Natural Capital Committee

Final Response to the 25 Year Environment Plan Progress Report

October 2020

Background to the Natural Capital Committee

The government's Environment White Paper: The Natural Choice was published in 2011. In this report, the government committed to '*establishing an independent Natural Capital Committee (NCC)... The Committee's remit was to advise the government on the state of English natural capital.*' The NCC was established in 2012 as an independent Committee chaired by Professor Dieter Helm.

Since then, the NCC has published a plethora of advice on the sustainable use of natural capital in England and most notably a recommendation to the government to create a 25 Year Environment Plan (25 YEP). The government accepted this recommendation, developed it and the Plan was launched by the Prime Minister, Theresa May in January 2018.

The second and final term will conclude before the end of 2020. The key focus during this term has been advising the government on the implementation of the 25 YEP; including the development of suitable metrics to be used to track progress against the Plan's objectives.

NCC Member | **Profile**

Professor Dieter Helm CBE (Chair)

Dieter is an economist specialising in utilities, infrastructure, regulation and the environment, and concentrating on the energy, water, communications and transport sectors primarily in Britain and Europe. He is a Professor at Oxford University, a Fellow of New College, Oxford.

Professor Kathy Willis CBE

Kathy is a Professor of Biodiversity and Head of the Long-term Ecology laboratory at the University of Oxford. She is also the Principal of St Edmund Hall, one of the Colleges that make up the University of Oxford. Until recently, she was the Director of Science at the Royal Botanic Gardens, Kew. She has over 30 years of research experience focusing on modelling and remotely determining important landscapes for biodiversity and ecosystem services across the world. Most recently she has been leading a research team to develop new and emerging models and technologies to assist land managers in decision making to ensure the best outcomes for business and biodiversity.

Professor Ian Bateman OBE

Ian is a Professor of Environmental Economics and a Director of the Land, Environment, Economics and Policy Institute (LEEP) at the University of Exeter. His research interests focus on ensuring sustainable wellbeing through the integration of natural and social science knowledge within economic analysis, public and private sector decision making and policy. Particular interests lie in the fields of quantitative analysis, integrated modelling and the valuation of non-market benefits and costs.

Professor Paul Leinster CBE

Paul is a Professor of Environmental Assessment at Cranfield University and was formerly Chief Executive of the Environment Agency. He has over 40 years of practical experience in environmental management, science, policy development and regulation. Before joining the EA in 1998, Paul worked in the private sector for a number of major companies. He has a particular interest in translating research into effective policy, regulatory, operational and governance measures and in natural capital and ecosystem service approaches to environmental management. Paul has a number of non-executive roles.

Professor Colin Mayer CBE

Colin is a Professor of Management Studies, Saïd Business School at the University of Oxford. He is an expert on all aspects of corporate finance, governance and taxation, the regulation of financial institutions and the role of the corporation in contemporary society.

Professor Chris Collins

Chris is the Chair of Environmental Chemistry at the University of Reading. He is the Natural Environment Research Council Soils Coordinator and chairs Defra's Hazardous Substances Advisory Committee, providing expert advice to the UK government on how to protect the environment and human health via the environment from chemicals. His research focuses on determining the factors controlling exposure of biota to environmental pollution and the role of soil organic carbon in modifying pollutant exposure and the parallels between pollutant and carbon cycling in soils.

Professor Melanie Austen

Melanie is a Professor of Ocean and Society at the University of Plymouth. For the last 20 years, she has been leading national and international collaborative and interdisciplinary marine research projects that support sustainable marine policy, environmental management, communities and their wellbeing and industry. She is a member of the Joint Nature Conservation Committee (JNCC), was the first Chief Scientific Advisor to the UK's Marine Management Organisation (MMO), is an Honorary Professor at the University of Exeter medical school, and a member of several Expert Advisory Groups.

The Committee is supported by a secretariat based in the Department of Environment, Food and Rural Affairs headed by Maniv Pathak with Elias Scheuermann (analytical lead for this report), Rebecca McIlhiney, Jake Harvey, James Farr, Andy Canning-Trigg, Felix Clarke and Jessica McGreevy.

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Chair’s message

Nine years ago, the government published the White Paper, The Natural Choice, committing to the objective “*to be the first generation to leave the natural environment of England in a better state than it inherited.*” It established the Natural Capital Committee (NCC) to advise on how best to achieve this objective. The NCC recommended that the government develop a 25 Year Environment Plan (25 YEP) and in 2018, following further advice from the NCC, it was finally published.

The 25 YEP is a huge achievement, setting out the government’s ambitions to improve the environment. The 25 YEP proposes, and the Environment Bill will mandate, a requirement for an annual Progress Report to set out how the government is performing against the ten 25 YEP goals. A previous Defra Secretary of State, Michael Gove, specially requested that the NCC scrutinises the 25 YEP annual reports, paving the way for the Office for Environmental Protection (OEP) to undertake this function from 2021.

The Committee provided an assessment of the government’s first Progress Report in 2019. In the absence of a natural capital baseline, the Progress Report focused on a long list of actions, with very little evidence of improvements in the state of our natural capital.

Many of these mistakes have been repeated in the government’s 2020 Progress Report. The NCC’s interim response to this report, published earlier this year, highlights that the integrated, systems based approach the 25 YEP demands is at real risk of being lost. As the Committee has previously advised, it is crucial to use the right framework and metrics or risk multiple policy failures including the success of the 25 YEP, all future Environmental Improvement Plans, the delivery of Environmental Land Management schemes and environmental net gain.

The Committee proposed an asset based framework for assessing progress in its interim response, which has been duly applied in this final response – bringing together a large volume of evidence on the state of natural capital in one place. This information can provide a template for the OEP to develop further and undertake a natural system based assessment required to effectively scrutinise the government’s 2021 Progress Report.

The evidence presented in this report further highlights the lack of progress, and some worrying declines: nine of the 25 years have already passed, and it is now looking very likely the next generation will inherit a poorer set of natural assets. As a matter of urgency, the government should ensure that the proposed Natural Capital and Ecosystem Assessment pilot and any subsequent fully developed baseline exercise focuses on measuring the extent and condition of all natural assets across England, as per the NCC’s detailed advice – not just habitats, and should incorporate a substantial citizen science component. These steps are essential if the objectives in the 25 YEP are to be met and if the OEP is to inherit a workable framework to hold government to account.

We can be green and prosperous, but it will not happen by default. The huge opportunities, both economic and environmental, should be grasped by this government.

Professor Dieter Helm, Chairman

Executive summary

The Natural Capital Committee's (NCC) final response to the second 25 Year Environment Plan (25 YEP) Progress Report – follows its interim response published in July 2020. In its interim response, the NCC raised concerns that the evidence presented in the Progress Report at best provides only a partial picture, given the narrow range of datasets considered, and mostly shows declines in England's environment. The Committee also set out a natural capital approach to assessing progress.

This report covers three areas, as follows:

i) Sets out a natural capital asset based framework for assessing progress against the 25 YEP;

ii) Demonstrates how this natural capital framework can be applied to independently scrutinise progress, with the NCC's assessment of seven natural assets summarised, and further detail provided across the associated technical annexes – thereby laying the foundation for the Office for Environmental Protection (OEP) to undertake this function from 2021; and

iii) Highlights the priority areas where the government should focus in order to turnaround the evidenced declines in natural assets and get on track to meet the 25 YEP objective to improve the natural environment within a generation.

Key points

The NCC has applied a natural capital asset based framework to provide an assessment of the state of natural capital. For the Environment Bill and other environmental policies to succeed, using the correct framework/metrics is essential. The Committee is not aware of existing, recent work that brings together a range of available evidence to provide an assessment of the extent and condition of natural capital assets.

1. The Committee's approach follows four key steps:

   i) Determine the main natural capital assets, and link these to the ten 25 YEP goals;

   ii) Identify natural asset components and existing datasets/evidence, and shortlist these on the basis of ecosystem services flows/ societal benefits they provide;

   iii) Develop an analysis of trends for each asset/its components, focussing on progress made towards compliance with existing targets/commitments relative to a 2011, long/near-term baseline where possible; and

   iv) Issue a 'RAG' rating based on this analysis to provide a transparent and accessible indication of the state of natural assets, where: 'Red' indicates a decline/deterioration; 'Amber' indicates no change, or where the evidence is inconclusive; and 'Green' indicates an improvement.

2. The seven technical annexes to this report and their underpinning datasets can provide a template for the OEP, and act as a starting point for the integrated natural system based assessment required to effectively undertake its statutory 25 YEP scrutiny function from 2021.

3. It should be noted that the following areas of analysis were not feasible given resource constraints: i) identifying and analysing all available data; ii) an assessment of the overall environmental system/future trajectories; and iii) the potential impact of the change in natural assets (stocks) on important ecosystem service flows. Such comprehensive analysis is critical for informing whether or not the government will meet the environmental 'significant improvement test' that it has set itself in the Environment Bill and developing optimal policy interventions across not only the ten 25 YEP goals, but also for attaining net zero by 2050. The NCC advises that the OEP should be properly resourced to undertake a comprehensive assessment of all available data and the environmental system, including prioritising the development of a natural system model/decision support tool to determine the impact of changes in the environment on ecosystem service flows and associated societal benefits.

4. A key building block for assessing progress robustly is to develop a natural capital baseline. The Committee's analysis indicates that a number of existing datasets could be used for some of these baseline asset measurements, in particular those for atmosphere and freshwater. For several of the assets, however, and in particular soils and marine, data is very limited. The NCC strongly recommends that Defra ensures that the planned Natural Capital and Ecosystem Assessment pilot, and any subsequent fully developed baseline exercise, focuses on identifying and measuring the extent and condition of all natural capital assets across England, as per the NCC's detailed advice – not just habitats. Consideration should also be given to incorporating a substantial citizen science component. The baseline should comprise an agreed set of metrics for each asset, measured at an agreed spatial resolution throughout England. The timing of the measurements should also coincide to create an environmental census that can be repeated at regular intervals to determine trends over time.

5. The NCC recommends that the Treasury should ensure that the baseline assessment is properly funded at the next Spending Review – there are huge economic opportunities to be realised from understanding the state of England's natural assets. The OEP will be unable to carry out its 25 YEP scrutiny function effectively without a natural capital baseline.

6. The NCC advises that OEP's remit needs to be expanded in the Environment Bill so that the government *must consider and respond* to its advice on setting and any revisions to interim and long-term targets/Environmental Improvement Plans. Without such a role for the OEP, the ambition to significantly improve the environment could be softened in favour of other government priorities and lead to further stalling of progress in meeting the 25 YEP objectives, undermining public confidence in the government's green commitments.

A summary of the current status of seven natural assets (atmosphere, freshwater, minerals and resources, marine, soils, biota and land (terrestrial, freshwater, and coastal margins habitats)) is presented below. In these assessments, the NCC has examined the trends in the asset using available long-term datasets, and progress made towards compliance with existing targets/ other commitments and provided key recommendations for improving progress.

The NCC's overall assessment of progress against the 25 YEP, across seven natural assets (see Table 1): atmosphere, freshwater, minerals and resources, marine, soils, land and biota, highlights starkly that the government is not on course to achieve its objective to improve the environment within a generation. None of the assets are rated 'Green', a number of assets are assessed as 'Red' (e.g. freshwater, soils, biota and land), and several assessed as 'Amber' (e.g. atmosphere and minerals and resources).

Table 1: Overall assessment of the state of natural capital

Natural capital asset	25 YEP goal area	RAG rating
Atmosphere (abiotic)	Clean air Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals	A[1]
Freshwater (abiotic)	Clean and plentiful water *But will also cover:* • Minimising waste • Mitigating and adapting to climate change • Managing exposure to chemicals • Reducing the risks of harm from environmental hazards • Using resources from nature more sustainably and efficiently	R
Marine (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals • Enhancing beauty, heritage and engagement with the natural environment • Reducing the risks of harm from environmental hazards	R
Soils (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals	R[2]
Biota (biotic)	Thriving plants and wildlife Enhancing biosecurity But will also cover: • Minimising waste • Managing exposure to chemicals • Mitigating and adapting to climate change • Using resources from nature more sustainably and efficiently • Enhancing beauty, heritage and engagement with the natural environment	R[3]
Land (terrestrial, freshwater, and coastal margins habitats) (abiotic and biotic)	• Enhancing beauty, heritage and engagement with the natural environment • Reducing the risks of harm from environmental hazards • Mitigating and adapting to climate change • Using resources from nature more sustainably and efficiently	R
Minerals and resources (abiotic)	• Using resources from nature more sustainably and efficiently • Minimising waste	A

1 Although we recognise that the overall assessment for the atmosphere asset is 'Amber', clearly the current status on the quality of the air we breathe (atmosphere) indicates an overall reduction in pollution levels in recent years but that in some urban areas levels are still resulting in significant health impacts.

2 The indicative assessment is based on the limited data available which is somewhat dated and collected sporadically. The trend from this limited data shows that the condition and extent of soils has deteriorated. See the soils annex for further detail.

3 The indicative assessment is based on the example datasets the NCC assessed, all show declines in abundance and/or distribution of terrestrial species.

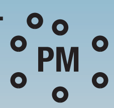
Atmosphere

The current status of the quality of the air we breathe (atmosphere) indicates an overall reduction in pollution levels in recent years, but in some urban areas levels are still resulting in significant health impacts.

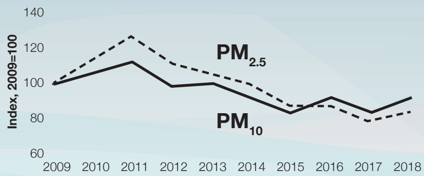
Why does this matter?
Poor air quality impacts human health; it has been estimated that the effects of long-term exposure to particulate air pollution alone in the UK causes up to 29,000 deaths per year.

PERSISTENT ORGANIC POLLUTANTS ↓

Emissions of assessed persistent organic pollutants (POPs) have reduced between 1990 and 2017 by between 87% and 97%.



Concentrations of particulate matter at urban roadside monitoring sites in the UK: 2009–2018

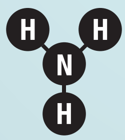


GREENHOUSE GASES ↓

Emissions of greenhouse gases have reduced between 1990 and 2018 from 794 to 451 MtCO2e.

AMMONIA ↑

Airborne ammonia levels are not on track to meet the target reduction of 8% of 2005 levels. Agriculture currently accounts for 88% of the ammonia emissions to air.



The overall assessment of the current status of the atmosphere asset is **'Amber': mixed/deteriorating**. The key findings in terms of the nine subgroups of the atmosphere asset are:

- Two of the groups (polycyclic aromatic hydrocarbons and heavy metals) have been classified as 'Red', three are 'Amber' (particulate matter, non-methane volatile organic compounds (NMVOC's) and other gases), and three are 'Green' (greenhouse gases, acid gases and persistent organic pollutants (POPs)).
- The quality of the air we breathe (atmosphere) has improved, given the overall reduction in pollution at a national level in recent years. However, in some local urban areas pollution is still resulting in significant health impacts.
- Poor air quality impacts human health – it has been estimated that the effects of long-term exposure to particulate air pollution alone in the UK causes up to 29,000 deaths brought forward per year.
- Emissions of greenhouse gases have fallen from 794 $MtCO_2e$ in 1990 to 451 $MtCO_2e$ in 2018.
- Emissions of assessed POPs have declined by around 87% to 97% (between 1990 and 2017).
- Emissions of assessed acid gases have declined by around 72% to 98% (between 1990 to 2017).
- Airborne ammonia levels are not on track to meet the target reduction of 8% of 2005 levels. Agriculture currently accounts for 88% of ammonia emissions.

Recommendations

1. **The NCC advises that the proposals in the 'Environment Bill – environmental targets'[4] policy paper for developing statutory Environment Bill targets for air quality (for example, *"introducing a target aimed at reducing average population exposure to $PM_{2.5}$ across England"*) should be set out more clearly, with national and local level targets.**

2. **The Government should collate and report local data alongside national data, to show the variation in the air quality at the regional level (for example, the number of local authorities in breach of air quality targets and giving rise to significant health impacts). The way the data is collected and analysed currently does not allow for such an assessment.**

3. **The relevant organisations should scale up the number of monitored sites and monitor consistently/periodically to provide an appropriate time series. For example:**

   a) **Determine what datasets can be used as a definitive baseline;**
   b) **Introduce measures to reduce groups of pollutants that are identified as in high concentrations in certain locations;**
   c) **Monitor to determine whether implemented measures are effective (evaluation); and**
   d) **Yearly monitoring to determine trends from the baseline.**

4 Defra, *Environment Bill – environmental targets* (2020) https://www.gov.uk/government/publications/environment-bill-2020/august-2020-environment-bill-environmental-targets

Freshwater

Progress towards achieving freshwater quality targets and commitments is poor, even though there has been some improvement in individual components.

Why does this matter?
Water supports and sustains life, the economy and wildlife. Correctly managed freshwaters can reduce the impact of flooding and drought.

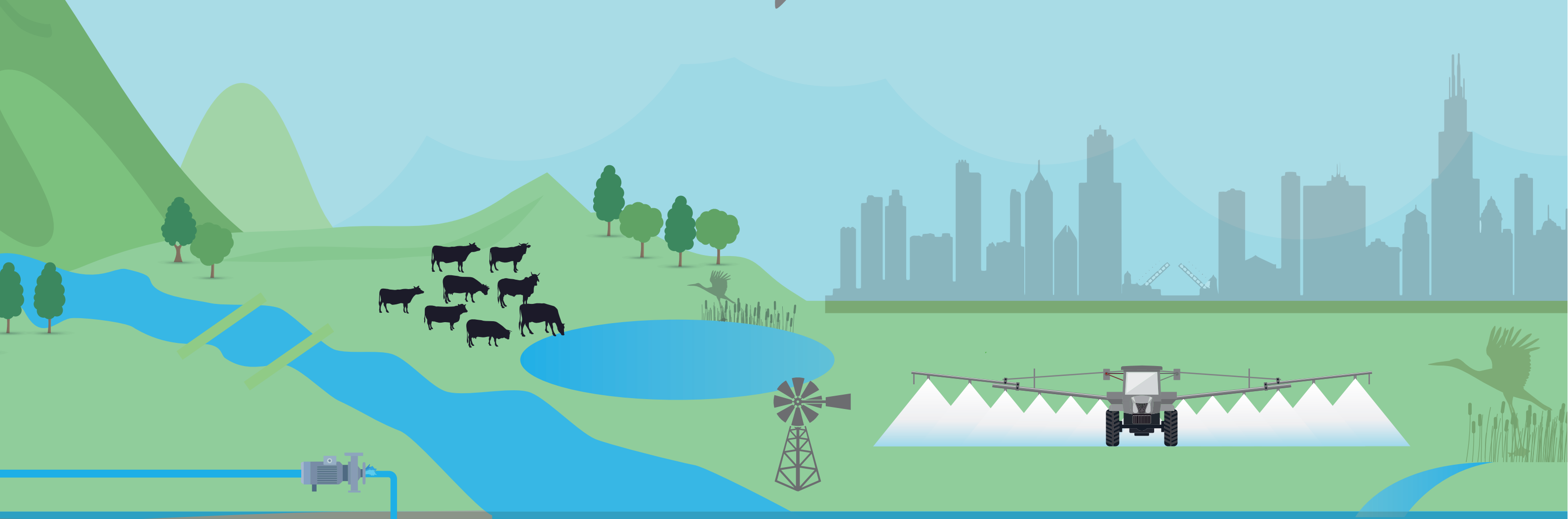
SURFACE WATER BODIES 0%

In 2019, no surface water bodies assessed in the UK met the criteria for ‘good’ chemical status.

REASONS FOR QUALITY FAILURE

The main reasons for water bodies in England failing to meet their water quality targets are:

- **39%** physical modifications
- **35%** discharges from sewage treatment works
- **35%** diffuse pollution from rural areas



Headwater streams, ponds and ditches

NOT MONITORED

RIVERS 14%

Only 14% of rivers meet the ‘good’ ecological status criteria (2019), the same percentage as in 2016. This compares with the 25 Year Environment Plan target for 75% to be as close to their natural state as soon as is practicable.

22% WATER LOSS

An estimated 22% of water currently put into the supply is lost through leakage, equating to around 3 billion litres of water per day.

OVERALL SURFACE WATERS ONLY 16%

ACHIEVING ‘GOOD’ ECOLOGICAL STATUS

The overall assessment of the current status of freshwater is **'Red': deteriorating**. The key findings in terms of the three subgroups of the freshwater asset are:

- Surface water bodies are not on track to meet the Water Framework Directive (WFD)[5] objective for 75% to have 'good' ecological status or potential by 2027. Only 16% of surface waters achieved 'good' ecological status in 2018.
- Only 14% (2019) of rivers met the 'good' ecological status criteria, the same percentage as in 2016. This compares with the 25 YEP target for 75% to be close to their natural state as soon as is practicable.
- Groundwater bodies are not on track to meet the WFD objective for 87% to have 'good' chemical status and 82% to have 'good' quantitative status.
- There are significant water management issues impacting the water environment including physical modifications (affecting 39% of water bodies in England), pollution from wastewater (affecting 35% of water bodies in England), and pollution from rural areas (affecting 35% of water bodies in England).[6]
- The status of many small freshwater bodies are not currently monitored as this is not a requirement of the WFD. The data that does exist is not assessed centrally.
- Limited progress has been made towards reducing water abstraction (between 2011 and 2017), reducing consumption per capita (between 2011/12 and 2017/18) and reducing water industry leakage (between 2014/15 and 2017/18).
- An estimated 22% of water currently put into the supply is lost through leakage, equating to around 3 billion litres of water per day.
- In 2019, surface water bodies assessed in the UK did not meet the criteria for 'good' chemical status.

Recommendations

1. **The NCC advises that any future natural capital based assessment should consider the long-term economic benefits of wide scale river restoration projects to restore modified water bodies to a near natural state. Land use change projects including changes in farming practices should also be central to this assessment.**

2. **The government should develop a baseline and metrics for the condition and extent of smaller water bodies comparable to those for WFD water bodies. Such an assessment should look to incorporate citizen science to engage communities and the use of other monitoring approaches.**

5 The EU Water Framework Directive https://ec.europa.eu/environment/water/water-framework/index_en.html

6 Based on the finding from the Environment Agency (EA) on the River Basin Management Plans: national evidence and data report – https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report

Marine

Abiotic properties of marine systems, that drive changes in oceanographic systems and underpin critical marine ecosystem services, indicate drastic climate-driven change. Even though the UK is an island nation, the available marine data provides an incomplete picture, with very limited data on marine assets.

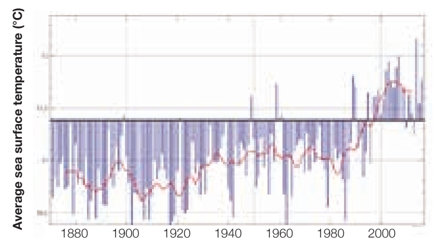
Why does this matter?

Marine comprises of seawater, seabed, and dynamic processes (e.g. waves, currents and tidally changing sea level) as well as biota. These operate together within a complex system to provide multiple services including coastal protection, climate regulation, waste management and assimilation, food, energy, leisure and recreation. Within this system, the synergistic effects of changing components can produce multiple and varied outcomes for the services.

TEMPERATURE ↑

The trend in seawater temperature since 1975 has been upward but with regional variation in the temperature and warming rate of sea surface water.

Sea surface temperature



CO_2 Carbon uptake

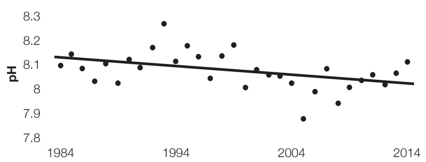
Pathogen, pollutant and nutrient runoff

Coastal erosion and increased sediment

pH ↓

Seawater pH levels are decreasing due to absorption of CO2, this is known as increasing ocean acidification.

Decreasing pH trend in top 0–20m water in the Greater North Sea (ICES and site specific observations)



>55%

Marine ecosystems are important for climate regulation, sequestering and storing more than half (55%) of the world's biologically sequestered carbon.

MARINE SEDIMENTS

Marine sediment can mitigate greenhouse gas emissions by acting as a carbon sink. There is evidence that human activities can damage these marine habitats in a way that causes their stored carbon to be released.

There is insufficient data to draw an assessment of organic carbon in the water column and sediment, and at present we are relying on models of spatial distribution of organic carbon.

The overall assessment of the current status of the marine asset is **'Red': deteriorating**. The key findings in terms of the five subgroups of marine assessed are:

- The very limited available marine data provides an incomplete picture – despite the fact that the UK is an island nation with considerable marine natural assets and associated ecosystem services and benefits.
- Trends for some physical and chemical parameters since 2011 indicate drastic climate-driven change in the marine environment. For example, seawater pH levels are decreasing due to the absorption of CO_2, a process known as increasing ocean acidification.
- There is insufficient data to draw an assessment of organic carbon in the water column and sediment.
- Of the 36 measurements assessed by the NCC, only 17 had an associated quantitative target, commitment or threshold set.
- The NCC has not had the resources to carry out a full analysis including data on marine biota. However, warming seas, reduced oxygen, ocean acidification and sea-level rise are already affecting UK coasts and seas.[7]

Recommendations

1. **The additional funding for monitoring and reporting through the proposed Natural Capital and Ecosystem Assessment provides an opportunity to broaden the scope of marine monitoring to allow for a joined up natural capital approach to protecting and improving the broad suite of marine assets.**

2. **The NCC acknowledges the government's intention to limit marine targets to a biodiversity target for marine protected areas (MPAs), within the first suite to be set under the statutory framework of the Environment Bill.[8] The NCC strongly advises that this should not prevent the Environment Bill framework from driving the protection of natural capital assets across the marine environment, in line with the 25 YEP goals. The current focus on MPA condition does not reflect the interconnected nature of the wider marine environment and its components and will not allow for integrated implementation and assessment measures to improve the condition of marine natural assets.**

3. **The government should urgently address data gaps related to assessing the extent and condition of marine natural capital assets, with a particular focus on how changes in the marine environment affect the dynamic flows of services and benefits. This evidence should then be utilised through the Environment Bill targets framework to review and set targets for marine beyond MPAs as a matter of urgency.**

7 MCCIP, *Report Card 2020* (2020): http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

8 Defra, *19 August 2020: Environment Bill – environmental targets* (2020) https://www.gov.uk/government/publications/environment-bill-2020/august-2020-environment-bill-environmental-targetsh

Soils

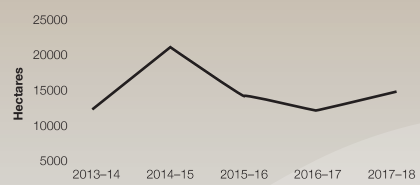
For metrics which are important for soil health, our collated data indicates a deterioration in soil asset extent and condition.

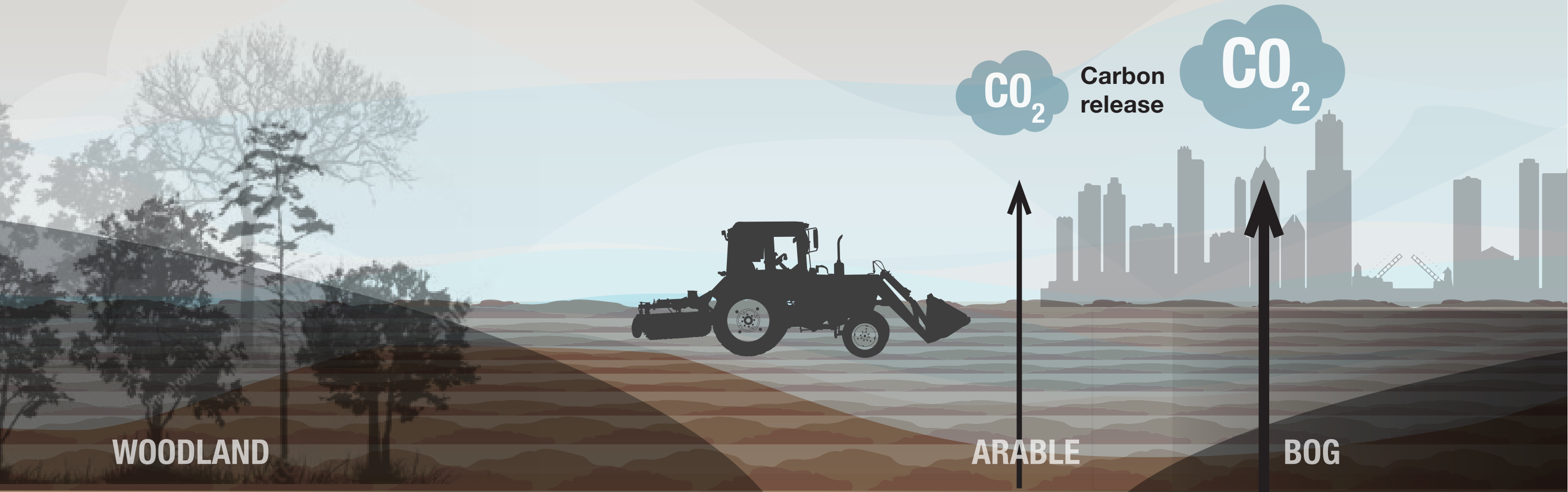
Why does this matter?
Improved soil management can bring a multitude of benefits including: nutrient cycling; water regulation; carbon storage; biodiversity; enhanced climate resilience; food and fibre production; waste management; GHG emission control; and reduced erosion.

DEVELOPED USE ↑ 8.3%

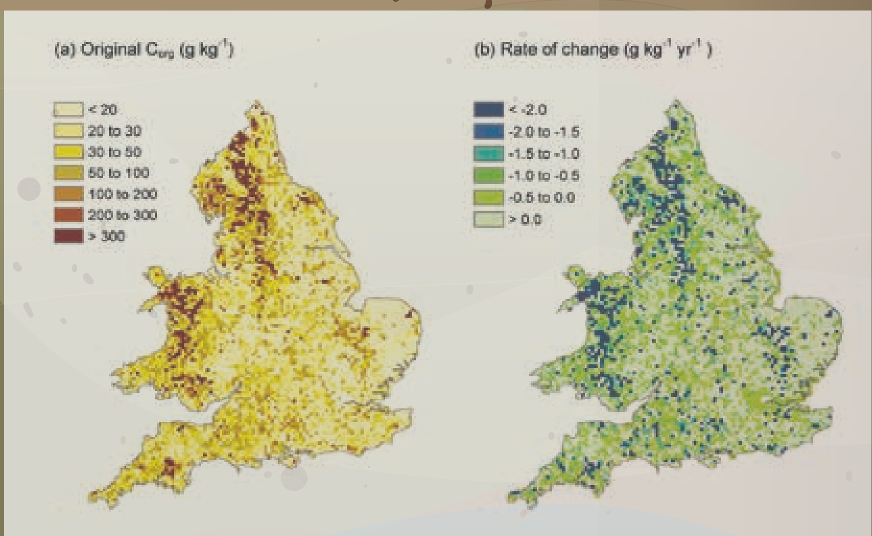
The Ministry of Housing, Communities and Local Government (MHCLG) reported that in 2018 8.3% of England's land area is of a developed use. Of this total, 7.16% (79,164 hectares) was converted from non-developed to developed use between 2013 and 2018. Such land is very likely to constitute land where soil sealing has occurred degrading soil function.

Area of land lost to development annually





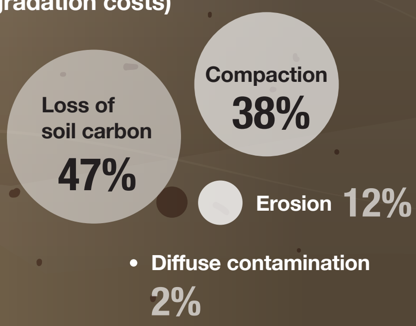
A national survey is urgently needed to provide data on extent and condition of soils, including establishing a baseline assessment of soils against which change can be measured. Past surveys have shown declines in soil carbon other studies have only found this in arable soils.



DEGRADATION ↑ £0.9 –1.4 BILLION

Soil degradation through erosion, intensive farming and development incurs losses estimated at between £0.9 –1.4 billion per year for England and Wales.

Processes leading to soil degradation (% of estimated degradation costs)



The overall assessment of the current status of the soils asset is **'Red': deteriorating**. The key findings in terms of the soil components assessed are:

- Several of the metrics included in the NCC's assessment which are important for soil health (covering data from 2007 or earlier) indicate a deterioration.
- Many of the soil asset components considered in the NCC's analysis did not have data available at a sufficient spatial and especially temporal coverage to allow an assessment of the condition/extent of England's soils. The partial data available – the majority of which is sourced from the 2007 Countryside Survey – shows that important components of soil health are changing. Trend data on soil depth, extent and condition are not available, but pressures on soils have been increasing.
- Carbon is a key metric for determining soil health, yet there is only limited data on carbon in soils.
- The Ministry of Housing, Communities and Local Government (MHCLG) reported in 2018 that 8.3% of England's land area is of a developed use. Of this total, 7.2% (79,164 hectares) was converted from non developed to developed use between 2013 and 2018.[9] Developed land is very likely to constitute land where soil sealing has occurred through the covering of soil with impermeable materials.

Recommendations

1. **The NCC repeats its recommendation that a national survey is urgently needed to provide data on the extent and condition of soils, including establishing a baseline assessment of soils against which change can be measured. Only then will we know if we are on track to meet the government target to manage our soils sustainably by 2030. This requires a significant scale-up in the number of sites monitored consistently at fixed periods to provide data that can show changes over time. The national survey should aim to improve certainty in modelled data, with data regularly updated. Defra's proposed Natural Capital and Ecosystem Assessment should be used to deliver this, with a focus on delivering coverage at appropriate spatial scales.**

2. **If current evidence is not sufficient to support a legally binding target for soils through the Environment Bill legislative framework, then the NCC recommends setting a shadow target for soils in the interim, in line with the ambition to ensure soils are sustainably managed by 2030.**

3. **The five soil types outlined in the Environment Bill targets policy paper is a good place to start but looking at these alone will not allow for an integrated natural system based assessment. The NCC advises that there is no 'one size fits all' indicator for soil health, and the soil types will need to be assessed across different land cover/habitat types to assess their condition, the services they deliver, and to understand how/why these are changing over time.**

9 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018

Land (terrestrial, freshwater and coastal margin habitats)

The majority of priority habitats are not on track to meet the UK 2020 Biodiversity Strategy target, and only 51% of National Nature Reserves are in 'favourable' condition.

Why does this matter?
The varied and diverse priority habitats of the UK and National Nature Reserves not only support many of our rare, iconic and endangered species, but also ecological communities which provide multiple important ecosystem services including CO_2 sequestration and storage, water-flow regulation, important habitats for pollinators and spaces for recreation.

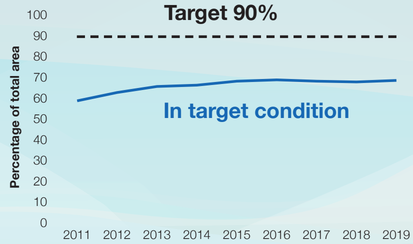
14% LAND AREA

In 2013 there were 1.87 million hectares (ha) of terrestrial and costal priority habitats which represented 14% of the total land area of England.

BIODIVERSITY 2020 STRATEGY TARGET ↓

The government is not meeting, and is not on track to meet, the Biodiversity 2020 Strategy target to have '90% of priority habitats to be in a 'favourable' or 'unfavourable recovering' condition.'

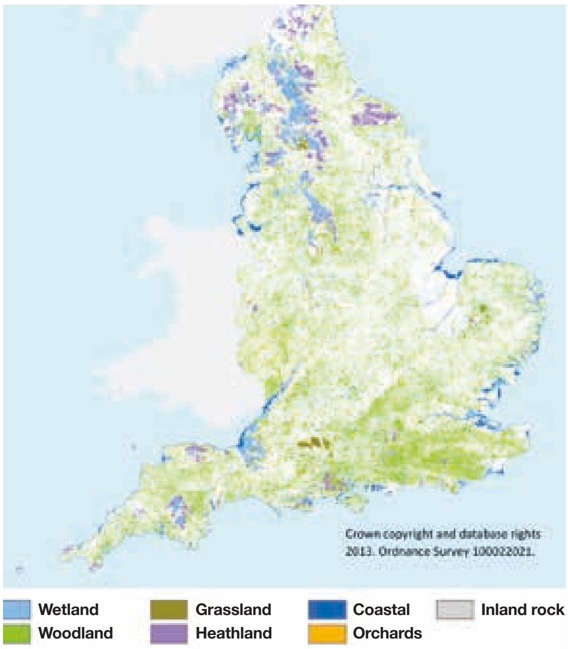
Condition of priority habitats as a percentage of total area, 2011 to 2019



PRIORITY HABITATS

Of the 24 priority habitat types, only 1/3 achieved the individual target of 80% of 'favourable' or 'unfavourable recovering' condition.

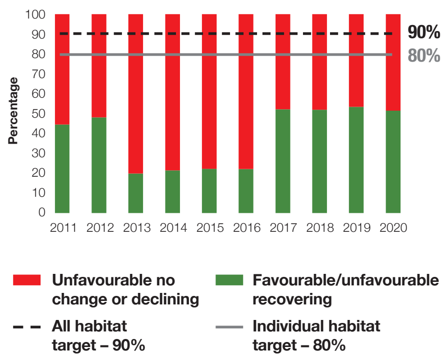
Distribution of terrestrial and coastal priority habitats in England, 2013



PRIORITY HABITATS

There has been almost no change in the extent (in ha terms) of individual priority habitats since 2011.

Condition of deciduous woodland in England: 2011 to 2020



The overall assessment of the terrestrial, freshwater, coastal and marine margins habitats (land) asset is **'Red': deteriorating**. The key findings in terms of components assessed for this asset are:

- The government is not meeting/is not on track to meet the Biodiversity 2020 Strategy target to have 90% of priority habitats in a 'favourable' or 'unfavourable recovering' condition.
- Of the 24 priority habitat types, only 1/3 have achieved the individual target of 80% of 'favourable' or 'unfavourable recovering' condition.
- There has been almost no change in the extent (in terms of area (hectares (ha))) of individual priority habitats since 2011.

Recommendations

1. **The NCC advises that the government should assess the feasibility of setting a legally binding target through the Environment Bill legislative framework to replace the existing target[10] from the Biodiversity 2020 Strategy that will end in 2020.**

2. **The Committee recommends that a clear plan to deliver on the existing commitments is required. This should be closely linked to developing new metrics and prioritising improved monitoring to report on delivery of these commitments. The government should ensure that it commits the necessary resources to deliver on the improvement of priority habitats.**

10 England Biodiversity strategy outcome: Better wildlife habitats with 90% of priority habitats in favourable or recovering condition and at least 50% of SSSIs in favourable condition, while maintaining at least 95% in favourable or recovering condition

Biota

Key terrestrial species and ecological communities (biota) that are known to underpin critical ecosystem services in the UK indicate serious declines.

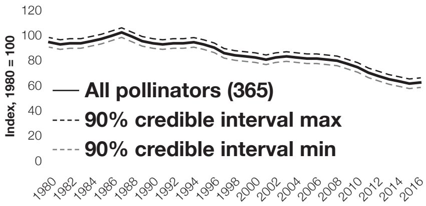
Why does this matter?
A loss in these key species and ecological communities directly impacts important societal benefits that we gain from them, including pollination, CO2 sequestration, water-flow regulation, clean air, recreation, pest control and a thriving wildlife.

POLLINATORS 30% DECLINE ↓

Species which are critical for ecosystem function, such as pollinators, show dramatic declines between 1980 and 2016.

Records from 365 pollinating bee and hoverfly species, across a number of 1km grid squares in the UK, indicate a 30% decline in occurrence between 1980 and 2016.

Change in occupancy of pollinators in the UK, 1980 to 2016



Clean air

Carbon sequestration

Water flow regulation

Pollination

Recreation

Decomposition

NATURAL PEST CONTROL 16% DECLINE ↓

Between 1970–2009 there has been a 16% decline in some species that provide pest control in the UK. However, the negative impact of this decline on pest control has been offset by the fact that over the same interval in time there have been increases (17%) in other species that perform the same function.

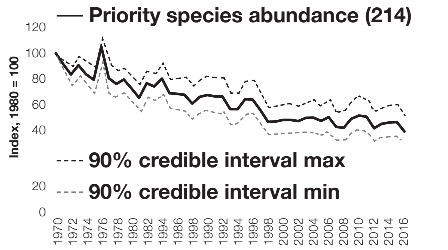
Changes in frequency of occurrence between 1970–2009

Ant species	Dragonfly and damselfly species	Ladybird species	Wasp species	Spiders species
14% ↓	54% ↓	27% ↓	17% ↓	16% ↓
14% ↑	35% ↑	10% ↑	12% ↑	15% ↑

PROTECTED SPECIES 60% DECLINE ↓

Changes in the abundance of rare, iconic or protected species in the UK between 1970 and 2016 have shown up to a 60% decline in relative abundance, with the biggest declines apparent for some moth species.

Change in the relative abundance of priority species in the UK, 1970 to 2016



The overall assessment of the current status of the biota asset is **'Red': deteriorating**. The key findings in terms of components assessed for this asset are:

- Species which are critical for ecosystem function such as pollinators show dramatic declines between 1980 and 2016. For example, records from 365 pollinating bee and hoverfly species across a number of 1km grid squares in the UK indicate a 30% decline in occurrence between 1980 and 2016.[11]
- Between 1970-2009 there has been a 16% decline in some species that provide pest control in the UK. However, the negative impact of this decline on pest control has been offset by the fact that over the same interval in time there have been increases (17%) in other species that perform the same function.[12]
- Changes in the abundance of rare, iconic and/or protected species in the UK between 1970 and 2016 have demonstrated up to 60% decline in the relative abundance of priority species, with the biggest declines apparent for some moth species.[13]

Recommendations

1. **The range of biodiversity targets that the UK government needs to adopt to determine progress towards the 25YEP should be more closely focused on a sub-set of species that are known to: i) underpin key ecosystem functions; ii) support other flows/ecosystem services; iii) be rare, iconic or protected species. Good work is being carried out measuring various groups of terrestrial biota. However, the NCC advises that there needs to be much better co-ordination to ensure key groups are measured in a regular and consistent way and duplication is removed.**

2. **The scope of monitoring of the terrestrial biota asset should be simplified with a common methodology adopted for measuring abundance, occurrence and distribution. Currently, there are a plethora of methods, making comparisons between datasets complex and difficult to compare and contrast.**

3. **The NCC advises that much greater attention needs to be given to determining trends over time. Currently, the interval of time between measurements is hugely variable and some key datasets (e.g. UK hedgerows) have not been updated on a national scale since 2007. Without a regular interval of measurement, starting from a clear baseline, it will be impossible to measure progress against targets due to be set as part of the Environment Bill legislative framework to improve those aspects of nature that provide important societal benefits.**

4. **Urgent consideration needs to be given to devising a set of clear set of metrics to assess those marine species that are important in underpinning key ecosystem services.**

11 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects* (2020): https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

12 Oliver *et al*, *Declining resilience of ecosystem functions under biodiversity loss* (2015): https://www.nature.com/articles/ncomms10122

13 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a* (2019): https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

Minerals and resources

The current status on the use of resources and of waste management activities indicates that although a number of targets are now in place, progress in achieving them is mixed.

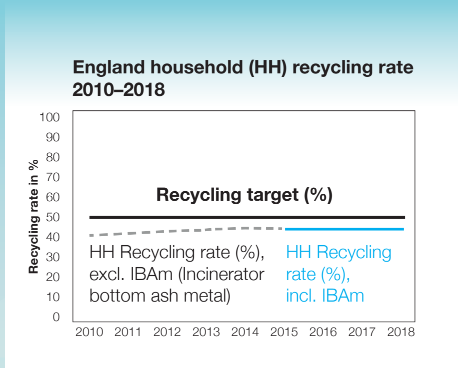
Why does this matter?
As goods consumed are made using renewable and non-renewable natural resources, if they are discarded without being reused or recycled this represents a missed opportunity for the circular economy and drives the additional use of non-renewable raw materials.

RECYCLING 44%

Household waste recycling rates have plateaued since 2013 at around 44%.

Aluminium cans take 80 years to decompose

Plastic bottles take 500 years to decompose



CONSTRUCTION

Construction waste recovery rates have plateaued since 2010.

FOOD WASTE ↑ £20 BILLION

In the UK alone, an estimated 10 million tonnes of food and drink are wasted post-farm gate annually, worth around £20 billion.

ILLEGAL SITES ↑

Waste-related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

FLYTIPPING ↑ 1,070,000

There were 715,000 flytipping incidents in England in 2012/13 and this increased to 1,070,000 incidents in 2018/19.

The overall assessment of the current status of minerals and resources is '**Amber': mixed/deteriorating**. The key findings in terms of the three subgroups of the minerals and resources assessed are:

- Waste targets are not being met, such as household recycling and recovery of end-of-life vehicles (ELVs).
- Household waste recycling rates have plateaued since 2013 at around 44%.
- Construction waste recovery rates have plateaued since 2010.
- There were 715,000 fly tipping incidents in England in 2012/13 and this increased to 1.07 million incidents in 2018/19.
- In the UK alone, an estimated 10 million tonnes of food and drink worth around £20 billion are wasted post-farm gate every year.
- Waste related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

Recommendations

1. **There is a negative impact on the environment of sending waste to landfill and a loss of valuable resources: the NCC advises that there needs to be an end to unnecessary landfilling in line with the waste hierarchy (e.g.: prevent, reduce, reuse, recycle, etc.). England should follow the lead of Wales and Germany in terms of setting targets for achieving higher recycling rates.**

2. **The NCC advises that statutory deadlines should be set for phasing out the use of natural resources which lead to long-term negative impacts on other natural assets and result in irreversible damage (e.g. the extraction and use of non-renewable energy sources on the condition of atmosphere, freshwater, biodiversity and marine).**

Background

This report sets out the Natural Capital Committee's (NCC) final advice on the government's second 25 Year Environment Plan (25 YEP) Progress Report, published in June 2020.[14] The Committee's assessment of the Progress Report has been delivered in two parts: an interim report, published in July 2020[15], and this final independent assessment of progress.

The previous Defra Secretary of State, Michael Gove, formally commissioned the NCC to scrutinise the 25 YEP Progress Report. The NCC Terms of Reference[16] also requires it to report on the implementation of the 25 YEP, including the development of suitable metrics to track progress against the Plan's objectives. The Committee's objective for this advice is to undertake an independent assessment of progress and present the Office for Environmental Protection (OEP) with a natural capital framework to undertake its statutory monitoring of the 25 YEP from 2021.

This final response provides:

i. A summary of the NCC's interim response and advice on a green economic recovery;

ii. Sets out a natural capital framework for assessing progress; and

iii. Presents an independent analysis/assessment of seven natural capital assets, including recommendations for improving progress against the 25 YEP objectives.

14 HM Government, *25 Year Environment Plan Progress Report: April 2019 to March 2020* (2020): https://www.gov.uk/government/publications/25-year-environment-plan-progress-reports

15 NCC, *Interim response to 25 Year Environment Progress Report and advice on a green economic recovery* (July 2020): https://www.gov.uk/government/publications/natural-capital-committee-advice-on-governments-25-year-environment-plan

16 HM Government, *Natural Capital Committee Terms of Reference* (2016): https://www.gov.uk/government/groups/natural-capital-committee#terms-of-reference

1. Summary of NCC's interim response to the 2020 Progress Report

In July 2020, the NCC published its interim response to the government's 2020 Progress Report[17], and advice on a green economic recovery. The main points from this report are summarised below.

1. Overall, the NCC is concerned that the evidence presented in the Progress Report at best provides only a partial picture and mostly shows declines in England's environment.

2. The government has still not put in place the appropriate metrics and baseline[18] required to measure changes in the environment, as advised by the NCC. This not only prevents a proper assessment of progress but also misses opportunities to identify the highest economically valuable projects.

3. In the Progress Report, a partial selection of datasets and indicators are presented to demonstrate progress, with a range of starting points. The NCC advises that this approach increases the risk of government selecting small positive improvements and ignoring the overall declines in the environment.

4. The 25 YEP represents the government's overarching strategy for improving the environment. Furthermore, the Environment Bill will require that the 25 YEP and all future Environmental Improvement Plans (EIP) *'significantly improve the natural environment.'*[19] The NCC is concerned by the lack of a strategic approach to assessing progress by, for example, joining up the range of metrics, actions and commitments across the 10 goals in an integrated way. For example, 16 strategies (HMG Green Finance Strategy, UK Marine Strategy, and the upcoming Nature Strategy) and many actions are detailed in the Progress Report, but it is not clear if they are part of a joined up, coherent and integrated plan to protect and improve the whole environment system. The NCC advises that reporting on progress must go beyond listing strategies and actions, and instead provide an assessment of intended outcomes and environmental improvements.

5. The NCC has advised that the Environment Bill should include a suite of legally binding interim and long-term environmental targets, well beyond a single target in each of the four priority areas, as currently proposed. This is essential for ensuring that the ten 25 YEP goals and all future EIPs drive actual environmental improvement.

The Committee has set out a natural capital based framework for assessing progress in protecting and improving the environment. For the Environment Bill and other environmental policies to succeed, using the correct framework/metrics is essential. The Committee has consistently demonstrated how investment in natural capital would yield far greater returns than those afforded by public spending elsewhere. For example, woodland and catchment restoration show economic returns that equal or exceed those in many other capital infrastructure investment areas, including road and rail projects.[20] Wetland creation has benefit cost ratios as high as 9:1.[21] If the government's vision for a green recovery is to be a success, then it must take an integrated, natural capital approach, as per the 25 YEP framework, to assess where investment is most needed and delivers the highest returns. The natural capital approach to assessing progress developed by the NCC is presented in the next section.

17 NCC, *Interim response to 25 Year Environment Progress Report and advice on a green economic recovery* (July 2020): https://www.gov.uk/government/publications/natural-capital-committee-advice-on-governments-25-year-environment-plan

18 HM Government, *Natural Capital Committee Terms of Reference* (2016): https://www.gov.uk/government/groups/natural-capital-committee#terms-of-reference

19 Defra, *Environment Bill 2019-21* (2019): https://services.parliament.uk/bills/2019-21/environment.html

20 Bateman, I.J. and Mace, G.M., *The natural capital framework for sustainable, efficient and equitable decision making* (2020): https://www.nature.com/articles/s41893-020-0552-3

21 NCC, *Natural Capital Committee's third state of natural capital report* (2015)): https://www.gov.uk/government/publications/natural-capital-committees-third-state-of-natural-capital-report

2. Natural capital framework for assessing progress against the 25 YEP

The natural capital approach for assessing progress – as set out in the interim response[22] – against the 25 YEP has been presented in three phases as follows:

i) Determine the core components of natural capital assets;
ii) Identify existing data sets related to these components; and
iii) Undertake an assessment of the state of natural capital/analysis of progress.

These three phases are described below.

Phase one – Determine natural capital assets

To define natural capital assets and the associated components, the analysis has followed the definition by the NCC from 2014 in the paper '*Towards a framework for defining and measuring changes in natural capital*' (Table 2).[23]

Table 2: NCC definitions of natural assets, broad habitats, and goods

Natural Capital asset	Definition
Atmosphere	The layer of gases surrounding Earth including oxygen, carbon dioxide and nitrogen used by all living organisms, and the processes which give rise to climate and weather.
Freshwater	Freshwater bodies (rivers, lakes, ponds and ground-waters) and wetlands. This includes water, sediments, living organisms and the interactions between these.
Oceans	Saline bodies of water that occupy the majority of the Earth's surface. This includes water, sediments, living organisms and the interactions between these.
Species	All living organisms including plants, animals, fungi, and micro-organisms.
Ecological Communities	A group of actually or potentially interacting species living in the same physical environment e.g.: wildlife habitats.
Soils	The combination of weathered minerals, organic materials, and living organisms and the interactions between these.
Land	The physical surface of the Earth and space for human activity. This includes the various landforms and processes which shape these (weathering and erosion).
Sub-soil assets	Other non-living substances in the Earth's crust including rocks and aggregates as well as non-mineral substances such as fossil fuels.
Minerals	Naturally occurring, non-living substances with a specific chemical composition formed by geologic processes.
Coasts	The transitional zone between land and oceans. This includes water, sediments, living organisms and the interactions between these.

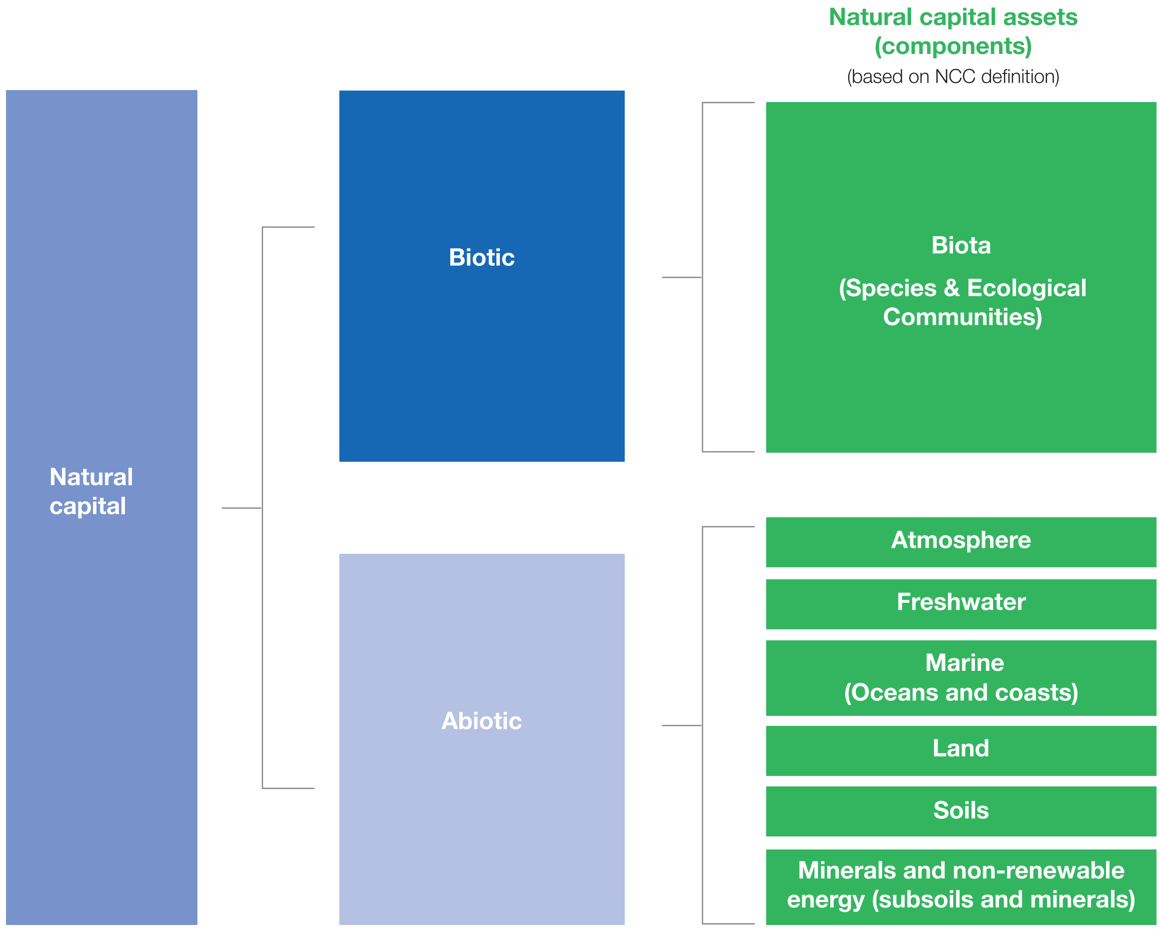
Source: NCC 2014

22 NCC, *Interim response to 25 Year Environment Progress Report and advice on a green economic recovery* (July 2020): https://www.gov.uk/government/publications/natural-capital-committee-advice-on-governments-25-year-environment-plan

23 NCC, *Working paper: Towards a framework for defining and measuring changes in natural capital (March 2014):* https://www.gov.uk/government/publications/natural-capital-committee-initial-term-working-papers-2012-to-2015https://www.gov.uk/government/publications/natural-capital-committee-initial-term-working-papers-2012-to-2015

The Committee provides a list of assets with their respective definitions. Given the complexity of natural capital and the potential overlap of elements from these definitions, some assets were consolidated to avoid duplication. For example, species and ecological communities were consolidated under the 'biota' heading, while coasts and oceans under the 'marine' heading. Assets were also divided into 'abiotic' and 'biotic' elements (see Figure 1).

Figure 1: Natural Capital assets



Source: NCC 2020

In order to undertake a full assessment of the condition and extent of these seven natural assets, it is important to identify the main components. The NCC in its interim response to the 25 YEP Progress Report advised that the government's Outcome Indicator Framework (OIF), for example, only provides narrow coverage of natural assets meaning that important measures are being overlooked. A desk-based literature review was undertaken to scope components/datasets for each of the seven natural assets – these were then assessed and consolidated.

Aligning natural assets to the ten 25 YEP goals

The next step requires alignment of these seven natural capital asset groups with the 10 goals in the 25 YEP and the four priority areas outlined in the upcoming Environment Bill[24] (see Table 3), so this analysis can be used to report on progress against the 25 YEP and any targets set within the priority areas.

As detailed in previous NCC advice, tracking progress is made more difficult by the ambiguity and lack of precision in defining the 10 goals.[25] A similar issue exists for the four priority areas, for example, there is no definition for water. In addition, these asset groups were also mapped against the UK National Ecosystem Assessment (NEA) habitat types for completeness.

24 Defra, *Bill documents — Environment Bill 2019-21* (2020) https://services.parliament.uk/Bills/2019-21/environment/documents.html

25 NCC, *Natural Capital Committee's sixth annual report* (2019) https://www.gov.uk/government/publications/natural-capital-committees-sixth-annual-report

Table 3: Aligning NCC asset grouping with 25 YEP goals and Environmental Bill priority areas

NCC asset grouping	Main 25 YEP goals	Environmental Bill Priority areas	UKNEA broad habitats
Atmosphere (abiotic)	Clean air Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals	Air quality, Climate Change Act – carbon budgets, Resource efficiency and waste reduction	
Freshwater (abiotic)	Clean and plentiful water *But will also cover:* • Minimising waste • Mitigating and adapting to climate change • Managing exposure to chemicals • Reducing the risks of harm from environmental hazards • Using resources from nature more sustainably and efficiently	Water, Resource efficiency and waste reduction	• Freshwater, wetlands, and floodplains
Marine (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals • Enhancing beauty, heritage • Engagement with the natural environment	Resource efficiency and waste reduction, Climate Change Act – carbon budgets, Resource efficiency and waste reduction, Water	• Marine • Coastal margins
Biota (biotic)	Thriving plants and wildlife Enhancing biosecurity *But will also cover:* • Minimising waste • Managing exposure to chemicals • Mitigating and adapting to climate change • Using resources from nature more sustainably and efficiently • Enhancing beauty, heritage and engagement with the natural environment	Biodiversity	• Marine • Coastal margins • Semi-natural grassland • Farmland • Mountains, moorlands, and heaths • Urban • Woodland • Freshwater, wetlands, and floodplains
Soils (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals		
Land (terrestrial, freshwater, and coastal margins habitats) (abiotic and biotic)	• Enhancing beauty, heritage and engagement with the natural environment • Reducing the risks of harm from environmental hazards		All habitat types
Minerals and resources (abiotic)	• Using resources from nature more sustainably and efficiently • Minimising waste		

Source: NCC 2020

Phase two – Data scoping and stakeholder engagement

Scoping existing datasets

The first part of phase two involves scoping existing datasets which could be used to inform the assessment of the natural capital assets. The scoping process was undertaken through an extensive desk literature review which looked at several datasets. From this initial scoping exercise, only a limited number of datasets were found that measured the condition and extent of assets. To address this, proxy data was used as a substitute to indicate changes in the condition and extent of these assets. These scoped datasets were consolidated to create a database covering all the seven natural capital asset groups as per Figure 1.

In addition to the desk literature review, the Committee/its secretariat engaged with Defra, the Environment Agency, and Natural England experts.

Phase three – Analysis of progress

In the final phase, an assessment has been undertaken using the datasets scoped within the second phase and through engagement with experts.

The NCC has relied on existing data and analysis with expert input rather than developing new analysis. Evidence and data from a range of different sources – with significant variation in the quality and quantity of data available – has been compiled to produce the assessments. For example, concentrations of $PM_{2.5}$ are only available for urban and roadside areas. There are also limited datasets covering England only, with most covering the UK or Great Britain. The assessment includes a high level overview of data quality/availability for each of the seven assets and underlying components.

The Committee is not aware of recent work that brings together a range of available evidence to provide an assessment of the extent and condition of natural capital assets. The seven technical annexes and underpinning datasets can provide a template for the OEP, and act as a starting point for the natural system based assessment required to effectively undertake its statutory 25 YEP scrutiny function from 2021.

The assessment considers different starting points (or 'baseline') for several of the natural assets analysed, with a 'RAG' rating assigned for each as follows:

1. **Compliance against target/commitment** is the comparison of the target/ commitment baseline against the most recent data. For example, assessing the reduction of ammonia from 2005 levels (target baseline) against the 2020 target of 8% reduction.
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/ evidence. For example, comparing the change between 1970 and 2018.
3. **The NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when Government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses.*"[26] Here, the 2011 baseline (where data is available) is compared against the most recent data/evidence. This also relates to the NCC census advice[27] and its interim response to the 25 YEP Progress Report for a need to have a common base year to assess progress against.
4. **The short-term trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

It should be noted that an assessment of the overall environmental system and its future trajectories or the potential impact of the change of these natural capital assets (stocks) on important ecosystem service flows, was not feasible given resource constraints. Such analysis is, however, critical for informing whether or not the government will meet the environmental *'significant improvement test'* that it has set itself in the Environment Bill and developing optimal policy interventions across not only the ten 25 YEP goals, but also for attaining net zero by 2050. The NCC advises that the OEP should be properly resourced to undertake a comprehensive assessment of the environmental system, including by prioritising the development of a natural system model/decision support tool to determine the impact of changes in the environment on ecosystem service flows and associated societal benefits.

26 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

27 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan* (2019) https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

3. NCC's independent assessment of progress

In this section, an overall assessment of the state of natural capital is presented, followed by a summary of each of the seven natural assets the NCC has considered, including recommendations for achieving progress against the 25 YEP. The detailed underpinning methodology, analysis and assessment of data availability for each of the seven assets is set out in the technical Annexes 1 to 7.

Summary of findings – is the state of our natural assets improving?

The NCC's overall assessment of progress against the 25 YEP, across seven natural assets: atmosphere, freshwater, minerals and resources, marine, soils, land and biota, **highlights starkly that the government is not on course to achieve its objective to improve the environment within a generation.**

The Committee's assessment uses a 'RAG' rating approach to provide a transparent and accessible indication of the state of natural assets. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. 'Red' indicates a decline/deterioration; 'Amber' indicates no change, or where the evidence is inconclusive; 'Green' indicates an improvement. Note that a 'Grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability.

None of the seven natural assets are rated 'Green', and a number of assets are assessed overall as 'Red' (e.g. freshwater, biota, soils and land), and several assessed as Amber' (e.g. atmosphere and minerals and resources). The next generation will, as a consequence, inherit a poorer set of natural assets. Important ecosystem services/flows are being lost (recently estimated at around £1 trillion per annum, based on partial national natural capital accounts by the Office for National Statistics[28]) and where critical thresholds for renewable assets are breached, these benefits will be lost in perpetuity. The overall assessment of natural capital assets is presented in Table 4. A more detailed assessment is presented in the sections that follow and the individual technical asset annexes.

A key building block for assessing progress robustly is to develop a natural capital baseline. The Committee's analysis indicates that a number of existing datasets could be used for some of these baseline asset measurements, in particular those for atmosphere and freshwater. For several of the assets, however, and in particular soils and marine, data is very limited. The NCC strongly recommends that Defra ensures that the planned Natural Capital and Ecosystem Assessment pilot, and any subsequent fully developed baseline exercise, focuses on identifying and measuring the extent and condition of all natural capital assets across England, as per the NCC's detailed advice – not just habitats. Consideration should also be given to incorporating a substantial citizen science component. The baseline should comprise an agreed set of metrics for each asset, measured at an agreed spatial resolution throughout England. The timing of the measurements should also coincide to create an environmental census that can be repeated at regular intervals to determine trends over time.

The NCC recommends that the Treasury should ensure that the baseline assessment is properly funded at the next Spending Review – there are huge economic opportunities to be realised from understanding the state of England's natural assets. The OEP will be unable to carry out its 25 YEP scrutiny function effectively without a natural capital baseline.

The NCC advises that the OEP's remit needs to be expanded in the Environment Bill so that the government *must consider and respond* to its advice on setting and any revisions to interim and long-term targets/Environmental Improvement Plans. Without such a role for the OEP, the ambition to significantly improve the environment could be softened in favour of other government priorities and lead to further stalling of progress in meeting the 25 YEP objectives, undermining public confidence in the government's green commitments.

28 Office for National Statistics (ONS), *UK natural capital accounts: 2019* (2019): https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2019

Table 4: Overall assessment of the state of natural capital

Natural Capital asset	25 YEP goal area	RAG rating
Atmosphere (abiotic)	Clean air Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals	A[29]
Freshwater (abiotic)	Clean and plentiful water *But will also cover:* • Minimising waste • Mitigating and adapting to climate change • Managing exposure to chemicals • Reducing the risks of harm from environmental hazards • Using resources from nature more sustainably and efficiently	R
Marine (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals • Enhancing beauty, heritage and engagement with the natural environment • Reducing the risks of harm from environmental hazards	R
Soils (abiotic)	Mitigating and adapting to climate change *But will also cover:* • Minimising waste • Managing exposure to chemicals	R[30]
Biota (biotic)	Thriving plants and wildlife Enhancing biosecurity *But will also cover:* • Minimising waste • Managing exposure to chemicals • Mitigating and adapting to climate change • Using resources from nature more sustainably and efficiently • Enhancing beauty, heritage and engagement with the natural environment	R[31]
Land (terrestrial, freshwater, and coastal margins habitats) (abiotic and biotic)	• Enhancing beauty, heritage and engagement with the natural environment • Reducing the risks of harm from environmental hazards • Mitigating and adapting to climate change • Using resources from nature more sustainably and efficiently	R
Minerals and resources (abiotic)	• Using resources from nature more sustainably and efficiently • Minimising waste	A

29 Although we recognise that the overall assessment for the atmosphere asset is 'Amber', clearly the current status on the quality of the air we breathe (atmosphere) indicates an overall reduction in pollution levels in recent years but that in some urban areas levels are still resulting in significant health impacts.

30 The indicative assessment is based on the limited data available which is somewhat dated and collected sporadically. The trend from this limited data shows that the condition and extent of soils has deteriorated. See the soils annex for further detail.

31 The indicative assessment is based on the example datasets the NCC assessed, all showed declines in abundance and/or distribution of terrestrial species.

Summary assessment for the seven natural assets

Atmosphere

The NCC has scoped the atmosphere asset and the most important components, and the pressures acting upon them, for judging condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis. Further detailed information and analysis is provided in **Annex 1**.

Background

The atmosphere – the layer of gases surrounding the Earth including oxygen, carbon dioxide (CO_2), and nitrogen – is used by all living organisms and contains the processes which give rise to climate and weather. Very small changes to the physical state of the atmosphere can have extensive impacts on life on earth. For instance, a relatively small increase in atmospheric temperature can have profound effects on sea level and climate. The atmosphere acts as a system, and concepts of 'thresholds'[32] or 'tipping points' and synergistic effects[33] of changing components, produce multiple and varied outcomes, sometimes taking generations before the full effects are felt.

In order to understand where changes in air quality and atmospheric processes will affect human health or the environment, it is important to first understand where pollution is most concentrated, how it occurs, and what elements are involved. To do so, robust data and evidence are required so the impacts on human health and the environment can be assessed. For instance, using the impact of pollutants on air quality to indicate where the most significant changes are happening. An example of the effects of air pollution on health is the effects of long-term exposure to particulate matter. In the UK, it is estimated to result in 29,000 deaths a year being brought forward.[34] The combined cost of the effects of particulate matter ($PM_{2.5}$) and Nitrogen dioxide (NO_2) on health, is estimated to be £1.6 billion (£1.5 billion for $PM_{2.5}$ and £61 million for NO_2) between 2017 and 2025.[35]

In June 2019, the UK legislated a target of achieving net zero greenhouse gas (GHG) emissions by 2050. Actions to mitigate climate change must include the maintenance of current carbon stocks as well as a reduction in emissions and the need for actively removing GHG from the atmosphere. The effects of GHG emissions (CO_2, Methane (CH_4), etc.) are both direct, in terms of the impacts on human health and biodiversity from poorer air quality, and indirect through a warming climate with more extreme weather events and the acidification of the oceans.

The government is not meeting, or on track to meet, all of its targets. For example, the reduction in emissions of ammonia was estimated in 2017 to be only 0.1% against a target reduction of 8%.[36] There is a range of targets for atmospheric emissions, but there is no central location where all of the existing targets, limits, and objectives are presented for the atmosphere asset.

32 A point or level at which new properties emerge in an ecological, economic or other system, whereby a small change in a pressure or driver can lead to a relatively large change in the state of natural capital, with consequences for the benefits it provides (as illustrated in Figure 3). This new state of natural capital is called an alternative stable state. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Some of the best-known examples arise from studies of abrupt responses in water quality in shallow lakes as a result of increases in pollution inputs. **Source:** NCC Terminology Paper: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf

33 An effect arising between two or more agents, entities, factors, or substances that produces an effect greater than the sum of their individual effects. **Source:** http://www.businessdictionary.com/definition/synergistic-effect.html

34 Public Health England (PHE), Mortality effects of long-term exposure to air pollution in the UK (2010) https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk

35 Public Health England (PHE), *Estimation of costs to the NHS and social care due to the health impacts of air pollution* (2018) https://www.gov.uk/government/publications/air-pollution-a-tool-to-estimate-healthcare-costs

36 National Atmospheric Emissions Inventory (NAEI), *Data: air Quality Data* https://naei.beis.gov.uk/data/

The Environment Bill[37] allows for long-term targets to be set in respect of any matter which relates to the natural environment, or people's enjoyment of it. It requires the government to set at least one target in four priority areas: air quality, biodiversity, water, and resource efficiency and waste reduction, as well as a target for fine particulate matter ($PM_{2.5}$). The NCC has advised that further statutory targets are needed for a range of atmospheric components, in order to give an accurate picture of whether GHG emission targets are being met and to meet the environmental principles contained within the bill.

Overview of approach to assessing the atmosphere asset

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of the atmosphere asset. Based on this review and expert input, the NCC has shortlisted 66 potential substances that are acting as a pressure on air quality or atmospheric processes. These substances are also regarded to have the greatest impact and pose the greatest risks to the environment and human health. There is limited data on the concentrations of these substances, and most of the data available is based on emissions which are used as a proxy in the development of this assessment. For this reason, the NCC's assessment of the atmosphere has focused on the measurement of pressures (emissions data) instead of concentration data (which look at the condition) due to the limited availability of this type of data.[38]

The 66 identified substances have been grouped under nine headings – see Figure 2 for a visual presentation – following the same approach as the UK Pollutant Release and Transfer Register (PRTR)[39] and the National Atmospheric Emissions Inventory (NAEI)[40], as follows:

1. Particulate matter (PM);
2. Polycyclic aromatic hydrocarbons (PAHs);
3. Greenhouse gases (GHG);
4. Acid gases;
5. Ozone depleting substances (ODS);
6. Non-methane volatile organic compounds (NMVOCs);
7. Heavy metals;
8. Persistent organic pollutants (POPs);
9. Other gases.

This allows for an overarching assessment to be made. However, it should be noted that this list of substances does not cover all those that would be required to assess the whole of the environment. In addition, emissions are only terrestrial and those from marine infrastructure or vessels are not included. Further iterations of the list will be required where a periodical review to account for new substances will be needed to keep the list up to date. To take action to address the impacts of air pollution, reliable, consistent, and routinely produced data is required.

