STATE OF NATURE

SCOTLAND

2023

state of nature PARTNERSHIP

Little Assynt Estate Lochinver,
Mark Hamblin / scotlandbigpicture.com

Contents

Capercaillie, Dave Braddock (rspb-images.com)

SUMMARY

Scotland's nature has been under pressure and changing for many centuries. The trends in this report span the last 30 to 50 years of reliable data. Scotland ranks amongst those countries where habitats and species have been most depleted by human impacts through history.

The ability of Scotland's environment to provide benefits to people, such as reducing the impacts of extreme weather or removing pollution from our air and water, has declined, with quantified evidence of deterioration going back to 1950. Efforts to recover natural capital in Scotland still have a long way to go to meet the needs of people and nature.

Declines in biodiversity may be driven by the intensive use of our land for agriculture and forestry, overgrazing and the use of our seas for fishing. These impacts are exacerbated by climate change, pollution, inappropriate development, invasive non-natives and disease. However, some species are benefiting from some of these factors, expanding their ranges with climate change or taking advantage of intensively managed habitats.

What is clear, is that despite progress to restore ecosystems, save species and move towards nature-friendly land and sea use, Scotland's nature and wider environment continues to decline and degrade. With each subsequent report, our monitoring and measuring of these losses improves and refines. As signatory to the UN Convention on Biological Diversity, the UK countries must work towards ambitious targets to address nature loss through the Global Biodiversity Framework. However, the response, investment and prioritisation of what is needed to reverse these declines is still far from being commensurate with the scale and pace of the crisis.

We have never had a better understanding of the State of Nature and what is needed to fix it.

#STATEOFNATURE

Headlines

Average 15% decline in species' abundance

For 407 terrestrial and freshwater species, abundance across Scotland has fallen by 15%, on average, since 1994.

49% decline in average abundance of Scottish seabirds

The abundance of 11 seabird species in Scotland has fallen by 49% on average since 1986. These results pre-date the current outbreak of Highly Pathogenic Avian Influenza.

Average 15% increase in the distributions of invertebrate species

Distributions of 2,149 invertebrates increased by 15% on average since 1970. This was driven by climate change and large average increases in the distributions of aquatic insect species that support freshwater nutrient cycling.

11% of species are threatened

Of 7,508 species in Scotland that have been assessed using IUCN Red List criteria, 11% have been classified as threatened with extinction from Great Britain.

Strong decreases in plant and lichen distributions

Since 1970, the distributions of 47% of flowering plants, 62% of bryophytes (mosses and liverworts) and 57% of lichens have decreased, compared to 27, 25 and 34% of flowering plants, bryophytes and lichens respectively, that have increased in distribution.

Grayling, Paul Sawyer (rspb-images.com); Fulmar, Richard Carlyon (rspb-images.com); Emerald Moth, Phil Formby / WTML; Capercaillie, Ben Andrew (rspb-images.com); Norwegian specklebelly, Andy Acton

What do our headlines mean?

This report presents the state of Scotland's biodiversity with trends in species within habitats as evidence of how nature is faring. It summarises the pressures on nature and actions to restore nature.

Of the many tens of thousands of species in Scotland, from microbes to trees, we have up-to-date, systematic data on only a minority. This report cannot possibly be comprehensive. It should be seen as our best objective estimate of the state of nature in our country.

Biodiversity change can be measured in different ways, but here we use species' abundance (the number of individuals), distribution (the proportion of sites occupied) and extinction risk. We measure these for as many species as possible and summarise the results as:

- The average change in abundance or distribution over time
- The proportion of species at risk of extinction from the country
- The number of species that have increased or decreased in abundance or distribution over time.

Gannet, Katie Nethercoat (rspb-images.com)

Responding to the crisis

A new set of international biodiversity targets has been agreed under the UN Convention on Biological Diversity through the Global Biodiversity Framework 2022. To support the delivery of these, the Scottish Government has committed to a national biodiversity strategy, to a Nature Restoration Fund and to putting in place legally binding targets to restore nature: these will aim to halt and reverse long-standing national declines in biodiversity.

We structure this report around a broad grouping of these international targets: Improved species status, Nature-friendly farming, and sustainable forestry and fisheries, Protected areas, Ecosystem restoration and Nature, climate and people.

The power of volunteers

We would not be able to report on the State of Nature, understand the pressures nature faces or the effectiveness of our conservation action without the efforts of thousands of people, mostly volunteers, who collect the data used here. Given the challenging nature of Scotland's remote land and seas, we are particularly grateful to people who carry out this vital work in all sorts of terrain, weather and sea conditions.

Glen Loy Phuiteachan pinewood, John MacPherson

Capercaillie, Dave Braddock (rspb-images.com)

GEÀRR-CHUNNTAS

Tha nàdar na h-Alba air a bhith fo bhrùthadh is fo atharrachadh fad iomadh linn. Tha an aithisg seo a' coimhead air na treandaichean a tha a' dol air ais 30 gu 50 bliadhna leis gu bheil dàta earbsach againn mun àm ud. Tha Alba am measg nan dùthchannan a chaidh na bith-àrainnean is spèiseasan aice a sgioladh gu mòr mòr le daoine tron eachdraidh.

Chan eil àrainneachd na h-Alba cho comasach 's a b' àbhaist air buannachdan a thoirt do dhaoine, mar eisimpleir a' dìon o dhearg-aimsir no a' toirt truailleadh às an adhar no uisge, agus tha fianais air crìonadh a' chomais seo a' dol air ais gu 1950. Ged a thathar ri ath-leasachadh a' chalpa nàdarra ann an Alba, bidh e fada fhathast gus am freagair e air na dh'fheumas daoine agus an nàdar.

Dh'fhaoidte gu bheil a' bhith-iomadachd a' crìonadh is sinne ri dian-àiteachas is coilltearachd air an fhearann againn, ionaltradh thar a' chòir agus ri iasgach nar marannan. Tha atharrachadh na gnàth-shìde, truailleadh, droch leasachadh, spèiseasan neo-dhùthchasach sgaoilteach is tinneasan a' fàgail na buaidh seo nas miosa. Air an làimh eile, tha cuid a spèiseasan a' faighinn buannachd an cois nan adhbharan seo 's an rainse aca a' fàs nas motha an cois atharrachadh na gnàth-shìde no iad a' gabhail brath air bith-àrainnean a tha fo dhian-stiùireadh.

Ged a tha sinn a' dèanamh adhartas ag ath-shlànachadh nan èiceo-shiostaman, a' sàbhaladh spèiseasan agus a' tionndadh ri dòighean àiteachais is iasgaich nach eil cho trom air an fhearann is air a' mhuir, tha nàdar agus àrainneachd na h-Alba a' sìor-chrìonadh is a' sìor-fhàs nas miosa. Aithisg air aithisg, tha sinn a' sìor-fhàs nas fheàrr air marasgladh is tomhas a' challa seo. Feumaidh dùthchannan na RA obrachadh a dh'ionnsaigh thargaidean mòra airson aghaidh a thoirt air call nàdair tro Fhrèam-obrach Eadar-nàiseanta na Bith-iomadachd 's sinn nar soidhniche air Cunnradh nan Dùthchannan Aonaichte air Bith-iomadachd Bhith-eòlach. Ge-tà, tha an fhreagairt, an t-airgead agus na prìomhachasan a thaobh na tha a dhìth airson na crìonaidhean seo a thilleadh fhathast tuilleadh is gann an coimeas ri meud is astar na h-èiginn.

Cha robh tuigse nas fheàrr againn a-riamh roimhe air cor an nàdair agus na tha a dhìth gus a chur ceart.

#CORANNÀDAIR

Cinn-naidheachd

15% de chrìonadh sa chuibheas ann am pailteas nan spèiseasan

Tha pailteas 407 spèiseas air tìr agus ann am fìor-uisge air tuiteam le 15%, sa chuibheas, o 1994.

Crìonadh 49% sa chuibheas ann am pailteas eòin-mhara na h-Alba

Tha pailteas 11 spèiseas de dh'eòin-mhara ann an Alba air tuiteam le 49% sa chuibheas o 1986. Chaidh am measadh seo a dhèanamh ron taomadh làithreach de chnatan-mòr ro-ghalar-dhùsgach nan eun.

Tha sgaoileadh nan lusan is crotal air lùghdachadh gu mòr

O 1970, chrìon an sgaoileadh aig 47% de lusan flùrach, 62% de chòinnich is àinean-uisge agus 57% de chrotail an coimeas ri 27% de lusan flùrach, 25% de chòinnich is àinean-uisge agus 34% de chrotail a tha nas sgaoilte.

Tha 11% de spèiseasan ann an cunnart

Chaidh measadh a dhèanamh air 7,508 spèiseas ann an Alba a rèir Liosta Dhearg an IUCN agus chunnacas gu bheil 11% an cunnart dol à bith sa Bhreatainn Mhòir.

Fàs 15% sa chuibheas ann an sgaoileadh nan neo-dhruim-altachan

Dh'fhàs an sgaoileadh aig 2,149 neo-dhruim-altachan le 15% o 1970. Thachair seo ri linn atharrachadh na gnàth-shìde agus fàs mòr sa chuibheas dhen sgaoileadh aig spèiseasan de mheanbh-fhrìdean uisgeach a tha an sàs cuairt bheathachail an fhìor-uisge.

Grayling, Paul Sawyer (rspb-images.com); Fulmar, Richard Carlyon (rspb-images.com); Norwegian specklebelly, Andy Acton; Capercaillie, Ben Andrew (rspb-images.com); Emerald Moth, Phil Formby / WTML

Dè 's ciall dha na cinn-naidheachd againn?

Tha an aithisg seo a' toirt sùil air cor bith-iomadachd na h-Alba agus treandaichean aig spèiseasan agus bith-àrainnean mar fhianais air cor an nàdair. Tha i na geàrr-chunntas air a' bhrùthadh a th' air nàdar agus na thathar a' dèanamh airson ath-shlànachadh.

Tha na mìltean mòra de spèiseasan ann an Alba, bho mheanbhagan gu craobhan, agus chan eil dàta eagarach, ùr againn ach do mhion-chuid dhiubh. Chan urrainn dhan aithisg seo a bhith uile-chùiseach. Bu chòir gun coimheadar oirre mar deagh thuairmse cothromach air stàit an nàdair nar dùthaich.

Nithear tomhas air bith-iomadachd ann an diofar dhòighean ach an seo tomhaisidh sinne pailteas spèiseis (co mheud dhiubh a th' ann), sgaoileadh (co mheud ionad a tha fo chòmhnaidh aca) agus cunnart dol à bith agus bheir sinn sùil air uiread a spèiseasan 's urrainn dhuinn agus, nì sinn geàrr-chunntas air an toradh mar seo:

- Cuibheas an atharrachaidh a thaobh pailteis no sgaoilidh thar ùine
- Co-rèir nan spèiseasan a th' ann an cunnart dol à bith san dùthaich air fad
- Co mheud spèiseas a chaidh am pailteas no an sgaoileadh aca am meud no an lughad thar ùine.

Gannet, Katie Nethercoat (rspb-images.com)

A’ toirt aghaidh air an èiginn

Chaidh àireamh de thargaidean eadar-nàiseanta a thaobh bith-iomadachd aontachadh fo Chunnradh nan Dùthchannan Aontaichte air Bith-iomadachd Bhith-eòlach tro Fhrèam-obrach Eadar-nàiseanta na Bith-iomadachd 2022. Airson taic a chur ri coileanadh nan targaidean seo, chuir Riaghaltas na h-Alba an sàs ro-innleachd nàiseanta na bith-iomadachd is Maoin Ath-shlànachadh Nàdair agus targaidean a bhios ceangaltach fon lagha airson nàdar ath-shlànachadh: bidh iad seo ag amas air a’ chrìonadh fhada ann am bith-iomadachd a stad is a thilleadh.

Tha structar na h-aithisg seo stèidhichte air buidhneachadh mòr dhe na targaidean eadar-nàiseanta seo: Cor spèiseasan nas fheàrr, Àiteachas, coilltearachd sho-sheasmhach is iasgach a bhios math dhan nàdar, Sgìrean fo dhìon, Ath-shlànachadh èiceo-shiostaman is Nàdar, a’ ghnàth-shìde is daoine.

