2010 the SAC was declared to be in 'unfavourable declining' condition because of the dieback of Alders[13]. An investigation undertaken in partnership with Forest Research identified that this was most likely the result of water logging, associated tree disease (*Phytophthora*), and herbivory[14].

A partnership comprising SNH, Transport Scotland, BEAR Scotland, the Scottish Environment Protection Agency and the land managers assessed the causes of the waterlogging, and found a change in the management of the causeway sluice gates following the retirement of the last sluice gate keeper to be an important factor. The sluices have since been automated, a network of drainage ditches has been reopened, and deer numbers have been lowered to combat excessive browsing and trampling. The woodland is now believed to be recovering, but its return to favourable condition is threatened by invasive plants (Himalayan Balsam and Skunk Cabbage); the local community is now helping to control these.

Photo: Steve Austin

Drainage channels on moorland

URBANISATION

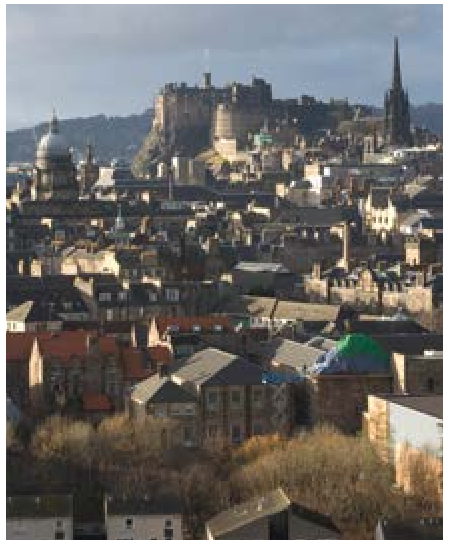


Photo: Peter Cairns (rspb-images.com)

Urbanisation is a threat to biodiversity globally, through loss of valuable wildlife sites and fragmentation of habitats due to the increase in transport systems and infrastructure[1].

This fragmentation has severely impacted on species dispersal and mortality, thus increasing genetic bottlenecks[2], inbreeding, isolation and the chance of local populations going extinct. Urbanisation continues, with the area covered by impermeable materials, such as concrete, increasing in many regions between 2009 and 2016[3].

Despite the harmful impacts of urbanisation, many of our species have become reliant on urban habitats such as gardens, allotments, parks and brownfield sites (vacant and derelict land). Well-designed urban green infrastructure offers habitats for wildlife and can connect populations, thereby reducing adverse ecological effects[4,5]. As well as impacting biodiversity, urbanisation can lead to "Nature Deficit Disorder"[6] whereby people are deprived of the health and well-being benefits that contact with nature can provide.

GARTCOSH'S GREAT CRESTED NEWTS

Scottish Enterprise took over Gartcosh, northeast Glasgow, as a long-term regeneration opportunity, but were surprised to find a set of ponds holding a substantial population of Great Crested Newts. After surveys, a 10ha area containing the 13 original ponds, plus eight newly created ponds, was designated as an Amphibian Conservation Area in 1998. However, Scottish Enterprise soon came to regard this area as crucial to their regeneration plans and a nearby 29ha site was prepared as the Gartcosh Nature Reserve in 2003. SNH agreed to a translocation of the amphibians from the original site.

The translocation moved 1,012 adult Great Crested Newts, estimated to be at least 10% of the total Great Crested Newt population in Scotland, as well as 10,173 other amphibians[7].

Modelling of the 10-year post-translocation survey dataset indicated that the translocation had been broadly successful, although there was variation in population estimates and some evidence of decline.

The site is surrounded by railway tracks and motorways, making dispersal to and from other sites extremely unlikely, and severely limiting genetic exchange. The Scottish Government is seeking to encourage the building of affordable housing in areas with reasonable employment prospects, and as a publicly owned site close to Glasgow, Gartcosh is highly suitable; house building has been underway around the Gartcosh Nature Reserve for some years. Planning permission for a new road was granted in 2015. This came with conditions that include tunnels and fences to allow animals to access all parts of the reserve without having to cross the road[8].

The tunnels are being monitored using customised time-lapse cameras. Cameras have great advantages in providing unbiased high-quality data over long periods of time, which maximises the opportunities for robust comparisons. Gartcosh has unrivalled population monitoring data over several years and this, in addition to high-quality tunnel monitoring data, will provide substantial evidence of the effectiveness of the tunnel and fence systems.

Photo: Neil Phillips (rspb-images.com)

Great Crested Newt

WOODLAND

Despite Scotland being the most wooded of the UK countries, with around 19% woodland cover, it remains one of the most heavily deforested countries in Europe, with woodland cover well below the current European average of 37%[1,2].

Just under a quarter (311,000ha) of Scotland's woodland is considered native[3]. This includes globally important areas of Atlantic rainforest, including Oak and Hazel woodland, and Caledonian pine forest – widely recognised as being of very high value to biodiversity, but fragmented and restricted in range[3]. The remaining three-quarters (1.4 million ha) is mainly commercial forestry plantation dominated by conifers, which benefit a smaller range of largely generalist species.