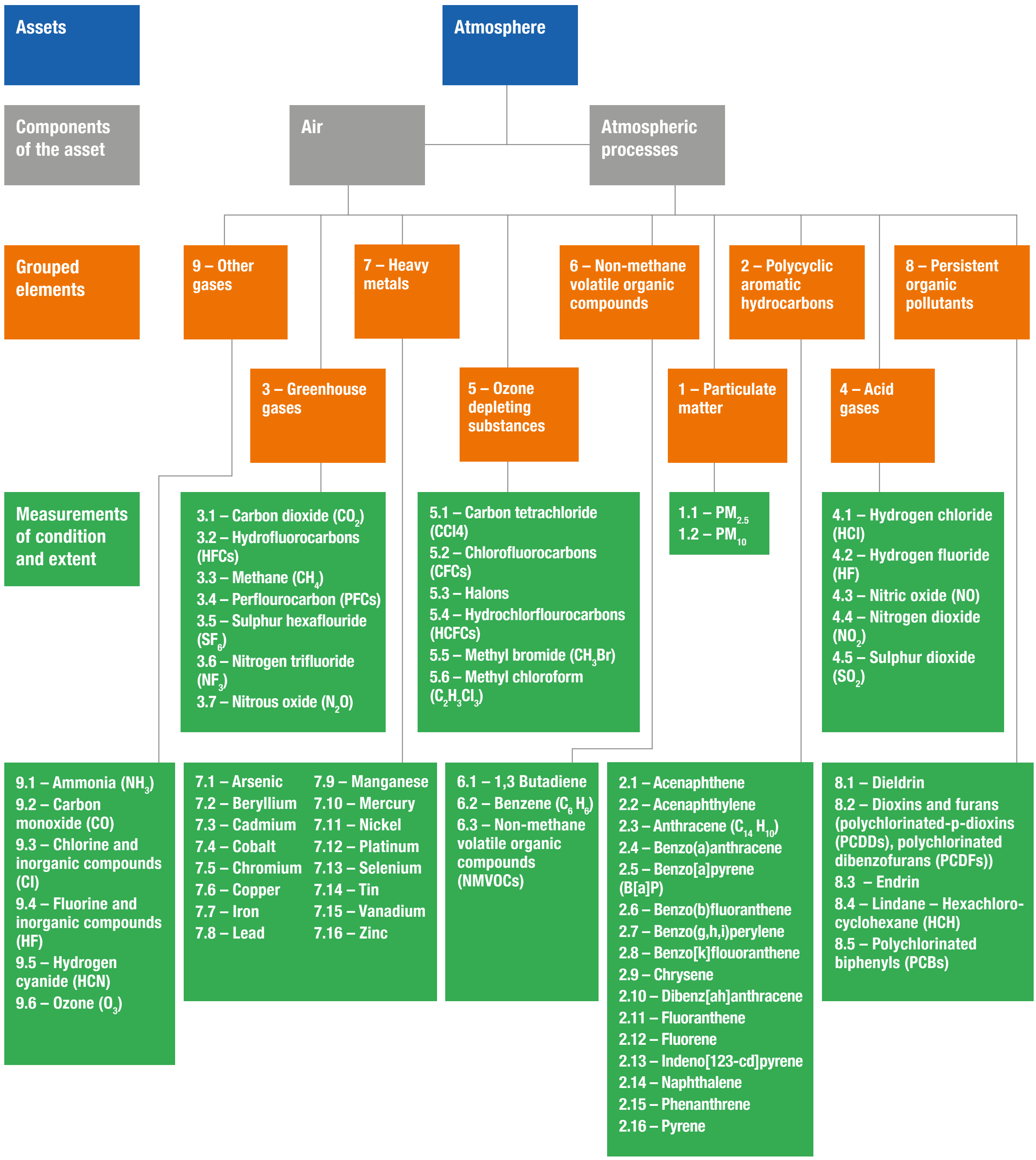
37 HM Government *Environment Bill* 2020: https://services.parliament.uk/Bills/2019-21/environment.html

38 For example, out of the 66 substances scoped, 12 of these had no data, 52 had data on emissions, and 17 had some data on concentrations. Even where concentration data is available, it is either somewhat dated or only provides a partial assessment of the atmosphere, being limited to rural or urban areas for example. Another limitation of the datasets used is that not all have data for England – given this limitation the assessment that follows uses data for both England and the UK. To keep the assessment consistent and comparable, the data used is at the UK level. This also aligns with the majority of the targets and limits which are mostly set at the UK level.

39 Defra, *UK Pollutant Release and Transfer Register (PRTR) data sets: pollutant releases* (2019) https://www.gov.uk/guidance/uk-pollutant-release-and-transfer-register-prtr-data-sets

40 NAEI, *UK emissions data selector* (2019) https://naei.beis.gov.uk/data/

Figure 2: Atmosphere components for assessment



Source: NCC 2020

Summary of the analysis

The NCC has produced a partial assessment of emissions and concentrations of atmospheric pollution, focusing on emissions data, given the limited data available on concentrations.

The overall assessment of the atmosphere annex – based on the datasets available (i.e. an assessment to the 66 measurements) – is '**Amber**': **mixed/deteriorating** – this reflects that the current quality of the air we breathe (atmosphere) has improved, given the overall reduction in pollution at a national level in recent years. However, in some local urban areas pollution is still resulting in significant health impacts as evidenced by the 29,000 number of deaths bought forward. At present local data is not collated and reported alongside national data, meaning that the variation in air quality at regional level (or the number of local authorities in breach of air quality targets) is not known.

The NCC's findings are presented in Table 5 where a RAG rating for each of the nine groups is provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the 66 measurements. The key findings in terms of the nine subgroups of the atmosphere assets are:

- Two of the groups (Polycyclic aromatic hydrocarbons and heavy metals) have been classified as 'Red', three are 'Amber' (particulate matter, non-methane volatile organic compounds (NMVOC's) and other gases), and three are 'Green' (greenhouse gases, acid gases and persistent organic pollutants (POPs)).
- The quality of the air we breathe (atmosphere) has improved, given the overall reduction in pollution at a national level in recent years. However, in some local urban areas pollution is still resulting in significant health impacts
- Poor air quality impacts human health – it has been estimated that the effects of long-term exposure to particulate air pollution alone in the UK causes up to 29,000 deaths per year.
- Emissions of greenhouse gases have fallen from 794 $MtCO_2e$ in 1990 to 451 $MtCO_2e$ in 2018.
- Emissions of assessed POPs have declined by around 87% to 97% (between 1990 and 2017).
- Emissions of assessed acid gases have declined by around 72% to 98% (between 1990 to 2017).
- Airborne ammonia levels are not on track to meet the target reduction of 8% of 2005 levels. Agriculture currently accounts for 88% of ammonia emissions

Please refer to **Annex 1** for a detailed analysis of the atmosphere asset and its components.

Table 5: Indicative (partial) assessment of the atmosphere

Measurements used to assess the atmosphere asset	Data availability	Overall assessment
Particulate matter (PM)	Partial data on concentrations of $PM_{2.5}$ and PM_{10} up to 2018. The data used for the assessment is based on Defra ENV 2 dataset. Emissions data for $PM_{2.5}$ and PM_{10} is available up to 2017. The data used for the assessment is based on the NAEI dataset.	Based on the limited data available on the concentrations of $PM_{2.5}$ and PM_{10}, the data shows that these have reduced for roadside and urban backgrounds when compared to 2011 levels. However, the trend since 2015 shows that concentrations have either remained flat or slightly increased. • Data on emissions of $PM_{2.5}$ have declined by just under 0.5% when compared to the 2011 level, while PM_{10} has increased 1.8% over the same period. Given these mixed results the RAG rating here is amber. See further details under the PM section in annex 1.
Polycyclic aromatic hydrocarbons (PAHs)	Data on PAHs emissions is available for 16 substances. The data used for the assessment is based on the NAEI dataset.	The emissions data of PAHs shows that emissions have increased for 15 out of the 16 substances since the 2011 level, with dibenz[*a,h*]anthracene being the exception. Given that emissions have increased the RAG rating allocated here is red. • Emissions of PAHs between 2011 and 2017 have increased between 8% and 63%, with the exception of dibenz[*a,h*]anthracene which has declined by just under 19%.
Global warming potential	Emissions data is available for the seven greenhouse gas up to 2018. The data used for the assessment is based on the Department of Business, Energy, and Industrial Strategy (BEIS) greenhouse gas inventory dataset.	Based on the most recent data from BEIS greenhouse gas inventory, emissions have declined for all gases with the exception of Nitrogen trifluoride (NF_3) when compared to the 2011 level. As emissions have reduced for most of the gases the RAG allocated is green. • Emissions of methane (CH_4) and carbon dioxide (CO_2) have declined by 61% and just under 39% since 1990. See further details under the global warming potential section below.
Acid gases	There is no data on the concentration of acid gases. Emissions data were available for four of the five substances up to 2017. The data used for the assessment is based on the NAEI data.	When compared to the 2011 level, emissions have declined for the four substances where data is available (HCl, HF, NO_2, and SO_2). Given the reductions in emissions, the RAG allocated here is green. • Sulphur dioxide (SO_2) has declined by 95% since 1990. See further details under the acid gases section below.

Measurements used to assess the atmosphere asset	Data availability	Overall assessment
Ozone depleting substances (ODS)	Data was not available for ozone-depleting substances at the UK level. Data is only available for the consumption and production of ODS at the EU level.	Unable to produce an assessment as data is not available for England or the UK level. Data from the UN environment programme shows consumption and production data only at an EU level. The EU level data shows that consumption has reduced since 2013.[41]
Non-methane volatile organic compounds (VOCs)	There is no comprehensive data on the concentration of NMVOCs across England. There are limited modelled estimates which are based on a limited number of active monitoring sites (four). Data on NMVOCs are presented for two compounds (1, 3 butadiene and benzene) and as an aggregated dataset. The most recent data is from 2017 and is based on the NAEI dataset.	Based on the limited data available on emissions, there has been a decline in emissions of benzene and 1,3 butadiene. However, the RAG rating here is amber due to the fact that the emissions trend has been flat since around 2014. • Since 2014 emissions of NMVOCs have been flat around 800 kilotons. For further details see the NMVOC section below.
Heavy metals	There is limited data available on concentrations of heavy metals, with the most recent data being from 2015. This data is based on a small sample averaged across the UK. Data on emissions is available for 13 of the 21 heavy metals, and the data is used is from the NAEI.	As the data on concentrations is somewhat dated and is based on a small sample it has not formed part of this RAG rating. The RAG rating is based on emissions data. There is a mixture in the change in emissions for heavy metals since 2011, with some metals showing an increase in emissions levels such as Cadmium, Chromium, Manganese, Vanadium, and Zinc. While for Arsenic, Lead, Mercury, Selenium, and Tin there has been a decline when compared to the 2011 level. Also, for some metals, the change has been limited (less than 1%) such as Beryllium, Copper, and Nickel.
Persistent organic pollutants (POPs)	There is no data on the concentration of POPs. Of the 5 substances, scoped emissions data is available for three.	The emissions data for Dioxins and Furans, Lindane, and PCBs have declined when compared to 2011 levels. Based on these findings, the RAG rating here is green. This RAG rating should be treated with caution given the limited number of substances being assessed. • Emissions of dioxins, lindane and Polychlorinated biphenyls (PCBs) have decreased since 1990 by 87%, 97% and 92% respectively.
Other gases	Only limited data on concentration is available in terms of percentage land area for ammonia. Emission data is only available for two of the seven substances.	Based on the limited emissions data available, emissions have increased for NH_3, while CO emissions have declined since 2011. Given the mixed results, the RAG rating here is amber. • Emissions of ammonia have been flat/increasing since 2008.

Source: NCC 2020

41 Calculated for each calendar year, it is mainly defined as 'production plus imports minus exports' (quantities destroyed or used in certain applications like feedstock are subtracted where relevant). As such, its formula can yield a negative number when substances are produced and imported in quantities that do not compensate for the amounts exported or destroyed. This usually happens when exports or destruction take place for ODS that were previously on the market in the EEA-28 (stocks). https://www.eea.europa.eu/data-and-maps/indicators/production-and-consumption-of-ozone-3/assessment

Recommendations

The NCC advises that there is considerable scope to achieve better progress towards improving the condition and extent of the atmosphere asset (e.g. this asset links to the following 25 YEP goals: clean air and mitigating and adapting to climate change, and will also be relevant to minimising waste and managing exposure to chemicals.)

The Committee's recommendations are set out below.

1. The NCC advises that the proposals in the '*Environment Bill – environmental targets*'[42] policy paper for developing statutory Environment Bill targets for air quality (for example, "*introducing a target aimed at reducing average population exposure to* $PM_{2.5}$ *across England*") should be set out more clearly, with national *and* local level targets.

2. The relevant organisations should scale up the number of monitored sites and monitor consistently/periodically to provide appropriate time series. For example:
   a) Determine what datasets can be used as a definitive baseline;
   b) Introduce measures to reduce groups of pollutants that are identified as in high concentrations in certain locations;
   c) Monitor to determine whether implemented measures are effective (evaluation); and
   d) Yearly monitoring to determine trends from the baseline.

3. Air quality is highly variable in terms of location and types of emission. The NCC's assessment highlights that the current arrangements for monitoring and measuring emissions and concentrations against targets do not result in a holistic assessment of the state of the atmosphere in England (as is acknowledged in the UK Clean Air Strategy)[43]. For example, local air quality monitoring is the responsibility of Local Authority's, but they are not required to submit their data centrally so that an overall assessment can be made. The NCC advises that more localised monitoring needs to take place in order to develop a clearer picture of progress against an agreed baseline and that this needs to be reported in a central repository.

4. The Government should collate and report local data alongside national data, to show the variation in air quality at regional level (or the number of local authorities in breach of air quality targets, and giving rise to significant health impacts). The way that data is collected and analysed currently does not allow for such an assessment.

5. The NCC advises that a suite of targets will be needed to improve the condition and extent of air (as a natural capital asset). New targets need to identify where atmospheric pollutants are causing harm to human health and ecosystems to be in poor condition. Also, the proposed statutory targets will need to be broadened in order to address the significant pressures on air quality.

6. The government needs to assess the feasibility of setting a target that goes beyond the existing particulate matter threshold and brings these in line with the World Health Organisation (WHO) guidelines.

7. The NCC advises that the government should commission a review of existing targets to scope which areas require stronger and/or new targets to improve air quality, as part of its target setting process.

42 Defra, *Environment Bill – environmental targets* (2020) https://www.gov.uk/government/publications/environment-bill-2020/august-2020-environment-bill-environmental-targets

43 Defra, *Clean Air Strategy* 2019 (2019) https://www.gov.uk/government/publications/clean-air-strategy-2019

Freshwater

The NCC has scoped the freshwater asset and identified the most important components, and the pressures acting upon them, for judging condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis (with further detail on the analysis and approach set out in **Annex 2**), and recommendations.

Background

Freshwater is essential for life. Of all the water on Earth, only 2.5% is freshwater, and only 1% of this is accessible for human use.[44] Freshwater is utilised by many sectors of our economy, as well as being used for recreation and wellbeing. Both the availability and quality of freshwater are important considerations. Too much water, and the timing of such an event may cause flooding. Conversely, too little water can result in drought. These, together with the presence of pollutants, are pressures which have implications for humans, nature, and the economy.

The Water Framework Directive (WFD)[45] provides a valuable source of long-term data on the condition and extent of some freshwater bodies.

Overview of approach to assessing the freshwater asset

The NCC has undertaken a literature review to identify datasets which indicate the condition and extent (or availability) of the freshwater natural capital asset. Based upon this, the NCC have identified three components of the freshwater asset; surface water, groundwater bodies and water resources as displayed in Figure 3.

The NCC approach adopted for assessing surface water and groundwater bodies is derived, albeit not exclusively, from the WFD where *most* surface water and groundwater bodies have been subject to long-term monitoring. WFD monitoring programmes inform River Basin Management Plans[46] which direct how freshwater is managed and improved.

The Environment Agency publishes a series of datasets to comply with the WFD[47,48], which are more comprehensive than the data available for most of the other natural capital assets. This open source data has formed the basis of the NCC's assessment. However, being collected for the purpose of the WFD, these datasets are not fully compatible with a natural capital approach. For example, analysis and reporting at different geographic scales beyond the core WFD process can be complex.

WFD data, collated by the Environment Agency, is presented for cycle 1 and cycle 2,[49] for the former the baseline point is 2009 and for the latter, the baseline point is 2013. It is important to highlight that these two cycles and respective datasets are not directly comparable, as cycle 2 follows a different monitoring and classification standard. Further detail can be found under the Environment Agency *Data Catchment Explorer*[50, 51] website.

The overall assessment of surface water is underpinned by an analysis of lakes, rivers and streams, canals, transitional water bodies and small water bodies have been individually assessed – see Figure 3. The sub-component assessment follows the same approach of the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. Groundwater bodies are not divided into sub-components in the WFD in the way that surface water bodies are.

44 National Geographic: *Freshwater Crisis*. https://www.nationalgeographic.com/environment/freshwater/freshwater-crisis/

45 The EU Water Framework Directive https://ec.europa.eu/environment/water/water-framework/index_en.html

46 River Basin Management Plans https://www.gov.uk/government/collections/river-basin-management-plans-2015

47 Environment Agency, *Catchment Data Explorer* https://environment.data.gov.uk/catchment-planning/

48 Data published by central government. https://data.gov.uk/

49 There are differences in the waters bodies that are monitored between cycle 1 and 2. In the majority of cases there was little or no change from the water body reported in the first cycle River Basin Management Plan (RBMP). In others, due to extensive merging or splitting of waterbodies, there was a significant change. This process resulted in the creation of some new waterbodies, e.g.: by splitting a large waterbody into two small new ones, as well as the removal of many small waterbodies which were below the size thresholds set out in the WFD guidance. **Source:** https://data.gov.uk/dataset/b8580c97-8108-46cd-8295-ec0c431a2937/wfd-water-framework-directive-cycle-1-and-cycle-2-water-body-changes

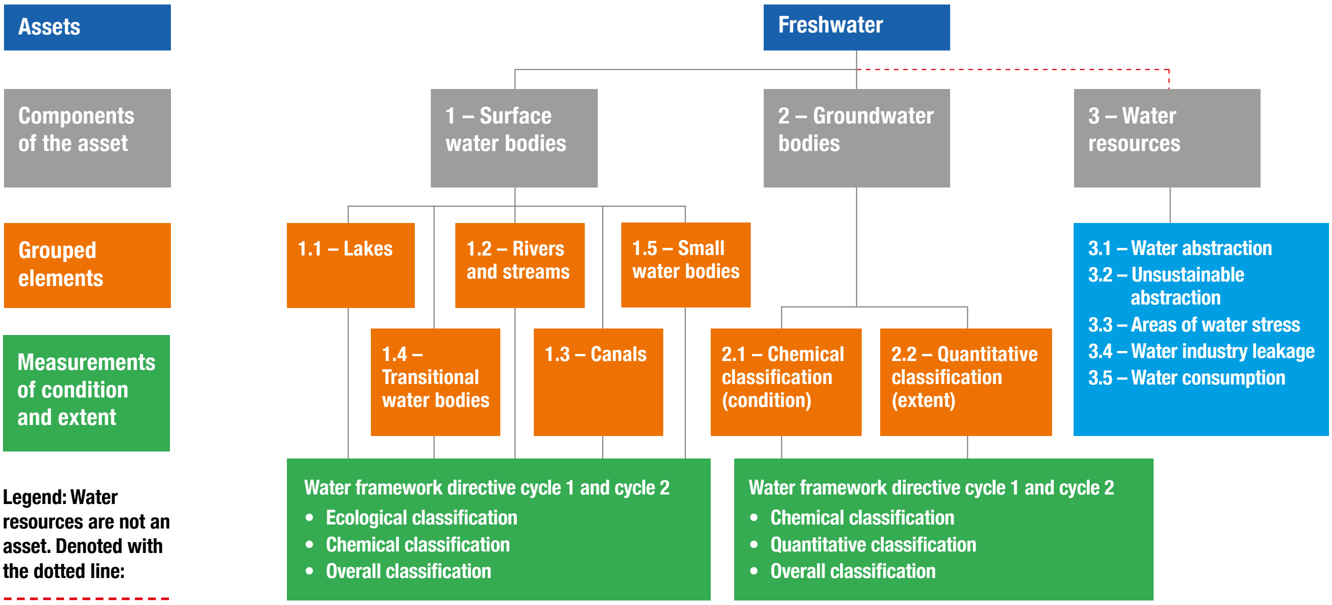
50 Environment Agency, *Catchment Data Search* https://environment.data.gov.uk/catchment-planning/

51 At the time of producing this document additional WFD data was published by the Environment Agency, available at https://environment.data.gov.uk/catchment-planning/data-download/#/. There was insufficient time for the NCC to carry out an assessment of this data.

The literature review has identified a notable gap in freshwater data relating to small water bodies[52]. These are standing or flowing bodies of freshwater which can be man-made or natural, e.g.: ponds or streams. As small water bodies fall outside the remit of the WFD, most do not have any long-term systematic monitoring of quality and extent. The exception to this is where a small waterbody is a protected site, such as a Site of Special Scientific Interest.

The NCC has assessed the available data on water resources. This third component considers the pressures for the freshwater asset resulting from human use of the resource. The objective is to present a comprehensive picture and show the scale and key sources of pressures on this asset. Water resources have been assessed using a number of open data sources covering water abstraction, unsustainable abstraction, water stress, leakage and consumption.

Figure 3 Freshwater components for assessment



Source: NCC 2020

Summary of the analysis

The overall assessment of the freshwater asset – based on the datasets available – **is 'Red': deteriorating** – this is based on the limited progress government has made towards meeting targets. There are three drivers for this assessment, summarised in Table 6. Firstly, surface water bodies are not on track to meet the objective for 75% to have 'good' ecological status or potential by 2027. Secondly, ground waters bodies are not on track to meet the objective for 87% to have 'good' chemical status and 82% to have 'good' quantitative status. Lastly, limited progress has been made towards reducing water abstraction, reducing consumption per capita and reducing water industry leakage. The key findings in terms of the three subgroups of the freshwater asset are:

- Surface water bodies are not on track to meet the Water Framework Directive (WFD) objective for 75% to have 'good' ecological status or potential by 2027. Only 16% of surface water bodies achieved 'good' and 'high' status in 2018.
- The number of rivers and streams meeting the WFD cycle 2 objectives of 'good' ecological status has declined from 28% in 2013 to 14% in 2018.
- Groundwater bodies meeting 'good' chemical status (condition) is only 53% vs. a target of 87%, and 'good' quantitative status (extent) is only 69% vs. a target of 82%.

52 Riley, W.D. et al., *Small Water Bodies in Great Britain and Ireland: Ecosystem function, human-generated degradation, and options for restorative action* (2018). *Science of the Total Environment* 645, 1598–1616. https://doi.org/10.1016/j.scitotenv.2018.07.243.

- The significant water management issues impacting the water environment include physical modifications (affecting 39% of waterbodies in England), pollution from wastewater (affecting 35% of waterbodies in England), and pollution from rural areas (affecting 35% of water bodies in England).[53]
- The status of many small freshwater bodies is not currently monitored as this is not a requirement of the WFD. The data that does exist is not assessed centrally.
- Limited progress has been made towards reducing water abstraction (between 2011 and 2017), reducing consumption per capita (between 2011/12 and 2017/18) and reducing water industry leakage (between 2014/15 and 2017/18).
- Around 22% of water currently put into the supply is lost through leakage, equating to around 3 billion litres of water per day.[54]
- In 2019 no surface water bodies assessed in the UK met the criteria for good chemical status.

The assessment uses a 'RAG' rating approach to indicate the status of the three freshwater components. Please see Table 6 and associated descriptive text for further information and **Annex 2** for a detailed analysis of the atmosphere asset and its components.

Table 6: Indicative assessment of freshwater

Components of the asset	Data availability	Overall assessment
1. Surface water bodies	There are limitations to the surface water assessment, because: • The most recent data is from 2016 as the Environment Agency has moved to triennial reporting. • There is no comprehensive data on S mall water bodies (SWB). As a result, the assessment is based on a limited set of evidence.	The RAG rating is deteriorating, even though data from the WFD cycle 2 on chemical classification presents an increase in the percentage of water bodies that meet 'good' status. This is because there has been a significant decline in ecological status. Surface water bodies are also not on track to meet their target of 75% of achieving 'good' ecological status or potential by 2027, with only 16% achieving 'good' status in 2018.
2. Groundwater bodies	There are limitations to the groundwater bodies assessment, because: • The most recent data is from 2015.	The assessed RAG rating for groundwater bodies shows that groundwater bodies are deteriorating. This is because groundwater bodies are not meeting their 'good' chemical status (87%) or 'good' quantitative status (82%) and the latest data present a mixed outcome. Where around 53% achieved 'good' chemical status and around 69% achieved 'good' quantitative status in 2015 (in cycle 2).
3. Water resources	There is limited data available on water consumption per capita, areas of water stress and unsustainable abstraction.	Based on the increase of water abstraction over the last five years, and that water consumption per capita and water leakage have remained somewhat stable/declined, the RAG rating for water resources is red.

53 Based on the finding from the Environment Agency (EA) on the River Basin Management Plans: national evidence and data report – https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report

54 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

Recommendations

The systematic monitoring of the freshwater bodies included in the WFD means that there is an established dataset and associated targets already in place for most of the freshwater natural capital assets. This, together with the established River Basin Management Planning process, means that there already exists an institutional framework for improving freshwater. In this context, the NCC advises that there is considerable scope to achieve better progress towards improving the condition and extent of the freshwater asset (i.e. the second of the 25 YEP goals: '*clean and plentiful water'*). The Committee's recommendations are set out below.

1. The NCC advises that any future natural capital based assessment should consider the long-term economic benefits of wide scale river restoration projects to restore modified waterbodies to a near natural state. Land use change projects including changes in farming practices should also be central to this assessment, and the impacts on the marine environment considered.

2. The government should develop a baseline and metrics for the condition and extent of smaller waterbodies comparable to those for WFD water bodies. Such an assessment should look to incorporate citizen science to engage communities, and the use of other developing monitoring approaches.

3. The River Basin Management Planning process[55] directs how organisations work to improve freshwater within each of the eight river basin districts. In spite of this process, the results of the NCC assessment indicates 25 YEP objective of clean and plentiful water is unlikely to be achieved if the current trajectory continues. A natural capital based assessment of the investment required to improve freshwater and the long-term economic benefits of this approach is urgently needed.

4. The water abstraction plan describes how unsustainable abstraction is currently being addressed.[56] Long-term water abstraction targets mirroring the ambitions of the 25 YEP are required to direct action beyond 2027.

5. The 25 YEP reiterates Ofwat's challenge for water companies to reduce water leakage by 15% between 2020-2025.[57] The NCC support the conclusions of Environment, Food and Rural Affairs (EFRA) Committee that a more ambitious long-term target is needed for this metric.[58]

6. The NCC recommends more stringent measures to be introduced to reduce per capita consumption of water by consumers, focusing on the areas at risk of serious water stress.[59] A literature review to discover why similar countries, such as Germany, have a lower per capita consumption and if their models of water use could be adopted in England.

55 Environment Agency, *River basin management plans: 2015* https://www.gov.uk/government/collections/river-basin-management-plans-2015

56 Defra, *Water abstraction plan 2016* (2020) https://www.gov.uk/government/publications/water-abstraction-plan-2017/water-abstraction-plan

57 Ofwat, *PR19 final determinations: Securing cost efficiency technical appendix* (2020) https://www.ofwat.gov.uk/publication/pr19-final-determinations-securing-cost-efficiency-technical-appendix/

58 Environment, Food and Rural Affairs Committee, *Regulation of the water industry: Eight Report of Session 2017-19* (2018) https://publications.parliament.uk/pa/cm201719/cmselect/cmenvfru/1041/1041.pdf

59 Environment Agency, Areas of water stress: final classification (2007) https://www.iow.gov.uk/azservices/documents/2782-FE1-Areas-of-Water-Stress.pdf

Marine

The NCC has scoped the marine asset and the most important components, for judging condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis (with further detail on the analysis and approach set out **in Annex 3**), and recommendations.

Background

The UK's marine environment provides important regulating ecosystem services including coastal protection, climate regulation, and waste management (e.g. detoxification and sequestration) and assimilation.

Benefits (or 'ecosystem services/flows') from better management of marine natural capital include:

- Biodiversity;
- Recreation and wellbeing;
- Carbon storage and sequestration;
- Food production;
- Waste management; and
- Flood water storage and protection from extreme weather events.

Marine assets (and processes) operate together within a complex system to provide these services, and within this system, the synergistic effects[60] of changing components can produce multiple and varied outcomes; 'tipping points' can occur as 'thresholds'[61] are passed such that certain changes have knock-on and possibly catastrophic effects on related assets and the services they deliver.

For example, evidence suggests that the abiotic changes detailed in the analysis below are driving changes in oceanographic systems and the functioning, dynamics and structure of marine ecosystems. Analysis of available evidence, based on an extensive peer-reviewed research base, suggests that prevailing oceanographic and climatic conditions are the overall drivers of change for plankton productivity and distribution, with knock-on effects for the whole marine ecosystem and its services and benefits.[62]

Examples of how these changes are affecting marine ecosystems and the processes, such as the carbon cycle, which they support include:[63]

- Future warming is likely to continue the northward shift in the geographical distribution of primary and secondary production of plankton and may further decrease mean plankton community body size. This would have consequences for the entire marine food web, compounded by negative impacts on services such as oxygen production and ocean carbon storage as well as seafood production;
- Salinity and temperature changes affect water density, circulation patterns and stratification. Projected changes to shelf-sea stratification may lead to less upward mixing of nutrients, reduced primary productivity (largely from plankton) and increased eutrophication;
- Ocean acidification could negatively affect calcifying organisms of the plankton community and the rate at which they sink and transport carbon to the seabed.

60 An effect arising between two or more agents, entities, factors, or substances that produces an effect greater than the sum of their individual effects. **Source:** http://www.businessdictionary.com/definition/synergistic-effect.html

61 A point or level at which new properties emerge in an ecological, economic or other system, whereby a small change in a pressure or driver can lead to a relatively large change in the state of natural capital, with consequences for the benefits it provides (as illustrated in Figure 3). This new state of natural capital is called an alternative stable state. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Some of the best known examples arise from studies of abrupt responses in water quality in shallow lakes as a result of increases in pollution inputs. **Source:** NCC Terminology Paper: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf

62 Marine Climate Change Impacts Partnership, *Report Card 2020* (2020) http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/ and MOAT, Changes in plankton biomass and abundance (2020): https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/pelagic-habitats/plankton-biomass/

63 Ibid

Due to the systemic nature of the marine environment, with 'thresholds' and 'tipping points' still uncertain,[64] better understanding is required concerning how the different asset components operate together across this system in order to take a joined up natural capital approach to protecting them and the services they deliver.

The need to understand how marine assets operate together within a system is demonstrated by evidence on climate change and the marine carbon cycle. Climate change is already recognised as a major pressure on marine assets, the effects of which are likely to increase in coming decades. Despite this, our understanding of its effects on marine assets is remarkably limited; the NCC's assessment finds that there is not even sufficient data to draw an assessment of organic carbon in the water column and sediment, despite the statutory commitment to deliver net zero. Marine ecosystems are important for climate regulation and are responsible for an estimated 55% of the world's biologically sequestered carbon,[65] and, at the same time, they are affected by changes in climate regulation processes. *"Under a high-emissions scenario, models predict that the amount of Particulate Organic Carbon (POC) reaching the Atlantic seafloor will decrease by ≤15%, resulting in a ≤7% reduction in benthic biomass"*.[66]

Available evidence makes it clear that warming seas, reduced oxygen, ocean acidification and sea-level rise are already affecting UK coasts and seas. These changes are putting increasing pressure on food webs, with effects seen in seabed-dwelling species, as well as plankton, fish, mammals and birds.[67] Climate change is not the only pressure on marine ecosystems however, and change driven by other human activities also affect these natural capital assets. The changes detailed in Annex 3 signal the need for further research into how natural capital assets are affected by both environmental drivers and human pressures such as fishing and pollution.

The NCC considers that an asset based assessment of biologically mediated natural carbon stocks in the marine environment would provide a powerful tool for marine management even just considering carbon sequestration. The importance of carbon cycling in the UK's temperate marine ecosystems is largely ignored in natural capital accounting. Coastal habitats alone (i.e. saltmarshes and sand dunes) if maintained in their current state could contribute around £1bn in CO_2 sequestration over the period 2000-2060 (3.5% discount rate), but that may fall to £0.25 billion if habitat loss continues.[68] However, biogeochemical cycling of marine carbon (between the overlying air, seawater and seabed) is itself an integral process within the marine environment with huge implications for all marine assets and the services they provide.

The importance of understanding the role of integrated processes in marine ecosystems, and how they will adapt to change, starts to be reflected in the 25 YEP Progress Report 2020. The report lists the main action taken towards 25 YEP goal three, thriving plants and wildlife, as also the main contributor towards goal seven, mitigating and adapting to Climate Change: *"helping to restore the marine environment's resilience to climate change by designating 41 new Marine Conservation Zones covering 12,000km² of marine habitat."*[69]

Overview of approach to assessing the marine asset

The NCC has undertaken a literature review to scope out measurements (datasets) to assess the condition and extent of the marine natural capital asset. The assessment uses data and evidence from a range of sources.

As per the limitations discussed below the evidence presented here should be treated with caution and at best presents an indication of the condition and extent of the marine asset and its components. The NCC has presented as much data as was readily available and was unable to present a comprehensive assessment.

To produce the assessment of marine, the NCC started by scoping out the abiotic components of the asset which are presented in Figure 4 below. The 'seawater' marine asset includes coastal and offshore marine waters, with transitional waters included as a component of the freshwater asset (see Annex 2). The 'seabed' element of the marine asset consists of the seabed below the littoral zone. Littoral, supralittoral, and coastal components are included in the terrestrial, freshwater, and land asset (see Annex 6). A data trend assessment followed (where data and evidence were available) to consider how these components and subcomponents changed over time, and where possible try to infer the status of their condition and extent.

64 See NCC Terminology Paper, p10: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf

65 Nellemann, Christian et al., *Blue carbon A UNEP rapid response assessment* (2009): https://www.researchgate.net/publication/304215852_Blue_carbon_A_UNEP_rapid_response_assessment

66 Marine Climate Change Impacts Partnership, *Report Card 2020* (2020) http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

67 Ibid

68 Beaumont et al., The value of carbon sequestration and storage in coastal habitats (2014) https://www.sciencedirect.com/science/article/pii/S0272771413005143?via%3Dihub

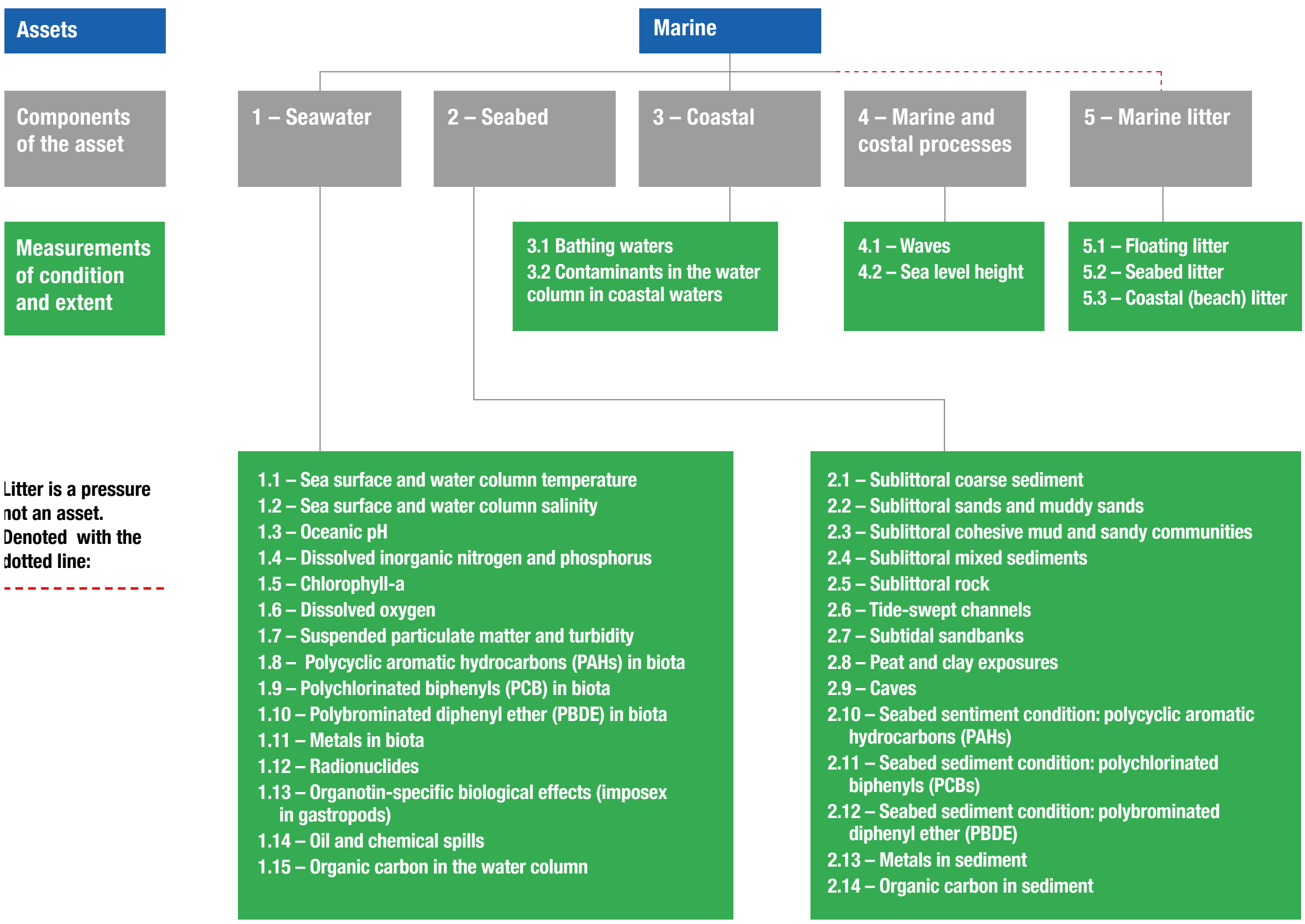
69 Defra, *25 Year Environment Plan progress report: April 2019 to March 2020* (2020) https://www.gov.uk/government/publications/25-year-environment-plan-progress-reports

There are significant data gaps in the marine environment when compared to other assets such as the atmosphere and freshwater. For some of the marine and coastal components where data is available, it is often based only on a small number of sites, and/or the time series covers only a short or sporadic period, or it is modelled data.

Given the small number of monitoring sites, for several of the components discussed in Annex 3 , the evidence presented is based on modelled analysis and is somewhat dated, for example, with the most recent assessment being from 2015 or earlier. There is a clear need for more periodic reporting and maintenance of the data. Significant further work is needed to improve the quality of the data and increase data availability for trend analysis.

There is also a limitation in the spatial scale and cover of availability of data for England, availability of data for England is limited and has only been found with only a couple of the components such as coastal bathing waters and litter having a reasonable cover. Given this limitation, data for the UK and sea regions around England and the UK have sometimes been used as a proxy. This was necessary to enable an assessment to be made.

Figure 4: Marine components for assessment



Source: NCC 2020

Summary assessment of marine asset

To provide an assessment of the marine asset, a RAG rating is used to indicate the change over time, and where data is available since 2011. Please see Table 7 and associated descriptive text for further information.

Where data was available, an indicative trend assessment of the historical data was undertaken as per Table 7. The 2011 point is used as the starting point for the assessment, as this was when Government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses*."[70]

The overall assessment of the marine asset annex, based on the datasets available, is **'Red': deteriorating** – this is based on the fact that the amount of litter in coastal and marine areas has increased, that coastal waters are not meeting the WFD 'good' ecological status target and that not all bathing waters achieved sufficient status. Further details can be found in **Annex 3**. As the summary of the NCC's assessment in Table 7 shows, the data available does not allow for more than a very partial assessment of the extent and condition of marine natural capital assets.

The best available evidence for the marine environment indicates deteriorating asset condition and huge changes in line with predicted climate change trends, at the same time as only delivering a partial picture. This is a significant cause for concern and further investment in monitoring these assets is needed – the marine environment supports major earth systems. Prevailing oceanographic and climatic conditions are the overall drivers of change for plankton productivity and distribution, and for other marine biota, with knock-on effects for the whole marine ecosystem and its services and benefits.

The key messages from the NCC's assessment are as follows:

- The available marine data provides an incomplete picture, with very limited data on marine assets despite the fact that the UK is an island nation with considerable marine natural capital assets, services and benefits.
- For the majority of asset components, there is a lack of systematic data points to provide sufficient spatial coverage to indicate trends and to provide a baseline against which to measure change. This means that maps showing the extent of assets such as seabed components and water column characteristics rely heavily on modelling, introducing a high degree of uncertainty into our understanding of the extent and condition of marine assets.
- Trends for some physical and chemical parameters since 2011 indicate drastic climate-driven change in the marine environment. For example, seawater pH levels are decreasing due to the absorption of CO_2, a process known as increasing ocean acidification.
- There is insufficient data to draw an assessment of organic carbon in the water column and sediment.
- Of the 36 measurements assessed by the NCC, only 17 had an associated quantitative target, commitment or threshold set.
- The NCC has not had the resources to carry out a full analysis including data on marine biota. However, warming seas, reduced oxygen, ocean acidification and sea-level rise are already affecting UK coasts and seas.[71]

70 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

71 MCCIP, *Report Card 2020* (2020): http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

Table 7: Indicative assessment of the marine asset

Components of the asset	Data availability	Overall assessment
1. Marine seawater	There is limited trend data available and, in most cases, this is somewhat dated (e.g.: most recent data is from 2015) and the raw data is not available only the final analysis.	The amber RAG rating here is based on the limited data available – needs to be treated with caution. Most of the measurements in the assessment are rated amber – no change/not possible to assess due to the way the data is presented (e.g.: covers a broad period 2010-2015) or data is not available.
2. Marine seabed	Data is not available for all or most of the seabed components. Data is only available as maps or point in time.	Unable to produce an assessment as there is insufficient data available.
3. Coastal	Data is available at the England level for both coastal and bathing waters and a time series is available.	The RAG rating here is deteriorating, given that coastal and bathing waters are not meeting their respective Water Framework Directive (WFD) and Bathing Waters Directive (BWD)[72].
4. Marine and coastal processes	The NCC has not been able to find enough data for waves. While for sea level data is available but is limited to a few sites and the time series varies from site to site.	Unable to produce an assessment as there is insufficient data available.
5. Marine and coastal litter	There is limited data available and a time series exist for: • Beach litter; and • Seafloor litter.	The RAG rating here is deteriorating, this is on the basis that the Government is not meeting its target for plastic in Fulmar stomachs, and litter on beaches and the seafloor have increased.

Recommendations

Application of the natural capital approach to the marine environment presents particular challenges, but these are not insurmountable and should not detract from the importance of continuing to seek mechanisms by which to apply the approach in practice. As an island nation, the UK has considerable marine natural capital assets services and benefits that could support and underpin green-blue economic growth. In general, data for England's marine environment are inconsistent, and there are significant gaps in understanding how habitats and species support the delivery of ecosystem services.

1. Available evidence on biotic components indicates significant change in the marine environment in line with climate change scenario modelling, and Government should prioritise achieving a better understanding of how these changes affect marine natural capital assets, the dynamic flows of services and benefits, and the system as a whole.

2. The government should urgently address data gaps related to assessing the extent and condition of marine natural capital assets, with a particular focus on how changes in the marine environment affect the dynamic flows of services and benefits. This evidence should then be utilised through the Environment Bill targets framework to review and set targets for marine beyond marine protected areas (MPAs) as a matter of urgency.

3. The additional funding for monitoring and reporting through the proposed Natural Capital and Ecosystem Assessment provides an opportunity to broaden the scope of marine monitoring to allow for a joined up natural capital approach to protecting and improving the broad suite of marine assets.

72 Although the overall assessment for the coastal asset is red, there has been significant progress made to bathing waters which has been RAG rated as amber.

4. The NCC acknowledges the government's intention to limit marine targets to a biodiversity target for marine protected area (MPA) condition, within the first suite to be set under the statutory framework of the Environment Bill.[73] The NCC strongly advises that this should not prevent the Environment Bill framework from driving the protection of natural capital assets across the marine environment, in line with the 25 YEP goals. The current focus on MPA condition does not reflect the interconnected nature of the wider marine environment and its components and will not allow for integrated implementation and assessment measures to improve the condition of marine natural assets.

5. Instead, the NCEA should aim to build the evidence and understanding required to assess natural capital assets across the marine environment as part of an integrated system. A systems' approach is required that reflects the highly interconnected nature of marine natural capital assets and the processes, and services they support. Marine monitoring addresses the lack of systematic data and uncertainty about asset extent and condition, as well as providing data on the effect of all of these physical and chemical factors on biotic assets. This will support and validate modelling for future changes and hence enable prioritisation and reduction in future monitoring needs. Without this, future interventions and targets will be limited by the same failure of evidence on assets, and dynamics of the system that maintains them, which prevents action today.

6. A priority for future assessments should be organic carbon in the marine environment, as well as better understanding the effects of change on the carbon cycle: there are indicators that the cycle/system is changing, but since data for the carbon itself is not available, it remains a poorly quantified element of an interconnected system. Marine ecosystems are vital for global carbon regulation but the extent of biological carbon storage and sequestration in marine is poorly quantified despite being likely as significant a factor as terrestrial equivalents in soil and biota.

73 Defra, *19 August 2020: Environment Bill – environmental targets* (2020) https://www.gov.uk/government/publications/environment-bill-2020/august-2020-environment-bill-environmental-targetsh

Soils

The NCC has scoped the soil's asset and the most important components for judging the condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis (with further details on the analysis and approach set out in **Annex 4**), and recommendations.

Background

Improved soil management can bring a multitude of benefits including: nutrient cycling; water regulation; carbon storage; biodiversity; enhanced climate resilience; food and fibre production; waste management; greenhouse gases emission control; and reduced erosion.

The NCC has previously advised on developing a set of metrics for assessing healthy soils.[74] Metrics should be developed as a priority and data gaps should be filled to deliver the information on soil type, condition and extent which will be needed to inform decision making regarding interventions at both national and local scales. This will require significant resources, and the aim for a suite of actions to ensure soils are sustainably managed by 2030 needs to be implemented urgently. The NCC's partial analysis shows that further data is needed on soil carbon and many other aspects of soil that deliver benefits.

Defra has advised that it is developing a healthy soils indicator as part of the 25 Year Environment Plan Outcome Indicator Framework (25 YEP OIF), and has established five broad soil types for which a future soil indicator will identify the key biological, physical and chemical soil health variables which best inform the condition of each of these five broad types.[75] The NCC advises that Defra will also need to prioritise developing an understanding of how land management practices impact soils' ability to deliver environmental benefits. An improved understanding of this is also committed to the environmental targets policy paper. However, the NCC advises that this must be incorporated in assessments as a priority if the government is to meet its aim for sustainable management of soils by 2030. For example, 79,164 hectares (7.2% of total developed land in England) were converted from non-developed to developed use between 2013 and 2018, representing a major pressure on the extent and condition of soils.

With a complex system of pressures and flows driving changes in soils and the services they provide; it is vital to have a clear picture of both the extent and condition of different soil types and also their function/the services they deliver. There will not be a 'one size fits all' indicator for soil health, and the soil types will need to be assessed across different land cover/habitat types.

Most evaluations carried out have assessed the suitability of soils for particular uses such as agriculture, focusing on soil assets grouped under certain land use categories, particularly arable soils. Soils managed as part of woodland habitat, or peat soils, for example, require a different set of metrics to indicate their condition. It is clear that land use needs to be considered to supplement data on soil types in order to assess these assets and on both local and national scales.

Hence while the results of the NCC's assessment highlight the urgent need for further national monitoring programmes to assess the extent and condition of soils, such a monitoring programme will need to be integrated into a wider systems based natural capital approach to ensure that all assets, flows and benefits/ecosystem service – services such as habitat specific trends, and the importance of biota to soil function – can be accounted for.

A good example of this is how soil carbon change has varied not only across different soil types but also across land use categories. Policy aimed at managing soil carbon will need evidence of the biological, physical and chemical parameters that control soil function, and also the type of habitat/land use in which the soil exists; all of these affect soil carbon stocks, and will be needed to inform interventions to manage them (see **Annex 4** for detail on how the Office for National Statistics has calculated estimates for soil carbon stocks).

74 See https://www .gov.uk/government/publications/natural-capital-committeeadvice-on-developing-an-environmental-baseline-census and Natural Capital Committee advice on soil management: https://www.gov.uk/government/ collections/natural-capital-committee-documents See https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census and Natural Capital Committee advice on soil management: https://www.gov.uk/government/collections/natural-capital-committee-documents

75 Defra, *Environment Bill – environmental targets* (2020) https://www.gov.uk/government/publications/environment-bill-2020/august-2020-environment-bill-environmental-targets

Targets

The Environment Bill targets policy paper states that the development of a long-term, outcome based soil target can only begin once work to develop metrics and an indicator for soil health is complete. A commitment has already been made to develop a suite of tools for managing soils sustainably by 2030, first in Defra's 2009 publication Safeguarding Our Soils and recommitted to in the 25 YEP.[76]

The NCC has also researched existing targets/thresholds for components being assessed under soils, finding only one commitment for organic carbon, and found no targets, thresholds or objectives for the other measurements that could be applied generally to soils. The NCC considered Soil Guideline Values developed by the Environment Agency, and category 4 screening levels (C4SL) developed by Defra, but these are maximum thresholds for chemicals in contaminated land in respect to human health, primarily for use in urban planning, and don't apply more widely to soils. There are no firm, legally binding commitments in the 25 YEP or elsewhere for the improvement of the condition and extent of soils.

A starting point would be to undertake an England-wide measurement of soil carbon. Carbon is the primary metric to target to begin the process of improving soils; it is central to soil function as it sustains biological activity while providing nutrition and conditions for crop growth. This would also be in line with the work being undertaken by the Scottish and Welsh Governments, where soil carbon is being used as an ecosystem health indicator and a wellbeing indicator respectively. Additionally, there is industrial interest in carbon sequestration for the purpose of offsetting and policy engagement through the 4 per 1000 initiative. Care is required regarding just how much carbon soils can retain, but operational envelopes can be developed.

Overview of approach to assessing the soils asset

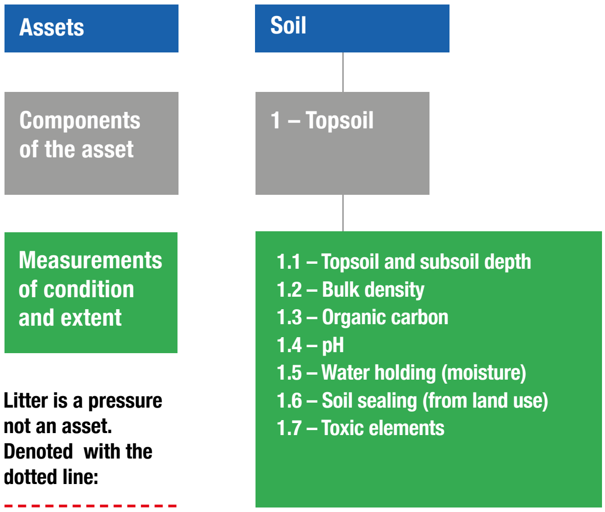
Unlike other assets assessed by the NCC, there are no government national statistics on the state of soils in England. There is only a limited amount of data from two key sources, and these are not based on a long-term time series but based on ad-hoc sampling. For example, the Countryside Survey (CS) has only been undertaken three times: in 1978, 1998, and 2007 and this forms the bulk of the evidence that follows.

Given the limited evidence that is available, the NCC has not produced a detailed/comprehensive assessment of soils. Instead, the NCC has presented the available evidence on key measurements such as soil carbon, pH, and contaminants. These only provide a high-level indication of the state of soils and several other measurements are required to enable a more detailed assessment. The NCC has also included a list to supplement the evidence presented when aiming for a more complete picture in future. This list includes components also identified as contributing to soil health, but which are out of the scope of this exercise (broad scoping of soil asset extent and condition based upon available data). The measurements of this list could form part of broad soil health. These include measurements such as macronutrients, toxic elements, and metals. See Table 9 found in Annex 4.

In line with the approach taken with the other natural capital assets, the NCC has started by scoping out the important components of the soils asset, as presented in Figure 5. There is a single overall component – topsoils – with 21 sub-components. This reflects the data availability which is mostly based on topsoil sampling covering a depth of 0-15cm. Based on this topsoil data, trend assessment followed (where data was available) to see how the measurements in Figure 5 changed over time and, where possible, try to infer the status of their condition and extent.

76 Defra, *Safeguarding our soils: A strategy for England* (2009) https://www.gov.uk/government/publications/safeguarding-our-soils-a-strategy-for-england

Figure 5: Soil components for the assessment



Source: NCC 2020

Summary of the analysis

The overall assessment of the soils asset, based on the datasets available, is **'Red': deteriorating**. In order to provide a sense of the condition and extent of soils in England, the NCC has looked at key soil measurements (indicators) to assess soil health, as listed in Table 8. These measurements present a snapshot based on available data, and could form the basis for a baseline assessment of soils. The key messages from the NCC's assessment are as follows:

- Several of the metrics included in the NCC's assessment which are important for soil health (covering data from 2007 or earlier) indicate a deterioration.
- Many of the soil asset components considered in the NCC's analysis did not have data available at a sufficient spatial and especially temporal coverage to allow an assessment of the condition/extent of England's soils. The partial data available, the majority of which is sourced from the 2007 Countryside Survey, shows that important components of soil health are changing. Trend data on soil depth, extent and condition are not available, but pressures on soils have been increasing.
- Carbon is a key metric for determining soil health, yet there is only limited data on carbon in soils.
- The Ministry of Housing, Communities and Local Government (MHCLG) reported in 2018 that 8.3% of England's land area has been for developed use. Of this total, 7.2% (79,164 hectares) was converted from non developed to developed use between 2013 and 2018.[77] Developed land is very likely to constitute land where soil sealing has occurred through the covering of soil with impermeable materials.

77 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018

Table 8: List of components for topsoils and soils

1. Topsoil	Asset component	Data availability/ overall assessment	Targets/thresholds/ objectives
	1.3 Organic carbon	Unable to produce an assessment as insufficient evidence and data is available.	The UK has signed up for the '4 per 1,000' initiative:[78] • The initiative aims for an annual 0.4% increase in soil organic matter.[79]
	1.1 – Topsoil and subsoil depth 1.2 – Bulk density 1.4 – pH 1.5 – Water holding (moisture) 1.6 – Arsenic 1.7 – Cadmium (Cd) 1.8 – Chromium (Cr) 1.9 – Lead (Pb) 1.10 – Mercury (Hg) 1.11 – Platinum (Pt) 1.12 – Tin (Sn) 1.13 – Titanium (Ti) 1.14 – Vanadium (V) 1.15 – Boron (B) 1.16 – Chlorine (Cl) 1.17 – Copper (Cu) 1.18 – Iron (Fe) 1.19 – Manganese (Mn) 1.20 – Molybdenum (Mo) 1.21 – Nickel (Ni)	Unable to produce an assessment as insufficient evidence and data is available.	No specific target exists for these components, except where detailed below.

Recommendations

1. The NCC repeats its recommendation that a national survey is urgently needed to provide data on the condition and extent of soils, including establishing a baseline assessment of soils against which change can be measured. Only then will we know if we are on track to meet the government target to manage our soils sustainably by 2030. This requires a significant scale up in the number of sites monitored consistently at fixed periods to provide appropriate time series to demonstrate change. The national survey should aim to improve certainty in modelled data, with data updated regularly. Defra's proposed Natural Capital and Ecosystem Assessment should be used to deliver this, with a focus on delivering coverage at appropriate spatial scales.

2. The NCC advises that soil condition and extent metrics should be developed as a priority, utilising both new and current data so that this is available to inform decision-making regarding interventions at both national and local scales. This requires capacity to use this data to develop indicators for different soil functions, going beyond the previous focus on agriculture and contaminants to assess for the broad range of services that soils provide.

3. The five soil types outlined in the Environment Bill targets policy paper is a good place to start but looking at these alone will not allow for a systems based natural capital assessment. There will not be a 'one size fits all' indicator for soil health, and the soil types will need to be assessed across different land cover/habitat types to assess their condition and the services they deliver and understand how/why these are changing over time.

78 4 per 1000, *Welcome to the "4 per 1000"* https://www.4p1000.org/

79 Soil Association, *Measuring soil health* (2018) https://www.soilassociation.org/media/15138/monitoring-soil-health.pdf

4. Government should build on heightened current levels of engagement from land managers, including by delivering financial incentives for improving the health of soils through the proposed Environmental Land Management scheme. Soils should be a priority outcome for the delivery of public money for public goods delivered through the scheme. The scheme should provide funding to support the broad range of public goods that soils provide and should not include funding aimed primarily at improving the productivity of soils for agriculture as food is a private good.

5. If current evidence is not sufficient to support a legally binding target for soils through the Environment Bill legislative framework, then the NCC recommends setting a shadow target for soils to be put in place in the interim, in line with the ambition to ensure soils are sustainably managed by 2030.

6. The NCC has previously advised that carbon is the primary metric to target to begin the process of improving soils; it is central to soil function as it sustains biological activity while providing nutrition and conditions for crop growth. The potential sequestration of carbon in soils as a result of the net zero commitment will have a huge effect on agriculture and is an opportunity to deliver improved soil health and restored ecosystems. It is vital that the right framework is available for delivering this, and the data to support decision making.


SLOW

Land (terrestrial, freshwater, coastal and marine margin habitats) asset

The NCC has scoped the most important habitats and types of land covers and used existing evidence to judge the condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis (with further details on the analysis and approach set out in **Annex 5**), and recommendations.

Background

In developing the assessment of natural capital assets, the NCC has sought to separate out the biotic or 'living' elements, from the non-biotic. This allows for definitive measurements to be made about the extent or condition of an asset, through its components, without the use of proxies or overarching groups, giving a more accurate picture of the stocks of natural capital. In some instances, however, the functions provided by a component of an asset cannot be understood by just measuring the biotic and non-biotic components separately.

An example in the marine environment is the role of saltmarsh. Saltmarsh is made up of a range of biotic components (vegetation, insects, shellfish, worms, etc.), which create an accretion of minerals (sand, sediment) on the coast. A healthy functioning saltmarsh will provide a range of ecosystem services, including flood protection, spawning grounds for fish stocks, carbon absorption/sequestration, etc. Measuring the individual biotic elements, however, will not help to describe the entirety of the functions that they provide together, and the non-biotic elements will not exist without the biota. It is necessary therefore to think of the saltmarsh as an entity made up of biotic and non-biotic elements that work together as a habitat.

The UK Biodiversity Broad Habitat classification[80] sets out a framework for commonly defining habitat types across the whole of the UK. In this assessment, the NCC has identified the most important habitats from this list for ecosystem services where the biotic and non-biotic elements need to be considered together in order to accurately describe the ecosystem services provided.

The UK National Ecosystem Services Assessment (UKNEA)[81] was the first analysis of the UK's natural environment in terms of the benefits it provides to society and continuing economic prosperity. The England Biodiversity Strategy[82] sets out a range of targets for protecting and enhancing 'habitats', based on the recommendations of the UKNEA. It is notable however that the UK's 6th Annual Report on biodiversity[83] indicated that all of the targets set within the biodiversity strategy for 2020 were likely to be missed. A replacement for the strategy to protect England's biodiversity is currently in development. The findings from this assessment should help to target the terrestrial, freshwater, coastal and marine habitats which should be considered as priorities in terms of the ecosystem services and identify which pressures are preventing them from achieving a fully functional condition.

Overview of approach to assessing the Land (terrestrial, freshwater and coastal margins habitats) asset

Information on the condition and extent of the habitats for which the only available data assesses both biotic and non-biotic elements together has been considered. It has not been possible to assess connectivity given the lack/limited availability of data. In addition, the NCC has consolidated historical trend data on the priority habitats, which has not been presented previously by Defra (for example, only very recent data has been presented in the England biodiversity indicators). By doing so the NCC has been able to present the change in the condition and limited change to the extent (in terms of area (ha)).

Ideally, the physical features of the environment would be treated as separate assets to the biotic elements. The NCC's assessment has been presented in this way to the extent that the data allows. For example, the chemical classifications of freshwater environments have been presented in Annex 2 (freshwater), whereas the data on freshwater species has been presented in Annex 6 (biota). This assessment presents the information that cannot be separated in this way because it considers the biotic and non-biotic elements of each habitat together.

80 JNCC *Terrestrial habitat classification schemes* https://jncc.gov.uk/our-work/terrestrial-habitat-classification-schemes/

81 UKNEA http://uknea.unep-wcmc.org/Default.aspx

82 Defra, *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*(2011) https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

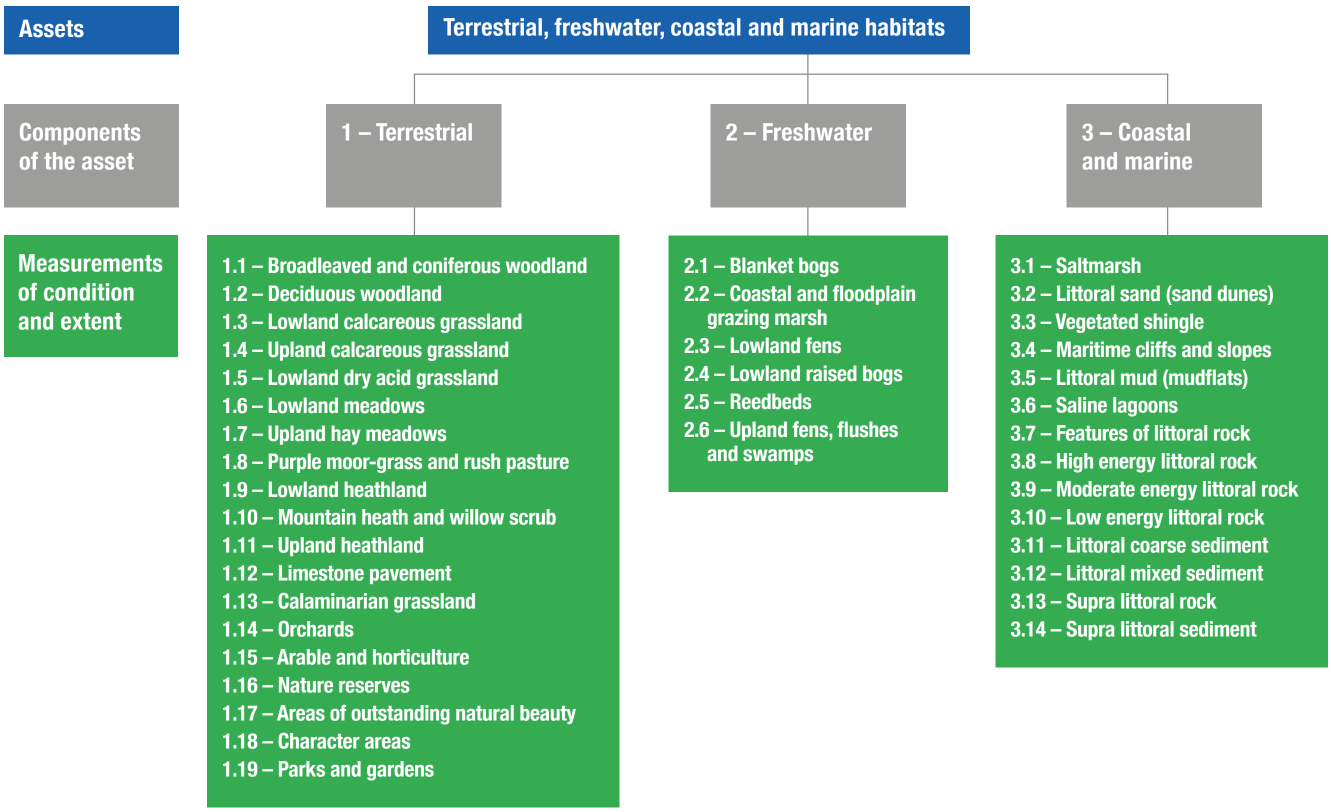
83 JNCC, United Kingdom's 6th National Report to the Convention on Biological Diversity2019 https://jncc.gov.uk/our-work/united-kingdom-s-6th-national-report-to-the-convention-on-biological-diversity/

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of terrestrial, freshwater, coastal margins habitats. In order to produce this assessment, the NCC has used datasets and evidence from:

- Natural England[84];
- Defra statistics [85,86,87];
- The Forestry Commission[88];
- UK Soils Observatory (UKSO)[89];
- The National Association of Areas of Outstanding Natural Beauty[90].

For each of the habitats shown in Figure 6, this annex assesses its condition and extent, and the trends.

Figure 6: Terrestrial, freshwater, coastal and marine margins environment



Source: NCC 2020

84 Several sources see sections that follow for specific sources of data/evidence.

85 Defra, *Extent and condition of priority habitats* (2019) https://www.gov.uk/government/statistics/england-biodiversity-indicators

86 Defra, *ENV09 – England biodiversity indicators* (2019) https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

87 Defra, *Structure of the agricultural industry in England and the UK at June* https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

88 Forestry Commission, *Woodland Area, Planting and Restocking: 2008 – 2020* – based on various weblinks see 2018 source here: https://data.gov.uk/dataset/c2cd1a34-743a-49e9-b953-77436d598627/woodland-area-planting-and-restocking-2018-edition

89 UKSO, *Land cover map 2015* (2017) http://www.ukso.org/static-maps/land-cover-map.html

90 The National Association of Areas of Outstanding Natural Beauty, *The UK's AONBs – Overview* https://landscapesforlife.org.uk/about-aonbs/aonbs/overview

Summary of the analysis

The NCC has produced a partial assessment of the condition and extent of terrestrial, freshwater and coastal margins habitats asset.

The assessment uses a 'RAG' rating approach, as per the other assets, to indicate the status of the terrestrial, freshwater, coastal and marine habitats asset and associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments.

The overall assessment of the terrestrial, freshwater, coastal and marine habitats annex, based on the datasets available, is **'Red'**: **deteriorating** – this is based on the fact that the majority of priority habitats do not meet the England Biodiversity target. Only 51% of National Nature Reserves (NNR) are in 'favourable' condition, and the number of parks in the risk register has increased between 2018 and 2019. This assessment is based on the three groups (see points 1-3 below) and is underpinned by the trend assessment made to the measurements (**see Annex 5** for further information).

1. Terrestrial;
2. Freshwater;
3. Coastal margins habitats.

The NCC's findings are presented in Table 9 with a RAG rating provided for each of the three groups. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the measurements. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC assessments are:

- The government is not meeting and is not on track to meet the Biodiversity 2020 Strategy target to have 90% of priority habitats in a 'favourable' or 'unfavourable recovering' condition.
- Of the 24 priority habitats, only 1/3 achieved the individual target of 80% of 'favourable' or 'unfavourable recovering' condition.
- There has been almost no change in the extent (in area terms) of individual priority habitats since 2011.

Table 9: Indicative assessment of the habitats assessed in this annex

Habitat type	Data availability	Overall assessment
1. Terrestrial	For most of the terrestrial habitats, the data is comprehensive. However, there are the following limitations: • The NCC has presented data from 2011, but only the 2019 data has been previously published. • The data for 'arable and horticulture' is limited to the total area covered by these two land uses. Information on the condition and extent of arable field margins (a priority habitat) is missing. • The data for parks and gardens is limited to estimates of the total numbers, rather than the area covered or their condition. • Ideally, biotic and non-biotic elements would be assessed separately.	Most terrestrial habitats have been deteriorating for the last several years (e.g.: traditional orchard) though some are in better condition than they were in 2011.
2. Freshwater	For most of the freshwater habitats assessed, the data is comprehensive. However, there are the following limitations. • The NCC has presented data from 2011, but only the 2019 data has been previously published. • There is no historic data on the extent of wetlands. • Ideally, biotic and non-biotic elements would be assessed separately.	Most of the freshwater habitats assessed have been deteriorating for the last several years, though some are in better condition than they were in 2011.
3. Coastal and marine	For most of the coastal and marine habitats assessed, the data is comprehensive. However, there is no data available on the condition or extent of littoral rock habitats. Ideally, biotic and non-biotic elements would be assessed separately.	Most of the marine and coastal habitats assessed have been deteriorating for the last several years, though some are in better condition than they were in 2011.

Recommendations

At present, there are targets for the improvement of priority habitats, however, based on the NCC's assessment of published data, the government is not on track to meet these outcomes by the end of 2020.

1. The NCC advises that the government should assess the feasibility of setting a legally binding target[91] through the Environment Bill to replace the existing target from the Biodiversity 2020 Strategy that will end in 2020.

2. The Committee recommends that a clear plan to deliver on the existing commitments is required. This should be closely linked to developing new metrics and prioritising improved monitoring to report on delivery of these commitments. The government should ensure that it commits the necessary resources to deliver on the improvement of priority habitats.

91 England Biodiversity strategy outcome: Better wildlife habitats with 90% of priority habitats in favourable or recovering condition and at least 50% of SSSIs in favourable condition, while maintaining at least 95% in favourable or recovering condition

Biota

The NCC has scoped the biota asset and created a high level framework for assessing the most important species, for judging condition (and extent). This section provides a background to the assessment and framework, an overview of the approach taken to produce the analysis, a summary assessment of the analysis and recommendations.

Background

In creating this assessment of natural capital assets, the NCC has separated out the biotic (or 'living' components) from the abiotic (see Figure 1, page 28). This was to give a more accurate picture of the stocks of each asset and avoid biotic elements being double counted as they exist across the different assets: dragonflies for example, live in both the freshwater and terrestrial assets.

The biota asset, therefore, consists of species and ecological communities. The NCC's 2014 paper, 'Towards a framework for defining and measuring changes in natural capital' defines species as: "*all living organisms including plants, animals, fungi and microorganisms*" and ecological communities as "*a group of actually or potentially interacting species living in the same physical environment e.g. wildlife habitats*."[92] Species and ecological communities deliver a multitude of benefits to humans and ensure ecosystems continue to function, for example they have a role in: decomposition and nutrient cycling, predation, carbon storage and sequestration, pollination, recreation, clean air and water, water purification and pest control.

There is plenty of evidence that species and the ecological communities they inhabit are in decline and targets to prevent this happening are not being met. For example, the recent Convention on Biological Diversity report states that *"none of the Aichi Biodiversity Targets will be fully met"*[93]. This has implications not only for the species themselves but also for the wealth of benefits to humans that they provide; both are at risk. Species and ecological communities operate within a complex system, including the abiotic assets, to deliver flows and services. The NCC advises that any assessment should aim to account for this system and focus on identifying species and community 'thresholds' past which species and communities may not be able to recover and therefore deliver benefits.[94]

Overview of approach to assessing the biota asset

The NCC has undertaken a light touch literature review to begin identifying datasets which measure the condition or extent of species. However, assessing all species in a taxonomic way has multiple issues and would lead to a large, complex and difficult to interpret dataset. It is therefore necessary to develop a natural capital method to categorise which species should form part of this assessment. The NCC's assessment has focused on a number of terrestrial species and ecological communities that are known to underpin critical ecosystem services and therefore any decline would result in a loss of the important societal benefits that they provide. Please refer to **Annex 6** for the Committee's detailed analysis of the biota asset, datasets used and worked examples.

The components identified by the Committee in this analysis should be developed further to examine in detail all biotic asset components in ecosystems that are known to support key ecosystem services. To ensure these are captured, the NCC recommends measuring species using the following three categories:

1. Species which are critical for ecosystem function;
2. Species which support other flows/ecosystem services; and
3. Rare, iconic or protected species.

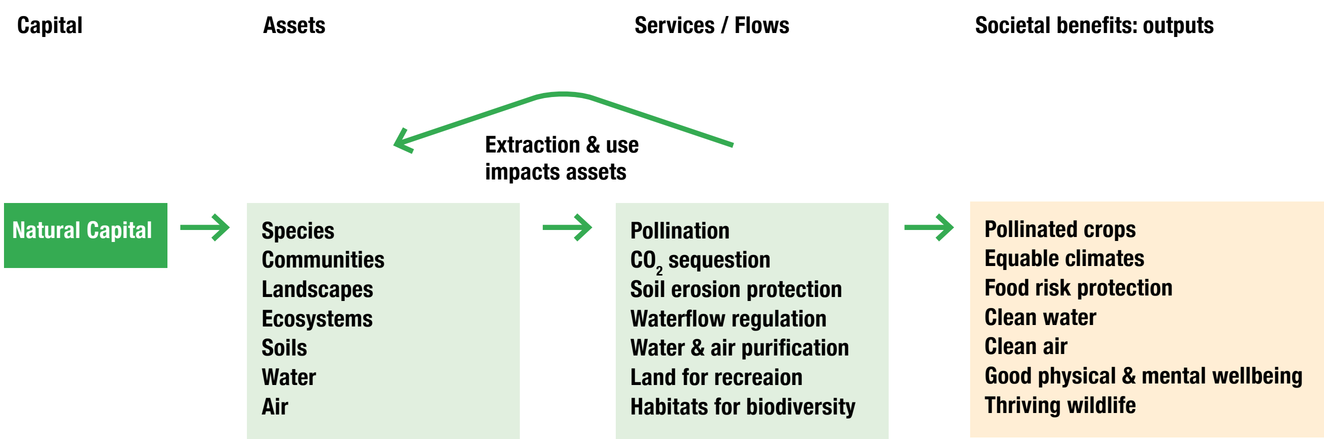
92 NCC, *Working paper: Towards a framework for defining and measuring changes in natural capital* (March 2014): https://www.gov.uk/government/publications/natural-capital-committee-initial-term-working-papers- 2012-to-2015

93 Convention on Biological Diversity, *Global Biodiversity Outlook 5* (2020): https://www.cbd.int/gbo5

94 NCC, *State of natural capital; restoring our natural assets* (2014): https://www.gov.uk/government/publications/natural-capital-committees-second-state-of-natural-capital-report

By using these three categories, it is possible to capture the species which underpin the various ecosystem services (see Figure 7).[95] This assessment attempts to consider all services species directly or indirectly provide and whether they result in private and public goods.[96] It is important to recognise that species can support a variety of ecosystem services and goods; for example, trees can provide timber, fuel, carbon storage and sequestration, water flow regulation, soil erosion protection and recreation. There is likely to be overlap in species between the three categories set out above – which underlies their importance in supporting multiple ecosystem services.