Cumhachd luchd saor-thoileach

Cha b’ urrainn dhuinn aithris air cor an nàdair a chur a-mach, tuigsinn dè am brùthadh a th’ air an nàdar no dè cho èifeachdach ’s a tha an obair-ghlèidhteachais againn às aonais spàirn nam mìltean de dhaoine, a’ mhòrchuid dhiubh nan saor-thoileach, a chruinnicheas an dàta a chleachd sinn an seo. Leis an dùbhlan a tha nàdar iomallach na h-Alba a’ cur romhainn air muir is tìr, tha sinn gu h-àraid taingeil dha na daoine a nì an obair riatanach seo ge be dè an aimsir no dè seòrsa muir no tìr a th’ ann.

Glen Loy Phuiteachan pinewood, John MacPherson

INTRODUCTION

Humanity's best and most up-to-date global assessment of the state of the living world is the UN Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services report. It concludes that biodiversity is currently being lost at a rate faster than ever before in human history, and that nature and its vital contributions to people are deteriorating worldwide[1]. Scotland is no exception: the current draft Scottish Biodiversity Strategy to 2045 states that the *'evidence base points consistently to a natural environment that has been heavily degraded, with continued declines across much of our land and seascapes'*[2].

Otter, Ben Andrew (rspb-images.com)

This is the fourth *State of Nature* report and is the product of a wide partnership of organisations coming together to make our best shared quantitative assessment of biodiversity in Scotland. Previous State of Nature reports have delivered a powerful shared evidence-base across government, business, academia and the voluntary sector, that has informed the development of biodiversity metrics in Scotland's Environment Strategy and in the National Performance Framework, and the outputs are now common currency in environmental dialogues across sectors.

Understanding the State of Nature is a vital platform for change and is the starting point for tackling losses. The social and ecological consequences of living in a nature-depleted country are immense. They include impacts on human health, happiness and wellbeing, alongside direct costs associated with lost and damaged ecosystem services. For example, pressures on marine ecosystems impact species across many groups – including those that provide a significant human food source and underpin coastal economies. Recent years have seen severe flooding in Scotland[3] aggravated by poor habitat management, increased urban development and climate change. Repairing flood damage is enormously expensive[4].

Scotland's incredible array of species and habitats are profoundly embedded in Scottish life, history, arts and culture, from endemic species like the Scottish Primrose and Scottish Crossbill to internationally important seabird colonies, vast blanket bogs and rich native rainforests and pinewoods.

Active investment to prevent damage and to restore species and ecosystems is cheaper than bearing the costs of continuing degradation[5]. Peatlands are a prime example. The blanket bogs of Caithness and Sutherland store 400 million tonnes of carbon, and Scotland's peatlands extend across many other parts of the country. However, 75% of our peatlands are damaged, and are therefore releasing significant atmospheric carbon, and around 13% of Scotland's entire territorial carbon emissions are estimated to come from degraded peatland[6]. Restoring peatland habitats brings multiple benefits to biodiversity, whilst also protecting carbon stores, improving national resilience to climate change and mitigating future change.

The scale and pace of nature restoration remains inadequate to halt and reverse nature losses. Funding for biodiversity was assessed as insufficient in the face of historic and ongoing losses in the 2020 Convention on Biological Diversity report[7]. However, in 2023, we can draw on many decades of conservation action that has demonstrably worked for a range of species and habitats. Urgent action can successfully 'bend the curve' of biodiversity loss and reverse, to a significant extent, past damage. Government, NGOs and other partners agree that we must scale up our efforts on dedicated conservation and restoration action for ecosystems and species, while simultaneously tackling the drivers of biodiversity loss. Making these changes will have society-wide implications[8]: 96% of Scots think the natural environment is important to the country[9], and the recently launched People's Plan for Nature[10] clearly signals a powerful public appetite for nature renewal.

KEY FINDINGS

Terrestrial and freshwater

Change in species' abundance

The abundance indicator for 407 terrestrial and freshwater species, for which Scotland-specific trends are available, shows a decline in average abundance of 15% between 1994 and 2021 (Figure 1, Uncertainty Interval (UI): -26% to -5%). Over the last 10 years (2010–2020) the decline was 9% (UI: -15% to -2%).

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 (Figure 1).

- Since 1994, 126 species (31%) showed strong or moderate declines and 153 species (38%) showed strong or moderate increases; 128 species (31%) showed little change.
- Over the last 10 years (2010-2020), 172 species (43%) showed strong or moderate declines and 144 species (36%) showed strong or moderate increases; 82 species (21%) showed little change.

The species' abundance indicator for Scotland covers 1994 to 2021. Ecologically, this is a very short timeframe in the context of previous historical losses. For example, it does not capture historic woodland loss, forestry expansion or the post-war intensification of agricultural management.

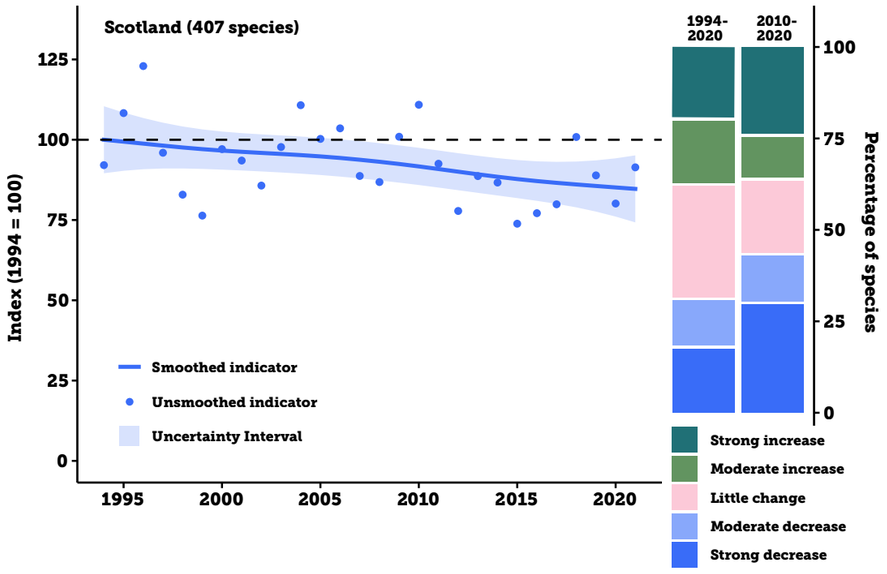


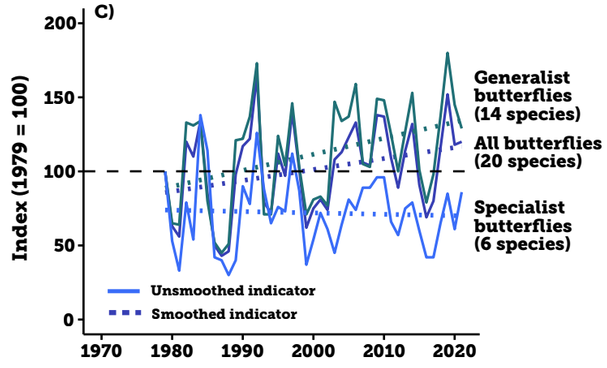
Figure 1: Change in average species' abundance across terrestrial and freshwater species in Scotland, based on Scotland-specific trends of birds (130 species), butterflies (26 species), mammals (9 species) and moths (242 species). The bar chart shows the percentage of species within the indicator that have increased, decreased (moderately or strongly) or shown little change in abundance (1994–2020: 407 species, 2010–2020: 398 species).

See page 46 to find out how to interpret this report

Species' abundance indicators by group

The composite nature of multispecies indicators means they can hide important variations in trends among both individual species and species groups. Here, to help better understand changes in the headline abundance indicators, we present it disaggregated into major species groups. This allows the use of longer or shorter time series where available.

- The abundance indicator for 242 moth species starts in 1970 and overall shows a decline of 18% (Figure 2A, UI: -29% to -6%). Over the past 10 years, the indicator was -17% lower in 2020 compared to 2010 (UI: -25% to -9%).



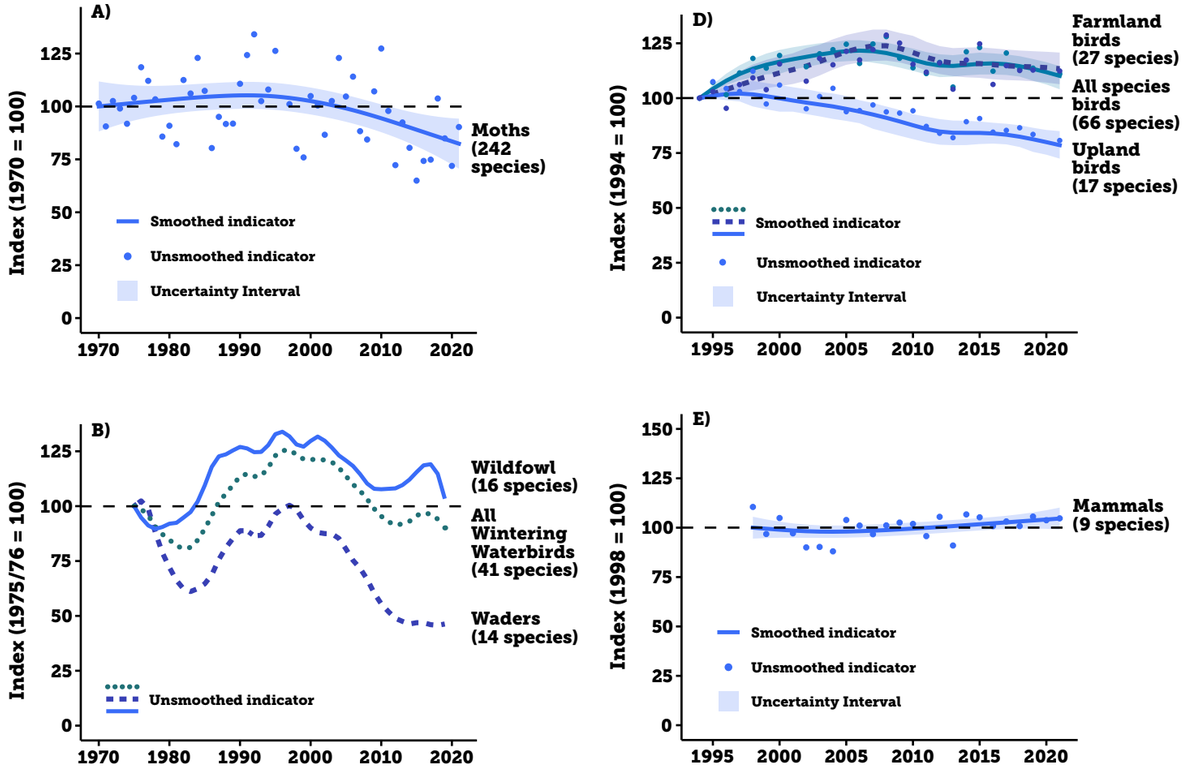


Figure 2: Change in average species' abundance for terrestrial and freshwater species in Scotland by habitat preference, level of specialism or taxonomic group. A) Moths, B) NatureScot Scottish Wintering Waterbird Indicator, C) NatureScot Terrestrial Insect Abundance - Butterfly Indicator, D) NatureScot Scottish Terrestrial Breeding Bird Indicator and E) Mammals. Source for NatureScot's Indicators: nature.scot.