Photo: Mike Read (rspb-images.com)

Woodlands in Scotland face pressure from fragmentation, browsing and grazing, INNS and new pests and pathogens[4,5]. Climate change will interact with these drivers, increasing the frequency of drought, flood and extreme weather events, leading to changes in distribution and altered competitive relationships between species. Challenges facing woodland and woodland managers are exemplified by the percentage of woodland features on protected sites in favourable or recovering condition, which dropped from 68.1% in 2017 to 65.2% in 2019[6]. Overgrazing and INNS (principally *Rhododendron ponticum*) were the most frequent pressures recorded at sites in unfavourable condition, though undergrazing can also present problems for some plants and lichen assemblages, due to increased shade[7]. Evidence suggests that many specialist lichen species have continued to decline in abundance as well as distribution because of negative habitat pressures[8]. Despite the many pressures, some woodland species have fared well in Scotland in recent years: the Woodland Bird Index increased by 69% between 1994 and 2017, with 19 of the 23 monitored species increasing over the period[9].

REVIVING AND RE-CREATING NATIVE WOODLAND

Over the course of 15 years, Borders Forest Trust has acquired – through volunteer fundraising, grants from charitable trusts and public subscription – 3,100ha of the Southern Uplands across Dumfriesshire and the Scottish Borders, collectively known as The Wild Heart of Southern Scotland project[10].

Upland ecosystems have been substantially affected by long-term patterns of grazing, but wildlife-sensitive management and considered tree planting is now restoring the area. Over the course of the project nearly a million trees and shrubs have been planted, including new woodlands, wood pasture and riparian buffer strips. Nature is beginning to return to the restored landscape and a recent scientific study found that the number of woodland bird species recorded regularly had risen from two in 2008 to 14 in 2015.

This project has demonstrated that planting trees and shrubs, even at high altitudes and in severe conditions, is a perfectly achievable approach to restoring ecologically damaged and degraded marginal upland areas and provides a template that could be copied across the country.

Photo: David Woodfall (rspb-images.com)

LANDSCAPE SCALE RESTORATION

Cairngorms Connect is an ambitious multi-partner project with a 200-year vision to enhance habitats, species and ecological processes across a vast area within the Cairngorms National Park[11]. Covering 600 square kilometres, including ancient Caledonian pine forest and montane willow communities, the biggest land restoration project in Britain will allow forests to expand, naturalise rivers and restore huge tracts of peatland. Work on this project is currently in its infancy but milestones have been set for actions, monitoring, research, publicity and demonstration.

POLLUTION

Pollution – from plastic waste and chemicals in our soils, waters and air to the noise and light from cities and transport – threatens the environment and the species that inhabit it, not to mention our own health and well-being. From nutrient enrichment on mountain tops to the plastic litter in our seas, there are few places in Scotland left uncompromised by the by-products of modern human life. There has been marked progress, particularly since the 1990s, but the legacy of over 200 years of industrial development still remains, and we face challenges from new forms of pollution too.

Photo: Ernie Janes (rspb-images.com)

Air pollution and nutrient enrichment affect biodiversity and ecosystem services, harm human health and contribute to climate change. Widespread changes have been recorded to sensitive ecosystems in Scotland, with farming, transport, energy and industry being the key pollution sources.

Levels of the principal air pollutants have all declined in Scotland since 1990, and all but ammonia are at levels below 40% of their 1990 value[1]. Most semi-natural habitats, and over two-thirds of our wildflowers (such as Harebell and Betony), require low levels of nitrogen[2]. Eutrophication, acidification and toxification of ecosystems have been shown to drive declines in the presence, abundance and health of sensitive species of plants, lichens and other fungi[3]. Further up the food chain, the moth species whose larvae depend on low nutrient-adapted plants declined strongly between 1970 and 2010[4]. Even in montane regions, far from the sources of air pollution, excess nitrogen is deposited in the rain, altering plant communities and ecological functioning[5]. While reactive nitrogen (NOx) levels have fallen to around 30% of their 1990 value, the reduction in ammonia has been relatively small, with no significant change since 2007. Many pollutants have long-term impacts so the influence on many sensitive habitats remains considerable. New threats have arisen with the introduction of novel agrochemical and pharmaceutical products, and plastic pollution is increasingly recognised as causing harm to natural systems.

Diffuse pollution has been reduced in Scotland, particularly since the 1990s, but still represents a significant risk to freshwaters[6]. Agriculture and forestry are the main contributors of diffuse pollution, with nutrient and pesticide run-off, soil erosion through cultivation and poaching by animals close to watercourses adding individually small, but cumulatively large, pollution loads. Further diffuse pollution arises from contaminated drainage from roads and urban areas, along with deposition of acid pollutants from the air. In 2018, 12% of lochs and 20% of rivers and canals were in "poor" or "bad" condition, according to Water Framework Directive assessments[7]. These were primarily associated with intensively managed farmland.

MOSS SPECIES PROVIDE TELLTALE SIGNS OF POLLUTION AND CLIMATE CHANGE

Revealing evidence that points towards an increase in temperature and reducing nitrogen levels in Scotland has been discovered by analysing data from species records of mosses and liverwort (bryophytes). Scientists from the James Hutton Institute and SNH have collaborated on a project which shows bryophytes can be used to assess the health of our ecosystems[8]. The newly developed indicator, which links bryophyte records in the National Biodiversity Network to information on the habitat preferences of different species, provides good evidence of how mosses and liverwort have reacted to changes in pollutants[9]. The indicator draws together over half a million records going back to 1960. Most of these records were made by volunteers from the British Bryological Society.

