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Environmental Standards Scotland

Baseline Evidence Review – Biodiversity and Ecosystem Resilience

(Strategy and Analysis)

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Contents

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1.0	ESS	Baseline evidence review of public sources accessed up to August 2022.	30/09/2002

Executive summary

This baseline evidence review provides a high-level summary of key published information about the current position, recent trends and performance and progress towards relevant targets and standards in biodiversity in Scotland.

Background

A series of rapid reviews of key evidence sources were undertaken to support the identification of environmental issues of most concern. These are where Environmental Standards Scotland (ESS) proposes to focus its initial analytical work.

Eight reviews were produced, covering the environmental categories of air; biodiversity and ecosystem resilience; climate change; cross-cutting environmental governance; land and soil; population, human health and cultural heritage; resource use and waste; and water. These categories are primarily intended to help Environmental Standards Scotland organise, manage and prioritise its work. They are based on those used in the Strategic Environmental Assessment and the Environmental Impact Assessment processes. Considering the evidence within each category provides a structure for assessment.

There will be overlaps amongst these categories and to minimise duplication, topics have been covered under what was considered to be the most relevant category. For example, information relating to the freshwater and marine environment is largely covered in the ‘Water’ review.

Rapid reviews were undertaken in each topic area, with a narrow scope of identifying key data sources and summarising what they tell us about how the environment is changing in Scotland. The focus was on National or Official Statistics and Annual Reports and their related data, mainly from Government and other national organisations. This enabled the review to obtain a high-level summary of current environmental conditions and to ensure confidence in the quality of the information.

The approach started with the data, considering whether Scotland is on track to achieve its current environmental targets and objectives. They are not intended to be detailed explorations of individual issues e.g. reasons for changes in abundance in any particular individual species. Similarly, they are not intended to provide exhaustive lists of relevant legislation. If a topic is not included, it is because it is

covered in another review or relevant published data was not found within the scope of the review at this point. However, the topic will still form part of ongoing horizon scanning activity and could be explored in the future with relevant organisations.

Future stages of analysis will consider whether performance trends relate to any issues of compliance with or effectiveness of environmental legislation and scrutinise the detail underpinning trends identified.

ESS' monitoring and analysis work will progress through a series of stages. This will range from horizon scanning to identify high-level areas of concern, through to a deepening analysis and understanding of how things are changing, the causes of this, and how policy and regulatory decisions affect this. All of the monitoring and analysis work will be focused on identifying areas where further investigation or use of ESS' powers may be necessary. The work will also support active investigations, and assessing whether the changes that have been made in response to ESS' recommendations or use of powers are having the desired impact.

As the analytical priorities are taken forward, it is likely that some will quickly be identified as not having any compliance or effectiveness issues that merit further analysis or investigation at this stage. These can then be returned to horizon scanning in case an issue arises in the future, and a new issue can be added to the list of those subject to more detailed analysis. The list of analysis priorities is expected to be dynamic and regularly updated. The evidence reviews, however, are a snapshot in time as of August 2022 and there is no plan for these to be updated on a regular basis.

Summary of key baseline evidence review findings

The World Economic Forum's 2022 Global Risks Report[1] identified biodiversity loss and ecosystem collapse as the third top global risk by severity over the next 10 years (after climate action failure and extreme weather events). Reporting on Scotland's Environment Strategy confirms, based on NatureScot's State of Nature Scotland report, that this is also reflected in Scotland where there has been a sustained net loss of biodiversity in the last five decades[2,3].

Protecting species and habitats is a key means of addressing biodiversity loss. More of Scotland's land is protected (17.6%) than other parts of the UK (e.g. 6.5% in

England). However, recent research reports have questioned whether protection is sufficient and whether more effective management is required.

Scotland is falling short of its target for 80% of features in protected nature sites (SSSI, SAC, SPA and Ramsar) to be in favourable condition (77.9% as at 31 March 2021). Progress towards the biodiversity strategy target of improving the condition of native woodland also appears to be insufficient with a decline from 68.1% of woodland features on protected sites in favourable or recovering condition in 2017 to 64.3% in 2021. Targets relating to woodland creation also appear to have been missed. On the other hand, progress has been made on acidification and eutrophication. The annual rate of peatland restoration has also been increasing although it will need to continue to do so to meet long-term ambitions.

Invasive species are the biggest reason for features being in unfavourable condition followed by overgrazing. Invasive non-native species (INNS) represent a pressure on biodiversity and ecosystems. Available indicators show an increasing spread of established INNS in Great Britain during the last six decades and no reduction in the establishment rate of new species. The State of Nature Report 2019 shows that despite recent progress in policy and legislation, there is evidence that the impact and threat from INNS is intensifying significantly in Scotland.

More generally, the most commonly identified range of pressures on biodiversity and ecosystems include agriculture / land use, climate change, invasive non-native species and pollution.

Biodiversity is a large and complex area. A wide range of evidence and analysis is available but, due to the complexity of the area and data challenges, further work would be required to understand where ESS should best engage in this area. In particular, it has been difficult to draw conclusions from the available data on the current status of wildlife crime and more analysis would be required to fully understand progress on mitigation and adaptation strategies.

Conclusions for initial ESS analytical priorities

This baseline review identified a wide range of possible issues for further analysis, including control of invasive species, management and connectivity of protected areas and deeper dives into particular pressures or individual species where there have been declines.

However, for the purposes of setting out initial analytical priorities, ESS will focus on:

- Biodiversity decline, with a particular focus on pressures and mitigation strategies.
- Control and impact of invasive non-native species.

ESS' proposed Strategic Plan describes how issues will be prioritised for further analysis according to a range of criteria, including:

- Importance – the size and risk of the potential effect on the environment and/or public health; the urgency with which improvement is required;
- Nature and Scope – recent trends in environmental performance; whether the issue of concern appears to be systematic and/or longstanding;
- Neglect – whether there has been action taken on the issue of concern, or further action is planned in the near future; and
- Added-value – the contribution we could make, considering whether other monitoring, oversight or scrutiny bodies are planning to take, or could take, action to address the issue of concern.

The biodiversity and ecosystem resilience analytical priorities take account of that scheme and recognise the importance of these issues. For example, the potential impact that biodiversity loss can have on the environment as well as the fact that there has been a sustained loss in biodiversity over the past five decades. In keeping with the prioritisation process, the contributions of other actors and the added value that ESS can bring to an area will also be considered, in deciding where to focus future work.

Although ESS intends to focus on three issues in the first instance, other issues will be retained on a list for potential future analysis and horizon scanning in line with the stages of monitoring and analysis work set out in the strategic plan.

Biodiversity and Ecosystem Resilience Baseline Evidence Review

1. Introduction

This baseline evidence review provides a high-level summary of key published information about the current position, recent trends and performance and progress towards relevant targets and standards in biodiversity in Scotland.

The Convention on Biological Diversity defines biological diversity as meaning *'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems'*[4].

2. Methodology

A rapid review of key evidence sources has informed this report. This has focussed on scanning across the topic area, identifying key data sources and summarising what they tell us about how the environment is changing in Scotland and whether environmental targets and objectives are on track to be achieved.

The scope of the work was deliberately narrow and was intended to provide a snapshot of the evidence rather than a fully comprehensive picture. Where ESS' initial assessment of the evidence has identified potential concerns or issues that warrant further scrutiny, more detailed monitoring and analysis will be considered.

The work focussed on published analytical reports and datasets, searching for relevant evidence by:

- using the term 'biodiversity' sometimes in combination with 'pressures', 'mitigation', 'solutions' and / or 'adaptation'.
- using the terms 'species' and 'habitat' sometimes in combination with 'protected', 'condition', 'connectivity', 'invasive' and / or 'native / non-native'.
- using the terms 'wildlife crime', 'ecosystem condition', 'ecosystem health', 'ecosystem services', 'natural capital'.
- having searched for the broad terms 'species' and 'habitat', sometimes specific searches were undertaken for particular types e.g. 'mammals' or 'woodland'.

- where necessary these terms were combined with ‘Scotland’, ‘UK’, ‘EU’ or ‘International’ to search for comparisons with other countries.

These terms were derived from ESS’ environmental categories and sub-categories. Specific searches of key organisations’ websites were also undertaken, based on knowledge and understanding of those active in the area. For biodiversity data this focussed on NatureScot, JNCC, Marine Scotland, Scottish Government, DEFRA, Environment Agency and Eurostat. There is some subjectivity in the choice of terms and organisations which may have an impact and was somewhat mitigated by consulting with key stakeholders on sources.

The focus of the reviews was on National or Official Statistics and Annual Reports and their related data, mainly from Government and other national organisations, to obtain a high-level summary of current environmental conditions with a tight scope which allowed the reviews to be completed in time to inform strategic plan development. Only publicly available information was considered. Individual research reports or grey literature on specific, detailed areas of the topic were not within scope. Evidence of issues relating to compliance with or effectiveness of environmental legislation was not the focus at this stage. It is envisaged that this will form part of future analysis activity on priority analytical areas.

The approach started with the data, considering whether Scotland is on track to achieve its current environmental targets and objectives in this area. They are not intended to be detailed explorations of individual issues e.g. reasons for changes in abundance or distribution of any one specific species. Similarly, they are not intended to provide exhaustive lists of relevant legislation.

Baseline evidence reviews have been undertaken in each of the ESS Environmental Categories and there are naturally some topics which could fall across a number of reviews. For example, many of the issues relating to the marine environment have been considered in the ‘Water’ review and covered this to a lesser extent here.

If a topic is not included, it is because it is covered in another review or no relevant published data was found within scope. However, the topic is likely to still form part of future horizon scanning activity and could be explored in the future with relevant organisations.

Initial drafts of the evidence reviews were shared with the ESS Board and with key identified analytical stakeholders to provide a proportionate check that no key sources had been missed and no information had been misinterpreted. Going forward into more detailed analytical projects and undertaking further horizon scanning, ESS expects to engage a wide range of experts, including academics and specialist organisations.

3. Legislative and policy background

Scotland's Biodiversity Strategy is made up of two parts:

- Scotland's biodiversity: it's in your hands (2004)[5]
- 2020 Challenge for Scotland's Biodiversity (2013)[6]

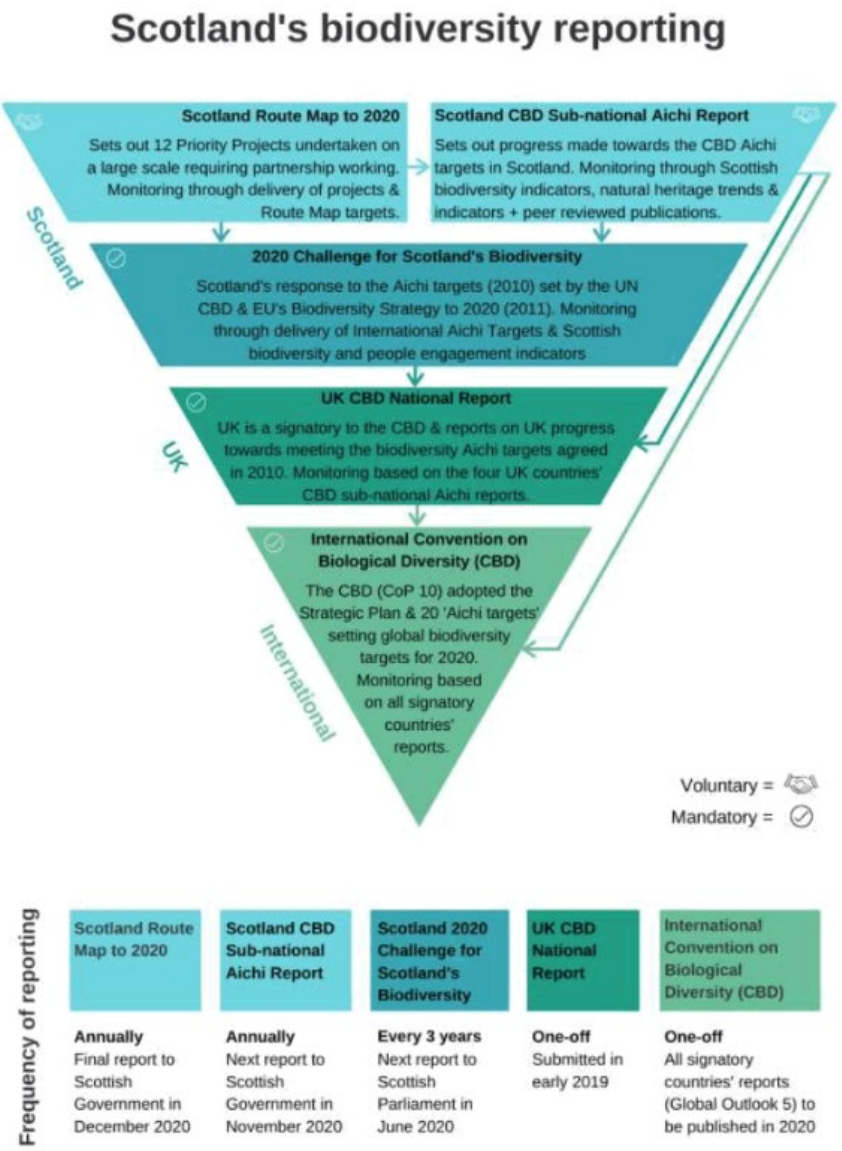
The aims of the 2020 Challenge are to:

- *"protect and restore biodiversity on land and in our seas, and to support healthier ecosystems.*
- *connect people with the natural world, for their health and wellbeing and to involve them more in decisions about their environment.*
- *maximise the benefits for Scotland of a diverse natural environment and the services it provides, contributing to sustainable economic growth.*

Progress against the strategy is monitored by a set of biodiversity indicators[7] which are referenced throughout this report where appropriate. In addition, Scotland's Biodiversity: A Route Map to 2020 (2015)[8] sets out the priority projects for delivery to improve the state of nature in Scotland, with delivery and reporting led by NatureScot. Together, these documents set out how Scotland intends to achieve the outcomes of the European Biodiversity Strategy for 2020[9] and the UN Aichi targets[10].