- Scotland hosts internationally important numbers of wintering waterbirds. Many of Scotland's estuaries are crucial for wintering and migrating waders and waterfowl. Between 1975 and 2019 overall waterbird numbers (41 species/ populations) have on average decreased by 10% (Figure 2B[115]). Within this, wader species (14 species) have fared particularly poorly, having declined to 55% lower than in 1975/76. The quality of migratory stopover sites for waders, and timing mismatches in breeding season food availability in Arctic breeding grounds, may be negatively impacting these species[115].
- Since the start of the time series in 1979 to the most recent assessment in 2021 the all-species and generalist butterfly species groups increased by 43% and 46% respectively (Figure 2C), likely influenced by a warming climate, allowing species traditionally restricted to more southerly parts of the UK to become more abundant in Scotland[112]. The specialist species group shows a stable trend. Of the 20 species included in the all-butterfly species index, nine have increased significantly, two have decreased.
- Since the start of the time series in 1994 to the most recent estimate in 2021 the all-species combined bird indicator increased by 10%[113] (Figure 2D,UI: 5% to 15%). The farmland bird indicator increased by 13% (UI: 6% to 21%), in contrast to patterns of change shown in farmland birds in other UK countries [131]. It should be noted that both indicators are now declining and the farmland indicator started after the main period of intensification of agricultural management, so that earlier losses are not reflected. Within farmland, abundance trends are in general more positive in pastoral areas compared to arable ones. The upland bird index decreased by 21% (UI: -28% to -15%) over the same time period. Long-term changes in upland bird populations may have been influenced by climate change, plantation forest expansion and changes in site management[114].
- The abundance indicator for nine mammal species starts in 1998 and shows no change in average abundance (Figure 2E, 5%, UI: -1% to +10%). Within this average, there is a good deal of variation in species levels changes. The indicator covers five bat species, three of which have increased, two increasing deer species, and the declining Rabbit and Brown Hare.

Change in species' distribution

Plants and lichens

- The distribution indicator for 1,223 vascular plant species shows a decline of 14% (Figure 3A, UI: -16% to -13%) between 1970 and 2019. Within this average, the distributions of 47% of species decreased, 27% of species increased and 26% showed little change. Species associated with arable farmland and semi-natural grassland showed particular declines[117].
- The distribution indicator for 879 bryophyte species showed an average decline of 32% (Figure 3B, UI: -38% to -27%) since 1970. The distributions of 62% decreased, 25% increased and 13% showed little change. Warmer drier summers as a result of climate change are likely to be having a negative impact on some bryophyte species[118].
- The distribution indicator for 1,577 lichen species showed an average decline of 36% (Figure 3C, UI: -38 to -33%) between 1980 and 2021. The distributions of 57% of species decreased, 34% increased and 9% of species showed little change. Scotland is the only UK country where lichen distributions are declining on average. Historical declines in lichens associated with heavy industry were less severe across much of Scotland[98] which may explain why they tend to show less of a positive response to reduced sulphur dioxide pollution. In Scotland, the loss of lichens may reflect the decline of nitrogen-sensitive species as the cumulative effects of nitrogenous air pollution have grown, plus the ongoing effects of habitat loss[119]. However, a regional decline in identification capacity may also be part of this overall pattern.

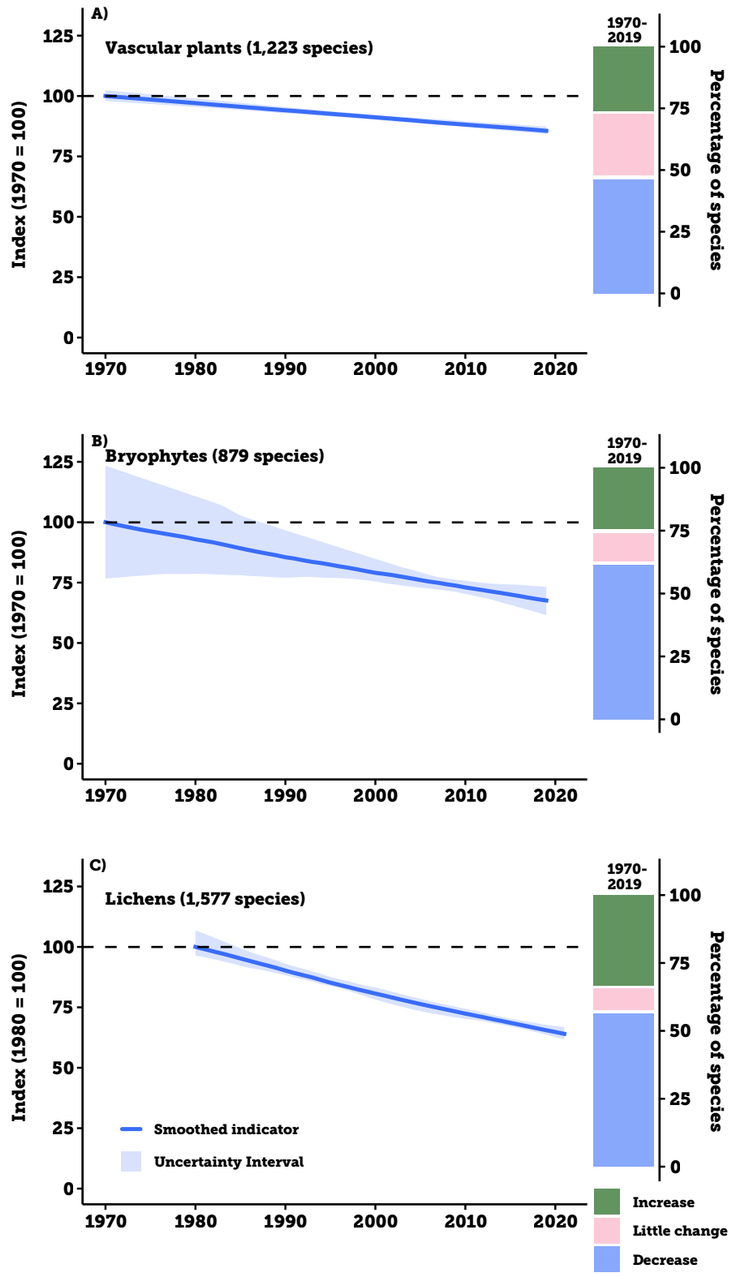


Figure 3: Change in average species' distribution for A) vascular plants, B) bryophytes and C) lichens in Scotland. The bar chart shows the percentage of species within the indicator that have increased, decreased or shown little change in distribution.

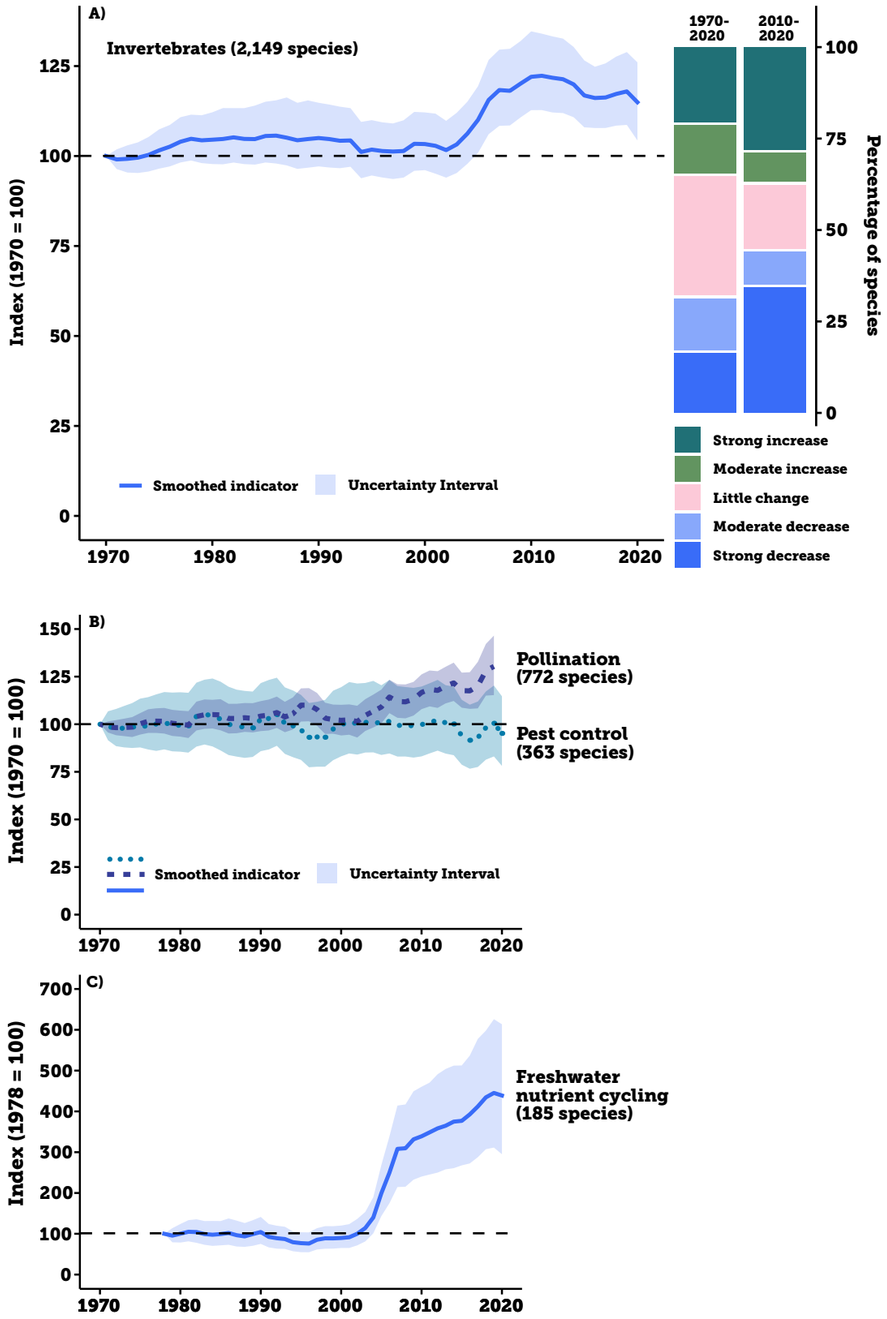


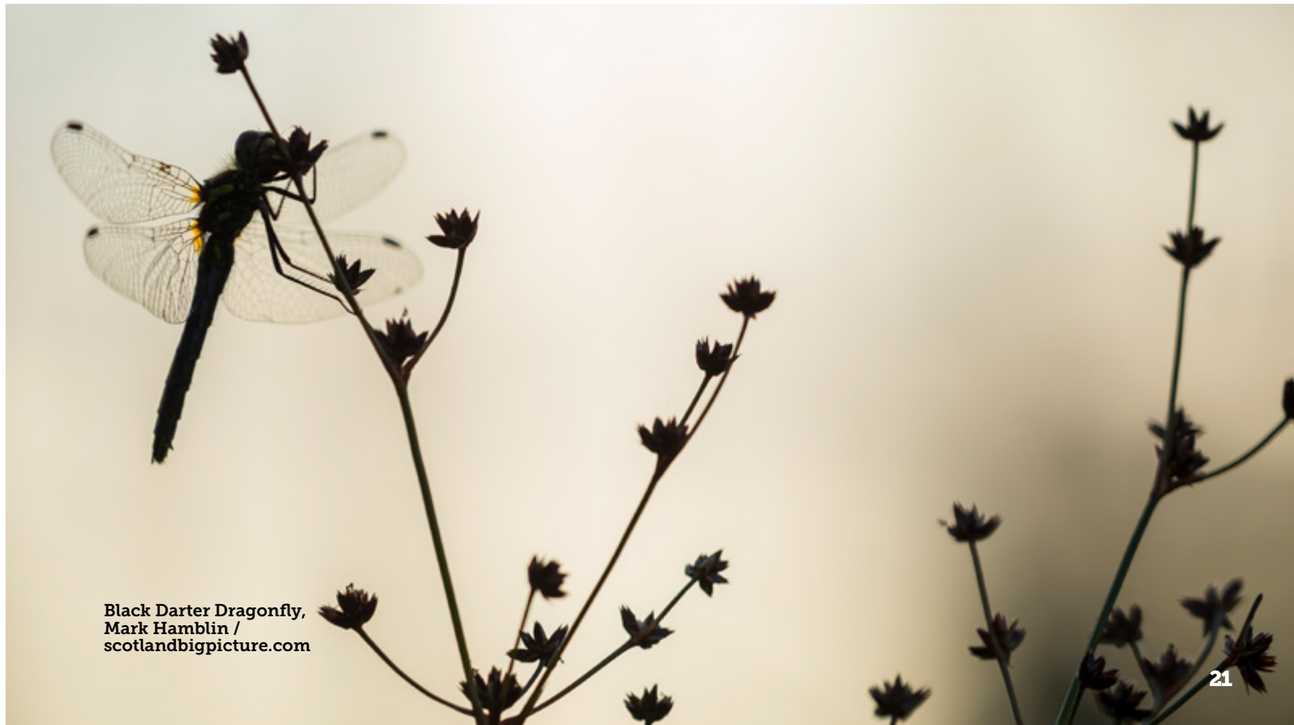
Figure 4: Change in average species' distribution for A) Terrestrial and freshwater invertebrates in Scotland. The bar charts shows the percentage of species within the indicator that have increased, decreased (moderately or strongly) or shown little change in distribution. Insect species grouped by ecological function, B) pollination, pest control and C) freshwater nutrient cycling.