The indicator breaks down information into 10 catchment-based Scottish regions and the data indicated a peak in the 1990s, with sensitive species then starting to increase. Most records are from semi-natural habitats, so it appears that bryophyte records largely reflect changes in atmospheric nitrogen pollution and it is heartening to see some signs of recovery from pollution. There is evidence for a similar pattern at a UK level for bryophytes and lichens, although this must be set against the decline in abundance as well as distribution for specialist lichen species because of negative habitat pressures[10].

INVASIVE AND NON-NATIVE SPECIES

Invasive non-native species (INNS) are a major driver of biodiversity loss globally[1]. Impacts include predation, competition, hybridisation, novel disease and pathogen transfer, and habitat degradation. The effects in Scotland broadly reflect the international and wider UK situation: significant and intensifying impacts on many native taxa, especially in the most vulnerable environments – islands, freshwater bodies and native woodlands[2].

The available indicators show an increasing spread of 190 established INNS across terrestrial, freshwater and marine environments in Great Britain during the last six decades – with northwards shift a common pattern[3]. They also show no reduction in the establishment rate of new non-native species. With evidence that climate change and INNS will impact biodiversity in a negative synergy, it is evident that despite recent progress in policy and legislation, the impact and threat from INNS is intensifying significantly in Scotland.

ERADICATION OF INNS ON ISLANDS

The Shiant Isles are one of the most important breeding colonies for seabirds in Europe. Historical evidence indicates that current populations are greatly reduced through the presence of non-native Black Rats, thought to have arrived from an 18th century shipwreck, which predate upon seabird eggs and chicks[4]. Some previous breeders, like Manx Shearwaters, have been wiped out on the islands.

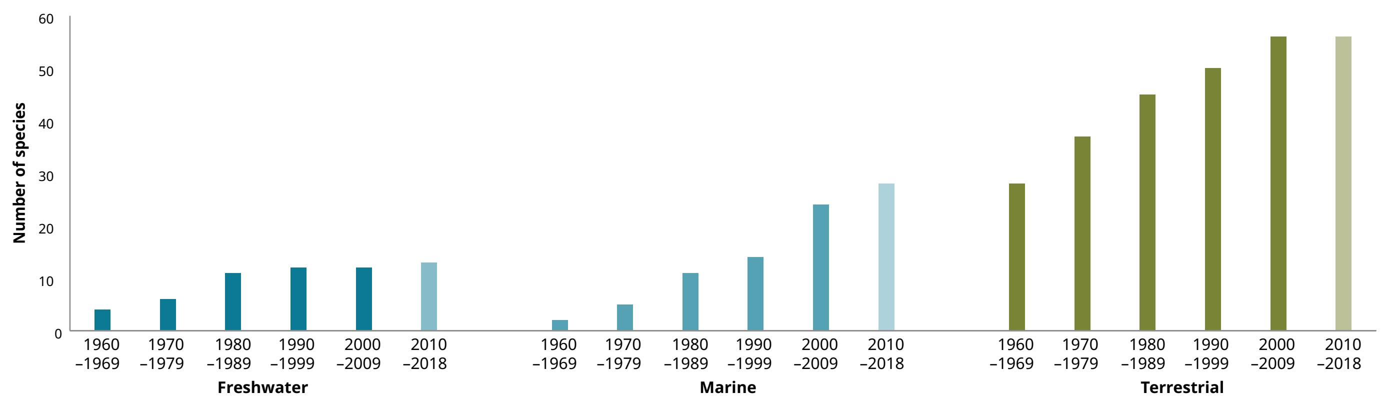
A rat eradication and biosecurity project took place during winter 2015–2016, led by RSPB Scotland and funded by the EU LIFE fund and SNH, with the support of the Nicolson family, custodians of the islands. Wildlife Management International Limited ran operations, using rodenticide contained in bait stations set across the Shiant Isles and taking more than four months to complete.

In March 2018 the Shiants were declared officially free of rats. Manx Shearwaters and Storm Petrels were encouraged to nest using call playback, and in 2017 calling Storm Petrels were recorded on the islands for the first time. Seabirds and other wildlife on the islands are being monitored to determine responses, and a comprehensive biosecurity plan is being implemented to prevent reinvasion of mammal predators[5].

RHODODENDRON

Rhododendron ponticum was introduced to Scotland via the horticulture trade; since then, it has thrived in the mild, wet conditions of the west of Scotland and has spread across much of the available habitat. If left untreated it eliminates vegetation, outcompetes native tree and shrub regeneration and has significant impacts on other woodland species groups such as mosses and lichens. It is a major cause of unfavourable site condition on designated sites, including more than half of those designated under the EU Habitats Directive for Western acidic oak woodland – the "Celtic Rainforest", for which Scotland has significant international responsibilities[6]. Rhododendron is also a key host and reservoir for fungus-like *Phytophthora* tree pathogens[7]. Several large-scale control projects have tackled the issue in Scotland, but success rates have been poor, with reinvasion of previously cleared areas. Key past weaknesses have been failure to eradicate at the whole-population scale, and failure to implement legacy biosecurity arrangements post-eradication. A national approach has been developed to highlight priority areas and guide implementation of control[8].