The Nature Conservation (Scotland) Act 2004 requires a progress report on implementation of the Scottish Biodiversity Strategy to be produced every three years and laid in Parliament. Five reports have been laid, in 2007, 2010, 2014, 2017 and 2020. The 2020 report covers the period 2017 to 2019[11]. It includes a useful diagram demonstrating the relationship between Scotland's biodiversity strategies and reporting and UK and international systems which has been reproduced below.

Figure 1: The relationships between global, European, UK and Scotland reporting on biodiversity



Source: Scottish Biodiversity Strategy: report to Parliament 2017 to 2019

A new Biodiversity Strategy is expected to be published by the end of 2022 with a delivery plan published within six months. The strategy is intended to set out the Scottish Government's approach to delivering Scotland's contribution to the goals of the new Global Biodiversity Framework which is expected to be agreed this year at COP 15. It is currently subject to consultation.[12]

In support of the new strategy, a new Natural Environment Bill is expected to be laid before Parliament in 2024 and lead to statutory targets for nature recovery.

However, there are a range of other strategies which all contribute mitigation / adaptation actions in relation to biodiversity, including the Scottish Government's Environment Strategy[2], Climate Change Plan[13] and Pollinator Strategy[14]. There are also a range of strategies that have important implications for biodiversity such as the Land Use Strategy[15], Forestry Strategy[16], Future Fisheries Management Strategy[17] and proposed Circular Economy route map[18] and legislation[19]. It is outwith the scope of this evidence review to make an overall assessment of progress or likely impact of the range of strategies.

A wide range of relevant legislation was found during the review. However, this baseline work was not designed to search for legislation in particular and therefore the information below is unlikely to be comprehensive. Further work would be required to produce a complete list but the below is provided to offer some legislative background.

Biodiversity was considered by Hough (2022)[20] in their research to identify environmental priorities and analytical requisites for Environmental Standards Scotland (ESS). Hough identified that there are many pieces of legislation covering aspects of biodiversity, including:

- Nature Conservation (Scotland) Act 2004[21]. The Act gave every public body a duty "to further the conservation of biodiversity" and committed Scottish Ministers to prepare a Scottish Biodiversity Strategy and to report regularly to the Scottish Parliament on its implementation. The duty relates to all biodiversity in any setting and is therefore not restricted to specific species, habitats, or locations.
- Wildlife and Natural Environment (Scotland) Act 2011[22] (known as the WANE Act). This sets out the approach to dealing with invasive non-native species. In addition, under the Act, every public body in Scotland is required to produce a publicly available report on compliance with the Biodiversity Duty. This must be completed once every three years.
- legislation related to planning and environmental impact assessments[23]
- marine legislation with a biodiversity component - Marine (Scotland) Act 2010[24], Marine and Coastal Access Act 2009[25], and The Conservation of Offshore Marine Habitats and Species Regulations 2017[26].

There are a wide range of other potentially relevant pieces of legislation, including the following highlighted by the Scottish Government on its biodiversity and wildlife web pages:

- Wildlife and Countryside Act 1981[27]
- Protection of Wild Mammals (Scotland) Act 2002[28]
- The Conservation (Natural Habitats Etc) Regulations 1994[29]
- secondary legislation relating to invasive, non-native species, including the Wildlife and Countryside Act 1981 (Keeping and Release and Notification Requirements) (Scotland) Order 2012[30] and Amendment Order 2012[31], (Exceptions to section 14)(Scotland) Order 2012[32] and Amendment Order 2012[33] and The Bee Keeping (Colonsay and Oronsay) Order 2013[34].
- Deer (Scotland) Act 1996[35]
- Protection of Badgers Act 1992[36]
- Salmon and Freshwater Fisheries (Consolidation)(Scotland) Act 2003[37]

Scotland has also signed up to international conventions such as:

- The protection of wetlands of international importance (Ramsar Convention)[38] and the protection of species and habitats of European importance (BERN Convention)[39].
- The Convention on Biological Diversity (CBD)[4]. At the Convention, 20 global Aichi targets[10] were set to be achieved by 2020, which will help us to focus on creating a greater variety of life within Scotland.

SPICe's Environment Subject Profile[40] also includes a range of useful background information on the biodiversity strategic and legislative landscape.

4. Baseline evidence for environmental areas

Species and habitats

Species – overall

Scotland is home to an estimated 90,000 animal, plant and microbe species[41]. Some species, like the Scottish primrose and the Scottish crossbill are found nowhere else in the world.

There are a number of different measures which consider the abundance and distribution of species. It is important to note that these can include a range of different species, monitored over different time periods and caution should be exercised in any comparisons between sources. Further analysis on the reasons for differences between measures may be valuable.

Scotland's national indicator on biodiversity, the State of Nature Scotland 2019[3] report and NatureScot's experimental statistics publication on marine and terrestrial species indicators[42], provide an over-arching view of progress in this area.

The national indicator is a headline measure which combines trends on three indices (marine abundance, terrestrial abundance and terrestrial occupancy) sourced from the experimental statistics and which are intended to reflect the overall status of Scottish biodiversity across marine and terrestrial habitats. Scottish Government have published a report on the background to the creation of the national indicator[43]. Naturally headline indicators can mask variation in trends between species and there is more detailed information in the experimental statistics and State of Nature reports which helps to explain this.

The national indicator is assessed as **performance maintaining**[44,43] based on the change between the most recent two years. This means that none of the individual indices were improving or worsening. Performance is stable for the index of marine abundance if the values are within 5 per cent, for the index of terrestrial abundance if within 6 per cent, and for the index of terrestrial occupancy if within 1 per cent.

In the very **short-term** the index of abundance of (11) marine species rose by 2.7% between 2015 and 2016 while the index of abundance of (371) terrestrial species fell by 4.8%, and the index of occupancy of (2,466) terrestrial species rose by 0.8%. However, over the **longer-term**, between 1994 and 2016 the indicator reveals a

sustained decline for both marine and terrestrial abundance. The index of abundance of marine species **fell** by 36% and of terrestrial species by 31%. The index of occupancy of terrestrial species **rose** by 24%. However, this reflects changes in species distribution which may, in part, be due to the northward colonisation of southerly species due to climate change.

These changes are against the background of a **sustained decline** in biodiversity between 1970 and 1994 as noted in the State of Nature Scotland 2019 report. One of the main conclusions of the report is that the abundance and distribution of Scotland's species has on average declined over recent decades and most measures indicate that this decline has continued in the most recent decade.

That report presents similar trends on abundance though with slightly different data. It preceded the development of the national indicator and, although uses many of the same data sources, the indices were developed to start in 1970 where possible, to include vascular plant trends and do not include many trends for marine fish that feed into the national indicator[43].

Between 1994 and 2016, the terrestrial abundance indicator for 352[1] species **declined** by 24%. Strong or moderate decreases in abundance were seen in 49% of species while 28% showed increases. In the last ten years to 2016, 48% had strong or moderate decreases while 33% had strong or moderate increases. The proportion of species defined as showing strong changes in abundance (either increasing or decreasing), rose from 45% over the long-term (1994 to 2016) to 62% over the ten years to 2016.

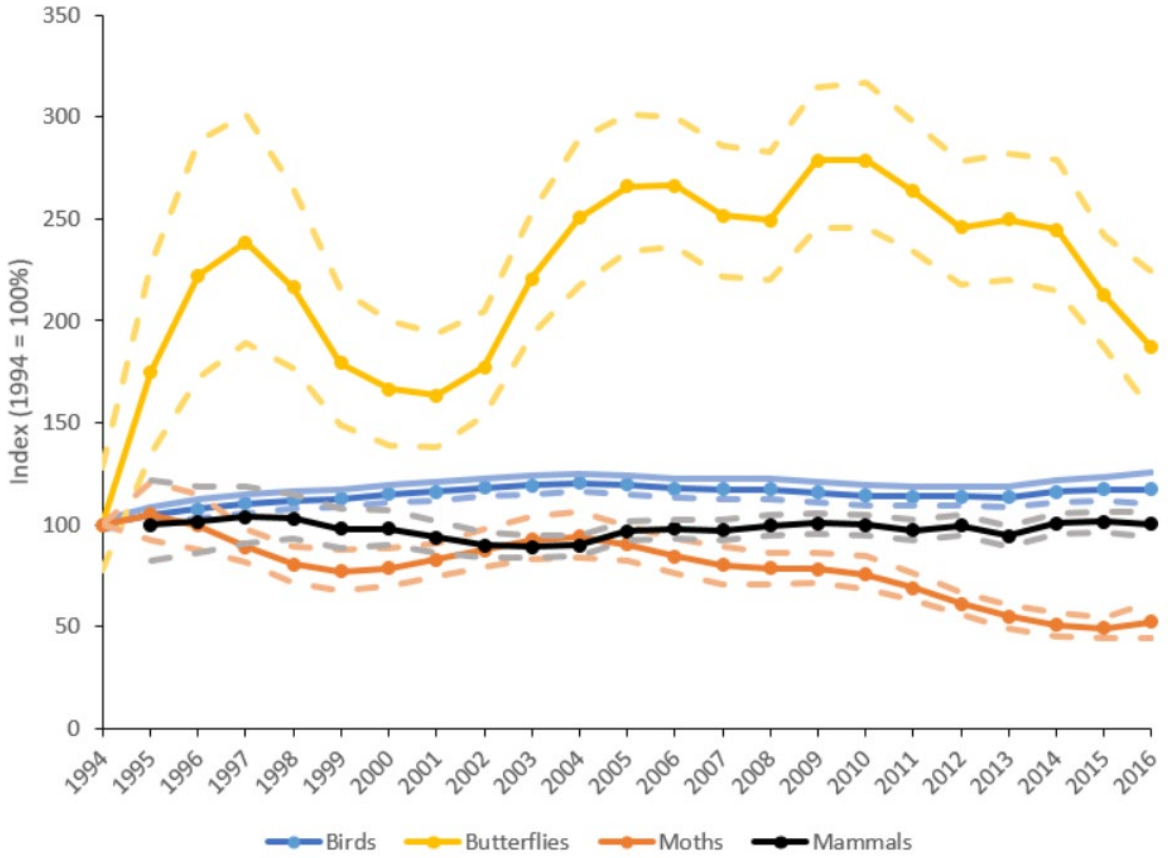
However, unlike the national indicator which shows that terrestrial occupancy rose over the period 1994 to 2016, State of Nature Scotland considers the occupancy of 2,970 terrestrial species and finds that there was a 14% **decline** in distribution since 1970, and a 2% decline since 2005. 33% of the species in the index have decreased in distribution while 20% have increased since 1970. In the last ten years to 2016, 37% had strong or moderate decreases while 30% had strong or moderate increases. Over the long-term, 23% of species showed a strong change in

[1] Species numbers are slightly different from the national indicator and this appears to be due to considering the longer-term trends rather than restricting to a 1994 baseline although this is not always clear and the difference between the two sources would need further exploration since it can led to some differences in conclusions.

distribution (either increase or decrease). Over the short-term this rose to 45% of species.

More detailed data indicates that these overall trends mask variation for different species, with some increasing in abundance and others decreasing. It is important to note that many of these indices of abundance and distribution are based on less than 1% of all relevant species in Scotland and therefore are not representative of the trends of all of Scotland's biodiversity. Different sources sometimes draw different conclusions on trend direction based on very similar data and this is highlighted where relevant.

Figure 2: Disaggregated terrestrial abundance indicator. Source: NatureScot Experimental Statistics



Birds (excluding seabirds)

NatureScot's Marine and Terrestrial Species Indicators: Experimental Statistics[42] (Figure 2) publication shows that the index of abundance for birds (113 species) rose to a value of 20% above the 1994 starting point by 2004, but has stayed stable since, ending **17% over baseline** in 2016. State of Nature Scotland found **no**

statistically significant change in bird abundance (143 species) since 1994 but a short-term decline of 7% between 2006 and 2016.

NatureScot's official statistics publication on Birds[45] finds that, of 66 terrestrial breeding bird species, 34 increased, 26 declined and 6 were stable in terms of abundance between 1994 and 2019. Considering the indicator of all terrestrial breeding birds, similar to the experimental data above, this increased steadily until the mid-2000s and then declined to fluctuate between 14% and 17% above its 1994 index value. In 2019, it was **14% over baseline**.