Invertebrates

The distribution indicator for 2,149 terrestrial and freshwater invertebrate species, with Scotland-specific data, increased between 1970 and 2020 by an average of 15% (Figure 4, UI: +4% to +26%). Within this average, similar proportions of species showed strong or moderate decreases (32%), strong or moderate increases (35%) or little change (33%).

To help understand these patterns more clearly, species groups were categorised by the ecological functions they provide (Figure 4[96]). Some groups provide more than one function and so are included in more than one indicator.

- Pollinating insects (bees, hoverflies and moths), which play a critical role in food production, show an average increase of 30% (UI: 15% to 47%) since 1970. This contrasts with pollinator declines in other UK countries and across much of Europe. Climate change might be a factor in this increase, but the trend merits further study.
- Insect groups (ants, carabid, rove and ladybird beetles, hoverflies, dragonflies and wasps) that predate species which damage food crops showed on average little change (-5%; UI: -22% to +15%).
- The average distribution of species providing freshwater nutrient cycling (mayflies, caddisflies, dragonflies and stoneflies) shows a very rapid increase in the 2000s, ending 339% (UI: 195% to 514%) higher in 2020 compared to 1978. This pattern may in part be related to changes in river water quality[97] around the turn of the 21st century following implementation of the Water Framework Directive. However (unlike other UK countries), the initial decline in distributions prior to the 1980s is not captured here, as we can only report subsequent changes. This very rapid increase in freshwater insects explains much of the increase in the 'all invertebrates' indicator (Figure 4). It does not however reflect any more recent changes in freshwater species since 2020.



Black Darter Dragonfly, Mark Hamblin / scotlandbigpicture.com

Extinction risk

Here we break down the IUCN Red List assessments for Great Britain to show the proportion of taxa that are known to have occurred in Scotland, that qualify for each of the standard threat categories. Taxa assessed as Critically Endangered, Endangered or Vulnerable are formally classified as threatened. Only assessments formally approved by the commissioning statutory nature conservation body have been included.

Since the 2019 *State of Nature* report, the number of taxa formally assessed using the IUCN Regional Red List process[98], and known to have occurred in Scotland, has increased from 6,413 species to 7,508. At present we cannot assess whether extinction risk is changing over time because the vast majority of species have only a single Red List assessment. Of the extant taxa, for which sufficient data are available, 764 (10.7%) qualify as being threatened and are therefore at risk of extinction from Great Britain (the scale at which Red List assessments are made) (Figure 5). Of the different taxonomic groups, 347 (14.6%) plants, 140 (8.6%) fungi and lichens, 119 (36.5%) vertebrates and 158 (5.6%) invertebrates qualify as threatened.

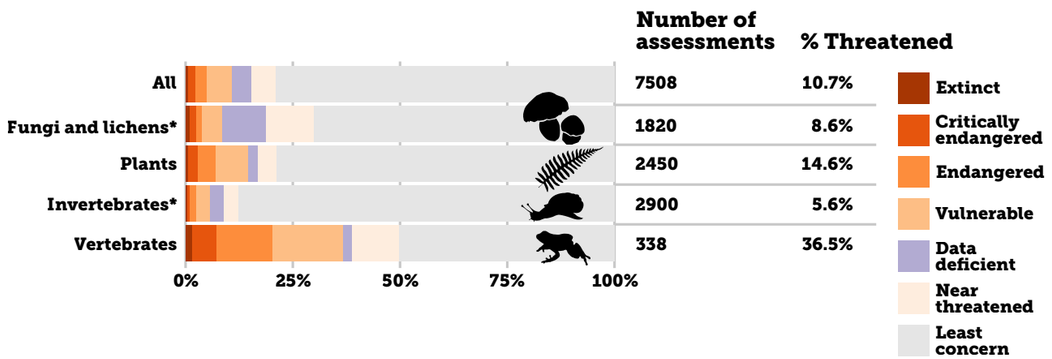


Figure 5: Summary of Great Britain National Red Lists for species present in Scotland, showing the proportion of assessed species in each Red List category, by broad taxonomic group. *At a Great Britain level only selected invertebrate groups have been assessed and less than 1% of fungi species.

Marine

Change in species' abundance

Seabirds

Scotland's breeding seabirds are of international importance. Between 1986 and 2019, the abundance indicator for 11 breeding seabird species shows an average decline of 49% (Figure 6[120]). Of particular concern are precipitous declines in Arctic Skua and Kittiwake, influenced by climate change and changes in fish populations in part associated with fishing pressure. These declines pre-date the as yet unknown but significant impact of ongoing outbreaks of Highly Pathogenic Avian Influenza.

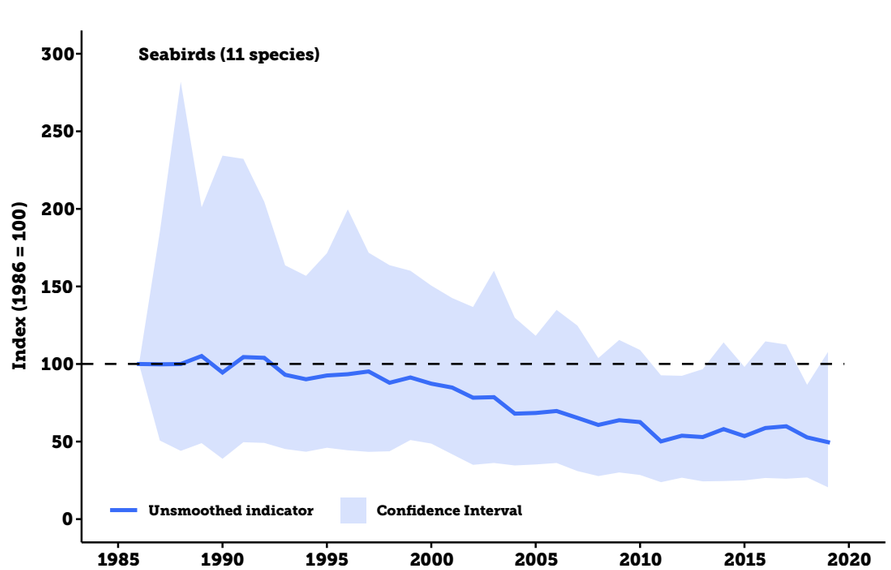
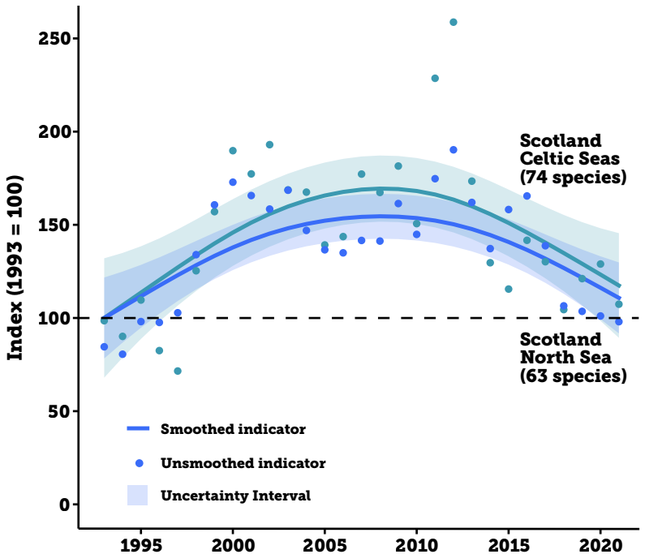


Figure 6: Scottish Biodiversity Indicator – The Numbers and Breeding Success of Seabirds[120].
Change in average species' abundance across 11 seabirds with Scottish-specific trends.
Source: nature.scot



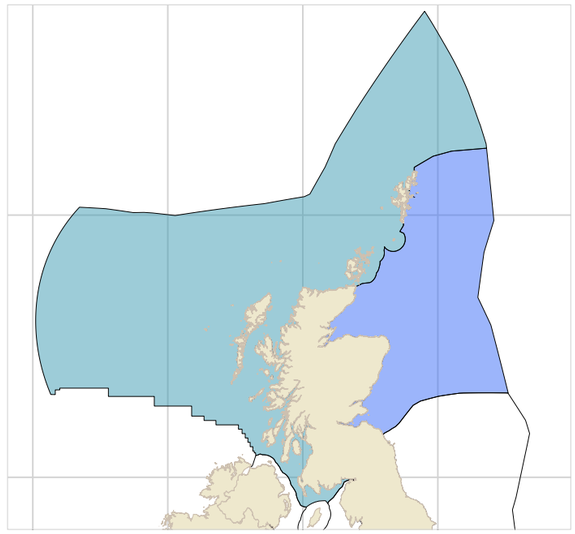


Figure 7: Change in average species' abundance for demersal and bathypelagic fish species (fish that live at or close to the seabed) in the Scottish Celtic Seas and the Scottish Greater North Sea from 1993 to 2021.

Demersal fish

Average abundance of demersal fish species in both the Celtic Seas and Greater North Sea increased in the early years of the 21st century but has since declined towards pre-2000 levels (Figure 7, Celtic Seas: +17%, UI: -11% to +46%; Greater North Sea: +11%, UI: -8% to +30%). The proportion of stocks of fish and shellfish harvested sustainably (below the maximum sustainable yield) has more than doubled since 1991, with the latest estimate being 69% in 2019[99]. However, some fish stocks such as Cod remain in a poor state while others like Sandeels are still harvested in large tonnages despite being important prey for seabirds, marine mammals and other fish species[100]. The increase in stocks sustainably harvested may account for some of the increase in the demersal fish indicator during the first half of the time series. Some areas of the North Sea have been closed to Sandeel fisheries since 2000 and there are signs that this has benefited both the fish and their seabird predators[132]. It is less clear what is driving the more recent declines. Work is ongoing to improve understanding of climate-change driven impacts on plankton communities at the base of the marine food web and implications for wider ecosystem functioning, including the productivity of fisheries[101].

Pressures

On land, pressures come from many sources, including climate change, agriculture, upland management, land-use change, habitat fragmentation, changes in grazing levels, pollution and invasive non-native species.

Climate change places additional stresses on Scotland's wildlife, sometimes exacerbating the impacts from other pressures, for example habitat fragmentation[102] or invasive non-native species. Many species previously only present in the south of the UK are now present in Scotland and increasing in abundance. This is a pattern shown particularly clearly with butterflies, with generalist butterfly species increasing on average and several species thought to be positively impacted by climate change[112]. Conversely, species already at the southern limit of their range in Scotland and that directly or indirectly depend on cooler climates for survival, eg, Mountain Ringlet, Cross-whorl Snail and Dotterel, are potentially vulnerable to ongoing climate change, as are montane plants and bryophytes[103]. Three Arctic-Alpine specialist vascular plants have suffered severe declines of over 50% of their population size since the mid-1990s[104]. Scotland hosts internationally important populations of bryophytes (mosses, liverworts and hornworts). These species are well adapted to our moist climate. However, warmer summers and more frequent droughts are affecting the assemblage of species, with a decline in species that are intolerant of hotter or drier summers[118]. Droughts are becoming more frequent and more intense, and modelling suggests that this pattern will continue, with intensifying impacts on habitats and species[105].

Pollution

The Scottish distributions of more than half of lichen species have declined since 1980. Statistical analysis of data from long-term grassland sites in Scotland demonstrates that while there is some recovery from high levels of sulphur deposition in the 1970s there is no comparable recovery from the impacts of nitrogen pollution[106]. Anthropogenic nitrogen deposition is implicated in the decline in condition and extent of some key habitats in upland areas of Scotland[107]. Montane specialist bird species such as Dotterel are dependent on this habitat, and loss of Racomitrium heath is implicated in the decline of this species.