UK Biodiversity Indicator: Number of new INNS established in or along 10% or more of Great Britain's land area or coastline, 1960 to 2018 (final columns in each habitat refer to nine years rather than 10)



Source: jncc.gov.uk/ukbi-B6

UPLAND MANAGEMENT

Uplands cover about half of Scotland's area (estimates vary from 44% to 85% depending on the definition used[1]), encompassing a variety of habitats and reflecting the country's diverse geology, climate and relief. Blanket bog and upland heath are globally rare habitats but are found in relative abundance here. Scotland has 60% of the UK's internationally important peatlands, which have a key role in carbon capture and sequestration[2,3].

Land use for farming, forestry, sporting estates and recreation continues to influence land management and condition of upland habitats.

- Agriculture has a significant influence, through grazing, drainage and application of nutrients. In the north and west, crofting exerts a significant influence on the landscape; in the last decade there has been a decline in livestock grazing in some areas and undergrazing is a pressure. In many other areas, overgrazing from high deer and livestock densities is a principal pressure on habitats, altering vegetation and preventing tree regeneration[4].
- In the 20th century, large areas of upland were planted with non-native plantation forestry; more recently some expansion of native woodland, following major historic losses, has occurred[5].
- Grouse moor management exerts a powerful influence over land in upland areas[6]. Inappropriate muirburn, including on deep peat, can damage vegetation and soil, leading to nitrogen deposition and release of carbon[7]. Differing management objectives still lead to significant conflicts in the uplands[8,9], and the illegal persecution of birds of prey continues to have a major impact on species' distribution[10].
- Some sensitive habitats have also been damaged by windfarms and hill tracks, although this is mitigated, to some degree, through planning processes. Following widespread historic degradation of peatland habitats, major efforts have been made in recent decades to protect and restore blanket bog habitats, with significant positive progress in the Flows of Caithness and Sutherland, the Western Isles and elsewhere[11]. Integrating land use for multiple benefits and managing conflicts in the uplands remains one of Scotland's biggest challenges.

MAR LODGE ESTATE NATIONAL NATURE RESERVE

In 2017 the Mar Lodge Estate, owned by the National Trust for Scotland, became the UK's largest National Nature Reserve, at 29,000ha[12].

The landscape is internationally significant for its sense of wildness, scale and diversity. The montane plateau is among the most significant areas of wild land in the British Isles, and part of the Cairngorm Mountains National Scenic Area and Cairngorms Wild Land Area. The estate encompasses four of the five highest summits in the British Isles and holds a total of 15 Munros. The Cairngorms are home to Britain's largest area of arctic-alpine flora and snowbed communities.

Caledonian pinewood today covers around 2,350ha of Mar Lodge Estate. Collaboration with neighbouring estates led to a plan to cull deer and erect a fence, which has resulted in the successful regeneration of over 800ha of pinewood since 1995. Birch and montane scrub is also recovering across large areas. These habitats are important for Red Squirrel, Black Grouse, Capercaillie, Scottish Crossbill, Parrot Crossbill, wood ants, other invertebrates and fungi. Some of the Scots Pines provide the second longest native pine chronology in Scotland, stretching back to 1477.

Moorlands cover the majority of the estate and provide essential habitat for Hen Harriers and Red Grouse. Burning is no longer used to manage the moorland, acknowledging the risk this poses to the woodland, people and the carbon which is locked up in the peat soils.

Mar Lodge has a rich cultural as well as natural history, including its development as a sporting estate in the 19th century. Deerstalking, walked-up grouse shooting and Salmon fishing still happens on the estate but nature conservation and public access is its primary purpose now.

Photo: Tim Hunt

Round-leaved Sundew

MARINE CLIMATE CHANGE AND OCEAN ACIDIFICATION

Scotland's seas, which make up around 61% of the UK's total marine area, are highly dynamic, supporting a diverse range of habitats and species and an increasingly varied array of marine industries. Scotland's Marine Atlas[1] and the Marine Climate Change Impacts Partnership[2] identify climate change and commercial fishing activity as the two biggest threats to the health of Scotland's seas, findings that have been echoed globally[3].

The marine environment absorbs vast quantities of the heat caused by increased greenhouse gases in the atmosphere, resulting in rising ocean temperatures[4]. Changes in sea surface temperature can also alter carbon sequestration rates[5], water currents[6], nutrient mixing[7], species' distribution (e.g. moving to higher latitudes)[8] and the spread of INNS[9].

The way different plankton species respond to warming surface waters has led to major shifts in marine food chains, with declines in top predators as prey fish become less common and less accessible. There are also concerns about changes to nutritional value of prey fish[10]. Declines in Scotland's Kittiwakes and other seabirds are a key example of impacts evident throughout the food chain[11,12].

Ocean acidification results from changes in ocean chemistry primarily as a result of the increased uptake of carbon dioxide from the atmosphere. There are concerns that this can cause calcareous shells of sea snails to dissolve[13]. Acidification is also of particular concern as it could further reduce the rate at which CO_2 is absorbed from the atmosphere, thus aggravating climate change[14].

Pressures are predicted to increase from renewable energy developments; in line with international targets to reduce climate change, there has been a substantial increase in installations in Scottish waters, with further large-scale projects proposed[15]. In the light of this there is increasing research into the cumulative impact and long-term effects of windfarm developments – for example, with concerns about collision risk for seabirds[16,17].