Figure 7: the relationship between natural capital assets and the services and benefits they provide



Source: Willis et al[97]

1. Species which are critical to ecosystem function

Core functioning species such as those which support production, decomposition and nutrient cycling are fundamental to the functioning of ecosystems. These species can rarely be directly valued for their contribution in natural capital assessments, but without these species the asset would cease to function.

Examples are: microorganisms for their role in decomposition and nutrient cycling; primary producers (plants on land and in water and phytoplankton, algae and other autotrophic micro-organisms in water) for biomass and carbon; top predators and parasites for population regulation; pollinators for stability of non-agricultural systems; biogenic habitat generators and maintainers for biomass, carbon storage and sequestration, and stability of seabed systems.

2. Species which support other flows / ecosystem services and goods

Other flows and goods include protection from natural hazards, recreation, clean air and water, pollination, pest control and water purification. These often result in direct goods and can often be valued for their contribution and their direct and important benefits to humans.

Examples include: wild crop and livestock relatives for genetic diversity; pollinators for food crop security; species which make up biogenic reefs for flood defence and extreme weather mitigation.

95 Ecosystem services or flows as defined in the NCC terminology document are: The current flow of ecosystem services provided by natural capital stocks and the systems within which they are embedded. These yield the welfare-bearing goods and services which provide actual or potential benefits to humans. Flows can be split between ecosystem and abiotic services.

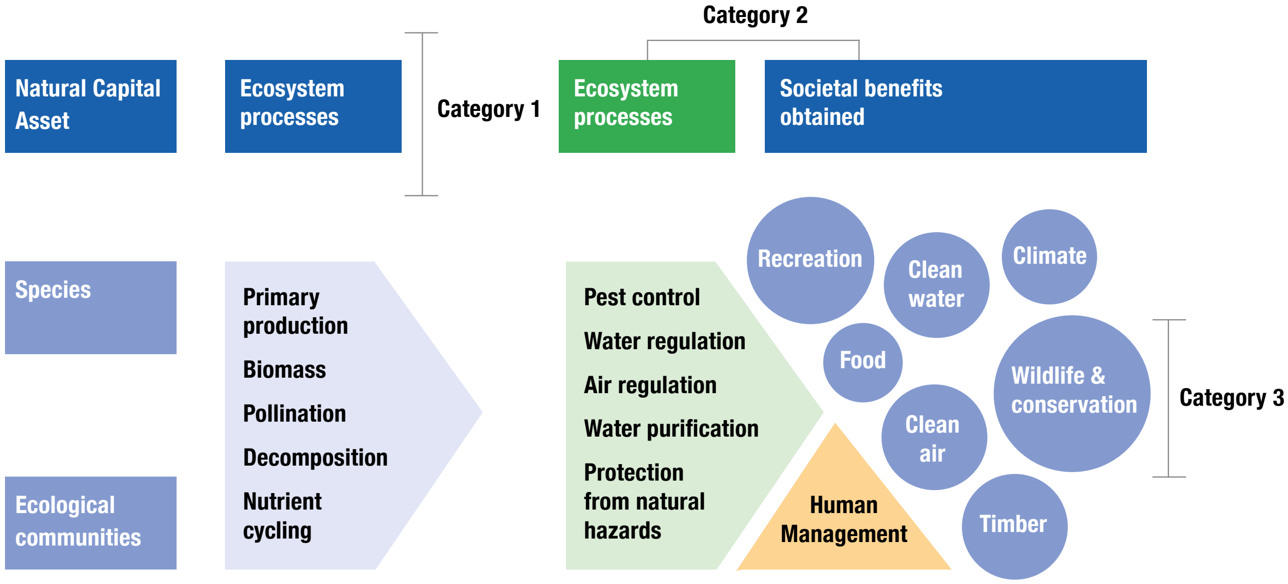
96 Goods as defined in the NCC terminology document are: Fish, timber, farmed food and drinking water are all examples of goods that deliver benefits or are of 'value' to humans. However, other types of goods and services can produce wellbeing even without a direct use. For example, the knowledge that a valued species continues to exist can generate wellbeing.

97 Willis, K.J., et al., (unpublished)

3. Rare, iconic or protected species

Species can be assessed in two different categories when undertaking natural capital assessments. They are both an asset in themselves but there are also species which have direct benefits to people through conservation priorities because they are either rare or iconic, as illustrated in Figure 8 below:

Figure 8: Schematic of biota asset components and a selection of ecosystem processes, services and goods illustrating the categories in this analysis



Source: NCC 2020

This category should seek to monitor the species which are classified as are rare or iconic.

Examples include: large vertebrates, birds, mammals, flowering plants; flagship or umbrella species which provide protection for wider communities or habitats; phylogenetically distinct species; endangered species.

There are currently records for around 27,000 species of plants, animals, fungi and microorganisms in the UK. These are available via the following databases:

- The National Biodiversity Network atlas data[98];
- The Ocean Biodiversity Information System database[99];
- The Patheon database[100]; and
- The JNCC taxon designations dataset.[101]

98 National Biodiversity Network, *NBN atlas* (2020): https://nbnatlas.org/

99 Ocean Biodiversity Information system: https://obis.org/

100 Environmental Information Data Centre, *The Pantheon database* (2020): https://data.gov.uk/dataset/98bf1f81-548b-4273-853f-a354cb00e713/the-pantheon-database-habitat-related-traits-conservation-status-and-taxa-associations-for-invertebrates-in-england

101 Joint Nature Conservation Committee, *Conservation designations for UK taxa* (2020): https://jncc.gov.uk/our-work/conservation-designations-for-uk-taxa/

However, to identify which of these species fall into the three categories is a major undertaking and something the NCC recommends the OEP takes forward. For this annex and to gain a broad oversight of the trends in the three natural capital categories described above, the Committee used the following datasets and indexes to illustrate its approach as follows:

- Oliver *et al*[102];
- JNCC pollinator index[103]; and
- JNCC priority species index.[104]

Summary of the analysis

The overall assessment of the biota annex – based on the examples provided – **is 'Red'**: **species are declining over the timescale in which they were assessed.** This assessment is based on the examples used for each of the three categories:

1. Species which are critical for ecosystem function
   a. Pollinators
2. Species which support other flows / ecosystem services and goods
   a. Natural pest control
3. Rare / iconic / protected species
   a. Priority species

Based on the datasets available, the NCC findings are presented in Table 10 with a RAG rating for each of the examples provided. Detailed analysis is provided in **Annex 6**. The key findings from the NCC assessments are as follows:

- Two categories have been classified as 'Red' (species which are critical for ecosystem function and rare, iconic or protected species) and one as 'Amber' (species which support other flows/ecosystem services or goods).
- Based on the evidence assessed:
  - o Pollinator species have declined in abundance and distribution across the UK between 1970 and 2016.
  - o Between 1970-2009 there has been a 16% decline in some species that provide pest control in the UK. However, the negative impact of this decline on pest control has been offset by the fact that over the same interval in time there have been increases (17%) in other species that perform the same function.
  - o Rare, iconic and protected species (Priority species[105]) in the UK have declined in both abundance and distribution with the biggest decreases seen for some moth species.
- These apparent declines are extremely concerning because loss of species abundance and distribution will negatively impact the ecosystem services and goods these species provide.

102 Oliver *et al*, *Declining resilience of ecosystem functions under biodiversity loss* (2015): https://www.nature.com/articles/ncomms10122

103 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects* (2020): https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

104 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance* (2019): https://jncc.gov.uk/our-work/ukbi-c4a-species-abundance/ and JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution* (2019): https://jncc.gov.uk/our-work/ukbi-c4b-species-distribution/

105 Priority species are defined by JNCC as species which require actions to conserve them or species which are included within the respective countries' biodiversity or environment strategies. There are 2,890 species on the combined UK countries list however only a small proportion of these have enough data available to measure abundance and/or distribution.

Table 10: Partial assessment of Biota asset

Components of the biota asset	Example used	Data availability	NCC partial assessment
Species which are critical for ecosystem function.	Pollinators	Long-term index for some pollinators is available. Limited to distribution data.	The distribution of UK pollinators is in decline, this trend is fairly uniform across all of the taxonomic groups involved in pollination.
Species which support other flows/ecosystem services and goods	Natural pest control	Some long-term datasets available from the volunteer recording schemes and standardised monitoring available for some taxonomic groups. Need to review data availability against identified natural pest control species.	Between 1970-2009 there has been a 16% decline in some species that provide pest control in the UK. However, the negative impact of this decline on pest control has been offset by the fact that over the same interval in time there have been increases (17%) in other species that perform the same function. This trend is not uniform across the taxonomic groups.
Rare, iconic or protected species	Priority species	Long-term index is available for priority species, it covers a small subset of the species on the UK biodiversity list.	Priority species assessed have declined in both abundance and distribution, although this trend is not uniform across the taxonomic groups: • Moths and butterflies have declined in abundance whereas birds and mammals have remained relatively stable. • Bryophytes and lichens have increased in distribution whereas bees, wasps and ants, other insects and moths have declined.

Recommendations

1. The range of biodiversity targets that the UK government should adopt to determine progress towards the 25YEP should be more closely focused on a sub-set of species that are known to i) underpin key ecosystem functions; ii) support other flows/ecosystem services; iii) be rare, iconic or protected species. Good work is being carried out measuring various groups of terrestrial biota but the NCC advises that there needs to be much better co-ordination to ensure key groups are measured in a regular and consistent way and duplication is removed.

2. The scope of monitoring of the terrestrial biota asset should be simplified with a common methodology adopted for measuring abundance, occurrence and distribution. Currently there are a plethora of methods making comparisons between datasets complex and difficult to compare and contrast.

3. The NCC advises that much greater attention needs to be given to determining trends over time. Currently the interval of time between measurements is hugely variable and some key datasets (e.g. UK hedgerows) have not been updated on a national scale since 2007. Without a regular interval of measurement, starting from a clear baseline, it will be impossible to measure progress against targets due to be set in the Environment Bill to improve those aspects of nature that provide important societal benefits.

4. Urgent consideration needs to be given to devising a set of clear set of metrics to assess those marine species that are important in underpinning key ecosystem services.

Minerals and resources

The NCC has scoped the minerals and resources assets and identified the most important components, and the pressures acting upon them, for judging condition (and extent). This section provides a background to the assessment, an overview of the approach taken to produce the analysis, a summary assessment of the analysis (with further detail on the analysis and approach set out in **Annex 7**), and recommendations.

Background

Minerals and resources are classified as a natural capital asset, made up of individual components that occur naturally within the UK. The focus for this assessment is:

- non-renewable energy resources (coal, oil and natural gas), minerals and metals commonly extracted in the UK (e.g. sand, gravel, limestone, aluminium, tin, etc.); and
- waste and the resources derived from waste (e.g.: recyclates; energy).

Together these constitute a resource from which societal value can be created. For example, extraction of resources creates jobs, provides energy and materials for a wide range of activities all of which help to grow the UK economy, but they are also finite and in some instances their extraction and/or use can lead to negative impacts on other natural capital assets, such as the atmosphere or freshwater.

Waste and the resources that can be derived from waste through recycling, recovery, re-use, and energy generation are not a natural capital asset, but a pressure to the natural environment. However, waste has an important role in the mitigation of the extraction of virgin materials[106] from the natural environment and in the production of energy through incineration and anaerobic digestion.

In order to understand where changes in the availability of resources and minerals are important, the NCC has reviewed the known stocks (where data is available) and the current rates of use/extraction. Where the use of resources is problematic, either because of the negative effects of their use (e.g. greenhouse gas (GHG) emissions), or because declining availability is leading to greater use of imports, this has been flagged with a RAG status.

The higher the amount of waste that can be recycled and reused, the lower the amount of virgin material that needs to be extracted from the natural environment. For example, there are no limits on the number of times aluminium can be recycled, the same can be said for glass and metals. Also, recycling is more energy efficient: recycling glass is around 33% more energy-efficient than producing glass from virgin materials.[107]

In addition to reducing the need for more virgin material, recycling, reuse and recovery of resources also reduces the damage to the natural environment. When waste is landfilled it can have negative impacts on the environment and to humans including:

- Air pollution and damage atmospheric processes (e.g.: acid gases from flaring; methane and carbon dioxide)[108];
- Leachate entering water streams[109];
- Soils and land pollution; and
- Damage to wildlife.

The NCC notes that there are no existing government targets for the use or extraction of minerals or resources, even where the current use is negatively impacting the ability to meet targets that have been set for other assets. For example, the effect of oil use in transport, and industry/energy generation on air quality and greenhouse gas targets.

106 Materials sourced directly from nature in their raw form, such as wood or metal ores. Manufacturing products using virgin materials uses much more energy and depletes more natural resources, as opposed to producing goods using recycled materials. Source: https://recyclenation.com/green-glossary/virgin-materials/

107 Recycling Nation, *How Many Times Can Recyclables Be Recycled?* https://recyclenation.com/2017/06/how-many-times-can-recyclables-be-recycled/

108 Public Health England, *RCE-18: impact on health of emissions from landfill sites* (2011) https://www.gov.uk/government/publications/landfill-sites-impact-on-health-from-emissions

109 WWT online, *Getting to Grips with… landfill leachate* (2018) https://wwtonline.co.uk/features/getting-to-grips-with-landfill-leachate

The NCC has assessed current performance against existing targets for the reduction of waste and identified where trends are a cause for concern. The key identified targets for waste are as follows:

- Household waste;
- Construction and demolition waste;
- Biodegradable municipal waste (BMW);
- Packaging waste;
- End-of-life vehicles (ELVs);
- Waste Electrical and Electronic Equipment (WEEE); and
- Portable batteries collection rate.

It should also be noted that waste is a major contributor to greenhouse gas (GHG) emissions, both through incineration and the production of methane through decomposition. The UK Government has legislated a target of net zero GHG emissions by 2050. Actions to mitigate climate change must include the maintenance of current carbon stocks as well as a reduction in emissions from non-renewable energy sources which provide fuel for transport (28% of all GHG emissions 2011-18)[110], energy supply (23%), the use of minerals for industry and construction that emit CO_2 (i.e. limestone/cement) (2%) and the need to prevent emissions from waste (5%) e.g. wastewater, decomposing waste and emissions from waste incineration. The effects of GHG emissions (carbon dioxide, methane, etc.) are both direct, in terms of the impacts on human health and biodiversity from poorer air quality, and indirect through a warming climate with more extreme weather events and the acidification of the oceans.

The Environment Bill[111] allows for long-term targets to be set in respect of any matter which relates to the natural environment, or people's enjoyment of it. It requires the government to set at least one target in four priority areas: air quality, biodiversity, water, resource efficiency and waste reduction. In the areas of waste and resource efficiency the Bill proposes greater responsibilities for statutory bodies and enables the Secretary of State in England to set statutory targets. The NCC has advised that further statutory targets are needed for resource efficiency and waste reduction, in order to give an accurate picture of whether natural capital resources are being used sustainably and to meet the environmental principles contained within the Bill.

Overview of approach to assessing the Minerals and Resources asset

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of mineral resources[112] and resources from waste. The assessment uses data and evidence from:

- The Department for Business, Energy, and Industrial Strategy (BEIS) Digest of UK Energy Statistics (DUKES)[113];
- The Coal Authority;
- The Oil and Gas Authority[114];
- Office for National Statistics (ONS)[115];
- The British Geological Survey (BGS) UK Minerals Yearbook evidence and data[116];
- The Crown Estate evidence on offshore aggregates;
- Defra Waste Statistics;
- The Environmental Agency data;
- National Waste Packaging Database data[117]; and
- Eurostat data.

110 HM Government 2020 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf

111 HM Government *Environment Bill* 2020: https://services.parliament.uk/Bills/2019-21/environment.html

112 Mineral resources here refers to: metals, rocks, sand, and minerals and it also energy minerals.

113 BEIS, *Digest of UK Energy Statistics (DUKES)* (2019) https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes#2013

114 Oil and Gas Authority, *UK Oil and Gas Reserves and resources Report as at end 2018* (2018) https://www.ogauthority.co.uk/news-publications/publications/2019/uk-oil-and-gas-reserves-and-resources-report-as-at-end-2018/

115 Office for national Statistics (ONS), *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas/current

116 British Geological Survey, *United Kingdom Minerals Yearbook 2002 – 2019* https://www.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

117 National Packaging Waste Database (NWPD), *Public reports* https://npwd.environment-agency.gov.uk/

To produce the assessment of minerals and resources the NCC has started by scoping out the components of the asset which are presented in Figure 9. A data trend assessment followed (where data was available) to see how these components and subcomponents changed over time and where possible try to infer the status of their condition and extent. Please refer to **Annex 7** for the Committee's detailed analysis, datasets used and methodology.

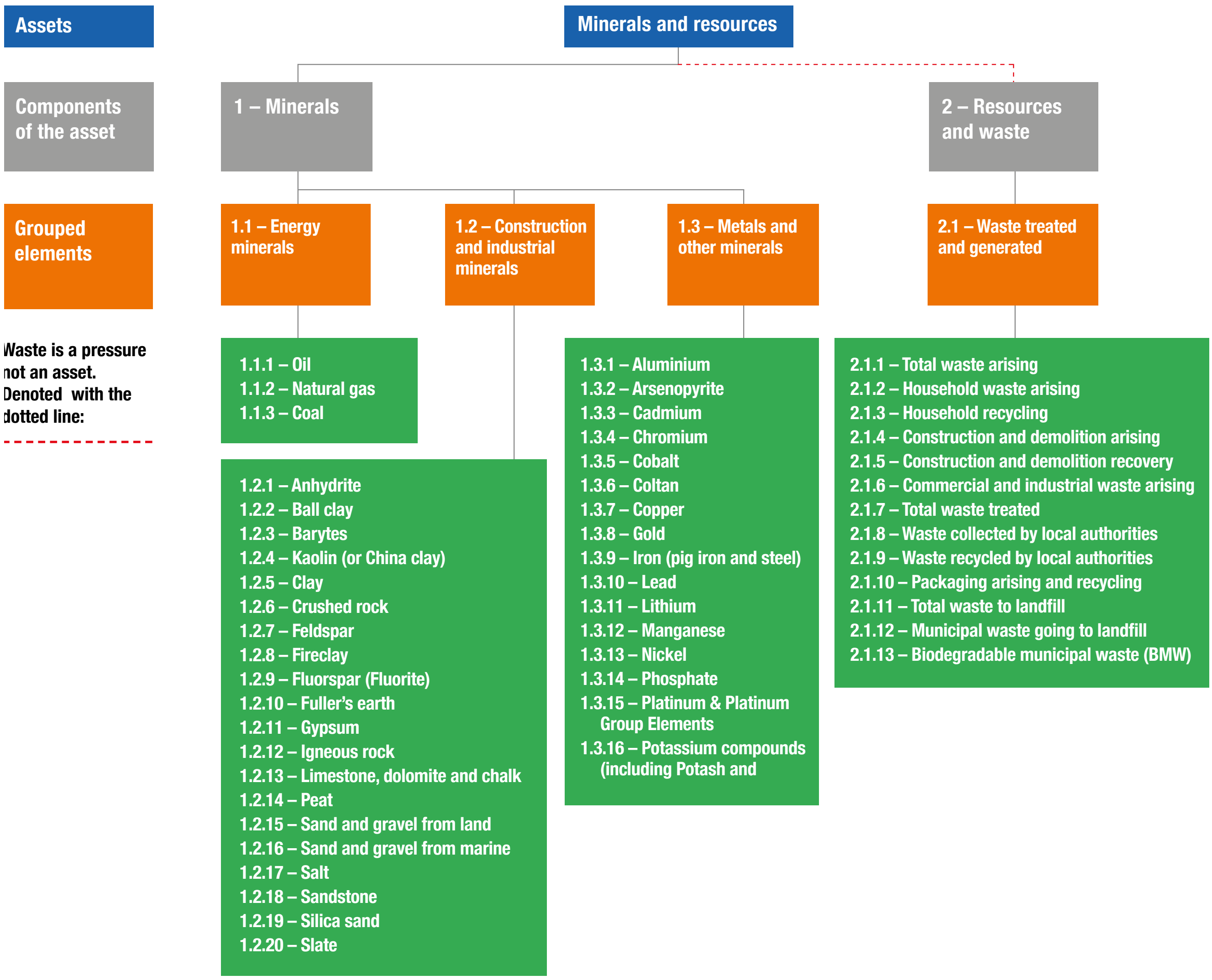
Based on this review, the NCC has scoped a list of 71 minerals and resources and waste streams. The NCC has selected these substances based on the committee expertise and available data. These substances are also the ones seen to have the greatest impact on the economy and/or pose the greatest risks to the environment and human health.

The identified minerals and resources have been grouped under headings with waste as an additional topic:

1. Non-renewable energy;
2. Minerals;
3. Resources and waste.

This allows for an overarching assessment to be made. However, it should be noted that this list of substances does not cover all those that are required to assess the whole of the environment. Further iterations to list will be required and to keep this list up to date it will require periodical reviews to account for new components.

Figure 9: Minerals and resources components for assessment



Source: NCC 2020

Summary of the analysis

The overall assessment of the minerals and resources annex – based on the datasets available – **is 'Amber'**: **mixed** – this is based on waste targets not being met, such as household recycling and recovery of end of life vehicles (ELVs), the continued extraction of minerals (for construction and industrial use) and the recent increase in the consumption of oil and decline in reserves. On the other hand, some progress has been made such as increases in the collection of portable batteries, reduction in gas consumption and reduced production of some minerals (e.g.: iron).

This assessment is based on three groups: non-renewable energy, minerals and resources, and waste.

The NCC's findings are presented in Table 11 where a RAG rating for each of the three groups is provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the measurements underpinning these groups. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC's assessment are as follows:

- Waste targets are not being met, such as household recycling and recovery of end of life vehicles (ELVs).
- Household waste recycling rates have plateaued since 2013 at around 44%.
- Construction waste recovery rates have plateaued since 2010.
- There were 715,000 fly tipping incidents in England in 2012/13 and this increased to 1.07 million incidents in 2018/19.
- In the UK alone, an estimated 10 million tonnes of food and drink worth around £20 billion are wasted post-farm gate every year.
- Waste related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

The assessment uses a 'RAG' rating approach to indicate the status of the atmosphere asset and associated components. Please see table 11 and associated descriptive text for further information

Table 11: Indicative assessment of the minerals and resources asset

Components of the asset	Data availability	Overall assessment
1. Non-renewable energy	There is data on reserves and resources of oil and gas – data is available from 1973. There is limited data on the resources of coal, with data only being available from 2016.	Based on this limited data, gas and oil proven (1P) and probable (2P) reserves continue to steadily decline. Coal reserves have increased, but trend data starts in 2016 which limits what can be inferred.
2. Minerals	There is almost no data on reserves and resources of minerals for either England or the UK. There is some limited data on offshore reserves of natural aggregates and some historical data on land natural aggregates. Data is available for the production for some years for several minerals however, this data is often based on estimates.	Given the limited evidence available on reserves and resources of minerals, the assessment is based mostly on the production of these which limits what can be inferred. Some of the minerals saw a reduction in their production levels such as iron and clay. While, for other minerals, there has been an increase such as natural aggregates, gypsum, and silica sand.
3. Resources and waste	There is a significant amount of data on resources and waste ranging from data on waste arising from portable batteries to recycling and recovery rates for construction and demolition.	The overall assessment for waste is mixed, this is based on several waste types having higher levels of waste and not meeting recycling and recovery targets, such as waste from household and end-of-life vehicles. Also, a significant amount of waste is exported from the UK to third party countries which leaves considerable uncertainty about whether these actually get recycled.

The overall assessment based on the three groups set out above is underpinned by an analysis of datasets on reserves, production, consumption, and changes in quantity/rates. A full summary assessment of the condition, extent and pressures of these measurements, grouped by the three overall groups, is presented in **Annex 7**. The assessment follows the same approach of the overall assessment. The Committee's 'Amber' assessment indicates that there is considerable scope to achieve better progress towards improving the condition and extent of the minerals and resources asset (e.g.: this asset links to the following 25 YEP goals: "*using resources from nature more sustainably and efficiently*", and "*minimising waste*"). The Committee's recommendations are set out below.

Recommendations

1. The NCC advises that statutory deadlines should be set for phasing out the use of natural resources which lead to long-term negative effects on other natural capital assets and result in irreversible damage (e.g. the extraction and use of non-renewable energy sources on the condition of atmosphere, freshwater, biodiversity and marine).

2. The government should ensure a detailed understanding of the use of minerals and resources, their associated economic benefits, potential substitutes and the environmental effects on the UK from the extraction of overseas resources if it is to set meaningful targets in relation to minerals and resources.

3. There is a negative effect on the environment of sending waste to landfill and a loss of valuable resources: the NCC advises that there needs to be an end to unnecessary landfilling in line with the waste hierarchy (e.g.: prevent, reduce, reuse, recycle, etc). England should follow the lead of Wales and Germany in terms of setting targets for achieving higher recycling rates.

4. The waste targets established under the European Waste Directive provide a clear comparative framework for the UK Government's performance in reducing and reusing waste. Further binding targets on the reduction of resources that produce waste (e.g. plastics for packaging) will be necessary to ensure that other assets (e.g. marine, freshwater) are not irreversibly harmed.

5. The NCC recommends that the government should assess the feasibility of setting a target that goes beyond the current target on the household recycling rate (in line with the Circular Economy Package).

6. Government should seek to address important data gaps – such as commercial and industrial waste and improve data availability/access (also quality) – for example by improving transparency and consolidating data in one place.

Annex 1

Atmosphere

Atmosphere

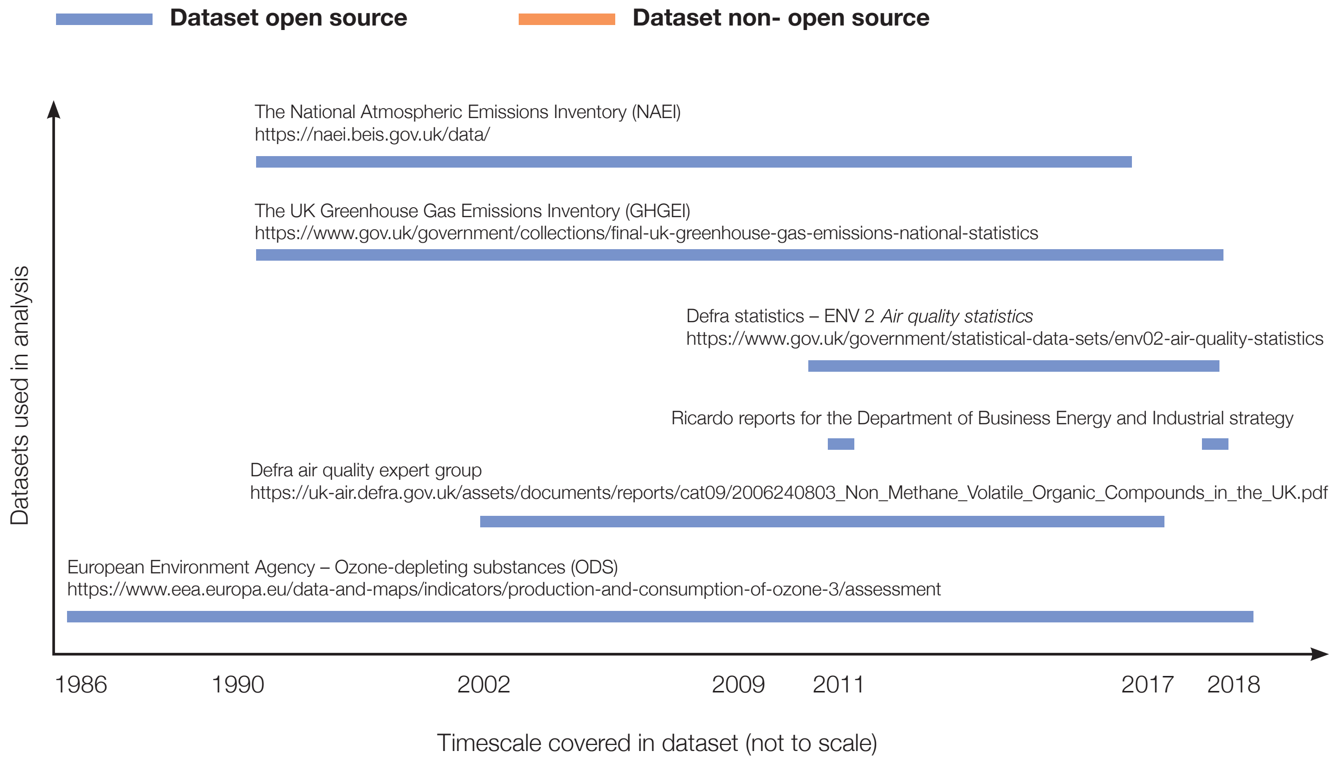
Background

The atmosphere - the layer of gases surrounding the Earth including oxygen, carbon dioxide (CO_2), and nitrogen - is used by all living organisms and contains the processes which give rise to climate and weather. Very small changes to the physical state of the atmosphere can have extensive impacts on life on earth. For instance, a relatively small increase in atmospheric temperature can have profound effects on sea level and climate.

In order to understand where changes in air quality and atmospheric processes will affect human health or the environment, it is important to first understand where pollution is most concentrated, how it occurs, and what elements are involved. To do so, robust and comprehensive data is required to enable an assessment of the status of athmosphere asset. To produce the atmosphere assessment the Natural Capital Committee (NCC) has looked at a range[1] of datasets, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the atmosphere asset

Datasets used in atmosphere asset analysis, timescale covered and their status (open or non-open source)



Source: NCC 2020

1 Given the limited resources available to the NCC the list of datasets is not comprehensive and further work is required to scope additional datasets to complement this assessment.

Atmosphere asset

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of the atmosphere asset. Based on this review, the NCC has scoped a list of 66 potential substances. There is limited data on the concentrations of these substances, and most of the data available are based on emissions which are used as a proxy in the development of this assessment. In order to produce the atmosphere assessment, the NCC has used datasets and evidence from:

- The UK Pollutant Release and Transfer Register (PRTR)[2];
- The National Atmospheric Emissions Inventory (NAEI)[3];
- The UK Greenhouse Gas Emissions Inventory (GHGEI)[4];
- The Stockholm Convention on Persistent Organic Pollutants[5];
- The Montreal Protocol[6]; and
- The Scottish Pollutant Release Inventory[7]; and
- Defra, ENV02 – *Air quality statistics* (2019)[8]

The substances that have been included in this list are the ones seen to have the greatest impact and pose the greatest risks to the environment and human health. For example, it has been estimated that the effects of long-term exposure to particulate matter air pollution in the UK have an effect equivalent to 29,000 deaths a year.[9] In addition to the deaths estimate, in England, the total costs to the NHS and social care have been estimated for $PM_{2.5}$ and NO_2. In 2017, the cost has been estimated at around £42.9 million, and for the period 2017-2025, the cost was estimated to be around £1.6 billion.[10]

These 66 substances have been grouped under nine headings following the same approach of PRTR and NAEI: see Figure 1 for detailed grouping of substances - this allows for an overarching assessment to be made. However, it should be noted that this list of substances does not cover all those that are required to assess the whole of the environment. In addition, emissions are only terrestrial and those from marine infrastructure or vessels are not included. Further iterations of the list will be required where a periodical review to account for new substances will be needed to keep the list up to date. To take action to address the impacts of air pollution, reliable, consistent, and routinely produced data is required.

2 Defra, *UK Pollutant Release and Transfer Register (PRTR) data sets: pollutant releases* (2019) https://www.gov.uk/guidance/uk-pollutant-release-and-transfer-register-prtr-data-sets

3 NAEI, *UK emissions data selector* (2019) https://naei.beis.gov.uk/data/

4 BEIS, *Final UK greenhouse gas emissions national statistics* (2020) https://www.gov.uk/government/collections/final-uk-greenhouse-gas-emissions-national-statistics

5 Defra, *National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants: United Kingdom of Great Britain and Northern Ireland (2017)* https://consult.defra.gov.uk/eu-environment/uk-nip-for-stockholm-convention-on-pops-2017/supporting_documents/UK%20National%20Implemention%20Plan%20for%20the%20Stockholm%20Convention%20on%20POPs%202017.pdf

6 UN Environment Programme, *Treaties* https://ozone.unep.org/treaties/montreal-protocol

7 SEPA, *Scottish Pollutant Release Inventory: Pollutant Fact Sheets* https://www2.sepa.org.uk/SPRIPA/Pages/SubstanceSearch.aspx

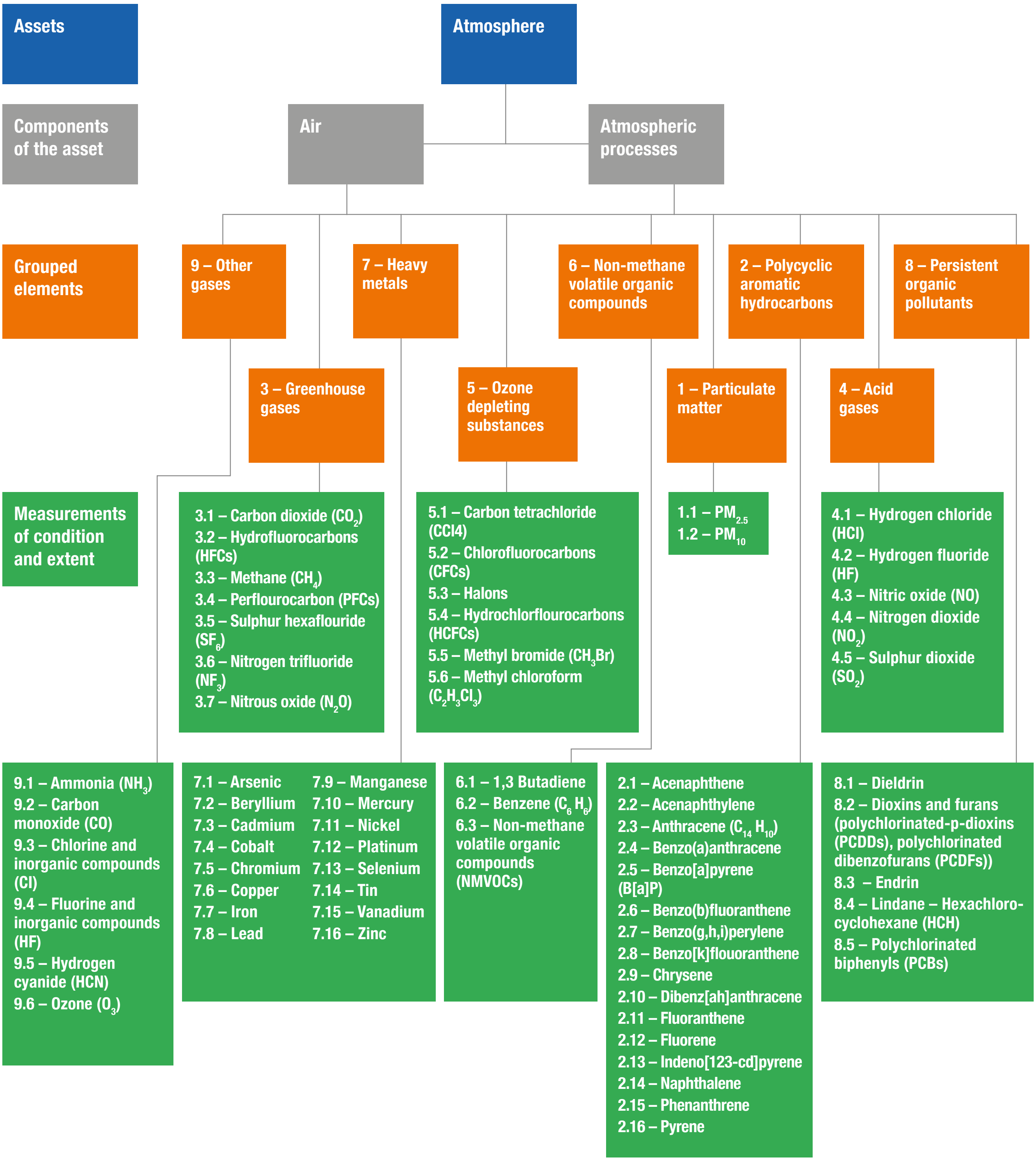
8 https://www.gov.uk/government/statistical-data-sets/env02-air-quality-statistics

9 Public Health England (PHE), *COMEAP: mortality effects of long-term exposure to particulate air pollution in the UK* (2010) https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk

10 Public Health England, *Estimation of costs to the NHS and social care due to the health impacts of air pollution* (2018) https://www.gov.uk/government/publications/air-pollution-a-tool-to-estimate-healthcare-costs

Currently, there is a limited availability of datasets measuring the concentration, emissions and trends of these 66 substances in the atmosphere. For example, out of the 66 substances scoped, 12 of these had no data, 52 had data only on emissions, and 17 had partial data on concentrations. Even where concentration data is available, it is either somewhat dated or only provides a partial assessment of the atmosphere, being limited to rural or urban areas for example. Another limitation of the datasets used is that not all have data for England - given this limitation the assessment that follows uses data for both England and the UK. To keep the assessment consistent and comparable, most of the data used is based on the UK level. This also aligns with the majority of the targets and limits which are mostly set at the UK level.

Figure 1: Atmosphere components for assessment



Source: NCC 2020

Concentration and emissions data collection and modelling

In addition to the trend data, to make this assessment as comprehensive as possible, the NCC has also provided a spatial overview of concentrations and emissions in England, where evidence is available. These maps present estimates of emissions and concentrations compiled at 1x1 km resolution[11] and are based on 2011 and the most recent emissions inventory data (e.g.: 2017). The maps assist in presenting the data at a local level and show where concentrations and emissions are at their highest. It is important to highlight that the maps are not directly comparable.

How concentrations estimates and maps are developed

The Air Quality Framework Directive and the four Daughter Directives[12] require the UK to undertake air quality assessments and report their findings. These assessments are based on monitoring sites and can also include other means to estimate concentrations (such as modelling). In the UK, through the Air Quality Standards Regulation[13], the concentrations of key pollutants are also measured by the Environment Agency through approximately 300 monitoring sites[14]. The following are the key monitoring networks:

- Automatic Urban and Rural Network (AURN), which has approximately 170 monitoring sites. The network captures continuous ambient concentrations on a nearly-hourly basis.[15]
- Heavy Metals Network (HMN), which has approximately 24 monitoring sites[16]
- Polycyclic Aromatic Hydrocarbons Network, which has approximately 30 monitoring sites[17]
- Automatic Hydrocarbon Network, which has approximately four sites[18]

Ricardo used the data from the monitoring network above and data from sites outside the network, such as Local Authority and Heathrow Airwatch sites, to build and calibrate the models used to produce these maps. Using the data from these additional sites provided an independent assessment of the validity of the mapped estimates in relation to the Air Quality Directive data quality objectives.[19]

For further details on the methodological approach on how the concentration maps were produced can be found in the *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017.*[20]

How the emissions inventory and maps are developed

The data underpinning the emissions maps that are found in section 1- 9 of this annex is based on the National Atmospheric Emissions Inventory (NAEI) and are compiled through a geographic information system (GIS). The inventory gets updated on a yearly basis (two years in arrears). Each year the full inventory time-series is recalculated to take into account improved data and advances in compilation methods. The historical maps (e.g.: 2011 maps), however, do not get updated (historical maps have not been recalculated) which means that the maps are not directly comparable. The historical maps used in this assessment provide an indication of the changes that have occurred since 2011. The inventory uses data from several individual sectors in the UK. For example, fuel consumption data comes from the Digest of UK Energy Statistics (DUKES)[21].

11 Mapped outputs for ammonia (NH_3), methane (CH_4) and nitrous oxide (N_2O) are produced under the same framework, but some sources are limited to 5x5 km resolution due to non-disclosure constraints.

12 Air Quality Framework Directive (1996/62/EC) and the four Daughter Directives 1999/30/EC, 2000/69/EC, 2002/3/EC and 2004/107/EC.

13 Legislation.gov.uk, *The Air Quality Standards Regulations 2010* (2010) http://www.legislation.gov.uk/uksi/2010/1001/contents/made

14 Defra UK Air, *Monitoring network* https://uk-air.defra.gov.uk/networks/

15 Defra, *Background to concentrations of air pollutants* (2020) https://www.gov.uk/government/publications/air-quality-statistics/background

16 Defra UK Air, *Heavy Metals Network* https://uk-air.defra.gov.uk/networks/network-info?view=metals

17 Defra UK Air, *Polycyclic Aromatic Hydrocarbons (PAH)* https://uk-air.defra.gov.uk/networks/network-info?view=pah

18 Defra UK Air, *Automatic Hydrocarbon Network* https://uk-air.defra.gov.uk/networks/network-info?view=hc

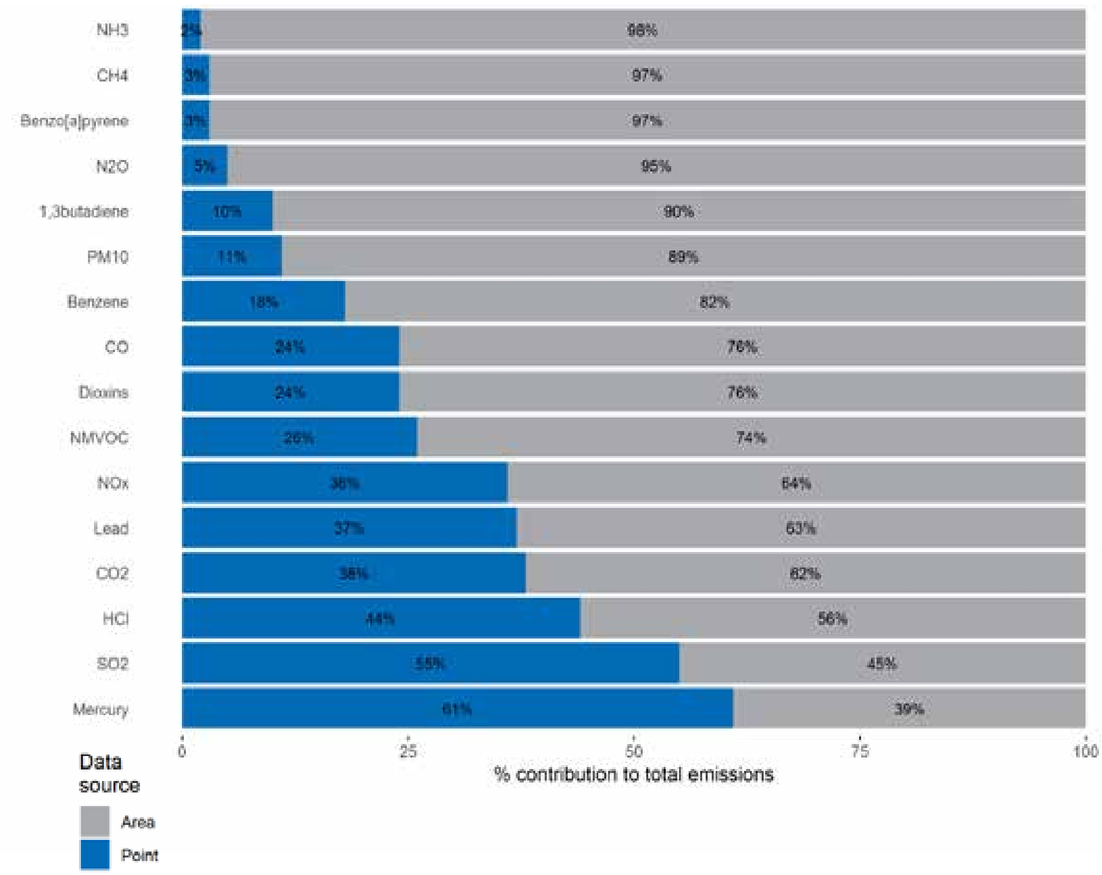
19 UK Air, *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017* (2019) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903201606_AQ0650_2017_MAAQ_technical_report.pdf

20 UK Air, *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017* (2019) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903201606_AQ0650_2017_MAAQ_technical_report.pdf

21 BEIS, *Digest of UK Energy Statistics (DUKES)* https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

To produce the maps, a spatial characterisation of emission distributions across the UK was built up from several component distributions for each NAEI emission sector. For large industrial 'point' sources, emissions were compiled from detailed official sources prepared by the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW) and the Department of Agriculture, Environment and Rural Affairs Northern Ireland (DAERA), and Local Authorities. These enabled both the geographic location and the magnitude of the emissions to be characterised. For other smaller and more widely distributed sources, known as 'area' sources, less detailed information on the location and magnitude of emissions was available. Figure 2 presents the type of data underpinning each map, these vary in quality. In general point source data is of better quality than the area-based data.[22] As shown below, there is a significant reliance on area-based data in the production of the maps, these should be treated with caution and have been presented to provide a sense of the emissions and concentration levels in the UK.

Figure 2: Contribution of data sources to mapped emissions totals (2017) – based on Ricardo estimates



Source: NAEI - UK emissions Mapping Methodology (2019)

In the sections that follow, further details are provided on how each map has been derived. The methodological approach Ricardo adopted to develop the inventory and emissions maps is provided in the *UK Emission Mapping Methodology*[23].

22 NAEI, *UK emissions Mapping Methodology* (2019), https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1910040848_Mapping_Methodology_for_NAEI_2017_v1.pdf

23 NAEI, *UK emissions Mapping Methodology* (2019), https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1910040848_Mapping_Methodology_for_NAEI_2017_v1.pdf

Summary of overall (partial) atmosphere assessment

The NCC has produced a partial assessment on emissions and concentrations of atmospheric pollution, focusing on emissions data, given the limited data available on concentration.

The assessment uses a 'RAG' rating approach to indicate the status of the atmosphere asset and associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. See Table 1 for the RAG scale – note that the 'grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'amber' rating ('no change' / 'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 1: RAG rating scale for atmosphere assessment

RAG rating	Colour
Unable to assess/data not available	(grey)
Increase in emissions/concentrations	(red)
No change/mixed	(amber)
Decrease in emissions/concentrations	(green)

The overall assessment of the atmosphere annex – based on the datasets available – is 'Amber': **mixed/ deteriorating**. This reflects that the current quality of the air we breathe (atmosphere) has improved, given the overall reduction in pollution at a national level in recent years. However, in some local urban areas pollution is still resulting in significant health impacts as evidenced by the 29,000 number of deaths bought forward. At present local data is not collated and reported alongside national data, meaning that the variation in air quality at regional level (or the number of local authorities in breach of air quality targets) is not known. This assessment is based on the nine group headings (see points 1-9 below) and is underpinned by the trend assessment made to the 66 measurements.

1. Particulate matter (PM);
2. Polycyclic aromatic hydrocarbons (PAHs));
3. Global warming potential (green house gasses (GHG));
4. Acid gases;
5. Ozone depleting substances (ODS);
6. Non-methane volatile organic compounds (NMVOCs);
7. Heavy metals;
8. Persistent organic pollutants (POPs);
9. Other gases.

Based on the datasets available, the NCC findings are presented in Table 2 with a RAG rating for each of the nine groups is provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the 66 measurements. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC assessments are:

- Two of the groups (polycyclic aromatic hydrocarbons (PAHs) and heavy metals) have been classified as red, three are amber (particulate matter, non-methane volatile organic compounds (NMVOC's) and 'other gases'), and three are green (greenhouse gases, acid gases and persistent organic pollutants (POPs)).
- The current status on the quality of the air we breathe (atmosphere) indicates an overall reduction in pollution levels in recent years but that in some urban areas levels are still resulting in significant health impacts.
- Poor air quality impacts human health; it has been estimated that the effects of long-term exposure to particulate air pollution alone in the UK causes up to 29,000 deaths brought forward per year.
- Emissions of greenhouse gases have declined between 1990 and 2017 from 794 to 451 MtCO2e.
- Emissions of assessed POPs have declined between 1990 and 2017 between 87% and 97%.
- Emissions of assessed acid gases have declined between 1990 and 2017, between 72% and 98%.
- Airborne ammonia levels are not on track to meet the target reduction of 8% of 2005 levels. Agriculture currently accounts for 88% of the ammonia emissions to air.

Table 2: Indicative (partial) assessment of the atmosphere

Measurements used to assess the atmosphere asset	Data availability	Overall assessment
1. Particulate matter (PM)	Partial data on concentrations of $PM_{2.5}$ and PM_{10} up to 2018. The data used for the assessment is based on Defra ENV 2 dataset. Emissions data for $PM_{2.5}$ and PM_{10} is available up to 2017. The data used for the assessment is based on the NAEI dataset.	Based on the limited data available on the concentrations of $PM_{2.5}$ and PM_{10}, the data shows that these have reduced for roadside and urban backgrounds when compared to 2011 levels. However, the trend since 2015 shows that concentrations have either remained flat or slightly increased. • Data on emissions of $PM_{2.5}$ have declined by just under 0.5% when compared to the 2011 level, while PM_{10} has increased 1.8% over the same period. Given these mixed results the RAG rating here is amber. See further details under the PM section below.
2. Polycyclic aromatic hydrocarbons (PAHs)	Data on PAHs emissions is available for 16 substances. The data used for the assessment is based on the NAEI dataset.	The emissions data of PAHs shows that emissions have increased for 15 out of the 16 substances since the 2011 level, with dibenz[a,h]anthracene being the exception. Given that emissions have increased the RAG rating allocated here is red. • Emissions of PAHs between 2011 and 2017 have increased between 8% and 63%, with the exception of dibenz[a,h]anthracene which has declined by just under 19%
3. Global warming potential	Emissions data is available for the seven greenhouse gas up to 2018. The data used for the assessment is based on the Department of Business, Energy, and Industrial Strategy (BEIS) greenhouse gas inventory dataset.	Based on the most recent data from BEIS greenhouse gas inventory, emissions have declined for all gases with the exception of Nitrogen trifluoride (NF_3) when compared to the 2011 level. As emissions have reduced for most of the gases the RAG allocated is green. • Emissions of methane (CH_4) and carbon dioxide (CO_2) have declined by 60% and just over 39% since 1990. See further details under the global warming potential section below.
4. Acid gases	There is no data on the concentration of acid gases. Emissions data were available for four of the five substances up to 2017. The data used for the assessment is based on the NAEI data.	When compared to the 2011 level, emissions have declined for the four substances where data is available (HCl, HF, NO_2 and SO_2). Given the reductions in emissions, the RAG allocated here is green. • Sulphur dioxide (SO2) has declined by 95% since 1990. See further details under the acid gases section below.
5. Ozone depleting substances (ODS)	Data was not available for ozone-depleting substances at the UK level. Data is only available for the consumption and production of ODS at the EU level.	Unable to produce an assessment as data is not available for England or the UK level. Data from the UN environment programme shows consumption and production data only at an EU level. The EU level data shows that consumption has reduced since 2013.[24]

24 Calculated for each calendar year, it is mainly defined as 'production plus imports minus exports' (quantities destroyed or used in certain applications like feedstock are subtracted where relevant). As such, its formula can yield a negative number when substances are produced and imported in quantities that do not compensate for the amounts exported or destroyed. This usually happens when exports or destruction take place for ODS that were previously on the market in the EEA-28 (stocks). https://www.eea.europa.eu/data-and-maps/indicators/production-and-consumption-of-ozone-3/assessment

6. Non-methane volatile organic compounds (VOCs)	There is no comprehensive data on the concentration of NMVOCs across England. There are limited modelled estimates which are based on a limited number of active monitoring sites (four). Emissions data on NMVOCs are presented for two compounds (1, 3 butadiene and benzene) and as an aggregated dataset. The most recent data is from 2017 and is based on the NAEI dataset.	Based on the limited data available on emissions, there has been a decline in emissions of benzene and 1,3 butadiene. However, the RAG rating here is amber due to the fact that the emissions trend has been flat since around 2014. • Since 2014 emissions of NMVOCs have been flat around 800 kilotons. For further details see the NMVOC section below.
7. Heavy metals	There is limited data available on concentrations of heavy metals, with the most recent data being from 2015. This data is based on a small sample averaged across the UK. Data on emissions is available for 13 of the 21 heavy metals, and the data is used is from the NAEI.	As the data on concentrations is somewhat dated and is based on a small sample it has not formed part of this RAG rating. The RAG rating is based on emissions data. There is a mixture in the change in emissions for heavy metals, with some metals showing an increase in emissions levels such as cadmium, chromium, manganese, vanadium, and zinc compared to the 2011 level. While for arsenic, lead, mercury, selenium, and tin there has been a decline when compared to the 2011 level. Also, for some metals, the change has been limited (less than 1%) such as beryllium, copper, and nickel.
8. Persistent organic pollutants (POPs)	There is no data on the concentration of POPs. Of the 5 substances, scoped emissions data is available for three.	The emissions data for dioxins and furans, lindane, and PCBs have declined when compared to 2011 levels. Based on these findings, the RAG rating here is green. This RAG rating should be treated with caution given the limited number of substances being assessed. • Emissions of dioxins, lindane and polychlorinated biphenyls (PCBs) have decreased since 1990 by 87%, 97% and 92% respectively.
9. Other gases	Only limited data on concentration is available in terms of percentage land area for ammonia. Emissions data is only available for two of the seven substances.	Based on the limited emissions data available, emissions have increased for NH_3, while CO emissions have declined since 2011. Given the mixed results, the RAG rating here is amber. • Emissions of ammonia have been flat/increasing since 2008. For further details see the other gases section below.

Source: NCC 2020

Summary RAG rating for individual measurements

The overall assessment, based on the nine groups set out above, is underpinned by an analysis of 66 sub-components (as displayed in Figure 1). A full summary assessment of the condition, extent and pressures of these 66 sub-components, grouped by the nine overall components are presented in Table 3. The assessment follows the same approach of the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. The assessment is split into four categories, with a RAG rating assigned for each, as follows:

1. **Compliance against target/commitment** is the comparison of the target or commitment baseline against the most recent data. For example, assessing the reduction of ammonia from 2005 levels (target baseline) against the 2020 target of 8% reduction;
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/evidence. For example, comparing the change between 1970 and 2018;
3. **The NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when the government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses*."[25] Here 2011 baseline, where data is available, is compared against the most recent data/evidence. This also relates to the NCC census advice[26] and its interim response to the 25 YEP Progress Report for a need to have a common base year to assess progress against;
4. **The short-term, trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

The overall assessment RAG rating is based on each measurement's RAG rating presented in Table 3 below. There is variation in terms of emission and concentration levels between each of the nine groups and between the period assessed (e.g.: long-term vs short-term). In most groups there has been a decline in the long-term trend assessment, however when looking at the short trend data there is a change in direction with several measurements showing an increase in emissions and/or concentrations levels (e.g.: $PM_{2.5}$, sulphur dioxide (SO_2), ozone (O_3) and 10 heavy metals). The points below summarise the key findings:

- Emissions of carbon dioxide (CO_2) which is the greenhouse gas with the highest emissions levels, has continued declining since its 1991 peak of 603 $MtCO_2e$ to just under 366 $MtCO_2e$.
- Concentrations of $PM_{2.5}$ and PM_{10} have started increasing based on the most recent data.
- Data at the England (or UK) level is not available/was not found for ozone-depleting substances.

25 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

26 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan* (2019) https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

The key RAG ratings for the individual measurements are presented below and in Table 3 below.

Table 3 Atmosphere asset measurements RAG ratings

Component and subcomponents of the asset		Assessment			
		Compliance with target or commitment	Long-term trend	Against NCC baseline (2011)	Short-term trend
Particulate matter	1.1 - $PM_{2.5}$	G	G	G	R
	1.2 - PM_{10}	G	G	A	A
Polycyclic aromatic hydrocarbons	2.1 - Acenaphthene	N/A	G	R	A
	2.2 - Acenaphthylene	N/A	R	R	A
	2.3 - Anthracene (C_{14} H_{10})	N/A	G	R	A
	2.4 - Benzo(a)anthracene	N/A	G	R	A
	2.5 - Benzo[a]pyrene (B[a]P)	N/A	G	R	G
	2.6 - Benzo(b)fluoranthene	N/A	G	R	G
	2.7 - Benzo(g,h,i)perylene	N/A	G	R	A
	2.8 - Benzo[k]flouoranthene	N/A	G	R	G
	2.9 - Chrysene	N/A	G	R	A
	2.10 - Dibenz[a,h]anthracene	N/A	G	G	G
	2.11 - Fluoranthene	N/A	G	R	A
	2.12 - Fluorene	N/A	G	R	A
	2.13 - Indeno[123-cd]pyrene	N/A	G	R	G
	2.14 - Naphthalene	N/A	G	R	A
	2.15 - Phenanthrene	N/A	G	R	A
	2.16 - Pyrene	N/A	G	R	A
Greenhouse gases	3.1 - Carbon dioxide (CO_2)	A	G	G	G
	3.2 - Hydrofluorocarbons (HFCs)		G	G	G
	3.3 - Methane (CH_4)		G	G	A
	3.4 - Perfluorocarbon (PFCs)		G	G	G
	3.5 - Sulphur hexaflouride (SF_6)		G	G	R
	3.6 - Nitrogen trifluoride (NF_3)		R	R	R
	3.7 - Nitrous oxide (N_2O)		G	A	A
Acid gases	4.1 - Hydrogen chloride (HCl)	N/A	G	G	G
	4.2 - Hydrogen fluoride (HF)	N/A	G	G	G
	4.3 - Nitric oxide (NO)	N/A	N/A	N/A	N/A
	4.4 - Nitrogen dioxide (NO_2)	A	G	G	G
	4.5 - Sulphur dioxide (SO_2)	G	G	G	G

Ozone depleting substances	5.1 - Carbon tetrachloride (CCl_4)	N/A	N/A	N/A	N/A
	5.2 - Chlorofluorocarbons (CFCs)	N/A	N/A	N/A	N/A
	5.3 - Halons	N/A	N/A	N/A	N/A
	5.4 - Hydrochlorofluorocarbons (HCFCs)	N/A	N/A	N/A	N/A
	5.5 -Methyl bromide (CH_3Br)	N/A	N/A	N/A	N/A
	5.6 Methyl chloroform ($C_2H_3Cl_3$)	N/A	N/A	N/A	N/A
Non-methane volatile organic compounds	6.1 - 1,3 Butadiene	N/A	G	G	G
	6.2 - Benzene (C_6H_6)	N/A	G	G	A
	6.3 - Non-methane volatile organic compounds (NMVOCs)	G	G	G	R
Heavy metals	7.1 - Arsenic	N/A	G	G	G
	7.2 - Beryllium	N/A	G	A	R
	7.3 - Cadmium	N/A	G	R	R
	7.4 - Cobalt	N/A	N/A	N/A	N/A
	7.5 - Chromium	N/A	G	R	R
	7.6 - Copper	N/A	G	A	A
	7.7 - Iron	N/A	N/A	N/A	N/A
	7.8 - Lead	N/A	G	G	A
	7.9 - Manganese	N/A	R	R	R
	7.10 - Mercury	There is a target with the aim to reduce land-based emissions of mercury to air and water by 50% by 2030. However, the target is ambiguous as it does not state from what the level the 50% will be from.	G	G	R
	7.11 - Nickel	N/A	G	A	R
	7.12 - Platinum	N/A	N/A	N/A	N/A
	7.13 - Selenium	N/A	G	G	R
	7.14 - Tin	N/A	G	G	R
	7.15 - Vanadium	N/A	G	R	R
	7.16 - Zinc	N/A	G	R	R

Persistent organic pollutants	8.1 - Dieldrin	N/A	N/A	N/A	N/A
	8.2 - Dioxins and furans (polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs))	N/A	G	G	G
	8.3 - Endrin	N/A	N/A	N/A	N/A
	8.4 - Lindane - hexachlorocyclohexane (HCH)	N/A	G	G	G
	8.5 - Polychlorinated biphenyls (PCBs)	N/A	G	G	G
Other gases	9.1 - Ammonia (NH_3)	R	G	R	A
	9.2 - Carbon monoxide (CO)	N/A	G	G	A
	9.3 - Chlorine and inorganic compounds (Cl)	N/A	N/A	N/A	N/A
	9.4 - Fluorine and inorganic compounds (HF)	N/A	N/A	N/A	N/A
	9.5 - Hydrogen cyanide (HCN)	N/A	N/A	N/A	N/A
	9.6 - Ozone (O_3)	G	R	R	R

Individual atmosphere measurements assessment: analysis

The sections that follow present the assessment for each of the 66 measurements underpinning each of the nine group headings (e.g.: greenhouse gases), starting with particulate matter and ending with other gases. The assessment of each measurement follows the approach and RAG rating presented in Table 1 above and the approach scoped in the previous section.

1. Particulate matter

Particulate matter is the term used to describe particles of soot (carbon), metals, or inorganic salts. These are usually classified based on their size [e.g.: typically less than or equal to 10 microns, PM10, (1 micron = 10^{-6})].[27] Under the particulate matter substances group, we assessed two substances; $PM_{2.5}$ and PM_{10}. For further details on UK targets and limits for these gases see Tables 25, 26 and 27 at the end of this report.

The overall assessment of particulate matter

The NCC's overall assessment of particulate matter is mixed: overall emissions and concentrations have declined from historical highs. However, evidence for the recent past (short-term trend) suggests that emissions and concentrations could be flat/increasing. For subgroup, level assessment see Table 4 for further details.

- Poor air quality impacts human health; it has been estimated that the effects of long-term exposure to particulate air pollution alone in the UK causes up to 29,000 deaths brought forward per year;[28]
- Roadside monitoring sites concentration levels have increased by over 6% for $PM_{2.5}$ between 2016 and 2017;
- Emissions of PM_{10} have declined by just under 55% between 1990 and 2017, however these have been flat/increasing since 2011.

27 SEPA, *Particulate matter – total* https://www2.sepa.org.uk/SPRIPA/Pages/SubstanceInformation.aspx?pid=125

28 Public Health England (PHE), *COMEAP: mortality effects of long-term exposure to particulate air pollution in the UK* (2010) https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk

Table 4 NCC assessment of particulate matter and RAG rating

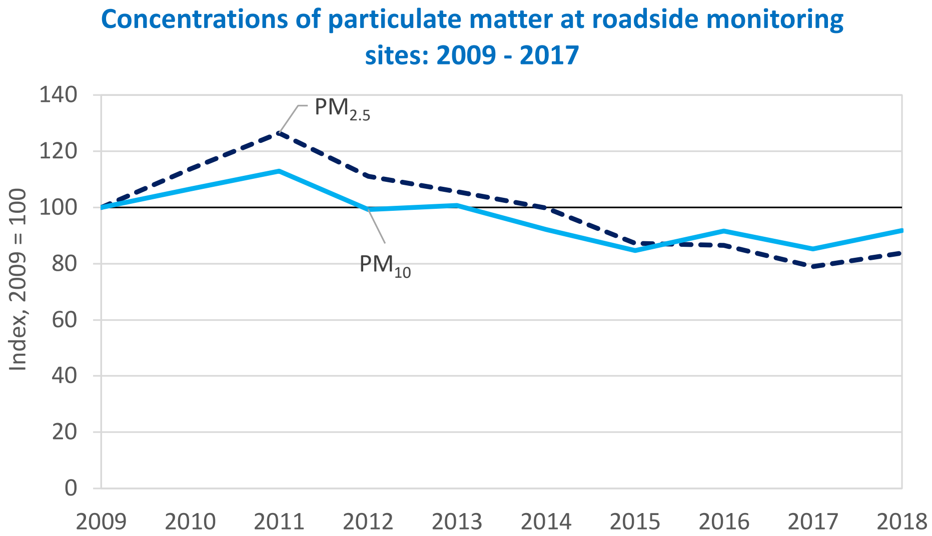
Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
1.1 - $PM^{2.5}$	The UK is meeting its $PM_{2.5}$ concentration target of 25 µg/m^3 annual mean, in 2018 concentration levels were to around 11 µg/m^3 at the roadside 10 µg/m^3 in urban background. It is also on track to reduce emissions by 30% from the 2005 baseline between 2020-2029, in 2017 emissions were just under 15% lower.	Emissions of $PM_{2.5}$ have declined by just under 55% since 1990. Roadside concentrations of $PM_{2.5}$ have also declined by just over 16% between 1990 and 2018. Concentrations data is not available from 1990 for urban background sites.	Emissions have also declined between 2011 and 2018 by just under 0.5%. Concentrations level have reduced between 2011 and 2018 for both roadside and urban background monitoring sites by just under 34% and just under 27% respectively.	There has been a slight decrease in emission between 2016 and 2017 but this was less than 1%. While for road and urban background monitoring sites, concentrations have increased by just over 6% and just under 5% respectively between 2017 and 2018.
1.2 - PM_{10}	The UK is meeting its PM_{10} concentration target of 40 µg/m^3 annual mean, in 2018 concentration levels were at just under 19 µg/m^3 at the roadside and just under 15 µg/m^3 in urban background.	Emissions of PM_{10} have decreased by just under 55% between 1990 and 2017. Concentration levels have also decreased between 1990 and 2018 at both roadside and urban background monitoring sites by just over 49% and just under 60% respectively.	Emissions have increased between 2011 and 2017 by just under 2%. However, concentration levels have reduced between 2011 and 2018 for both roadside and urban background, by just under 19% and just over 26% respectively.	Emissions have increased between 2016 and 2017 by just under 1%. Concentration levels have also increased for both roadside and urban background monitoring sites, by just under 8% and just under 4% respectively between 2017 and 2018.

Concentrations of particulate matter (PM)

The concentrations data available for particulate matter in the air are limited to measurements from the roadside and urban background monitoring sites, for $PM_{2.5}$ and PM_{10}. See Figures 3 and 4 for trend since 2009.

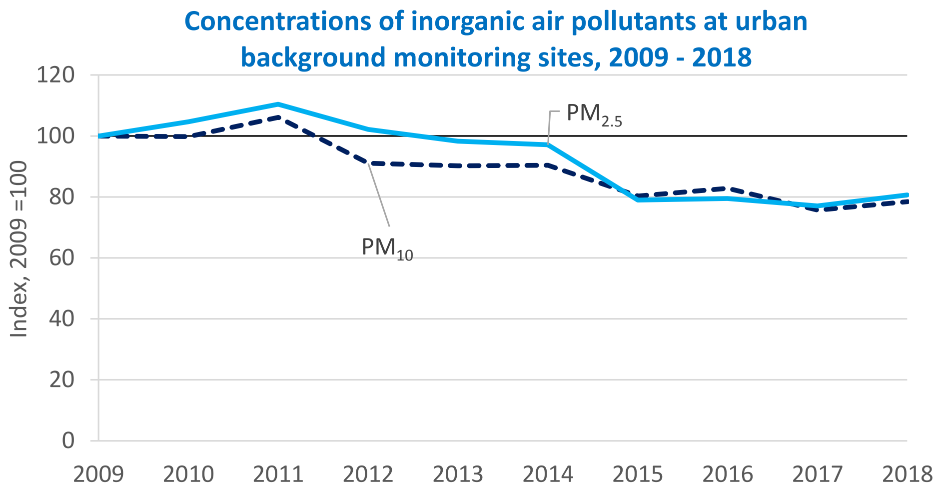
From the data it is apparent that the concentrations of both substances, at both sets of monitoring sites, increased between 2009-2011, though by a greater proportion at roadside monitoring sites. Since 2011, concentrations have shown a downward trend. The concentrations of $PM_{2.5}$ and PM_{10} at roadside monitoring sites in 2018 were 84% and 92% of their 2009 values respectively. The concentrations of $PM_{2.5}$ and PM_{10} at urban background monitoring sites in 2018 were 81% and 79% of their 2009 values respectively.

Figure 3: Concentrations of inorganic air pollutants at roadside monitoring sites in the UK: 2009 - 2018



Source: Defra[29]

Figure 4: Concentrations of inorganic air pollutants at urban background monitoring sites in the UK: 2009 - 2018



Source: Defra[30]

Spatial data (maps): concentrations of particulate matter (modelled)

To display the annual mean concentrations from the background and urban major roads spatially the NCC has presented maps produced by Ricardo. For PM_{10}, these will include large and small point sources, road traffic, and secondary organic and inorganic aerosol.[31,32] Presented in Figure 5, are the annual mean background concentrations of PM_{10} for 2011, while Figure 6 presents the most recent evidence from 2017. When comparing Figures 5 and 6, it can be seen that the concentration of modeled PM_{10} has declined throughout England. The highest levels of concentration are found in London, the South East of England, and the East of England. The scales between Figures 5 and 6 are not directly comparable, therefore these maps should only be used to provide a spatial sense of emissions.

29 Defra, *ENV02 – Air quality statistics* (2019) https://www.gov.uk/government/statistical-data-sets/env02-air-quality-statistics

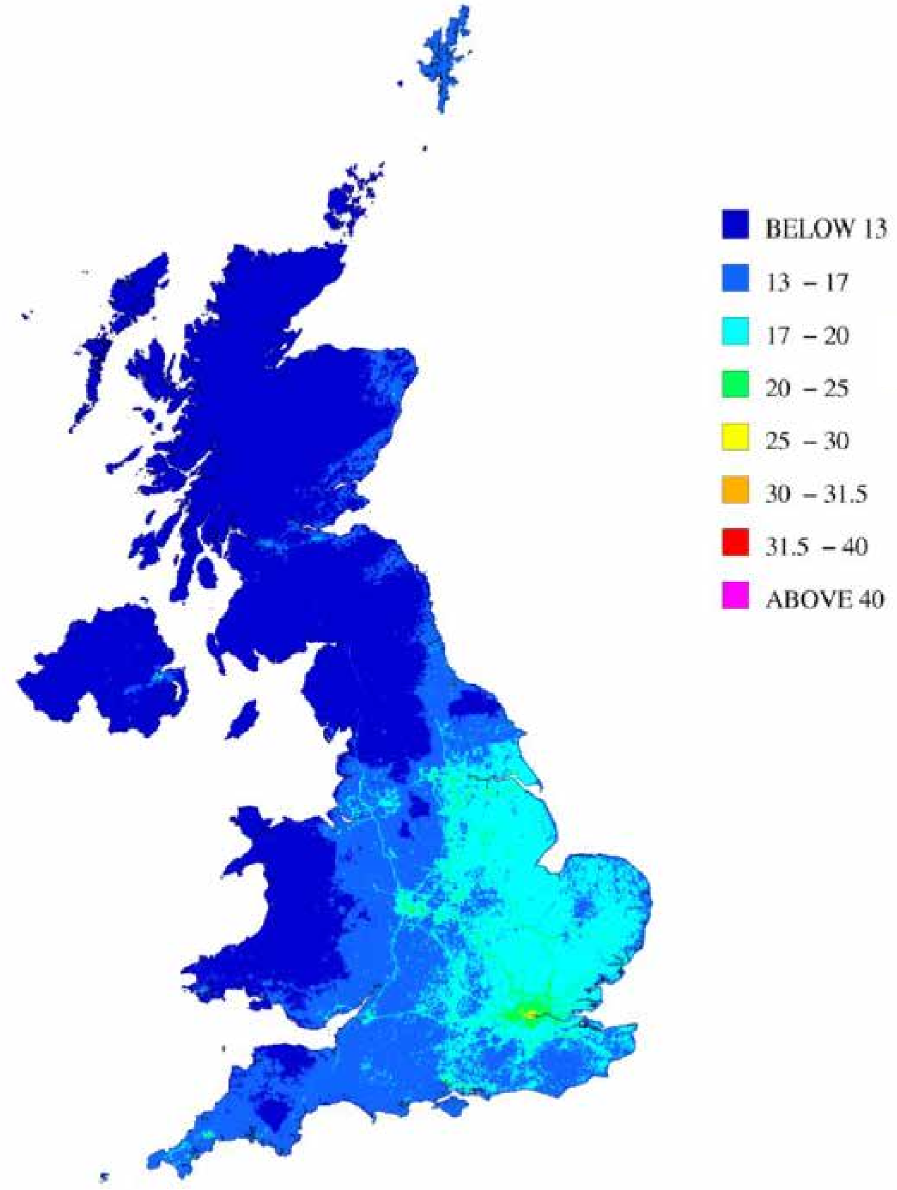
30 Defra, *ENV02 – Air quality statistics* (2019) https://www.gov.uk/government/statistical-data-sets/env02-air-quality-statistics

31 UK Air, *Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2011* (2012) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1310021025_AQD_DD4_2011mapsrepv0.pdf

32 UK Air, *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017* (2019) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903201606_AQ0650_2017_MAAQ_technical_report.pdf

Concentrations maps are also available for $PM_{2.5}$ concentrations. In Figure 7 annual mean background concentration of $PM_{2.5}$ is presented for 2011, while Figure 8 presents estimates for 2017. As per PM_{10}, concentrations of $PM_{2.5}$ have also declined when comparing to 2011 estimates. Figures 7 and 8 are not directly comparable, therefore these maps should only be used to provide a spatial sense of emissions.