Significant efforts to restore Scotland's rivers did not occur until 1965. Reductions in heavy industry, the enforcement of new international and national legislation and heightened environmental awareness all contributed to improvements in river quality.

Grangemouth oil refinery, David Palmar (rspb-images.com)

The proportion of river length classed as polluted declined from 7% in 1998 to 3% in 2018[108]. This change coincided with rapid increases in the distributions of many freshwater insects and may have played a part in these species' recoveries. Although many measures of water pollution have improved over the past few decades across Scotland and the UK more broadly, significant issues remain, in particular in catchments linked to intensive agriculture[109].

Agriculture

Scotland supports three-quarters of the vascular plant species found in Great Britain, and the distributions of 47% of these have declined since 1970. Species associated with arable farming have shown particular declines associated with changes in agricultural management, for example the increased use of herbicides and artificial fertilisers, and also the abandonment of small-scale cropping around crofts in northern and western areas. Species associated with acid and calcareous grassland also showed substantial declines likely linked to conversion of these habitats to farmland and associated increased use of chemical fertilisers, re-seeding and a change from hay to silage production[117].

Sea use and climate change

Scotland's seas are also subject to a range of pressures. Progress has been made on improving water quality, contaminants and eutrophication in coastal waters, and some fish stocks are showing signs of recovery. Other pressures, such as those associated with climate change, ocean acidification, marine plastics, unsustainable fisheries, offshore renewables and other developments, still exist and there is evidence of change in pelagic habitats and plankton communities.

Non-native species and disease

The ongoing outbreak of Highly Pathogenic Avian Flu (HPAI) in wild birds is the most serious ever recorded. The impact in the winter of 2021/2022 on the population of Barnacle Geese that come from Svalbard to winter on the Solway in Scotland was devastating, with around a third of the population dying. Eighteen of the 25 UK breeding seabird species tested positive for HPAI in 2022 and across RSPB reserves at least 15,000 birds were recorded dead. Seabirds are particularly vulnerable, as they normally have high adult survival rates and are slow to reproduce. For Great Skua and Gannets, two of the species where observed mortality was greatest, Scotland hosted, before HPAI impacts began 60% and 46% of the global populations respectively. Initial estimates suggest a decline in occupied Great Skua territories of well over a half in Foula, Shetland, which is the largest colony of this species in the world[111] and seabird population monitoring work in 2023 will produce estimates of the impacts of HPAI on the numbers of those seabird species most badly affected in 2021/22. Raptors have experienced marked declines in breeding success linked to HPAI, particularly Golden and White-tailed Eagles[110]. The ongoing impact of HPAI is difficult to predict, but this novel additional pressure on our wildlife emphasises the need for resilient ecosystems and species populations.

Invasive non-native species (INNS) continue to spread and increase in terrestrial, freshwater and marine environments across Scotland[95]. INNS present on islands that are important for breeding seabirds constitute a major threat to globally significant populations. Invasive species continue to impact habitats and native species across Scotland, and several projects are underway to combat the threat. However overall the problem is intensifying, and the threat is likely to increase with climate change.

RSPB Inversnaid, Loch Lomond, Andy Robinson

HISTORICAL CHANGES

The *State of Nature* reports focus on recent changes in biodiversity. However, Scotland's biodiversity has been altered by centuries of habitat loss and fragmentation, management changes, development and persecution. This is important because changes that occurred before the past few decades are critical context regarding the scale of the deterioration of our natural environment. In a phenomenon known as 'shifting baselines', each new generation views the world in which it grew up as the reference for how things should look, rather than recognising that biodiversity is already depleted. We cannot measure this depletion precisely, so here we present three examples that bring to life some of these longer-term changes that have occurred.

Plant species change

Plant Atlas 2020 presents an insight into the changing distributions of our wild plants over the last 70 years[11,12]. Over three million plant records of 2,555 species, collected by hundreds of botanists across Scotland, fed into the Atlas. Many of the habitats our plants depend on have been impacted by changes in agriculture since the 1950s. Nitrogen enrichment, habitat degradation and changes in grazing pressure have led to the decline of many species. Damp meadows have been drained, leading to long-term declines in plants such as Globeflower and Grass-of-Parnassus, and traditional grasslands have been reseeded or over-fertilised, resulting in declines for species such as Moonwort and Sheep's Sorrel. The decline of our arable wildflowers is particularly concerning, with 66% of these species, such as Corn Marigold, decreasing in range in Scotland over the last 70 years. This is primarily due to arable intensification, but also to the abandonment of small-scale cropping on crofts. Scotland's peat bogs and moorlands are being impacted by species such as Sitka Spruce, the most frequently planted non-native commercial forestry species in Britain, which is increasingly colonising neighbouring habitats, and was the plant that had the greatest increase in range of any species covered by Plant Atlas 2020.

Climate change is also a key driver of change in plant species. Rising summer temperatures have greatly reduced the areas where the snow lies late in the spring and summer, causing declines of some Scottish mountain plants, such as Alpine Lady-fern and Alpine Speedwell. Two ecosystem health indicators developed for Scotland[13] are based on bryophyte distributions (mosses, hornworts and liverworts). The results showed an increase in records of mosses associated with warmer summers and a decrease in those preferring cooler conditions. There has also been a decline in species sensitive to drought. This suggests that climate change is having an impact at the plant community level across Scotland.

Impact of marine fisheries on species and ecosystems

Fishing has been an important economic and cultural activity in Scotland for centuries. Archaeological evidence can provide an insight into changes in fish populations, as it helps us look at the impact of fishing over an even longer timescale[14]. Since 1924, the amount of fish landed has declined steeply, despite an increase in fishing effort. There are clear knock-on effects to Scotland's marine wildlife, for example, trends in gulls matched closely with the amounts of fish landed, with both having declined[15]. The reduction in the abundance of commercially caught fish has meant significant changes to the structure and functioning of ecosystems. In the Firth of Forth, rich mollusc beds, especially oysters, were the target of commercial fisheries in the 19th century. Now, low-diversity soft-sediment communities dominate the seabed and these communities are less productive and less diverse, with reduced mollusc biomass and species richness, likely due to the damaging effects of earlier bottom-trawling and dredging[16]. The Restoration Forth project is starting to address these declines. This project aims to release 30,000 native oysters and restore four hectares of seagrass by the end of 2024[17]. This is a small step towards restoring a healthy and resilient environment in the Firth. However, if successful, the project will demonstrate the feasibility and potentially significant benefits of ecosystem restoration in Scotland's marine environment.

Biodiversity Intactness Index

The Biodiversity Intactness Index (BII) takes an even longer-term view. This is done by collating species data from around the world (58,000 species from a wide range of taxonomic groups), and then building models that compare species data (richness and abundance) across different levels of land-use intensity, with the least modified examples of a habitat to act as a proxy for what would be there in the absence of human pressure.

Data are collated from ecological studies across the globe and the relationships between land cover, land-use intensity, and species richness and abundance are modelled. The models thus give an estimate of species diversity and abundance at near-undisturbed sites compared to similar areas with high human activity.

The most recent estimate of the global BII is 77%[18] which means, when averaged across all species, populations have declined to 77% of their presumed pre-modern levels. This is substantially lower than the 90% level suggested as necessary to keep within planetary boundaries of a healthy functioning ecosystem[19].

Scotland has a BII of 45%, which is similar to the other UK countries. These are some of the lowest BII values amongst the G7 countries (range 62-91%) and lower than other northern European countries such as Sweden (94%) and Norway (95%) (Figure 8).

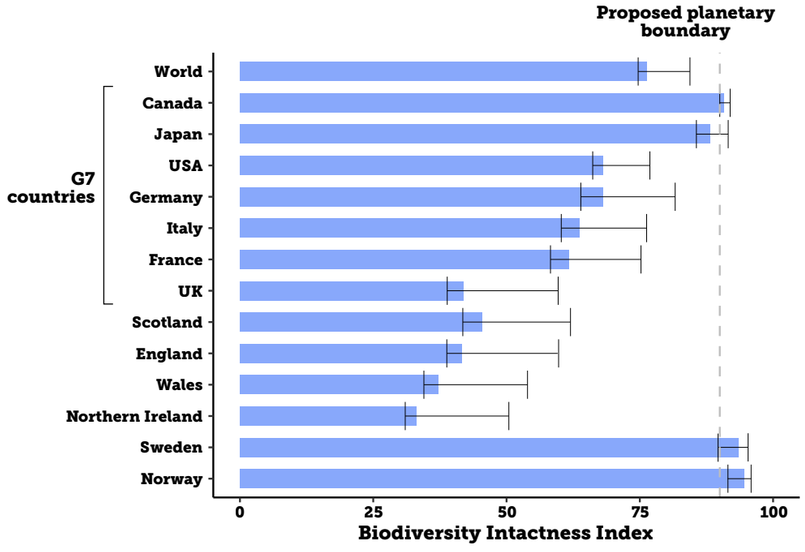


Figure 8: Estimates of the Biodiversity Intactness Index for 2010 for the world, the biggest global economies, the G7 countries, and select other countries in north-west Europe for a more direct comparison to the UK[18].

CONSERVATION RESPONSE

Global nature recovery targets

The Convention on Biological Diversity COP15 summit agreed the Kunming-Montreal Global Biodiversity Framework[20]. It launched a global mission to halt and reverse the loss of nature by 2030 and achieve recovery by 2050 'sustaining a healthy planet and delivering benefits essential for all people'. The Scottish Government played a leading role in highlighting the role of sub-national governments in securing these global aims, via the Edinburgh Declaration[21].

The new Framework includes four 2050 goals, covering protection and restoration of ecosystems, species and genetic diversity, as well as the sustainable use of biodiversity, the equitable sharing of benefits arising from biodiversity, and resource mobilisation.

These goals are underpinned by 23 targets to be achieved by 2030. The success of the new global targets will be dependent on how specific they are, our ability to measure progress and whether there are sufficiently strong implementation mechanisms[22]. The new framework is underpinned by commitments to mobilise resources for implementation, and to follow a cycle of planning, monitoring, reporting and reviewing. Countries have agreed to these implementation steps to drive the delivery of the global framework at the national level. National biodiversity targets underpinned by law have been shown to be more effective[23] and the response for nature needs to be given the same priority. The Scottish Government committed in the Bute House Agreement to bring forward legislation for binding nature recovery targets during the current parliament[24].

From page 27, we discuss conservation action in Scotland, framed around the National Biodiversity Framework targets (Figure 9), summarising what action is being taken, what we understand about the impact of these conservation actions on nature and people and, where possible, the future outlook.

JMT Knoydart, Vicky McClure

Global Goals for 2050

Goal A:	Goal B:	Goal C:	Goal D:
Outcomes for ecosystems, species and generic diversity	Sustainable use and nature's contributions to people	Equitable sharing of benefits from genetic resources	Means of implementation, including finance

2030 Mission

To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet

Global Targets for 2030

Reducing threats to biodiversity

- **Target 1:** Spatial planning
- **Target 2:** Ecosystem restoration
- **Target 3:** Protected areas
- **Target 4:** Recovery of ecosystems, species and genetic diversity
- **Target 5:** Overexploitation
- **Target 6:** Invasive non-native species
- **Target 7:** Pollution
- **Target 8:** Climate change

Meeting people's needs

- **Target 9:** Sustainable use of wild species
- **Target 10:** Sustainable production
- **Target 11:** Nature's contribution to people
- **Target 12:** Urban environment
- **Target 13:** Access and benefit sharing

Tools and solutions

- **Target 14:** Mainstreaming
- **Target 15:** Business action
- **Target 16:** Sustainable consumption
- **Target 17:** Biosafety
- **Target 18:** Subsidy reform
- **Target 19:** Financial resource mobilisation
- **Target 20:** Capacity building
- **Target 21:** Knowledge and data sharing
- **Target 22:** Indigenous peoples and local communities
- **Target 23:** Gender

Report chapters	Core targets
Improved species status	Goal A, T4
Nature-friendly farming, and sustainable forestry and fisheries	T10
Protected areas	T3
Ecosystem restoration	T2
Nature, climate and people	T1, T8, T12

Figure 9: Summary of the goals and targets agreed within the Kunming-Montreal Global Biodiversity Framework and how these targets are discussed within this report.