Kittiwakes

Photo: Ernie Janes (rspb-images.com)

BLUE CARBON

Oceans play an important role in regulating Earth's atmosphere, including through carbon sequestration; "blue carbon" is stored in living (animal and plant) and non-living (e.g. shells and skeletal) material.

Marine ecosystems have a higher capacity for storing carbon than terrestrial systems. For example, Scotland's peatlands store an estimated 1,620 million tonnes (Mt)[18], whereas the top 10cm of Scotland's marine sediments store an estimated 1,756Mt[19]. Scotland's marine sediments alone capture 28.2Mt CO_2e (carbon dioxide equivalent) per year[19], the equivalent of 64% of Scotland's 2017 carbon emissions[20].

Scotland's seas host a range of blue carbon habitats; from seagrass meadows and kelp forests that store carbon in living, organic material to maerl beds and biogenic reefs that convert carbon into calcium carbonate, locking it up for millennia. Protecting and enhancing blue carbon habitats will ensure these stores of carbon are protected, while at the same time enhancing their health.

Some of Scotland's blue carbon habitats are provided legal protection within nature conservation Marine Protected Areas (MPAs) and SACs. It is estimated that Scotland's inshore MPAs and SACs store 1.6% of the organic carbon and 2.7% of the inorganic carbon across Scotland's seas[21]. These sites store the equivalent of 210.8Mt of CO_2e, which equates to approximately five years of Scotland's annual greenhouse gas emissions[21].

MARINE – FISHERIES

The recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Global Assessment states that "in marine systems, fishing has had the most impact on biodiversity (target species, non-target species and habitats) in the past 50 years alongside other significant drivers"[1]. Ecosystem-based fisheries management is therefore fundamental to securing the urgent and necessary recovery of marine nature.

FISHERIES MANAGEMENT MEASURES

Delivering ecosystem-based fisheries management that protects and recovers nature at sea requires a suite of management measures. Quota is essential to limit removals of target commercial species, although scientific advice is not always applied in practice as intended, not all species have catch levels set and in the North East Atlantic, 40% of assessed fish stocks were subject to overfishing in 2017[2]. Seasonal measures and real-time closures can offer temporary protection for large aggregations of juveniles or spawning adults, such as for the Cod recovery plan, though progress has recently reversed, with declining stock levels and 70% cuts in Total Allowable Catch recommended by the International Council for the Exploration of the Sea[3]. Permanent spatial measures can protect critical fish and shellfish habitat, and where used these have demonstrated the capacity to protect commercially fished species. For example, a study in the Windsock fisheries closed area, overlapping the West Shetland Shelf MPA, showed an average 78% greater catch weight of Cod and other species, particularly of larger size classes, inside compared to outside[4]. However, the Windsock was partially opened to mobile gear in August 2019 under voluntary restrictions after the revision of EU fisheries technical regulations implemented by the European Parliament and Council[5]. At a smaller scale, an Isle of Man study found that the density of King Scallops was 30 times greater within a permanent closed area than when first protected[6]. MPAs are important spatial measures that contribute to the protection and recovery of marine biodiversity, requiring fisheries management measures to meet their objectives, but have not been established in Scotland to contribute to wider fisheries management objectives per se.

WIDER ECOSYSTEM EFFECTS

In 2011, Scotland's Marine Atlas stated that, along with climate change, fishing is the most widespread pressure on our seas and that the status of most seabed habitats is of "some" or "many" concerns. The UK administrations' latest assessment of progress towards GES under the Marine Strategy Regulations[7] confirmed GES will not be met by 2020 for fish, commercial fish and shellfish, and benthic habitats. Yet ensuring Seafloor Integrity (General Descriptor 6) "is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected" is crucial to recovering the nature of the seabed.

To date, Scotland's emerging MPA network has been the principal spatial tool for contributing to achieving seafloor integrity, including 31 new MPAs among a total of 217 sites comprising 22% of Scottish waters. Management measures introduced to protect over 2,200km^2 of the most vulnerable inshore sites from bottom-towed fishing gear in 2016 probably constitute the most significant contribution to this aim. There is a presumption of "sustainable use" in Scotland's MPAs, when for many widespread, sedimentary habitats and their associated species, we have a limited understanding of what is or is not sustainable[8]. The remaining inshore sites and most offshore sites await management measures, and they were not designed to establish or deliver fisheries management outcomes, though such secondary benefits may arise.

Bottom-towed fishing gear are "one of the most widespread sources of physical disturbance to the continental shelf seas throughout the world" shifting benthic communities into a new but less complex stable state, degrading "topographic complexity"[9], with the "most severe impact…in biogenic habitats in response to scallop-dredging…[and with]…soft-sediment habitats, in particular muddy sands,…surprisingly vulnerable"[10]. Damage to flame shell beds from scallop dredging in outer Loch Carron in 2017 starkly illustrated the vulnerability of biogenic features[11].

The greatest benefit to benthic and demersal nature derives from areas of seabed afforded the highest levels of protection. This can be through a range of measures, including marine reserves, providing direct protection for the widest range of species and habitats in a given area[12]. Conclusions from a study in Scotland's pioneering Community Marine Conservation Area in north Lamlash Bay, a No-Take Zone centred on damaged maerl beds[13], were "*consistent with the hypothesis that marine reserves can encourage the recovery of seafloor habitats…*".