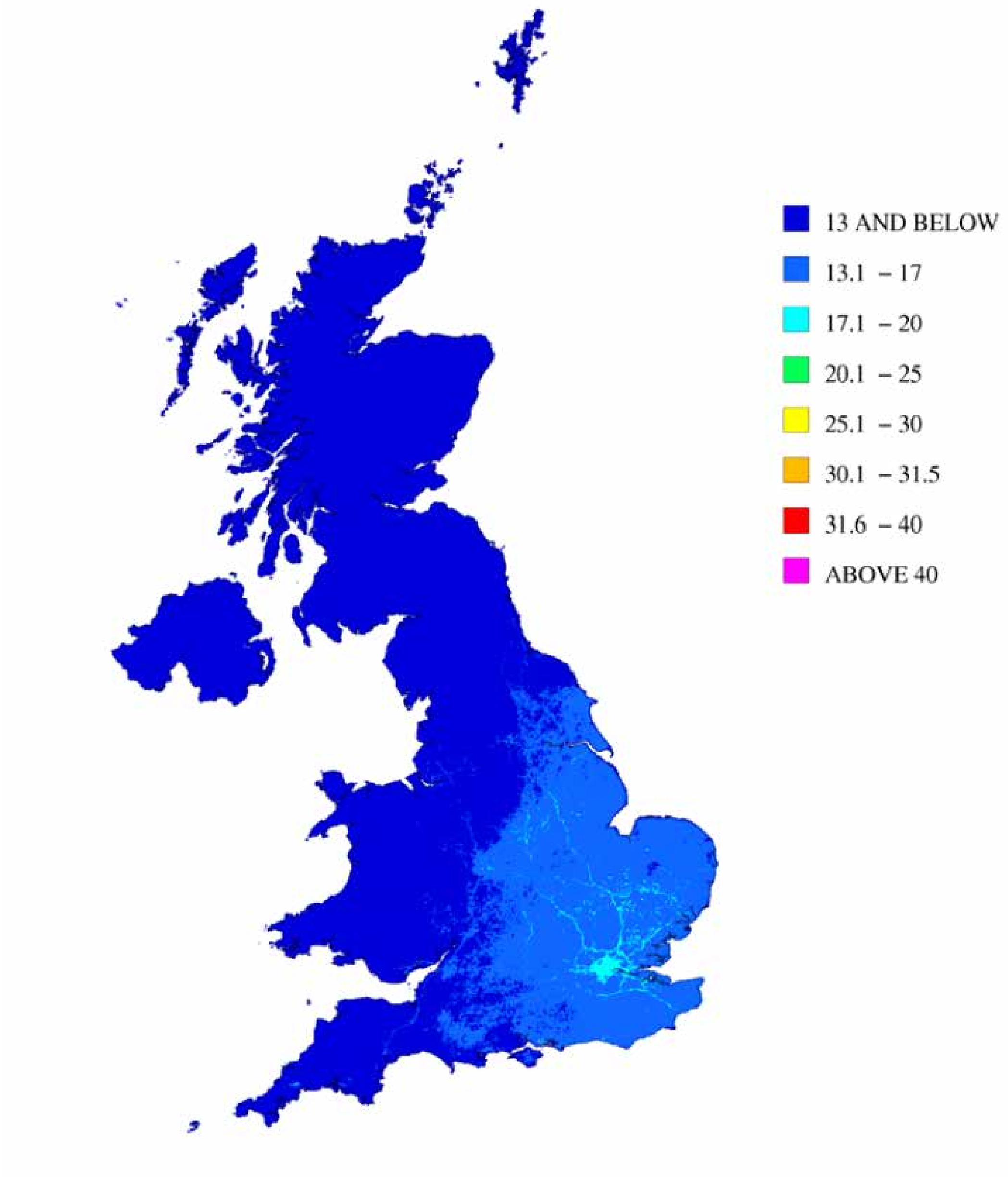
Figure 5: UK, annual mean background PM_{10} concentrations: 2011 (μg/m³, gravimetric)



Source: Ricardo-AEA[33]

33 Ricardo-AEA, *Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2011* (2012) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1310021025_AQD_DD4_2011mapsrepv0.pdf

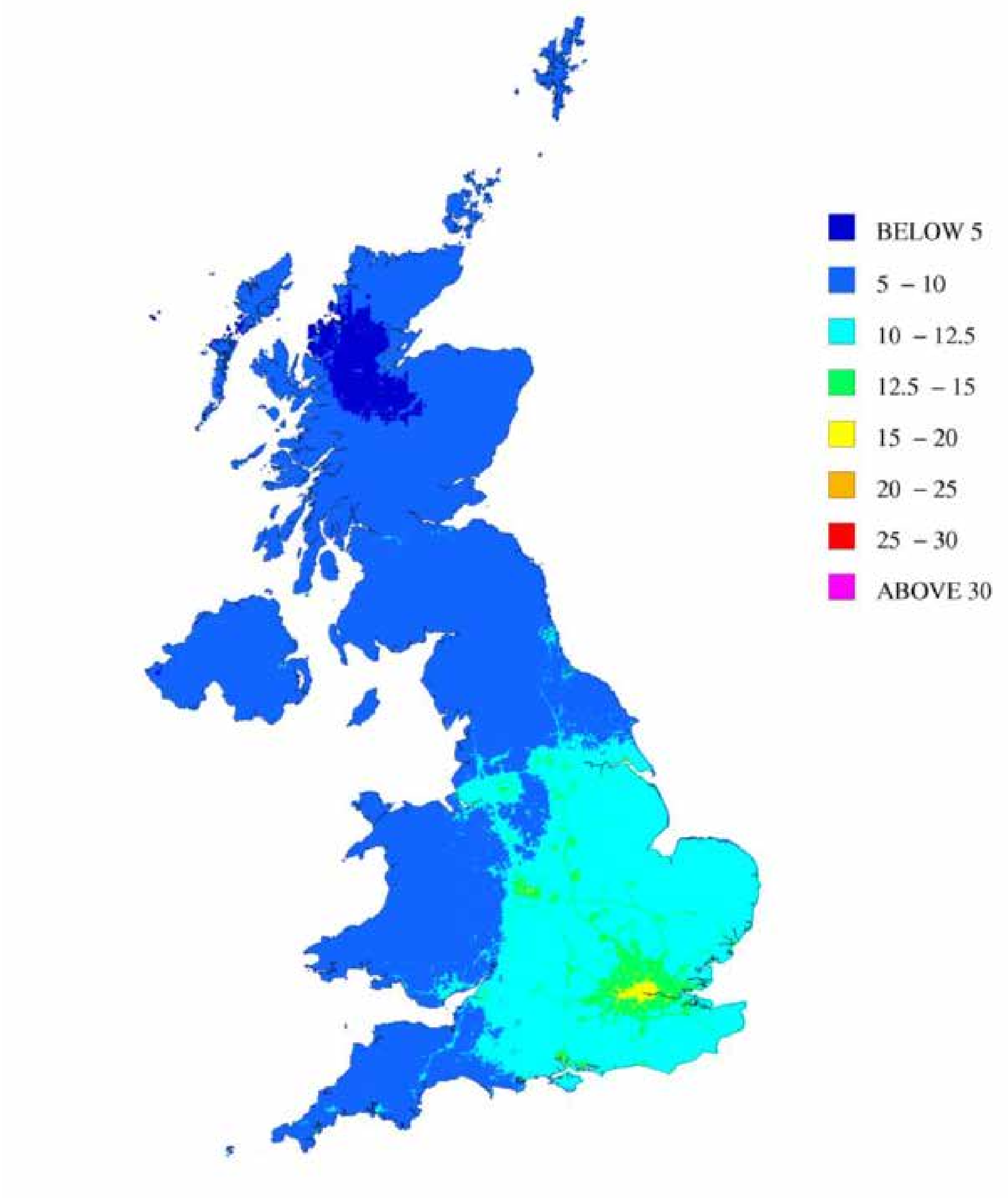
Figure 6: UK, annual mean background PM_{10} concentrations: 2017 (µg/m³, gravimetric)



Source: Ricardo-AEA[34]

34 Ricardo-AEA, *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017* (2019) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903201606_AQ0650_2017_MAAQ_technical_report.pdf

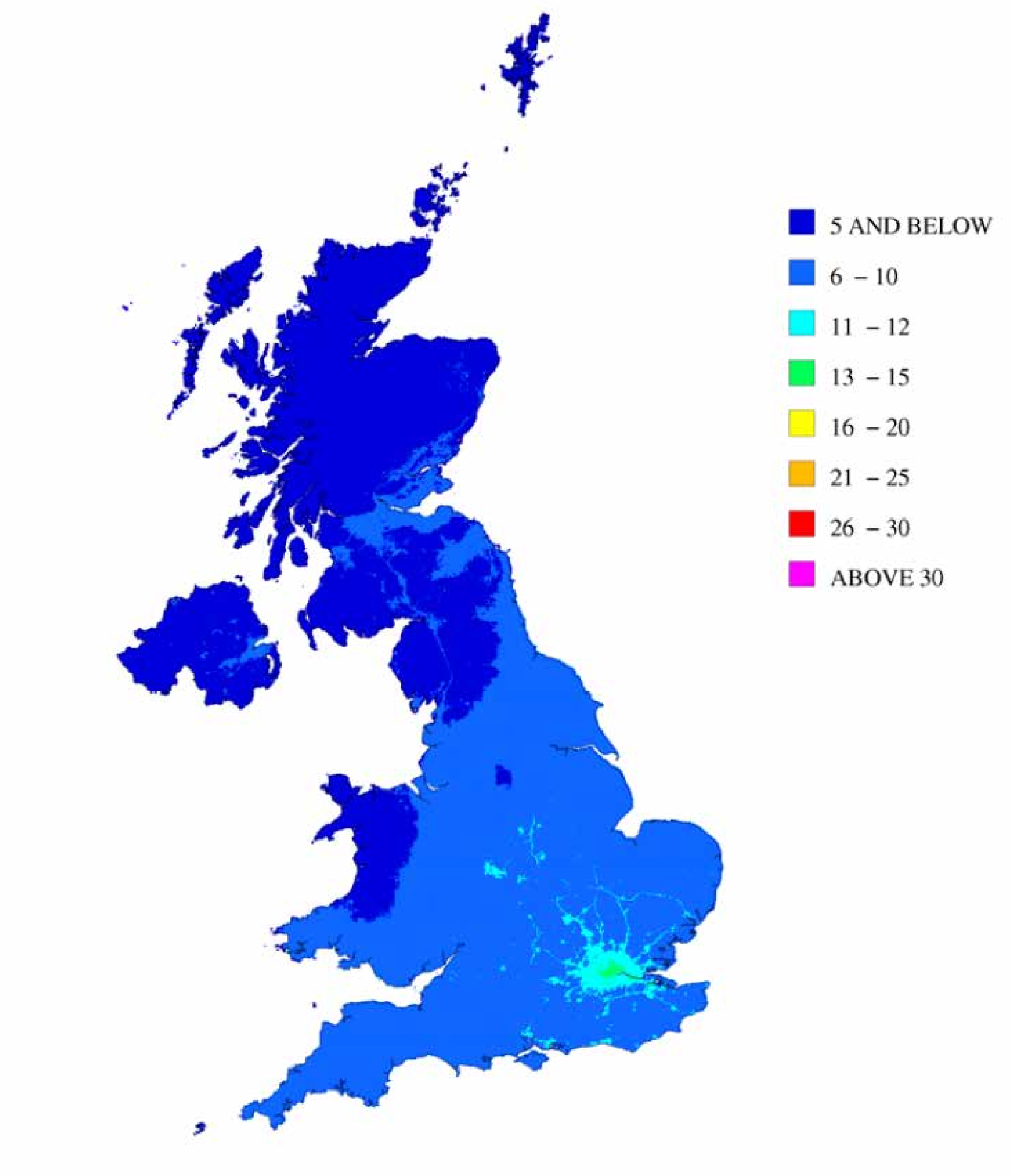
Figure 7: UK, annual mean background $PM_{2.5}$ concentrations: 2011 (µg/m^3, gravimetric)



Source: Ricardo-AEA[35]

35 Ricardo-AEA, *Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2011* (2012) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1310021025_AQD_DD4_2011mapsrepv0.pdf

Figure 8: UK, annual mean background PM2.5 concentrations: 2017 (µg/m3, gravimetric)



Source: Ricardo-AEA[36]

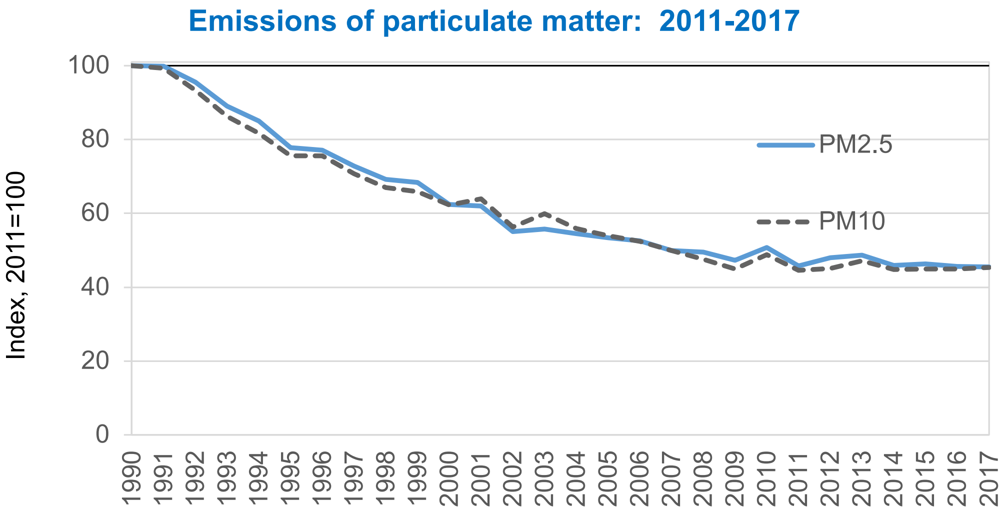
36 Ricardo-AEA, *Technical report on UK supplementary assessment under The Air Quality Directive (2008/50/EC), The Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017* (2019) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903201606_AQ0650_2017_MAAQ_technical_report.pdf

Emissions of particulate matter

Our assessment indicates that the emissions of PM_{10} and $PM_{2.5}$ have declined significantly since 1990, and by similar proportions. The emissions of $PM_{2.5}$ and PM_{10} have both fallen by 55%. However, the rate of decline has slowed over the period, particularly since around 2011. See Figure 9 for particulate matter emissions since 1990.

The EU target is for the emissions of $PM_{2.5}$ to be 30% lower in the years 2020-2029 than their 2005 level: see Table 25. The emissions of $PM_{2.5}$ in 2017 were only 15% lower than their 2005 level.

Figure 9: Emissions in the UK and Gibraltar of inorganic substances: 1990 - 2017



Source: NAEI37

Spatial data: particulate matter emissions

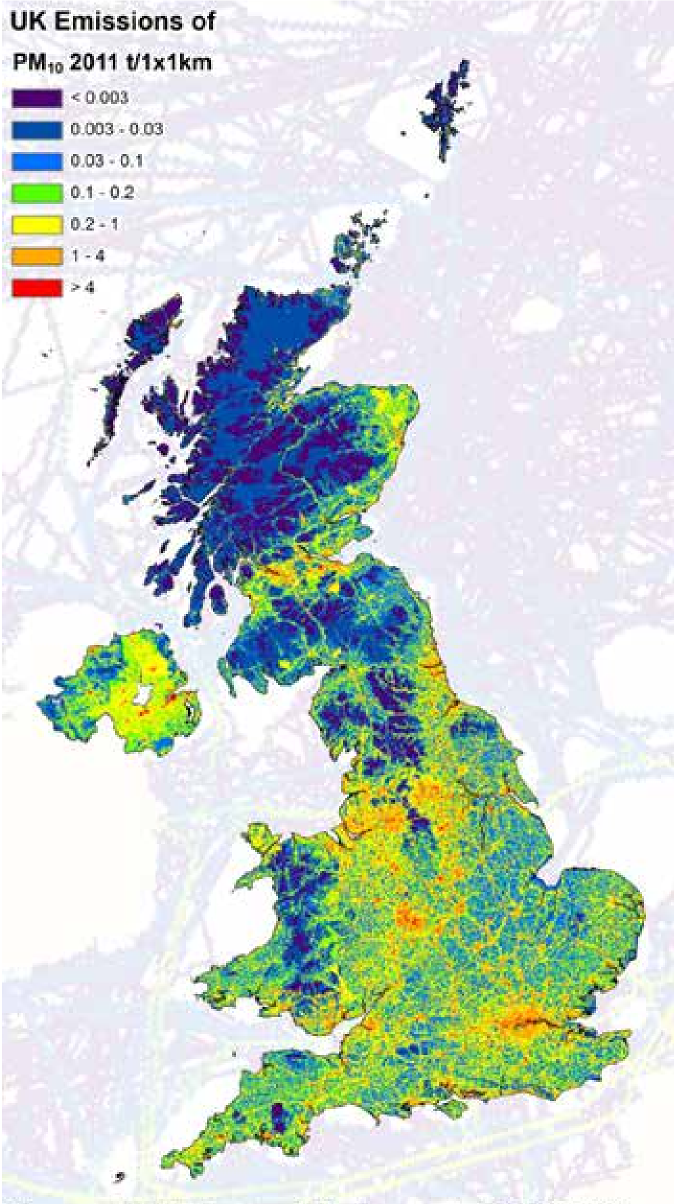
Maps presenting the spatial patterns of emissions of particulate matter in the UK are based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. For example, sectors such as transport, point sources, agriculture, and landfill. Emissions maps are available for $PM_{2.5}$, and PM_{10}. Presented in Figure 10 are the emissions from PM_{10} in 2011, while Figure 11 presents data for 2017. When comparing both figures it can be seen that emissions have increased since 2011, with the highest levels of emissions in England being found mainly in urban areas such as London, Birmingham, and Manchester.[38] For a higher resolution map presenting emissions of $PM_{2.5}$ see the NAEI interactive maps[39].

37 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

38 NAEI, *Download emissions map: Data for PM10 (Particulate Matter < 10µm) in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=24

39 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

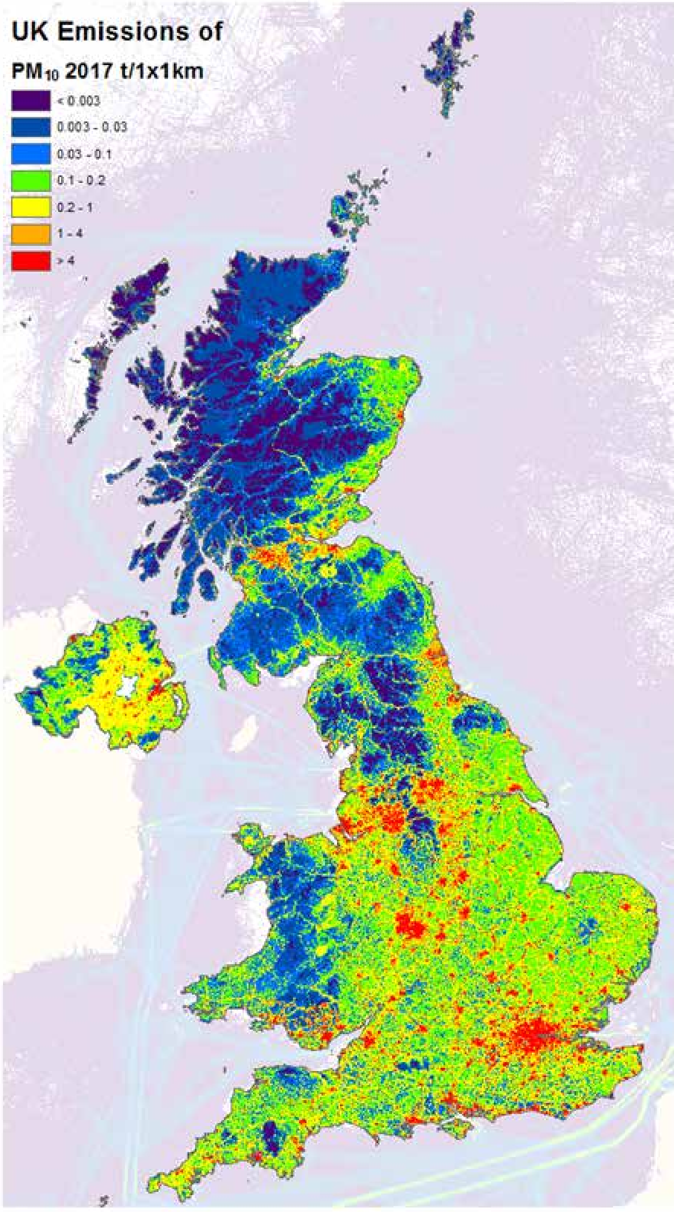
Figure 10: UK, PM_{10} emissions: 2011



Source: Ricardo-AEA[40]

40 Ricardo-AEA, *UK Emission Mapping Methodology 2011: A report of the National Atmospheric Emissions Inventory* (2013) https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1403100909_UK_Emission_Mapping_Methodology_2011-Issue_1.pdf

Figure 11: UK, PM_{10} emissions: 2017



Source: NAEI[41]

41 NAEI, *Download emissions maps: PM_{10} in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=24&emiss_maps_submit=naei-20200924150604

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) it is apparent that the main sources of emissions from particulate matter come from residential stationary combustion (e.g.: wood as domestic fuel) and other types of stationary combustion in manufacturing industries and construction. In 2017 emissions from these two sectors for $PM_{2.5}$ account for 56% of the total.[42] See Table 5 for a list of key sources of emissions.

Table 5: Key sectors and sources of particulate matter pollution

	Substance type	**Key sources of emissions**[43]
Particulate Matter	• $PM_{2.5}$ • PM_{10}	• Residential; • Manufacturing industries and construction; • Transport; and • Mineral products.

2. Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAH) are a group of persistent organic pollutant compounds. They are generally produced through incomplete combustion or pyrolysis.[44] PAHs can be released naturally from forest fires and volcanoes, and anthropogenic sources such as bonfires and fireworks. The PAH group is made of several hundred individual chemicals, for this assessment, 16 substances were assessed. For further details on targets and limits for these substances see Tables 25, 26 and 27 at the end of this report.

The overall assessment of polycyclic aromatic hydrocarbons

The NCC's assessment of the polycyclic aromatic hydrocarbons (PAHs) is deteriorating/mixed, since 1990 there has been a decline in the emissions of PAHs, however between 2011 and 2017, there has been an increase in emissions to 15 out of the 16 compounds. There is also a mixed outcome when comparing the estimates from the data between 2016 and 2017 which shows that most compounds had small changes (less than 1%). For a detailed assessment see Table 6 below.

42 NAEI, *Data* (2017) https://naei.beis.gov.uk/data/

43 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

44 NAEI, *Polycyclic Aromatic Hydrocarbons (PAH)* https://uk-air.defra.gov.uk/networks/network-info?view=pah

Table 6 NCC assessment of polycyclic aromatic hydrocarbons and RAG rating (emission data only)

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)[45]	Short-term trend
2.1 - Acenaphthene	N/A - unable to assess against the target as concentration data not available.	Emissions of acenaphthene have reduced by just under 86% between 1990 and 2017.	However, between 2011 and 2017 the level of emissions has increased by just over 24% from 24.6 tonnes to 30.6 tonnes.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.2 - Acenaphthylene	N/A - unable to assess against the target as concentration data not available.	There has been an increase in the level of emissions between 1990 and 2017 of over 124%.	There has also been an increase in emissions when comparing 2011 against 2017 of just over 63%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.3 - Anthracene ($C_{14}H_{10}$)	N/A - unable to assess against the target as concentration data not available.	Emissions of anthracene ($C_{14}H_{10}$) have reduced by just under 87% between 1990 and 2017.	However, between 2011 and 2017 the level of emissions has increased by just over 49%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.4 - Benzo(a) anthracene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the level of emissions of over 56%.	When assessing between 2011 and 2017 there was an increase of just under 57%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.5 - Benzo[a] pyrene (B[a]P)	N/A - unable to assess against the target as concentration data not available.	Emissions of anthracene (C14 H10) have reduced by just under 97% between 1990 and 2017.	However, between 2011 and 2017 the level of emissions has increased by just under 13%.	The most recent period shows a decline in the level of emissions between 2016 and 2017 of 2%.
2.6 - Benzo(b) fluoranthene	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions between 1990 and 2017 of just under 99%.	There has been an increase in emissions when comparing 2011 against 2017 of just over 20%.	Between 2016 and 2017 there was a reduction in emissions of just over 2%.
2.7 - Benzo(g,h,i) perylene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the level of emissions of just over 71%.	However, between 2011 and 2017 the level of emissions has increased by just over 42%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.8 - Benzo[k] fluoranthene	N/A - unable to assess against the target as concentration data not available.	Emissions of benzo[k] fluoranthene have reduced by just under 99% between 1990 and 2017.	When assessing between 2011 and 2017 there was an increase of just over 16%.	Between 2016 and 2017 there was a reduction in emissions of just under 2%.
2.9 - Chrysene	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions between 1990 and 2017 of just under 84%.	There has been an increase in emissions when comparing 2011 against 2017 of just under 52%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.

45 Where possible and data is available the NCC will use 2011 as the baseline point (starting point) to produce their assessment.

2.10 - Dibenz[a,h] anthracene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the level of emissions of just under 94%.	There has also been a reduction in emission between 2011 and 2017 of just under 19%	Between 2016 and 2017 there was a reduction in emissions of just over 2%.
2.11 - Fluoranthene	N/A - unable to assess against the target as concentration data not available.	Emissions of fluoranthene have reduced by just under 93% between 1990 and 2017.	However, between 2011 and 2017 the level of emissions has increased by just under 47%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.12 - Fluorene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the level of emissions of just under 80%.	There has been an increase in emissions when comparing 2011 against 2017 of just under 31%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.13 - Indeno [123-cd]pyrene	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions between 1990 and 2017 of just under 98%.	However, between 2011 and 2017 the level of emissions has increased by just under 8%.	While between 2016 and 2017 there was a decrease of just over 3%
2.14 - Naphthalene	N/A - unable to assess against the target as concentration data not available.	Emissions level have fallen between 1990 and 2017 by just over 57%.	When assessing between 2011 and 2017 there was an increase of just under 40%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.15 - Phenanthrene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the level of emissions of 88%.	However, between 2011 and 2017 the level of emissions has increased by just over 48%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
2.16 - Pyrene	N/A - unable to assess against the target as concentration data not available.	Emissions level have fallen between 1990 and 2017 by just under 87%.	There has been an increase in emissions when comparing 2011 against 2017 of just under 49%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.

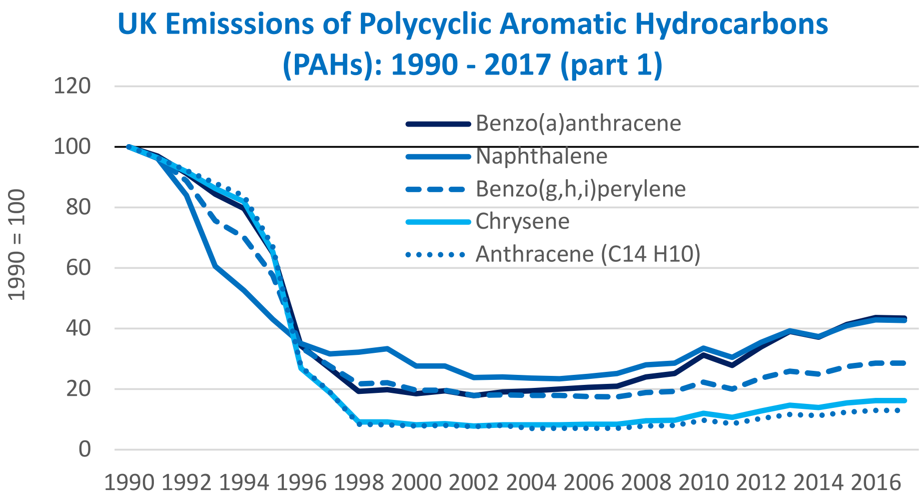
Concentrations of polycyclic aromatic hydrocarbons (PAHs)

No data is available/was found for the concentration of PAHs in England (or the UK), data is only available on emissions which are used as a proxy for this assessment.

Emissions of polycyclic aromatic hydrocarbons (PAHs)

Emissions of all sixteen of the PAHs shown decreased until around 1998. From then on, emissions either levelled off or gradually increased. The gases are shown on the graphs below in groups with similar patterns. The gases shown in Figure 12 experienced a significant initial decrease in emissions, in some cases decreasing by over 90% in the first eight years. For the next ten years, until 2008, emissions of these gases decreased more steadily, but have increased since. In 2017, emissions of 15 of these gases were between 57% and 98% lower than in 1990.

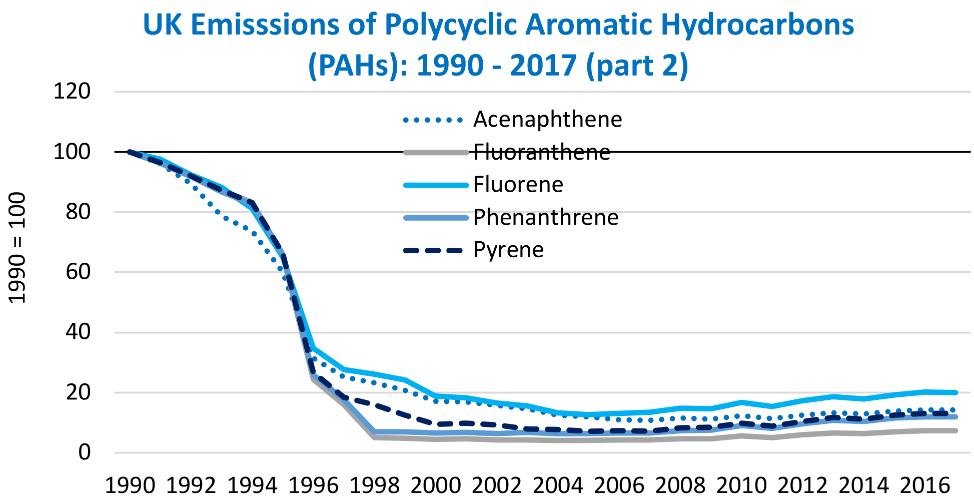
Figure 12: UK emissions of polycyclic aromatic hydrocarbons (PAHs): 1990 - 2017 (part 1)



Source: NAEI[46]

Emissions of the gases shown in Figure 13 generally experienced a similar initial decrease as the gases shown in Figure 12, but the subsequent increase was smaller. In 2017, emissions of these gases were between 80% and 93% lower than in 1990.

Figure 13: UK emissions of polycyclic aromatic hydrocarbons (PAHs): 1990 - 2017 (part 2)



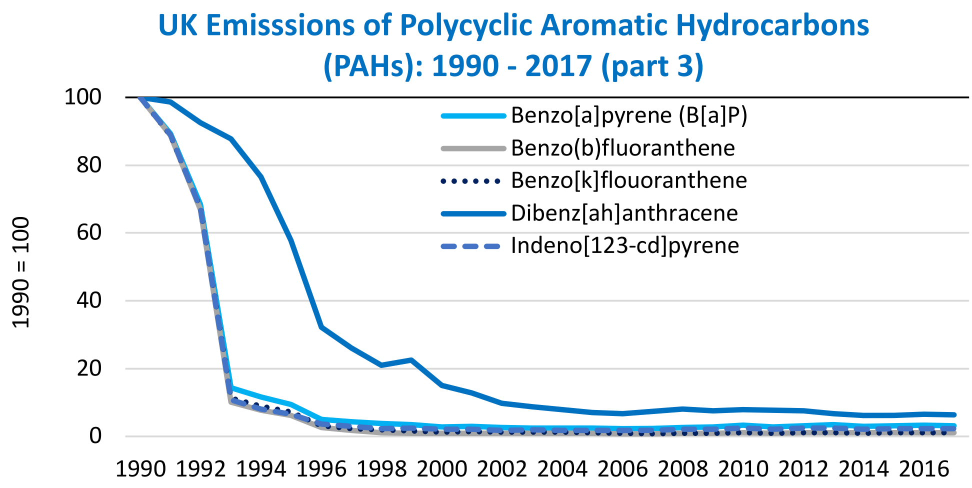
Source: NAEI[47]

The emissions of gases shown in Figure 14 experienced the greatest initial decrease, in some cases falling below 10% of their 1990 value in the first four years. The emissions of these gases then levelled off rather than increasing, finishing the period at the lowest levels compared with 1990 of all the PAHs. Emissions of these gases were between 94% and 99% lower in 2017 than in 1990.

46 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

47 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

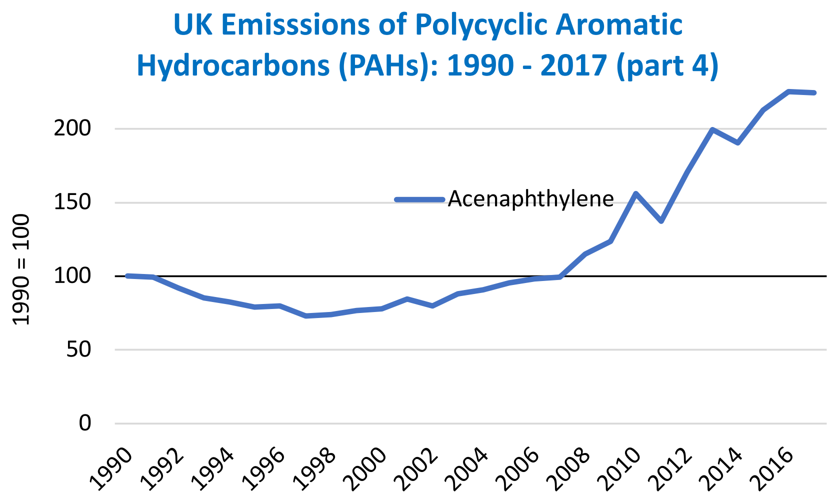
Figure 14: UK emissions of polycyclic aromatic hydrocarbons (PAHs): 1990 - 2017 (part 3)



Source: NAEI[48]

Acenaphthylene, while following the same general pattern of decrease and subsequent increase as the other PAHs, has been shown on its own because it was the only gas whose emissions were higher at the end of the period than at the start - see Figure 15. The initial decrease in the emissions of acenaphthylene was much smaller than the initial decreases in the emissions of the other PAHs, though still significant: in 1997 emissions were 27% lower than in 1990. Whereas the subsequent increases in the emissions of the other PAHs were slight, the emissions of acenaphthylene increased dramatically after 1997, ending the period at 225% of their 1990 value.

Figure 15: UK emissions of polycyclic aromatic hydrocarbons (PAHs): 1990 - 2017 (part 4)



Source: NAEI[49]

Spatial data: Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs map on emissions is only available for benzo[a]pyrene, and a map has only been found for 2017, hence it has not been possible to compare against the 2011 level spatially. Figure 16 presents emissions in the UK based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. The data underpinning the benzo[a]pyrene map is mainly based on area source data (97%), which is of inferior quality to source point data. In 2017, the highest level of emissions was concentrated in urban areas such as London and the South East of England.[50] For a higher resolution map see NAEI interactive emissions maps[51].

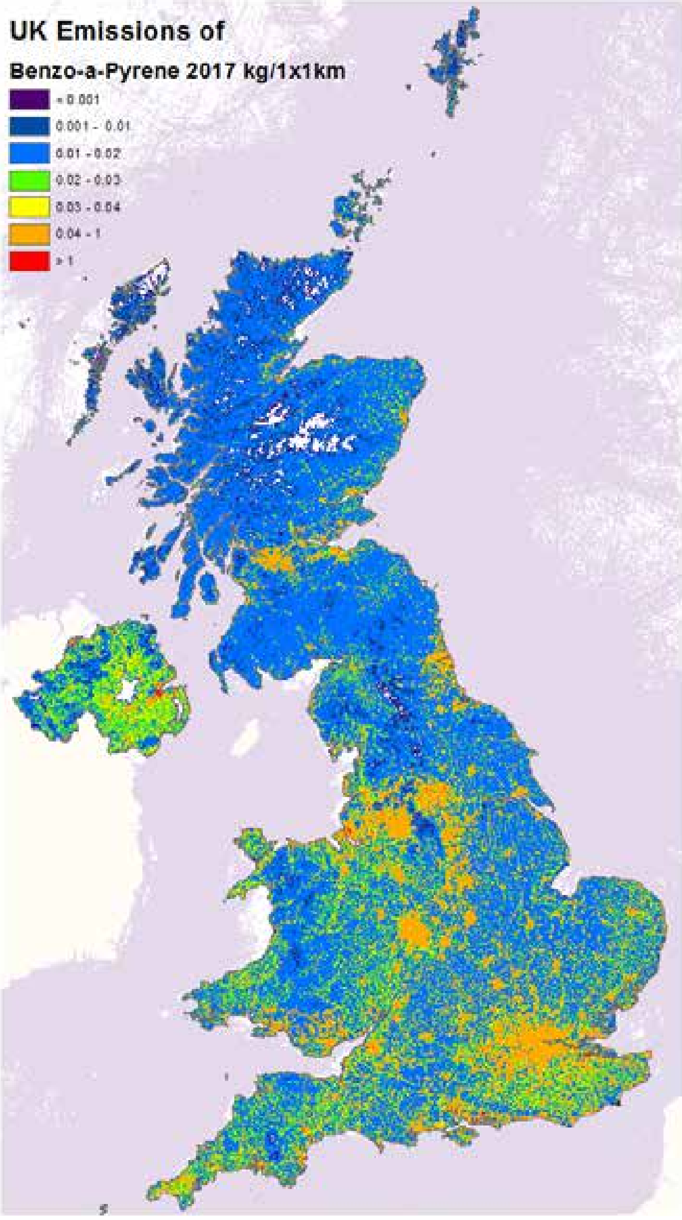
48 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

49 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

50 NAEI, *Download Emission Map Data for Benzo[a]pyrene in 2017 https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=41&emiss_maps_submit=naei-20200224155712*

51 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

Figure 16: UK, emissions of benzo[a]pyrene: 2017



Source: NAEI[52]

52 NAEI, *Download emission maps: Benzo[a]pyrene in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=41&emiss_maps_submit=naei-20200224155712

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) the main sources of emissions from PAHs are residential stationary combustion (e.g.: wood as domestic fuel) and other types of stationary combustion in manufacturing industries and construction. Table 7 presents the key sources of emissions from the NAEI data.[53]

Table 7: Key sectors and sources of PAH emissions

	Substance type	Some of the key sources of emissions[54]
Polycyclic aromatic hydrocarbons (PAHs)	• Acenaphthene • Acenaphthene • Acenaphthylene • Anthracene (C14 H10) • Benzo(a)anthracene • Benzo[a]pyrene (B[a]P) • Benzo(b)fluoranthene • Benzo(g,h,i)perylene • Benzo[k]flouoranthene • Chrysene • Dibenz[a,h]anthracene • Fluoranthene • Fluorene • Indeno[123-cd]pyrene • Naphthalene • Phenanthrene • Pyrene	• Residential; • Wood processing; • Waste management; • Fugitive emission from solid fuels; • Mobile combustion in manufacturing industries and construction; • Road transport; • Agriculture/forestry/fishing: off-road vehicles and other machinery; • National navigation (shipping); • Public electricity and heat production; • Iron and steel production; • Petroleum refining.

3. Greenhouse Gases

Greenhouse gases (GHGs) are gases that warm the planet by absorbing energy and slowing the rate at which this energy is released into space. To measure the impacts of the different greenhouse gases, the global warming potential (GWP) was developed to allow for comparison between these.[55] The NCC analysis focuses on seven greenhouse gases under the Kyoto Protocol[56]. For further details on targets and limits for these gases see Tables 25, 26 and 27 at the end of this report.

The overall assessment of greenhouse gases

The NCC's overall assessment of the greenhouse gases is improving /mixed, emissions of carbon dioxide, hydrofluorocarbons, methane, perfluorocarbon and nitrous oxide have declined since 1990 and over the most recent period. For an assessment of each gas see Table 8 for further details.

- Emissions of greenhouse gases have declined between 1990 and 2017 from 794 to 451 MtCO2e.
- Methane (CH_4) emissions (the second largest in terms of $MtCO_2e$) has been flat since 2016, at around 51 $MtCO_2e$.

53 NAEI, *Data* (2017) https://naei.beis.gov.uk/data/

54 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

55 EPA, *Greenhouse Gas Emissions* https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

56 NAEI, *Overview of greenhouse gases* https://naei.beis.gov.uk/overview/ghg-overview

Table 8 NCC assessment of greenhouse gases and RAG rating

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
3.1 - Carbon dioxide (CO_2)	Based on the assessment by the Committee on Climate Change (CCC) government is not on track to meet the fourth and fifth carbon budgets and further actions are required.	There has been a decrease in the level of emissions of carbon dioxide between 1990 and 2018 of just under 39%.	When assessing between 2011 and 2018 there has also been a decline of just under 20%.	Data between 2017 and 2018 shows that there was a decline of just over 2%.
3.2 - Hydrofluorocarbons (HFCs)		Between 1990 and 2018 there was a reduction in hydrofluorocarbons (HFCs) emissions of under 10%.	There has also been a decrease in emissions when comparing 2011 against 2018 of just over 12%.	Between 2017 and 2018 there was a decline in emissions of HFCs of just over 7%.
3.3 - Methane (CH_4)		Emissions of methane have reduced by just over 61% between 1990 and 2018.	There has also been a reduction in emission between 2011 and 2018 of just under 16%	There was almost no change in the level of emissions between 2017 and 2018 – less than 1%.
3.4 - Perfluorocarbon (PFCs)		There has been a decrease in the level of emissions of perfluorocarbon between 1990 and 2018 of just over 84%.	Emissions levels have also declined when comparing 2011 and 2018 by just over 38%.	Data between 2017 and 2018 shows that there was a decline of just under 48%.
3.5 - Sulphur hexaflouride (SF_6)		Emissions levels of sulphur hexafluoride (SF_6) have reduced by just over 58% between 1990 and 2018.	There has also been a reduction in emission between 2011 and 2018 of just under 13%	Between 2017 and 2018 there was an increase in emissions of SF_6 of just over 7%.
3.6 - Nitrogen trifluoride (NF_3)		There has been an increase in the level of emissions of nitrogen trifluoride (NF_3) between 1990 and 2017 of just under 41%.	There has also been an increase in emissions when comparing 2011 against 2018 of just under 95%.	Data comparing between 2017 and 2018 shows that there was an increase of 10%.
3.7 - Nitrous oxide (N_2O)		There has been a decrease in the level of emissions of nitrous oxide (N_2O) between 1990 and 2018 of just under 58%.	There was almost no change in the level of emissions between 2011 and 2018 – less than 1%.	There was almost no change in the level of emissions between 2017 and 2018 – less than 1%.

Emissions of greenhouse gases

Emissions data is available for all relevant greenhouse gases, up to 2018. These seven gases[57] are shown here split onto two graphs, for ease of interpretation.

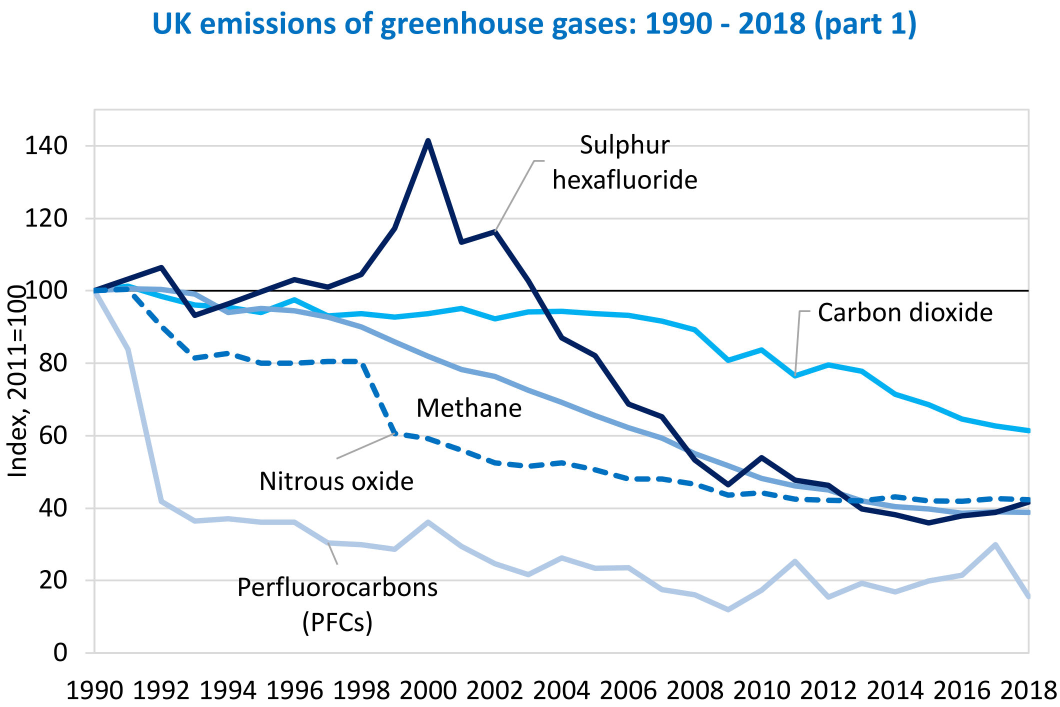
The emissions of the gases shown in Figure 17 have trended downwards since 1990, though emissions of sulphur hexafluoride first increased, in 2002 reaching 116% of their 1990 value. Emissions of sulphur hexafluoride, along with emissions of methane, and nitrous oxide, finished the period around 60% lower than in 1990.

The emissions of perfluorocarbons were 84% lower in 2018 than in 1990, though their starting point was a fraction of the emissions of other greenhouse gases.

Emissions of carbon dioxide, the gas with the greatest impact on global warming, were 39% lower in 2018 than in 1990.

These figures do not consider the global warming footprint of goods and services imported into the UK. According to the Office for National Statistics, the UK's net imports of carbon dioxide emissions per capita increased from 1.7 tonnes in 1992 to 5.1 tonnes in 2007, offsetting progress made by reducing domestic emissions.[58]

Figure 17: UK emissions of greenhouse gases: 1990 - 2018 (part 1)



Source: BEIS[59]

Emissions in the gases shown in Figure 18 did not trend downwards. The emissions of hydrofluorocarbons (HFCs) fluctuated around their 1990 value in a volatile manner, with a high in 1997 of 160% of their 1990 value and a low of 80% of their 1990 value, only two years later. HFC emissions in 2018 were 91% of their 1990 value.

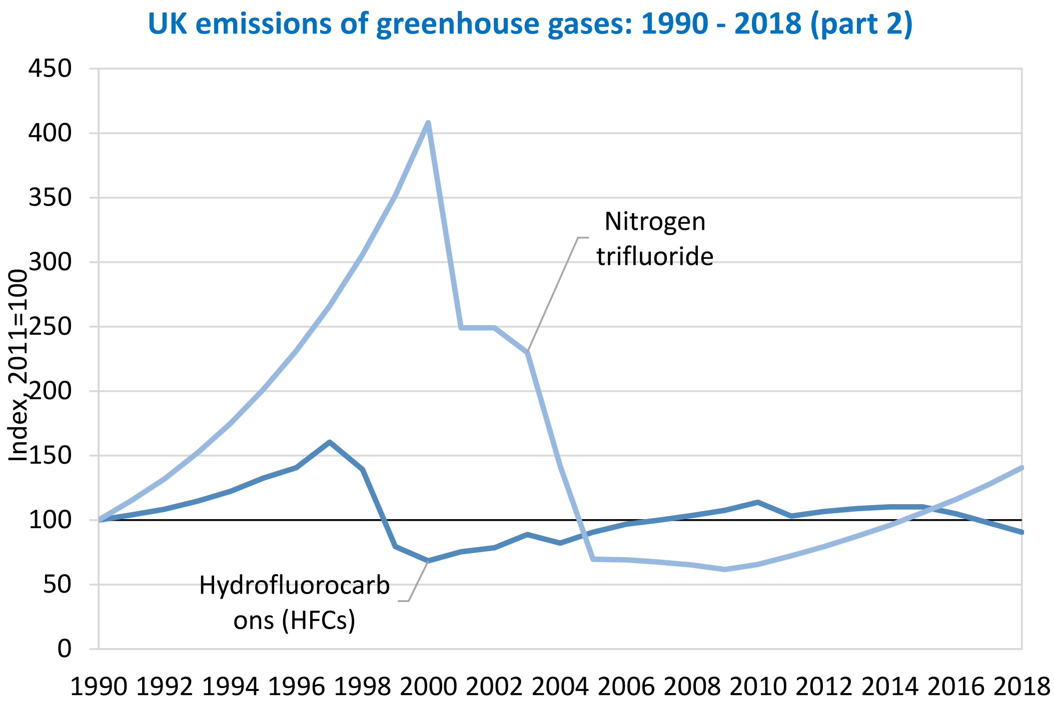
Nitrogen trifluoride emissions have fluctuated around their 1990 value even more widely, with a peak in 2000 at 408% of their 1990 value and a low in 2009 of 62% of their 1990 value. Emissions of nitrogen trifluoride in 2018 were 141% of their 1990 value.

57 The seven gases are: Carbon dioxide, Hydrofluorocarbons, Methane, Perfluorocarbon, Sulphur hexafluoride, Nitrogen trifluoride, and Nitrous Oxide.

58 ONS, *The decoupling of economic growth from carbon emissions: UK evidence* (2019) https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence

59 BEIS, *Final UK greenhouse gas emissions national statistics* (2020) https://www.gov.uk/government/collections/final-uk-greenhouse-gas-emissions-national-statistics

Figure 18: UK emissions of greenhouse gases: 1990 - 2018



Source: BEIS[60]

In the UK, the greenhouse gas with the highest level of emissions is CO_2, and it has a global warming potential of 1 (it is used as the reference gas)[61]. As per Table 9, the other greenhouse gases have much higher global warming potential (GWP) than CO_2.

Table 9 Greenhouse gas emissions for the UK and respective global warming potential over a 100-year time horizon

GHG emissions in $MtCO_2e$	GWP values over a 100-year time horizon[62]	2011	2018
Carbon dioxide (CO_2)	1	455.7	365.7
Hydrofluorocarbons (HFCs)	4 - 12,400[63]	14.8	13.0
Methane (CH_4)	28	61.1	51.5
Perfluorocarbons (PFCs)	6,630 – 11,110	0.4	0.3
Sulphur hexafluoride (SF_6)	23,500	0.6	0.5
Nitrogen trifluoride (NF_3)	16,100	0.0	0.0
Nitrous oxide (N_2O)	265	20.5	20.4

Source: Greenhouse Gas Protocol[64]

60 BEIS, *Final UK greenhouse gas emissions national statistics* (2020) https://www.gov.uk/government/collections/final-uk-greenhouse-gas-emissions-national-statistics

61 Global warming potential is a metric used to compare the impacts of different gases. It is measure of how much energy the emissions of 1 ton of gas will absorb over a given period of time -

62 Greenhouse Gas Protocol, *Global Warming Potential Values* https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

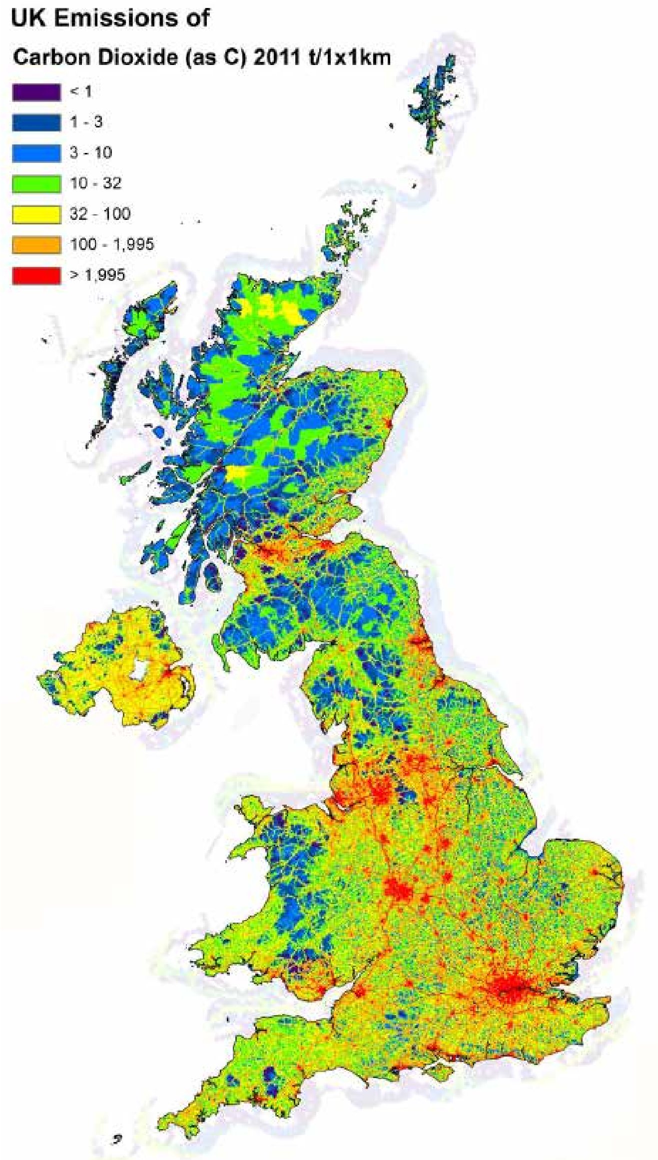
63 The time horizon will vary by the type of HFC see GHG protocol for individual time horizons: https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

64 Greenhouse Gas Protocol, *Global Warming Potential Values* https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

Spatial data (maps): Greenhouse gases

Greenhouse gas emissions in the UK are based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector, for example, sectors such as transport, point sources, agriculture, and landfill. Emissions maps are available for carbon dioxide, methane, and nitrous oxide. Presented in Figure 19 are the emissions from CO_2 in 2011, while Figure 20 presents data for 2017. When comparing both figures it can be seen that emissions have increased in some areas and fallen in others since 2011.[65] For a higher resolution map presenting emissions of CO_2 see the NAEI interactive maps[66].

Figure 19: UK, CO_2 emissions: 2011



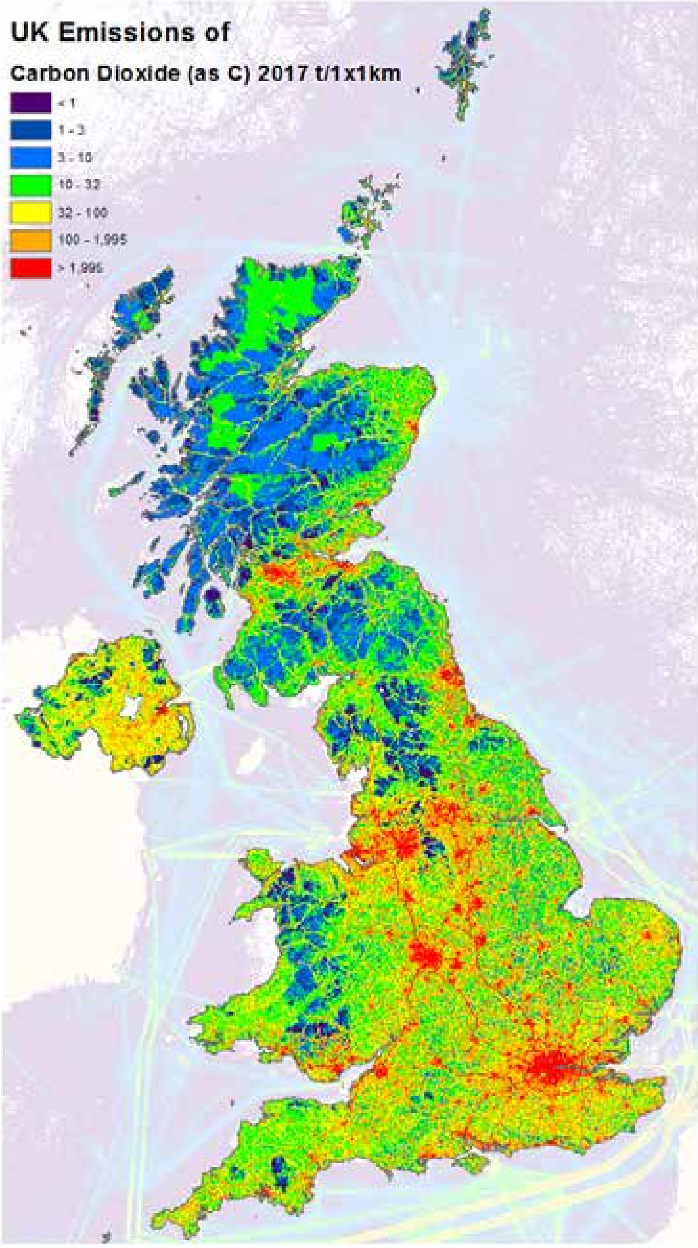
Source: Ricardo-AEA[67]

65 NAEI, *Download emissions map: Data for PM10 (Particulate Matter < 10µm) in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=24

66 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

67 Ricardo-AEA, *UK Emission Mapping Methodology 2011: A report of the National Atmospheric Emissions Inventory* (2013) https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1403100909_UK_Emission_Mapping_Methodology_2011-Issue_1.pdf

Figure 20: UK, CO_2 emissions: 2017



Source: NAEI[68]

68 NAEI, Download emission maps: Carbon dioxide as Carbon 2017 (2019)

Sources of emissions:

Emissions data here are based on BEIS' greenhouse gas emissions data. See Table 10 for key sources of emissions. The sector with the largest emissions based on 2018 data is the transport sector, which is one of the hardest sectors to decarbonise given its reliance on fossil fuels.

Table 10: Key sectors and sources of greenhouse gas pollution

	Substance type	The key source of emissions[69]
Greenhouse gases	• Carbon dioxide (CO_2)	• Energy supply; • Business; • Transport; • Public; • Residential; • Agriculture; • Industrial process; • Land use, land use change and forestry (LULUCF), and • Waste management.
	• Methane (CH_4)	
	• Nitrous oxide (N_2O)	
	• Hydrofluorocarbons (HFCs)	• Business; • Residential; and • Industrial process.
	• Perfluorocarbon (PFCs)	
	• Sulphur hexafluoride (SF_6)	
	• Nitrogen trifluoride (NF_3)	

4. Acid gases

Acid gases can be defined as any gaseous compound which, when dissolved in water, will form an acidic solution. The most common types of acid gases are hydrogen chloride (HCl), hydrogen fluoride (HF), sulphur oxides (SO_2 and SO_3) and nitrogen oxides (NOx). Additionally, carbon dioxide (CO_2) and hydrogen sulphide (H_2S) are also acid gases, the former being assessed under the greenhouse gas section of this report.[70] There are five compounds assessed under the acid gases. For further details on targets and limits for these gases see Tables 25, 26 and 27 at the end of this report.

The overall assessment of acid gases

The NCC's overall assessment of the acid gases is improving, emissions have been fallen for four of the five compounds being assessed. See Table 11 for further details and breakdowns for each compound.

- Emissions of sulphur dioxide (SO_2) have declined by over 95% in 2017 from 1990 levels.
- Emissions of assessed acid gases have declined between 1990 and 2017, by 72% and 98% respectively.

69 Based on the emissions from all sectors.

70 Environmental technology, *What is an acid gas* https://www.envirotech-online.com/news/air-monitoring/6/breaking-news/what-is-an-acid-gas/49302

Table 11 NCC assessment of acid gases and RAG rating

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
4.1 - Hydrogen chloride (HCl)	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in hydrogen chloride (HCl) emissions of under 98%.	There has also been a decline in emissions between 2011 and 2017 of just under 49%.	Over the short-term between 2016 and 2017, the data shows a decline of just under 13%.
4.2 - Hydrogen fluoride (HF)	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions of hydrogen fluoride (HF) between 1990 and 2017 of just over 89%.	When assessing between 2011 and 2017 there has also been a decline of just over 61%.	Between 2016 and 2017 there was a decline in emissions of HF of just over 10%.
4.3 - Nitric oxide (NO)	N/A – A target/ commitment was no found/exist.	N/A – Data is not available/have been found.	N/A – Data is not available/have been found.	N/A – Data is not available/have been found.
4.4 - Nitrogen dioxide (NO_2)	The government seems to be on track to meet the emissions target reduction of 55% from the 2005 baseline between 2020-2029. In 2017, the data shows that emissions have reduced by just under 50%.	Between 1990 and 2017 there were a reduction in hydrogen chloride (NO_2) emissions of just under 72%.	There has also been a reduction in emissions between 2011 and 2017 just under 24%.	Over the short-term between 2016 and 2017, the data shows a decline of just over 3%.
4.5 - Sulphur dioxide (SO_2)	The latest data shows that the government is on track to meet the sulphur dioxide (SO_2) target of 59% reduction from 2005 levels (baseline) between 2020-2029. In 2017, emissions had reduced by just over 77%.	Emissions levels of SO_2 have declined between 1990 and 2017 by just under 95%.	Emissions have also reduced between 2011 and 2017 by over 58%.	Between 2016 and 2017 there was a decline in emissions of SO_2 of just under 2%.

Concentrations of acid gases

There is no data on concentrations of acid gases, the sections that follow are based on data on emissions which are used as a proxy.

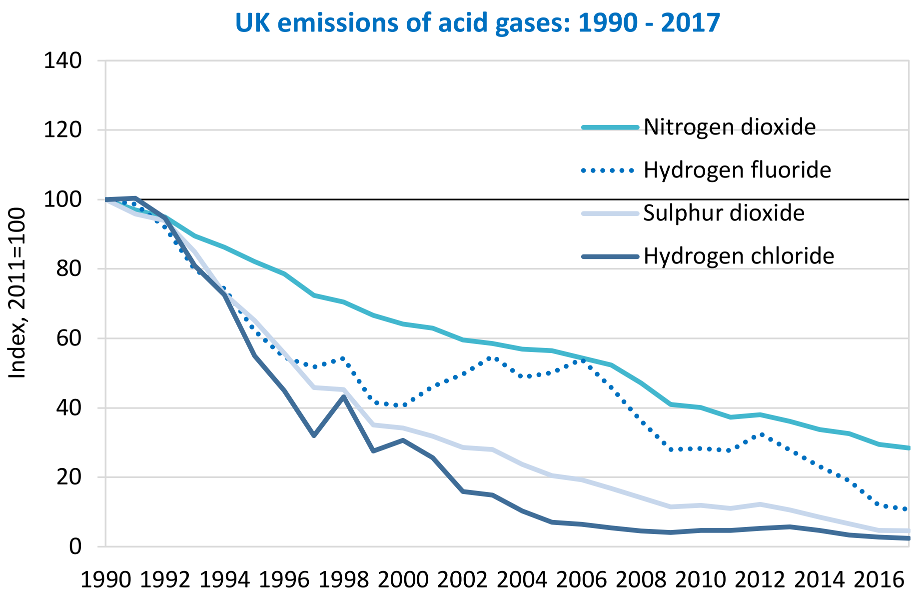
Emissions of acid gases

Data on emissions of nitric oxide is not available, but the data that is available indicates that emissions of the other four acid gases have declined significantly since 1990. The emissions of these gases in the UK in 2017 were between 98% (hydrogen chloride) and 72% (nitrogen dioxide) lower than their 1990 values – See Figure 21. The rate of decline in emissions slowed for all the gases from about 1997 onwards.

The EU target is for the emissions of nitrogen oxide, including nitrogen dioxide, in the years 2020 - 2029 to be 55% lower than their 2005 levels: see Table 25. In 2017, emissions were just under 50% lower than their 2005 level.

The EU target for sulphur dioxide is that emissions in the years 2020 - 2029 should be 59% lower than their 2005 levels: see Table 25. Emissions of sulphur dioxide have complied with this target in 2017 reaching a reduction of just under 78% below their 2005.

Figure 21: UK emissions of acid gases



Source: NAEI[71]

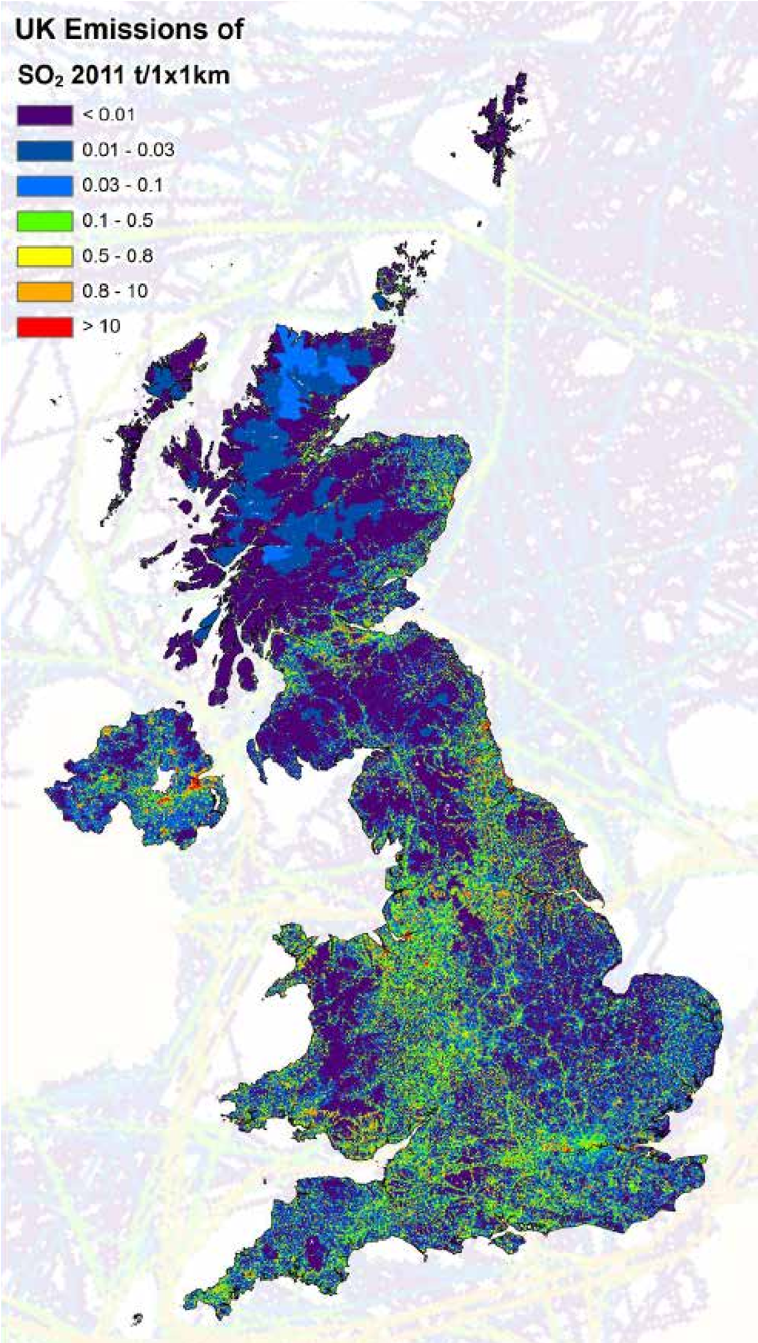
Spatial data: acid gases

The maps presenting emissions in the UK are produced based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. For example, sectors such as transport, point sources, agriculture, and landfill. Emissions maps for acid gases are available for hydrogen chloride, nitrogen oxides, and sulphur dioxide. Presented in Figure 22 are the emissions from SO_2 in 2011, while Figure 23 presents data for 2017. Emissions of SO_2 have declined since 2011, however it's difficult to see this reduction in the maps below. For higher resolution maps SO_2 see the NAEI interactive emissions maps[72].

71 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

72 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

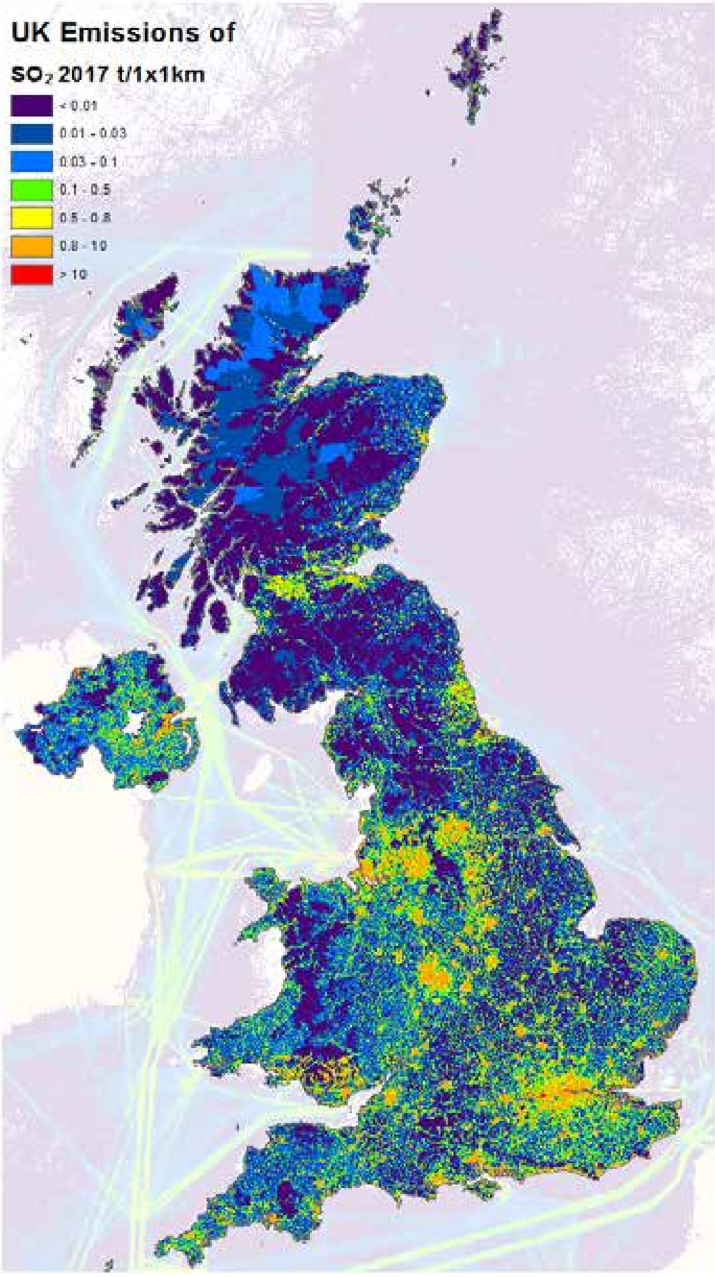
Figure 22: UK, SO_2 emissions: 2011



Source: Ricardo-AEA[73]

73 Ricardo-AEA, *UK Emission Mapping Methodology 2011: A report of the National Atmospheric Emissions Inventory* (2013) https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1403100909_UK_Emission_Mapping_Methodology_2011-Issue_1.pdf

Figure 23: UK, SO_2 emissions: 2017



Source: NAEI74

74 NAEI, *Download emission map: Sulphur dioxide (SO_2) 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=8&emiss_maps_submit=naei-20200924152252

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI), the main sources of emissions from acid gases can be found in public electricity and heating production, transport, and residential combustion: see Table 12 for the list. NO_2 is the gas with the highest level of emissions on the list.

Table 12: Key sectors and sources of acid gas pollution

	Substance type	Some of the key sources of emissions[75]
Acid gases	• Hydrogen chloride (HCl) • Hydrogen fluoride (HF) • Nitrogen oxide (NOx) - expressed as nitric oxide (NO) and nitrogen dioxide (NO_2) • Sulphur dioxide (SO_2)	• Public electricity and heat production; • Stationary combustion in manufacturing industries and construction: other and pulp, paper and print; • Other mineral products; • Fugitive emission from solid fuels Iron and steel production; • Stationary combustion in manufacturing industries and construction: non-metallic minerals. • Road transport; • National navigation (shipping); • Stationary combustion in manufacturing industries and construction; • Petroleum refining; • Residential.

5. Ozone depleting substances (ODS)

Ozone-depleting substances (ODS) are chemicals that can deplete the stratospheric ozone layer. These are long-lived chemicals that contain chlorine and or bromine. ODS fall under the 1987 Montreal Protocol, which sets out a mandatory phase-out of ODS.[76] There are six substances assessed under this section.

The overall assessment of ozone-depleting (ODS) substances

There is no trend data on ODS, so it has not been possible to produce a trend assessment of ODS.