Based on the same data, the smoothed[2] woodland bird index (23 species) showed an increase of 59%. The biggest increases are for Chiff Chaff, Great Spotted Woodpecker and Blackcap. The biggest long-term decrease (-53%) is for Capercaillie. The only other species to decline more than 10% in woodland was Chaffinch. However, over the short-term the pattern is more mixed.

The smoothed farmland bird index (27 species) increased steadily up to the late 2000s, peaking at 24% above 1994 and currently 14% higher. The greatest long-term increases have been for Goldfinch (+363%) and Great Tit (+175%). Magpie, Whitethroat and Jackdaw populations on farmland also increased by more than 100%. However, there have been substantial long-term declines in other farmland birds including more than 50% for Greenfinch, Kestrel and Lapwing and 25-50% in Oystercatcher and Rook.

The smoothed upland bird index (17 species) shows a statistically significant decline of 18% and nine species are in significant long-term decline. Five species (Dotterel, Curlew, Black Grouse, Hooded Crow and Dipper) have declined by more than 45%.

The unsmoothed data show that, between 2018 and 2019, the all species farmland, woodland and upland bird indices were stable i.e. have not changed more than 5% since last reported.

NatureScot also publish data on the abundance of wintering waterbirds[46] covering both marine and freshwater species (41 species). Between 1975/76 and 2019/20, abundance decreased by 10%, peaking at 26% above the baseline in 1997/98 and

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[2] Smoothing is a statistical term describing techniques applied to prevent short-term population variability and sampling error having an undue influence. NatureScot uses unsmoothed data to assess short-term trends and smoothed data to assess long-term trends.

then steadily declining to 2013/14 after which it has had a period of fluctuation. Wader numbers (14 species) have declined since 1975/76 and are currently fairly stable since 2012 at around 50% of their baseline. Meanwhile goose (7 species), and ducks and swans (16 species) have increased by 263% and 3% respectively over the baseline to 2019/20.

JNCC publish indicators of the abundance of birds in the UK[47]. This shows a different picture at a UK level over a longer time period. Unlike Scotland where the above data from 1994 shows that woodland and farmland birds have been increasing, the UK data from 1970 indicates that bird species abundance in the UK is declining in the same habitats. ONS recently published the first assessment (experimental estimates) of species abundance in the UK[48] based on the UN system of environmental-economic accounting ecosystem accounting framework. This uses the same data as the JNCC information but is presented in a different way and shows a similar picture with *'bird species abundance in long-term decline in woodland, enclosed farmland and freshwater habitats'*.

DEFRA also publish annual National Statistics on wild bird populations in the UK[49]. This suggests that while there has only been a small decrease (10%) between 1970 and 2019 when all species were considered, this masks substantial change for some species. There have been particularly large decreases for farmland birds (index down 45% on 1970), woodland birds (down 25% on 1970) and seabirds (index down 24% on 1986). On the other hand, wintering waterbirds have increased by 86% between 1975/76 and 2019/20 although there has been a slow decrease from the peak in 1996. These trends are based on unsmoothed data although a similar pattern is seen in the smoothed trends covering 1970 to 2018.

Many of these indices are based on data from the Breeding Bird Survey run by the British Trust for Ornithology (BTO) on behalf of a partnership including JNCC and RSPB. The survey report for 2020[50] presented some challenges in analysis due to COVID. However, the 2019[50] report includes trends analysis for 69 species of bird in Scotland with enough data and show that 26 species increased over the long-term (1995 to 2018) while 12 decreased. There were statistically significant decreases in this period for Greenfinch (67%), Kestrel (61%), Curlew (59%), Lapwing (56%), Swift (52%), Hooded Crow (44%), Oystercatcher (39%), Wheatear (39%), Rook (34%), Starling (29%), Common Sandpiper (24%), and Pied Wagtail (22%). At the same

time there were statistically significant increases for Chiff Chaff (836%), Blackcap (539%), Tree Sparrow (426%), Great Spotted Woodpecker (399%), Goldfinch (224%), Whitethroat (130%), House Martin (110%), Stonechat (99%), Tree Pipit (80%), Reed Bunting (70%), Lesser Redpoll (67%), Raven (63%), Long-tailed Tit (63%), Magpie (62%), Wren (55%), Cuckoo (54%), House Sparrow (51%), Great Tit (48%), Jackdaw (47%), Song Thrush (38%), Blackbird (31%), Buzzard (30%), Dunnock (29%), Willow Warbler (25%), Yellowhammer (24%), Robin (22%).

The BTO's waterbird survey also provides evidence of population trends of non-breeding waterbirds across the UK. In Scotland, over the period 1993/94 to 2018/19, there have been decreases for Pochard (79%), Grey Plover (69%), Lapwing (58%), Bar-tailed Godwit (54%), Red-breasted Merganser (51%), Shoveller (48%), Turnstone (47%), Mallard (45%), Golden Plover (40%) and a range of others with decreases less than 40%. There have been large increases for British / Irish Greylag Goose (4,100%), Canadian Light-Bellied Brent Goose (1,540%), Canada Goose (767%), Black-tailed Godwit (693%) Svalbard Light-bellied Brent Goose (600%) and a range of others with increases less than 200%.

Butterflies

Butterflies are used as indicators of environmental change due to their rapid and sensitive responses to subtle habitat and climactic changes and reflection of the responses for other wildlife. NatureScot's experimental data publication (Figure 2) shows that the indicator for butterflies (25 species) has declined in recent years, and by 12% over the final year to 2016, but remains 87% **above its starting level** in 1994 having increased rapidly (but not uniformly) in the mid-1990s and through the 2000s. The State of Nature Scotland report found **no statistically significant change** in butterfly abundance (25 species) since 1979 but a short-term decline of 19% between 2006 and 2016.

NatureScot's official statistics publication on Butterflies[51], indicates that between 1979 and 2019, the all-species and generalist (14) species groups of butterflies have moderately increased. The specialist species group (6) shows a stable trend. Of the 20 species looked at, 8 have increased significantly (e.g. Small Pearl-bordered Fritillary), two have decreased (e.g. Grayling) and the remaining 10 show no significant change.

Annual Official Statistics on trends in butterfly abundance are published by JNCC[52] based on data from the Butterfly Monitoring Scheme and in partnership with Butterfly Conservation (BC), the UK Centre for Ecology and Hydrology (UKCEH) and British Trust for Ornithology (BTO)[53]. In 2021, around a third (34%) of butterfly species (56 assessed in total) in the UK showed a significant long-term decline compared to 29% showing a significant long-term increase. Despite this, over the last decade, most species are stable (6 with a significant increase, 1 with a significant decrease) although some species haven't recovered to the higher levels they showed in the early 1970s.

Over the long-term, in England (54 species assessed) almost twice (22 species) as many species showed a significant decline compared to significant increase (12 species) whereas in Scotland (24 species assessed), the number of species with significant increases (10) was greater than those with significant decreases (2) and in Wales (31 species assessed) the number of significant increases (8) and decreases (6) as similar. Some species are expanding their range in Scotland such as the Wall, Specked Wood and Ringlet.

Moths

NatureScot's experimental data (Figure 2) publication shows that the indicator of moth abundance (204 species) has **declined** by 48% since 1994. Over the longer term, State of Nature Scotland 2019 shows that there was a 25% **reduction** in moth species (175 species) since 1975 and a short-term reduction of 10% between 2006 and 2016.

Other pollinators

The UK has at least 1,500 species of insect pollinators including bumble bees, the honeybee, solitary bees, hoverflies, wasps, flies, beetles, butterflies and moths. Amongst bees, there are 25 species of bumble bee, 224 species of solitary bee and 1 honey bee species. In Scotland specifically, there are 23 species of bumble bee, 79 solitary bees and the honey bee. Evidence produced by DEFRA in 2014 found that of 26 species of bumble bee found in the UK, two are no longer present, six are found in a much smaller area of the country, one new species has arrived and one is being reintroduced[54,55].

The UK Biodiversity Indicator on the status (distribution)[56,57,58,59] of pollinating insects (148 bee species and 229 hoverfly species as an indicator of overall status) indicates that the long-term trend is **declining**. There has been a reduction in the index of 30% between 1980 and 2017. This indicates that pollinators are becoming more restricted in their distributions. The shorter-term decrease between 2012 and 2017 was 2% and assessed as little change. Over the long-term, 19% of species became more widespread and 49% less widespread. However, the trend was the reverse over the short term with more species increasing (46%) than decreasing (43%).

The hoverfly index indicates a gradual decline between 1987 and 2017, with the index ending 41% down on its 1980 value. More species have declined than increased in distribution over both the short and long-term (49% and 55% decreasing respectively; 44% and 15% increasing respectively).

The data for wild bees is more up to date and covers the period to 2019. This shows year on year fluctuation but a particular decline between 2007 and 2014. In 2019, it is estimated to be 9% lower than in 1980. Over the long-term more species have decreased (37%) than increased (24%) but over the short-term these are roughly equal with 40% decreasing and 42% increasing. The JNCC reporting on this indicator suggests that loss of foraging habitat, use of pesticides and weather effects may have had an impact though more research would be required to understand relative importance of each.

No data is currently available on the abundance of these other pollinators.

The technical annex to the Pollinator Strategy for Scotland 2017-2027 provides some further background information on Scotland's pollinators and pressures affecting them[14].

Mammals

NatureScot's experimental data (Figure 1) publication indicates that Scottish mammal abundance (9 species) has shown **little change** over the 22-year period from 1994 to 2016, ending level with its baseline. State of Nature Scotland 2019 presents data from 1998 for 9 species and indicates a 9% **decline** in abundance to 2016, 5% in the short-term from 2006 to 2016. Note that the two different sources

refer to the trend differently with one describing little change and the other describing a statistically significant decline based on very similar data.

Bats

The National Bat Monitoring Programme[60] produces official statistics on population trends for British bat species. Sufficient data exists for trends for 11 of Great Britain's 17 breeding bat species. All have been **stable or increased** since 1999. Stable species include Daubenton's Bat, Serotine, Noctule, Soprano Pipistrelle, Whiskered/Brandt's Bat and the Brown Long-eared Bat. However, prior to 1999 there had been significant historical declines in bat populations.

JNCC's smoothed indicator of abundance covers 11 of the UK's 17 breeding bats and shows a 47% increase between 1999 and 2019. This is driven by particularly large increases for the Greater Horseshoe Bat, Lesser Horseshoe Bat and the Common Pipistrelle. No species show a decline. ONS' experimental estimates of species abundance in the UK[48] also include bats with indices broken down by habitat type using similar data. This suggests that bats have been increasing in abundance across woodland (40% increase), farmland (36%) and urban (28%) habitats but decreasing (7%) in freshwater, wetland and floodplain areas between 1999 and 2020.

Marine species (excluding seabirds)

Scotland's Marine Assessment 2020 considers species diversity in the marine environment. Despite a lack of sufficient data meaning they could not report on trends for some species and habitats, the assessment was able to conclude that:

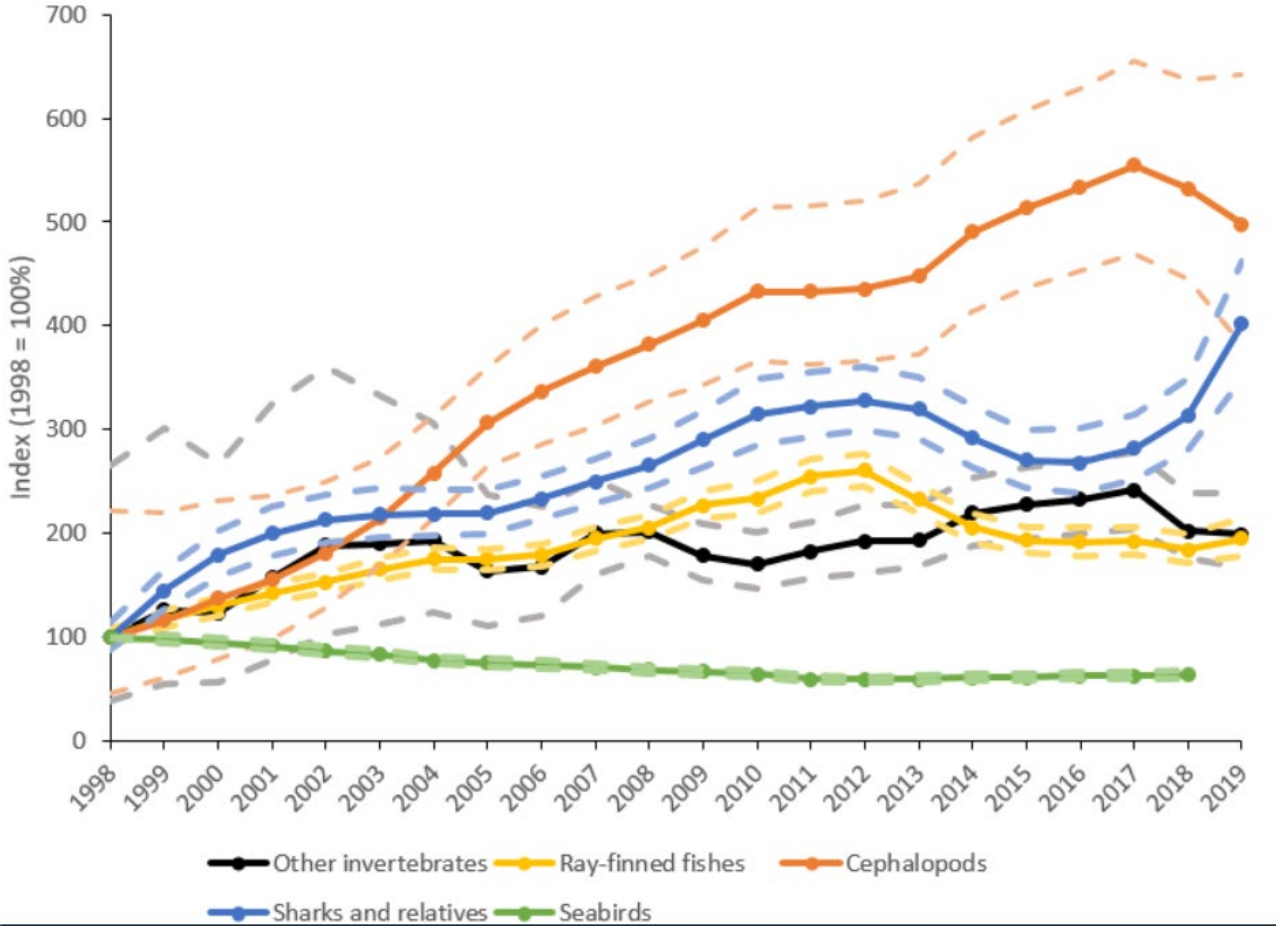
- the grey seal population has increased, particularly in the east. Meanwhile harbour seal populations are stable on the west coast but in decline in the North and East Coast and Northern Isles.[61] The more recent Scientific Advice on Matters Related to the Management of Seal Populations for 2021[62] supports this assessment although notes that western Scotland harbour populations are increasing in the central and northern sections of the West Scotland Seal Management Unit (SMU) and in the Southwest Scotland SMU. The UK's 2019 assessment of good environmental status[154] found that this had been achieved for grey seals but not for harbour seals in the Greater North Sea.

- Coastal bottlenose dolphins have increased in abundance on the east coast and expanded their range southwards. Harbour porpoise, white-beaked dolphin and minke whale populations in the North Sea are stable.[63] The 2019 UK assessment of good environmental status concluded that it was uncertain whether this had been achieved for cetaceans overall.
- The marine wintering waterbird index has increased between 1975/76 and 2017/18 with a peak in 2002/03 with recent years above the baseline level (around 131% currently).[46] This index uses a subset of the information referred to earlier in relation to NatureScot's wintering waterbird publication which covers both marine and freshwater birds.
- Stock abundance of nephrops in all areas of Scotland is considered to be healthy. Scallop stocks are stable or increasing in west Scotland and decreasing in east Scotland from a high level. Most crab and lobster stocks are fully or over-exploited.[64] The 2019 UK assessment[154] found that most stocks of shellfish had not achieved good environmental status.
- "Significant changes in the plankton community have occurred in some marine regions over the last three decades. The effects of these changes are not known but this observed ecological reorganisation could have an impact on the entire marine food web."[65]. The 2019 UK assessment[154] concluded that it was uncertain whether good environmental status had been achieved for pelagic habitats.
- There were no clear trends in deep sea fish diversity.[66] The 2019 UK assessment[154] found that, while these fish communities are recovering from past exploitation, good environmental status was not yet achieved.
- There was limited information on fish communities from inshore coastal waters except for 6 transitional waters monitored by SEPA as part of River Basin Management Planning. These were all assessed as having good ecological quality.
- The number of Atlantic salmon returning to Scottish coastal waters has declined over the last 50 years while the overall stock of sea trout is at its lowest level since 1952.

Scotland's Marine Assessment is a more comprehensive analysis than the high level summary data presented in the national indicator or in NatureScot's experimental

data publication (Figure 3). These show that the abundance of cephalopods (11 species, up 398%), ray-finned fish (147 species, up 95%), other invertebrates (6 species, up 99%) and sharks and relatives (37 species, up 301%) show a **significant increase** in average abundance since 1998.

Figure 3: Disaggregated Marine Abundance Indicator. Source: NatureScot Experimental Statistics



The Scottish Government's national indicator on the sustainability of commercial fish stocks also shows improvement. The percentage of key Scottish fish stocks fished sustainably increased from 34% in 2000 to 69% in 2020[3].

JNCC also reports on the percentage of marine fish (quota) stocks of UK interest that are harvested sustainably and the percentage with biomass at levels that maintain full reproductive capacity. They assess both as having positive trends in the

[3] Note that all years of this data are revised with every update and therefore this latest data from the National Performance Framework does not match what was published in the State of Nature report about the same measure.

long-term and the former also in the short-term while the latter on reproductive capacity has a negative short-term trend.[67]

Seabirds

State of Nature Scotland presents data showing a decline in the breeding seabird abundance indicator (12 species) between 1986 and 2016 of 38%. It notes that 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. This decline is also reflected in Scotland's Marine Assessment 2020 (a decline of 38% between 1986 and 2018 for 11 species) which found the decline to be steepest between 2000 and 2011 after which numbers and breeding success have been stable.[68] Both of these reports are based on data from JNCC's Seabird Monitoring Programme[69].

The UK's 2019 assessment of good environmental status found that this had not been achieved for breeding seabirds[154].

Red list species

11% of the 6,413 species found in Scotland assessed using the Regional Red List criteria have been classified as threatened with extinction from Great Britain – 265 plants (13%), 153 fungi and lichens (11%), 92 vertebrates (37%) and 132 invertebrates (5%).

The Convention on Biological Diversity's Strategic Plan for Biodiversity 2011 to 2020 included 20 targets, commonly referred to as the 'Aichi Biodiversity Targets'.[10] This included a target to prevent the extinction of known threatened species and improve and sustain their conservation status. Scotland recorded progress[70] on this as being insufficient, noting that two species of invertebrate (the Manx shearwater flea and the Caledonian planthopper) have not been recorded since the 1960s and are presumed extinct. The Scotland report also noted that further work is required to develop a Scotland priority species indicator.

Species - occupancy

In addition to abundance, NatureScot's experimental data publication also provides detail on changes in terrestrial occupancy (number of sites where a species is present, sometimes referred to as distribution) over time. This is available for a much

greater number of species than for abundance due to different sources (although it still represents a small proportion overall). This shows that:

- The occupancy of freshwater invertebrates (151 species) **decreased** on average in recent years but was still 198% above the 1994 baseline level in 2015.
- Terrestrial invertebrates (excluding insects, 343 species) show a similar pattern of recent **downturn** but the earlier increase was less substantial and so the line finishes 13% above the 1994 value.
- The average occupancy of terrestrial insects (1,104 species) has **increased** slowly since 1994, finishing at 26% above the baseline.
- Similarly, the average occupancy for bryophytes (218 species) ended 40% above the baseline.
- The indicator for lichens (650 species) has **fallen** by 14% since 1994.
- This data represents a small proportion of the relevant species found in Scotland and thus may not be representative of overall trends.

Given the numbers of species involved, these measures will mask changes for individual species. It has not been within the scope of this report to explore patterns within individual species or to determine why these changes are occurring unless the information is readily available. Future stages of analysis could consider the underpinning reasons for changes.

Habitats - overall

Some of Scotland's habitats are very rare, like coastal machair only found in Scotland and Ireland.

In the past, habitats have been defined according to the Phase 1 Habitat Classification[71] and the UK Biodiversity Action Plan Broad and Priority habitats. The JNCC published guidance on the Biodiversity Broad Habitat Classification in 2000[72] and this classification was used in the Countryside Survey 2007 which provides a key summary of Scotland's habitats. The Classification includes 17 terrestrial and freshwater types: broadleaved, mixed and yew woodland; coniferous woodland; boundary and linear features; arable and horticultural; improved grassland; neutral grassland; calcareous grassland; acid grassland; bracken; dwarf shrub heath

(heather moorland); fen, marsh and swamp; bog; standing water and canals; rivers and streams; montane habitats[4]; inland rock; and built-up areas and gardens.

The survey also reports on 8 of the UK's priority habitats: arable field margins; blanket bog; hedgerows; ponds; wet woodland; upland birchwoods; upland mixed ashwoods; and upland oak woods.

The 2007 Countryside Survey Report for Scotland[73] described Scotland's habitats and how these changed over time:

- the largest habitat in Scotland is bog at just over 2 million hectares (25.6%). This is followed by:
- acid grassland (983,000 hectares, 12.3%);
- coniferous woodland (956,000 hectares, 11.9%);
- improved grassland (906,000 hectares, 11.2%);
- heather moorland (894,000 hectares, 11.1%);
- arable and broad horticultural (534,0900 hectares, 6.6%);
- neutral grassland (461,00 hectares, 5.8%);
- broadleaved, mixed and yew woodland (251,000, 3.1%);
- fen, marsh and swamp (239,000 hectares, 3.0%);
- built-up areas and gardens (153,000 hectares, 1.9%);
- bracken (132,000 hectares, 1.6%);
- linear features (95,000 hectares, 1.2%);
- standing open waters (89,000 hectares, 1.1%);
- inland rock (84,000 hectares, 1.0%);
- montane (38,000 hectares, 0.5%);
- calcareous grassland (26,000 hectares, 0.3%); and
- river and broad streams (21,000 hectares, 0.2%).

Montane and inland rock make up a very small proportion of overall UK habitats. Around 90% of UK montane habitat is found in Scotland.

[4] The area above the former natural tree line. However, the JNCC guidance notes that since tree-line woodland has largely disappeared, this is now identified by the presence of artic-alpine species.

Between 1998 and 2007 there was a switch from arable (down 14%) to improved grassland (up 9%), an increase in broadleaved / mixed woodland (up 9%) reflecting new planting and diversification, and a decrease in coniferous woodland (down 7%), partly reflecting the felling cycle. Acid grassland increased by 8% replacing other habitats such as moorland and coniferous woodland.[74] Since 1990 there has been a large increase in the extent of bog habitats and a loss of heather moorland and fen, swamp and marshy habitats.

Nature Scot currently classifies 19 broad habitats within which there are 38 priority habitats. Priority habitats are those which are the most threatened and requiring conservation action and are statutorily required to be listed under Section 2(4) of the Nature Conservation (Scotland) Act 2004[21].

Since these definitions, the EU introduced a European Nature Information System (EUNIS)[75,76,77] and set out habitat codes in Annex I of the Habitats Directive, which it required Member States to use in habitat classification through the INSPIRE Directive[78]. This has been adopted by Nature Scot[79]. The EUNIS classification is used in the production of a habitat map of Scotland[80],[81] allowing international comparability. The map brings together habitat and land use data for analysis and policy development. A map of habitats and land at EUNIS level 2 is also available[82] and is expected to be used by NatureScot in Natural Capital assessments.

ONS recently published the first assessment (experimental estimates) of the extent of nature in the UK[48] based on the UN system of environmental-economic accounting ecosystem accounting framework. In 2019, 52% of landcover was enclosed farmland, 13% was woodland, 11% mountain, moorland and heath, 10% semi-natural grasslands, 7% urban, 5% freshwater, wetlands and floodplain and 2% coastal margins. The report indicates that across the UK urban environments have increased by 30%, freshwater, wetlands and floodplains by 25% and woodlands by 29% while mountain, moorland and heath decreased by 22% and enclosed farmland by 5% between 1990 and 2019. Land used for organic farming has decreased 32% between 2010 and 2020 with 3% of UK agricultural land being organic. This compares to an estimated 8% in the EU[83].

Scotland's environment web provides further summaries of Scotland's landscapes and habitats in a range of evidence papers produced in 2014[84] according to land

classes. It also includes an ecosystem health indicator on land cover[85] which describes a general trend for a greater proportion of heathland in North and West Scotland and cultivated land and grassland in the East and South. Woodland is widely distributed across the Scottish mainland. Even in traditionally built-up areas, there are areas of grassland, woodland, and surface waters[81].

Mountains and uplands

Mountains and uplands cover the largest area of Scotland (around 55% of land area according to the 2007 Countryside Survey) with a third being bog and the remainder a mix of acidic (rough) grassland, heather moorland, bracken, fen, marsh and swamp, inland rock and montane habitat. Scotland contains 90% of the montane habitat in the UK[86]. Near-natural habitats are very rare across Scotland and the rest of the UK[84]. Between 1990 and 2008, bog and bracken habitats increased while heather moorland and fen, swamp and marsh habitats decreased.

Assessments of upland condition have been carried out in 2005, 2010 and 2014. These found that the majority of features were favourable with conditions improving gradually over time. The 2014 assessment shows that uplands remain vulnerable to land management changes, atmospheric pollution and afforestation. As at 2014, 24% of Scotland's uplands lay within Special Protection Areas (SPAs), 16% in Special Areas of Conservation (SACs), 22% in Sites of Special Scientific Interest (SSSIs), 11% in National Parks and 3% in National Nature Reserves. 83% of protected upland features were in favourable condition (including unfavourable recovering) at 31 March 2022[87,88].