The growing weight of evidence suggests that anthropogenic use of the sea in Scottish waters, including the seafloor itself, means our seas are not meeting GES. Additional measures, whether established for fisheries management, for conservation, or for both, are likely to have benefits for both nature's recovery and wider society that should be further explored. Future fisheries management in Scotland must have an ecosystem-based approach which includes the recovery of marine nature at its core.

HISTORICAL CHANGE IN BIODIVERSITY

This report focuses on changes in biodiversity and the drivers of these changes, taking 1970 as baseline year. We must remember, however, that people have been shaping landscape and wildlife for millennia. This historic context is important in framing more recent changes that we can accurately measure. This is a selection of indicative milestones, trends, pressures and changes, from various sources – some broad and major, others quite specific. The list is not comprehensive. It is, rather, a brief illustration of the multiple historical perspectives on people and nature in Scotland.

PRE-1800

↑ TRENDS AND MILESTONES

- Woodland cover peaks c5,000 years ago across most of Scotland. Unique native pinewood and broadleaved ecological communities develop.
- Peatlands develop post-glaciation to cover c20% of Scotland.

PEOPLE AND NATURE

- Cultural significance of Scottish wildlife evident in art and literature from Neolithic through to Scottish Enlightenment.

PRESSURES

- Woodland clearance from c5,000 years ago. Felling accelerates for timber, tanning and charcoal in the 17th/18th centuries; most woodland is lost.

↓ TRENDS AND MILESTONES

- The Wolf becomes extinct in Scotland, probably in the late 17th century.

1800 TO 1900

↑ TRENDS AND MILESTONES

- Early 19th century: diverse multispecies fisheries sustained in coastal waters.
- Corncrakes and other farmland wildlife common and widespread across Scottish landscapes.

PEOPLE AND NATURE

- Origins of environmental movement accelerated by the extinction of the Great Auk.
- **1822** – Dalmarnock Bridge protests win access to countryside for Glasgow people.

PRESSURES

- River and air pollution in the Central Belt intensify with industrial revolution.
- **1880s** – steam trawlers meant a rapid increase in fishing effort.
- Draining of wetlands and peatlands intensifies.
- Loss of mixed farming as large-scale sheep operations develop.

↓ TRENDS AND MILESTONES

- The Great Auk goes extinct – last Scottish breeding in **1813**, globally extinct by **1844**.
- Intensification and industrialisation of marine fisheries lead to major landing declines in second half of 19th century, into 20th.

1900 TO 1950

↑ TRENDS AND MILESTONES

- Forest cover begins to increase – but much of it is non-native monocultures.

PEOPLE AND NATURE

- Modern Scottish conservation movement emerges post-WWII, with growing government commitment and voluntary sector, underpinned by science base.
- Oil in Navigable Waters Act **1922** reduces chronic marine oil pollution.

PRESSURES

- Urbanisation seen as the key issue for biodiversity, rather than broader land and sea-use patterns.
- To ensure national timber self-sufficiency, Forestry Commission establishes post-WWI – Scotland is the principal location for commercial planting.

↓ TRENDS AND MILESTONES

- Last Scottish White-tailed Sea Eagle killed in **1914**.
- Between **1903** and **1928** at least 6,028 Fin Whales were hunted in Scottish waters.
- Svalbard-breeding Solway Barnacle Geese hit a low post-WWII of less than 300 individuals through hunting and disturbance.

1950 TO 1980

↑ TRENDS AND MILESTONES

- Loss of native woodland slows as conservation designations and woodland grants are established.
- Ospreys return as Scottish breeders in **1954**.
- Northern Gannet populations grow, with the world's largest colonies in Scotland.

PEOPLE AND NATURE

- National wildlife protection legislation emerges.
- First National Nature Reserve in **1951** at Beinn Eighe.
- National Parks designated in England and Wales from **1951** – but not Scotland.
- Scottish Wildlife Trust formed **1964**.

PRESSURES

- Following WWII food shortages, and following joining of the EU Common Agricultural Policy in **1973**, farming methods intensify with wildlife losses.
- Use of DDT and other organo-chlorines becomes widespread from **1950**, affecting wildlife, especially songbirds and predators.
- Commercial forestry expands onto important wildlife habitats – native woodlands and peatlands.

↓ TRENDS AND MILESTONES

- Overfishing led North Sea Herring stocks to decline by over 99% between the **1960s** and mid-70s.
- Post-war farmland wildlife declines proceed across much of western Europe.
- The endemic Scottish Manx shearwater flea *Ceratophyllus fionnus* was last recorded in the **1970s**.

1980 TO 2000

↑ TRENDS AND MILESTONES

- Corncrake population begins to recover from **1991**.
- Red Kite and White-tailed Sea Eagle reintroductions succeed in re-establishing them as breeders in Scotland.
- Peatland restoration work expands.

PEOPLE AND NATURE

- Fiscal incentives for forestry on blanket bogs ended, late **1980s**.
- Sandeel fishery closures, with industry cooperation, in response to wildlife trends, Shetland and Forth.
- SNH formed in **1992** – one of the most enduring public wildlife agencies.

PRESSURES

- Overgrazing and non-native Rhododendron impacts drive key Atlantic woodland sites into unfavourable status.