Concentrations of ozone-depleting substances

As most ODS are being phased out, no data is available on the concentrations of ODS for England.

Emissions of ozone-depleting substances

No data is available on the emissions of ozone-depleting substances for England. This could be because most ODS have been phased out, with the exception of hydrochlorofluorocarbons (HCFCs). There is some limited evidence from the European Environment Agency (EEA) which uses UN estimates, that consumption in the EEA-28 has fallen from 343,000 ozone-depleting potential (ODP) tonnes in 1986 to negative values up to 2018 (with the exception of 2003 and 2012).

The value for 2018 was -1,048 ODP, the reason this is a negative estimate is due to how the EU estimates the consumption and production of ODS. These estimates are calculated on annual basis and are mainly defined as 'production plus imports minus exports'.[77, 78]

75 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

76 EEA, *Production and consumption of ozone-depleting substances in Europe* (2020) https://www.eea.europa.eu/data-and-maps/indicators/production-and-consumption-of-ozone-3/assessment

77 Consumption is a parameter that gives an idea of the presence of ODS on the market and tracks the progress in phasing out these chemicals. Calculated for each calendar year, it is mainly defined as 'production plus imports minus exports' (quantities destroyed or used in certain applications like feedstock are subtracted where relevant). As such, its formula can yield a negative number when substances are produced and imported in quantities that do not compensate for the amounts exported or destroyed. This usually happens when exports or destruction take place for ODS that were previously on the market in the EEA-28 (stocks). Additionally, different substances have different ODP values. If consumption is calculated in ODP tonnes, a negative value is also obtained when production/imports take place for low-ODP substances and exports/destruction take place for high-ODP substances. The latter is the current situation due to the fact that certain high-ODP substances are produced in the EU as by-products that, in general, are stocked before being destroyed.

78 EEA, *Production and consumption of ozone-depleting substances in Europe* (2020) https://www.eea.europa.eu/data-and-maps/indicators/production-and-consumption-of-ozone-3/assessment

Sources of emissions:

The uses of ODS and its sources are mainly refrigeration, air-conditioning, and heat pump equipment, which use compounds that are yet to be phased out.

6. Non-methane volatile organic compounds (NMVOC)

The non-methane volatile organic compounds (NMVOCs) are organic compounds, which are different in their chemical composition but are grouped as the majority of these display similar behaviour in the atmosphere.[79]

The overall assessment of non-methane volatile organic compounds

The NCC's overall assessment of the non-methane volatile organic compounds is improving / mixed, there has been a decline in emissions for all three NMVOCs being assessed, however under the short-term trend there is a flattening/increasing in emissions – see Table 13 for further details.

- Emissions of NMVOCs have declined by just under 72% between 1990 and 2017, however they been flat since 2013 and have increased between 2016 and 2017.

Table 13 NCC assessment of non-methane volatile organic compounds and RAG rating

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
6.1 - 1,3 Butadiene	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in emissions of 1,3 butadiene by just under 82%.	There has also been a decline in emissions between 2011 and 2017 of 10%.	Over the short-term between 2016 and 2017, the data shows a decline of just over 1%.
6.2 - Benzene (C_6H_6)	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions of benzene between 1990 and 2017 of just over 78%.	When assessing between 2011 and 2017 there has also been a decline of just under 2%.	There was almost no change in the level of emissions between 2016 and 2017 – less than 1%.
6.3 - Non-methane volatile organic compounds (NMVOCs)	The government seems to be on track to meet the emissions target reduction of 32% from the 2005 baseline between 2020-2029. In 2017, the data shows that emissions have reduced by just under 31%.	Emissions levels of NMVOCs have declined between 1990 and 2017 by just under 72%.	Emissions levels have also declined when comparing 2011 and 2017 levels by just over 6%.	However, between 2016 and 2017 there was a small increase of just over 1% in the level of emissions.

Concentrations of non-methane volatile organic compounds (NMVOCs)

There is limited evidence available on the concentrations of NMVOCs. The most recent evidence is based on Defra's Automated Hydrocarbon Network.[80] Defra has been monitoring VOCs since around 1995. At one point there were 13 monitoring stations in the UK, but given the general decline of concentrations of NMVOCs, the network has reduced to four automated sites. At present these four sites measure 32 compounds, see Table 14 for the full list.[81]

79 NAEI, *Non-methane Volatile Organic Compounds* https://uk-air.defra.gov.uk/assets/documents/reports/empire/naei/annreport/annrep99/chap5_5.html

80 Defra, *UK Air Automatic Hydrocarbon Network* https://uk-air.defra.gov.uk/networks/network-info?view=hc

81 Defra, *Air Quality Expert group – Non methane Volatile Organic Compounds in the UK* (2020) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2006240803_Non_Methane_Volatile_Organic_Compounds_in_the_UK.pdf

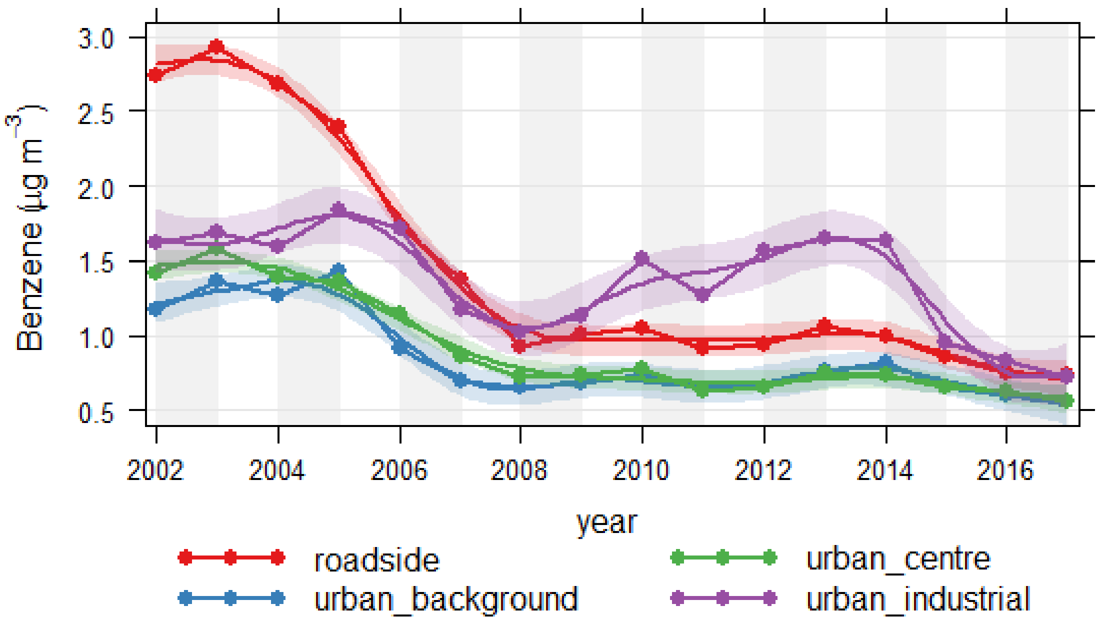
Table 14: List of NMVOCs monitored in the UK

List of non-methane volatile organic compounds		
1,2,3-trimethylbenzene	cis-2-pentene (VOC-AIR only)	n-heptane
1,2,4-trimethylbenzene	ethane	n-hexane
1,3,5-trimethylbenzene	ethene	n-octane
1,3-butadiene	ethylbenzene	n-pentane
1-butene	ethyne	o-xylene
1-pentene	iso-butane	propane
2+3-methylpentane (VOC-AIR only)	iso-octane	propene
2-methylpentane	iso-pentane	toluene
3-methylpentane (VOC-AIR only)	isoprene	trans-2-butene
benzene	m+p-xylene	trans-2-pentene
cis-2-butene	n-butane	

Source: Defra UK Air – Air Quality Expert Group

Most recent modelled data shows some decline in the concentrations of Benzene since 2011, with the largest decline coming from urban industrial, which declined from around 1.3 ug/m^3 to around less than 1 ug/m^3. These concentrations are below the annual mean limits of 5 ug/m^3. See Figure 24 for trend since 2002.

Figure 24: Smooth trend annual means by UK station type, non-automatic benzene: 2002 - 2017



Source: *Non-methane Volatile Organic Compounds in the UK* (2020)[82]

82 Defra, *Air Quality Expert group – Non methane Volatile Organic Compounds in the UK* (2020) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2006240803_Non_Methane_Volatile_Organic_Compounds_in_the_UK.pdf

Emissions of non-methane volatile organic compounds (NMVOCs)

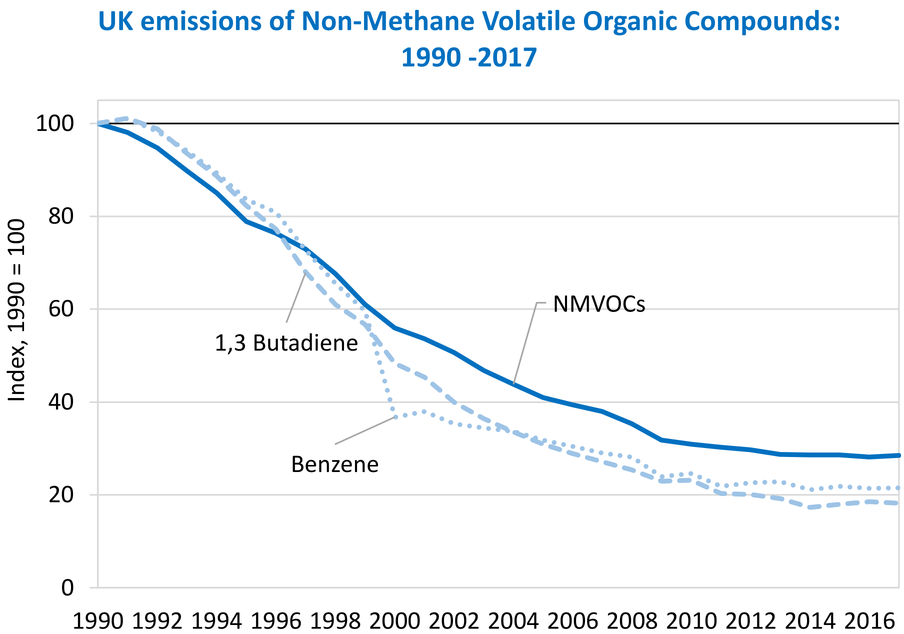
The data available in terms of emissions is presented by combining NMVOCs. In addition, separate data is also available for two NMVOCs compounds: 1,3 butadiene and benzene.

The emissions of 1,3 butadiene and the emissions of benzene followed a similar pattern to the emissions of NMVOCs as a whole. All three sets of figures trended downwards from 1990 before levelling off in around 2012 – see Figure 25. The emissions of NMVOCs as a whole were 72% lower in 2017 than in 1990. Emissions of benzene and 1,3 butadiene fell by a greater proportion than the emissions of NMVOCs as a whole, finishing the period 78% and 82% lower than their 1990 values respectively.

The EU target is for emissions of NMVOCs to be 32% lower than their 2005 value by 2020: see Table 25. The emissions of 1,3 butadiene had already come into compliance with this target by 2017, being just under 41% lower than their 2005 value. The emissions of benzene on the other hand were only 32% lower in 2017 than their 2005 value.

Emissions of NMVOCs as a whole were 31% lower in 2018 than their 2005 level.

Figure 25: UK Emissions of non-methane volatile organic compounds (NMVOCs)



Source: NAEI[83]

Spatial data: non-methane volatile organic compounds (NMVOCs)

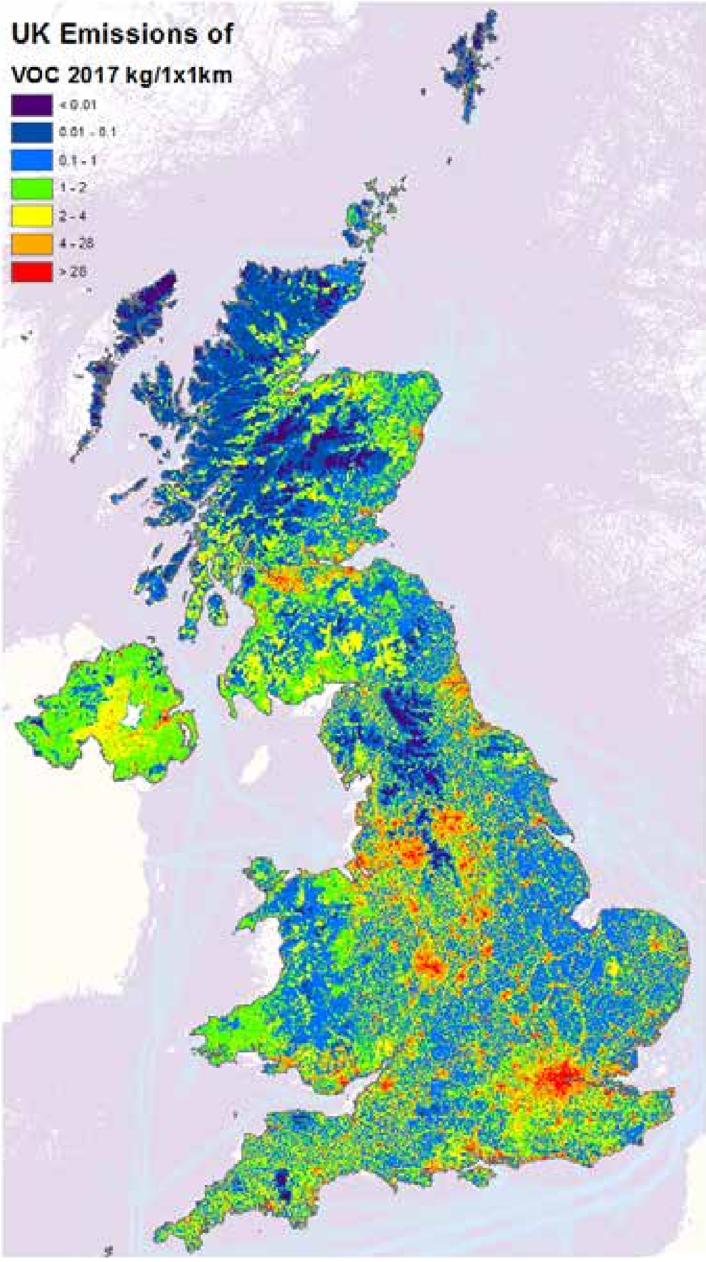
Under NMVOCs map data on emissions are available for 1,3 butadiene, benzene, and the combined NMVOC[84] compounds, and data has only be found for 2017, so it has not been possible to compare against 2011 level spatially. The maps presenting emissions in the UK are produced based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. In Figure 26, in 2017 the highest level of emissions was concentrated in urban areas such as London, Manchester, and the South East of England. For a higher resolution map see NAEI interactive emissions maps[85].

83 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

84 NAEI, *Download Emission Map Data for Non Methane VOC in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=9&emiss_maps_submit=naei-20200710180118

85 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

Figure 26: UK, total emissions of Non-methane VOCs: 2017



Source: NAEI[86]

86 NAEI, *Download emission maps* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=8

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) the main sources of emissions from NMVOCs can be found in Table 15.

Table 15: Key sources of emissions of NMVOCs

	Substance type	Some of the key sources of emissions[87]
Non-methane volatile organic compounds (NMVOCs)	• 1,3 Butadiene • Benzene ($C_6 H_6$) • Non-methane vocs (NMVOCs)	• Residential; • Transport; • Mobile combustion manufacturing; • Chemical industry; • Cremation; • Fugitive emissions from oil refining/storage; • Solvent, food and beverage industry; • Venting and flaring (oil, gas, combined oil, and gas).

7. Heavy metals

While there are around 40 heavy metals[88], there are several frameworks and monitoring schemes that look at different metals and metalloids. In order to produce a list of heavy metals the NCC has used three sources:

- Defra UK Air framework, 12 heavy metals are monitored under the Heavy Metals Network (HMN)[89];
- National Atmospheric Emissions Inventory (NAEI)[90] data is available on emissions for 13 metals and metalloids; and
- Air Pollution Information System (APIS)[91].

In total the NCC has scoped 22 heavy metals for the assessment, however given the limited data available an assessment has only been possible on 13 UK air heavy metals to assess concentration and 13 NAEI heavy metals to assess emissions. See Table 16 for the list of substances.

Table 16: List of heavy metals scoped by the NCC

Heavy metal	NAEI	UK air	APIS
1. Arsenic			
2. Beryllium		N/A	N/A
3. Boron	N/A	N/A	
4. Cadmium			
5. Cobalt	n/a		N/A
6. Chromium			
7. Copper			
8. Iridium	N/A	N/A	
9. Iron	N/A		N/A
10. Lead			
11. Manganese			N/A
12. Mercury		N/A	
13. Nickel			N/A
14. Osmium	N/A	N/A	
15. Palladium	N/A	N/A	
16. Platinum	N/A		

87 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

88 UN Environment, *Heavy Metals* https://www.unenvironment.org/cep/heavy-metals

89 UK Air, *Heavy Metals Network* https://uk-air.defra.gov.uk/networks/network-info?view=metals

90 NAEI, *Emissions data* (2019) https://naei.beis.gov.uk/data/

91 Air Pollution Information System, *Heavy metals* http://www.apis.ac.uk/overview/pollutants/overview_hm.htm

17. Rhodium	N/A	N/A	
18. Ruthenium	N/A	N/A	
19. Selenium			N/A
20. Tin		N/A	N/A
21. Vanadium			N/A
22. Zinc			

Source: NCC 2020

For further details on targets and limits for these heavy metals see Tables 25, 26 and 27 at the end of this report.

The overall assessment of polycyclic aromatic hydrocarbons

The NCC's overall assessment of the heavy metals is mixed/deteriorating, this is due to the recent increase in emissions of 10 heavy metals (see the short-term trend in Table 17 for further details).

- Lead emissions have significantly declined between 1990 and 1999, since then the rate of decline has decreased and emissions have remained flat since 2009 at around 95 -108 tonnes.
- Mercury emissions have also declined from their peak to around 4 tonnes in 2017.

Table 17 NCC assessment of heavy metals and RAG rating

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
7.1 - Arsenic	N/A – unable to assess as concentrations data is somewhat dated	Between 1990 and 2017 there was a reduction in emissions of arsenic by just under 71%.	There has also been a decline in emissions between 2011 and 2017 of just over 10%.	Over the short-term between 2016 and 2017, the data shows a decline of just over 2%.
7.2 - Beryllium	N/A – Data on concentrations not available/found.	Emissions levels of beryllium have declined between 1990 and 2017 by just under 62%.	There has been a slight increase, but this is within the 1% change.	Between 2016 and 2017 there was an increase in emissions of beryllium of just over 1%.
7.3 - Cadmium	N/A – unable to assess as concentrations data is somewhat dated	There has been a decrease in the cadmium between 1990 and 2017 of just under 83%.	However, when assessing between 2011 and 2017 there has been an increase of just over 5%.	Data comparing between 2016 and 2017 shows that there was an increase of just under 8%.
7.4 - Cobalt	N/A – unable to assess as concentrations data is somewhat dated	N/A	N/A	N/A
7.5 - Chromium	N/A – unable to assess as concentrations data is somewhat dated	The most recent data shows a decline in the level of emissions between 1990 and 2017 of 79%.	When assessing between 2011 and 2017 there was an increase of just under 5%.	There has also been an increase between 2016 and 2017 of just under 3%
7.6 - Copper	N/A – unable to assess as concentrations data is somewhat dated	When assessing between 1990 and 2017 there was decrease of just under 19%.	There has been a slight increase, but this is within the 1% change.	There has been a slight increase, but this is within the 1% change.

7.7 - Iron	N/A – unable to assess as concentrations data Is somewhat dated	N/A	N/A	N/A
7.8 - Lead	N/A – unable to assess as concentrations data Is somewhat dated	Between 1990 and 2017 there was a reduction in emissions of arsenic by just under 97%.	Emissions levels have also declined when comparing 2011 and 2017 levels by just over 6%.	There has been a slight increase, but this is within the 1% change.
7.9 - Manganese	N/A – unable to assess as concentrations data Is somewhat dated	There has been an increase in the level of emissions between 2000 and 2017 of just over 35%.	There has also been an increase in emissions when comparing 2011 against 2017 of just over 55%.	Data comparing between 2016 and 2017 shows that there was an increase of under 9%.
7.10 - Mercury	There is a target with the aim to reduce land-based emissions of mercury to air and water by 50% by 2030. However, the target is ambiguous as it does not state from what the level the 50% will be from.	Emissions levels of mercury have declined between 1990 and 2017 by just over 89%.	There has also been a decline between 2011 and 2017 of just over 33%.	However, there has been an increase in the level of emissions of mercury between 2016 and 2017 of just over 2%.
7.11 - Nickel	N/A – unable to assess as concentrations data Is somewhat dated	There has been a decrease in the emissions of nickel between 1990 and 2017 of just over 68%.	There has been a slight increase, but this is within the 1% change.	There has also been an increase between 2016 and 2017 of just over 16%.
7.12 - Platinum	N/A – unable to assess as concentrations data Is somewhat dated	N/A	N/A	N/A
7.13 - Selenium	N/A – unable to assess as concentrations data Is somewhat dated	When assessing between 2011 and 2017 there was a decrease of just under 87%.	There has also been a decline between 2011 and 2017 of just under 39%.	However, there has been an increase in emissions of selenium between 2016 and 2017 of just under 16%.
7.14 - Tin	N/A – Data on concentrations not available/found.	Between 1990 and 2017 there was a reduction in emissions of arsenic by just over 12%.	Emissions levels have also declined when comparing 2011 and 2017 levels by just over 11%.	Data comparing between 2016 and 2017 shows that there was an increase in emissions of tin of just over 1%.
7.15 - Vanadium	N/A – unable to assess as concentrations data Is somewhat dated	The most recent data shows a decline in the level of emissions of vanadium between 1990 and 2017 of just under 40%.	However, when looking over the 2011 and 2017 period there has been an increase in the level of emissions of just over 11%.	Emissions have also increased between 2016 and 2017 by just under 7%
7.16 - Zinc	N/A – unable to assess as concentrations data Is somewhat dated	Between 1990 and 2017 there was a reduction in emissions of zinc by just under 57%.	When assessing between 2011 and 2017 there was an increase of just over 2%.	There has also been an increase between 2016 and 2017 of just over 3%

Concentrations of heavy metals

There is limited data on concentrations of heavy metals and it is based on a limited number of monitoring sites across the UK. Data is available for the period 2004 -2015, and in the Table 18 below the most recent data is presented (2011 -2015). The data shows a decline in the concentrations of most heavy metals with copper and chromium having the largest declines when compared to 2011 levels. The concentrations of copper declined by around 43.4% and of chromium by around 37.6%. The only exceptions are nickel and selenium: their concentrations have increased by around 5.5% and 41.4% respectively.

Table 18: The UK mean annual concentrations (average from all sites)

UK mean annual concentrations ng m/3	2011	2012	2013	2014	2015
Arsenic	0.66	0.63	0.68	0.70	0.63
Cadmium	0.35	0.31	0.29	0.34	0.24
Cobalt	0.21	0.30	0.24	0.23	0.19
Chromium	6.06	5.17	5.01	3.79	3.78
Copper	18.2	15.9	15.7	12.4	10.3
Iron	616	526	573	481	489
Manganese	14.5	11.6	13.1	11.9	11.2
Nickel	3.98	3.65	4.25	5.18	4.20
Lead	14.9	11.2	11.5	10.5	9.79
Platinum	0.003	0.002	-	-	-
Selenium	0.58	0.78	0.96	0.87	0.82
Vanadium	1.62	1.25	1.47	1.58	1.20
Zinc	56.0	48.9	47.7	46.8	35.0
UK Heavy Metals Monitoring Network size	**15 in England; 7 in Wales; 2 in Scotland; and 1 in Northern Ireland.**	**15 in England; 7 in Wales; 2 in Scotland; and 1 in Northern Ireland.**	**17 in England; 7 in Wales; 2 in Scotland; and 1 in Northern Ireland.**	**13 in England; 6 in Wales; 2 in Scotland; and 1 in Northern Ireland.**	**15 in England; 6 in Wales; 2 in Scotland; and 1 in Northern Ireland.**

Source: Annual Reports on the UK Heavy Metals Monitoring Network (2011-2015)[92]

Emissions of heavy metals

Data on emissions are available for thirteen of the nineteen scoped heavy metals, displayed below on four separate graphs. Data is available from 1990 for all of these thirteen substances, apart from manganese. Data on the emissions of manganese is only available from 2000, so it has been displayed separately: see Figure 30.

Apart from manganese, emissions of all of the heavy metals for which data is available have trended downwards since 1990.

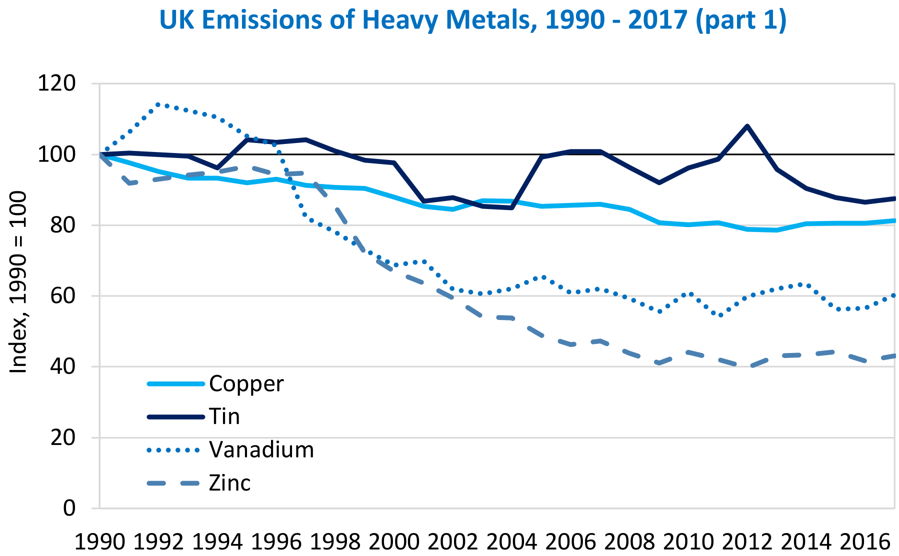
The emissions of nickel and vanadium experienced an initial uptick in emissions to 115% and 114% of their 1990 levels in 1992: see Figures 27 and 28. However, emissions of these substances subsequently declined, along with emissions of all the other heavy metals.

92 Source here is for 2015 data, for other years please see separate annual reports. Defra – UK air, *Annual Report for 2015 on the UK Heavy Metals Monitoring Network* (2016) https://uk-air.defra.gov.uk/assets/documents/reports/cat13/1611011539_NPL_Heavy_Metals_Annual_Report_FINAL_28072016.pdf

The rates of decline in the emissions of heavy metals were generally fastest in the late 1990s, before levelling somewhat or entirely around 2000.

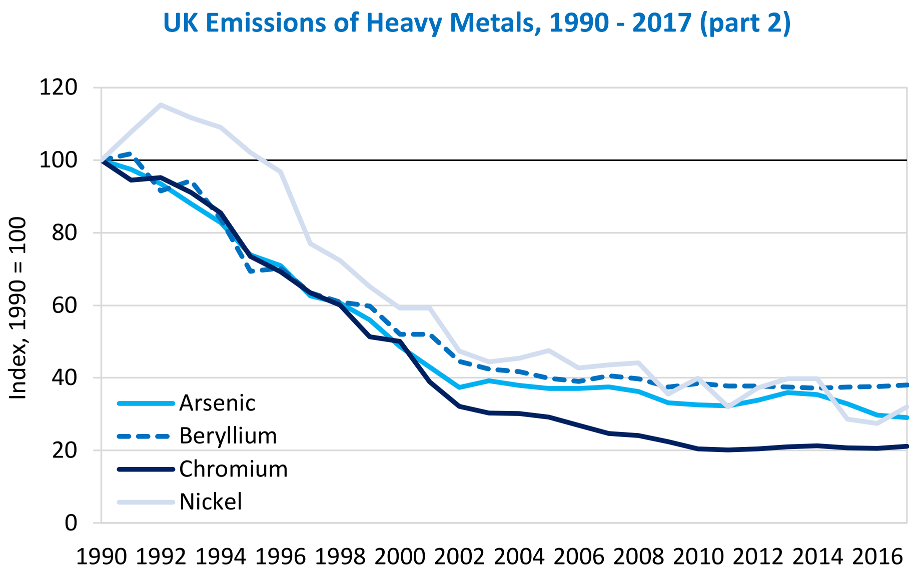
The heavy metals have been grouped by the extent of the decline in their emissions. In 2017, the emissions of the heavy metals displayed on Figure 27 were between 13% and 57% lower than their 1990 values. The emissions of the heavy metals displayed on Figure 28 were between 62% and 79% lower than their 1990 values. The emissions of the substances shown on Figure 29 were between 83% and 97% lower than their 1990 values. Lead was the metal whose emissions declined the most.

Figure 27: UK Emissions of Heavy Metals: 1990 - 2017 (part 1)



Source: NAEI[93]

Figure 28: UK Emissions of Heavy Metals: 1990 - 2017 (part 2)

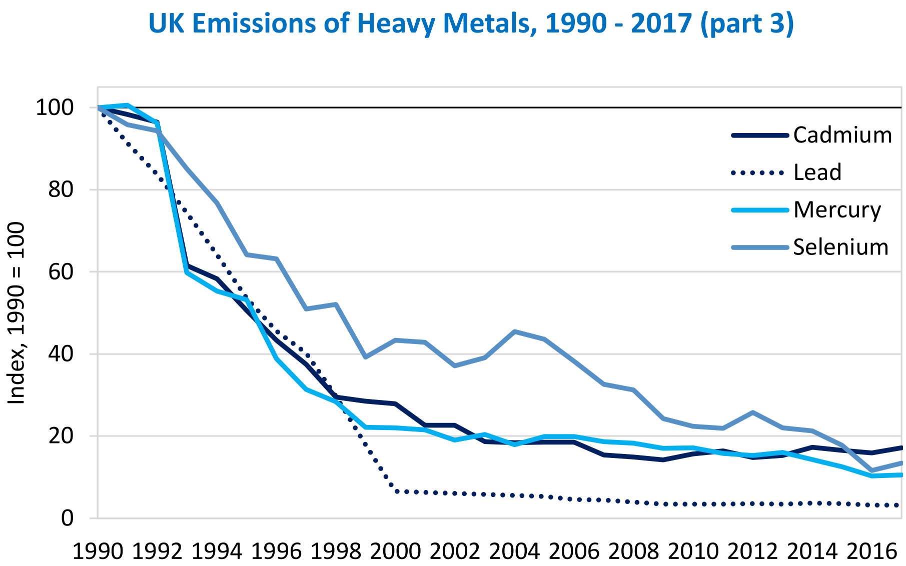


Source: NAEI[94]

93 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

94 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

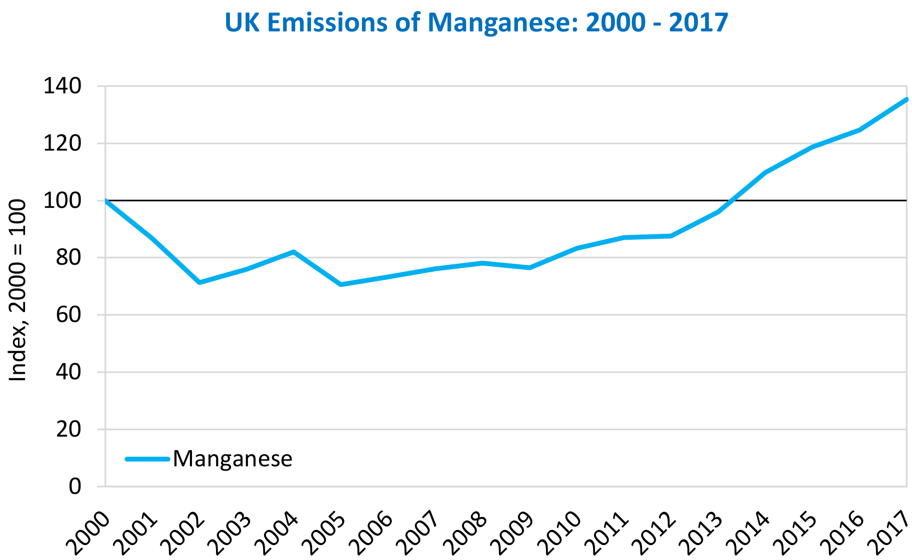
Figure 29: UK Emissions of Heavy Metals: 1990 - 2017 (part 3)



Source: NAEI[95]

Since 2000, the emissions of manganese have declined to 71% of their 2000 value in 2002, before gradually rising back up, surpassing their 2000 value in 2014 and finishing the period on 135% of their 2000 value.

Figure 30: UK Emissions of Manganese: 2000 – 2017



Source: NAEI[96]

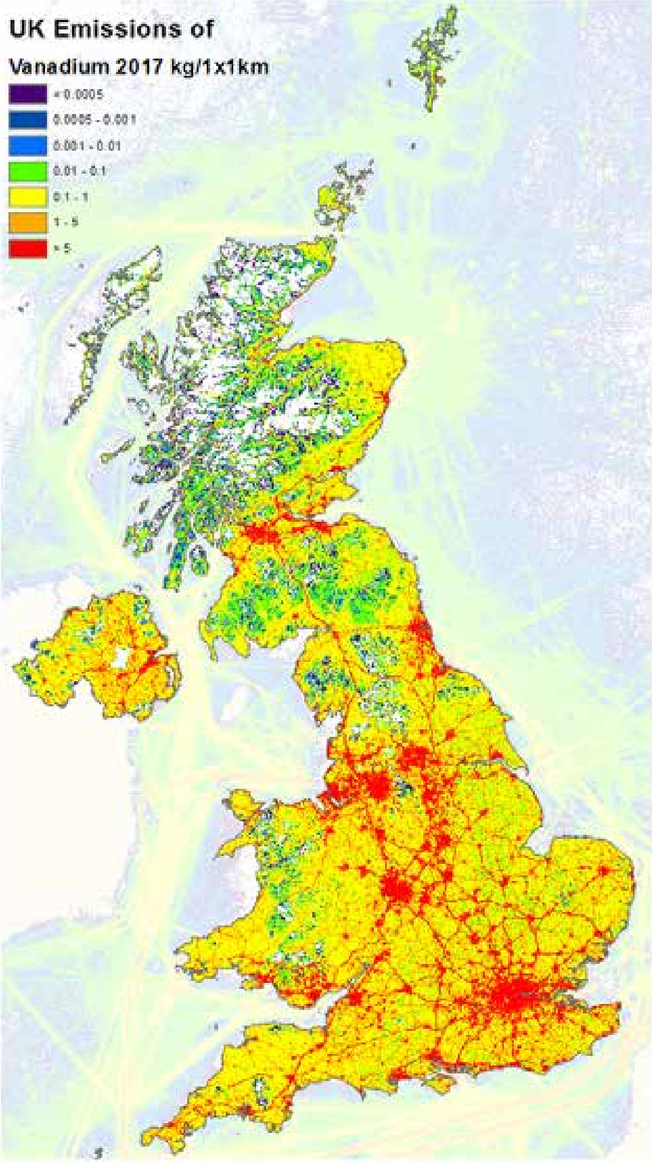
95 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

96 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

Spatial data: Heavy metals

Heavy metals emission maps are available for arsenic, cadmium, chromium, copper, lead, mercury, selenium, vanadium, and zinc, and data has only be found for 2017, so it has not been possible to compare against 2011 level spatially. The maps presenting emissions in the UK are produced based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. In Figure 31, in 2017 emissions of vanadium are at their highest in urban and main trunk roads in England.[97] For higher resolution vanadium map see NAEI interactive emissions maps[98].

Figure 31: UK, emissions of vanadium: 2017



Source: NAEI[99]

97 NAEI, *Download Emission Map Data for Vanadium in 2017* (2017) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=19

98 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

99 NAEI, Download emissions maps (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=19&emiss_maps_submit=naei-20161010195834

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) the main sources of emissions from heavy metals can be found in Table 19.

Table 19: Key sectors and sources of emissions of heavy metals

	Substance type	Some of the key sources of emissions[100]
Heavy Metals	• Arsenic • Beryllium • Boron • Cadmium • Chromium • Copper • Lead • Manganese • Mercury • Nickel • Osmium • Palladium • Platinum • Rhodium • Ruthenium • Selenium • Tin • Vanadium • Zinc	• Waste management; • Iron and steel production; • Residential; • Stationary combustion in manufacturing industries and construction; • Public electricity and heat production; • Transport; • Industrial processes; • Fugitive emissions from solid fuels; • Cremation; • Iron and steel production; • Transport (shipping); • Petroleum refining; and • Glass production.

8. Persistent organic pollutants (POPs)

Persistent organic pollutants (POPs) are chemicals of global concern due to their persistence in the environment and their negative effects to human health. Humans are exposed to POPs through food and air. The most commons POPS are organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT), industrial chemicals, most notably polychlorinated biphenyls (PCB), as well as unintentional by-products of many industrial processes, especially polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF), commonly known as 'dioxins'.[101] For this assessment, four substances have been assessed. For further details on targets and limits for these POPs see Tables 25, 26 and 27 at the end of this report.

The overall assessment of persistent organic pollutants

The NCC's overall assessment of the persistent organic pollutants (POPs) is improving, however this should be viewed with caution as it is based on data of only three pollutants. These three pollutants have shown a declining trend over the long and short-term, and from the NCC baseline of 2011. Further details on the change in emissions can be found in Table 20.

- Emission levels of polychlorinated biphenyls (PCBs) have since 1990 by just over 92%, from 6744 kg to 525 kg in 2017.
- Emissions of assessed POPs have declined between 1990 and 2017 between 87% and 97%.

100 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

101 WHO, *Persistent organic pollutants (POPs)* https://www.who.int/foodsafety/areas_work/chemical-risks/pops/en/

Table 20 NCC assessment of persistent organic pollutants and RAG rating (emissions data only)

Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)[102]	Short-term trend
8.1 - Dieldrin	N/A - unable to assess against the target as concentration data not available.	N/A – Data is not available/has not been found.	N/A – Data is not available/has not been found.	N/A – Data is not available/has not been found.
8.2 - Dioxins and furans (polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs))	N/A - unable to assess against the target as concentration data not available.	Between 1990 and 2017 there was a reduction in the emissions of dioxins and furans of just under 87%.	When assessing between 2011 and 2017 there has also been a decline of just under 14%.	Between 2016 and 2017 there was a decline in emissions of dioxins and furans of just under 2%.
8.3 - Endrin	N/A - unable to assess against the target as concentration data not available.	N/A – Data is not available/has not been found.	N/A – Data is not available/has not been found.	N/A – Data is not available/has not been found.
8.4 - Lindane - hexachlorocyclohexane (HCH)	N/A - unable to assess against the target as concentration data not available.	There has been a decrease in the level of emissions of lindane between 1990 and 2017 of just under 97%.	There has also been a decline in emissions between 2011 and 2017 of just under 54%.	Over the short-term between 2016 and 2017, the data shows a decline of 12%.
8.5 - Polychlorinated biphenyls (PCBs)	N/A - unable to assess against the target as concentration data not available.	Emissions levels of PCBs have declined between 1990 and 2017 by just over 92%.	Emissions levels have also declined when comparing 2011 and 2017 by just under 30%.	Data between 2016 and 2017 shows that there was a decline of just under 4%.

Concentrations of persistent organic pollutants (POPs)

No data is available / has been found for the concentrations of persistent organic pollutants (POPs) in England (or the UK), the sections that follow are based on emissions which are used as a proxy.

Emissions of persistent organic pollutants (POPs)

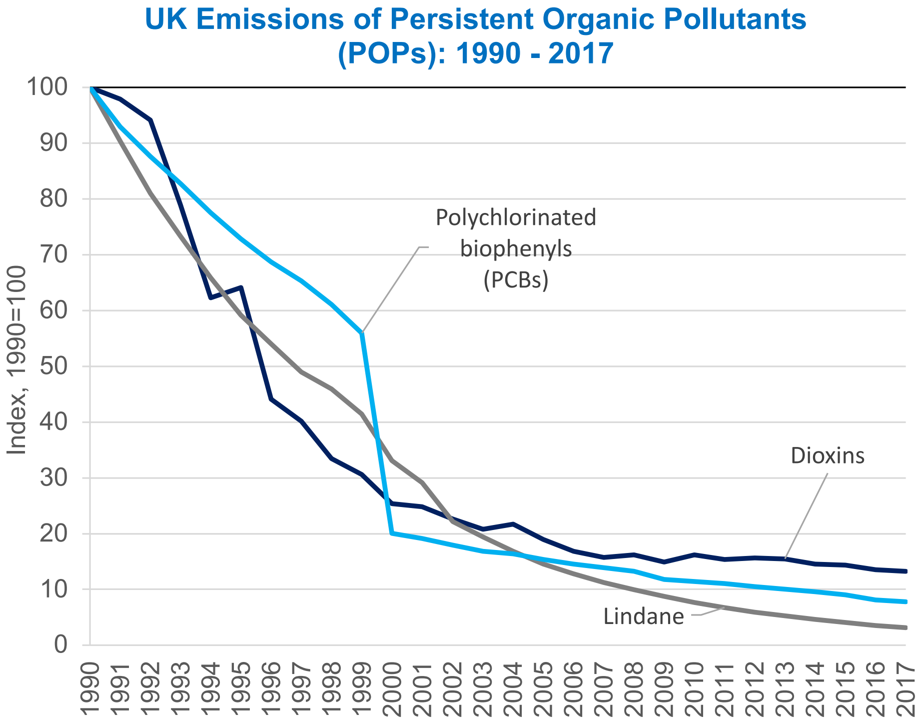
The emissions of all three of the POPs for which data is available have declined significantly since 1990. The emissions of all three gases fell by about 80% between 1990 and 2002, and have since declined more slowly. The emissions of dioxins and furans, PCBs and lindane were 87%, 92% and 97% lower in 2017 than their 1990 levels respectively – see Figure 32.

In 2001, the UK signed the Stockholm Convention on persistent organic pollutants, a United Nations treaty which aims to eliminate or restrict the production and use of POPs. The treaty, effective since 2004, obliges its signatories to take measures to eliminate the production and use of certain POPs, including lindane, and reduce the unintentional releases of others, including dioxins and PCBs.[103]

102 Where possible and data is available the NCC will use 2011 as the baseline point (starting point) to produce their assessment.

103 http://www.pops.int/Home/tabid/2121/Default.aspx

Figure 32: UK emissions of persistent organic pollutants (POPs): 1990 - 2017



Source: NAEI[104]

Spatial data: persistent organic pollutants (POPs)

Spatial data were not found/available for POPs.

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) the main sources of emissions from POPs can be found in Table 21.

Table 21: Key sectors and sources of emissions of POPs

	Substance type[105]	Some of the key sources of emissions[106]
Persistent Organic pollutants (POPs)	• Dieldrin • Dioxins and furans (polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)) • Endrin • Lindane-hexachlorocyclohexane (HCH) • Polychlorinated biphenyls (PCBs)	• Residential; • Waste management; • Consumption of POPs and heavy metals (e.g. electrical and scientific equipment); • Iron and steel production; • Stationary combustion in manufacturing industries and construction; • Use of pesticides; • National navigation (shipping); and • Stationary combustion in manufacturing industries and construction: non-metallic minerals.

104 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

105 Data on the source of emissions is not available for the compounds.

106 Based on the emissions from key sectors, this is not an exhaustive list. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

9. Other gases

This section brings together different types of compounds where there are seven substances assessed under the other gases. For further details on targets and limits for these other gases see Tables 25, 26 and 27 at the end of this report.

The overall assessment of other gases

The NCC's overall assessment of the other gases is deteriorating/mixed, this assessment is based on the increase in the concentrations levels of ozone (O_3) and emissions of ammonia which have started to increase since 2013, while emissions from carbon monoxide have been on a declining trend. No data was available/found for chlorine and inorganic compounds (Cl), fluorine and inorganic compounds (HF), and hydrogen cyanide (HCN). For the assessment of the individual measurements - see Table 22 for further details.

- Airborne ammonia levels are not on track to meet the target reduction of 8% of 2005 levels. Agriculture currently accounts for 88% of the ammonia emissions to air.

Table 22 NCC assessment of other gases and RAG rating

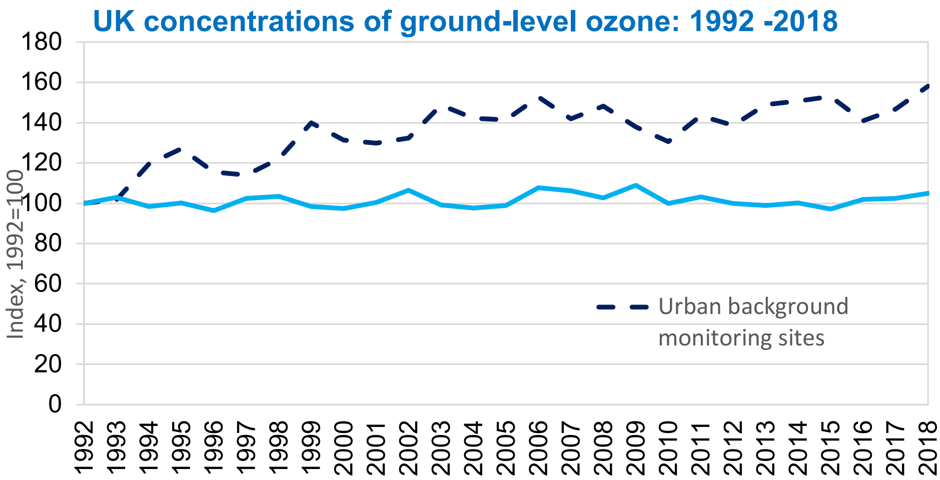
Measurable commitment	Compliance with target and or commitment	Long-term trend	NCC baseline (2011)[107]	Short-term trend
9.1 - Ammonia (NH_3)	The UK does not seem to be on track to meet its target reduction of 8% when compared to 2005 levels, in 2017 emissions were 0.1% lower than in 2005.	Emissions of ammonia ave declined when compared to 1990 levels, from 326 to just under 283 kilotonnes.	There has been an increase in emissions between 2011 and 2017 from 265 kilotonnes to just under 282 kilotonnes.	There has been a slight decrease, but this is within the 1% change.
9.2 - Carbon monoxide (CO)	N/A - No targets were found to assess against.	Emissions of monoxide carbon have been on a declining trend since 1990. There has been a decline of 79% between 1990 and 2017.	Emissions have also declined since 2011, by just over 16% between 2011 and 2017.	There has been a slight decrease, but this is within the 1% change.
9.3 - Chlorine and inorganic compounds (Cl)	N/A - No targets were found to assess against.	N/A	N/A	N/A
9.4 - Fluorine and inorganic compounds (HF)	N/A - No targets were found to assess against.	N/A	N/A	N/A
9.5 - Hydrogen cyanide (HCN)	N/A - No targets were found to assess against.	N/A	N/A	N/A
9.6 - Ozone (O_3)	The UK is meeting its ozone concentrations thresholds.	The concentration levels of ozone have increased between 1992 and 2018 by over 58% for urban and by just under 5% for rural background sites.	Concentration levels increased between 2011 and 2018, by 10% for urban and by just under 2% for rural background sites.	There has also been an increase in concentration levels between 2017 and 2018, from 58.3 μg/m^3 to 62.8 μg/m^3 for urban background and from 69.4 μg/m^3 to 71.1 μg/m^3.

107 Where possible and data is available the NCC will use 2011 as the baseline point (starting point) to produce their assessment.

Concentrations of other gases

The only other gas for which concentrations data is available is ground-level ozone. As per Figure 33, concentrations measured at urban and rural background sites have increased by 58% and 5% in 2018 when compared to 1992 levels respectively. In 2018, annual average maximum daily 8-hour mean concentrations of O_3 were at just under 63 μg/m³ for urban and just over 71 μg/m³ for rural. Concentrations have also increased between 2011 and 2018, and on year on year basis between 2017 and 2018.

Figure 33: UK concentrations of ground-level ozone

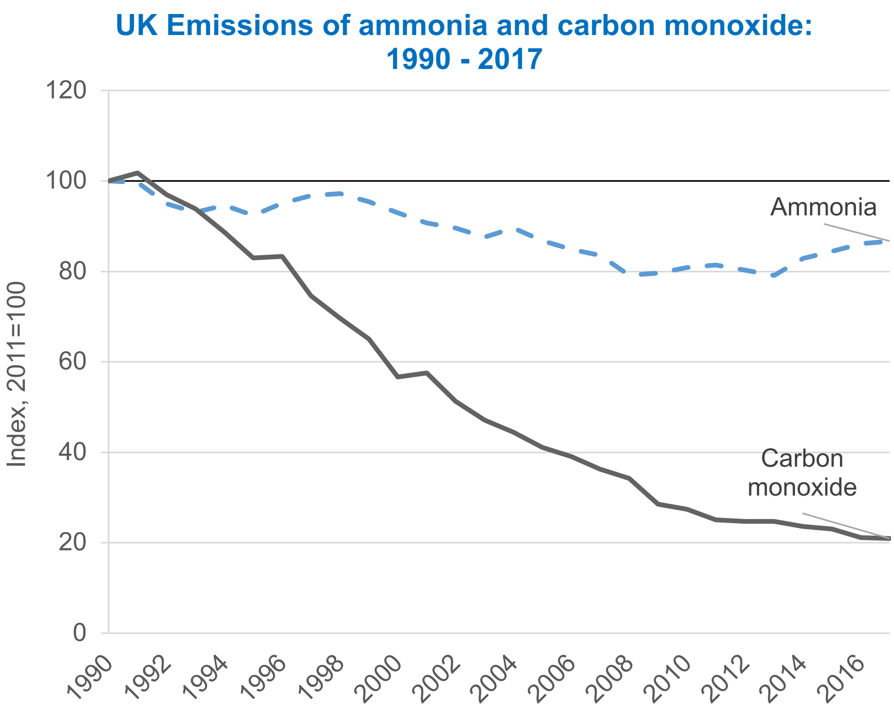


Source: Defra[108]

Emissions of other gases

The only other gases for which emissions data is available are ammonia and carbon monoxide. The UK emissions of both of these gases have declined since 1990. In 2017, the emissions of carbon monoxide were 79% lower than in 1990 and the emissions of ammonia were 13% lower than in 1990. The EU has a target for emissions of ammonia between 2020 and 2029 to be 8% lower than their 2005 level. The emissions of ammonia were only 0.1% lower in 2017 than in 2005. See Figure 34 for trend since 1990.

Figure 34: UK emissions of ammonia and carbon monoxide: 1990 - 2017



Source: NAEI[109]

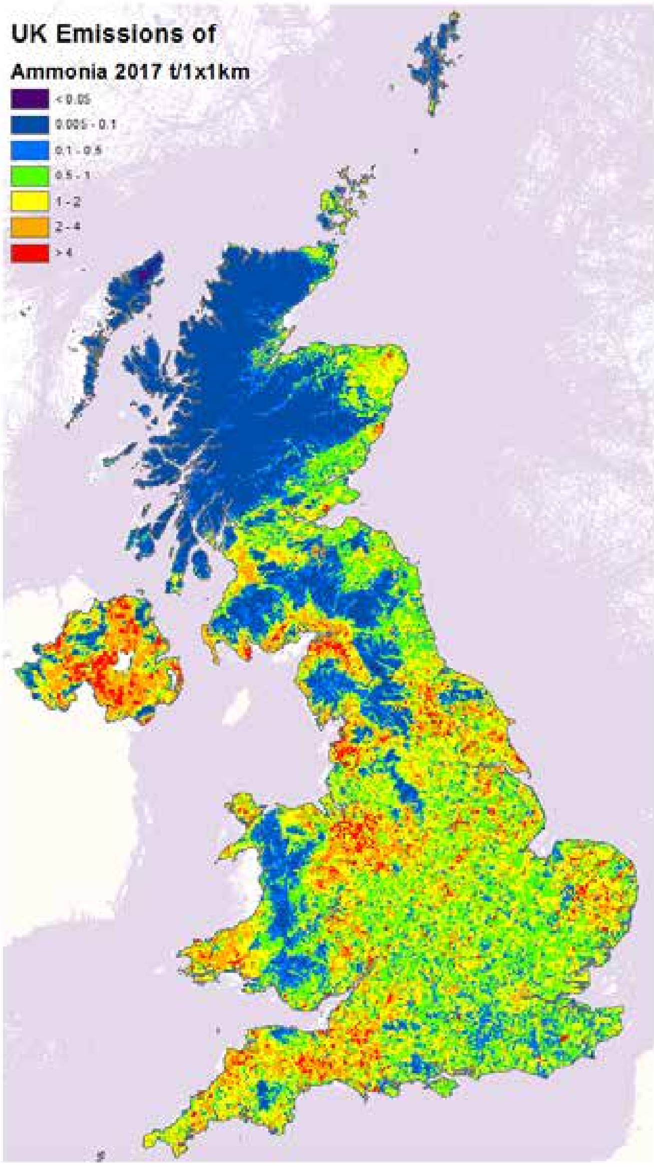
108 Defra, *ENV2 – Air quality* (2019) https://www.gov.uk/government/statistical-data-sets/env02-air-quality-statistics

109 NAEI, *Data – Emissions data pivot table viewer* https://naei.beis.gov.uk/data/

Spatial data: other gases

For the other gases section, maps on emissions are available for ammonia[110] and carbon monoxide. Data has only be found for 2017, so it has not been possible to compare against 2011 level spatially. The maps presenting emissions in the UK are produced based on modelled NAEI national total data and compiled through a geographic information system (GIS). This data is based on several component distributions for each NAEI emission sector. Figure 35 shows that in 2017 the highest levels of ammonia emission are found in the South West, West Midlands, and East of England regions. For a higher resolution map see NAEI interactive emissions maps[111].

Figure 35: UK, emissions of ammonia: 2017



Source: NAEI112

110 NAEI, *Download Emission Map Data for Ammonia in 2017 (*2017) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=21

111 NAEI, *UK Emissions Interactive Map* (2019) https://naei.beis.gov.uk/emissionsapp/

112 NAEI, *Download Emission Map Data for Ammonia in 2017* (2019) https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=21

Sources of emissions:

Based on the National Atmospheric Emissions Inventory (NAEI) the main sources of emissions from other gases are agriculture, road transport and residential, further details can be found in Table 23.

Table 23: Key sectors and sources of emissions of other gases

	Substance type	Some of the key sources of emissions[113]
Other gases	• Ammonia (NH_3) • Carbon monoxide (CO) • Chlorine and inorganic compounds (Cl). • Fluorine and inorganic compounds (HF) • Hydrogen cyanide (HCN) • Ozone (O_3) - ground-level ozone	• Agriculture (manure); • Residential; • Road transport; • Mobile combustion in manufacturing industries and construction; • Chemical production; and • Iron and steel production.

Local-level air pollution

The focus of the assessment for this report is at the national level, but the impacts of air pollution are to a local level and as the maps from the previous sections have shown there is considerable variation between regions in England. There is currently a requirement through the Local Air Quality Management (LAQM) for local authorities to assess the air quality in their area and designate Air Quality Management Areas (AQMA) if improvements are necessary. Where improvements are required local authorities have to produce an air quality Action Plan describing the pollution reduction measures it will put in place.[114]

There are almost 600 AQMA in England (which account for the majority in the UK) with the majority of these (505) being for nitrogen dioxide (NO_2). The main reason local authorities have to produce an AQMA is due to transport-related emissions.[115] Table 24 below is a list of some of the current action plans to mitigate air pollution.

Table 24: Local authorities' action plans

Action plan – local authority	Actions to mitigate air pollution[116]
Great Manchester air quality action plan (2016 –2021)[117]	• Modal shift (from private vehicle to public transport, cycling, and walking) • Reduce emissions from vehicles (by incentivising the replacement of older, more polluting vehicles with newer, smaller, cleaner, lower-emission vehicles) • Reducing congestion
West Midlands Combined Authority Regional Air Quality Review and Action Plan[118]	• Improvement to the public service fleet (e.g.: modernisation, replacement of buses and council vehicles) • Reduce the overall age of the taxi fleet • Car and bike sharing and implementation of cycle network • Control of industry emissions through permits and of bonfires and other unauthorised fires

113 Based on the emissions from key sectors, this is not an exhaustive list. Evidence might not be available for each individual substance. See NAEI data on emissions under the NFR code list: https://naei.beis.gov.uk/data/

114 Defra, *Local Air Quality Management – Policy guidance* (2016) https://laqm.defra.gov.uk/assets/laqmpolicyguidance2016.pdf

115 Defra, *Summary of AQMA data* https://uk-air.defra.gov.uk/aqma/summary

116 These are a limited number of the actions found in each action plan, for further details see individual actions plans.

117 Manchester City Council, Great Manchester air quality action plan 2016 –2021 (2016) https://secure.manchester.gov.uk/downloads/download/4166/air_quality_reports

118 AECOM, *West Midlands Combined Authority Regional Air Quality Review and Action Plan (*2019) https://www.sustainabilitywestmidlands.org.uk/wp-content/uploads/WMCA_Regional-Air-Quality-Review-and-Action-Plan_v5.pdf

Towards an ultra-low emission York Air Quality Action Plan 3 (2015 -2020) [119, 120]	• Anti-idling measures • Clean Air Zone (looking at the feasibility) • Reducing emissions from taxis (through low emissions vehicles) • Delivery of strategic electric vehicles charging stations • Eco Stars York – fleet recognition scheme which provides recognition and guidance on best practice
City of Westminster Air Quality Action Plan	• Reducing emissions from buildings and new development such as requiring all new major developments and developments with Combined Heat and Power (CHP) to be air quality neutral as a minimum • Reducing emissions from transport such as increasing the number of electric vehicle charging points within the city • Raise awareness of air pollution
Exeter City Council Air Quality Action Plan (2019 -2024)[121]	• Reduce congestion • New transport links and Park & Change facilities • Local Walking and Cycling Infrastructure Plan (LCWIP) • Developers to mitigate the effects of their development on air quality • An improved multi-modal public transport network, incorporating cleaner bus technologies

Atmosphere asset: existing targets, limits, and objectives

There is no central location where all the existing targets, limits, and objectives are presented for the atmosphere asset. To address this the NCC has undertaken a limited desk literature review to scope existing targets, limits, and objectives in England (and UK) that are relevant to the atmosphere asset. This was required so the NCC could assess progress against achieving compliance with these targets, commitments, thresholds and limits and meeting legal requirements. Given the limited resources within the NCC, the list presented in Tables 25, 26 and 27 is not comprehensive but provides a starting point for further iterations. To compile this list the NCC has focused on the following regulations governing air quality and atmospheric processes:

- European Directive emission reduction targets;
- European Directive target and limit values;
- UK national objectives;
- UK Air Quality Strategy (AQS) Objectives;
- The Montreal Protocol;
- Climate Change Act 2008;
- Industrial Emissions Directive;
- Solvents Directive; and
- The 25 Year Environment Plan commitments.

The tables below present the NCC findings covering all the nine heading groups from Figure 1. The evidence is presented under three headings: the first (Table 25) is around existing emissions reductions targets, the second (Table 26) around existing limits, and the third (Table 27) around environment level assessment concentration limit values. The limits will range from hourly to annual exposure, and where possible as many limits have been presented including limits due to human health impacts and environmental limits.

119 City of York Council, *Towards an ultra low emission York Air Quality Action Plan 3 (2015 -2020)* (2015) http://jorair.co.uk/wordpress/wp-content/uploads/2017/06/aqap3report.pdf

120 City of York Council, *Air Quality Action Plan (AQAP3) measures* http://jorair.co.uk/aqap3/

121 Exeter City Council, *Exeter City Council Air Quality Action Plan* (2019 -2024) 2019 https://exeter.gov.uk/media/5046/air-quality-action-plan-2019-2024-final-jy.pdf

Table 25: Existing emissions-related targets for key substances, gases, and compounds in the UK

Substance group	Substance type	Existing target/limits/objectives	Source of the target/limit/objectives
Particulate matter (PM)	$PM_{2.5}$	**Emissions reduction:** From 2005 level between 2020-2029: • 30% reduction from 2005 base level From 2005 level from 2030: • 46% reduction from 2005 base levels	**Emissions reduction:**[122] EU directive 2016/2284
Greenhouse gases[123]	Carbon dioxide (CO_2)	**Emissions reduction:** • At least 100% emissions reductions from 1990 levels by 2050 (Net zero)[124]	**Emissions reduction:**[125] Climate Change Act 2008
	Hydrofluorocarbons (HFCs)	**Emissions reduction:** • At least 100% emissions reductions from 1990 levels by 2050 (Net zero) • 80% reduction in HFC consumption by 2047 (Kigali Amendment to the Montreal Protocol).	**Emissions reduction:** Montreal Protocol[126]
	Methane (CH_4) Perfluorocarbons (PFCs) Sulphur hexafluoride (SF_6) Nitrogen trifluoride (NF_3) Nitrous oxide (N_2O)	**Emissions reduction:** • At least 100% emissions reductions from 1990 levels by 2050 (Net zero)	**Emissions reduction:**[127] Climate Change Act 2008
Acid gases	Nitrogen oxide (NOx) - expressed as nitric oxide (NO) and nitrogen dioxide (NO_2)	**Emissions reduction:** From 2005 level between 2020-2029: • 55% reduction From 2005 level from 2030: • 73% reduction	**Emissions reduction:** Ambient Air Directive Target Values - EU directive.[128]
	Sulphur dioxide (SO_2)	**Emissions reduction:** From 2005 level between 2020-2029 • 59% reduction From 2005 level from 2030 • 88% reduction	**Emissions reduction:** Ambient Air Directive Target Values - EU directive.[129]

122 European Union official journal: Directive (EU) 2016/2284 of the European Parliament and the Council (2016) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

123 Based on the gases of the Kyoto protocol using data from BEIS on greenhouse gas emissions. It also includes O_3 which is a greenhouse gas, but also an air pollutant.

124 BEIS, *UK becomes first major economy to pass net zero emissions law* (2019) https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

125 Legislation.gov.uk, *Explanatory Memorandum to Climate Change Act 2008 (2050 target amendment) 0rder 2019* (2019) https://www.legislation.gov.uk/ukdsi/2019/9780111187654/pdfs/ukdsiem_9780111187654_en.pdf

126 United Nations Industrial Development Organisation, *The Montreal Protocol evolves to fight climate change* https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/montreal-protocol-evolves-fight-climate-change

127 Legislation.gov.uk, *Explanatory Memorandum to Climate Change Act 2008 (2050 target amendment) 0rder 2019* (2019) https://www.legislation.gov.uk/ukdsi/2019/9780111187654/pdfs/ukdsiem_9780111187654_en.pdf

128 European Parliament, *Directive (EU) 2016/2284* (2016) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

129 European Parliament, *Directive (EU) 2016/2284* (2016) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

Non-methane volatile organic compounds (NMVOCs)[130]	Non-methane VOC (NMVOCs)	**Emissions reduction:** From 2005 level between 2020-2029: • 32% by 2020 From 2005 level from 2030: • 39% by 2030	**Emissions reduction:** Ambient Air Directive Target Values - EU directive.[131, 132]
	VOCs	**Emissions reduction:** For details targets see web link to the directive.	**Emissions reduction:** Solvents Directive 1999/13/EC.[133]
Heavy metals[134; 135]	Mercury	**Emissions reduction:** 50% reduction of land-based emissions to air and water by 2030.	**Emissions reduction:** 25 Year Environment Plan.[136]
Persistent organic pollutants (POPs)	Aldrin	The UK must take measures to eliminate the production and use of these chemicals.	The UN's Stockholm Convention[137]
	Chlordane		
	Chlordecone		
	Decabromodiphenyl ether		
	Dicofol		
	Dieldrin		
	Hexabromobiphenyl		
	Hexabromocyclododecane		
	Hexabromodiphenyl ether and heptabromodiphenyl ether		
	Hexachlorobenzene		
	Hexachlorobutadiene		
	Alpha hexachlorocyclohexane		
	Beta hexachlorocyclohexane		
	Lindane		
	Mirex		
	Pentachlorobenzene		
	Pentachlorophenol and its salts and esters		
	Polychlorinated biphenyls		
	Polychlorinated naphthalenes		

130 Based on the National Atmospheric Emissions Inventory (NAEI) definition of Non-methane Volatile Organic Compounds (NMVOCs) found here: https://naei.beis.gov.uk/data/

131 Defra, *Air quality: Explaining air pollution – at a glance* (2019) https://www.gov.uk/government/publications/air-quality-explaining-air-pollution/air-quality-explaining-air-pollution-at-a-glance

132 European Parliament, *Directive (EU) 2016/2284* (2016) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

133 European Parliament, *Council Directive 1999/13/EC* (1999) https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1999L0013:19990329:EN:PDF

134 The list of metals here is based on the definition provided by Heavy Metals Network (HMN) and the National Atmospheric Emissions Inventory (NAEI) data which is found here: https://naei.beis.gov.uk/data/

135 EU Targets value for the total content in the PM10 fraction averaged over a calendar year.

136 Defra, *A Green Future: Our25 Year Plan to Improve the Environment* (2018) https://www.gov.uk/government/publications/25-year-environment-plan

137 http://www.pops.int/Home/tabid/2121/Default.aspx

	Perfluorooctanoic acid, its salts and PFOA-related compounds		
	Polychlorinated biphenyls		
	Polychlorinated naphthalenes		
	Perfluorooctanoic acid, its salts and PFOA-related compounds		
	Short-chained chlorinated paraffins		
	Technical endosulfan and its related isomers		
	Tetrabromodiphenyl ether and pentabromodiphenyl ether		
	Toxaphene		
	DDT	The UK must take measures to restrict the production and use of these chemicals.	The UN's Stockholm Convention[138]
	Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride		
	Hexachlorobenzene	The UK must take measures to reduce the unintentional releases of these chemicals.	The UN's Stockholm Convention[139]
	Hexachlorobutadiene		
	Pentachlorobenzene		
	Polychlorinated biphenyls		
	Polychlorinated dibenzo-p-dioxins		
	Polychlorinated dibenzofurans		
	Polychlorinated naphthalenes		
Other gases	Ammonia (NH_3)	**Emissions reduction:**[140] From 2005 level between 2020-2029: • 8% reduction From 2005 level from 2030: • 16% reduction from 2005 levels after 2030	**Emissions reduction:** Ambient Air Directive Target Values - EU directive.[141]

138 http://www.pops.int/Home/tabid/2121/Default.aspx

139 http://www.pops.int/Home/tabid/2121/Default.aspx

140 European Parliament, *Directive (EU) 2016/2284* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

141 European Parliament, *Directive (EU) 2016/2284* (2016) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.344.01.0001.01.ENG&toc=OJ:L:2016:344:TOC

Table 26: Existing airborne concentration limits for substances, gases, and compounds in the UK

Substance group	Substance type	Existing target/limits/ objectives	Source of the target/limit/ objectives
Particulate matter (PM)	$PM_{2.5}$	**Airborne concentration limits:** • 25 µg/m^3 annual mean • 20 µg/m^3 exposure concentration obligation; and • 18 µg/m3 exposure concentration target - Percentage reduction plus all measures to reach.	**Airborne concentration limits:** Ambient Air Directive Limit Values – EU directive. [142]
	PM_{10}	**Airborne concentration limits:** • 40 µg/m^3 annual mean • 50 µg/m^3 not to be exceeded more than 35 times a year (measured from 24 hour mean)	**Airborne concentration limits:** Ambient Air Directive Limit Values - EU directive.[143]
Polycyclic aromatic hydrocarbons (PAHs)[144]	Acenaphthene	**Airborne concentration limits:** **EU:** • 1 ng/m^3 annual mean (applies to total PAH but expressed as the concentration of Benzo(a) pyrene)). **National:** • 0.25 ng/m^3 annual average	**Airborne concentration limits:** **EU:** Ambient Air Directive Target Values - EU directive.[145] **National:** National air quality objective[146]
	Acenaphthylene		
	Anthracene (C_{14} H_{10})		
	Benzo(a)anthracene		
	Benzo[a]pyrene (B[a]P)		
	Benzo(b)fluoranthene		
	Benzo(g,h,i)perylene		
	Benzo[k]flouranthene		
	Chrysene		
	Dibenz[a,h]anthracene		
	Fluoranthene		
	Fluorene		
	Indeno[123-cd]pyrene		
	Naphthalene		
	Phenanthrene		
	Pyrene		
Acid gases	Nitrogen oxide (NOx) - expressed as nitric oxide (NO) and nitrogen dioxide (NO_2)	**Airborne concentration limits:** • 40 µg/m^3 annual mean • 200 µg/m^3 one hour mean (not to be exceeded more than 18 times a year) • 400 µg/m^3 alert threshold	**Airborne concentration limits:** Ambient Air Directive Limit Values - EU directive.[147]

142 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

143 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

144 The substances within this group are based on the substances found in the National Atmospheric Emissions Inventory (NAEI) data found here: https://naei.beis.gov.uk/data/

145 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

146 Defra – UK Air, *Air Quality Objectives* https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

147 European Environment Agency –EEA, *Air quality map thresholds* (2017) https://www.eea.europa.eu/themes/air/air-quality/resources/air-quality-map-thresholds

	Sulphur dioxide (SO2)	**Airborne concentration limits:** • 266 µg/m³ 15 minutes (UK air quality strategy objectives) • 20 µg/m³ critical level for vegetation, winter • 125 µg/m³ daily mean, exceeded <= 3 days/year • 350 µg/m³ hourly mean, exceeded <= 24 hours/year • 500 µg/m³ alert threshold, 3 consecutive hours	**Airborne concentration limits:** UK air quality strategy (AQS) objectives.[148] Ambient Air Directive Limit Values - EU directive.[149]
Non-methane volatile organic compounds (NMVOCs)[150]	1,3 Butadiene	**Airborne concentration limits:** • 2.25 µg/m³ running annual mean	**Airborne concentration limits:** UK Air Quality Strategy (AQS) Objectives.[151]
	Benzene (C_6H_6)	**Airborne concentration limits:** • 5 µg/m³ annual average (England and Wales)	**Airborne concentration limits:** Ambient Air Directive Limit Values - EU directive.[152]
	VOCs	**Emissions reduction:** For details targets see web link to the directive.	**Emissions reduction:** Solvents Directive 1999/13/EC.[153]
Heavy metals[154; 155]	Arsenic	**Airborne concentration limits:** • 6 ng/m³ annual limits	**Airborne concentration limits:** Ambient Air Directive Target Values - EU directive.[156]
	Cadmium	**Airborne concentration limits:** • 5 ng/m³ annual limits	**Airborne concentration limits:** Ambient Air Directive Target Values - EU directive.[157]
	Lead	**Airborne concentration limits:** • 500 ng/m³ annual limits	**Airborne concentration limits:** Ambient Air Directive Target Values - EU directive.[158]
	Nickel	**Airborne concentration limits:** • 20 ng/m³ annual limits	**Airborne concentration limits:** Ambient Air Directive Target Values - EU directive.[159]

148 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

149 European Environment Agency –EEA, *Air quality map thresholds* (2017) https://www.eea.europa.eu/themes/air/air-quality/resources/air-quality-map-thresholds

150 Based on the National Atmospheric Emissions Inventory (NAEI) definition of Non-methane Volatile Organic Compounds (NMVOCs) found here: https://naei.beis.gov.uk/data/

151 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

152 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

153 European Parliament, *Council Directive 1999/13/EC* (1999) https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1999L0013:19990329:EN:PDF

154 The list of metals here is based on the definition provided by Heavy Metals Network (HMN) and the National Atmospheric Emissions Inventory (NAEI) data which is found here: https://naei.beis.gov.uk/data/

155 EU Targets value for the total content in the PM10 fraction averaged over a calendar year.

156 European Parliament, *Directive 2004/107/EC* (2005) https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:023:0003:0016:EN:PDF

157 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

158 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

159 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Persistent organic pollutants (POPs)[160]	Dioxins and furans (polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs))	**Airborne concentration limits:** • 0.1 ng/m^3 – assessed against the I-TEQ (International Toxic Equivalence	**Airborne concentration limits:** Industrial Emissions Directive (2010/75/EU).[161]
Other gases	Carbon monoxide (CO)	**Airborne concentration limits:** 10 mg/m^3 maximum daily 8-hour mean	**Airborne concentration limits:** Ambient Air Directive Target Values - EU directive.[162]
	Ground-level ozone (O_3):	**Airborne concentration limits:** • 120 µg/m^3 maximum daily 8 hour mean not to be exceeded more than 25 times a year • 180 µg/m^3 information threshold • 240 µg/m^3 alert threshold • 18,000 µg/m^3 one hour May-July (to protect vegetation) averaged over 5 years	**Airborne concentration limits:** EU Directive on air pollution by ozone (92/72/EEC) which was adopted in September 1992.[163]

Table 27: Environment-level assessment concentration limit values

Substance group	Substance type	Existing target/limits/ objectives	Source of the target/limit/ objectives
Acid gases	Hydrogen chloride (HCl)	**Airborne concentration limits:** • 750 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels[164]
	Hydrogen fluoride (HF)	**Airborne concentration limits:** **Conservation areas targets:** • 0.5 µg/m^3 is the weekly limit • 5 µg/m^3 is the daily limit **Environmental assessment levels:** • 16 µg/m^3 (monthly average) is the annual limit • 160 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels and Conservation Areas Target.[165]
	Nitrogen oxide (NOx) - expressed as nitric oxide (NO) and nitrogen dioxide (NO_2)	**Airborne concentration limits:** • 30 µg/m^3 annual mean (protection of vegetation) • 75 µg/m^3 daily mean (protection of vegetation)	**Airborne concentration limits:** Environmental assessment level limits.[166]

160 The substances under this group are based on the Stockholm Convention found here: http://chm.pops.int/TheConvention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx

161 Poole, *Schedule 13A Environmental Permit* (2016) https://www.poole.gov.uk/_resources/assets/attachment/full/0/49466.pdf

162 European Commission, *Air Quality Standards* https://ec.europa.eu/environment/air/quality/standards.htm

163 European Environment Agency –EEA, *Air quality map thresholds* (2017) https://www.eea.europa.eu/themes/air/air-quality/resources/air-quality-map-thresholds

164 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

165 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

166 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Ozone depleting substances (ODS)[167]	Carbon tetrachloride (CCl_4)	**Airborne concentration limits:** • 750 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Level.[168]
	Methyl chloroform (CH_3CCl_3)	**Airborne concentration limits:** • 11,100 µg/m^3 is the annual limit • 222,000 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[169]
Heavy metals[170; 171]	Beryllium	**Airborne concentration limits:** • 0.2 ng/m^3 annual limits	**Airborne concentration limits:** Environmental Assessment Levels.[172]
	Chromium	**Airborne concentration limits:** • 0.2 ng/m^3 annual limits	**Airborne concentration limits:** Environmental Assessment Levels.[173]
	Copper	**Airborne concentration limits:** • 10,000 ng/m^3 annual limits	**Airborne concentration limits:** Environmental Assessment Levels.[174]
	Manganese	**Airborne concentration limits:** • 150 ng/m^3 is the annual limit • 1,500.000 ng/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[175]
	Mercury	**Airborne concentration limits:** • 250 ng/m^3 is the annual limit • 1,500.000 ng/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[176]
	Platinum	**Airborne concentration limits:** • 50,000 ng/m^3 is the annual limit • 1,5000.000 ng/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[177]
	Rhodium	**Airborne concentration limits:** • 1,000 ng/m^3 is the annual limit • 30,000 ng/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[178]

167 Based on some of the substances under the scope of the Montreal Protocol.

168 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

169 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

170 The list of metals here is based on the definition provided by Heavy Metals Network (HMN) and the National Atmospheric Emissions Inventory (NAEI) data which is found here: https://naei.beis.gov.uk/data/

171 EU Targets value for the total content in the PM10 fraction averaged over a calendar year.

172 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

173 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

174 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

175 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

176 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

177 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

178 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

	Selenium	**Airborne concentration limits:** • 1,000 ng/m³ is the annual limit • 30,000 ng/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[179]
	Tin	**Airborne concentration limits:** • 50,000 ng/m³ is the annual limit • 1,000.000 ng/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[180]
	Vanadium	**Airborne concentration limits:** • 5,000 ng/m³ is the annual limit • 1,000 ng/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[181]
	Zinc	**Airborne concentration limits:** • 50,000 ng/m³ is the annual limit • 1,000.000 ng/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[182]
Persistent organic pollutants (POPs)[183]	Dieldrin	**Airborne concentration limits:** • 2.5 µg/m³ is the annual limit • 75 µg/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[184]
	Endrin	**Airborne concentration limits:** • 1 µg/m³ is the annual limit • 30 µg/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[185]
	Hexachlorocyclohexane (HCH) – lindane	**Airborne concentration limits:** • 5 µg/m³ is the annual limit • 150 µg/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[186]
	Polychlorinated biphenyls (PCBs)	**Airborne concentration limits:** • 0.2 µg/m³ is the annual limit • 6 µg/m³ is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[187]

179 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

180 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

181 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

182 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

183 The substances under this group are based on the Stockholm Convention found here: http://chm.pops.int/TheConvention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx

184 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

185 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

186 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

187 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

Other gases	Ammonia (NH_3)	**Airborne concentration limits:** Environmental Assessment Levels: • 180 µg/m^3 is the annual limit • 2,500 µg/m^3 is the hourly limit Protected Conservation Areas: • 1 µg/m^3 is the annual limit [where lichens or bryophytes (including mosses, landworts and hornwarts) are present] • 3 µg/m^3 is the annual limit (where lichens or bryophytes are not present)	**Airborne concentration limits:** Environmental Assessment Levels and Protected Conservation Areas.
	Carbon monoxide (CO)	**Airborne concentration limits:** • 30,000 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[188]
	Chlorine and inorganic compounds (Cl)	**Airborne concentration limits:** • 15 µg/m^3 is the annual limit • 290 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[189]
	Fluorine and inorganic compounds (HF)	**Airborne concentration limits:** • 160 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels.[190]
	Hydrogen cyanide (HCN)	**Airborne concentration limits:** • 220 µg/m^3 is the hourly limit	**Airborne concentration limits:** Environmental Assessment Levels. [191]

188 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

189 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

190 SEPA, *Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and appraisal of BAT* (2003) https://www.sepa.org.uk/media/35958/ippc_h1.pdf

191 Defra, *Air emissions risk assessment for your environmental permit* (2016) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Annex 2

Freshwater

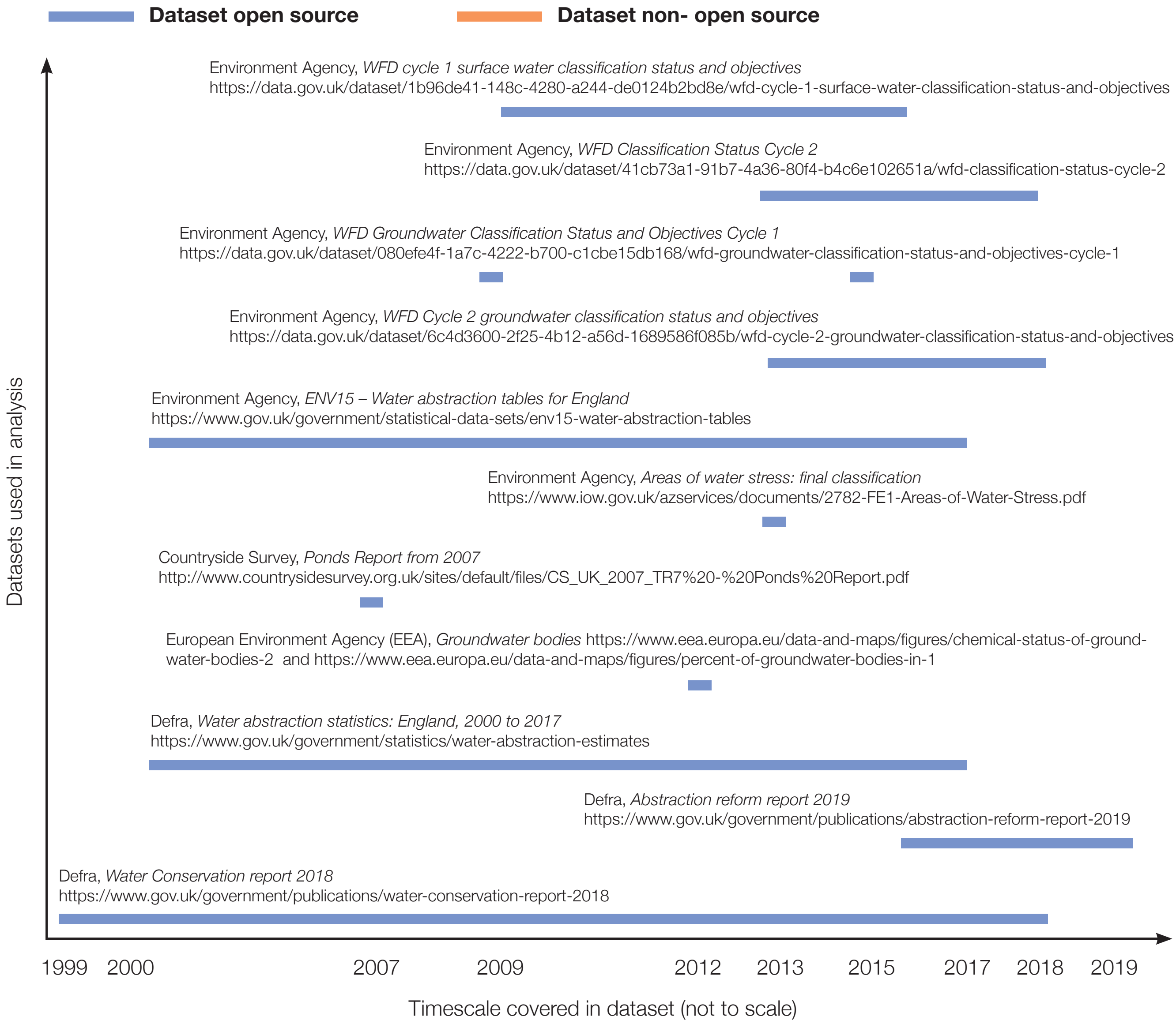
Freshwater

Background

Freshwater is essential for life. Of all the water on Earth, only 2.5% is freshwater, and only 1% of this is accessible for human use[1]. Freshwater is utilised by many sectors of our economy, as well as being used for recreation and wellbeing. Both the availability and quality of freshwater are important considerations. Too much water, and the timing of such an event may cause flooding. Conversely, too little water can result in drought. These, together with the presence of pollutants, are pressures which have implications for humans, nature, and the economy

In order to understand where changes in the status of fresh waters and how these will affect human health or the environment, it is important to first understand where pollution is most concentrated, how it occurs, and what elements are involved. To do so, robust and comprehensive data is required to enable an assessment of the status of freshwater asset. To produce the freshwater assessment the Natural Capital Committee (NCC) has looked at a range[2] of datasets, these are presented in Diagram 1 below.