Lowland grasslands

Lowland grasslands cover a third of Scotland. However, much of this has been fertilised or improved for agricultural productivity meaning unimproved, species rich grassland has become one of our rarest habitats[89].

The ecosystem health indicators available on the Scotland's environment web includes information on High Nature Value Farming and Forestry (HNVFF). This refers to farming and forestry systems important for the environmental benefits they provide, including support for a range of habitats and species (such as butterflies and birds) considered to be of high nature conservation importance. Between 2007 and 2013, 40% to 44% of the total amount of agricultural land in Scotland was

estimated to be under High Nature Value farming (2.3 to 2.4m hectares). In 2013, the number of agricultural holdings determined to be of HNV farming status was estimated at 2,089 accounting for only 4% of holdings but 44% of agricultural area. The area of woodland determined to be of HNV status was estimated at 575,000 hectares in 2013, 41% of total woodland[90,91]. The Highlands made up the largest area of HNV farming while the Western Isles had the highest percentage of its own utilised agricultural area under HNV, at 77%.

Wetlands

Wetlands[92] cover a range of habitat types, including peatlands, fens, marshes and blanket bog. They cover large areas of Scotland where poorly drained soils, high rainfall and low temperatures combine to create permanently or frequently waterlogged areas. Blanket bogs (a type of peatland) cover 23% of Scotland's land area (compared to around 10% for the UK as a whole) though are a globally rare habitat[93,94].

Freshwater

Scotland has more than 30,000 freshwater lochs and a large resource of rivers and streams[95]. The Water baseline evidence review contains more information.

Woodlands

Woodland includes a range of habitat types such as broadleaved, mixed and yew or coniferous woodland and the extremely rare Scottish rainforest (Atlantic Hazlewood and Western Oakwood) found on the west coast and supporting a diversity of bryophytes and lichens.

Woodland cover overall had risen to an estimated 19% (1.5m hectares) of Scotland's land area by 2021, a big increase from only 4.5% in the early 1900s[96], 11.8% in 1980 and 16.4% in 1995-99[97]. As at 31 March 2021, the area of woodland in the UK was estimated to be 3.2 million hectares, representing 13% of total land area in the UK, 10% in England (1.3 million hectares), 15% in Wales (0.3 million hectares), 19% (1.5 million hectares) in Scotland and 9% in Northern Ireland (0.1 million hectares).[97] Conifers account for around one half (51%) of the UK woodland area, ranging from 26% in England to 74% in Scotland. The area of woodland on farms in the UK has increased from 0.8 million hectares in 2011 to 1.1 million hectares in 2021. Just over half of all farm woodland was in Scotland in 2021. A total of 10.66 thousand hectares

of new planting took place in Scotland in 2020-21, up from 4.76 in 2016-17 and mostly by the private sector. Meanwhile 9.17 thousand hectares were restocked in Scotland in 2020-21.

The percentage of woodland that is sustainably managed in Scotland has increased from 44% in December 2001 to 60% in March 2021. As at March 2021, Scotland has 46% of all UK woodland and 63% of its sustainably managed woodland[98].

No woodlands in Scotland can now be considered truly natural. Just under one-third is considered native woodland with the rest dominated by introduced species. The total area of native woodland in Great Britain is estimated to be around 1.51 million hectares (49% of all woodland in Great Britain) with England having the highest percentage of its woodland being native (68%).[97]

A number of Scottish Strategies include commitments or targets related to woodland. The Climate Change Plan 2013-2027 aimed to plant 100,000 hectares of new woodland in the decade to 2022 (equivalent to 10,000 hectares per year)[99], the update to the Climate Change Plan 2018-2032[5,13] aims to introduce a stepped increase in the annual woodland creation rates from 2020/21. This is also described in the Bute House agreement which indicates plans to increase the annual woodland creation targets to 18,000 hectares per year by 2024/25 and the annual native woodland creation target to 4,000 hectares.

The climate change plan monitoring report indicated that Scotland was on-track to deliver its 12,000 hectare milestone for 2020/21[100]. However, reporting by the Forestry Commission[97] suggests that, in fact, only 10,660 hectares were created although this may have been impacted by COVID restrictions. Data from the same report suggests that the target of 100,000 to 2022 was also missed although Scotland did achieve more than 10,000 hectares per year in each of 2018-19, 2019-20 and 2020-21.

[5] The Climate Change Plan sets milestones of 12,000 hectares created in 2020/21, 13,500 in 2021/22, 15,000 in 2022/23, 16,500 in 2023/24 and 18,000 in 2024/25.

Coastline

Scotland also has around 18,000 km of coastline. Sand dunes, cliffs, saltmarsh and machair are examples of coastal habitats. Machair is found only in Scotland and Ireland.[101]

Species and habitats - targets

Although progress has been made in some areas, assessments indicate that the UK will not meet most of the 2020 Aichi targets (20 targets set out in the Convention on Biological Diversity's (CBD) Strategic Plan for Biodiversity 2011 to 2020 and intended to address and mitigate global biodiversity loss)[102]. This includes those relating to species and habitats. However, NatureScot's assessment is more positive than for the UK as a whole. Its final assessment shows Scotland meeting 9 of the 20 targets but progress on the remaining 11 was insufficient to meet the target by 2020[70]. JNCC on the other hand shows that in 2018, five targets were on track for the UK with progress being made for 14[103]. UN reporting, shows that none of the Aichi targets was fully met globally although there are examples of progress with 6 targets being partially achieved[104].

Genetic diversity

Genetic diversity is a key part of the CBD definition of biological diversity and there is a specific Aichi target (number 13) to maintain it. Scotland's final report on the target indicates that it is assessed as being met. Although there is no internationally agreed metric, Scotland has been at the forefront of work to develop monitoring and has assessed 26 species according to a genetic scorecard[105]. This concluded that 14 species were at negligible genetic risk, eight at moderate risk and four at risk of severe genetic problems. The latter four cover the Scottish wildcat, ash, great-yellow bumblebee and the freshwater pearl mussel[106] which are respectively affected by non-native species, ash-dieback pathogen, land-use change and population decline.

JNCC also provide reporting on two UK Biodiversity Indicators relating to genetic diversity – covering animal and plant genetic resources. The first suggests that the average effective population size of native breeds at risk has decreased between 2000 and 2020 for pigs and horses but increased in the same period for sheep and cattle and all were above UN thresholds of concern. However, for one breed of goat,

four of horse, one of sheep and two of cattle, the individual effective population size was below this threshold.[107]

The second indicator considers the enrichment index, a proxy measure of plant genetic diversity. It considers the number of new accessions into UK germplasm collections and finds that while there is annual variability, since 1960 there has been an increase overall and this has been more pronounced since 2000 due to the efforts of the Millennium Seed Bank. Between 2013 and 2018, the index increased by 15%.[108]

Summary

Evidence suggests that biodiversity has continued to decline to 2016 (the most recent year of data for many indicators) following a sustained decline in biodiversity between 1970 and 1994. Based on the national performance indicators, the index of abundance of marine species fell by 36% and the index of abundance of terrestrial species fell by 31% between 1994 and 2016. However, the index of occupancy of terrestrial species rose by 24% although other sources suggest this has declined since 1970.

The picture varies by species and depending on the source and time period considered. For example, data suggests that overall bird abundance has not changed greatly since 1994 but that this masks real variations for individual species with significant declines for upland birds (particularly Dotterel, Curlew, Black Grouse, Hooded Crow and Dipper) and a more mixed picture for farmland and woodland birds with increases overall but some individual birds having big decreases (e.g. Greenfinch, Kestrel, Lapwing, Oystercatcher and Rook for farmland and Capercaillie for woodland). There have also been significant declines for moths, other pollinators and seabird numbers. On the other hand, the sustainability of commercial fish stocks seems to be improving from low levels.

Targets relating to woodland creation appear to have been missed although this may have been impacted by COVID.

A wide range of evidence and analysis is available but, due to the complexity of the area and data challenges, further work would be required to understand where ESS should best engage in this area and how statistics vary between different measures and reports.

Protected species and habitats

NatureScot provides descriptions of the range of protected designations available[109,110]. In Scotland, there are 1,422 sites of special scientific interest (SSSIs), 242 special areas of conservation (SACs), 162 special protection areas (SPAs), 51 Ramsar sites (wetlands of international importance, all of which are also either SSSIs, SPAs or SACs) and 244 marine protected areas (including marine SPAs and SACs and those SSSIs with intertidal components) of which 230 are for conservation purposes[111,112]. There are also 11 Special Areas of Conservation in UK offshore waters (Scotland), 2 National Parks, 40 National Scenic Areas, 43 National Nature Reserves and a range of other local designations such as country parks[110].

The European Union Council Directive 92/43/EEC[113] is intended to *"ensure the conservation of a wide range of rare, threatened or endemic animal and plant species"* while Directive 79/409/EEC[114] aims to *"protect all of the 500 wild bird species naturally occurring in the European Union".* These Directives led to the creation of Special Protection Areas (for birds), Special Areas of Conservation (for habitats, animal and plant species) and a list of European protected species. This was translated into Scottish legislation by the Conservation (Natural Habitats, &c.) Regulations 1994[115] which provides the legal framework for protected sites and for species requiring strict protection. The Regulations were amended following the UK leaving the EU to ensure that the requirements still apply.

In addition to the European sites, SSSIs are a statutory designation under the Nature Conservation (Scotland) Act 2004; Marine Protected Areas for nature conservation under the Marine (Scotland) Act 2010[24] and the Marine and Coastal Access Act 2009[25]; National Parks under the National Parks (Scotland) 2000 Act; and National Scenic Areas under the Planning etc. (Scotland) Act 2006.

Protected habitats – land area

There is currently a Scottish Government commitment to protect 30% of Scotland's land for nature by 2030, and highly protect 10%. The Global Aichi Targets (Target 11) set by the Convention on Biological Diversity also committed Scotland to have 17% of terrestrial and inland water areas and 10% of coastal and marine areas to be designated as protected areas by 2020[10].

Networks of protected areas currently cover 17.6% (1.4 million hectares) of Scotland's land area, compared to 6.5% in England (0.8 million hectares) and a UK average of 10.6% (2.6 million hectares) as at 31 March 2021[2,116]. This data covers SSSI, SPA, SAC and Ramsar wetland sites. The EU estimates that 19% of its terrestrial areas are legally protected Natura 2000 sites (SPA and SAC) ranging from 8.5% in Denmark to 37.9% in Slovenia[83].

JNCC also report data including National Nature Reserves, National Scenic Areas, and National Parks (though these are not primarily biodiversity designations) and this increases the figure to 29.6% (2.3 million hectares) for Scotland, compared to 27.8% 6.8 million hectares) for the UK as a whole, 26.4% in England (3.4 million hectares), 28.4% in Northern Ireland (0.4 million hectares) and 29.4% in Wales (0.6 million hectares) and these tend to be the primary figures used in reporting on UK Biodiversity Indicators[116] although this has attracted some criticism (see below). The EU estimates that 26% of its terrestrial areas are legally protected ranging from 13.9% in Ireland to 51.5% in Luxembourg[83,6].

Across the UK, the total extent of protected areas (including the wider landscape designations) on land has increased in the long-term (1950 to 2021) with no change in the short-term (2016 to 2021). However, there is some criticism that if the wider landscape areas are to be included in headline figures then they must deliver more for nature protection and restoration[117].

Protected habitats – sea area

Networks of protected areas covered 36.9% of Scotland's sea as at 31 March 2021, compared to 38.2% for the UK as a whole, 40.3% for England, 50.3% for Wales and 35.6% for Northern Ireland. However, these percentages mask the fact that Scotland has a much larger sea area to consider and actually it has protected by far the greatest area at 22.8 million hectares, compared to 9.3 million hectares for England, 1.5 million hectares for Wales and 0.2 million hectares for Northern Ireland. The total extent of protected areas at sea in the UK has increased in both the short and long-term. The EU estimates that 12% of its seas are protected by national designations and Natura 2000 sites, ranging from 1.98% in Italy to 45.38% in Germany[83].

[6] The data includes nationally designated protected areas and Natura 2000 sites.

Scotland's Biodiversity Route Map to 2020 had a target to incorporate 10% of seas in Marine Protected Areas and this was achieved in 2014.

The Bute House Agreement contains a commitment to designating a new suite of Highly Protected Marine Areas covering 10% of Scotland's seas. These are expected to include designations in both offshore and inshore waters and the aim is to achieve this by 2026 though achievement for off-shore requires the cooperation of the UK Government as this is not devolved.

Condition of natural features on protected nature sites

Scotland's national indicators[44] include a measure of the percentage of natural features on protected nature sites (SSSI, SAC, SPA and Ramsar) found to be in favourable condition. As at 31 March 2022, there were 1,880 protected sites in Scotland (although some of their boundaries overlap), which host a total of 5,590 designated natural features[88]. 77.9% were assessed as being in a favourable condition (including unfavourable recovering), 0.4 percentage points lower than in March 2021 and 1.9 percentage points higher than in 2007. Performance was assessed as maintaining on this indicator on the basis of the comparison with the previous year.