↓ TRENDS AND MILESTONES

- Breeding failures and prey fish availability issues become evident for Northern Isles seabirds.
- Black Grouse declines, especially in south of Scottish range.
- Farmland wildlife declines continue, including Great Yellow Bumblebee and Corn Bunting.

POST-2000

↑ TRENDS AND MILESTONES

- Populations of wintering geese increase significantly (except of the declining Greenland White-fronted Goose).
- **2016** – Scottish Government announce that Beavers, released in **2009**, are to remain in Scotland – the first time that a mammal has been reintroduced in the UK.

PEOPLE AND NATURE

- CBD's 2020 targets set in **2010**. In **2017** Scotland meets seven out of 20, compared with a global average of four, is making progress on 12 and submitted the world's first Aichi assessment.
- MPAs and Natura sites designated in Scottish waters.
- Loch Lomond and The Trossachs, and the Cairngorms, designated as National Parks in **2002** and **2003** respectively.

PRESSURES

- Water surface temperatures increase in rivers, lochs and seas – projected to increase further.
- Invasive species – new non-natives continue to establish. Species established in the south spread north. Climate change increases establishment probability.

↓ TRENDS AND MILESTONES

- The Loch Lomond Capercaillie population goes extinct, meaning significant range contraction.
- Curlew numbers have fallen by 48% since **1995**.

KEY FINDINGS FOR THE UK

Here we present the key findings from the UK-level *State of Nature 2019* report, to add context to the Scotland-specific results we have presented in this report. The statistics shown here demonstrate that the abundance and distribution of the UK's species has, on average, declined since 1970 and many measures suggest this decline has continued in the most recent decade. There has been no let-up in the loss of nature in the UK.

These pages are just the headline statistics; further breakdowns, a wider range of metrics, and information on what is driving change in the UK's nature for both better and worse can be found in *State of Nature 2019* at www.nbn.org.uk/stateofnature2019.

Our species' status metrics make use of two broad types of data:

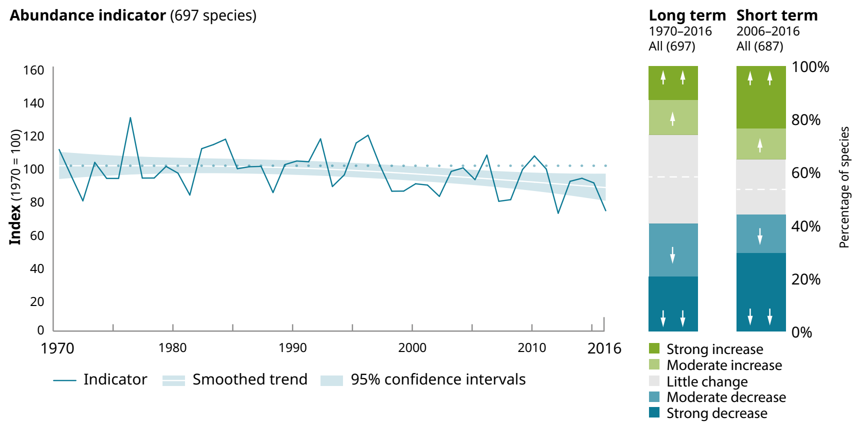
- **Abundance** data from a number of well-established monitoring schemes in the UK encompassing c700 species (birds, mammals, butterflies and moths). Many of these species are popular to record and are relatively easy to identify and to observe, making it possible to count individuals to get a measure of relative abundance. Our abundance metrics report the average change in relative abundance across these species.
- **Occupancy** data from large-scale datasets, which we can now use to generate trends for 6,654 species across a wide range of taxonomic groups (including vascular plants, lichens, bryophytes and a number of invertebrate groups). These trends measure the change in the proportion of occupied sites, so our metrics effectively report the average change in range for these species.

We show trends for species for our long-term period, from 1970 to 2016 for abundance data and from 1970 to 2015 for occupancy data. Our short-term period covers the final 10-year period of these time series.

Photo: Kevin Sawford (rspb-images.com)

Pine Marten

CHANGE IN SPECIES' ABUNDANCE



The abundance indicator for 697 terrestrial and freshwater species shows a statistically significant decline in average abundance of 13% (95% confidence intervals (CI) -22% to -5%) between 1970 and 2016. Over this long-term period the smoothed indicator fell by 0.31% per year. Over our short-term period, the decline was a statistically non-significant 6%, a rate of 0.65% per year. There was, however, no significant difference in the rate of change between the long and the short term. The white line with shading shows the smoothed trend and associated 95% CIs, the blue line shows the underlying unsmoothed indicator.

The bar chart shows the percentage of species within the indicator that have increased, decreased (moderately or strongly) or shown little change in abundance.