Datasets used in freshwater analysis, timescale covered and their status (open or non-open source)



1 National Geographic: *Freshwater Crisis*. https://www.nationalgeographic.com/environment/freshwater/freshwater-crisis/

2 Given the limited resources available to the NCC the list of datasets is not comprehensive and further work is required to scope additional datasets to complement this assessment.

In terms of the scope of this work, the NCC has relied on existing data and analysis with expert input rather than developing new analysis. Evidence and data from a range of different sources – with significant variation in the quality and quantity of data available - has been compiled to produce the assessments. The Committee is not aware of any existing, recent comprehensive work that brings together available evidence and integrates it into an assessment of the extent and condition of natural capital assets. These seven technical annexes and underpinning datasets can provide a template for the Office for Environmental Protection (OEP), and act as a starting point for the natural capital systems-based assessment required to effectively undertake its statutory 25 Year Environment Plan (25 YEP) scrutiny function from 2021.

Freshwater asset

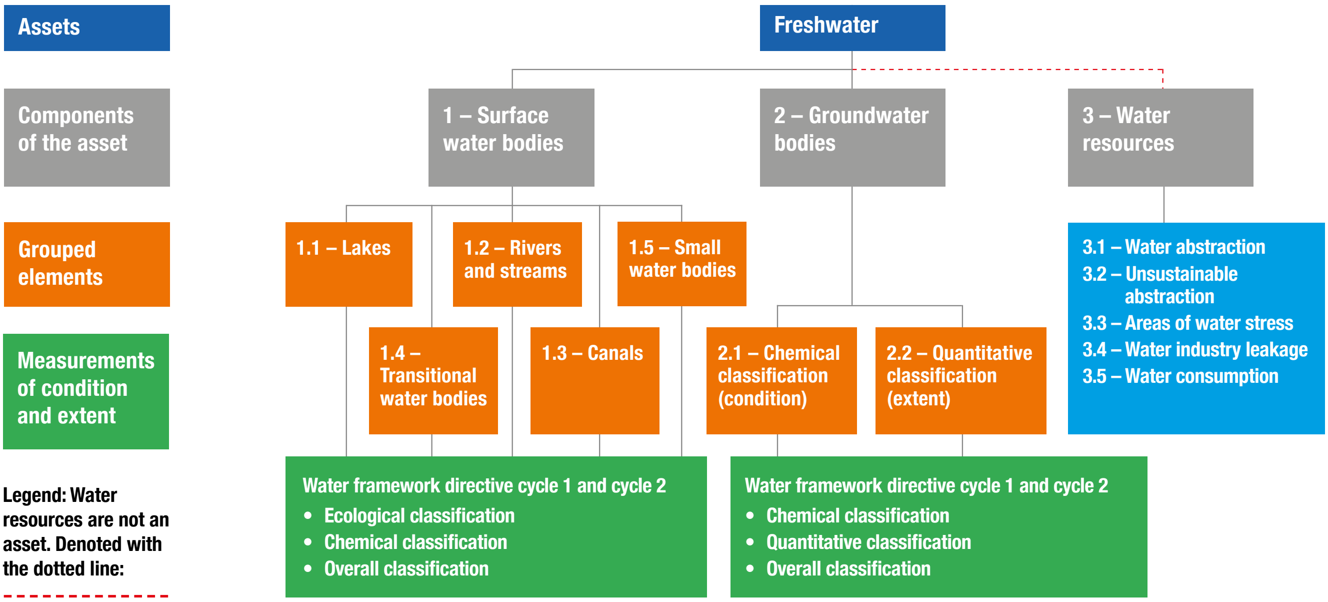
The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of freshwater. In order to produce the freshwater assessment, the NCC has used datasets and evidence from:

- Water Framework Directive (WFD)[3] cycle 1 & 2 and the Groundwater Directive[4] reported by the Environment Agency;
- Catchment Data Explorer[5];
- Evidence from the River Basin Management Plans[6];
- Data on abstraction from the Environment Agency[7];
- Evidence published by Defra on water resources; and
- Evidence from the European Environment Agency (EEA) for surface[8, 9] and groundwater[10].

To produce the assessment of freshwater the NCC has started by scoping out the components of the asset, which are presented in Figure 1.

A data trend assessment followed (where data was available) to see how these components and measurements changed over time and where possible try to infer the status of their condition and extent.

Figure 1: Freshwater components for assessment



Source: NCC 2020

3 Environment Agency, *About the Water Framework Directive* http://evidence.environment-agency.gov.uk/FCERM/en/SC060065/About.aspx
4 European Parliament, *Directive 2006/118/EC* (2006) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006L0118
5 Environment Agency, *Catchment Data Search* https://environment.data.gov.uk/catchment-planning/
6 Environment Agency, *River basin management plans: national evidence and data report* (2015) https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report
7 Environment' Agency, *ENV15 – Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables
8 EEA, *Ecological status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies
9 EEA, *Chemical status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/chemical-status-of-surface-water-bodies
10 EEA, *Groundwater quantitative and chemical status* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/groundwater-quantitative-and-chemical-status

To produce the assessment of surface and groundwater the NCC has followed the approach of the WFD, which is to classify water bodies based on their status classification, as displayed in Table 1. While Figure 2 and 3 below present the test taken under the WFD for surface and groundwater classification.

Table 1: Water Framework Directive (WFD) classification framework of water bodies

Waterbody type	Classification framework	Description
Surface water bodies	**Ecological status**	*"Ecological status is an assessment of the quality of the structure and functioning of surface water ecosystems. It shows the influence of pressures (e.g. pollution and habitat degradation) on the identified quality elements. Ecological status is determined for each of the surface water bodies of rivers, lakes, transitional waters and coastal waters, based on biological quality elements and supported by physico-chemical and hydromorphological quality elements. The overall ecological status classification for a water body is determined, according to the 'one out, all out' principle, by the element with the worst status out of all the biological and supporting quality elements"* [11].
	Chemical status	*"For surface waters, good chemical status means that no concentrations of priority substances exceed the relevant EQS established in the Environmental Quality Standards Directive 2008/105/EC (as amended by the Priority Substances Directive 2013/39/EU). EQS aim to protect the most sensitive species from direct toxicity, including predators and humans via secondary poisoning. A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous (present, appearing or found everywhere), persistent, bioaccumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs)"*[12].
	Overall status	It is the combined classification of ecological and chemical assessments.
Groundwater	**Chemical status**	*"To meet the aim of good chemical status, hazardous substances should be prevented from entering groundwater, and the entry of all other pollutants (e.g. nitrates) should be limited. In addition, impacts on surface water linked with groundwater or groundwater-dependent terrestrial ecosystems should be avoided, as should saline intrusions"*[13].
	Quantitative status	*"Good quantitative status can be achieved by ensuring that the available groundwater resource is not reduced by the long-term annual average rate of abstraction. In addition, impacts on surface water linked with groundwater or groundwater-dependent terrestrial ecosystems should be avoided, as should saline intrusions"*[14].
	Overall status	It is the combined classification of quantitative and chemical assessments.

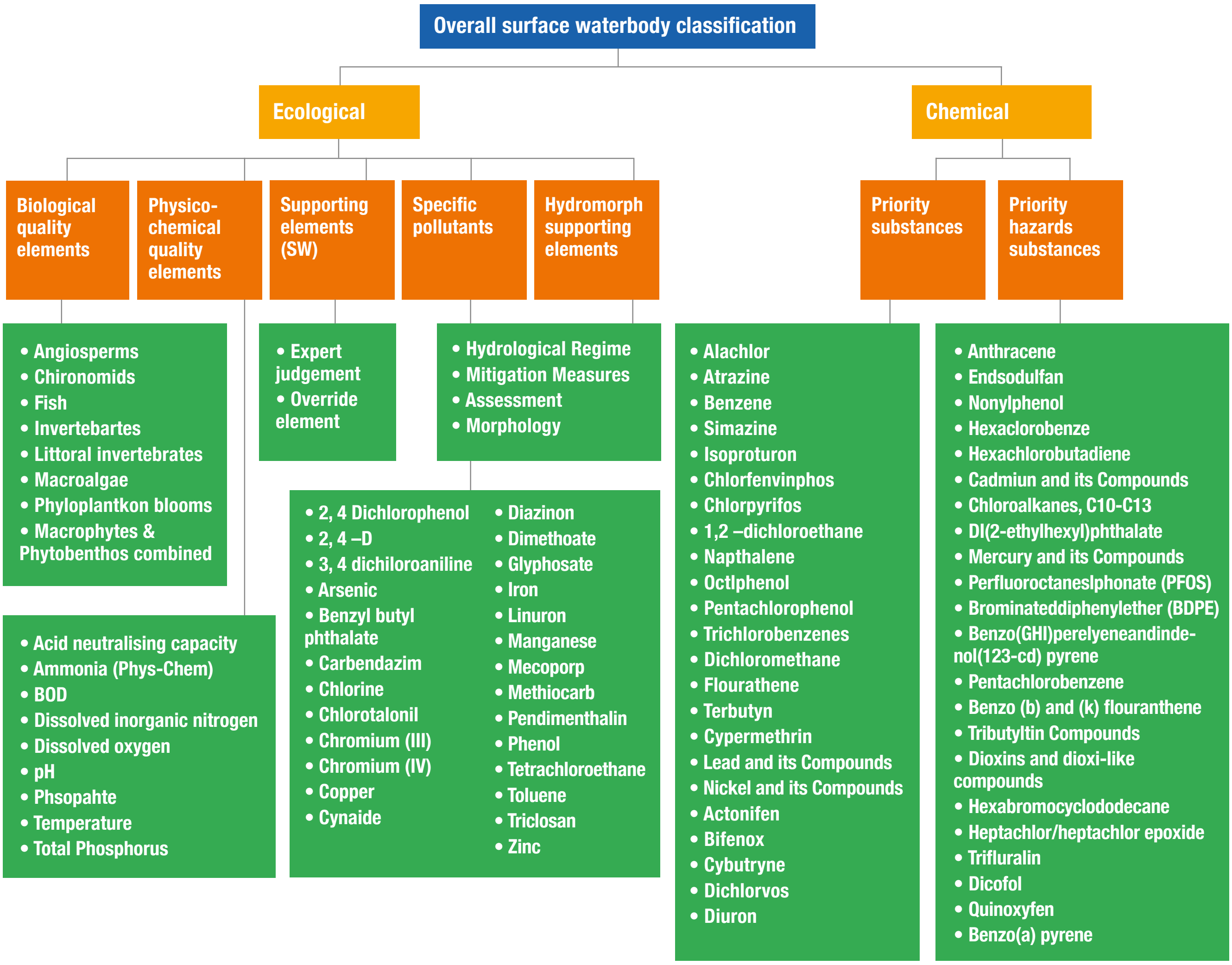
11 EEA, *Ecological status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies

12 EEA, *Chemical status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/chemical-status-of-surface-water-bodies

13 EEA, *Groundwater quantitative and chemical status* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/groundwater-quantitative-and-chemical-status

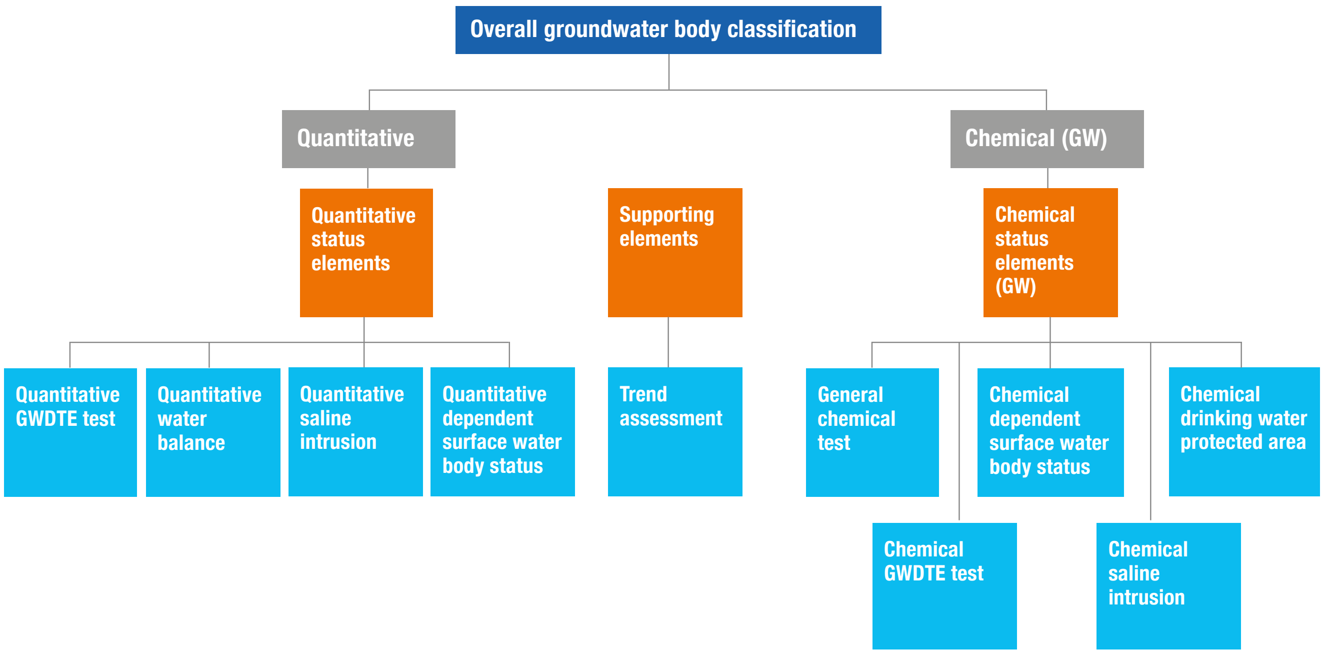
14 EEA, *Groundwater quantitative and chemical status* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/groundwater-quantitative-and-chemical-status

Figure 2: Water Framework surface water bodies overall, ecological and chemical classification tests



Source: EA catchment explorer[15]

Figure 3: Water Framework groundwater bodies overall, quantitative and chemical classification tests



Source: EA catchment explorer[16]

15 Environment Agency, *Catchment data explorer help page* https://environment.data.gov.uk/catchment-planning/help

16 Environment Agency, *Catchment data explorer help page* https://environment.data.gov.uk/catchment-planning/help

The WFD uses a scale to define the status of each water body, ranging from 'high' to 'bad'. See Table 2 below for a description of each status.

Table 2: Definition of status in the Water Framework Directive

Status	Definition
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife or fisheries.
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

Source: Environment Agency[17]

Using the classification presented in Table 1 and the status from Table 2, the NCC has then looked at currently available datasets and the evidence base in the England and/or UK to assess the condition and extent of each component of the freshwater asset presented in Table 3. To supplement the WFD classification, this assessment also looks at available datasets and evidence base in the England and/or UK to assess on the consumption of water (and leakage) and small water bodies (SWB) which are outside of the scope of the WFD.

Table 3: components and sub-components of the freshwater asset

Asset	Components of the asset	Subcomponents of the asset
Freshwater	Surface water bodies	• Lakes • Rivers and streams • Canals • Transitional waters • Small water bodies (SWB)
	Groundwater bodies	• Groundwater

The WFD data is presented for cycle 1 and cycle 2,[18] for the former, the baseline point is 2009 and for the latter, the baseline point is 2013. It is important to highlight that these two cycles and respective datasets are not directly comparable, as cycle 2 follows a different monitoring and classification standard. Further detail can be found under the Environment Agency *Data Catchment Explorer*[19] website.

17 Environment Agency, *Catchment data explorer help page https://environment.data.gov.uk/catchment-planning/help*

18 There are difference on the waters bodies that are monitored between cycle 1 and 2. In the majority of cases there was little or no change from the water body reported in the first cycle River Basin Management Plan (RBMP). In others, due to extensive merging or splitting of water bodies, there was a significant change. This process resulted in the creation of some new water bodies, e.g.: by splitting a large water body into two small new ones, as well as the removal of many small water bodies which were below the size thresholds set out in the WFD guidance. **Source:** https://data.gov.uk/dataset/b8580c97-8108-46cd-8295-ec0c431a2937/wfd-water-framework-directive-cycle-1-and-cycle-2-water-body-changes

19 Environment Agency, *Catchment Data Search* https://environment.data.gov.uk/catchment-planning/

Summary of overall (partial) freshwater assessment

The NCC has produced a partial assessment of the condition and extent of the freshwater asset. The assessment uses a 'RAG' rating approach to indicate the status of the freshwater asset and its associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. See Table 4 for the RAG scale – note that the 'grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'amber' rating ('no change' / 'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 4: RAG rating scale for the freshwater asset

RAG rating	Colour
Unable to assess	
Deteriorating	
No change/mixed	
Improving	

The overall assessment of the freshwater annex – based on the datasets available – is 'Red': **deteriorating** – this is based on the limited progress government has made towards meeting the WFD objectives for surface and groundwater. For example, for cycle 2 only 16% of surface water bodies achieve at least 'good' ecological status. In addition, water continues to be abstracted unsustainably and water consumption has remained flat at around 140 litres per capita since 2012/13. This assessment is based on the three group headings (see points 1-3 below) and is underpinned by the trend assessment made to the freshwater components (e.g.: lakes, rivers, etc...).

1. Surface water bodies
2. Groundwater bodies
3. Water resources

The NCC findings are presented in Table 5 based on the datasets available, with a RAG rating for each of the three group headings. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each freshwater components. In the sections that follow in this technical annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC assessments are:

- Surface water bodies are not on track to meet the Water Framework Directive (WFD) objective for 75% to have 'good' ecological status or potential by 2027. Only 16% of surface water bodies achieved 'good' and 'high' status in 2018.
- The number of rivers and streams meeting the WFD cycle 2 objectives of 'good' ecological status has declined from 28% in 2013 to 14% in 2018.
- Groundwater meeting 'good' chemical status (condition) is only 53% vs. a target of 87%, and 'good' quantitative status (extent) is only 69% vs. a target of 82%.
- The significant water management issues impacting the water environment include physical modifications (affecting 39% of water bodies in England), pollution from waste water (affecting 35% of water bodies in England), and pollution from rural areas (affecting 35% of water bodies in England).[20]
- The status of many small freshwater bodies are not currently monitored as this is not a requirement of the WFD. The data that does exist is not assessed centrally.
- Limited progress has been made towards reducing water abstraction (between 2011 and 2017), reducing consumption per capita (between 2011/12 and 2017/18) and reducing water industry leakage (between 2014/15 and 2017/18).
- Around 22% of water currently put into the supply is lost through leakage, equating to around 3 billion litres of water per day.'[21]

20 Based on the finding from the Environment Agency (EA) on the River Basin Management Plans: national evidence and data report - https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report

21 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

Table 5: Indicative assessment of freshwater

Components of the asset	Data availability	Overall assessment
1. Surface water bodies	There are limitations to the surface water assessment, because: • The most recent data is from 2016 as the Environment Agency has moved to triennial reporting; • There is no comprehensive data on small water bodies (SWB). So the assessment here is based on a limited set of evidence.	The RAG rating here is deteriorating, even though data from the WFD cycle 2 on chemical classification presents an increase in the percentage of water bodies that meet 'good' status. This is because there has been a significant decline in ecological status. Surface water bodies are also not on track to meet their target of 75% of achieving 'good' ecological status or potential by 2027, with only 16% achieving 'good' status in 2018.
2. Groundwater bodies	There are limitations to the groundwater assessment, because: • The most recent data is from 2015.	The assessed RAG rating for groundwater shows that groundwaters are deteriorating. This is because groundwater bodies are not meeting their 'good' chemical status (87%) or 'good' quantitative status (82%) and the latest data present a mixed outcome. Where around 53% (cycle 2) achieved 'good' chemical status and around 69% (cycle 2) achieved 'good' quantitative status in 2015.
3. Water resources	There is limited data available on water consumption per capita, areas of water stress and unsustainable abstraction.	Based on the increase of water abstraction over the last five years, and that water consumption per capita and water leakage have remained somewhat stable/decline, the RAG rating for water resources is red.

Individual freshwater components assessment

The overall assessment based on the three groups set out above is underpinned by an analysis of sub-components (as displayed in Figure 1). A full summary assessment of the condition, extent and pressures of these sub-components, grouped by the three overall components are presented in Table 6. The assessment follows the same approach of the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. The assessment is split into four categories, with a RAG rating assigned for each, as follows:

1. **Compliance against target/commitment** is the comparison of the target or commitment baseline against the most recent data. For example, assessing the condition of groundwater against WFD objectives;
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/evidence. For example, comparing the change between 1970 and 2018;
3. **The NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when Government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses*."[22] Here the 2011 baseline (where data is available) is compared against the most recent data/evidence. This also relates to the NCC census advice[23] and its interim response to the 25 YEP Progress Report for a need to have a common base year to assess progress against;
4. **The short-term trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

22 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

23 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan* (2019) https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

The overall assessment RAG rating is based on each measurement's RAG rating presented in Table 6 below. The data presents a decline in the number of surface water measurements (based on available data). For example, the number of rivers and streams meeting the WFD cycle 2 objectives of 'good' ecological status has declined from 29% in 2013 to 14% in 2018. There is also mixed evidence between cycle 1 and cycle 2 for both surface and groundwater bodies. The points below summarise the key findings:

- Rivers and streams have the lowest cycle 2 classification, with only 14% achieving at least 'good' status, falling short of the WFD objective of 75% of surface water bodies in England to have an objective of 'good' ecological status, or potential, by 2027.
- While, canals have the highest classification status under surface water, with just under 54% achieving at least 'good' status.
- It was estimated that in 2019, 9% of surface water was unsustainably abstracted.

The key RAG ratings for the individual measurements are presented below in Table 6.

Table 6: Measurements assessment and respective RAG ratings

Measurements of the component and subcomponents of the asset		Assessment			
		Compliance with target or commitment	Target/ long-term trend/	NCC baseline (2011)	Compliance with target or commitment
Surface water bodies	1.1 - Lakes	Cycle 1 - R	Cycle 1 - R	Cycle 1 - R	Cycle 1 - A
		Cycle 2 - R	Cycle 2 - A	Cycle 1 – N/A	Cycle 2 - A
	1.2 - Rivers and streams	Cycle 1 - R	Cycle 1 - R	Cycle 1 - R	Cycle 1 - R
		Cycle 2 - R	Cycle 2 - R	Cycle 1 – N/A	Cycle 2 - A
	1.3 - Canals	Cycle 1 - A	Cycle 1 - G	Cycle 1 - G	Cycle 1 - A
		Cycle 2 - R	Cycle 2 - R	Cycle 1 - N/A	Cycle 2 - R
	1.4 - Transitional water bodies	Cycle 1 - R	Cycle 1 - G	Cycle 1 - R	Cycle 1 - R
		Cycle 2 - R	Cycle 2 - G	Cycle 1 - N/A	Cycle 2 - R
	1.5 - Small water bodies	N/A	N/A	N/A	N/A
Groundwater bodies	2.1 - Groundwater bodies[24]	Cycle 1 - R	Cycle 1 - A	N/A	N/A
		Cycle 2 - R	Cycle 2 - A	N/A	Cycle 2 - A
Water resources	3.1 - Water Abstraction	N/A	G	R	R
	3.2 - Unsustainable abstraction	A	A	N/A	N/A
	3.3 - Areas of water stress	N/A	N/A	N/A	N/A
	3.4 - Water industry leakeage	N/A	A	R	R
	3.5 - Water consumption	N/A	A	A	R

24 Here the assessment is based on the combination of chemical and quantitative classificaitons.

1. Surface water bodies

The NCC's assessment of surface water bodies (based on data and evidence compiled for the WFD) looks at the condition and extent of inland waters[25] such as lakes, reservoirs, rivers, streams, canals, and transitional waters, but excludes ditches and surface water transfers – bathing waters are assessed under the **marine annex 3**. It also includes small waters bodies that are outside of the scope of the WFD[26], such as small lakes and ponds, as these are vital habitats for wildlife. See Table 7 for list surface water bodies (asset components) included under this assessment and current policy objectives (targets).

Table 7: List of water bodies and targets

<table>
<tr><th></th><th>Waterbody type</th><th>Existing target/limits</th></tr>
<tr><td rowspan="5">Surface water bodies</td><td>1.1 - Lakes[27]</td><td rowspan="4">Improvement target:
Water Framework Directive (WFD) (2000/60/EC) establishing a framework for European Community action in the field of water policy.[28]
The WFD target is to get 100% of water bodies in England to meet good ecological status or potential. However, the WFD has provisions on disproportionate cost and technical feasibility.
Given these provisions, the 2015 impact assessment set a lower target with the aim that 75% of surface water bodies in England to have an objective of good ecological status or potential by 2027.[29]
There are no specific targets for surface waters in terms of their chemical classification, only limits that need to be met.
The WFD target is also a commitment in the 25 Year Environment Plan (25 YEP) has the commitment: "Improving at least three-quarters of our waters to be close to their natural state as soon as is practicable"[30]. However, the plan does not define what is meant by soon as practicable.</td></tr>
<tr><td>1.2 - Rivers and streams</td></tr>
<tr><td>1.3 - Canals</td></tr>
<tr><td>1.4 - Transitional waters</td></tr>
<tr><td>1.5 - Small water bodies[31]</td><td>Improvement target:
There are no targets for the improvements of small water bodies.</td></tr>
</table>

The overall assessment of surface water bodies

From our assessment, it would appear that the overall state of surface water bodies (including lakes, rivers and streams, canals, transitional waters and coastal waters) has deteriorated over both cycles 1 and 2. For cycle 1, surface water bodies achieving 'high' or 'good' ecological status has declined from just over 23% in 2009 to just under 18% in 2016. While for cycle 2 there is a similar declining trend from just over 28% in 2013 to around 16% in 2018[32]. It is important to highlight that in 2015 England adopted the new monitoring and classification standards which are based on cycle 2 from the WFD. For completeness, in Figure 4 data from cycles 1 and 2 are presented together, however, these are not directly comparable. The points below summarise the key findings:

25 Defined as all standing or flowing water on the surface of the land, and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000L0060&from=HR

26 Artificial and modified lake water bodies are included within this dataset, however, generally only lakes above > 50 hectares were assessed under the WFD except for lakes in protected areas, where a minimum of 5.0ha. **Source:** https://data.catchmentbasedapproach.org/datasets/05087d88c1064a73ab24696527b0d782_0

27 Lakes also include artificial lakes, reservoirs, and flooded gravel pits.

28 European Parliament, *Directive 2000/60/EC* (2000) https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF

29 Environment Agency, *Update to the river basin management plans: impact assessment* (2015) https://www.gov.uk/government/publications/update-to-the-river-basin-management-plans-impact-assessment

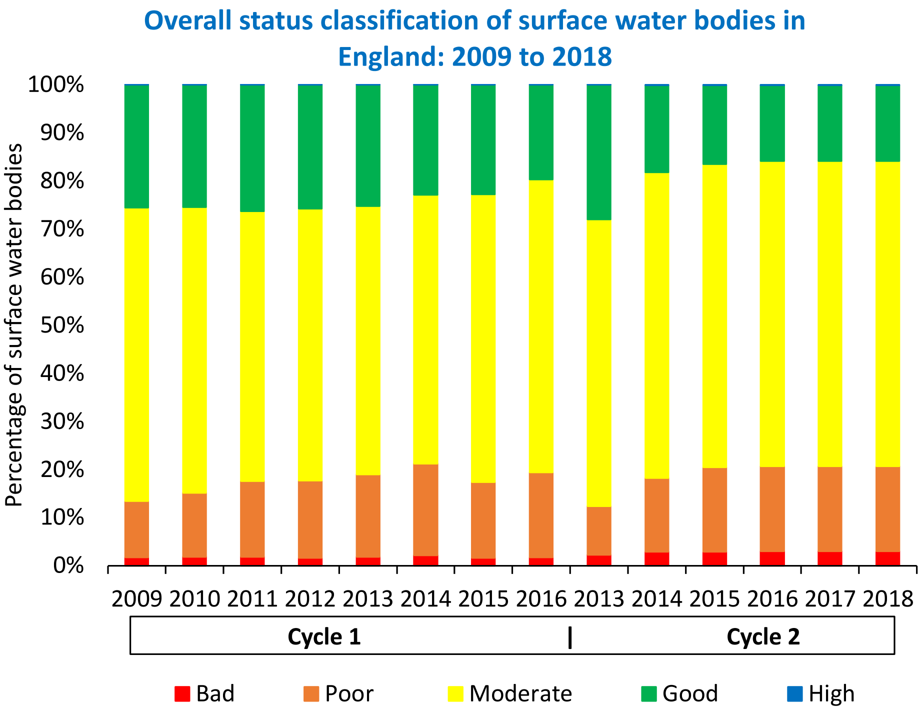
30 Defra, *25 Year Environment Plan* (2018) https://www.gov.uk/government/publications/25-year-environment-plan

31 Small water bodies compromised ponds, small lakes, ditches, streams, upland waters, and small streams.

32 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment.

- Rivers and streams have the lowest cycle 2 classification, with only 14% achieving at least 'good' status, falling short of the WFD objective of 75% of surface water bodies in England having a 'good' ecological status or potential by 2027.
- The number of rivers and streams meeting the WFD cycle 2 objectives of 'good' ecological status has declined from 29% in 2013 to 14% in 2018.
- While, canals have the highest classification status under surface water bodies, with just under 54% achieving at least 'good' status in cycle 2.
- The significant water management issues impacting the water environment include physical modifications (affecting 39% of water bodies in England), pollution from waste water (affecting 35% of water bodies in England), and pollution from rural areas (affecting 35% of water bodies in England).[33]
- The status of many small freshwater bodies are not currently monitored as this is not a requirement of the WFD. The data that does exist is not assessed centrally.

Figure 4: Status classification of surface water bodies in England: 2009 to 2018



Source: Environment Agency – WFD cycles 1 and 2.[34, 35]

At present, the data therefore suggests that England is not on track to meet the WFD objective of getting 75% of surface water bodies to have an objective of 'good' ecological status[36] or potential. See Table 8 for the NCC short, long and baseline assessment. Further discussion on why surface water bodies are not meeting this objective is provided under the 'reasons for failure section'. The sections that follow present the classification of individual water bodies.

33 Based on the finding from the Environment Agency (EA) on the River Basin Management Plans: national evidence and data report - https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report

34 Environment Agency, *WFD cycle 1 surface water classification status and objectives* (2020) https://data.gov.uk/dataset/1b96de41-148c-4280-a244-de0124b2bd8e/wfd-cycle-1-surface-water-classification-status-and-objectives

35 Environment Agency, *WFD Classification Status Cylce 2* (2020) https://data.gov.uk/dataset/41cb73a1-91b7-4a36-80f4-b4c6e102651a/wfd-classification-status-cycle-2

36 Ecological status is an assessment of the quality of the structure and functioning of surface water ecosystems. It shows the influence of pressures (e.g. pollution and habitat degradation) on the identified quality elements. Includes of mix of chemicals, physical and biological parameters.

Table 8: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
75% of surface water bodies in England to have an objective of ‘good’ ecological status or potential by 2027.	**Cycle 1:** Progress towards meeting the objective of 75% of surface water bodies in England to have ‘good’ ecological status or potential by 2027 does not seem to be on track. The latest evidence shows that under 18% met ‘good’ and ‘high’ ecological status.	**Cycle 1:** Data between 2009 and 2016 presents a decline in the number of surface water bodies meeting ‘high’ and ‘good’ ecological status from around 23% to just under 18%.	**Cycle 1:** Data between 2011 and 2016 presents a decline in the number of surface water bodies meeting ‘high’ and ‘good’ ecological status from around 24% to just under 18%.	**Cycle 1:** Data between 2015 and 2016 presents a decline in the number of surface water bodies meeting ‘high’ and ‘good’ ecological status from just over 20% to just under 18%.
	Cycle 2: Progress towards meeting the objective of 75% of surface water bodies in England to have ‘good’ ecological status or potential by 2027 does not appear to be on track. The latest evidence shows that under 16% met ‘good’ and ‘high’ ecological status.	**Cycle 2:** Data between 2013 and 2018 shows a decline in the number of surface water bodies meeting ‘high’ and ‘good’ ecological status from just over 28% to just under 16%.	**Cycle 2:** Data is not available.	**Cycle 2:** From 2016 the Environment agency publishes data on a triennial basis, so it is not possible to compare the latest data 2018 with 2017 as these are the same. When comparing to 2015, there has a been a small decline of under 1 percentage point.
1.1 - Lakes	**Cycle 1:** Based on data from cycle 1 only 27% of lakes achieved ‘good’ and ‘high’ ecological status in 2016. There has also been a decline in the number of lakes achieving ‘high’ and ‘good’ ecological status	**Cycle 1:** Between 2009 and 2016 there has been a decline in the number of lakes achieving ‘high’ and ‘good’ ecological status from just under 35% to 27%	**Cycle 1:** There has been a decline in the number of lakes achieving ‘high’ and ‘good’ ecological status from just under 35% in 2011 to just over 27% in 2016	**Cycle 1:** There has been a slight increase in lakes achieving ‘high’ and ‘good’ ecological status from just under 27% to just over 27%.
	Cycle 2: Based on data from cycle 2 just over 16% of lakes achieved ‘good’ and ‘high’ ecological status in 2018. Falling short of the 75% objective.	**Cycle 2:** Between 2013 and 2018 there has been a slight decline in the number of lakes achieving ‘high’ and ‘good’ ecological status from just 17% to just over 16%	**Cycle 2:** Data is not available.	**Cycle 2:** From 2016 the Environment agency publishes data on a triennial basis, so it is not possible to compare the latest data 2018 with 2017 as these are the same. When comparing to 2015, there has been a small decline of under 1 percentage point.

1.2 - Rivers and streams	**Cycle 1:** Based on data from cycle 1 rivers and streams are not on track to meet the WFD target of 75% surface water bodies in England to have an objective of 'good' ecological status or potential by 2027, with just under 17% achieving 'high' and 'good' in 2016.	**Cycle 1:** There has been a decline when comparing 2009 and 2016 estimates, from just over 23% of rivers and streams achieving 'good' and 'high' ecological status to just under 17%	**Cycle 1:** There has been a decline in the number of rivers and streams achieving 'high' and 'good' ecological status from just over 24% in 2011 to just under 17% in 2016.	**Cycle 1:** Between 2016 and 2015 the number of rivers and streams achieving 'high' and 'good' decline from over 20% to just under 17%.
	Cycle 2: Based on data from cycle 2 rivers and streams are not on track to meet the WFD target of 75% surface water bodies in England to have an objective of good ecological status or potential by 2027, with just under 14% achieving 'high' and 'good' in 2018.	**Cycle 2:** Data between 2013 and 2018 shows a significant decline in the number of rivers and streams meeting 'high' and 'good' ecological status from 29% to just under 14%.	**Cycle 2:** Data is not available.	**Cycle 2:** From 2016 the Environment agency will publish data on a triennial basis, so it not possible to compare the latest data 2018 with 2017 as these are the same. When comparing to 2015, there has a been a small decline of under 1 percentage point.
1.3 - Canals	**Cycle 1:** Based on data from cycle 1 canals are not meeting the WFD objective of 75% surface water bodies in England to have an objective of 'good' ecological status or potential by 2027, but could be on track to meet this objective by 2027. In 2016, 67% achieved 'high' and 'good' ecological status.	**Cycle 1:** The number of canals achieving 'high' and 'good' has increased between 2009 and 2016 from just over 61% to 67%.	**Cycle 1:** There has also been an increase in the number of canals achieving 'high' and 'good' between 2011 and 2016 from 53% to 67%.	**Cycle 1:** There was no significant change between 2015 and 2016 estimates.
	Cycle 2: Based on data from cycle 2 canals are not meeting the WFD target of 75% surface water bodies in England to have an objective of 'good' ecological status or potential by 2027, with just under 54% achieving 'high' and 'good' in 2018.	**Cycle 2:** Between 2013 and 2018 there has been a slight decline in the number of canals achieving 'high' and 'good' ecological status from under 68% to just under 54%.	**Cycle 2:** Data is not available.	**Cycle 2:** From 2016 the Environment agency will publish data on a triennial basis, so it not possible to compare the latest data 2018 with 2017 as these are the same. When comparing to 2015, there has a been a small decline of under 1 percentage point.

1.4 - Transitional water bodies	**Cycle 1:** Based on data from cycle 1 transitional water bodies are not on track to meet the WFD target of 75% surface water bodies in England to have an objective of 'good' ecological status or potential by 2027. In 2016, just over 16% achieved 'high' and 'good'.	**Cycle 1:** There has been an increase when comparing 2009 and 2016 estimates, from just over 14% achieving 'good' and 'high' ecological status to just over 16%.	**Cycle 1:** There has been a decline in the number of transitional waters achieving 'high' or 'good' between 2011 and 2016 from 21% to just over 16%.	**Cycle 1:** Between 2016 and 2015 the number of transitional water bodies achieving 'high' or 'good' decline from just over 21% to just over 16%.
	Cycle 2: Based on data from cycle 2 transitional water bodies are not meeting the WFD target of 75% surface water bodies in England to have an objective of good ecological status or potential by 2027, with just over 20% achieving 'high' and 'good' in 2018.	**Cycle 2:** Data between 2013 and 2018 shows an increase in the number of transitional water bodies achieving 'high' and 'good' ecological status from just over 19% to just over 20%.	**Cycle 2:** Data is not available.	**Cycle 2:** From 2016 the Environment agency will publish data on a triennial basis, so it not possible to compare the latest data 2018 with 2017 as these are the same. When comparing to 2015, there has a been a small decline of under 1 percentage point.
1.5 - Small water bodies (SWB)	No target or commitment exist/ was found/	Data is not available.	Data is not available.	Data is not available.

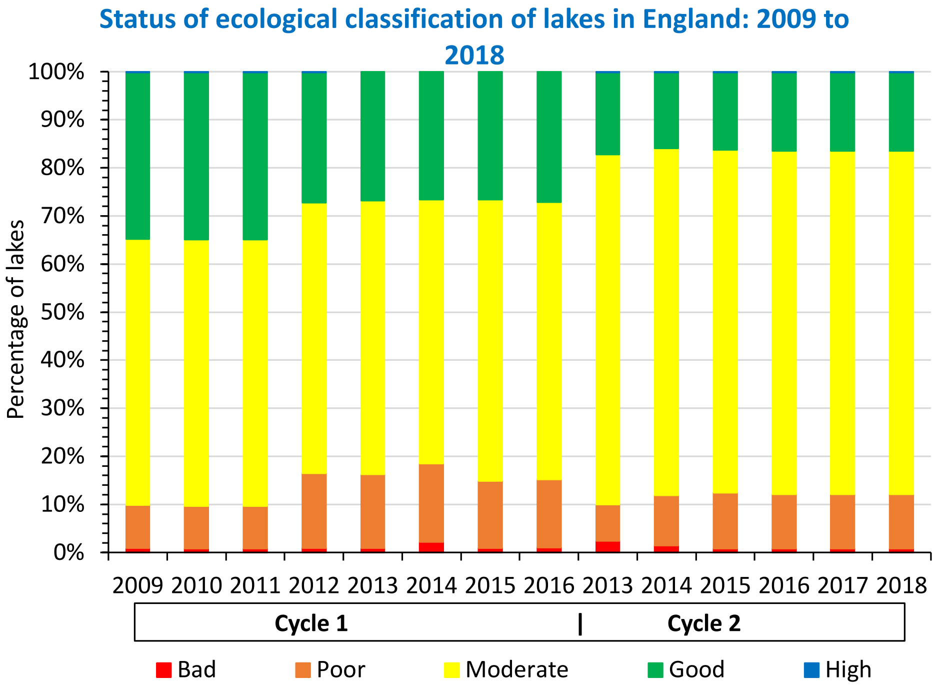
The condition of lakes

Using data from the WFD cycles 1 and 2, this section presents the NCC's assessment on the status of lakes, starting with the ecological classification.

In terms of ecological status, starting with data from cycle 2 in 2018,[37] it can bee seen that the number of lakes that achieved 'high' or 'good' ecological status stood at around 16%. When compared to 2013 (the earliest data is available for cycle 2) a small deterioration can be seen of just under 1 percentage point. It is important to highlight that of the 16% meeting 'high' or 'good' ecological status, the majority of lakes are under 'good' status with only one classified as high. See Figure 5 for the trend since 2009.

37 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. There number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

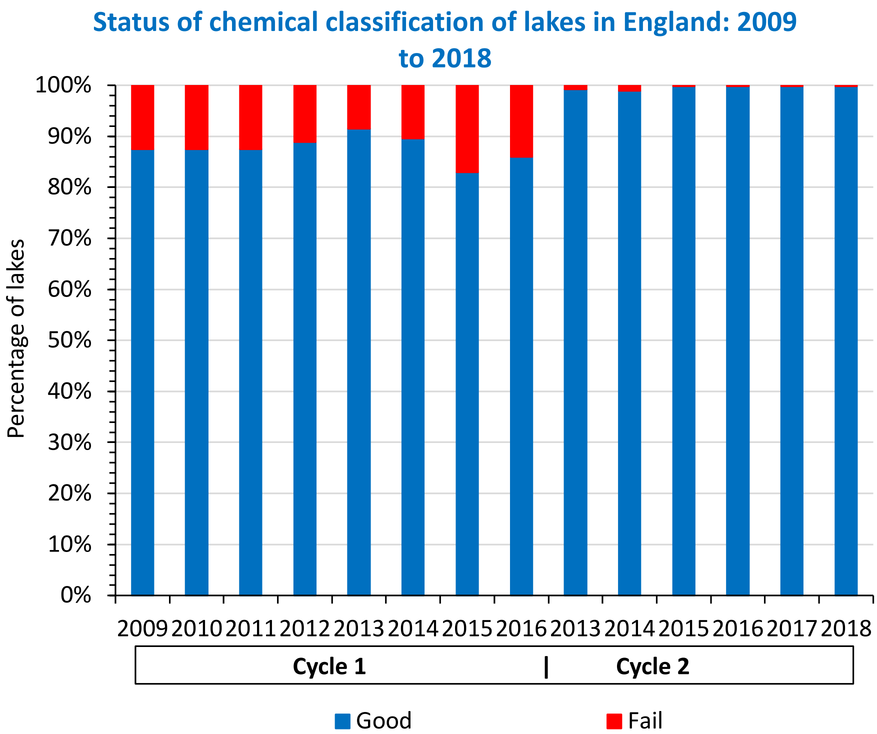
Figure 5: Status of lakes: ecological classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

The status of lakes in terms of the chemical classification shows that in 2018[38] just under 99% of lakes assessed achieved 'good' status and with just one lake having a 'fail' status. It is not possible to make a simple comparison with 2013 data from cycle 2 as more lakes were previously assessed. To provide an indication in terms of percentage change, the data presents a slight increase in the number of lakes achieving 'good' status. For cycle 1 data there has also been a decline in the number of water bodies being assessed between 2015 and 2016. See Figure 6 for a time series from 2009 to 2018, covering both cycles.

Figure 6: Status of lakes: chemical classification since 2009 for cycles 1 and 2

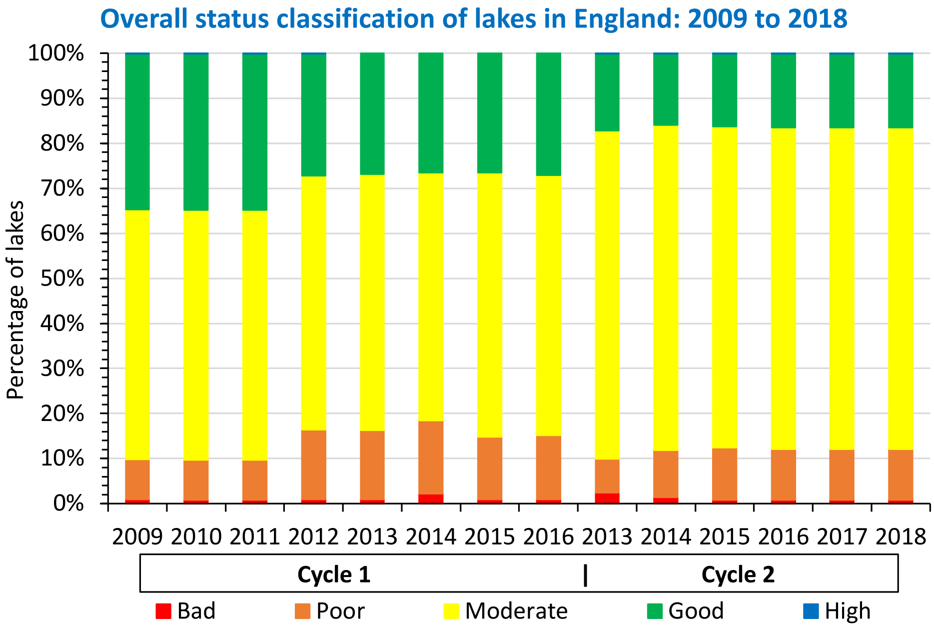


Source: Environment Agency – WFD cycles 1 and 2.

38 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. There number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

The overall (combined) status for lakes is almost identical to the ecological assessment, the main difference is in cycle 1 for the number of lakes meeting 'good' or 'moderate' status. As per the ecological status, in cycle 2 only around 16% of lakes meet the 'high' or 'good' ecological status for the overall assessment in 2018. This is in line with the overall status of surface water bodies of around 16% and falls short of the 75% WFD objective. See Figure 7 for the historical trend for cycles 1 and 2.

Figure 7: Status of lakes: overall classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

In addition to the WFD data, the Centre for Ecology and Hydrology (CEH) has made data on the condition and extent of lakes in England freely available. The data is presented at the lake level and covers several measurements such as water chemistry, quality, and typology. The data can be found under the CEH *UK lakes portal*[39].

The condition of rivers and streams

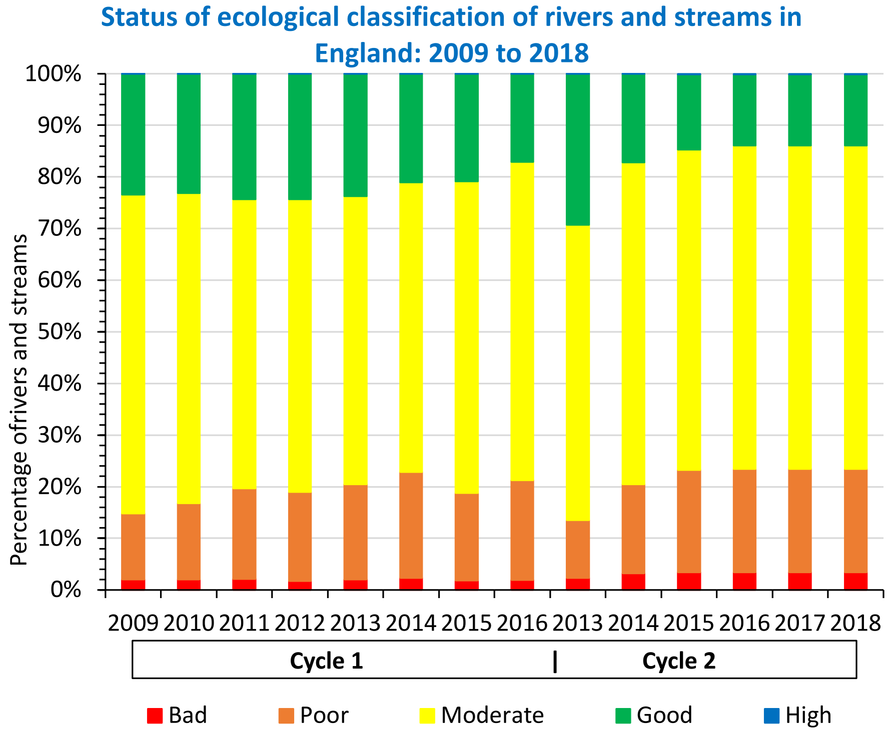
To assess the condition of rivers and streams, the NCC has based its assessment on the chemical, ecological, and overall (combined) classification of the WFD cycles 1 and 2.

For the ecological classification of rivers and streams, the latest data (from 2018[40] for cycle 2 shows that there has been a steady deterioration in the number of rivers and streams that achieve a 'good' or 'high' ecological, falling from around 29% in 2013 to around 14% in 2018. For cycle 1 the trend is similar with the data showing a decline between 2010 and 2016, from around 23% to 17%, respectively. See Figure 8 for the change in status since 2009.

39 CEH, *UK lakes portal* https://eip.ceh.ac.uk/apps/lakes/search.html

40 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. There number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

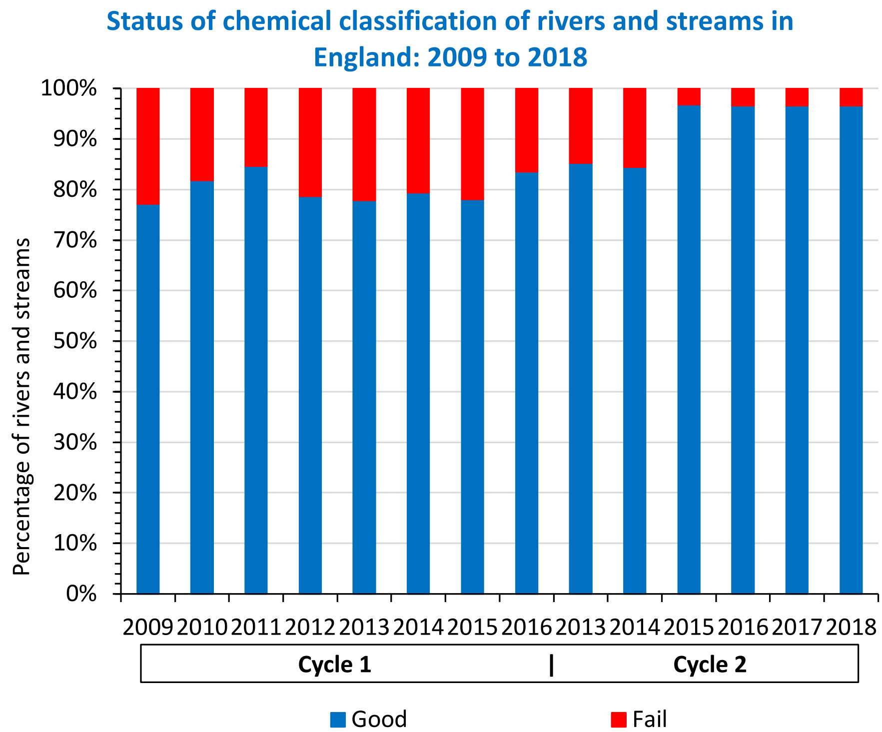
Figure 8: Status of rivers and streams: ecological classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

The latest data for chemical classification for cycle 2 from 2018[41] shows that only a small number of rivers and streams (around 3%) fail to meet 'good' chemical status. There has also been an increase in the number of rivers and streams meeting 'good' status from around 85% in 2013 to around 97% in 2018. For cycle 1, in 2009 around 77% achieved 'good' status, increasing to around 83% in 2016. See Figure 9 for the trend since 2009 for cycles 1 and 2.

Figure 9: Status of rivers and streams: chemical classification since 2009 for cycles 1 and 2

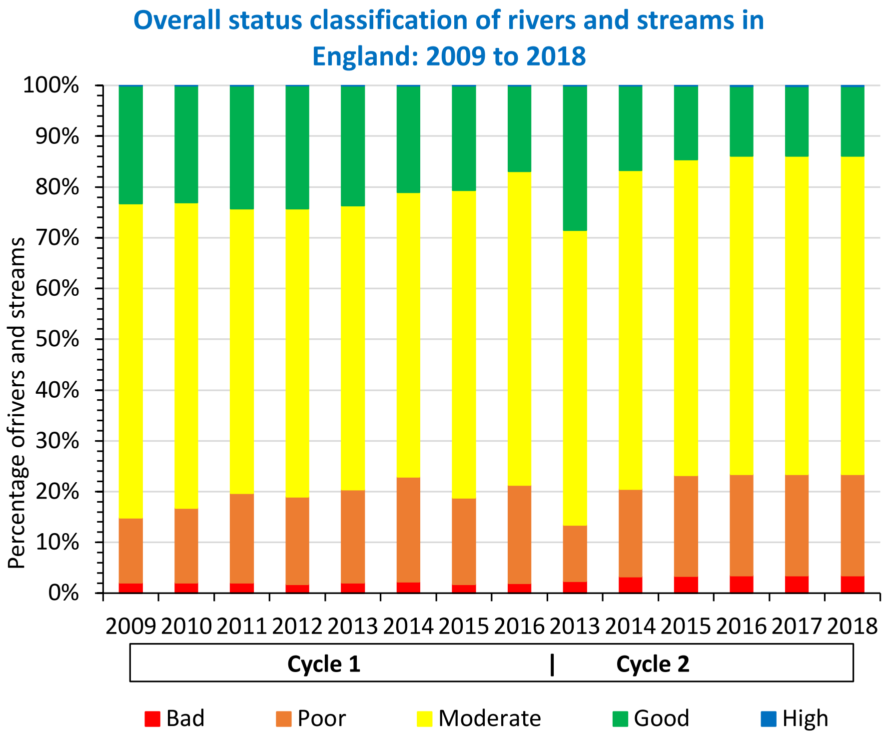


Source: Environment Agency – WFD cycles 1 and 2.

41 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. The number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

The overall status (combined chemical and ecological) for rivers and streams is almost identical to the ecological assessment. The main difference is the number of water bodies receiving 'good' and 'moderate' status, with the overall having a smaller number of good statuses. As per cycle 2's ecological status, only around 14% of rivers and streams achieved a 'good' or 'high' status. This is a somewhat lower estimate than the overall status of surface water bodies (of around 16%) and falls considerably short from the 75% WFD objective. See Figure 10 for the trend since 2009.

Figure 10: Status of rivers and streams: overall classification since 2009 for cycles 1 and 2



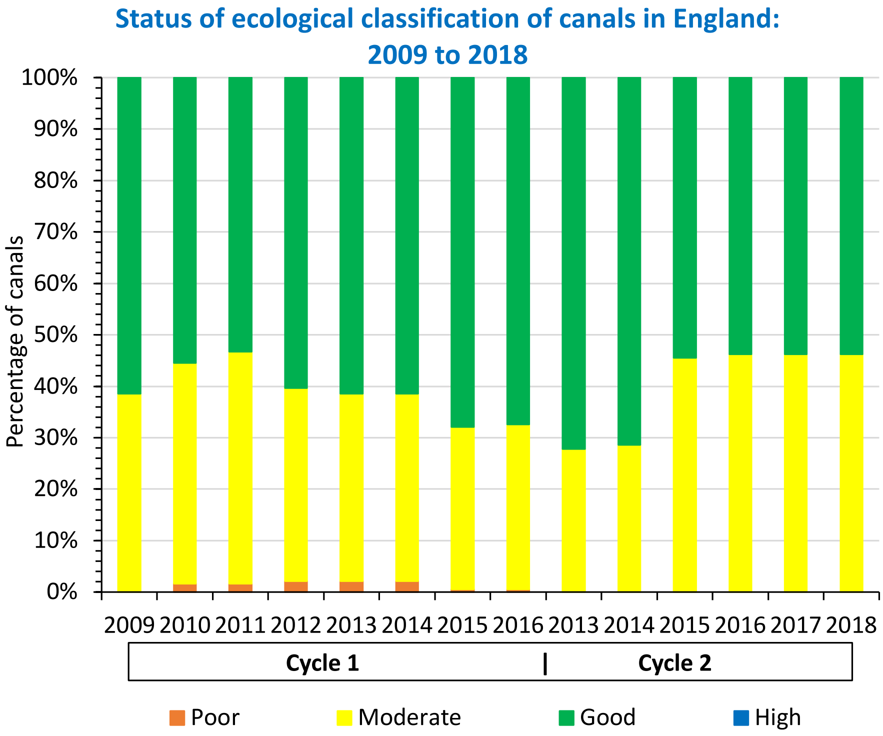
Source: Environment Agency – WFD cycles 1 and 2.

The condition of canals

To assess the condition of canals the NCC has followed the same approach as for lakes, rivers and streams. For the ecological classification, the latest cycle 2 evidence presents the number of canals meeting 'good' or 'high' status declining since 2013 from around 68% to 54% in 2018[42]. However, for cycle 1 the trend presents an improvement from around 53% in 2011 to around 67% in 2016. It is important to highlight that no canal achieves a 'high' status in either cycle. See Figure 11 for trend overtime for cycles 1 and 2.

42 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. There number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

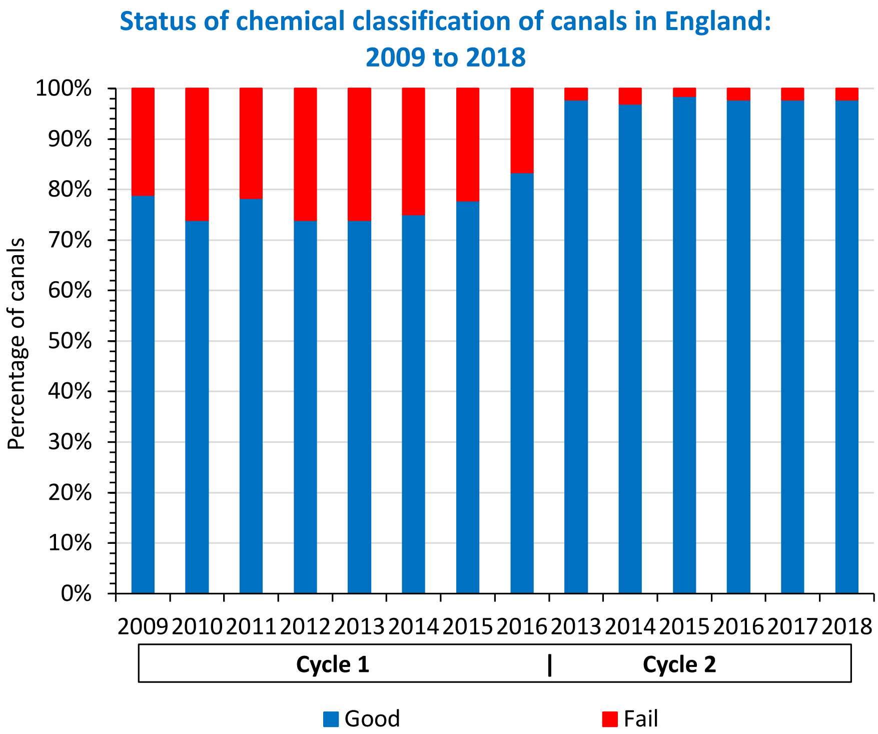
Figure 11: Status of canals: ecological classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

With respect to the chemical status, the latest cycle 2 trend since 2013 has been stable, with a minor increase from around 97% to around 98% in 2018[43] of those achieving 'good'. Cycle 1 data also presents a small increase between 2009 and 2016, from around 79% to 83% achieving 'good' status. See Figure 12 for trend overtime for cycles 1 and 2.

Figure 12: Status of canals: chemical classification since 2011 for cycles 1 and 2

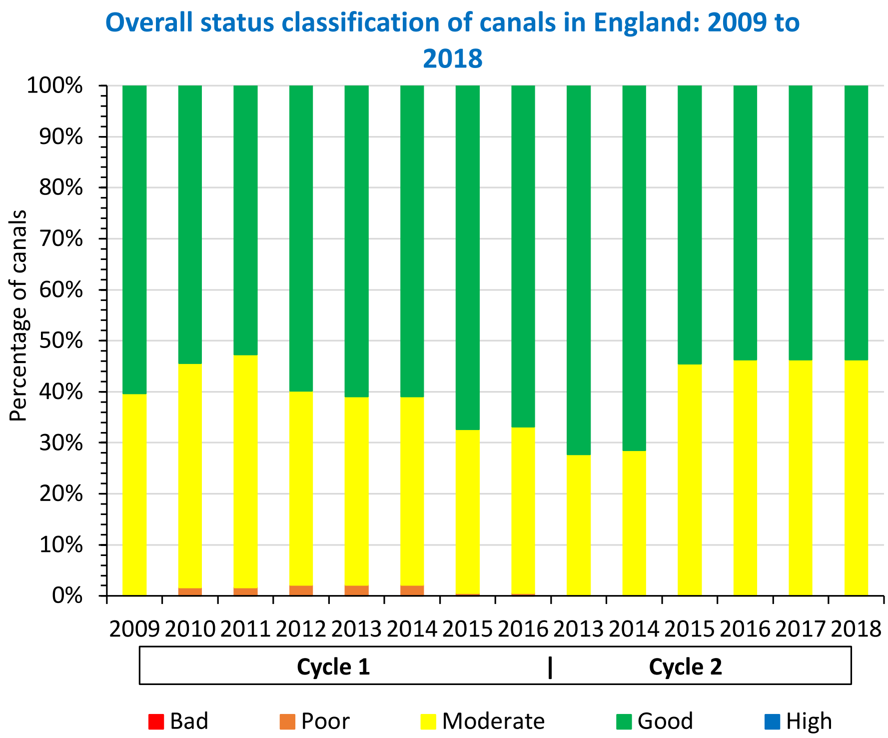


Source: Environment Agency – WFD cycles 1 and 2.

43 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. There number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

For the overall classification based on cycle 2, it can be seen that the same number of canals achieving 'high' or 'good' ecological status was around 54% in 2018. There are some minor differences between the ecological and overall classification within cycle 1. These are around the number of canals that meet 'good' and 'moderate' status. As per the ecological status in cycle 1, around 67% of canals achieve 'high' or 'good' ecological status. This is a much higher estimate than the overall status of surface water bodies which is estimated to be around 16%, however this still falls short of the 75% WFD objective. See Figure 13 for the trend over time for cycles 1 and 2.

Figure 13: Status of canals: overall classification since 2009 for cycles 1 and 2



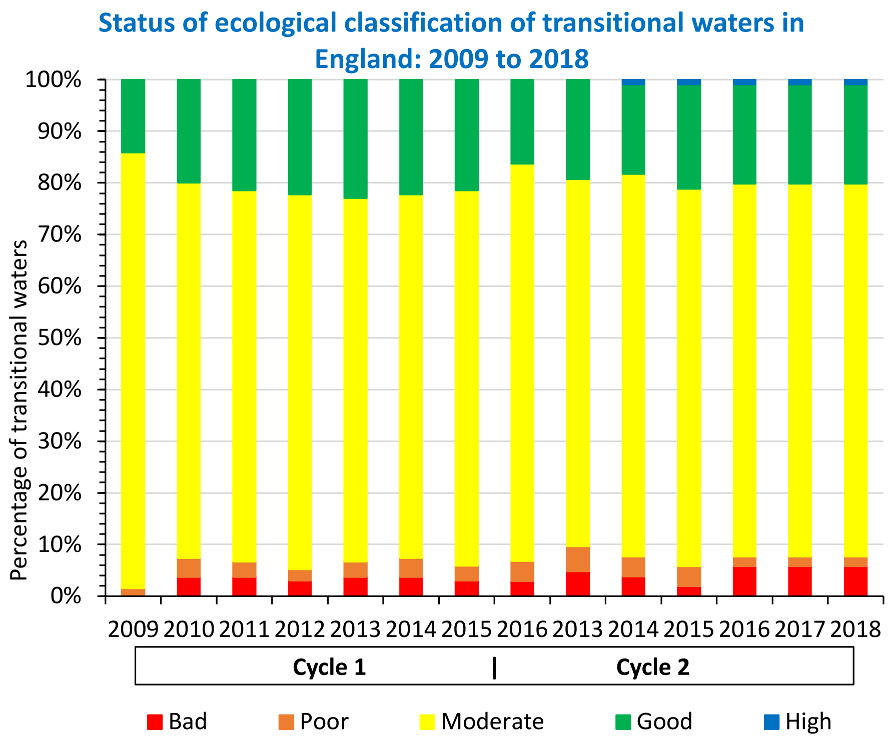
Source: Environment Agency – WFD cycles 1 and 2.