It is important to note that the 77.9% favourable figure includes 65.0% assessed as favourable, 6.5% assessed as unfavourable recovering and 6.4% assessed as unfavourable recovering due to management change[7].

Scotland has achieved the Aichi global target of 17% of terrestrial and inland water areas and 10% of coastal and marine areas being conserved. However, this is based only on the percentage area protected and Scotland had its own more stretching target focussing on the condition of these areas, requiring 80% to be in favourable condition (including unfavourable recovering) by 2016. As can be seen above, this target is not currently being met and there has been no significant improvement from 2010 (Figure 4 below). As a result, the final report on Achi progress[70] recorded this

[7] In relation to this category, the official statistics publication notes that 'in NatureScot's expert judgement the natural feature will in due course reach favourable condition'. Such feature are therefore counted as favourable until such time as a subsequent assessment verifies the condition or identifies further work needed.

Protected Areas target as having ‘insufficient progress’ despite achieving the area targets.

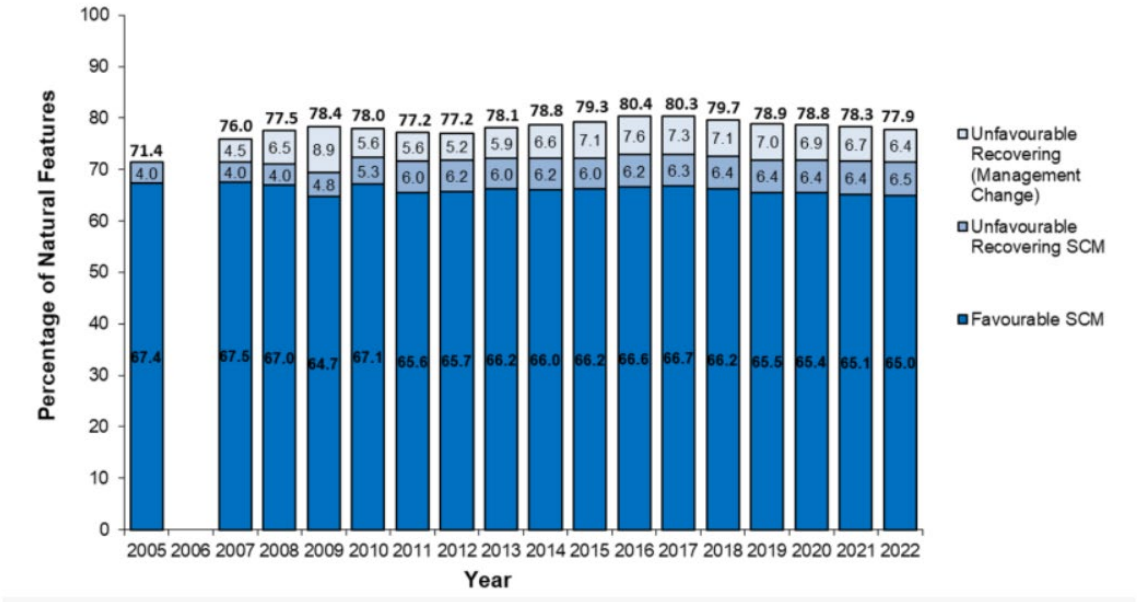
The data above is based on NatureScot’s Official Statistics publication which provide more detail[88]. By 31 March 2022, of the 5,590 designated natural features on protected sites, the condition of 5,301 had been assessed and form the basis of the Official Statistic. This baseline number can change as new assessments are completed. The change from 31 March 2021 was described as stable (less than 1 percentage point difference) but increasing (by 6.5 percentage points from 71.4%) over the longer-term from 2005 to 2021. The proportion of features in favourable / unfavourable recovering condition has decreased by 2.5 percentage points from 2016 when it peaked at 80.4%.

It is important to note that only 60 site condition monitoring (SCM)[8] feature assessments were completed in 2021/22 with NatureScot noting that site visits were limited due to COVID-19 restrictions and staff absences[88]. This follows 101 site visits in 2020/21 and 59 in 2019/20. The number of visits in 2019/20 was noted by NatureScot to be a planned reduction to allow investigation into future monitoring methods and new technologies. In 2018/19, 373 assessments were completed. There has been some criticism, for example from Scottish Environment Link, that the SCM has faced budget cuts and that the number of sites being monitored has declined[117].

There is considerable variation in the proportion of protected natural features in favourable / unfavourable recovering condition across different natural feature categories. Earth Sciences (including geological outcrops and landforms, fossil beds and caves) have the greatest proportion at 96.8% while species have the lowest at 72.3% and habitats were at 77.6%.

[8] Site condition monitoring is a rolling programme and how regularly features are monitored depends on their sensitivity and vulnerability e.g. an earth science feature may be assessed as little as every 24 years while lowland heath may be assessed as often as every 6 years.

Figure 4: Percentage of protected features in favourable condition. Source: NatureScot Official Statistics



Similarly, there is variation within habitat and species types. Protected marine habitats have the highest proportion in favourable / unfavourable recovering condition (96.1%) and protected woodlands (62.8%) the lowest. Protected wetlands and woodlands have seen a reduction by over 1 percentage point since March 2021 of 1.4 and 1.5 percentage points respectively while protected marine habitats have seen a reduction of 2 percentage points.

Vascular plants (93.7%) on protected sites have the highest proportion amongst species while marine mammals (58.6%) have the lowest.

Scotland's Biodiversity Strategy Routemap to 2020 has a target to increase the amount of native woodland in good condition. Reporting on the routemap[118] suggests progress is not sufficient with the percentage of woodland features on protected sites in favourable or recovering condition dropping from 68.1% as at 31 March 2017 to 62.5% as at 31 March 2019 and the latest data showing 64.3% as at 31 March 2021. Separate information from the woodland ecosystem health indicator suggests that in 2014, 39% of all native woodland was in satisfactory overall health for biodiversity i.e. where canopy cover was in the region 50-90%, where at least 90% of the canopy comprises native species, where herbivore impact is low or medium, where there are fewer than 3 invasive species present and where invasive species are not more than 10% of the cover[119,120].

The NatureScot data can be broken down to more detailed information on features[121]. This suggests that features in SPAs were less likely to be in favourable / unfavourable recovering condition (61%) than those in other protected designations (76% for Ramsar, 78% for SACs and 81% for SSSIs). Similarly, there are differences between protected habitat and species features. For example, 80% of supralittoral sediment features in protected coastal sites were in favourable / favourable recovering condition compared to 93% and 94% of littoral sediment and supralittoral rock features respectively[9].

Of the 60 site condition assessments made in 2021/22, 7 improved to favourable or recovering condition, 3 features were newly assessed as favourable and 26 deteriorated to unfavourable condition.

Amongst all those assessed as unfavourable, there is a group with no pressures on the protected area itself, or nearby, and yet the feature remains unfavourable. NatureScot comment that there are, therefore, factors outwith local management control that are influencing condition. This affects 428 natural features, with the majority being birds (399) and particularly seabirds (253). If these are included in the favourable percentage (in line with UK Biodiversity Action Plan reporting) then the overall percentage of favourable features increases from 77.9% to 85.9%.

There are differences in reporting methodology of site condition across the UK. England focuses on the percentage of protected area that is in favourable condition rather than the percentage of features in favourable condition as in Scotland. In England, 40.03% of the area of Special Protection Areas is in favourable condition and a further 49.44% in unfavourable recovering condition. For Special Areas of Conservation, these figures are 34.70% and 56.02% respectively, and for Sites of Special Scientific Interest they are 38.15% and 50.53%[122].

In 2021/22, NatureScot's official statistics on protected sites[88] publication showed that invasive species remained the biggest pressure (representing 21.2% of all negative pressures and having been constant at this level for a number of years),

[9] The review found a small number of differences between the data presented in the official statistics publication and the data on the protected sites website which could be investigated further. For example, the official statistics refer to 335 natural features in coastal protected habitat, 86.6% of which are in favourable (not including recovering) condition. Whereas the protected sites website has 334 (even though total number of all features matches) and 86.5%.

followed by overgrazing (17.6%, also constant for a number of years). The invasive species can be both native (e.g. bracken) and non-native (e.g. Rhododendron).

The report notes that *"Woodland and freshwater habitats are mainly adversely affected by non-native species such as Rhododendron or Japanese knotweed. Conversely, lowland grassland and coastal habitats are affected by the spread of invasive native species such as gorse, bracken and nettles".*

In terms of over-grazing, the report notes that "*this can be by wild herbivores such as deer, feral goats or rabbits; or farm stock; or a combination. Insufficient grazing to maintain the balance of species in the habitat has also been frequently identified as a pressure."*

Effectiveness of site protection

Two recent reports have raised concerns about whether protection is sufficient. A study published in the journal Nature[123] found that designation of protected areas alone does not necessarily bring benefits to species. Impacts vary greatly and protected areas need appropriate management to have the best results. Meanwhile, a report from the British Ecological Society on Protected Areas and Nature Recovery[124] found that 'the coverage of *effectively* protected terrestrial PAs could be as low as about 5% of UK territories'. Issues identified included insufficient funding, pressures inside and outside of boundaries and some protected areas not being designed to specifically prioritise biodiversity. The report suggests that the UK should be clear on the criteria needed to fulfil the 30% protection by 2030 target and that these should 'effectively protect nature in practice, and not merely exist as lines on a map'. This should be about 'transforming existing areas so that they can deliver for nature' with improved management and monitoring important.

ESS has not comprehensively reviewed evidence in this area and this may be an issue to consider in further analysis.

Protected species

The Habitat Regulations 1994[115] list a set of European protected animals and plants. Those which are present in Scotland can be found in a table compiled by NatureScot[125] which also includes those protected through other legislation.

Limited statistics were found in relation to protected species in particular beyond the information above on species as a protected feature within designated sites. However information is available on abundance and distribution of priority species at a UK level and on wildlife crime.

JNCC reports information on priority species[126]. These are defined as those appearing on one or more of the biodiversity lists of each UK country. The Scottish Biodiversity List[127] contains species that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland. It identifies where conservation action is needed, where negative impacts should be avoided, where a watching brief only is required and where communication is needed with the public. Across the UK the combined list contains 2,890 species which are highlighted as of conservation concern, while there are 1,947 on the Scottish Biodiversity List.

The UK index of abundance considers 224 of these species for which abundance trends are available. The indicator therefore includes a substantial number of species that, by definition, are becoming less abundant. By 2019, the index of relative abundance of priority species in the UK had declined by 61% since 1970 with 21% of species showing a strong or weak increase and 60% a strong or weak decline. Moths (84 species) have had the biggest decline, at 14% of their 1970 levels in 2017, while birds (103 species) have remained stable at 100% in 2019 of its baseline in 1970.

The UK index of distribution[128] of priority species considers 476 species for which distribution trends are available. Between 1970 and 2018, the UK index decreased, with a higher proportion of species decreasing in distribution than increasing. The long-term trend shows an overall decline of 4% which is not statistically significant and therefore the trend is considered as showing little or no change. Similarly, the short-term decline of 2% was not significant and the trend is assessed as little or no change. The bees, wasps and ants group experienced an overall decline, with an index value in 2018, 87% of that in 1980. These are counterbalanced by increases in bryophytes and lichens, where the index value was 61% higher in 2015 than 1970. Similar to the trend for abundance, moths have undergone the biggest decline with an index value in the final year 68% of the value in 1970. It is not clear what has caused these particular declines for moths.

Separate data for Scotland does not appear to be publicly available for either the abundance or distribution indicators of priority UK species although reporting on Aichi suggests there may be a plan to develop this.

Conservation status of habitats and species listed in the EU Habitats and Birds Directives

The European Union Council Directive 92/43/EEC[113] ("Habitats Directive") required member states to report on implementation every six years. The most recent report for the UK relates to 2019[129] and found that 45% (33 of 73 assessed species) were in favourable conservation condition, 33% were inadequate and 22% were bad. Of habitats, 82% (62 of 76 assessed) were in bad conservation condition while 11% were inadequate and only 8% were in favourable conservation condition. In total, the report indicates there were 93 species and 77 habitats listed in the Directives. The data indicates that for 20 species and 1 habitat the conservation status and trend in 2019 was unknown. For species this is around one fifth of the total and therefore could have an impact on the overall results. Scotland's country level contributions[130,131] to the overall UK report are published on the JNCC website and there has not been time within the scope of this review to study them in detail at this stage.

The reporting available shows that Scotland, and more widely the UK, have a low diversity of both habitats and species[132,133]. Scotland and UK are also notable in having almost ubiquitous 'bad' conservation status for all habitats[134]. Under the Habitats Directive, Scotland is dominated by two habitat types: grasslands and meadows; bogs, mires, and fens with over 70% of these considered to have bad conservation status. In contrast, the conservation status of individual species indicates that more than 60% of reports are of good status[135]. Trend analysis indicates that habitat conservation status in Scotland is fairly stable[136] but on the cusp of degradation while trends in species conservation status show stronger levels of stability[137].