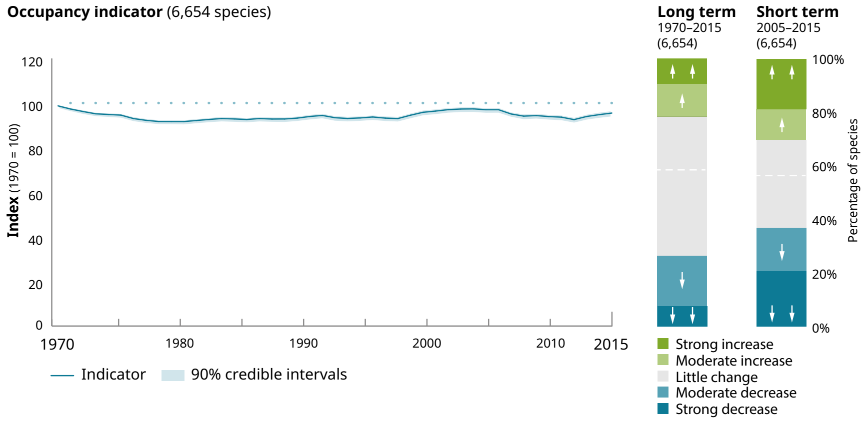
Within multispecies indicators like these there is substantial variation between individual species' trends. To examine this, we have allocated species into trend categories based on the magnitude of population change.

- Over the long term, 41% of species had strong or moderate decreases and 26% had strong or moderate increases; 33% showed little change.
- Over the short term, 44% of species had strong or moderate decreases and 36% had strong or moderate increases; 21% showed little change.
- Over the long term, 33% of species showed a strong change in abundance (either increase or decrease). Over the short term this rose to 53% of species.

Using a different, binary categorisation:

- Over the long term, 58% of species showed negative trends and 42% showed positive trends; over the short term, 53% of species showed negative trends and 47% showed positive trends.

CHANGE IN SPECIES' DISTRIBUTION IN THE UK



The occupancy indicator for 6,654 terrestrial and freshwater species shows that on average species' distributions have declined by 5% between 1970 and 2015. In 2015 the indicator was 1% lower than in 2005. Because species tend to decline in abundance before they disappear from a site, even this apparently small change of 5% could reflect more serious problems.

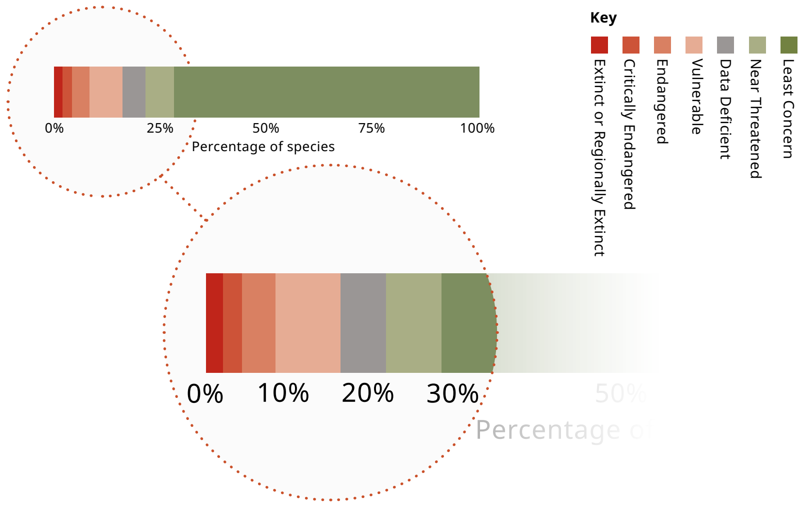
To examine the variation in species' distribution trends, we allocated species' trends into categories based on the magnitude of distribution change.

- Over the long term, 27% of species showed strong or moderate decreases and 21% showed strong or moderate increases; 52% showed little change.
- Over the short term, 37% of species showed strong or moderate decreases and 30% showed strong or moderate increases; 33% showed little change.
- Over the long term, 17% of species showed a strong change in distribution (either increase or decrease). Over the short term this rose to 39% of species.

Using a different, binary categorisation:

- Over the long term, 58% of species showed negative trends and 42% showed positive trends; over the short term, 56% of species showed negative trends and 44% showed positive trends.

NATIONAL RED LIST ASSESSMENT



Of 8,431 terrestrial and freshwater species that have been assessed against the IUCN Regional Red List criteria, 1,188 (15%) of the extant species, for which sufficient data are available, are formally classified as threatened and therefore at risk of extinction from Great Britain. In addition, 2% of species are known (133) or considered likely (29) to have gone extinct from Great Britain since 1500, and a further four species are extinct in the wild.

The bars show the percentage of assessed species falling into each of the IUCN Red List categories. Species classified as Critically Endangered, Endangered or Vulnerable are formally considered to be at risk of extinction.

MARINE

- Demersal fish indicators show increases in average abundance in the Celtic and North Seas of 133% and 58% respectively between the early 1980s and 2017.
- The UK Breeding Seabird Indicator shows a 22% decline in average abundance for 13 species over the long term.
- Trends in the abundance of marine mammals, for which we have data, vary by group; cetacean species show stable populations since the early 1990s, and Grey Seal numbers continue to increase while Harbour Seal numbers are decreasing in a number of areas.
- Changes in plankton communities are evident across the northern North Sea and the English Channel; the indicator for large copepods shows a 5% increase in the northern North Sea over the short term, compared to a 41% decrease in the English Channel.

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state of nature
PARTNERSHIP

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This report should be cited as: Walton P, Eaton M, Stanbury A, Hayhow D, Brand A, Brooks S, Collin S, Duncan C, Dundas C, Foster S, Hawley J, Kinninmonth A, Leatham S, Nagy-Vizitiu A, Whyte A, Williams S and Wormald K (2019). *The State of Nature Scotland 2019*. The State of Nature partnership.