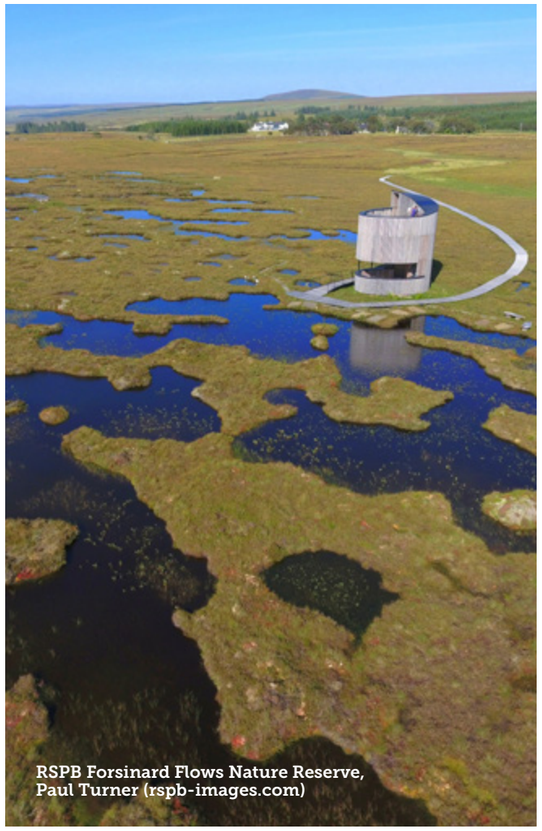
Mountain Hare, Ben Andrew (rspb-images.com)

Improved species status

Goal A of the Global Biodiversity Framework commits parties to: halt human-induced extinctions of threatened species, achieve a ten-fold reduction in risk and rate of extinction, maintain genetic diversity and increase the abundance of native wild species to healthy and resilient levels by 2050[20]. Preventing extinctions and halting or reversing declines requires both targeted actions for specific species and broad measures to improve environmental quality and tackle drivers of nature loss[25]. There is good evidence that conservation is effective for individual species when it can be applied to a high proportion of the population, and targeted conservation action has set some species on the path to recovery. In Scotland, many previously common and widespread species are continuing to decline. However, there are many success stories of species benefiting from conservation, for example, the population reinforcement of the Pine Hoverfly, Great Crested Newts benefited from pond creation by farmers and foresters[26] and Water Voles recolonising areas where invasive American Mink have been controlled[27]. It is important to remember that halting declines and reducing extinction risk are not the end goal of conservation. They are a critical step towards species recovery and attaining the 'healthy and resilient levels' urged in the Global Biodiversity Framework.

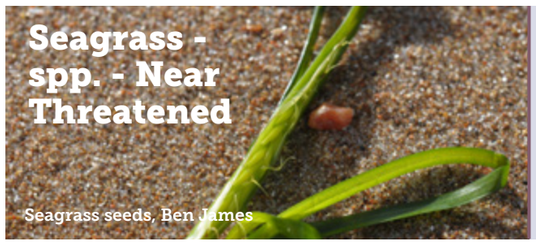
Action – how is species conservation being conducted in Scotland?

In recent decades, many effective conservation tools have been developed[28]. Figure 10 presents examples of species that have been subject to interventions including: reintroductions, habitat restoration or management; wider landscape interventions, like agri-environment schemes; legislative change and policy frameworks. The species below reflect a variety of taxonomies and life histories, with conservation actions implemented at a range of spatial scales by landowners, charities, government and the public. These examples focus on a single conservation action; however, in most cases more than one type of action will be needed to fully restore species' populations. Equally, actions designed to favour one target species often have beneficial impacts on others[29]. Multispecies conservation projects that embody this concept include Species on the Edge[30] in Scotland and Co-operation Across Borders for Biodiversity[31] which spans sites in Northern Ireland, Scotland and the Republic of Ireland. These partnerships operate at multiple sites and tackle an array of conservation challenges including habitat loss, invasive species impacts and disturbance, with benefits to threatened target species across multiple taxa. Moreover, they engage local communities, connecting people with nature.



RSPB Forsinard Flows Nature Reserve, Paul Turner (rspb-images.com)

Figure 10: Species examples showing the range of conservation interventions for a range of taxa.

Species and Great Britain Red List status	Population change	Conservation actions	Conservation actions and impact
 Red Squirrel, Ben Andrew (rspb-images.com)	**7%** contraction in range between 1993 and 2016[32]	Invasive species control	Saving Scotland's Red Squirrels (SSRS) works with volunteers and landowners to protect Red Squirrel populations from the non-native, invasive Grey Squirrel, through targeted control in priority areas. Grey Squirrels outcompete reds for resources and are a host for squirrelpox. This is asymptomatic in greys, but deadly to reds. When Grey Squirrels move into a Red Squirrel territory, they usually replace the native red population within 15 years[33]. Without the work of SSRS, it is likely the Red Squirrel's range in Scotland would have contracted considerably in line with national trends. Instead, red populations have remained largely stable, and even increased in localised areas[34].
 Pine Hoverfly, ©Lorne Gill, NatureScot	Range decline from four to one 10 x 10 km squares since 1980	Population reinforcement and habitat management	The species is declining across Europe due to a lack of its larval habitat: in Scotland, large rotten Scots Pine stumps. The Rare Invertebrates in the Cairngorms project is creating habitat and the Royal Zoological Society of Scotland has managed a captive breeding project, rearing over 8,000 larvae in one season. Early signs show population reinforcement has been effective, with surveyors finding evidence of breeding at three sites in the Cairngorms.
 Bristle Moss, Claire Halpin British Bryological Society	Range increase, 185 10 x 10 km (1900-1979) to 473 (1980-2023)	Legislation to reduce air pollution	Many bryophytes and lichens are negatively impacted by air pollution. The European Union National Emissions Ceiling Directive (Directive 2001/81/EC) compelled nations to work to reduce levels of various pollutants, including sulphur dioxide. The resulting declines in sulphur dioxide have coincided with population recoveries in a range of epiphytic bryophyte species, including the Wood Bristle Moss[35].
 Flapper skate, ©Fenella Wood	Increase in abundance following historical declines	Fisheries management measures Marine Protected Areas	The species was highly susceptible to overfishing. It nearly disappeared from much of the North Sea between the mid-1950s and early 1980s and was extirpated from the Irish Sea in the late 1970s. Fisheries legislation[36] now prohibits landing of the species by both commercial and recreational fishers. Flapper Skate remain a popular target for recreational anglers and the development of handling guidelines[37] is ongoing. The species appears relatively resilient to catch-and-release angling[38]. Flapper Skate are also recognised as a Priority Marine Feature[39] and a protected feature of two MPAs in Scottish waters.
 Seagrass seeds, Ben James	**33%** of UK seagrasses lost since the 1980s[40]	Marine Protected Areas Active habitat restoration	The primary conservation intervention for seagrass in Scottish waters is the protection of extant beds to prevent further losses. Seagrass is a feature of numerous MPAs[41] and afforded wider seas protection as a Priority Marine Feature. Seagrass restoration is currently in its infancy in Scottish waters. A Seagrass Restoration Handbook[42] is available to help guide practitioners. Genetic research is in progress to assist with identifying compatible seed sources. Two projects have actively started planting seagrass, Seawilding[43] and Restoration Forth[17].

Nature-friendly farming, and sustainable forestry and fisheries

Farming, fishing and forestry are important industries in Scotland, providing food, timber and livelihoods, and the current and future state of nature depends on these industries pursuing nature-friendly, sustainable approaches. The geographic extent of these industries means that careful planning and sustainable management is essential to help halt biodiversity loss and mitigate and adapt to the effects of climate change.

Farming

80% of Scotland's land is farmed[45] and technological advancements, intensification, use of agro-chemicals and artificial nitrogen and, changing agricultural policy has reduced the capacity of farmed landscapes to support wildlife, resulting in widespread biodiversity loss[46].

The abundance indicator for Scottish farmland bird species shows an average increase in abundance of 20% since 1994 (Figure 2D[47]), although now declining from a high in 2008. This contrasts with an overall decline in farmland birds across the UK. This may in part be explained by the Scottish indicator starting after the main period of agricultural intensification. However, within the indicator some species are increasing while others are in decline. Goldfinch, Great Tit, Magpie, Whitethroat, Reed Bunting, Buzzard and Jackdaw are doing well, but between 1995 and 2021 Kestrel, Lapwing and Oystercatcher declined by 71%, 66% and 36% respectively.

Various agri-environment schemes (AES) aiming to promote sustainable and nature-friendly farming have been developed by the Scottish Government. The current scheme, Agri-Environment Climate Scheme (AECS), is designed to promote land management practices which protect and enhance the natural heritage, improve water quality, manage flood risk, and mitigate and adapt to climate change[48]. In 2020, 20% of Scotland's farmland (1.6 million ha) was in AECS agreements[49], and in 2019 7% of a £600 million farming support budget in Scotland went towards delivering environmental improvements under AECS.

Although AES are the primary policy mechanism for addressing farmland biodiversity declines in the UK, their effectiveness is mixed[50-54]. However, there is strong evidence that well-targeted schemes, accompanied by appropriate advice, have increased the abundance of multispecies groups[55-57], as well as single species such as Corn Bunting[58,59] and Corncrake, where a targeted scheme increased the population from less than 500 males in 1993 to 1,274 in 2014[60]. It should be noted that recovery can sometimes require long time-scales[61]. In northeast Scotland, positive associations between bird abundance and specific scheme options that met species' ecological requirements have been found (eg water margins for Reed Buntings; species-rich grasslands for Yellowhammers; planting hedgerows for plant diversity and pollinator abundance[62]). Recent evidence suggests that around 47% of arable and 26% of pastoral lowland farms would need to be part of a scheme with specific options for farmland birds on 10% of each farm to start to recover regional farmland bird populations[63].

The Scottish Government's Agricultural Reform Programme is devising future payment schemes for land managers. A Route Map was published in 2023 setting out the new support framework and transition to the new schemes[64]. A list of measures is being appraised by the Scottish Government, which includes the targeted habitats and their desired outcomes. Many of these measures have been demonstrated to support a range of species (eg, biodiversity cropping and silvo-arable systems). Future effectiveness in halting and reversing biodiversity losses will depend on the levels of funding allocated to environmental improvement through these support payments, advice, implementation and monitoring.

Fisheries

Marine fishing has long been a part of Scottish culture. Nonetheless, overfishing and fishing methods that damage benthic (seafloor) habitats have been major drivers of marine biodiversity loss[65,66], and there have long been concerns about the sustainability of fish stocks[65,67]. Around 70% of UK fish landings by weight are in Scotland[67] with Scottish vessels landing 437,000 tonnes of sea fish and shellfish valued at £560 million in 2021[68].

The proportion of stocks of fish and shellfish harvested sustainably (below the maximum sustainable yield) is now 69%, more than double what it was in 1991[69], although some stocks like Cod remain in a poor state. Sustainable management is a positive step but does not necessarily mean the same as well-managed for nature.

There is some indication that this move towards sustainable fisheries has benefited species, with our measures of abundance change in bottom-dwelling fish showing an average increase in the early years of the 21st century. However, they have since declined towards pre-2000 levels (Figure 7). The Large Fish Indicator, a measure of the health of fish populations in the North Sea, also showed an increase between 2001 and 2016, suggesting fish populations were benefiting from more sustainable management[70].

The impact of marine fisheries is largely through overfishing of target species, incidental capture of non-target species of a range of taxa including seabirds and marine mammals, and damage to benthic substrates from bottom-trawling. While there are data available to indicate harmful levels of bycatch in some fisheries, this is not comprehensive. In Scotland, there are currently a series of projects underway to prevent accidental bycatch in creels through the Scottish Entanglement Alliance[71]. Remote Electronic Monitoring (REM) is vital to support sustainable fisheries; cameras on vessels would encourage more selective fishing, reducing wasteful discarding and bycatch, and improve data for management.