Directive 79/409/EEC[114] ("Birds Directive") has similar reporting requirements. The 2019 UK report[138] found that over a consistent time period (1989 to 2009), 44% of bird species had a decreasing short-term trend in terms of population size while 34%

were increasing and 21% were stable. On the long-term trend, 36% were decreasing, 53% increasing and 12% stable.

Wildlife crime

In the Bute House Agreement[139], the Scottish Government set out its aim to review the wider species licensing system and notes that urgent action is needed to tackle wildlife crime.

In terms of wildlife crime in Scotland, during 2019-20, 196 offences related to wildlife[140] were reported by the police. This was an increase of 13% on 2018-19 when 171 offences were reported but a significant decrease on 236 in 2017-18. Crimes against birds (e.g. poaching of game birds) remained the most commonly reported type of crime (36 offences) though had a 22% reduction from 2018-19 (46 offences) before which it had been relatively stable. In 2019-20, offences relating to hunting with dogs were joint most commonly recorded by the police, increasing from 22 in 2018-19 though this type of crime has fluctuated in recent years.

Most wildlife offences were recorded in the North East (32), Highlands & Islands (31) and Lothian & Borders (30). Dumfries and Galloway recorded almost half of all bird offences (16 of 36).

The number of cases received by the Crown Office and Procurator Fiscal Service (COPFS) continued to decrease. 49 were received in 2019-20, down from 54 in 2018-19 and 98 in 2014-15. No action was taken in 23 cases, 14 were dealt with by alternative to prosecution (with the majority being warning letters) and 12 went on to prosecution leading to 5 convictions.

Similarly, fewer people were proceeded against in Scottish Courts (12) where wildlife crime was the ‘main charge’ than in previous years. Conviction rates are presented as five year averages due to small numbers and the rate was 85% overall, ranging from 74% for hunting with dogs to 100% for birds. The most common punishment was a monetary fine as in previous years.

Summary

More of Scotland’s land is protected (17.6%) than other parts of the UK (e.g. 6.5% in England). However, recent research reports have questioned whether protection is sufficient and whether more effective management is required.

Focusing on protected nature sites (SSSI, SAC, SPA and Ramsar), there are 1,880 protected sites in Scotland, hosting a total of 5,590 designated natural features as at 31 March 2022. Over three quarters of features within these (77.9%) were assessed as being in a favourable / unfavourable recovering condition, up from 71.4% in 2005 but lower than the peak of 80.4% in 2016. The 2022 figure is short of the biodiversity strategy target of 80% in favourable condition by 2016. This measure was also considered in the final report on Aichi and reported as having 'insufficient progress' despite achieving the Aichi area-based targets.

A smaller number of sites were subject to condition monitoring in 2019/20, 2020/21 and 2021/22 compared to previous years and, while 2020/21 and 2021/22 are likely to have been affected by COVID-19, further work to understand the rationale and plans for future monitoring may be worthwhile.

Progress towards the biodiversity strategy target of improving the condition of native woodland also appears to be off track with a decline in the percentage of woodland features on protected sites in favourable or recovering condition from 68.1% in in 2017 to 64.3% in 2021.

Invasive species are the biggest reason for features being in unfavourable condition followed by overgrazing.

At a UK level, the abundance (number of individuals of a species) of priority species continues to decline since 1970 with priority moths having the biggest decreases while priority birds have remained stable. Distribution (number of sites where a species is present) of priority species is viewed as showing little or no change although certain groups, such as moths (biggest decrease) and bees, wasps and ants experienced an overall decline while others such as bryophytes and lichens increased.

It is difficult to draw conclusions from the available data on the current status of wildlife crime although the joint Scottish Government and Scottish Green party agreement indicates that urgent action is needed.

Invasive non-native species

Invasive non-native species (INNS) are those that have been introduced to a country and cause damage to the environment, economy, health and lifestyles. Whilst there are a large number of non-native species in the UK, only 10-15% of these cause significant adverse impacts and are considered invasive[141]. In general, aquatic species are often more invasive than terrestrial species, animals tend to be more invasive than plants. Invasive non-native species represent a pressure on biodiversity and ecosystems and are a major driver of biodiversity loss globally. It is estimated that INNS may cost up to £2bn each year across Great Britain, and around £300 million in Scotland alone[142]. Some such as giant hogweed can also affect human health and others like Japanese Knotweed can have significant economic impacts due to the cost of eradication[143].

JNCC monitors pressure from INNS, considering changes in the number of INNS established across 10% or more of the land area of Great Britain, or along 10% of more of the extent of its coastline[144]. Their data shows that there are 3,248 non-native species in Great Britain (over 900 in Scotland) and of these 2,016 are classed as reproducing in the wild. 194 non-native species are considered to be exerting a negative impact on nature biodiversity (47 freshwater species, 39 marine species and 108 terrestrial species), of which the majority (187, of which 104 are established across 10% or more of the land or coast) are established and breeding in the wild.

The available indicators show an increasing spread of these established INNS across terrestrial, freshwater, and marine (coastal) environments in Great Britain during the last six decades – with northwards shift a common pattern. They also show no reduction in the establishment rate of new non-native species. The State of Nature report 2019 assesses that despite progress in policy and legislation (such as the Great Britain INNS strategy[145] and the Wildlife and Natural Environment (Scotland) Act 2011[22]), the impact and threat from INNS is intensifying significantly in Scotland. The final report on the Aichi targets also indicated that insufficient progress had been made on the global target relating to invasive, non-native species both in Scotland and in other countries.

Scotland's Environment[146] encourages reporting of invasive non-native species via citizen science. It describes ten non-native species of concern: North American

Signal Crayfish, Zebra Mussel, Killer Shrimp, New Zealand Pigmyweed, Muntjac Deer, American Skunk Cabbage, Raccoon, Ruddy Duck, Chinese Mitten Crab, and Slipper Limpet. Most of these species are not currently in the wild in Scotland while others are, but only in localised populations. The public is asked to report sightings so that any issues can be tackled early.

NatureScot[147] reports four invasive plants as causing the most damage: rhododendron, Japanese knotweed, giant hogweed, and Himalayan balsam. American skunk cabbage and giant rhubarb have the potential to be invasive in certain circumstances.

The State of Nature UK 2019[102] report highlights examples of instances of INNS causing threats to Scottish biodiversity. The use of non-native pine species in productive forestry in the UK has led to the introduction of two strains of the *Dothistroma septosporum* fungus into Scotland. These are a threat to native Scot's pine, both directly through infection from these exotic fungi strains and indirectly potentially through hybridisation between the non-native and native *Dothistroma* species. This risk of hybridisation between an endemic species and an exotic species that are closely related can also risk effective extinction through the loss of the native species unique genetic identity, as is currently the case with the Scottish wildcat.

The Scottish Marine Assessment 2020[148] reports that no Scottish marine regions are confirmed free of non-native species. Three regions (West Highland, Argyll and Clyde) are assigned a red status as a result of having established populations of high-impact non-native species. A further six have amber status. North East and North Coast had insufficient information to assess.

The Biodiversity Observation Network (GEOBON) are developing an indicator[149] on the rate of spread of invasive alien species (another term for INNS) which may prove useful in the future if it is adopted widely.

In addition to non-native species, there are also instances of native species being stated as a pressure on biodiversity, particularly related to designated site management. For example, bracken and deer can cause a significant impact on some habitats in Scotland, due to competition with native flora or grazing pressure. However, native species are not generally considered to be invasive in the same

way as for non-native species and are not included in the definition used in legislation, therefore an assessment of progress in this area would require further work.

Summary

INNS represent a pressure on biodiversity and ecosystems. Available indicators show an increasing spread of established INNS in Great Britain during the last six decades and no reduction in the establishment rate of new species. The State of Nature Report 2019 assesses that despite recent progress in policy and legislation, it is evidence that the impact and threat from INNS is intensifying significantly in Scotland.

Ecosystem condition and services

Ecosystem health indicators

One of the underpinning themes of the Scottish Biodiversity strategy is an ecosystem approach, recognising that nature provides us with many services and benefits, such as air, water, food, health and wellbeing.

Scotland's Environment website presents a range of ecosystem health indicators[150] covering condition, function and sustainability or resilience. Condition indicators are covered by other sections (e.g. condition of protected sites, species abundance) or other baseline evidence reviews (e.g. freshwater condition in the 'Water' review and soil carbon in the 'Land and Soil' review) and are not repeated here. Similarly many of the sustainability indicators are captured elsewhere (e.g. soil sealing under 'Land and Soil').

Function indicators aim to measure *"the extent to which ecosystems retain their natural function and so have the capacity to deliver a range of benefits"*. Two available indicators focus on habitat connectivity and acid and nitrogen pollution. These are discussed further below.

Scotland's National Marine Plan[151] includes, as strategic objectives, the EU's Marine Strategy Framework Directive Good Environmental Status Descriptors[152]. There are 11 objectives covering a range of issues including biological diversity and non-indigenous species. An assessment of progress has been made at a UK level[153]. Here the descriptor for biological diversity has been broken down to 6 different species / habitats and therefore the 11 descriptors translate into 15 overall assessments.

The progress report shows that 4 of the descriptors are considered to have been achieved (eutrophication, changes in hydrological conditions, contaminants and contaminants in seafood). A further 2 are considered to have been partially achieved with an improving trend since 2012 (seals and food webs) while 3 have been partially achieved with a stable trend (cetaceans, pelagic habitats and the input of anthropogenic sound). However, birds, fish, benthic habitats, non-indigenous species, commercial fish and shellfish, and litter are not considered to have achieved good environmental status although the trend for fish and commercial fish and shellfish is considered to be improving[154].

Marine issues are considered in more detail in the Water baseline evidence review.

Habitat connectivity

The Millennium Ecosystem Assessment identified habitat loss and fragmentation as being one of five direct drivers of biodiversity loss[155,156]. NatureScot produce a connectivity indicator[157] which considers how well species can move from one habitat patch to another based on their dispersal abilities and the intervening land cover. There is a great deal of variation in connectivity across Scottish catchment areas and habitat types. For example, the connectivity (equivalent connected area as a percentage of the total habitat area) of fen / marsh / swamp habitat ranges from 9.9% to 34.4% across Scotland while semi-natural woodland ranges from 3.4% to 9.5%.

Scotland's Biodiversity Strategy has a target to improve connectivity between habitats and ecosystems. The most recent progress report indicates that Scotland was on track to achieve the target through developing an 'integrated habitat opportunity mapping for Central Scotland' and a project to improve habitat condition and connectivity at 10 landscape clusters of 40 sites across the Central Scotland Green Network[158]. However, it did note that plans to develop a national ecological network had insufficient progress.

JNCC also produce an experimental indicator on connectivity at a UK level. This suggests that for UK butterflies (33 species), functional connectivity has slightly increased (by 10%) between 1985 and 2012 with most of the increase occurring in the short term from 2000. For woodland birds (29 species) there has been a decrease (of 34%) in the same period, mostly occurring from 1999. These overall trends mask differences for individual species. Between 1985 and 2012, 33% of butterfly species increased in functional connectivity while 19% decreased.

NatureScot also have a project underway to map Scotland's pollinator habitats which may offer useful information in the future[159].

GEOBON are developing an indicator[160] on protected area representativeness and connectedness which may prove useful in the future if it is adopted widely.

Acid and nitrogen pollution

Acid and nitrogen pollution can lead to acidification and eutrophication[161,162]. This data is based on critical loads – thresholds for these pollutants above which significant harm to sensitive habitats may occur. Around 30% of UK land is sensitive to acidification and around 30% to eutrophication (with some areas sensitive to both). However, these figures are much higher in Scotland at 53% and 54% respectively.

Since 1980, there has been a marked decline in the exposure of ecosystems to acidification across Europe. The UK data is interpreted as showing that the largest reduction in the area of acid-sensitive habitats with exceedance of acidity critical loads is in Scotland, where it reduced from 74.4% in 1996 to 24.4% in 2018 and is forecast to continue improving. Scotland also has lower levels of acidification exposure than other parts of the UK - 24.4% of acid sensitive habitats had exceedance of critical loads in Scotland in 2018 compared to 59.8% in England, 78.4% in Wales, 68.9% in Northern Ireland and 40.4% for the UK as a whole. However, given that a higher share of its land is sensitive to acidification, the actual areas exceeded are larger than Wales and Northern Ireland and similar to England at around 10,400 km^2 in both Scotland and England. Scotland also has the lowest acidity average accumulated exceedance in every year. Scotland also has a lower percentage of protected sites (SSSIs, SACs and SPAs) having exceedances than other parts of the UK at around 50% compared to 70% in other countries (except SSSIs in England which is at 57% exceeded).

When comparing values across Europe and the UK, Scotland also has low levels of nitrogen deposition, broadly comparable with other countries like Norway and Sweden. The largest reduction in the UK in the area of nitrogen-sensitive habitats with critical load exceedance was in Scotland, falling from 59.4% in 1996 to 35.2% in 2018. In all years, it has the lowest percentage of habitat area with nitrogen exceedances. However, given the much larger share of its land which is sensitive, the area exceeded (15,195 km^2 for 2018) is similar to England at 18,670 km^2. Scotland also has the lowest nitrogen average accumulated exceedance in every year. Between 78.6% and 98.0% of designated sites in England, Wales and Northern Ireland currently have exceedances compared to 74% to 81% in Scotland.