Transitional water bodies

Transitional waters have been included under the freshwater asset following the approach of the WFD. However, the assessment found here is also relevant to the assessment found in the Marine Annex.

The ecological classification of transitional waters (cycle 2) for 'high' or 'good' ecological status has slightly increased between 2013 and 2018, from around 19% to around 20% respectively. Overall the trend over this period has stable between 18% and 21%. For cycle 1 the data also presents an increase in the number of transitional waters meeting 'good' or 'high' ecological status, from around 14% in 2009 to around 16% in 2016. Only one transitional water body has achieved a 'high' status in cycle 2 (zero in cycle 1). For further details see Figure 14 on the trend for both cycles.

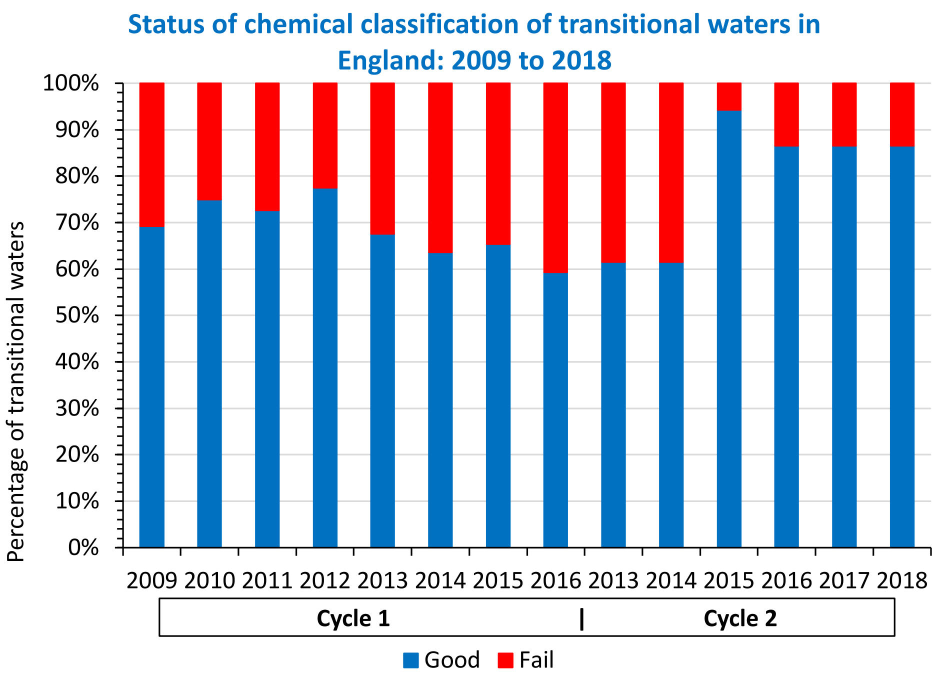
Figure 14: Status of transitional waters: ecological classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

Based on cycle 2 data for the chemical classification it can be seen that transitional waters meeting the 'good' status has increased since 2013 reaching a peak of around 94% in 2015, but declined to 87% for the period 2016-2018[44]. For cycle 1 the data presents a steady decline, from around 69% in 2009 to around 59% in 2016. See Figure 15 for the trend since 2009.

Figure 15: Status of transitional waters: chemical classification since 2009 for cycles 1 and 2

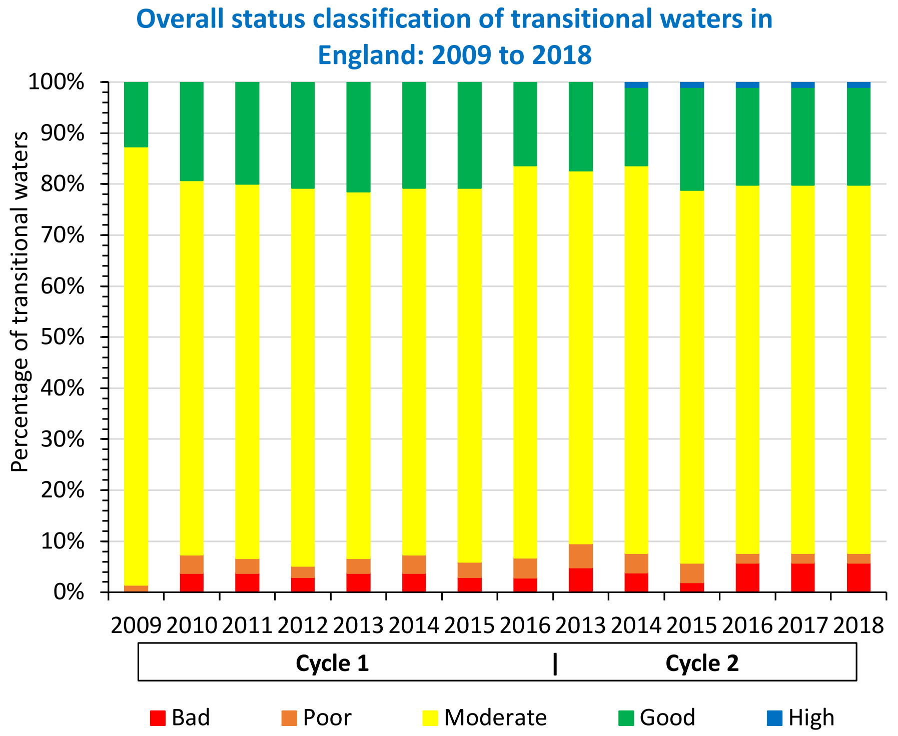


Source: Environment Agency – WFD cycles 1 and 2.

44 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment. The number of water bodies being assessed differes between cycle 1 and cycle 2 as well.

There are minor differences between the ecological and the overall classification, with a slightly smaller number of transitional water bodies achieving 'good' status in the latter. As per the ecological status, around 20% of canals meet the 'good' or 'high' ecological status in cycle 2. This is a slightly higher estimate than the overall status of surface water bodies of around 16%. However, this still falls short of the 75% WFD objective. See Figure 16 for trend overtime for cycles 1 and 2.

Figure 16: Status of transitional: overall classification since 2009 for cycles 1 and 2



Source: Environment Agency – WFD cycles 1 and 2.

Small water bodies (SWB)

There is limited evidence on the condition and extent of small waters bodies (SWB), as these mostly fall outside the scope of the WFD. These SWB provide vital ecosystem services such as natural flood / drought control, nutrient retention and cycling, and trapping sediment and contaminants.[45]

Given the limited evidence and data availability, the focus to assess SWB has been on ponds. There is some data available on the condition and extent of ponds in England and Wales, the most recent data available is from the Freshwater Habitat Trust[46]. The water quality results collected by the trust volunteers and staff present that 66% of the ponds[47] tested had 'clean water', which is defined as having chemistry and biology that would be normal for its area in the absence of significant human pressure. It is sometimes called 'the natural background', 'minimally impaired water quality' or, 'the reference condition'.

In addition to the Freshwaters Trust data, there is also data available from the Countryside Survey from 2007. The 2007 survey is the first to assess the physico-chemical condition and biological quality of ponds. Survey results show that 58% of ponds in England had elevated levels of phosphorus or nitrogen when compared to baseline levels in ponds located in areas of semi-natural land cover.

In terms of extent, it is estimated that in the UK there were around 800,000 ponds in the nineteenth century, falling to around 200,000 by the 1980s.[48] The Countryside Survey has estimated the number of ponds in England in 1998 and 2007. In 1998, the survey estimated there to be around 197,000 ponds, increasing to around 234,000 in 2007. In Table 9 these were estimated by pond size and their respective confidence interval (CI).

45 Riley W, Potter E, Biggs E, and et al.; *Small Water Bodies in Great Britain and Ireland: Ecosystem function, human-generated degradation, and options for restorative action* (2018) https://www.sciencedirect.com/science/article/pii/S0048969718327268

46 Freshwater Habitats Trust, *People, Ponds and Water report* (2018) https://freshwaterhabitats.org.uk/wp-content/uploads/2015/03/PPW-Evaluation-_-FINAL-VERSION.pdf

47 This was based on sample size of 2,939 ponds, of which 66% had tested for clean water

48 Jefries, M. J., *Ponds and the importance of their history: an audit of pond numbers, turnover and the relationship between the origins of ponds and their contemporary plant communities in south-east Northumberland, UK* (2012) https://link.springer.com/article/10.1007/s10750-011-0678-4

Table 9: Estimated number and proportion of ponds in four size classes across England in 2007

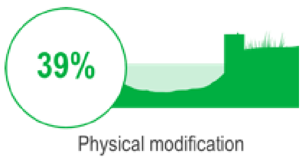
	Pond size				
	0.0025 – 0.04 ha	**0.04 – 0.2 ha**	**0.02 – 1 ha**	**1 – 2 ha**	**Total**
Number of ponds	158,600	59,100	14,200	2,200	234,100
95% Confidence intervals (CI)	127,200, 193,300	48,200, 71,200	8,800, 21,800	400, 4,700	n/a
% of the total	68%	25%	6%	1%	100%

Source: Countryside Survey[49]

Reason for failure: for surface water bodies

In addition to classifying the status of each water body, the Environment Agency also records the reason for failure for the water bodies that do not achieve the relevant WFD objectives. A reason for failure is assigned when a water body is failing to achieve 'good' or 'high' status under the WFD. There are seven reasons for failure, and these are described below in Table 10 and are found in the latest *River basin management plans: national evidence and data report*[50]. The reasons for not meeting their objectives range from physical modifications, invasive species, changes to the flow and level of water, and sources of pollution.

Table 10: Reasons for failure

Reason for failure	Water management issues[51]
	"People have made many physical changes to rivers, lakes and estuaries, for example, flood defences and weirs, and changes to the size and shape of natural river channels for land drainage and navigation. These modifications alter natural flow levels, cause excessive build up of sediment in surface water bodies and the loss of habitats and recreational uses. In many cases the uses and associated physical modifications need to be maintained. In these circumstances it may not be possible to achieve good ecological status".
	"Waste water, or sewage, can contain large amounts of nutrients (such as phosphorus and nitrates), ammonia, bacteria, harmful chemicals and other damaging substances. It can enter water bodies where sewage treatment technology to remove enough of the phosphorus and harmful chemicals doesn't exist, from leakages from privately owned septic tanks and, in wet weather, storm overflows can discharge untreated sewage having a significant impact on bathing waters. Population growth and changes in rainfall patterns are increasing the pressure on the sewer network".
	"Some approaches to land management have increased the amount of soils and sediment that are being washed off the land carrying phosphorus into waters which can cause excessive algae growth called 'eutrophication'. A changing climate means that more intense rainfall is likely to occur, increasing the risk of impacts further. Nitrate from fertilisers has built up in groundwater over decades and will take a long time to reduce. Sedimentation from erosion, forestry practices, saturated and compacted fields and livestock trampling on river banks has affected river ecology by smothering fish spawning grounds. Other impacts include bacteriological contaminants from animal faeces, pesticides from farming, forestry, golf courses and parks and inappropriately storing and applying livestock slurry on land. These contaminants pose a particular threat to bathing waters, shellfish waters and drinking water".

49 Countryside Survey, Ponds Report from 2007 (2010) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR7%20-%20Ponds%20Report.pdf

50 Environment Agency, *River basin management plans: national evidence and data report* (2015) https://www.gov.uk/government/collections/river-basin-management-plans-2015

51 Based on the finding from the Environment Agency (EA) on the *River Basin Management Plans: national evidcen and data report* - https://www.gov.uk/government/publications/river-basin-management-plans-national-evidence-and-data-report

11% Pollution from towns, cities and transport	"Rainwater draining from roofs, roads and pavements carries pollutants, including grit, bacteria, oils, metals, vehicle emissions, detergent and road salt drains to surface water, including estuaries and coastal waters. Many homes and workplaces have 'misconnected' drains, meaning that dirty water often enters surface waters and groundwater rather than foul sewer drains".
6% Changes to the natural flow and level of water	"Reduced flow and water levels in rivers and groundwater caused by human activity (such as abstraction) or less rainfall than usual can mean that there is not enough water for people to use and wildlife might not be able to survive. Reduced flow affects the health of fish and exaggerates the impacts of barriers such as weirs. Climate change research shows that by 2050 England can expect significant seasonal variations, with higher winter and lower summer flows, and a reduction in flow overall. In the long-term, there will be less water available to abstract for drinking, industry and irrigating crops".
3% Pollution abandoned mines	"Minewater is water that has naturally entered the mine workings. When the mines were operating the minewater was drained or pumped to keep it away from working areas. After mines close, mine workings flood. This results in both surface waters and groundwater being contaminated with dissolved metals such as iron, lead, copper, zinc or cadmium. In addition, impacts from the leaching of metals due to ore crushing and settlement lagoons can be a real concern because the resulting spoil heaps are often large and close to water".
2% Non-native invasive species	"Non-native invasive species can have significant economic impacts. The cost of controlling invasive species to make sure that flood defences and the natural environment are not compromised is rising. American Signal Crayfish are becoming widespread and affect animals such as fish and invertebrates. Other species such as mitten crabs destroy habitats like reed beds and can cause banks to collapse by burrowing into them. Climate change is thought to drive certain species northwards, increasing their frequency and variety in the future and affecting the condition of water bodies".

The reasons for failure are also presented as a map that assists in the visualisation of where water bodies are located. The data is available through the Catchment Based Approach Open Data under their *Reasons for Not Achieving Good* web portal[52].

2. Groundwater

To assess the condition and extent of groundwaters the NCC has followed the same approach of the WFD and the Groundwater Directive[53]. This is around classifying the groundwater bodies in terms of their chemical and quantitative status. See Table 11 for list groundwater assessment and objectives (targets).

Table 11: List of water bodies and targets

	Waterbody type	Existing target/limits
Groundwaters	Groundwater	**Improvement target:** Water Framework Directive (WFD) (2000/60/EC) establishing a framework for European Community action in the field of water policy.[54] **Objectives in England:** • 87% of groundwater bodies have an objective of good chemical status; and • 82% have an objective of good quantitative status

52 Catchment Based Approach Open Data, *WFD Reasons for Not Achieving Good* (last updated 2020) https://data.catchmentbasedapproach.org/datasets/wfd-reasons-for-not-achieving-good?geometry=-5.345%2C52.358%2C1.697%2C53.517

53 European Parliament, *Directive 2006/118/EC* (2006) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006L0118

54 European Parliament, *Directive 2000/60/EC* (2000) https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF

In addition to the WFD objectives, the groundwater directive stipulates that:[55]

- Pollution trend studies to be carried out by using existing data and data which is mandatory by the WFD (referred to as "baseline level" data obtained in 2007-2008);
- Pollution trends to be reversed so that environmental objectives are achieved by 2015 by using the measures set out in the WFD;
- Measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved by 2015;
- Reviews of technical provisions of the directive to be carried out in 2013 and every six years thereafter;
- Compliance with good chemical status criteria (based on EU standards of nitrates and pesticides and threshold values established by Member States).
- To assess the condition of groundwaters data from the Water Framework Directive (WFD) cycle 2 are used. Data available is limited between 2013 and 2015.

The groundwater quality standards are set out in Table 12, however further details can be found in the Groundwater Directive.

Table 12: Groundwater directive standards

Pollutant	Quality standard
Nitrates	50 mg/l
Active substances in pesticides, including their relevant metabolites, degradation and reaction products.[56]	0,1 μg/l 0,5 μg/l (total)[57]

Overall assessment of groundwater bodies

The assessment of the water resources – based on the datasets available – is 'Red': **deteriorating**. The latest data for cycle 2 presents the number of water bodies achieving 'good' overall has slightly increased from around 41% in 2013 to around 42% in 2015, an increase of 0.7% from two groundwaters bodies. Data from cycle 1 presents a slightly higher increase from around 42% to around 46% between 2009 and 2015. Given the limited data available in terms of time series, this limits the assessment that can be made. See Figure 17 for trend overtime for cycles 1 and 2.

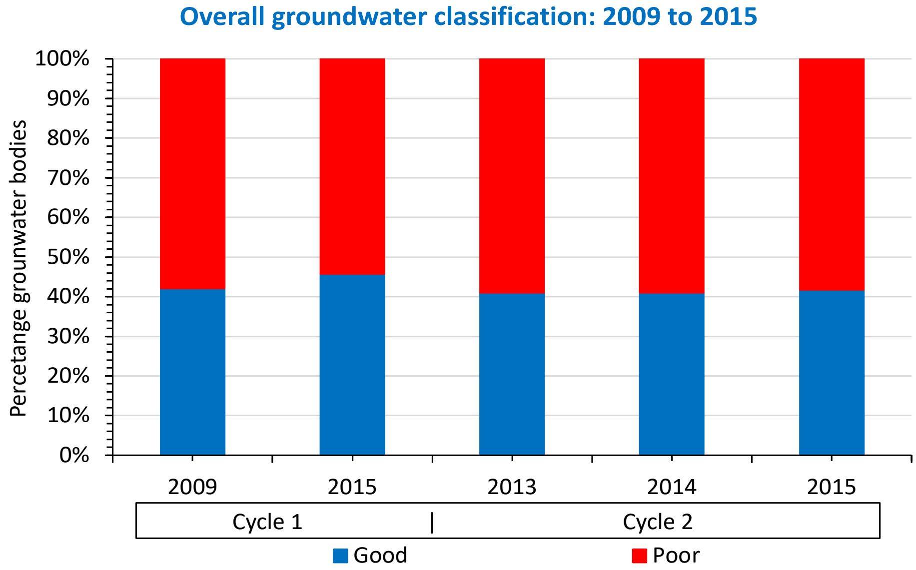
- Groundwater meeting 'good' chemical status (condition) is only 53% vs. a target of 87%, and 'good' quantitative status (extent) is only 69% vs. a target of 82%.

55 European Commission, *Groundwater* https://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm

56 'Pesticides' means plant protection products and biocidal products as defined in Article 2 of Directive 91/414/EEC and in Article 2 of Directive 98/8/EC, respectively

57 'Total' means the sum of all individual pesticides detected and quantified in the monitoring procedure, including their relevant metabolites, degradation and reaction products.

Figure 17: Status of groundwaters: the overall classification based on the WFD cycles 1 and 2 since 2009



Source: Environment Agency – WFD cycle 1[58] and 2[59]

In terms of overall progress towards meeting the WFD objectives, the number achieving a 'good' status in both the chemical and quantitative classifications is below the respective objectives. The point below summarises the key findings. See individual sections that follow and Table 13 below for further details.

- Groundwater meeting 'good' chemical status (condition) is only 53% (cycle 2) vs. a target of 87%, and 'good' quantitative status (extent) is only 69% (cycle 2) vs. a target of 82%.

Table 13: NCC assessment of progress and RAG rating

Measurable commitments	Compliance with target and/or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
Chemical: 87% of groundwater bodies have an objective of good chemical status	**Cycle 1:** From the latest data for cycle 1 only around 53% of groundwater bodies met 'good' status in 2015, falling short of the 87% objective.	**Cycle 1:** Only two data points are available (2009 and 2015). There is a declining trend between these to points from just over 59% to just under 53%.	**Cycle 1:** Data are not available for 2011.	**Cycle 1** Data are not available.
	Cycle 2: For cycle 2 the data also fall short of the WFD objective with 'good' status only being achieved by around 53% of groundwater bodies.	**Cycle 2:** Evidence is only available between 2013 and 2015, which shows a small increase from just over 51% to just under 53%.	**Cycle 2:** Data are not available for 2011.	**Cycle 2:** While for cycle 2 the data presents a slight increase from just under 52% in 2014 to just under 53% in 2015.
Quantitative: 82% have an objective of good quantitative status	**Cycle 1:** The latest data for cycle 1 presents that just under 76% of groundwater bodies met 'good' status in 2015, falling short of the 82% objective.	**Cycle 1:** Only two data points are available (2009 and 2015). There is an increasing trend between these to points from just over 65% to just under 76%.	**Cycle 1:** Data are not available for 2011.	**Cycle 1:** Data are not available.
	Cycle 2: For cycle 2 the data also fall short of the WFD objective with 'good' status only being achieved by around 69% of groundwater bodies.	**Cycle 2:** Evidence is only available between 2013 and 2015, which shows a small decrease of under 1 percentage point.	**Cycle 2:** Data are not available for 2011.	**Cycle 2:** From the latest (2015) cycle 2 the data presents a slight decline from around 70% (2014) to around 69% (2015).

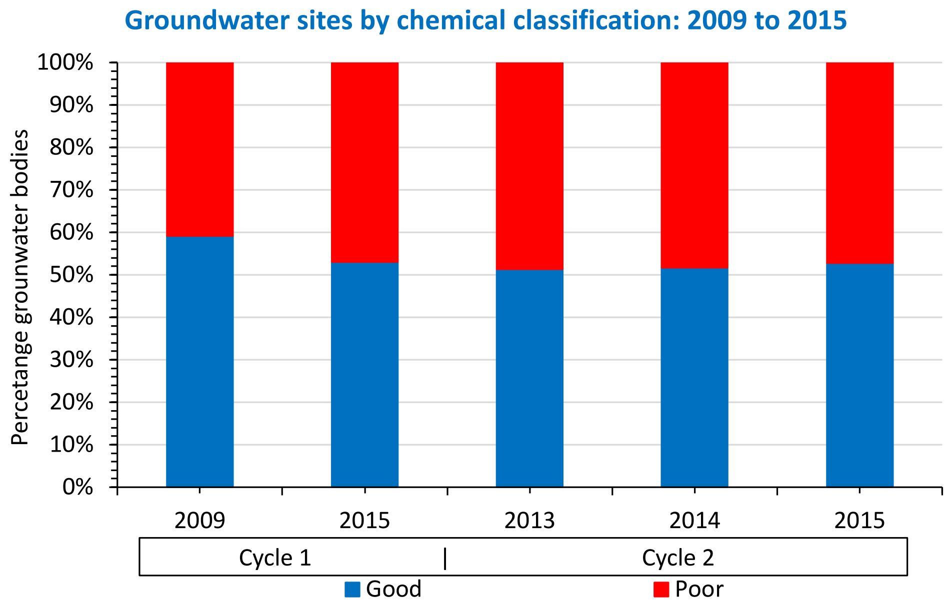
58 Environment Agency, *WFD Groundwater Classification Status and Objectives Cycle 1* (2020) https://data.gov.uk/dataset/080efe4f-1a7c-4222-b700-c1cbe15db168/wfd-groundwater-classification-status-and-objectives-cycle-1

59 Environment Agency, *WFD Cycle 2 groundwater classification status and objectives* (2020) https://data.gov.uk/dataset/6c4d3600-2f25-4b12-a56d-1689586f085b/wfd-cycle-2-groundwater-classification-status-and-objectives

Chemical classification (condition)

The most recent data available from cycle 2 for the chemical status is from 2015, which shows that the number of groundwater bodies achieving 'good' status has slightly increased from around 51% in 2013 to around 53% in 2015, an increase of four groundwater bodies. While data for cycle 1 presents a decline from 59% in 2009 to 53% in 2015. Both cycles fall short of the WFD objective of 87% of groundwater bodies to have an objective of 'good' chemical status. See Figure 18 of the change the classification since 2013.

Figure 18: Groundwater chemical classification based on the WFD cycles 1 and 2 since 2009



Source: Environment Agency – WFD cycle 1[60] and 2[61]

The quantitative classification data is also available in terms of catchment areas. In Table 14 the evidence is presented for cycle 2. The data present the catchment areas that have achieved 'good' and 'poor' status, with the highest levels of 'good' status being achieved by the Thames (11%) and Humber (10%) areas. While the areas with the highest levels of 'poor' being found in Humber (9%) and the South West (8%).

Table 14: Chemical classification by catchment area since 2013 - cycle 2

Chemical classification	2013		2014		2015	
	Good	Poor	Good	Poor	Good	Poor
Anglian	5.9%	5.5%	5.9%	5.5%	5.9%	5.5%
Dee	0.4%	0.0%	0.4%	0.0%	0.4%	0.0%
Humber	8.9%	10.0%	8.9%	10.0%	9.6%	9.2%
Northumbria	1.1%	2.6%	1.1%	2.6%	1.1%	2.6%
North West	2.2%	4.4%	2.6%	4.1%	2.6%	4.1%
Severn	7.7%	4.4%	7.7%	4.4%	7.7%	4.4%
Solway Tweed	1.1%	0.7%	1.1%	0.7%	1.1%	0.7%
South East	6.3%	5.9%	6.3%	5.9%	6.3%	5.9%
South West	7.4%	8.1%	7.4%	8.1%	7.4%	8.1%
Thames	10.3%	7.0%	10.3%	7.0%	10.7%	6.6%
Total	51.3%	48.7%	51.7%	48.3%	52.8%	47.2%

Source: Source: Environment Agency – WFD cycle 1[62] and 2[63]

60 Environment Agency, *WFD Groundwater Classification Status and Objectives Cycle 1* (2020) https://data.gov.uk/dataset/080efe4f-1a7c-4222-b700-c1cbe15db168/wfd-groundwater-classification-status-and-objectives-cycle-1

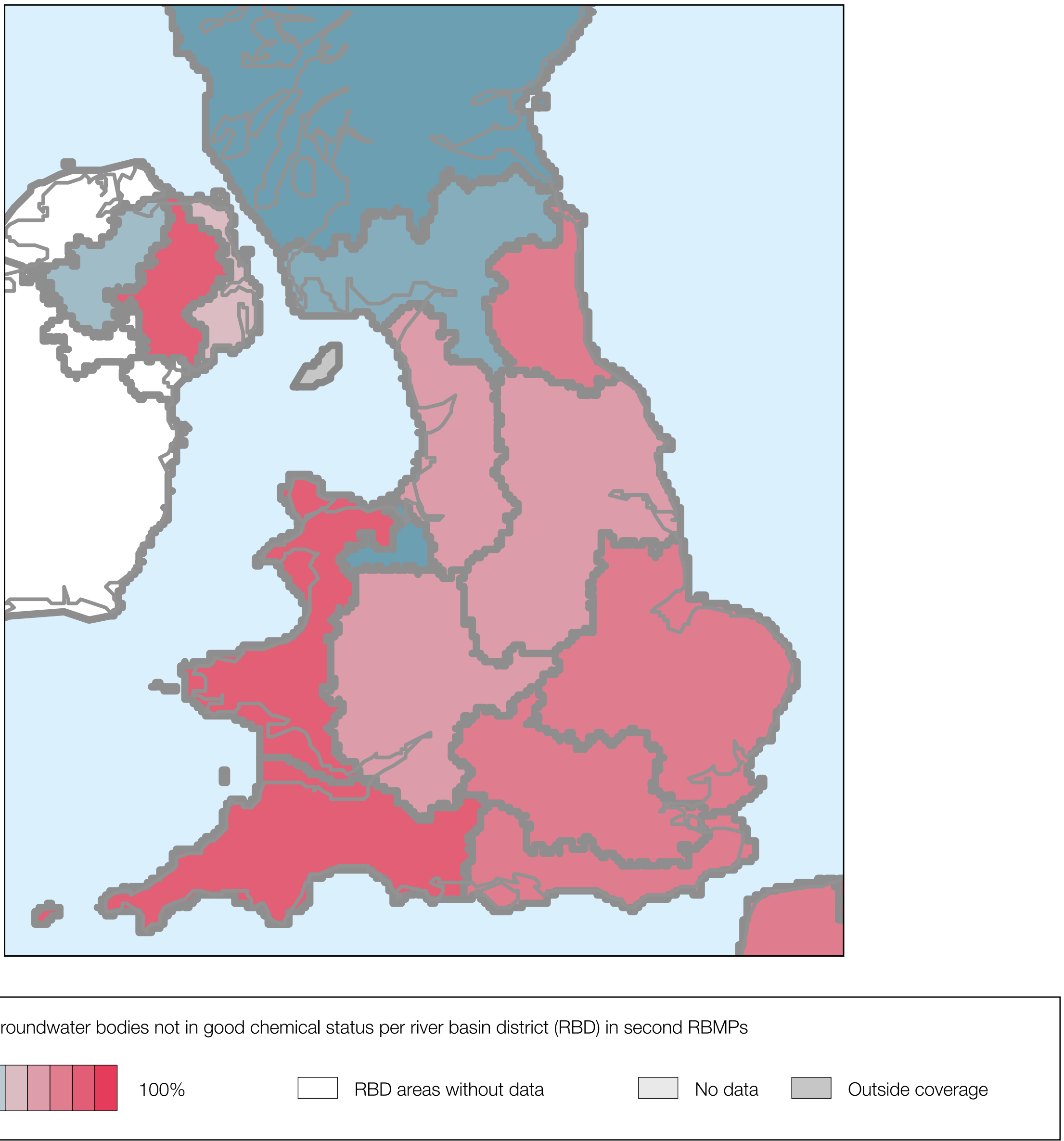
61 Environment Agency, *WFD Cycle 2 groundwater classification status and objectives* (2020) https://data.gov.uk/dataset/6c4d3600-2f25-4b12-a56d-1689586f085b/wfd-cycle-2-groundwater-classification-status-and-objectives

62 Environment Agency, *WFD Groundwater Classification Status and Objectives Cycle 1* (2020) https://data.gov.uk/dataset/080efe4f-1a7c-4222-b700-c1cbe15db168/wfd-groundwater-classification-status-and-objectives-cycle-1

63 Environment Agency, *WFD Cycle 2 groundwater classification status and objectives* (2020) https://data.gov.uk/dataset/6c4d3600-2f25-4b12-a56d-1689586f085b/wfd-cycle-2-groundwater-classification-status-and-objectives

Data on chemical status is also available spatially, see Figure 19 which presents the percentage of groundwater bodies not in 'good' chemical status per river district, based on the second River Basin Management data. For a higher resolution map see the European Environment Agency (EEA): *Percentage of area of groundwater bodies not in good quantitative status per river basin district web portal.*

Figure 19: Percentage of area of groundwater bodies not in good chemical status per river basin district (RBD) in second RBMPs



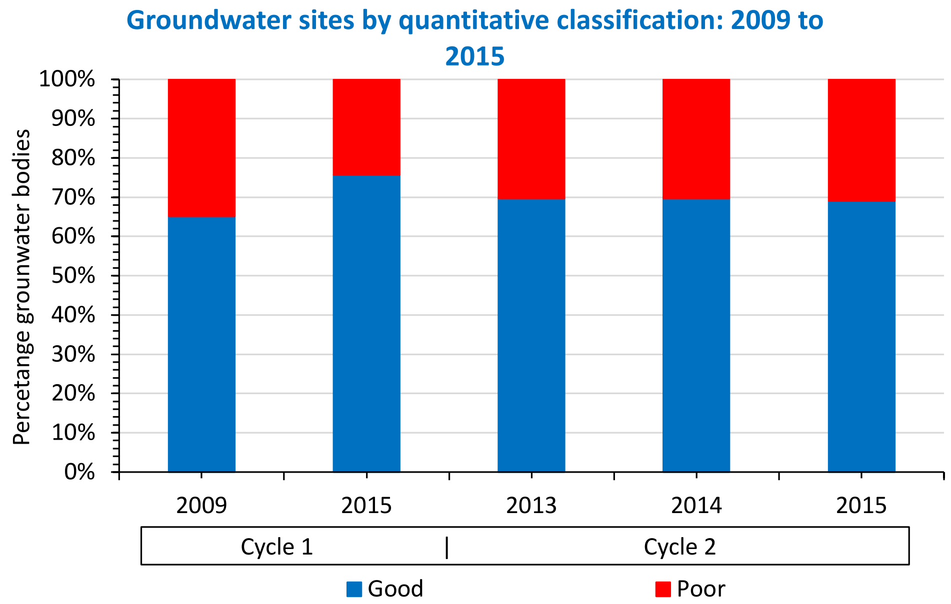
Source: European Environment Agency (EEA)[64]

64 EEA, *Percentage of area of groundwater bodies not in good quantitative status per river basin district* (2019) https://www.eea.europa.eu/data-and-maps/figures/chemical-status-of-groundwater-bodies-2

Quantitative classification (extent)

To measure the extent of groundwater bodies, the NCC has used data on the quantitive classification based on data and evidence compiled by the Environment Agency to observe how extent has changed over time. From this, it is apparent the number of groundwater bodies achieving 'good' status in cycle 2 has remained constant since 2013 at around 69% - 70%. However, when looking at data from cycle 1, the data presents an increase from around 65% in 2009 to around 76% in 2015. Both cycle estimates fall short of the WFD objective of 82% of groundwater bodies to have an objective of 'good' quantitative status. See Figure 20 of the change the classification since 2013.

Figure 20: Groundwater quantitative classification for cycles 1 and 2 since 2009



Source: Environment Agency – WFD cycle 1[65] and 2[66]

The quantitative classification data is also available in terms of catchment areas. In Table 15 the NCC has presented the evidence for cycle 2. This presents data in catchment areas that have achieved 'good' and 'poor' status, with the highest levels of 'good' status being found in the South West (14%) and Humber (14%) areas. The catchment areas being classified as 'poor' are found in the Thames (8%) followed by Anglian and South East areas (both at 6% each).

Table 15: Quantitative classification by the catchment area since 2013 - cycle 2

Quantitative classification	2013		2014		2015	
	Good	Poor	Good	Poor	Good	Poor
Anglian	6.3%	5.2%	6.3%	5.2%	5.5%	5.9%
Dee	0.4%	0.0%	0.4%	0.0%	0.4%	0.0%
Humber	15.1%	3.7%	15.1%	3.7%	14.0%	4.8%
Northumbria	3.3%	0.4%	3.3%	0.4%	3.3%	0.4%
North West	5.9%	0.7%	5.9%	0.7%	5.9%	0.7%
Severn	8.1%	4.1%	8.1%	4.1%	8.9%	3.3%
Solway Tweed	1.5%	0.4%	1.5%	0.4%	1.5%	0.4%
South East	6.6%	5.5%	6.6%	5.5%	6.3%	5.9%
South West	13.3%	2.2%	13.3%	2.2%	14.0%	1.5%
Thames	9.2%	8.1%	9.2%	8.1%	9.2%	8.1%
Total	69.7%	30.3%	69.7%	30.3%	69.0%	31.0%

Source: Environment Agency – WFD 2[67]

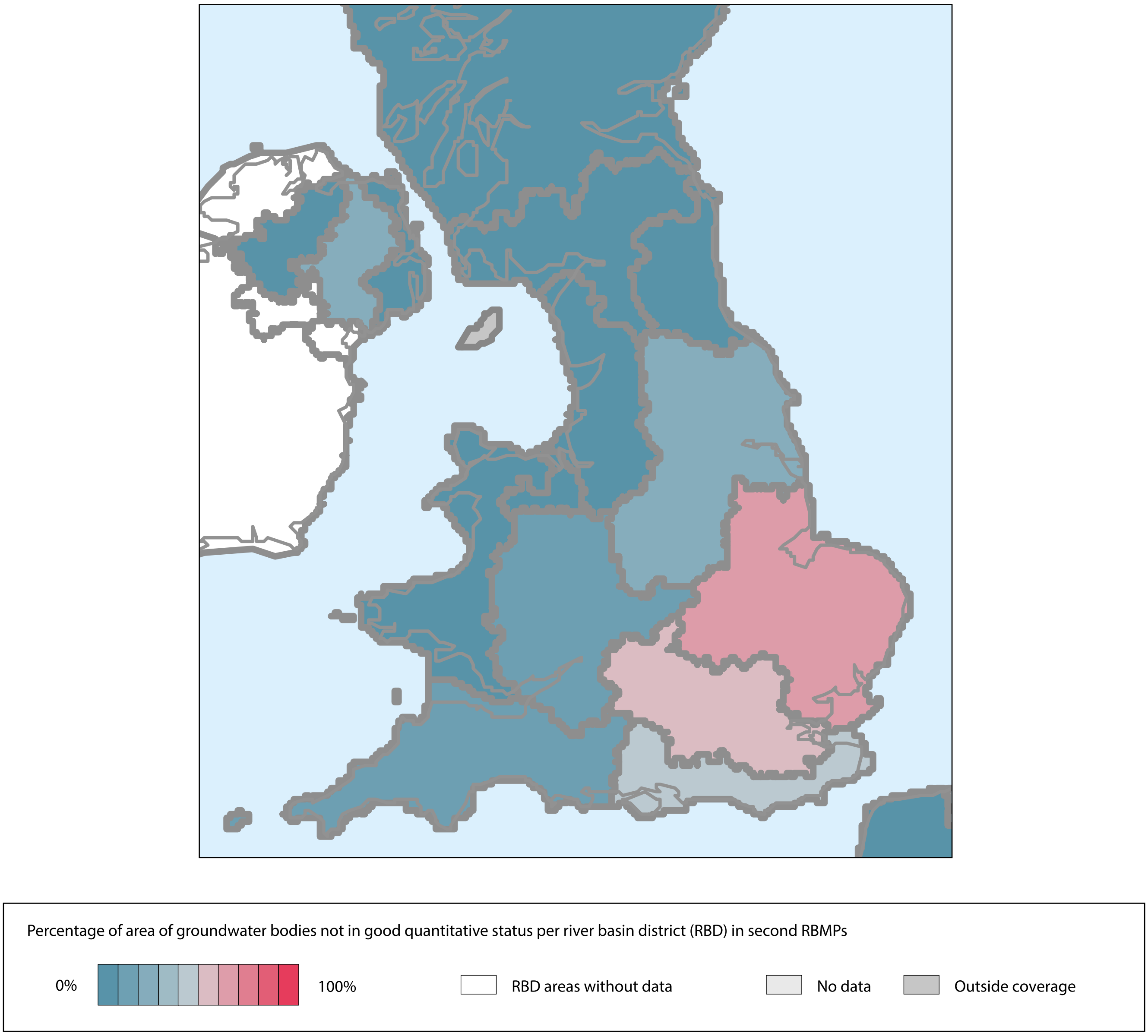
65 Environment Agency, *WFD Groundwater Classification Status and Objectives Cycle 1'* (2020) https://data.gov.uk/dataset/080efe4f-1a7c-4222-b700-c1cbe15db168/wfd-groundwater-classification-status-and-objectives-cycle-1

66 Environment Agency, *WFD Cycle 2 groundwater classification status and objectives* (2020) https://data.gov.uk/dataset/6c4d3600-2f25-4b12-a56d-1689586f085b/wfd-cycle-2-groundwater-classification-status-and-objectives

67 Environment Agency, *WFD Cycle 2 groundwater classification status and objectives* (2020) https://data.gov.uk/dataset/6c4d3600-2f25-4b12-a56d-1689586f085b/wfd-cycle-2-groundwater-classification-status-and-objectives

Data on quantitative status is also available spatially, see Figure 21 which presents the percentage of groundwater bodies not in good chemical status per river district, based on the second River Basin Management data.

Figure 21: Percentage of the area of groundwater bodies not in good quantitative status per river basin district



Source: European Environment Agency (EEA)[68]

68 EEA, *Percentage of area of groundwater bodies not in good quantitative status per river basin district* (2019) https://www.eea.europa.eu/data-and-maps/figures/percent-of-groundwater-bodies-in-1

3. Water resources

In order to complement and support the limited condition and extent evidence and data from the previous sections, the following sections present the evidence and data on the key pressures to the freshwater asset. The objective is to present a comprehensive picture and show the scale and key sources of pressures to this asset. In Table 16 the key measurements of pressures and their respective targets, limits and commitments are presented.

Table 16: List of water bodies and targets

	Measurement	Existing target/limits or commitment
Water resources	Water abstraction	No targets/limit or commitment exist/were found.
	Unsustainable abstraction	Defra has a target to reduce the amount of unsustainable abstraction for surface and groundwater:[69] **Surface water:** • Unsustainably abstracted: 6% • Potentially unsustainably abstracted: 4% • Sustainably abstracted: 90% **Groundwater:** • Unsustainably abstracted: 23% • Sustainably abstracted: 77%
	Areas of water stress	No targets/limit or commitment exist/were found.
	Water industry water leakage	There is a commitment from Ofwat that is reiterated in the 25 Year Environment Plan (25 YEP) to reduce water leakage by 15% between 2020-2025.[70]
	Water consumption per capita	There is no national water consumption per capita target in England, there is however targets set by water companies such as: [71] • Southern Water: 100 litres by 2040 • Yorkshire Water: 111 litrs by 2045

The overall assessment of water resources

The assessment of the water resources – based on the datasets available – is 'Red': **deteriorating** – this is based on the limited progress made towards reducing water abstraction and their objective. This is also due to recent estimated increases in water industry leakage and per capita consumption of water. The next sections focus on water abstraction and water resources (consumption and leakage). Table 17 below presents a high-level assessment of the trend for water abstraction and water resources. The points below summarise the key findings:

- Limited progress has been made towards reducing water abstraction (between 2011 and 2017), reducing consumption per capita (between 2011/12 and 2017/18) and reducing water industry leakage (between 2014/15 and 2017/18).'
- It was estimated that in 2018, 9% of surface water was unsustainably abstracted.
- Around 22% of water currently put into the supply is lost through leakage, equating to around 3 billion litres of water per day.[72]

69 Defra, *Water abstraction plan* (2017) https://www.gov.uk/government/publications/water-abstraction-plan-2017/water-abstraction-plan

70 Ofwat, *PR19 final determinations: Securing cost efficiency technical appendix* (2020) https://www.ofwat.gov.uk/publication/pr19-final-determinations-securing-cost-efficiency-technical-appendix/

71 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

72 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

Table 17: Water resources assessment

Measurable commitments	Compliance with target and/or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
3.1 - Water abstraction	No target exists or was found.	Based on the evidence available estimated abstraction (excluding tidal) has declined from 2000 to 2017 from around 11,151 to 10,395 million cubic litres.	Between 2011 and 2017 there has been an increase in the abstraction from 8,193 to 10,395 million cubic litres.	Between 2016 and 2017 there was an increase in the abstraction of water of just under 8%.
3.2 - Unsustainable water abstraction	Given the limited data, it has not possible to say if the government is on track to meet its abstraction target.	The data shows mixed results. For example, there has been an increase in the amount of water being sustainably abstracted from 82% in 2016 to 84% in 2019 (the target is 90% by 2021).	Data is not available.	Data is not available.
3.3 - Areas of water stress	No target exists or was found.	Not enough data is available to produce an assessment.	Not enough data is available to produce an assessment.	Not enough data is available to produce an assessment.
3.4 - Water industry leakage	Unable to assess against the target as the period covered by the target start in 2020.	Change in water leakage in millions of litres per day has slightly declined, but the decline has been within the 1% change.	There has been a slight increase in water industry leakage from 2,949 to 2,986 million litres per day.	There has also been an increase when looking at year on year change of over 2%.
3.5 - Water consumption	No national target exists.	Per capita consumption of water in 2017/18 was 7 litres lower than than 1999/00.	There was a small decline in per capita consumption of water in between 2011/12 and 2017/18 from just over 144 to just under 143 litres per person per day (l/p/d).	There has been an increase in water consumption between 2016/17 and 2017/18, from just over 140 to just under 143 litres per household per day (l/p/d).

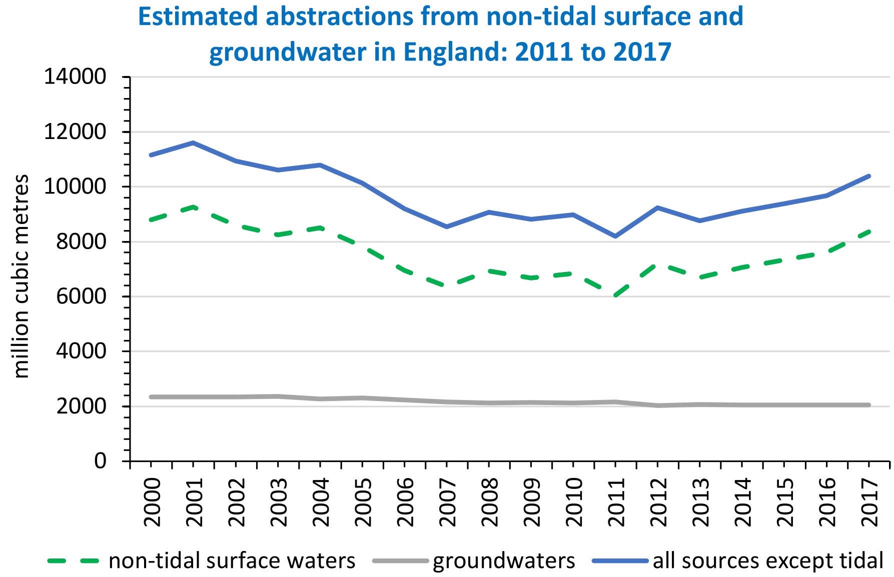
Source of water (abstraction)

Abstraction is the removal of water resources, permanently or temporarily, from rivers, lakes, canals, reservoirs, or underground strata. The Environment Agency estimates the amount of water that is abstracted from surface and groundwater sources and publishes statistics from 2000.[73]

Water abstraction from non-tidal surface water and groundwater has declined between 2000 and 2017 from around 11,151 to 10,395 million cubic litres. While between 2011 and 2017 it has increased from around 8,193 to 10,395 million cubic metres (a 27% increase). All of this increase has come from the increase of abstraction of non-tidal waters which has increased from 6,042 to 8,350 million cubic metres, an increase of around 38%. This increase from 2011 and 2017 is mostly accounted for by the electricity supply industry, which increased by 1,800 million cubic metres. While groundwater abstraction has declined since 2011 by around 5%. See Figure 22 for the trend since 2000.

73 Defra, *Water abstraction statistics: England, 2000 to 2017* (2019) https://www.gov.uk/government/statistics/water-abstraction-estimates

Figure 22: Estimated abstractions from non-tidal surface water and groundwater in England, 2000 to 2017

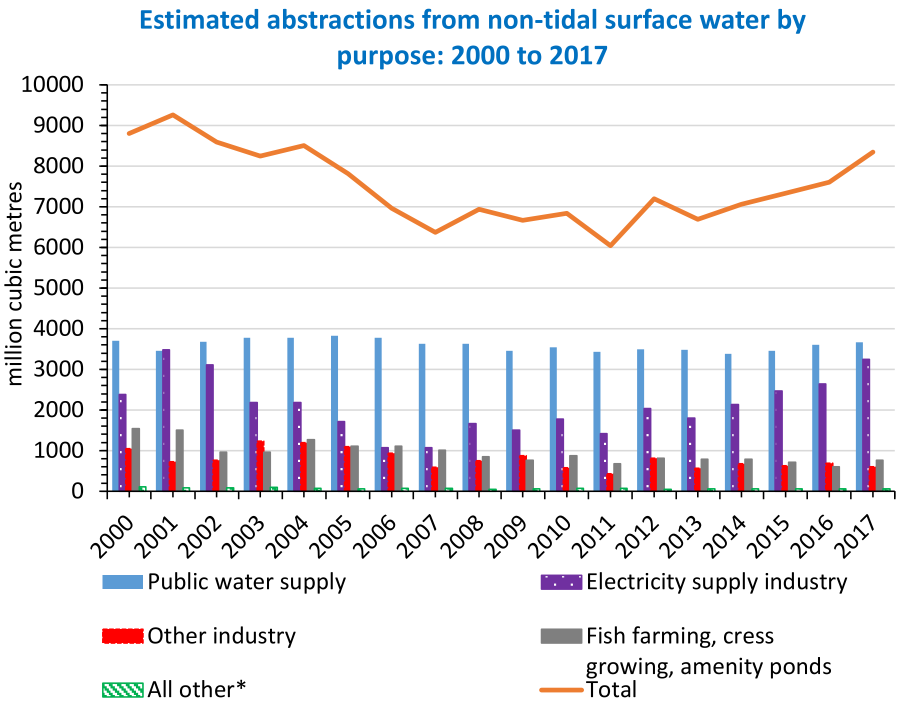


Source: Environment Agency – ENV15 data[74]

Non-tidal surface water abstraction

The estimated amount of water abstraction from non-tidal has decreased from 8,799 to 8,350 million cubic metres between 2000 and 2017. However, it has increased from 6,042 in 2011 to 8,350 million cubic metres in 2017, an increase of around 38%. This has been mostly due to the increase in abstraction by the electricity supply industry, from 1,424 in 2011 to 3,252 million cubic metres in 2017. The largest estimated abstraction comes from the public water supply which accounted for 44% in 2017. The two largest abstraction industries (public water and electricity supply) accounted for 83%. Water abstraction has increased for most of the industries since 2011, with the exception of agriculture (including spray irrigation). Given the smaller amount of water abstraction for some industries, these have been combined under *all other*, these will be discussed in the next section. See Figure 23 for non-tidal surface water trend since 2011.

Figure 23: Estimated abstractions from non-tidal surface water by purpose in England, 2000 to 2017



*all others refers to: agriculture, private water supply, and other.

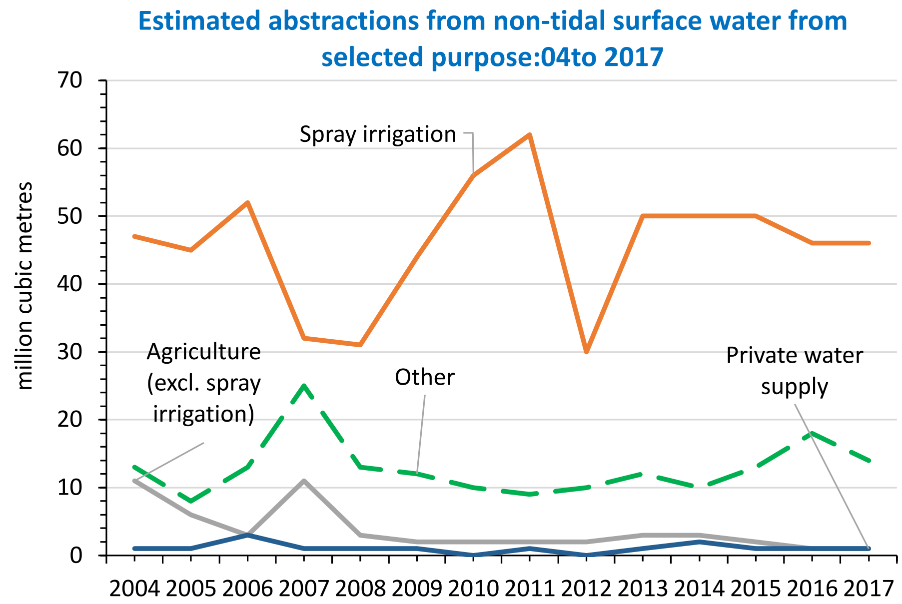
Source: Environmental Agency – ENV15 data[75]

74 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables

75 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

In Figure 24 the abstraction for smaller amounts have been combined under *all other* industries is presented, these account for a small fraction (under 1%) of the overall non-tidal surface water being abstracted. The largest level of abstraction comes from spray irrigation in the agriculture industry, which has fluctuated since 2011.

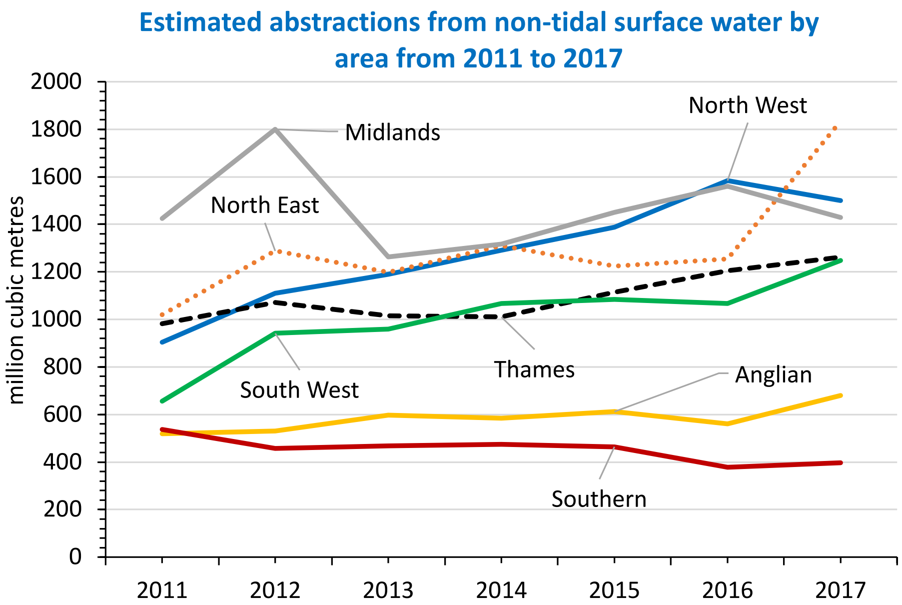
Figure 24: Estimated abstractions from non-tidal surface water by purpose from selected industries in England: 2000 – 2017



Source: Environment Agency – ENV15 data[76]

Data on abstraction is also available by area (see Figure 25), where the area with the largest abstraction from non-tidal surface water in 2017 was the North East of England, which accounted for around 1,834 million cubic metres (22%) of the total being abstracted. The North East also had the second-largest increase in abstraction when compared to 2011 (around 80%), with the South West having the highest at around 90% increase. The region with the lowest abstraction in 2017 was the Southern area which accounted for 397 million cubic metres (around 5%) and was the only region to see a decline in abstraction when compared to 2011 (around 26% reduction).

Figure 25: Estimated abstractions from non-tidal surface water by area in England: 2011 – 2017



Source: Environment Agency – ENV15 data[77]

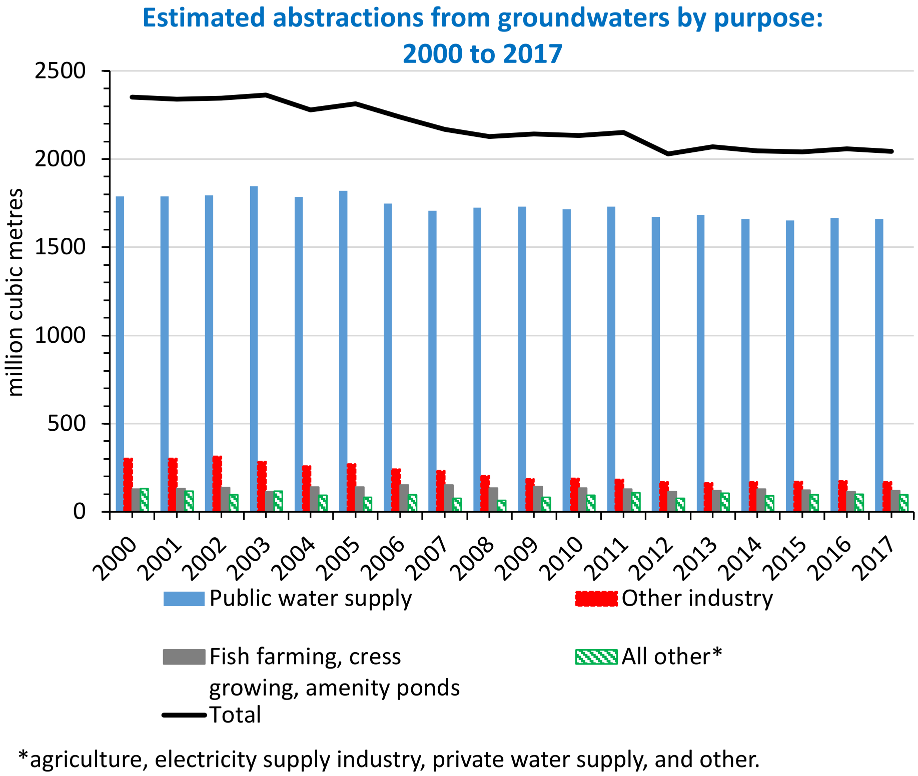
76 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

77 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

Groundwater abstraction

In 2017, groundwater abstraction accounted for just under 20% of the total non-tidal surface and groundwater abstraction. As per the non-tidal data, the largest level of abstraction for groundwater is for the public water supply, accounting for just over 81% in 2017. As per Figure 26, the three largest industries accounted for just over 95% of all the groundwater abstraction. Given the smaller amount of water abstraction for some industries, these have been combined under *all other*, these will be discussed in the next section. Overall groundwater abstraction is on a declining trend since 2000 water abstraction has declined by 13% from 2,352 to 2,044 million cubic litres. A decline can also be seen between 2011 and 2017 and on a year on year basis.

Figure 26: Estimated abstractions from groundwater by purpose in England: 2000 – 2017

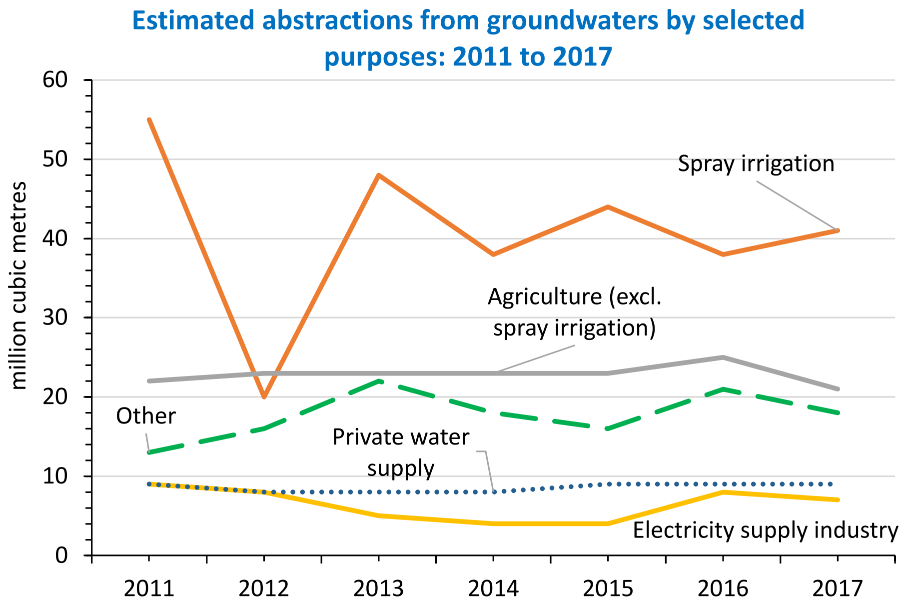


Source: Environment Agency – ENV15 data[78]

In Figure 27 the abstraction for all other industries is presented, these account for just under 5% of the overall groundwater being abstracted. The largest level of abstraction comes from spray irrigation in the agriculture industry (same as non-tidal surface water), which has fluctuated since 2011.

78 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

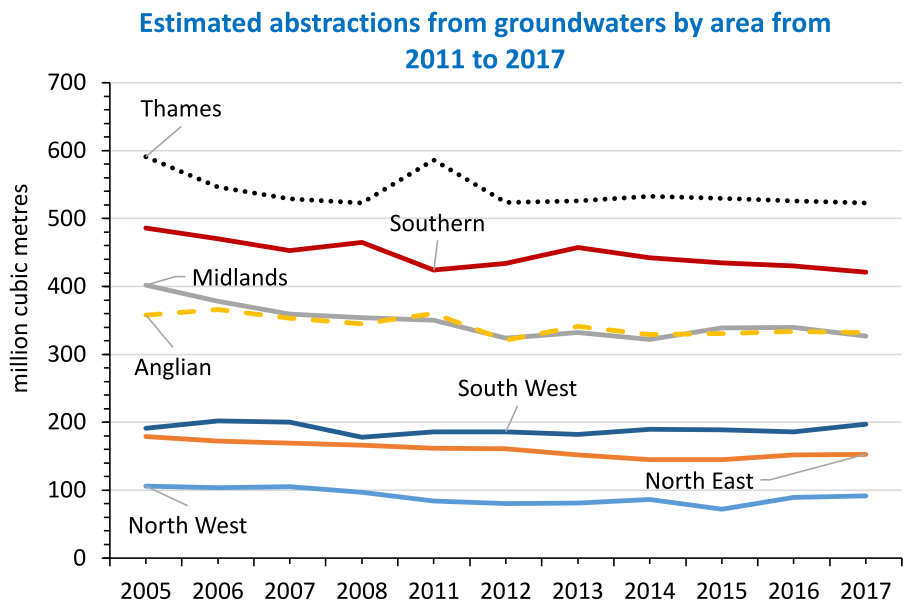
Figure 27: Estimated abstractions from groundwater by purpose by selected industries in England: 2011 – 2017



Source: Environment Agency – ENV15 data[79]

Data on abstraction is also available by area (see Figure 28), and the area with the largest abstraction from groundwater in 2017 was the Thames area, which accounted for around 523 million cubic metres (just under 26%) of the total being abstracted. The region with the lowest abstraction in 2017 was the North East area which accounted for 92 million cubic metres (just over 4%), it was also the region that saw the largest increase when compared to 2011 (just under 10% increase).

Figure 28: Estimated abstractions from groundwater by area in England: 2000 – 2017



Source: Environment Agency – ENV15 data[80]

79 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

80 Environment Agency, *ENV15 - Water abstraction tables for England* (2019) https://www.gov.uk/government/statistical-data-sets/env15- water-abstraction-tables

Reason for change in the level of abstraction

In the latest statistical release for abstraction, Defra points to some of the possible reasons for the change in the abstraction levels from one year to another, these could be due to a variety of factors, including:[81]

- Weather conditions, for example, drier and warmer years could result in an increase in abstraction for agriculture and spray irrigation. The highest 2 years for abstraction for the purpose of spray irrigation correspond with the lowest 2 years of annual levels of rainfall since 2000;
- Changes in the level of activity in different sectors;
- Improvements being made in the efficiency of water usage;
- Changes to abstraction licences, such as the issue of new licences; and
- Modifications to, or revocation of, existing licences.

Unsustainable abstraction

In 2017 Defra published the *Water Abstraction plan*[82], with the aim to end damaging abstraction of water from rivers and groundwater. The plan commits to address unsustainable abstraction and move around 90% of surface water bodies and 77% of groundwater bodies to the required standards by 2021.[83]

There is limited data on the unsustainable abstraction of surface water, with the latest data (2019) showing that around 84% of surface water bodies now support the required flow standards. This is an increase of around 2 percentage points from the 2016 baseline, which equates to a change in about 110 water bodies – see Table 18 for a detailed breakdown. In addition, there has been a decrease in the number of 'potentially unsustainably abstracted' water bodies by 3 percentage points. However, the number of unsustainably abstracted has increased to 9% (about 380 surface water bodies) in 2019.[84]

Table 18: Proportion of surface water bodies sustainably abstracted

Year	Unsustainably abstracted	Potentially unsustainably abstracted	Sustainably abstracted
2016 (abstraction plan)	8%	10%	82%
2019 (latest data)	9%	7%	84%
2021 (target)	6%	4%	90%

Source: Abstraction reform report[85]

In terms of groundwater, abstraction evidence is only available for 2016, which was estimated that 28% is being unsustainably abstracted. See Table 19 for the 2021 target and 2016 estimate.

Table 19: Proportion of groundwater bodies being abstracted

Year	Unsustainably abstracted	Sustainably abstracted
2016 (abstraction plan)	28%	72%
2021 (target)	23%	77%

Source: Abstraction reform report[86]

81 Defra, *Water abstraction statistics: England, 2000 to 2017* (2019) https://www.gov.uk/government/statistics/water-abstraction-estimates

82 Defra, *Water abstraction plan* (2017) https://www.gov.uk/government/publications/water-abstraction-plan-2017/water-abstraction-plan

83 Defra, *Water abstraction plan: environment* (2017) https://www.gov.uk/government/publications/water-abstraction-plan-2017/water-abstraction-plan-environment

84 Defra, *Abstraction reform report 2019* (2019) https://www.gov.uk/government/publications/abstraction-reform-report-2019

85 Defra, *Abstraction reform report 2019* (2019) https://www.gov.uk/government/publications/abstraction-reform-report-2019

86 Defra, *Abstraction reform report 2019* (2019) https://www.gov.uk/government/publications/abstraction-reform-report-2019

Areas of water stress

The Environment Agency on the request of Defra's Secretary of State has developed the water stress areas methodology to present which are at risk of serious water stress. The Environment Agency methodology looks at whether:[87]

a) the current household demand for water is a high proportion of the current effective rainfall, which is available to meet that demand; or

b) the future household demand for water is likely to be a high proportion of the effective rainfall which is likely to be available to meet that demand

This methodology indicates the relative water stress using a simple formula that produces a score for each water company across England. The most recent evidence on water stress areas[88] is from 2013. Where nine water companies were classified as having 'serious stress'. See Table 20 for each company classification.

Table 20: Water company stress classification in 2013 - (L=low, M= medium, S=serious)

Water Company Area	Current Stress (2013)
Affinity Water (formerly Veolia Water Central)	S
Affinity Water (formerly Veolia Water East)	S
Affinity Water (formerly Veolia Water South Wast)	S
Anglian Water	S
Bristol Water	M
Cambridge Water	M
Cholderton & District Water	M
Dee Valley Water	M
Dwr Cymru Welsh Water	M
Essex & Suffolk Water	S
Northumbrian Water	M
Portsmouth Water	M
Sembcorp Bourmemouth Water	L
Severn Trent Water	M
South East Water	S
South Staffordshire Water	M
South West Water	M
Southern Water	S
Sutton & East Surrey Water	S
Thames Water	S
United Utilities	M
Veolia Water Projects	M
Wessex Water	M
Yorkshire Water	M

Source: Environment Agency[89]

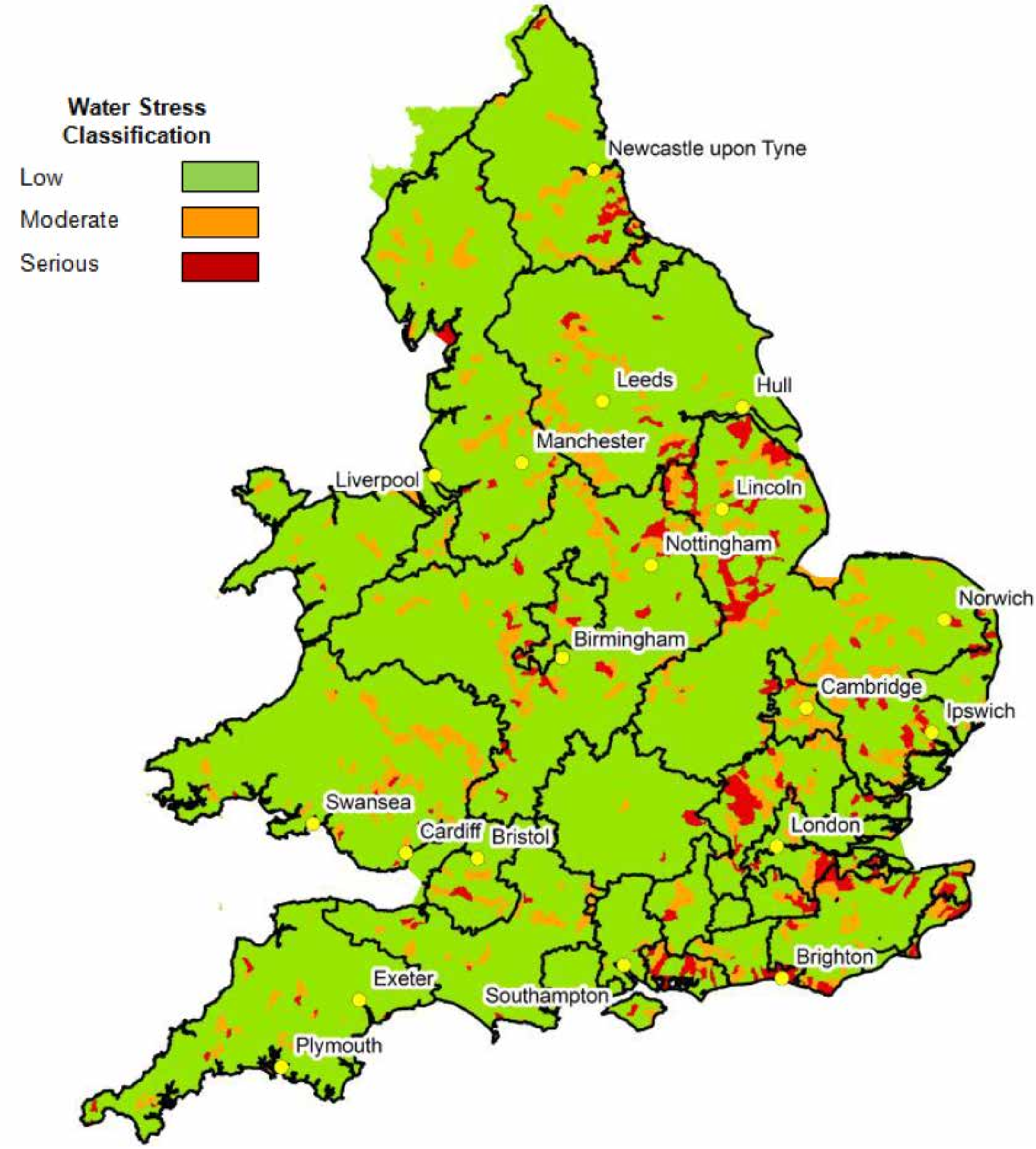
87 Environment Agency, *Areas of water stress: final classification* (2007) https://www.iow.gov.uk/azservices/documents/2782-FE1-Areas-of-Water-Stress.pdf

88 This is a measurement to provide an indication of relative water stress in individual water company areas by assessing the degree to which the resources in each water body within the area are exploited. This is calculated by the proportion of rainfall reaching rivers and streams, or percolating to groundwater, that is exploited through abstraction by water companies, businesses and farmers.

89 Environment Agency, *Areas of water stress: final classification* (2013) https://www.gov.uk/government/publications/water-stressed-areas-2013-classification

The areas classified as 'serious' in Table 11 should be designated as 'areas of serious water stress' for the purposes of Regulation 4 of the Water Industry (Prescribed Condition) Regulation 1999 (as amended). The classification is designed to support the decision about metering in these areas. Figure 29 presents spatially the water bodies that are at risk of stress withing individual water company areas.[90]

Figure 29: Water bodies at risk of stress within individual water company areas



Source: Environment Agency[91]

90 Environment Agency, *Areas of water stress: final classification* (2013) https://www.gov.uk/government/publications/water-stressed-areas-2013-classification

91 Environment Agency, *Areas of water stress: final classification* (2013) https://www.gov.uk/government/publications/water-stressed-areas-2013-classification

Water industry water leakage

As per the Defra *Water conservation report*[92], pressure on water resources is increasing due to population growth, the impact of climate change, and the need to have sufficient water to protect the environment. In some parts of England, water is being taken from the environment which is damaging ecosystems. The Water Industry National Environment Programme estimated that there needs to be a reduction in the amount of water being abstracted by over 700 million litres per day (Ml/d) to address environmental problems.[93]

The report also states that there needs to be a 'twin-track' approach in dealing with available water resources. The twin-track approach is about increasing supply and reducing demand in order to secure the resilience of water. There needs to be a reduction in the amount of water that is consumed and wasted. The 25 YEP reiterates Ofwat's challenge of reducing water leakage by 15% between 2020-2025.[94] However, this target has been challenged for not being ambitious enough.[95]

Defra has estimated the amount of water leakage by water companies (see Table 21) since 2014/15. It can be seen that leakage has remained constant at around 106-109 litres per property per day[96]. There is significant variation between companies, range from as low 80 litres for Southern Water to as high as 172 for Thames water in 2017/18.