Implementation of ecosystem-based fisheries management will be critical and includes commitments to alter management of industrial fisheries for Sandeels. Sandeels are

Volunteers at RSPB Forsinard Flows Nature Reserve, Paul Turner (rspb-images.com)

small shoaling fish and have been described as the most important forage fish in the North Sea, as they are key to the diets of Seabirds, marine mammals and larger fish. Climate change is the main pressure on Sandeels, but industrial fishing exacerbates their decline. All UK administrations have recognised that urgent measures are needed to protect Sandeels and their wider marine ecosystem and the Scottish Government is currently consulting on a closure of Scottish waters to Sandeel fisheries. All four fisheries administrations have agreed the Joint Fisheries Statement that sets out the policies for achieving the eight objectives of the UK Fisheries Act 2020 and are developing some of the key elements including Fisheries Management Plans.

Forestry

Forestry is economically important, and woodland cover has increased over the past century in Scotland from a baseline of heavy historic deforestation. Uniform planting of non-native tree species and lack of effective management in native woodlands, particularly of deer and invasive non-native species, has led to reductions in some specialist woodland wildlife, and an increased risk to native tree species from new pests and pathogens[72,73]. However, not all woodland wildlife is decreasing. Some woodland birds have increased markedly, with some species such as Willow Warbler shifting their range northwards[47].

Woodland covers approximately 19% of Scotland. This increased greatly in the 20th century from a level of around 4% for the preceding six centuries or more[72]. The condition of native woodlands has been affected through grazing pressure, invasive species (plants, animals and pathogens), fragmentation, climate change and management. 73% of Scotland's woodland is coniferous, of which the majority is non-native. Sitka Spruce, the most important commercial species in terms of area, is well-adapted to current conditions. While it produces a valuable timber crop and reduces the need for imports of wood, it can cause problems as it self-seeds, becoming established in sensitive areas including peat bogs and species-rich grassland, and thereby adversely impacting on both biodiversity and carbon capture[73]. Sitka Spruce has undergone the most significant increase in range of any species recorded in the 2020 Plant Atlas[11,12].

The Forestry Grant Scheme offers financial support for the creation of new woodland and the sustainable management of existing woodland. Within the scheme, there is a range of support options covering planting, woodland protection, harvesting and more. Woodlands are often managed for multiple uses, including recreation and biodiversity.

Scotland's Forest Strategy, which shapes public sector forestry and economic support, balances the needs for commercial viability, carbon sequestration, recreation and biodiversity. It also supports a move from monoculture to a greater species diversity. The 2023 consultation on the Forestry Grant Scheme solicited views on enhancing biodiversity in Scotland's forests. The Scottish Government has also launched a riparian woodland target, which identifies around 175,000 ha along rivers and burns across Scotland that has the potential for woodland planting and will receive higher rates of grant funding. As well as woodland species, this intervention targets species that benefit from cooler well-oxygenated water such as Atlantic Salmon.

Protected areas

Protected areas, a key pillar of nature conservation, are legally designated sites where natural features including species and habitats are safeguarded and managed for the benefit of wildlife and people. The protected area target of the 2020 Aichi Convention on Biodiversity was one of the few to be partially met, with countries collectively designating protected status for 17% of land and 10% of sea, although inadequate progress was made on the other elements of the target, which stated protected areas need to be effectively and equitably managed, ecologically representative and well-connected. Similarly, in Scotland, while the extent of protected areas target was met, overall the target was assessed as 'insufficient progress' due to the condition of protected areas, with further work needed on management, representativeness, integration and connectivity of sites[7]. Target 3 of the Global Biodiversity Framework commits to extending protection to at least 30% of land and sea, a target to which the Scottish Government has committed[74]. The 30% target can be met through a combination of protected areas and 'Other Effective Area-Based Conservation Measures' (OECMS)[75].

Action – extent and condition

Scotland has a variety of protected area designations. On land, the main designations for nature are Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites; taken together these sites cover 18% of Scotland's land[76]. In these sites the primary focus is on nature conservation, but other activities are permitted if they do not damage the natural features. Landscapes such as National Parks are designated for a range of purposes, including but not limited to conservation of natural heritage. In National Parks, natural and cultural heritage is supposed to take priority if there are conflicting management goals[77]. Here, we concentrate on protected areas where conservation is the primary focus.

Monitoring of protected areas in Scotland is done at the feature level and the proportion of natural features in favourable condition was 65.2%, ([78]; Mar 2023) a decrease from 67.5% in 2007. Figure 11 shows the pressures affecting natural feature condition, with the top pressures being invasive species (21.1%), over-grazing (17.5%) and water management (8.7%).

Butterwort, Paul Turner (rspb-images.com)

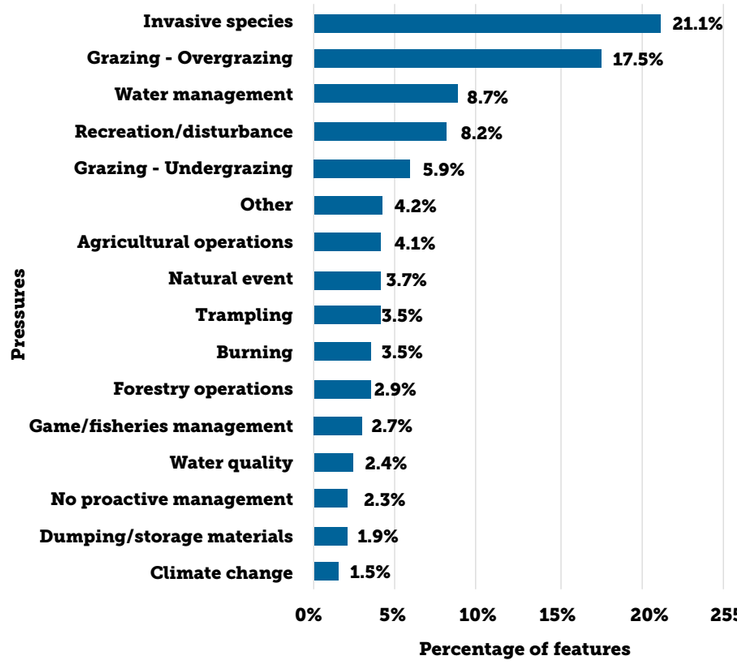


Figure 11: Summary of the main negative pressures on natural features on protected sites.
Source: nature.scot[79]

At sea, although significant progress has been made in designating marine protected areas (MPAs), which now cover 37% of Scottish seas, these designations are not yet delivering ocean recovery objectives, and further progress is needed on site monitoring and management. Scotland's Marine Assessment 2020 underscored the critical challenges facing marine biodiversity, primarily climate change and fishing activities. Fisheries management measures are not yet in place in all relevant MPAs, although there are commitments to consult on new measures for these sites in 2024. Furthermore, the regulatory framework allows for licensable activities, including aquaculture and renewable energy developments, to be considered within MPAs. Notably, many consents granted prior to an area's designation as an MPA remain valid and operational. New measures are also being developed to protect diverse habitats such as seagrass, maerl and Flame Shell beds at key coastal biodiversity locations outside the Scottish MPA network. These new measures are also expected to be consulted on alongside those for MPAs in 2024.

Impact

In some cases, protected areas are associated with more positive population trends. For example, trends for bird species of conservation concern are more positive when there is a high coverage of protected areas in the surrounding area[80]. Similarly, sites designated for a target species group, for example SPAs for birds[81] or SPAs and Ramsar sites for wetland birds[82] have stronger positive associations with both current abundance and trends in abundance. Recent trends in invertebrate species distribution have on average declined both in protected and unprotected areas at a similar rate, even across a subset of rarer species[83]. Likewise, for a range of plant and animals, trends in declining and priority species are on average similar in landscapes with and without protected areas[84]. However, the extent to which population declines reflect site-level issues, including effectiveness of management, governance and enforcement, or drivers that lie beyond site boundaries (eg, climate change, diffuse pollution) is uncertain.

Protected areas, carbon and other ecosystem services

Healthy ecosystems on land and at sea generate many benefits for people: providing sources of food, income for local communities and opportunities for recreation. The Dasgupta Review highlighted that the benefits of protecting 30% of land and ocean would exceed costs to achieve this and would provide better financial and higher non-monetary benefits than currently, as well as delivering significant social benefits[5]. Critically, protected areas also provide cost-effective climate change mitigation through carbon capture and storage, and help with adaptation to climate impacts such as reducing the impact of storms, flooding or coastal erosion. Across nature-rich terrestrial habitats in Scotland, 63% of carbon stocks are found within existing protected areas[85]. Restoring degraded sites in the network will protect carbon stocks and, in some cases, increase them via sequestration[86]. In marine environments, MPAs can also contribute substantially to climate change mitigation if they protect and effectively manage 'blue carbon' stores[87]. Collectively, Scotland's blue carbon environments store 2,627 Mt C[88]. Marine sediments store the vast majority of Scotland's blue carbon with fjords functioning as carbon sequestration hotspots.

Future

There is strong evidence that terrestrial protected areas help colonising or range-shifting species[89], something that is becoming commonplace in a changing climate. Recently a positive association was found between protected area extent and colonisation of new areas by birds[81]. Protected areas were also more likely to be colonised by locally novel pollinator species compared to unprotected areas[83]. In order for protected areas to continue to support climate adaptation, the likely future climatic niches for species and habitats must be considered as the network expands, as well as ensuring connectivity to existing sites to deliver nature networks.

The Scottish Government has committed to protect at least 30% of Scotland's land for nature by 2030. NatureScot has been undertaking a co-design process with stakeholders to develop a framework for 30x30 and in parallel a framework for delivering nature networks. A new Monitoring and Surveillance Strategy for protected areas is also being developed in Scotland.

Ecosystem restoration

Scotland's Draft Biodiversity Strategy highlights the global biodiversity crisis and how this is driven by a range of direct and indirect drivers. Ecosystem change and degradation in key habitats is one of these direct drivers of biodiversity loss in Scotland and ecosystem restoration is the process which aims to reverse the damage. It can simultaneously enhance biodiversity, ecological function and the delivery of ecosystem services. Both global and national policy initiatives are encouraging restoration and protection of natural and semi-natural habitats, Target 2 of the Global Biodiversity Framework commits to ensuring that 30% of degraded habitats are under effective restoration by 2050, and to restore, maintain and enhance nature's contribution to people, through ecosystem-based approaches and nature-based solutions to the climate emergency. Below we focus on woodland, peatland and marine as the ecosystems where Scotland's role in their restoration and conservation is crucial for nature.

Woodland

The extent of native woodland peaked around 5,000 years ago. Since then, clearance of native forests for timber and charcoal, and agriculture, alongside increases in grazing pressures, have brought about significant landscape changes, with woodland being reduced to around 4% of Scotland's area by 1350[72]. Scotland is among the most heavily deforested countries in Europe, despite growth in non-native commercial forestry[72]. Native woodland ecosystems, including Caledonian pinewoods and temperate rainforests in the west, are now a fraction of their original area and are fragmented, with associated risks of loss of diversity, local species extinctions and reduced ecosystem resilience[90]. The most recent condition assessment found just 3% of native woodland was in favourable condition, with the vast majority (94%) assessed as being in intermediate condition[91]. Techniques for restoring woodland are well understood and tested. They include planting or encouraging natural regeneration of native trees, reducing grazing and browsing pressure from livestock and deer, safeguarding genetic diversity, eradicating and excluding invasive non-native species such as Rhododendron ponticum, and thinning or coppicing, where appropriate, to open the woodland canopy.

Case study:

Lichens and bryophytes, Jill Donnachie

Woodland Expansion Project

The Woodland Expansion Project focuses on the protection and growth of native woodland within the Coigach and Assynt Living Landscape, which currently extends to 4,000 ha covering 6.5% of the landscape[92]. The primary objectives were to secure existing woodland fragments, enable expansion via natural regeneration and strategic planting of native species, and improve connectivity between woodland fragments to establish wildlife corridors for woodland biodiversity. Benefits to people were also a core objective, by illustrating the practical benefits of woodland such as shelter for people, wildlife and livestock, sources of sustainable firewood and support for community orchards.

Peatland

Scotland retains some of the largest and most intact blanket bog globally, but losses to drainage, ploughing and planting for commercial conifers, commercial peat extraction and damage through burning has led to extensive degradation. It is estimated that currently 75% of Scottish peatlands are damaged[6]. Peatland restoration is a key opportunity for nature-based solutions in relation to climate change. Peatlands are the largest terrestrial carbon store in the UK, most of which are in Scotland, but while near-natural peatlands are carbon neutral, degraded sites release carbon. National funding from Scotland's Peatland Action Programmes is supporting peatland restoration at large scales.