Natural capital

Ecosystem health has links to services (the benefits people get from ecosystems, such as provisioning of clean drinking water and the decomposition of waste) and natural capital (elements of the natural environment that provide valuable goods and services to people, such as the stock of forests, water, land, minerals, and oceans)[163].

Two indicators relating to natural capital accounts are included in the monitoring framework for the Scottish Government's Environment Strategy[164,165,166]. The latest data presented on the monitoring framework shows that:

- The annual monetary flow of services from Scotland's natural capital (excluding fossil fuels) has been increasing since 1999. Natural capital accounting values goods and services provided by nature, to estimate the benefits that these natural assets provide to humanity. In 2018, the annual monetary flow was £4bn, nearly triple the £1.4bn in 1998 (the start of the time series). This was largely driven by an increase in the amount of energy produced from renewable sources as well as an increase in the level of timber production and in the number of hours which people spend on outdoor recreation.
- Overall, the capacity of Scotland's terrestrial ecosystems to provide benefits to people has increased slightly since 2000, following decades of decline, but individual indicators within the natural capital asset index tell a more nuanced story. For example, the condition of heathland, and peat, mire and fen habitats have all improved and are likely to continue to do so given plans for further restoration. However, the condition of woodland Sites of Special Scientific Interest continues to decline. A back-casting exercise also suggests that natural capital in Scotland is at low levels when considering long-term trends, and declined significantly between 1950 and 1990. Despite recent improving trends, the potential of Scotland's habitats to contribute to wellbeing remains a long way below historic highs.

ONS have also published woodland natural capital accounts which value the ecosystem services from woodland for England, Scotland, Wales and Northern Ireland[167]. This shows that the value of ecosystem services from woodland in

Scotland is estimated to be £1.2bn in 2017 with carbon sequestration representing 44% of this. This compares to £1.6bn for England, £320m for Wales and £100m for Northern Ireland. The value of timber and wood fuel to Scotland was estimated to be £165m in 2017, around 60% of the value of UK timber and wood fuel. The average per person spend per visit to woodland in Scotland has reduced over time (although more visits are taking place) and is less than in England.

Nature-based solutions to climate change

The Scottish Government's Environment Strategy includes three indicators of nature based solutions to climate change[168]. This recognises that the climate and nature crises are intrinsically linked and nature-based solutions have the potential at a global level to achieve around a third of the mitigation effort needed to deliver the Paris Climate Agreement:

- The first indicator measures the area of woodland created each year in Scotland. The total area of woodland in Scotland in 2020 was 1.467 million hectares, around 19% of total land area. Annual targets have been set for the number of hectares of woodland to be created each year – rising from 12,000 hectares created in 2020/21 to 18,000 hectares created in 2024/25. Progress on this indicator has been covered earlier in this report.
- The second concerns the overall ecological condition of woodlands based on evaluating fifteen individual criteria. The vast majority (94%) is in intermediate condition (which should not be taken as implying acceptable or sustainable and a significant proportion require action to prevent condition declining). 1% is assessed as favourable and 5% as unfavourable. The main reason for woods falling into unfavourable or intermediate condition is due to fragmentation, low levels of older trees and of veteran trees.
- It is estimated that 80% of Scotland's 1.9m hectares of peatland is degraded. Degraded peatland can become a net source of carbon emissions and restoration is important for maintaining the health of the ecosystem and retaining the carbon stored within as well as having important biodiversity benefits. 24,990 hectares were restored between 2012-13 and 2019-20. The annual rate has been increasing but will need to continue to do so to meet the long-term ambition to restore 250,000 hectares of peatland by 2030.

Summary

Further analysis is required in this area to build a more complete picture of ecosystem condition, including connectivity. However, there are indicators of natural capital accounting which value the goods and services provided by nature to estimate the benefits that these provide to humanity. These indicate that the annual flow of services from Scotland's natural capital (excluding fossil fuels) has been increasing since 1999 and reached £4bn in 2018, largely driven by an increase in the amount of energy produced from renewable sources, an increase in timber production and an increase in the number of hours people spend on outdoor recreation. Overall, the capacity of Scotland's terrestrial ecosystems to provide benefits to people has increased slightly since 2000, following decades of decline (between 1950 and 1990). Individual indicators within the natural capital index also tell more varied stories.

Progress has been made on acidification and eutrophication of water bodies and the annual rate of peatland restoration has been increasing, although it will need to continue to do so to meet long-term ambitions.

Pressures on biodiversity and ecosystems

Pressures on biodiversity and ecosystems are considered in a number of reports and strategies from both Scottish and International institutions. It is challenging to quantify the main drivers of biodiversity loss but there is a high degree of agreement between sources in terms of the range of pressures identified.

The earlier section on the condition of natural features on protected sites noted that invasive species were the biggest pressure on favourable status followed by over-grazing.

State of Nature Scotland 2019 identifies key pressures acting on nature in Scotland[3] more generally. This identifies agriculture (covering over 70% of Scotland), climate change, hydrological change, urbanisation, woodland management, pollution (including soil, water and air pollution), invasive non-native species, upland management, marine climate change and fisheries as key drivers of change. In relation to agriculture, the report identifies the increased use of pesticides and fertilisers, continuous cropping, changed sowing seasons and the loss of non-cropped habitats as being the biggest changes in farmland management that have had the greatest impact on Scotland's nature.

It also highlights changes in pressures in recent decades with some easing (e.g. reductions in freshwater pollution and increases in woodland cover) and others improving (e.g. sustainability of commercial fish stocks in Scotland increasing from 34% in 2000 to 69% in 2020[10,44] although at a UK level Good Environmental Status (GES) is still not expected to be met by 2020 for fish, commercial fish and shellfish, and benthic habitats[169]). On the other hand, some pressures have increased such as agriculture productivity, house building on thousands of hectares of habitat every year and average temperatures, which have increased by nearly 1 degree.

Scotland's Biodiversity Strategy Routemap to 2020 identified most of the same pressures and also recognised a lack of recognition of the value of nature and disconnection with nature as indirect past pressures[8].

[10] This data is the latest from the National Performance Framework and does not match the figures quoted in the State of Nature report. All years of data are revised every time the indicator is updated.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment on Biodiversity and Ecosystem Services (IPBES 2019)[170] identified five key direct drivers of change in nature. Over the past 50 years, these were found to be (starting with those of most impact): changes in land and sea use; direct exploitation of organisms; climate change; pollution; invasion of alien species.

The experimental statistics report from NatureScot on marine and terrestrial species indicators[42] considers the likely impact of the five key drivers mentioned above:

Driver	Positive impacts	Negative impacts
Land- and sea-use change	• Recent agri-environment schemes have arrested declines for some farmland species; • generalist woodland species have benefitted from afforestation.	• Agricultural intensification has driven declines in many species; • afforestation has resulted in the loss of other habitats; • urbanisation has resulted in habitat loss and fragmentation.
Climate change	• Northward and altitudinal range expansions in many species leading to increases in abundance and occupancy.	• Range retractions in northern and montane species; • Complex influences on ecosystems and foodwebs (e.g. in Scotland's seas).
Pollution	• Levels of principal air and water pollutants have declined in Scotland in recent decades; • Recoveries in some bryophytes and invertebrates may have occurred in response.	• Long-term effects of atmospheric pollutants on sensitive habitats remain in evidence; • Novel air and water pollutants are a concern.
Natural resource use and exploitation	• Recent changes in fish management, with an increasing number of commercial fish stocks being fished sustainably, have led to some signs of	• Fishing with bottom-towed gear continues to cause damage to sensitive seabed habitats.

	recovery albeit from very low baselines.	
Invasive species	• Some projects have removed or reduced populations of INNS.	• Numbers of INNS established continue to grow, with northward range shifts, and intensifying impacts on native wildlife.

Finally, the Millennium Assessment of Ecosystems and Human Well-being (though relating to the early 2000s) identified the most important direct drivers of biodiversity loss and ecosystem service changes globally as habitat change (such as land use changes), climate change, invasive alien species, overexploitation and pollution.[156]

In terms of interventions to manage drivers and pressures, it is important to recognise the difference between local drivers (such as land use or invasive species) and global drivers (such as climate change).

Summary

There are a wide range of pressures on biodiversity and ecosystems. Those commonly identified include agriculture / land use, climate change, invasive, non-native species and pollution. Further analysis would be required to understand where there are particular issues and challenges and the extent of these as well as local versus global drivers.

Mitigation / adaptation strategies for biodiversity

Many aspects of mitigation / adaptation are covered in earlier sections of this report e.g. targets to increase the area and condition of protected sites and to increase woodland creation. However, further analysis would be required in this area to determine progress on mitigation / adaptation across the board, taking account of other more qualitative evidence sources.

As noted in earlier sections, a new Biodiversity Strategy is expected to be published by the end of 2022 with a delivery plan then published within six months. It is currently subject to consultation.[171] In support of the new strategy, a new Natural Environment Bill is expected to be laid before Parliament in 2024 and lead to statutory targets for nature recovery. These are expected to be the main drivers of improvements to biodiversity in the coming years and it will be important to take stock of how these are progressing through further analysis in the future.

5. Comparisons to other countries

It has not been possible to conduct a comprehensive comparison to other countries across all aspects of biodiversity. Relevant evidence is captured for key indicators in other parts of this report and this section focuses only on broad measures of biodiversity progress.

The available evidence suggests that Scotland and other UK countries are amongst the poorer performers globally but that Scotland may be doing marginally better than other parts of the UK.

NatureScot's assessment of progress on the 20 Global Aichi targets for 2019, finds that 9 are on-track and 11 are showing progress but that this is insufficient to meet the target for 2020[70]. JNCC's assessment for the UK for 2018 and the State of Nature UK 2019 report, both indicate that five targets are on track and progress being made for 14[103]. The UK is therefore seen to be making insufficient progress, however this is not dissimilar to other countries.

The Biodiversity Intactness Index is an international index which can be used to compare countries on how nature has fared under pressures from humanity in terms of how much of an area's natural diversity remains. It has been adopted as a core indicator for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and has been used in key reports such as the Dasgupta Review on the Economics of Biodiversity. The index is designed to be used alongside other measures that look at ongoing trends in wildlife species, such as those discussed in other parts of this review. Based on analysis from the Natural History Museum and the RSPB, Scotland is rated in the bottom 12% (28th from bottom out of 240) of global countries and territories for biodiversity intactness though marginally ahead of the other UK nations[172,173,174]. Scotland's biodiversity intactness was assessed as 56% i.e. it has retained just over half of its historic land-based biodiversity. However, some caution should be exercised as there has been some recent criticism that the index can over-estimate intactness and underestimate losses[175].

The State of Nature UK 2019 report also comments on some areas of difference for Scotland compared to the rest of the UK[102], including:

- Generally farmland birds are faring better in Scotland, where on average they have increased since the 1990s, than elsewhere.
- Metrics show declines in moths and butterflies across the UK, although trends in Scotland are, on average, stable.
- Scotland has seen the largest area increase in woodland cover between 1999 and 2018 (156,000 ha) while Northern Ireland had the greatest proportional increase (39%) but remains the least wooded UK country. Conifers account for 51% of the UK's woodland area, varying from 26% in England to 74% in Scotland, though much of this is commercial plantation of non-native tree species. Summary of next steps

This baseline review identified a wide range of possible issues for further analysis, including control of invasive species, management and connectivity of protected areas and deeper dives into particular pressures or individual species where there have been declines.

However, for the purposes of setting out initial analytical priorities, ESS will focus on:

- Biodiversity decline, with a particular focus on pressures and mitigation strategies;
- Control and impact of invasive non-native species.

ESS' proposed Strategic Plan describes how issues will be prioritised for further analysis according to a range of criteria, including:

- Importance – the size and risk of the potential effect on the environment and/or public health; the urgency with which improvement is required;
- Nature and Scope – recent trends in environmental performance; whether the issue of concern appears to be systematic and/or longstanding;
- Neglect – whether there has been action taken on the issue of concern, or further action is planned in the near future; and
- Added-value – the contribution we could make, considering whether other monitoring, oversight or scrutiny bodies are planning to take, or could take, action to address the issue of concern.

The biodiversity and ecosystem resilience analytical priorities take account of that scheme and recognise the importance of these issues. For example, the potential impact that biodiversity loss can have on the environment as well as the fact that there has been a sustained loss in biodiversity over the past five decades. In keeping with the prioritisation process, the contributions of other actors and the added value that ESS can bring to an area will also be considered, in deciding where to focus future work.

Although ESS intends to focus on three issues in the first instance, other issues will be retained on a list for potential future analysis and horizon scanning in line with the stages of monitoring and analysis work set out in the strategic plan.

6. Summary of next steps

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Although ESS intends to focus on three issues in the first instance, other issues will be retained on a list for potential future analysis and horizon scanning in line with the stages of monitoring and analysis work set out in the strategic plan.

7. Summary of key sources

The end notes to this review provide details of the references and sources used throughout the document. This section is intended to provide a shorter note of those reports (in future iterations) and data sources which have been identified as likely to be important for an ongoing understanding of biodiversity in Scotland.

Biodiversity Overview / Reporting on Strategies

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