Case study:

RSPB Forsinard Flows Nature Reserve, Paul Turner (rspb-images.com)

Work in the Flow Country

Work in the Flow Country includes restoration projects by RSPB at Forsinard National Nature Reserve over the last 25 years. This included felling 2,593 ha of non-native forestry with the aim of restoring natural bog habitat[94]. Large-scale trials of different ways of restoring bog following forestry removal has enabled the implementation of the best restoration practices. Initial results suggest the water table is rising, and invertebrates and bird assemblages are gradually converging with those found in natural bogs. The Flow Country is currently under consideration for World Heritage status, which could bring significant social, cultural and economic benefits.

Marine

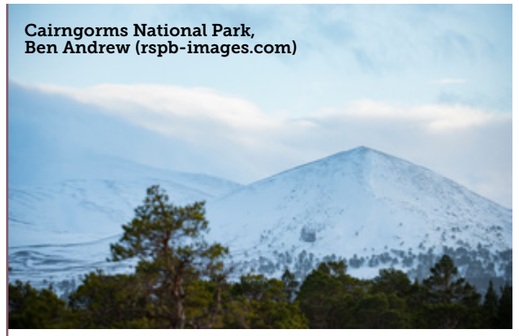
Marine ecosystems have also undergone anthropogenic degradation. Marine food webs are changing, with significant reductions in plankton biomass and species compositions, correlated with climate-driven warming sea temperatures. The precise implications are not fully understood, but as the basis of pelagic food webs, changes in plankton communities are linked to population changes in marine predators. For example, the index of Scottish breeding seabirds showed that top predators in marine environments declined by 49% between 1986 and 2019. No areas of seafloor around Scotland currently meet good ecological status, in part due to habitat disturbance from fishing, and of the five Scottish Marine Regions where an assessment could be made in 2018, none of them met a 'no loss' target for biogenic marine habitats (biogenic 'made by organisms' eg algae, marine worms)[93].

Case study:

Eelgrass, Lewis Jefferies / WWF-UK

There are several seagrass restoration projects around Scotland that are supported and driven by Project Seagrass[44]. Seawilding[43] is a community-led marine habitat restoration project on the west coast that has restored 0.35 ha of subtidal seagrass habitat. Restoration Forth[17] is a WWF-led partnership with other organisations and local communities in the Firth of Forth, where seed planting at three locations aims to restore four ha of seagrass. Other community-led projects are carrying out baseline survey work in preparation for future active seagrass restoration.

Case study:



Cairngorms National Park, Ben Andrew (rspb-images.com)

Cairngorms Connect

Cairngorms Connect is the UK's largest habitat restoration project, covering 60,000 ha in the Cairngorms National Park. It has a 200-year vision that aims to improve and protect habitats such as native woodland, peatlands and rivers. Neighbouring landowners have united around a shared vision for landscape restoration, including collaborative deer control. This enables native woodland to regenerate, resulting in its marked expansion including the return of palatable species that are otherwise challenging to regenerate, such as Aspen. There are early signs that this is benefiting a wider range of woodland-associated species, including birds such as Willow Warbler and moths such as Coxcomb Prominent and Lesser Swallow Prominent. One of the key aspects of Cairngorms Connect is its focus on involving and collaborating with local people. Engaging with local communities is key to achieving wider conservation goals and ensuring that local people can benefit from the project. Cairngorms Connect works closely with local communities, including farmers and landowners, to develop conservation plans and initiatives that are compatible with their needs and interests. The project also provides opportunities for local people to participate in its conservation efforts through volunteering and citizen science programmes. These help to build a sense of ownership and pride in the local environment, while increasing public awareness of conservation issues.

Capercaillie, Ben Andrew (rspb-images.com)

Nature, climate and people

The nature and climate emergency requires urgent action, at scale, across all areas of society.

Climate change is already affecting people and nature in Scotland. These impacts will increase with more drought events, rising air and water temperatures, more frequent and intense storms, increased severe rainfall events, increased frequency of wildfires and sea level rise. Climate change acts as an impact multiplier, exacerbating other pressures on biodiversity such as land use change, exploitation levels and invasive species.

Scotland has adopted a target to reach carbon net zero by 2045, with interim targets of a 75% reduction by 2030, and 90% by 2040. There are associated targets for woodland expansion and renewable energy development. Currently, the land, including degraded peatlands and soils managed for agriculture, emits 50% of Scotland's net greenhouse gases.

This report confirms that Scotland is a highly nature-depleted country, and that losses of nature continue today. To combat biodiversity loss, the Scottish Government is committed to bring forward legally binding targets for nature restoration in 2024/5. The draft Scottish Biodiversity Strategy to 2045, its first five-year Delivery Plan and an Investment Plan reflect at national scale our response to the United Nations Convention on Biological Diversity Global Framework, agreed in Montreal and Kunming in 2022[20], and have the core aim of scaling up species recovery and ecosystem restoration to halt and reverse biodiversity loss. They go to public consultation in summer 2023, as this report is launched.

Nature restoration must work simultaneously and synergistically with mitigation of and adaptation to the impacts of climate change. Both must be achieved while meeting people's needs for food, energy, a sound economy and wellbeing through access to nature. Scotland's human population is projected to continue increasing until around mid-2033, peaking at 5.53 million. We also need to avoid taking action domestically that could lead to unintentional impacts on nature overseas, so-called 'offshoring' – for example, if we import food produced in ways that harms highly biodiverse landscapes in other countries.

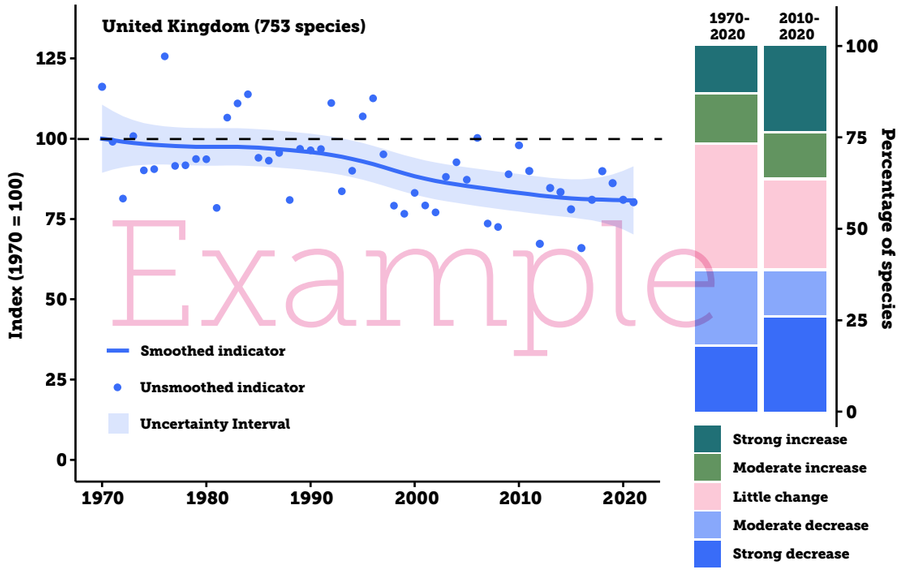
These questions represent a defining challenge of our times. There have been biodiversity targets before but we have nationally and globally failed to meet the majority of them. To fail again now in meeting nature and climate targets, or to frame and enforce those targets too weakly to ensure recovery, would severely impoverish future human generations and would risk a collapse of ecological processes on which the whole living world depends.

There is an appetite among Scots for progress. In a recent opinion poll[9], 96% of Scots thought that the natural environment is important to the country as a whole and 92% that it is important to them personally. However, 82% thought that Scotland's nature is currently in good condition. This reveals a significant issue around public understanding of the challenges facing nature in Scotland. The findings of this report highlight that shortcoming, and the importance of building the required levels of concern and determination towards progress. We do live in a nature-depleted country, and we are continuing to lose nature now, on our watch. But – testament to the incredible richness of the living world – we still retain astonishing and unique natural treasures in Scotland. We can and we must collectively act now: we have so much to lose if we don't.

APPENDICES

How to interpret this report

We have included this section to help you understand the different measures presented in the *State of Nature 2023* report and how they should be interpreted. For full details of the methods and how these measures were calculated, as well as caveats around interpretation, please refer to pages 188-194 of the main report.



Which data have we used?

- We present trends in abundance and distribution for terrestrial and freshwater species across Scotland, and trends in abundance for marine fish and seabirds.
- Abundance trends are based on changes in the number of individuals at a monitored site, a measure that reflects a species' population size. Distribution trends are based on changes in the number of sites where a species is present. Distribution trends may be calculated at different spatial scales, here we use 1 km^2 for terrestrial and freshwater invertebrates and 10 km^2 for plants and lichens.
- These records came from a wide range of sources, including national monitoring schemes and biological records.
- Abundance trends are for native species only. Distribution trends for invertebrates are primarily for native species but may include a small number of non-native species. Due to the small number of these species, their impact on the average trend lines is likely to be minimal[121]. Distribution trends for vascular plants include species introduced to the UK more than 500 years ago.
- We present assessments of national Red List status for native species.
- Details of our data sources and the species they cover are given at stateofnature.org.uk

How are distribution and abundance metrics related?

The status of species as measured by abundance is considered a key metric for conservation – providing information as to how species are faring and assessing the effectiveness of conservation measures or the impact of particular pressures. However, such data are taxonomically limited, and in contrast the volume of opportunistic species records[122] extends the taxonomic, spatial and temporal coverage of species datasets and analyses. Recent statistical developments have enabled greater use of these datasets for the estimation of species' distribution trends[123-125]. Distribution and abundance trends are often related, and there is evidence that they tend to operate in the same direction[126,127]. However, the relationship between the two measures of change can be complex. In particular, there is evidence that the magnitude of change in distribution trends is smaller than changes in abundance. This is because many species can show substantial variation in abundance without disappearing from sites or occupying new ones. Additionally, for some species or species' groups abundance and distribution trends move in opposite directions, but this is less common[128,129].

Green satin lichen, Jill Donnachie / WTML

What are the graphs telling me?

The measures we present, at a UK and individual country level, show the following:

- Change over time – Species indicator – The average change in the status of species, based on abundance or distribution data.
- Categories of change – The percentage of species in each trend category eg strong increase or little change.
- Extinction risk – An assessment of Red List status for each species occurring in that country.

Please note that our measures are not directly comparable with those presented in the previous *State of Nature* reports because the current report is based on an increased number of species, updated methods and, in some cases, different data sources.

Change over time – Species indicator

These graphs show indicators based on the abundance data and distribution data separately. Species indicator graphs show the average change in the status of species based on either abundance or distribution data. The shaded areas show a measure of uncertainty around the indicator.

Results reported for each figure include total percentage change in the indicator over the long term and the short term.

Categories of change

Each species was placed into one of three or five trend categories based on annual percentage changes. Results reported for each figure include the percentage of species that showed strong or moderate changes, and those showing little change, in each time period.

Thresholds for assigning species' trends to the categories are given in the Methods section of the main report. A small number of species did not have a short-term assessment, as data were unavailable for recent years.

Extinction risk

We summarised the Great Britain Red Lists to present the proportion of species in each threat category overall, and by different taxonomic groups. In each country we interpret existing Great Britain Red Lists, based on those species known to have occurred in a particular country, with the exception of Northern Ireland, where we used all-Ireland Red List assessments.

Results reported for each figure include the overall percentage of species assessed that are regarded as threatened with extinction from Great Britain or Ireland. This is the percentage of extant species, for which sufficient data are available, classified as Critically Endangered, Endangered or Vulnerable in the latest IUCN Red List assessments.

Official statistics

Where appropriate, trend figures from the official UK or UK country biodiversity indicators[130] are presented alongside the *State of Nature* 2023 analyses.

What time period does this report cover?

In general we show abundance trends in species from 1970 to 2021 and distribution trends from 1970 to 2020. We refer to this as our long-term period. Our short-term period covers the final 10 years of an indicator, often 2010 to 2020. Data availability means that some abundance and distribution indicators start after 1970.

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