Table 21: Water company leakage in average litres per property per day

Water Company	2014/15	2015/16	2016/17	2017/18
Affinity Water	125	121	116	116
Anglian Water Services	90	86	86	85
Bournemouth Water	101	96	93	92
Bristol Water	86	84	88	87
Cambridge Water	100	96	103	101
Essex & Suffolk Water	77	77	84	82
Northumbrian Water	115	113	112	113
Portsmouth Water Ltd	93	89	96	103
Severn Trent Water Ltd	126	122	119	123
South East Water	102	97	96	94
South Staffordshire Water Plc	119	119	119	123
South West Water Ltd	105	103	103	106
Southern Water	75	77	80	80
Sutton & East Surrey Water	85	86	84	83
Thames Water	177	173	171	172
United Utilities	140	138	134	137
Wessex Water	114	113	112	110
Yorkshire Water	128	126	129	131
Average	**109**	**106**	**107**	**108**

Source: Defra internal analysis presented in the *Water Conservation report 2018*

92 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

93 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

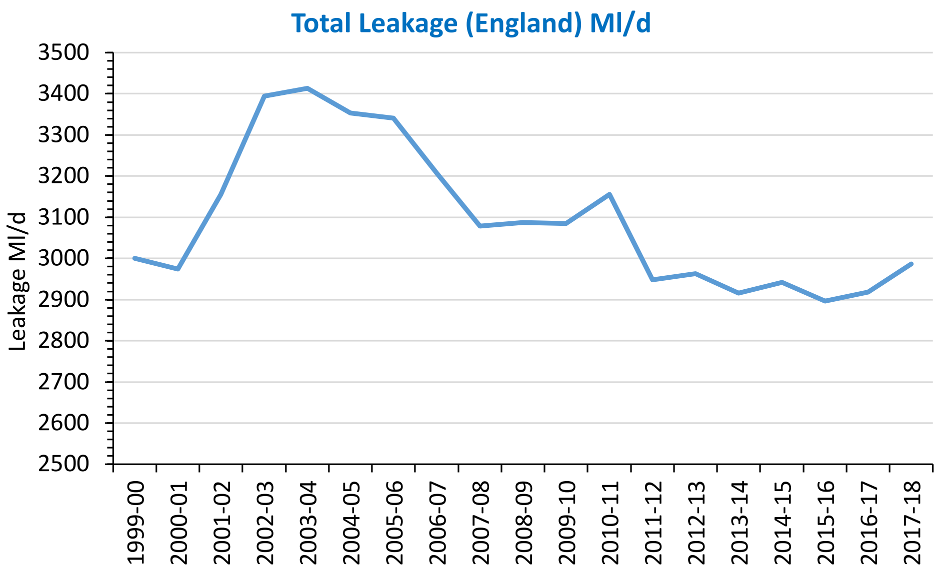
94 Ofwat, *PR19 final determinations: Securing cost efficiency technical appendix* (2020) https://www.ofwat.gov.uk/publication/pr19-final-determinations-securing-cost-efficiency-technical-appendix/

95 Environment, Food and Rural Affairs Committee, *Regulation of the water industry: Eight Report of Session 2017-19* (2018) https://publications.parliament.uk/pa/cm201719/cmselect/cmenvfru/1041/1041.pdf

96 Average is total leakage divided by number of properties.

Defra has estimated that "*around 22% of water currently put into the supply is lost through leakage; equating to around 3 billion litres of water per day*"[97]. This is reflected in Figure 30 which presents water leakage since 1999. Between 2011/12 and 2017/18, the trend has remained somewhat constant at around 2,900-3,000 million litres of water, with limited progress made over this period to reduce the amount of leakage.

Figure 30: Water leakage since 1999 in million litres per day (Ml/d)



Source: Defra internal analysis presented in the *Water Conservation report 2018*

Water consumption (per capita consumption)

In addition to reducing the amount of water leakage, there is also a need to reduce the amount of water that is being consumed. To make a significant difference to the environment, Defra and the Environment Agency has estimated that if water leakage was reduced by 50% and per capita consumption was reduced to 100 litres per day, enough water could be provided to an additional 20 million people by 2050 without taking more from the environment.[98]

As can be seen in Table 10, no water company is near achieving the 100 litres objective, as water per capita consumption (PCC) has remained flat at around 140 litres. In 2017/18, the worst performer had a PCC of 159 litres, with the best performer only achieving 129 litres. See the full breakdown of PCC in Table 22.

97 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

98 Defra, *Water Conservation report 2018* (2018) https://www.gov.uk/government/publications/water-conservation-report-2018

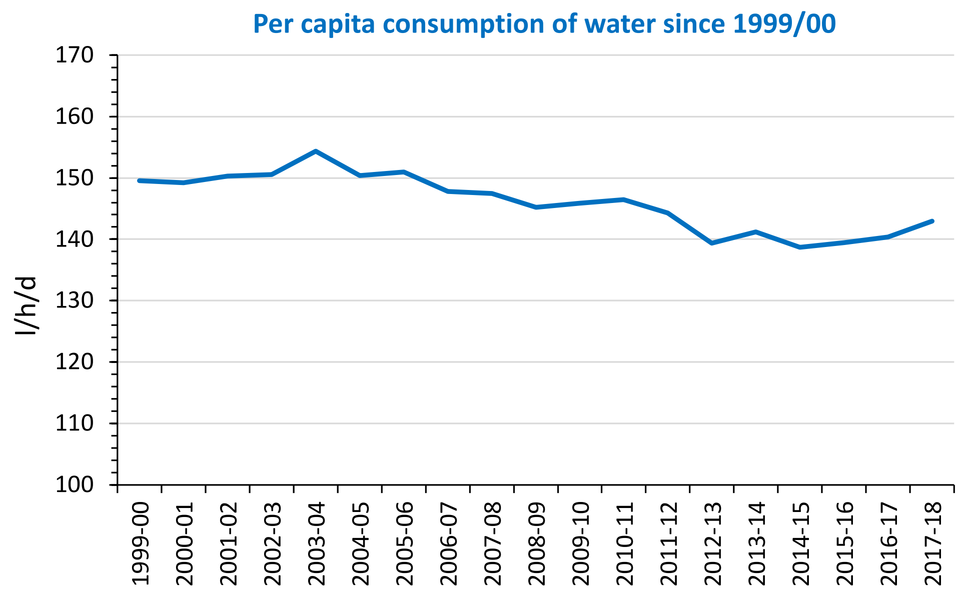
Table 22: Water company per capita consumption in average litres per person per day (l/p/d) in recent years

Water Company	2013/14	2014/15	2015/16	2016/17	2017/18
Affinity Water	154	148	152	155	155
Anglian Water	135	133	135	136	137
Bournemouth Water	144	136	134	144	141
Bristol Water	144	143	141	144	146
Cambridge Water	133	131	133	140	145
Essex & Suffolk Water	152	151	151	152	153
Northumbrian Water	142	142	145	141	144
Portsmouth Water	148	146	143	145	148
Severn Trent Water	129	126	130	131	133
South East Water	156	157	161	151	150
South Staffordshire Water	131	129	129	128	130
South West Water	137	135	137	136	142
Southern Water	141	135	130	131	129
Sutton & East Surrey Water	167	161	161	158	159
Thames Water	156	150	149	146	145
United Utilities	129	130	130	139	142
Wessex Water	138	138	137	141	143
Yorkshire Water	136	133	133	135	133
England average	**141**	**139**	**139**	**140**	**143**

Source: Defra internal analysis presented in the *Water Conservation report 2018*

As per Figure 31, water PCC has remained around 140-150 litres since 1999. Looking at the more recent trend since 2012/13 it can be seen that consumption flatlined.

Figure 31: Per-capita consumption since 1999 in litres per person per day (l/p/d)



Source: Defra internal analysis presented in the *Water Conservation report 2018*

Annex 3

Marine

Marine

Background

The UK's marine environment provides important regulating ecosystem services including coastal protection, climate regulation, and waste management (e.g.: detoxification and sequestration) and assimilation.

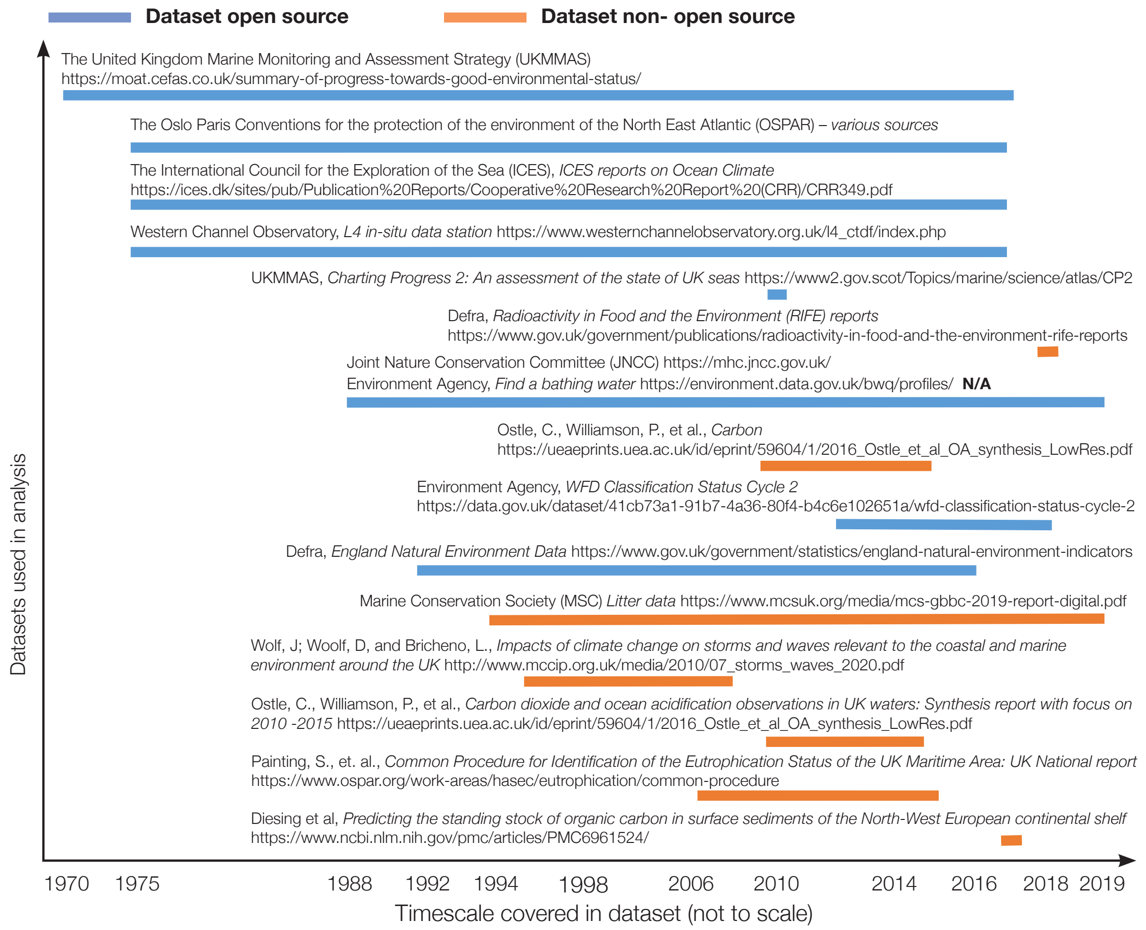
Benefits (or 'ecosystem services/flows') from better management of marine natural capital include:

- Biodiversity;
- Recreation and wellbeing;
- Carbon storage and sequestration;
- Food production;
- Waste management; and
- Flood water storage and protection from extreme weather events.

In order to understand changes in the status of the marine asset and how these will affect human health or the environment, it is important to first understand where pollution is most concentrated, how it occurs, and what elements are involved. To do so, robust and comprehensive data is required to enable an assessment of the status of the marine asset. To produce the marine assessment the Natural Capital Committee (NCC) has looked at a range[1] of datasets, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the marine asset

Datasets used in marine analysis, timescale covered and their status (open or non-open source)



Source: NCC 2020

1 Given the limited resources available to the NCC the list of datasets is not comprehensive and further work is required to scope additional datasets to complement this assessment.

Marine asset

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of the marine environment. In order to produce the marine assessment, the NCC has used datasets and evidence from:

- The United Kingdom Marine Monitoring and Assessment Strategy (UKMMAS)[2];
- The Oslo Paris Conventions for the protection of the environment of the North East Atlantic (OSPAR)[3];
- The International Council for the Exploration of the Sea (ICES)[4];
- Defra statistics;
- The Environment Agency;
- The Marine Conservation Society (MCS)[5];
- The Joint Nature Conservation Committee (JNCC)[6];
- Luisetti *et al* (2019)[7];
- Bricheno *et al* (2015)[8];
- Wolf *et al* (2020)[9]; and
- Marine Climate Change Impacts Partnership (MCCIP)[10].

To produce the marine assessment, the NCC was cognisant of the following directives and guided by them where relevant and appropriate:

1. The Marine Strategy Framework Directive (MSFD)[11] which sets a list of 11 descriptors of environmental status – see Table 1 below with the description of Good Environmental Status (GES);[12]
2. Water Framework Directive (WFD); and
3. The Bathing Waters Directive (BWD) for coastal waters.

2 UKMMAS, *Introduction to UK Marine Strategy* https://moat.cefas.co.uk/introduction-to-uk-marine-strategy/

3 OSPAR, *Assessment portal* https://oap.ospar.org/en/

4 ICES, *Publications* https://www.ices.dk/publications/Pages/Home.aspx

5 MCS, *Great British Beach Clean* https://www.mcsuk.org/beachwatch/greatbritishbeachclean

6 JNCC https://jncc.gov.uk/

7 Luisetti et al, Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK, (Ecosystem Services, Volume 35), February 2019, pp 67-76 https://www.sciencedirect.com/science/article/pii/S2212041618300536

8 Bricheno, L.M., Wolf, J. and Aldridge, J. (2015) *Distribution of natural disturbance due to wave and tidal bed stress around the UK. Continental Shelf Research*, 109, 67–77 https://www.sciencedirect.com/science/article/pii/S0278434315300583

9 Wolf, J; Woolf, D, and Bricheno, L (2020) *Impacts of climate change on storms and waves relevant to the coastal and marine environment around the UK* http://www.mccip.org.uk/media/2010/07_storms_waves_2020.pdf

10 MCCIP http://www.mccip.org.uk/

11 European Parliament, Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) 2008 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056

12 European Commission, *Our Oceans, Seas and Coasts: Achieve Good Environmental Status* https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

Table 1 Qualitative descriptors of the EU Marine Strategy Framework Directive

	Qualitative descriptors for determining good environmental status
Good Environmental Status (GES)	1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
	2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
	3. Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
	4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
	5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
	6. Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
	7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
	8. Concentrations of contaminants are at levels not giving rise to pollution effects.
	9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
	10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
	11. The introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

To produce the assessment of marine the NCC started by scoping out the abiotic components of the asset which are presented in Figure 1 below. The ‘seawater’ marine asset includes coastal and offshore marine waters, with transitional waters included as a component of the Freshwater asset - see *Annex 2*. The ‘seabed’ element of the marine asset consists of the seabed below the littoral zone. Littoral, supralittoral, and coastal components are included in *Annex 5* Land which covers the coastal and freshwater habitats asset. A data trend assessment followed (where data and evidence were available) to see how these components and subcomponents changed over time and where possible try to infer the status of their condition and extent.

There are significant data gaps in the marine environment when compared to other assets such as the atmosphere and freshwater. For some of the marine and coastal components where data is available, data is often based only on a small number of sites, and/or the time series covers only a short or sporadic period, or it is modelled data.

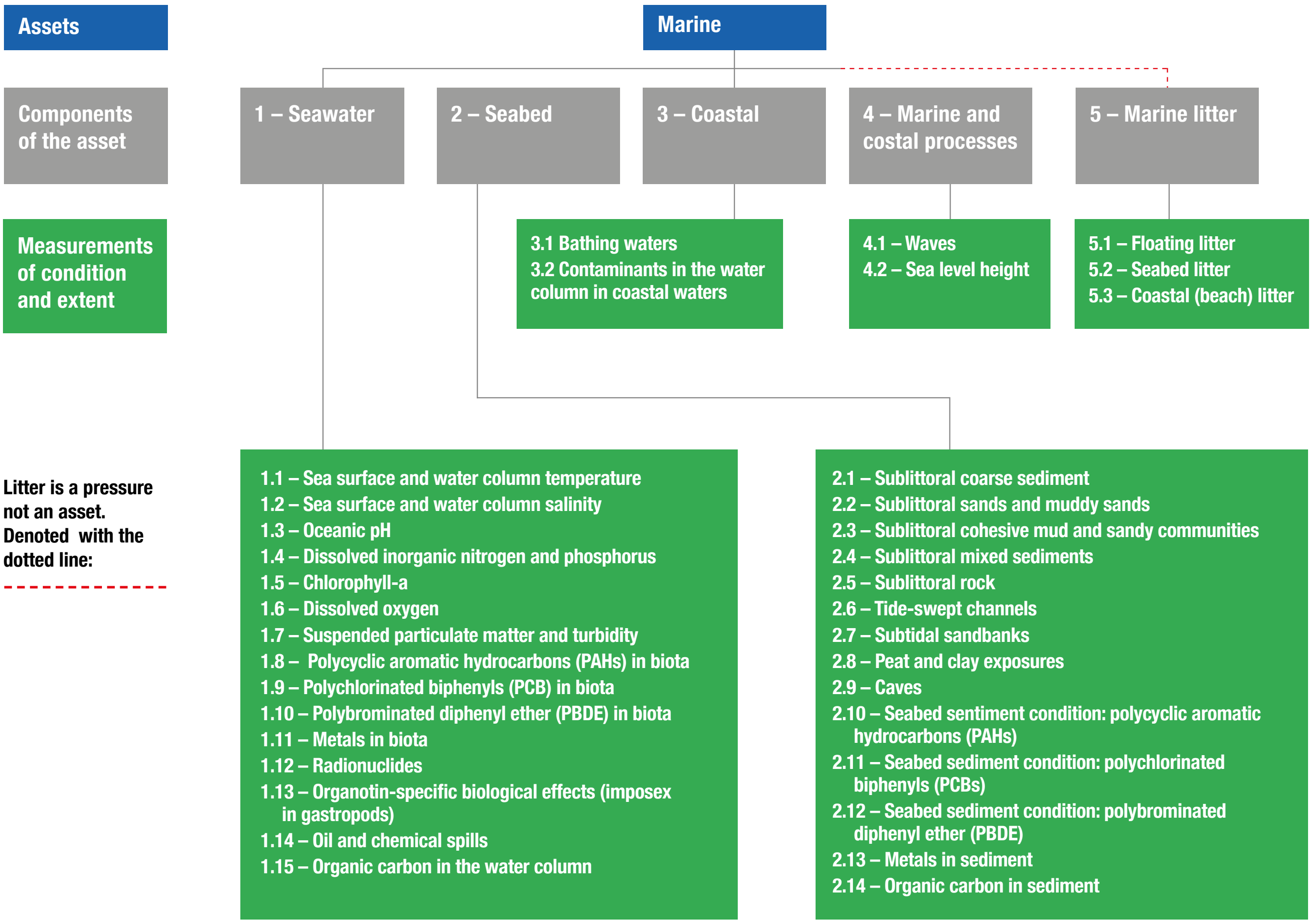
Given the small number of monitoring sites, for several of the components discussed in the marine annex the evidence presented is based on modelled analysis and is somewhat dated, for example with the most recent assessment being from 2015 or earlier. There is a clear need for more periodic reporting and maintenance of the data. Significant further work is needed to improve the quality of the data and increase data availability.

There is also a limitation in the spatial scale, where availability of data for England is limited and has only been found for a couple of the components such as coastal bathing waters, and litter. Given this limitation, data for the UK and sea regions around England and the UK have been used as a proxy. This was necessary to enable an assessment to be made.

As per the limitations above the evidence presented here should be treated with caution and at best presents an indication of the condition and extent of the asset.

The NCC has presented as much data as was available (and found within the limited resources available to the Committee) to present a comprehensive assessment.

Figure 1: Marine measurements of the asset



Source: NCC 2020

Targets, data gaps, and objectives

Of the 36 measurements assessed by the NCC only 17 had a quantitative target, commitment or threshold set. The lack of targets for the marine environment is partly explained by the lack of data discussed above.

Monitoring in the marine environment has largely focused on meeting the reporting requirements of specific projects/policies. The NCC has provided advice on integrating the monitoring of marine assets into a broader natural capital assessment with appropriate metrics, a baseline, and appropriate time series and spatial coverage; to build understanding and evidence of the extent and condition of marine assets, services and benefits to underpin a joined-up systems based approach to managing them.

For example, assessments of benthic habitats have targeted Marine Protected Areas (MPAs), mainly only providing spatial coverage of those sites and with a focus on the designated features of interest within them.[13] This means that assessments of assets across the broader marine environment, such as the asset register undertaken by the North Devon Marine Pioneer, need to rely on proxy measures which introduce increased uncertainty into the assessments and limit their spatial and temporal resolution. A report on the Marine Pioneer notes that there remains a lack of confidence in the baseline data that can inform on the extent of the habitat natural capital assets.[14] Similarly, monitoring under the UK Marine Strategy aims to address descriptors for 'good environmental status' but these descriptors were not designed to reflect the systems' capacity to continue delivery of wider services and benefits.

13 SWEEP, *North Devon Marine Pioneer Report 2: A Natural Capital Asset and Risk Register (2019):* https://www.northdevonbiosphere.org.uk/uploads/1/5/4/4/15448192/7._north_devon_marine_pioneer_report_2_march_2019.pdf

14 Ibid.

The NCC has previously advised that future high-level objectives, criteria for measuring progress, the operational targets, and the indicators and thresholds in Defra's 2019 Marine Strategy part 1 not only lack ambition but bear no relation to natural capital asset assessment requirements for ensuring sustainability of ecosystem service flows or for natural capital accounting.[15]

The NCC recognises that the scope of such assessments have often been limited by funding, the challenging practicalities of data collection, and the highly dynamic (spatially and temporally) nature of many marine assets. The NCC has previously advised that collecting data on marine assets requires significant investment to fill the gaps in data[16] – gaps which the NCC's analysis shows are significant. The Committee has suggested some possible areas to begin based on the likelihood that investment in these areas would deliver huge returns by allowing the maintenance of natural capital assets and the services they provide into the future:

- Any exercise which would attempt to build a comprehensive map of the seabed and its ecosystems should be funded as a priority, as this could deliver significant returns on investment.[17]
- Benthic (seabed) habitats can be assessed in discrete, spatially-bound, service providing 'units' using a combination of hydrographic data, sediment sampling and biological surveys. In assessing the offshore marine environment, priority should be given to establishing a baseline measure of their extent and condition.
- Ocean colour measured through satellite observations and integrated across annual cycles provides an indication of productivity of phytoplankton – a key pelagic functional group (i.e.: a partial proxy for the phytoplankton asset).[18]

Summary of overall (partial) marine asset assessment

The NCC has produced a partial assessment of the condition and extent of the marine asset.

The assessment uses a 'RAG' rating approach to indicate the status of the marine asset and its associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. Table 2 shows the RAG scale – note that the 'grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'amber' rating ('no change'/'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 2: RAG rating scale for marine assessment

RAG rating	Colour
Unable to assess	
Declined/deteriorated	
No change/mixed	
Improved	

15 NCC, *Natural Capital Committee advice on government's 25 Year Environment Plan and progress reports (2020)* https://www.gov.uk/government/publications/natural-capital-committee-advice-on-governments-25-year-environment-plan

16 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan (2019)* https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

17 Cefas, *Eunomia, UK National Seabed Mapping Programme – Scoping Study (2016)* https://www.maritimeuk.org/media-centre/publications/uk-national-seabed-mapping-programme-scoping-study/

18 Valente et. al, *Stochastic models for phytoplankton dynamics in Mediterranean Sea (2016)* https://www.sciencedirect.com/science/article/pii/S1476945X15000744

The overall assessment of the marine asset annex, based on the datasets available, is **'Red': deteriorating** – this is based on the fact that the amount of litter in coastal and marine areas has increased, that coastal waters are not meeting the WFD 'good' ecological status target and that not all bathing waters achieved sufficient status. This assessment is based on the five group headings (see points 1-5 below) and is underpinned by the trend assessment made to the measurements assessed in this annex.

1. Marine seawater
2. Marine seabed
3. Coastal
4. Marine and coastal processes
5. Marine and coastal litter and waste

Based on the datasets available, the NCC findings are presented in Table 3 with a RAG rating for each of the five heading groups provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the measurements. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC assessments are:

- Seawater pH levels are decreasing due to the absorption of CO_2, this is known as increasing ocean acidification.
- There is insufficient data to draw an assessment of organic carbon in the water column and sediment.
- The number of fulmars with more than 0.1g of plastic in 2014-2018 was 49%, much higher than the target of 10%.
- Between 1994 and 2019 there has been an increase in the number of bathing waters achieving at least 'sufficient' from 46% to 98%.

Table 3 Indicative assessment of the marine asset

Components of the asset	Data availability	Overall assessment
1. Marine seawater	There is limited trend data available and, in most cases, this is somewhat dated (e.g.: most recent data is from 2015) and the raw data is not available only the final analysis.	The amber RAG rating here is based on the limited data available – needs to be treated with caution. Most of the measurements in the assessment are rated amber - no change/not possible to assess due to the way the data is presented (e.g.: covers a broad period 2010-2015) or data is not available.
2. Marine seabed	Data is not available for all or most of the seabed components. Data is only available as maps or a point in time.	Unable to produce an assessment as there is not sufficient data available.
3. Coastal	Data is available at the England level for both coastal and bathing waters and a time series is available.	The RAG rating here is deteriorating given that coastal and bathing waters are not meeting their respective Water Framework Directive (WFD) and Bathing Waters Directive (BWD)[19] targets.
4. Marine and coastal processes	The NCC has not been able to find enough data on waves. While for sea level data is available, but is limited to a few sites and the time series varies from site to site.	Unable to produce an assessment as there is not sufficient data available.
5. Marine and coastal litter	There is limited data available and a time series exist for: • Beach litter • Seafloor litter	The RAG rating here is deteriorating - this is on the basis that the Government is not meeting is fulmars target, and that litter in beaches and seafloor have increased.

19 Although the overall assessment for the coastal asset is red, there has been significant progress made to bathing waters which has been RAG rated as amber.

As the summary of the NCC's assessment in Table 3 shows, the data available does not allow for more than a very partial assessment of the extent and condition of marine natural capital assets. For the majority of asset measurements, there is a lack of systematic data points to provide sufficient spatial coverage, to indicate trends and to provide a baseline against which to measure change. This means that maps showing the extent of assets, such as seabed components and water column characteristics rely heavily on modelling, introducing a high degree of uncertainty into our understanding of the extent and condition of marine assets.

The best available evidence for the marine environment indicates a deteriorating asset condition and huge changes in line with predicted climate change trends, at the same time as only delivering a partial picture. This is a huge cause for concern and further investment in monitoring these assets is needed – the marine environment supports major earth systems.

Summary RAG rating for individual measurements

The overall assessment, based on the five groups set out above, is underpinned by an analysis of measurements used to assess the marine asset components (as displayed in Figure 1). A full summary assessment of the condition, extent and pressures of these measurements, grouped by the five overall components, are presented in Table 4. The assessment follows the same approach as the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. The assessment is split into four categories, with a RAG rating assigned for each, as follows:

1. **Compliance against target/commitment** is the comparison of the target or commitment baseline against the most recent data. For example, assessing the reduction of ammonia from 2005 levels (target baseline) against the 2020 target of 8% reduction.
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/evidence. For example, comparing the change between 1970 and 2018.
3. **The NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when Government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses*".[20] Here, the 2011 baseline (where data is available) is compared against the most recent data/evidence. This also relates to the NCC census advice[21], and its interim response to the 25 YEP Progress Report, for a need to have a common base year to assess progress against.
4. **The short-term, trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

The overall assessment RAG rating is based on each measurement's RAG rating presented in Table 4 below. Areas where there is a clear need for action include coastal waters that are not meeting the WFD target and marine litter, such as beach, floating and seabed litter. The points below summarise the key findings:

- The amount of estimated seabed litter has increased between 1992 and 2016, from around 95 items to around 358 per km^2 respectively.
- The overall classification of coastal waters (cycle 2) achieving at least 'good' has declined from just over 45% to just under 44% between 2015 and 2018.
- Mean concentrations of polycyclic aromatic hydrocarbons (PAHs) are below the 'effects range-low' criterion (ERL) to a statistically significant degree but not below the OSPAR Background Assessment Concentration (BACs) to a statistically significant degree.

20 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

21 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan (2019)* https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

The key RAG ratings for the individual measurements are presented in Table 4 below.

Table 4 Subcomponents assessment and respective RAG ratings

Component and measurements of the asset		Assessment			
		Compliance with target or commitment	Long-term trend	Against NCC baseline (2011)	Short-term trend
Marine seawater	1.1 – Sea surface and water column temperature	N/A	R	A	A
	1.2 – Sea surface and water column salinity	N/A	A	A	A
	1.3 – Oceanic pH	N/A	R	N/A	N/A
	1.4 – Dissolved inorganic nitrogen and phosphorus	A	A	N/A	N/A
	1.5 – Chlorophyll-a	G	A	A	A
	1.6 – Dissolved oxygen	G	A	A	A
	1.7 – Suspended particulate matter and turbidity	N/A	R	N/A	N/A
	1.8 – Polycyclic aromatic hydrocarbons (PAHs) in biota	G	G	N/A	N/A
	1.9 – Polychlorinated biphenyls (PCB) in biota	A	G	N/A	G
	1.10 – Polybrominated diphenyl ether (PBDE) in biota	N/A	N/A	N/A	N/A
	1.11 – Metals in biota	G	A	N/A	N/A
	1.12 – Radionuclides	N/A	N/A	N/A	N/A
	1.13 – Organotin-specific biological effects (imposex in gastropods)	G	G	N/A	N/A
	1.14 – Oil and chemical spills	N/A	R	R	R
	1.15 – Organic carbon in the water column	N/A	N/A	N/A	N/A
Marine seabed	2.1 – Sublittoral coarse sediment	N/A	N/A	N/A	N/A
	2.2 – Sublittoral sand	N/A	N/A	N/A	N/A
	2.3 – Sublittoral mud	N/A	N/A	N/A	N/A
	2.4 – Sublittoral mixed sediments	N/A	N/A	N/A	N/A
	2.5 – Sublittoral rock	N/A	N/A	N/A	N/A
	2.6 – Tide-swept channels	N/A	N/A	N/A	N/A
	2.7 – Banks	N/A	N/A	N/A	N/A
	2.8 – Peat and clay exposures	N/A	N/A	N/A	N/A
	2.9 – Caves	N/A	N/A	N/A	N/A
	2.10 – Seabed sentiment condition: polycyclic aromatic hydrocarbons (PAHs)	N/A	G	N/A	N/A
	2.11 – Seabed sediment condition: polychlorinated biphenyls (PCBs)	N/A	A	N/A	N/A
	2.12 – Seabed sediment condition: polybrominated diphenyl ether (PBDE)	N/A	N/A	N/A	N/A
	2.13 – Metals in sediment	N/A	N/A	N/A	N/A
	2.14 – Organic carbon in sediment	N/A	N/A	N/A	N/A

Coastal	3.1 – Bathing waters	R	G	G	A
	3.2 – Cycle 1 contaminants in the water column in coastal waters	R	R	R	R
	3.2 – Cycle 2 contaminants in the water column in coastal waters	R	G	N/A	R
Marine and coastal processes	4.1 – Waves	N/A	N/A	N/A	N/A
	4.2 – Sea level height	N/A	N/A	N/A	N/A
Marine and coastal litter and waste	5.1 – Floating litter	R	G	G	G
	5.2 – Seabed litter	N/A	R	R	R
	5.3 – Coastal (beach) litter	N/A	R	R	G

Individual marine components assessment

The UK has excellent dynamic spatial models of marine ecosystems, their biogeochemistry and biology linked to hydrodynamic models. These can be forced by climate change models to give scenarios of changes in natural capital and ecosystem services. More widespread applications of this UK science would allow adaptation and mitigation in our use and management of marine natural capital - e.g. for leisure (short-term forecasting of bathing water safety, long-term planning for future pathogen hazards), for planning future management of fisheries and aquaculture resource, or for natural flood defence capability provided by saltmarsh and reefs under climate change. The NCC's analysis indicates that the major chemical and physical parameters affecting marine ecosystem dynamics and structures are changing. This highlights the urgent need for further data to validate modelling future changes, to better understand their effects on marine natural capital.

The United Kingdom Marine Climate Change Impacts Partnership (MCCIP) lists the direct physical and chemical indicators of oceanic change due to a warming climate. These include: warming seas, reduced oxygen, ocean acidification and sea-level rise. These are predicted to drive changes in oceanographic systems and the functioning, dynamics and structure of marine ecosystems.[22]

The marine carbon cycle is central to these changes, and they could drastically alter the ability for seas and coastal waters to continue storing biologically sequestered carbon to mitigate further climatic change before thresholds or tipping points are. Marine ecosystems are important for climate regulation, sequestering and storing more than half (55%) of the world's biologically sequestered carbon.[23] Yet, the importance of carbon cycling in the UK's temperate marine ecosystems, offshore and inshore pelagic ecosystems, estuaries, sedimentary seabed, etc. is largely ignored in natural capital accounting. The future of the marine carbon cycle depends on both the abiotic elements listed here, and the ability of the biotic components, most significantly plankton, to adapt to these changing conditions. As such the organic carbon in the water column and sediment, and chlorophyll-a (used here to assess eutrophication), are also included in the abiotic marine assets section.

The 2020 MCCIP Report Card draws on 26 scientific reviews (commissioned by MCCIP) on the observed and projected climate change impacts for UK seas. In the following sections the NCC considers its own analysis of the available data on the physical and chemical components of the marine asset, in light of the climate change scenario projections reported on by MCCIP. The trend data from the NCC's analysis shows that these components are indeed changing as expected under climate change scenario modelling.

22 Marine Climate Change Impacts Partnership, *Report Card 2020 (2020)* http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

23 Nellemann et al., *United Nations Environment Programme, Blue Carbon. A Rapid Response Assessment (2009)* https://www.researchgate.net/publication/304215852_Blue_carbon_A_UNEP_rapid_response_assessment

1. Marine seawater

For the assessment of marine seawater, the NCC has started by scoping out what are the key components of this asset to then produce an assessment of their condition and extent. The full list of components is presented in Table 5 below. The NCC has also looked at whether any target, commitment, and or threshold exist against these components so that they can measure the progress towards achieving them.

Table 5: List of components and target/thresholds

	Seawater component	Targets/criteria/thresholds
1.1	Sea surface and water column temperature	There is no target relating to seawater temperature.
1.2	Sea surface and water column salinity.	There is no target relating to seawater salinity.
1.3	Ocean pH (acidification)	There is no target relating to seawater pH levels.
1.4	Dissolved Inorganic Nitrogen and phosphorus concentrations	There is a Marine Strategy part 3 target towards meeting Good Environmental Status (GES): *Nutrient concentrations are below the levels which could lead to harmful eutrophication effects*.[24]
1.5	Chlorophyll-a	The UK target for eutrophication 'non-problem areas' is that there should be no increase in the 90th percentile[25] of chlorophyll in the growing season (linked to increasing anthropogenic input) based on periodic surveys.[26] In addition, the Marine Strategy part 3 includes a target towards meeting Good Environmental Status (GES): *Chlorophyll-a concentrations are below levels which could lead to harmful eutrophication effects*.[27]
1.6	Dissolved oxygen	There is a UK threshold level for dissolved oxygen: 50-75% oxygen saturation. There is also a target for eutrophication 'problem areas' that oxygen concentrations in bottom waters should remain above area-specific oxygen assessment levels (4 to 6 mg l-1).
1.7	Suspended sediments and turbidity	There is no target relating to suspended particulate matter (SPM) and turbidity.
1.8	Polycyclic aromatic hydrocarbons (PAHs) in biota	OSPAR Environmental Assessment Criteria (EACs) levels.[28]
1.9	Polychlorinated biphenyls (PCB) in biota	OSPAR Environmental Assessment Criteria (EACs) levels.[29]
1.10	Polybrominated diphenyl ether (PBDE) in biota	There is no target relating to PBDE.
1.11	Metals in biota	OSPAR Environmental Assessment Criteria (EACs) levels.[30]

24 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status* (2019) https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

25 Percentiles describe statistical distribution. The 90th percentile value is the concentration greater than 90% of observations, or conversely less than 10% of observations.

26 UKMMAS, *Chlorophyll Concentrations in the Water Column* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/chlorophyll/

27 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status* (2019) https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

28 Environmental Assessment Criteria (EAC) represent to contaminant concentration in the environment below which no chronic effects are expected to occur in marine species, including the most sensitive species. Concentrations below the EACs are considered to present no significant risk to the environment and are unlikely to give rise to unacceptable biological effects. Source: https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status

29 Ibid.

30 Ibid.

1.12	Radionuclides	In 1998, the UK Government agreed on a long-term Radioactive Substances Strategy (RSS) and signed the OSPAR Sintra Statement which included the following commitment: "We shall ensure that discharges, emissions and losses of radioactive substances are reduced by the year 2020 to levels where the additional concentrations in the marine environment above historical levels, resulting from such discharges, emissions, losses, are close to zero."[31] In addition, a target was set in UK Strategy for radioactive discharges[32] to reduce discharges of Tc-99 (technetium-99) to the following levels: • < 10 TBq/yr by 2006; and • < 1 TBq/yr by 2020.
1.13	Organotin-specific biological effects (imposex in gastropods)	OSPAR Environmental Assessment Criteria (EACs) levels.[33]
1.14	Oil and chemical spills	There is no target relating to oil and chemical spills.
1.15	Organic carbon in the water column	There is no target relating organic carbon.

The overall assessment of seawater

Based on the data available the overall assessment of seawater is **'Amber': mixed**. This is because most of the measurements being assessed have been given an amber RAG rating or do not have data available (grey RAG rating). This assessment is based on the individual assessments presented in Table 6 below. For example, sea surface and water column temperatures have increased. There has also been further deterioration in the status of the water column (coastal waters).

Table 6: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
1.1 - Sea surface and water column temperature	No target exists/was found.	Based on Figure 2-4 there has been an increase in the surface water temperature. For example, in Figure 4 the trend since 1975 has been upward, though with peaks and troughs.	Based on this limited data, Figure 2 presents an increasing trend, while Figure 4 presents a declining trend since 2011.	Based on Figure 2 there seems to have been a slight increase in sea surface water temperatures between 2015 and 2016. However, Figure 4 shows a decline between 2015 and 2016.
1.2 - Sea surface and water column salinity	No target exists/was found.	Based on the limited data available from the Rockall Trough, there has been an upward trend between 1975 and 2010, with a sharp decline from 2011.	Based on the Rockall Trough estimates there has been a decline in salinity when comparing 2011 levels with 2016 (latest data). There was also a small decline in the western channel observatory as per Figure 7.	Based on Figure 7 it is difficult to assess if salinity has significantly increased (by more than a percentage point) between 2017 and 2018.

31 OSPAR, *Ministerial Meeting of the OSPAR Committee: Sintra, 22-23 July 1998* (1998) https://www.ospar.org/documents?v=6877

32 BEIS, *UK strategy for radioactive discharges* (2009) https://www.gov.uk/government/publications/uk-strategy-for-radioactive-discharges-2018-review-of-the-2009-strategy

33 Environmental Assessment Criteria (EAC) represent to contaminant concentration in the environment below which no chronic effects are expected to occur in marine species, including the most sensitive species. Concentrations below the EACs are considered to present no significant risk to the environment and are unlikely to give rise to unacceptable biological effects. Source: https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status

1.3 - Seawater pH ('ocean acidification')	No target exists/was found.	The limited available data based on ICES (Greater North Sea) and site-specific observations show a declining trend in pH levels.	N/A – Data not available to produce an assessment.	N/A – Data not available to produce an assessment.
1.4 -Dissolved inorganic nitrogen (DIN) and phosphorus (DIP) concentrations	There is a target for coastal and offshore waters: 18 μM - Coastal waters 15 μM - offshore waters These thresholds are being breached for some seas in the Eastern Channel, Southern North Sea, Western Channel and Celtic Sea.	Given the limited data availability and the mixed results from sea regions, the RAG rating here is amber.	N/A – Data not available to produce an assessment.	N/A – Data not available to produce an assessment.
1.5 - Chlorophyll-a	Based on the data available the UK is meeting its target that there should be no increase in the 90th percentile of growing-season (March to October, inclusive) chlorophyll-a concentrations	Based on the limited data on long-term trend, there has been an increase in chlorophyll-a to the southern North Sea (offshore) and for Celtic Seas (coastal) when comparing 1990 to 2014 levels. While for the northern North Sea (offshore) and southern North Sea (coastal) there was a decline when comparing 1990 and 2014 levels. There was no significant change for the northern North Sea (coastal) and Celtic Seas (offshore) when comparing 1995 and 2014.	The data shows a decline in chlorophyll-a levels for: • Offshore concentration in the northern North Sea, the southern North Sea, Celtic Sea, and coastal southern North Sea. However, there has been an increase in coastal concentrations in: • The northern North Sea and the Celtic Sea.	Based on the year-on-year data between 2013 and 2014, the assessment is mixed given that concentrations have declined for coastal southern and northern North Sea and in the offshore Celtic Sea. While there have been increases in concentrations to offshore southern and northern North Sea and the coastal Celtic Sea.
1.6 - Dissolved oxygen	The UK currently meets the dissolved oxygen concentration threshold level of 6mg/l between 2006 and 2014.	When comparing early data points there has been limited/ mixed change in dissolved oxygen.	When comparing between 2011 and 2014 (latest data) concentrations of dissolved oxygen have declined for both the Greater North Sea and the Celtic Sea.	Concentrations have also declined when comparing 2013 and 2014 levels for both the Greater North Sea and the Celtic Sea.
1.7 - Suspended particulate matter and turbidity	No target exists/was found.	There have been increases in annual average surface suspended particulate matter in 5 out of 10 UK marine regions.	Data not available	Data not available

1.8 – Polycyclic aromatic hydrocarbons (PAHs) in biota	There is no specific target, however there is the OSPAR Background Assessment Concentrations (BACs), and the OSPAR Environmental Assessment Criteria (EACs) levels of PAHs which were below these levels.	At all the sites monitored, the observed concentrations of PAHs, although not as low as background levels, were at levels at which adverse effects on marine organisms are rarely observed.	Data not available	Data not available
1.9 – Polychlorinated biphenyls (PCB) in biota	Since 2012, 83% of the assessments in the Greater North Sea and 74% of assessments in the Celtic Sea have met the associated UK targets. CB118 was the only PCB congener to fail the Environmental Assessment Criteria (EAC) in four out of the five sampled biogeographic regions	Of the 329 trend assessments carried out in the Celtic Seas and Greater North Sea for polychlorinated biphenyls, 5 (2%) showed a significant upward trend, while 96 (29%) showed a significant downward trend. Of the 568 status assessments carried out, 442 (78%) were below the Environmental Assessment Criteria.	Data not available	All four of the biogeographic regions sampled showed significant downward trends, considering the mean of all seven PCB congeners.
1.10 – Polybrominated diphenyl ether (PBDE) in biota	No target exists/was found.	There is no long-term data, or OSPAR BACs or EACs against which to compare the data.	Data not available.	Data not available.
1.11 – Metals in biota	The concentrations of cadmium, lead and mercury measured in samples of fish and shellfish have been broadly stable and below thresholds, with 96% of assessments at 37 sampling stations monitored in the Greater North Sea, and 99% of assessments at 58 sampling stations monitored in the Celtic Seas met the individual target thresholds	Most sub-regions show static trends.	There is no long-term data to enable an assessment.	There is no long-term data to enable an assessment.
1.12 - Radionuclides	No target exists/was found.	The data is too limited (one site) to enable an assessment of England as a whole.	The data is too limited (one site) to enable an assessment of England as a whole.	The data is too limited (one site) to enable an assessment of England as a whole.

1.13 – Organotin-specific biological effects (imposex in gastropods)	Since 2012, imposex occurrence has reduced (generally below the UK parget threshold), the UK target has been met in 68% of assessments in the Greater North Sea and 89% of assessments in the Celtic Seas.	Most of the monitoring sites where assessments were made recorded mean values of Vas Deferens Sequence (VDS) below the Environmental Assessment Criteria (EAC) to a statistically significant degree.	Data not available	Data not available
1.14 – Oil and chemical spills	No target exists/was found.	The number of oil spills increased between 2000 and 2014 but the trend in the mass of material spilled is unknown.	The number of oil spills was higher in 2014 than in 2011 but the trend in the mass of material spilled is unknown.	The number of oil spills was higher in 2014 than in 2013, but the trend in the mass of material spilled is unknown.
1.15 – Organic carbon in the water column	No target exists/was found.	Data not available	Data not available	Data not available

Sea surface and water column temperature

Marine Climate Change Impacts Partnership (MCCIP) projection based on climate change scenario modelling: *'Warming of UK shelf seas is projected to continue over the coming century. Most models suggest an increase of between 0.25°C and 0.4°C per decade. There may be some regional differences. For example, warming is expected to be greatest in the English Channel and North Sea, with smaller increases in the outer UK shelf regions.'*[34]

NCC recommendation: To better account for variation, future assessments need to provide better coverage of the sea surface, and time series data on temperatures at different depths are needed to monitor changes in thermal stratification.

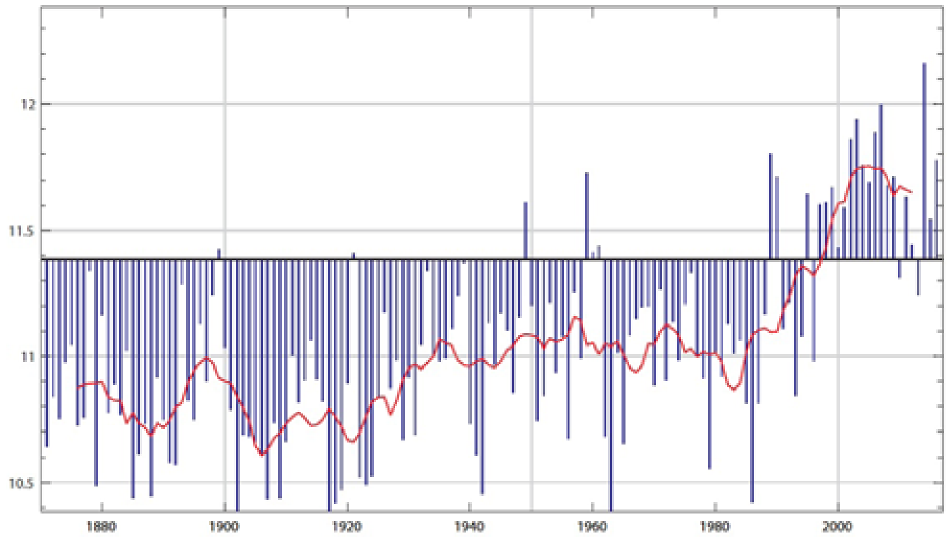
There is long-term data on the average temperature of UK shelf waters covering the period from 1870 to 2016. As presented in Figure 2 below, between 1870 and 1990 in most years the UK shelf waters temperature was below 11.5°C (degrees Celsius). Since 1990, in most years the temperature has been above 11.5°C and the trend shows an increasing pattern.[35]

The average sea temperature of UK waters between 2011 and 2016 continues to show the warming trend seen since the late 1990s. However, the cooler years (2011-2013) resulted in a slight decrease in the trend. The reduction is estimated to be around 0.28°C/decade over the period 1984-2014. The latter years of this period (2011-2016) were warmer, with 2014 presenting the highest positive anomaly relative to 1990-2010.

34 Marine Climate Change Impacts Partnership, *Report Card 2020 (2020)* http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

35 The blue bars show the annual values relative to the 1981-2010 average and the smoothed red line shows the 10-year running average.

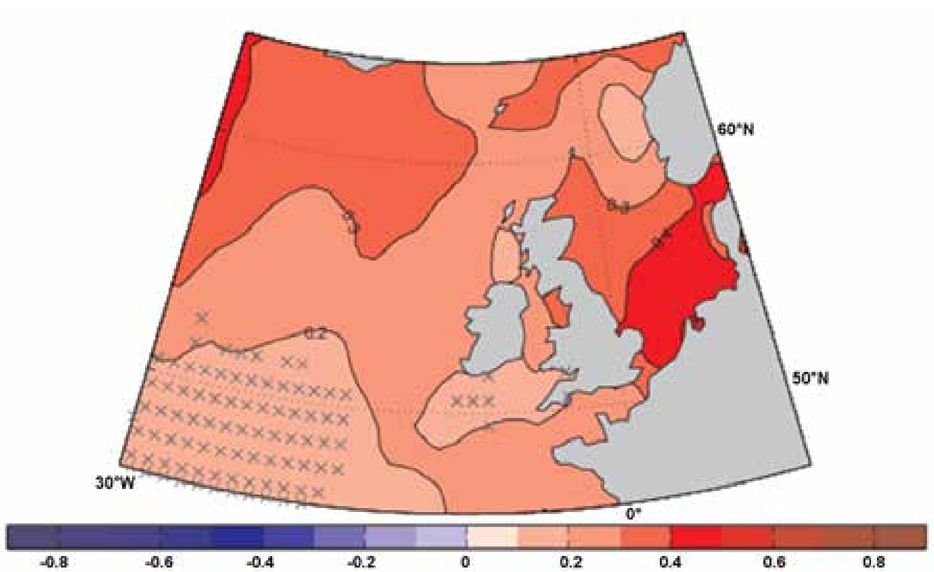
Figure 2: Time series of average sea surface temperature (in degrees Celsius) in UK shelf waters for the period 1870-2016. The blue bars show the annual values relative to the 1981-2010 average and the smoothed red line shows the 10-year running average.



Source: UKMMAS based on data from the HadISST1.1 data set.[36]

In addition to variation over time, there is also spatial variation in the temperature and warming rate of sea surface water. As per Figure 3, the highest temperature (trend from 1984 to 2014) occurs in the southern North Sea with 30-year warming rates of 0.45°C/decade. There have also been increases in the other seas around the UK: in the northern North Sea and the Atlantic Northwest Approaches the sea surface water temperature has been warming at a rate of 0.3-0.4°C/decade. The lowest observed warming UK area was the Celtic Sea at 0.17°C/decade.

Figure 3: Trend in annual average sea surface temperature (°C/decade) from 1984 to 2014. Hatched areas have a slope which is not significant at the 95% confidence level (alpha=0.05) using Mann-Kendall non-parametric test for a trend.



Source: UKMMAS[37] and based on data from Rayner and et al.[38]

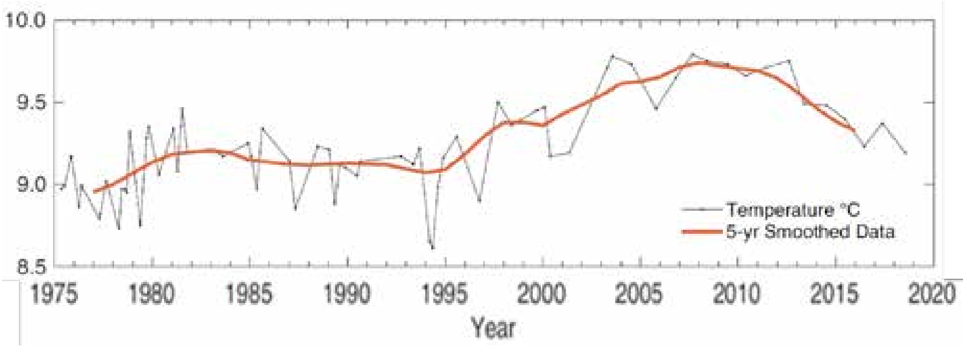
36 UKMMAS, *Sea surface and water column temperature in 2011-2015* https://moat.cefas.co.uk/ocean-processes-and-climate/sea-temperature/

37 UKMMAS, *Sea surface and water column temperature in 2011-2015* https://moat.cefas.co.uk/ocean-processes-and-climate/sea-temperature/

38 Rayner, N. et al, *Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century (2003)* https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2002JD002670

To supplement this data, the International Council for Exploration of the Sea (ICES)[39] has also kept a record of sea surface temperature for the Rockall Trough since 1975. As per Figure 4, it can be seen that between 1975 and 2008 temperatures were on an increasing trend, increasing from around 9°C in 1975 to over 9.5°C. Data for temperature after 2008 present a declining trend, towards the 9.0°C.

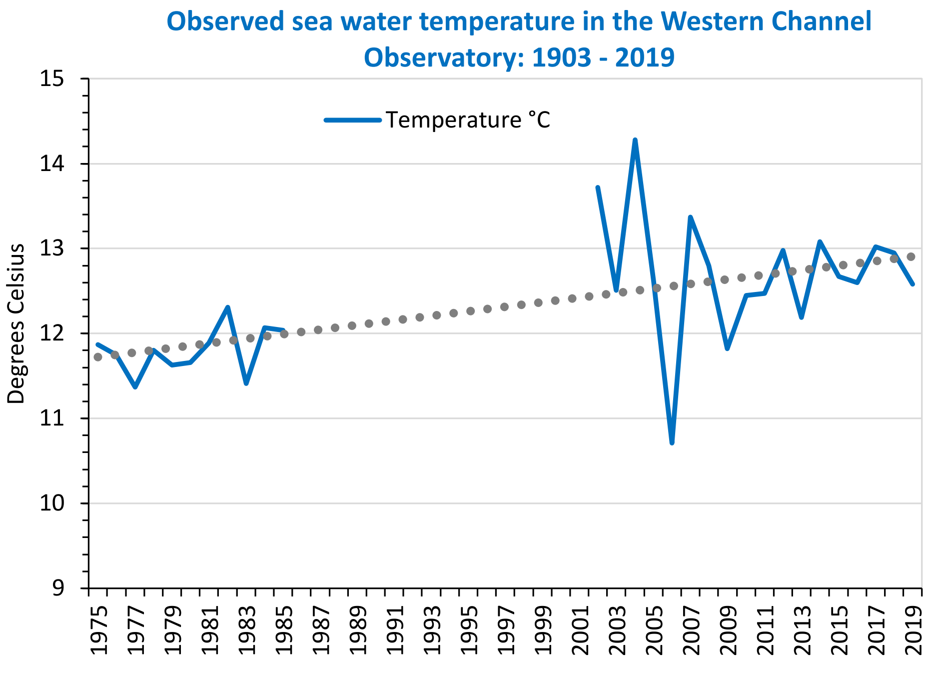
Figure 4: Rockall Trough temperature: 1975 - 2020



Source: ICES[40] based on data from the National Oceanography Centre and Scottish Association for Marine Science – UK.

In addition to the Rockall Trough data, there is also data available for some years from the Western Chanel Observatory which is found off the Plymouth coast. Data is available between 1975 and 1985 and between 2002 and 2019. There is more variability in the data for the later period than the earlier period. Starting from 1975, the linear trend is an increasing slope where the temperature was 0.7°C higher in 2019 than in 1975. When looking at the more recent period from 2002, sea temperature has declined from the 2004 peak of over 14°C to over 12°C in 2019. See Figure 5 for a historical trend since 1975.

Figure 5: Seawater temperature from the Western Channel Observatory: 1975 - 2019



Source: OSPAR[41] based on Western Channel Observatory[42] data

39 ICES, *ICES report on Ocean Climate 2018 (2019)* https://ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/CRR349.pdf

40 ICES, *ICES report on Ocean Climate 2018* (2019) https://ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/CRR349.pdf

41 OSPAR, *ICES report on Ocean Climate (IROC)* https://ocean.ices.dk/core/iroc

42 Western Channel Observatory, *L4 in-situ data station* https://www.westernchannelobservatory.org.uk/l4_ctdf/index.php

The latest assessment by Defra found in the Marine Strategy Part 3 that sea surface temperature was as follows. '*Between 2011 and 2015, the trend in sea surface temperature in UK waters reflects the warming observed in the Initial Assessment. A series of cold winters (2011 – 2013) resulted in a slight decrease to this trend, but since 2014 seas have been warmer again'.*[43] Based on this assessment a red RAG rating is given.

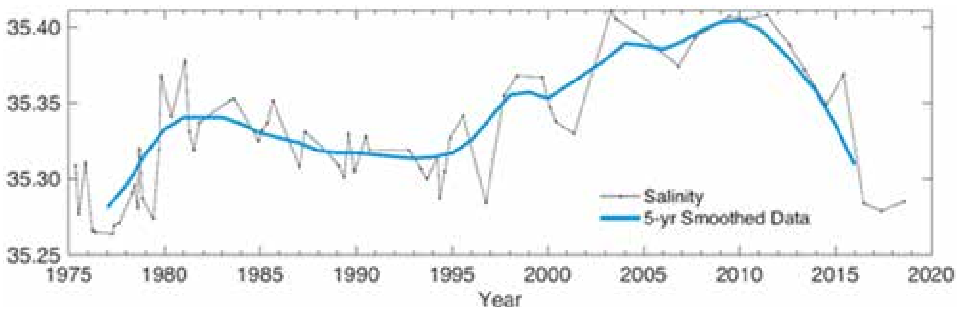
Sea surface and water column salinity

MCCIP projection based on climate change scenario modelling: '*Most 21st Century projections suggest that UK shelf seas, and the adjacent Atlantic Ocean, will be less saline than present, driven by ocean-circulation changes in response to climate change.'*[44]

Salinity and temperature have a vital role in controlling water density, affecting circulation patterns and the distribution and timing of stratification. Salinity also affects marine ecosystems. Changes to salinity in UK waters are largely influenced by the change in global circulation.[45]

The salinity levels of the upper ocean (0-800m water depth) to the west and the north of the UK have generally increased between 1975 and 2010, with a sharp decline from 2011, reaching values below the long-term mean (1981-2010) in 2018 in the Rockall Trough. Between 2016 and 2018, salinity was the lowest observed since 1978. See Figure 6 for the historical trend since 1975.

Figure 6: Rockall Trough salinity (lower panel) for the upper ocean (potential density 27.2– 27.50 kg m–3, representing the top 800m but excluding the seasonally warmed surface layer)



Source: ICES[46]

Data on salinity is also available from the Western Channel Observatory. As per temperature data, the time series is available between 1975 and 1985 and between 2002 and 2019. When looking over the whole time series the linear trend has an increasing slope. However, salinity levels in 1975 were almost identical to levels in 2019. Between 2011 and 2019, salinity levels have remained somewhat constant at around 35. See Figure 7 for the trend over time.

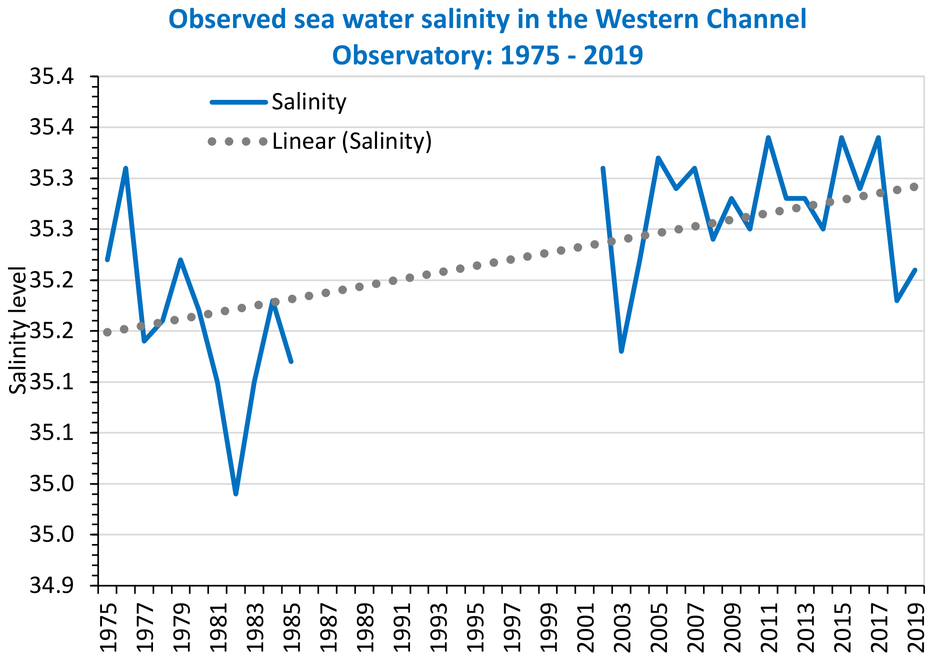
43 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status (2019)* https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

44 Marine Climate Change Impacts Partnership, *Report Card 2020 (2020)* http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

45 UKMMAS, *Sea surface and water column salinity in 2011-2015* https://moat.cefas.co.uk/ocean-processes-and-climate/salinity/

46 ICES, *ICES report on Ocean Climate 2018 (2019)* https://ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/CRR349.pdf

Figure 7: Seawater salinity from the Western Channel Observatory: 1975 - 2019



Source: OSPAR[47] based on Western Channel Observatory[48] data

The estimates in Table 7 below present the anomalies[49] which are relative to the mean and normalized by the standard deviation of salinity at each station for the period 1981-2010. For example, a value of +2 represents that the data are 2 standard deviations above the mean salinity. The anomalies are presented for the following sites:

- Western Channel Observatory;
- Rockall Trough;
- Faroe Shetland Channel - Shetland Shelf;
- Northern North Sea - Fair Isle Current;
- Southern North Sea – Felixstowe; and
- Southern North Sea - Helgoland Roads (Germany – which has been included for a broader context in the southern North Sea).

Table 7: Standardized salinity anomaly in the upper layer at stations around the UK and in the German Bight during the period 2000-2018. Shading highlights the scale of change with dark brown indicating higher increases in salinity while the darker green greater decreases in salinity

Observation site:	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Western Channel Observatory			1.55	-0.68	0.25	1.12	0.54	1.22	0.00	-0.02
Rockall Trough	1.17	1.14		1.79	1.75	0.92	0.64	1.16	1.32	1.54
Faroe Shetland Channel - Shetland Shelf	0.09	0.09	1.43	1.57	1.63	0.56	0.23	0.35	0.54	0.76
Northern North Sea - Fair Isle Current	-1.56	-1.93	-0.35	1.25	1.56	0.39	-0.26	-0.43	0.14	0.03
Southern North Sea - Felixstowe	0.08	-1.65	-1.23	-0.35	0.56	0.23	0.76	-0.2	1.27	1.13
Southern North Sea - Helgoland Roads (Ger)	0.04	-0.95	-0.27	0.6	0.44	0.29	1.02	-0.63	0.93	1.17

47 OSPAR, *ICES report on Ocean Climate (IROC)* https://ocean.ices.dk/core/iroc

48 Western Channel Observatory, *L4 in-situ data station* https://www.westernchannelobservatory.org.uk/l4_ctdf/index.php

49 "Anomalies" are the mathematical differences between each individual measurement and the average value of temperature, salinity, or other variables at each location. Positive anomalies in salinity imply saline conditions; negative anomalies imply fresh conditions.

Observation site:	2010	2011	2012	2013	2014	2015	2016	2017	2018
Western Channel Observatory	-0.11	0.87	1.17	0.11	-0.54	0.46	0.36		
Rockall Trough	1.49	1.57	1.02	0.58	-0.05	0.5	-1.82	-1.97	-1.8
Faroe Shetland Channel - Shetland Shelf	0.83	0.76	0.3	-0.04	0.06	-0.34	-1.3	-2.12	-1.98
Northern North Sea - Fair Isle Current	-0.53	0.47	0.74	-0.65	-0.76	-0.43	-0.58	-0.86	-0.95
Southern North Sea - Felixstowe	-1.47	0.8	2.07	-0.06	0.47	1.13	0.2	1.13	
Southern North Sea - Helgoland Roads (Ger)	-0.15	0.25	0.82	-0.58	1.21	0.67	1.15	0.7	1.57

Source: ICES Ocean Climate reports since 2003/04.[50]

Based on the latest assessment by Defra found in the Marine Strategy Part 3, in the UK '*the salinity of the upper ocean to the west and north of the UK has decreased sharply from 2011. This probably reflects a change in balance between the subtropical (salty) seawater versus subpolar (fresh) seawater in the North-East Atlantic. Lower salinity was also observed in the northern North Sea between 2013 and 2015'*.[51] Based on this assessment an amber RAG rating is given.

Seawater pH (ocean acidification)

MCCIP projection based on climate change scenario modelling: '*High-emission scenario models project that the average pH of continental shelf seawater could drop by up to 0.366 by 2100. Spatial variability in the rate of pH decline is projected with coastal areas declining faster. Under high-emission scenarios, it is projected that bottom waters will become corrosive to more-soluble forms of calcium carbonate (aragonite). Episodic undersaturation events are projected to begin by 2030. By 2100, up to 20% of the North-west European shelf seas may experience undersaturation for at least one month of each year.'*[52]

To be able to estimate long-term trends in pH, datasets need to cover a period longer than 25 years. The fixed-point data for UK waters is not long enough to calculate trends. The evidence the NCC presents are based on the findings from the ICES data[53] for the Greater North Sea, which cover the period 1984-2014 and have been produced for the *Carbon dioxide and ocean acidification observations in UK waters report*[54]. Also, to provide an indication of pH level in UK waters, data are presented for three sites across the UK.

Figure 8 shows a map of the location of the ICES pH data, with the OSPAR boundaries. The only regions to have been adequately sampled were in the Greater North Sea including the English Channel. The data used for the analysis starts in 1984, as there were not enough pH measurements from earlier data. The measurements are made within the top 20m.[55]

50 ICES, *Publications* https://www.ices.dk/publications/Pages/Home.aspx

51 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status (2019)* https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

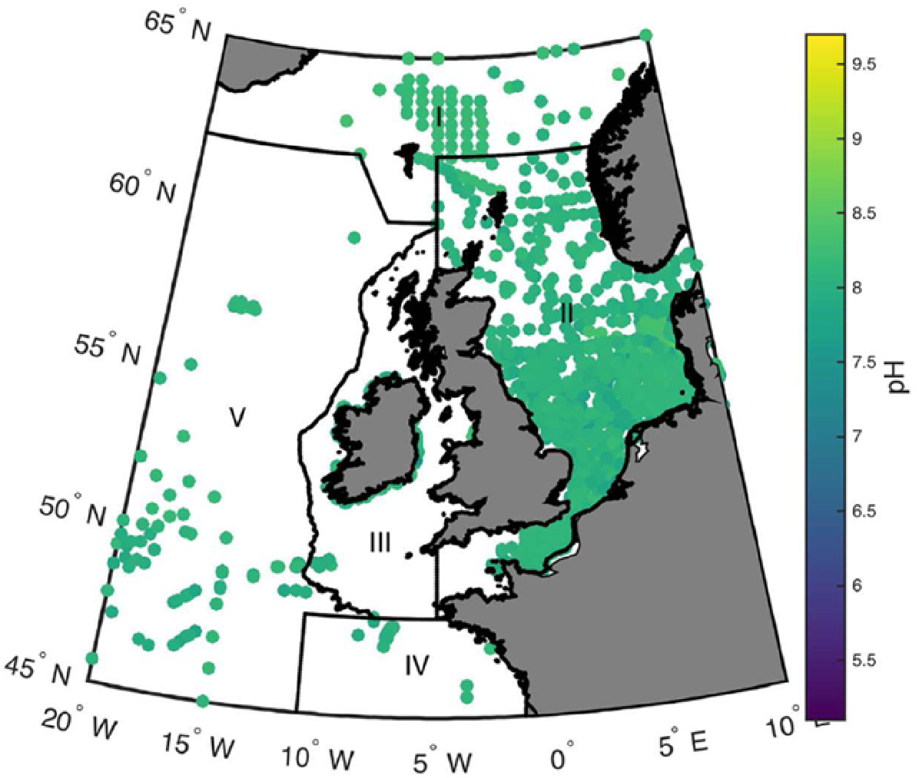
52 Marine Climate Change Impacts Partnership, *Report Card 2020 (2020)* http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

53 UKMMAS, *pH and ocean acidification* https://moat.cefas.co.uk/ocean-processes-and-climate/ocean-acidification/

54 Ostle, C., Williamson, P., et al., *Carbon dioxide and ocean acidification observations in UK waters: Synthesis report with focus on 2010 -2015 (2016)* https://ueaeprints.uea.ac.uk/id/eprint/59604/1/2016_Ostle_et_al_OA_synthesis_LowRes.pdf

55 Ibid.

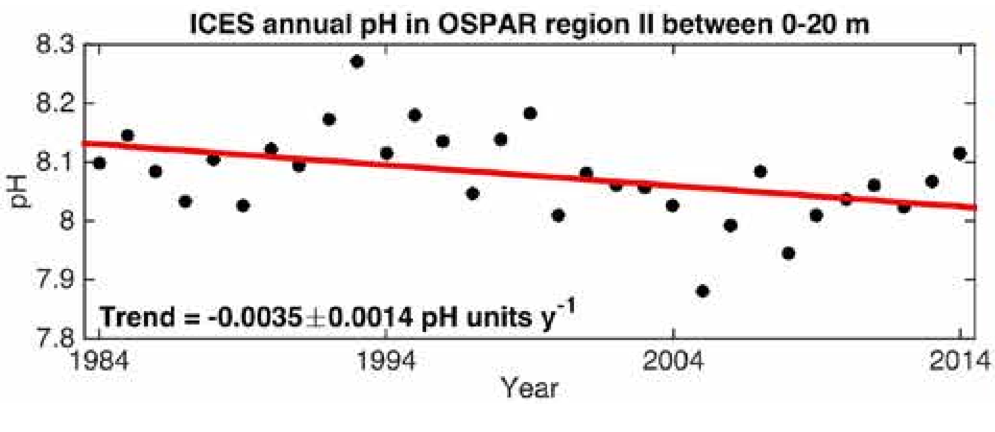
Figure 8: Map of the ICES pH data with OSPAR boundaries



Source: Ostle, C., Williamson, P., et al.[56] based on ICES data.

The analysis results are presented in Figure 9 and present a slightly declining trend in mean pH over the period (red line), from just over 8.1 to just over 8.0. The figure also presents the standard deviation.

Figure 9: Mean annual pH within the top 20m for the Greater North Sea between 1984 and 2014



Source: Ostle, C., Williamson, P., et al.[57] based on ICES data.

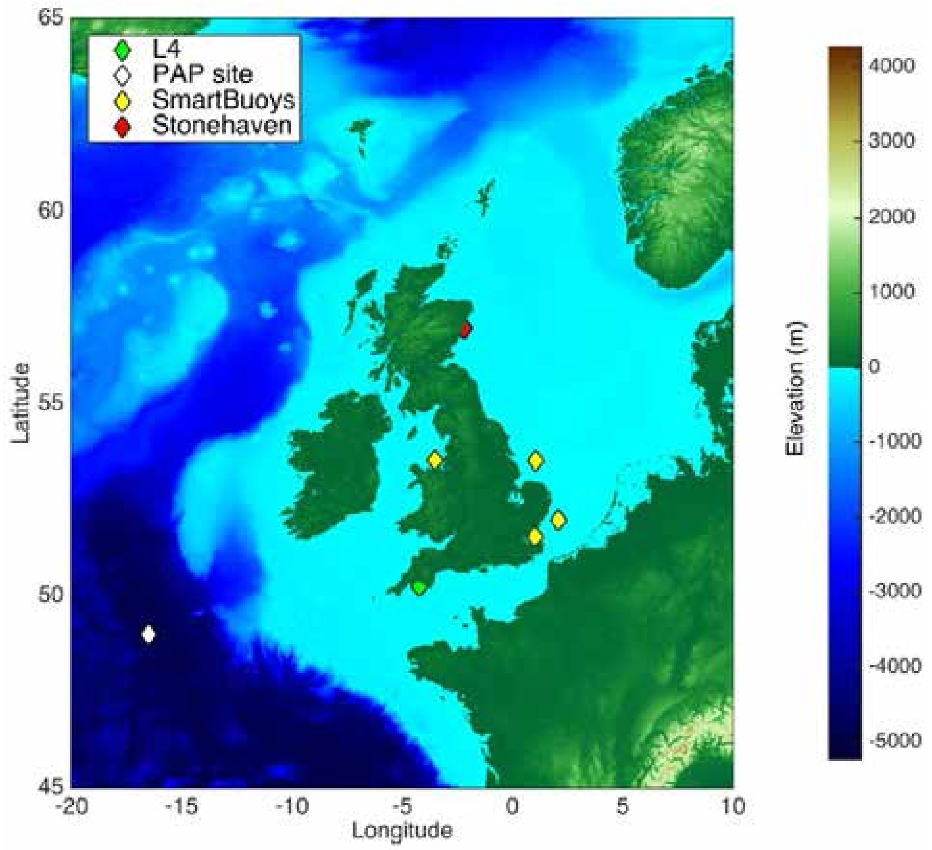
56 Ostle, C., Williamson, P., et al., *Carbon dioxide and ocean acidification observations in UK waters: Synthesis report with focus on 2010 -2015 (2016)* https://ueaeprints.uea.ac.uk/id/eprint/59604/1/2016_Ostle_et_al_OA_synthesis_LowRes.pdf

57 Ostle, C., Williamson, P., et al., *Carbon dioxide and ocean acidification observations in UK waters: Synthesis report with focus on 2010 -2015 (2016)* https://ueaeprints.uea.ac.uk/id/eprint/59604/1/2016_Ostle_et_al_OA_synthesis_LowRes.pdf

In terms of UK point site data, the same report (*Carbon dioxide and ocean acidification observations in UK waters report)* has estimated the pH levels for three sites (L4, Stonehave, and Smartbuoys) across the UK, as per Figure 10.

Figure 11 presents pH values calculated from DIC[58]and TA[59] based on samples collected from these three sites. Although these fixed-point observatories are positioned at different locations around the UK (covering the North Sea, Celtic Sea, and the English Channel) they all show high variability with pH estimates ranging from just over 7.7 to over 8.3, they compare reasonably well. Thus, pH shows clear seasonality, and particularly strong variability in some years.[60]

Figure 10: Fixed-point observation sites in the UK



Source: Ostle, C., Williamson, P., et al.[61]

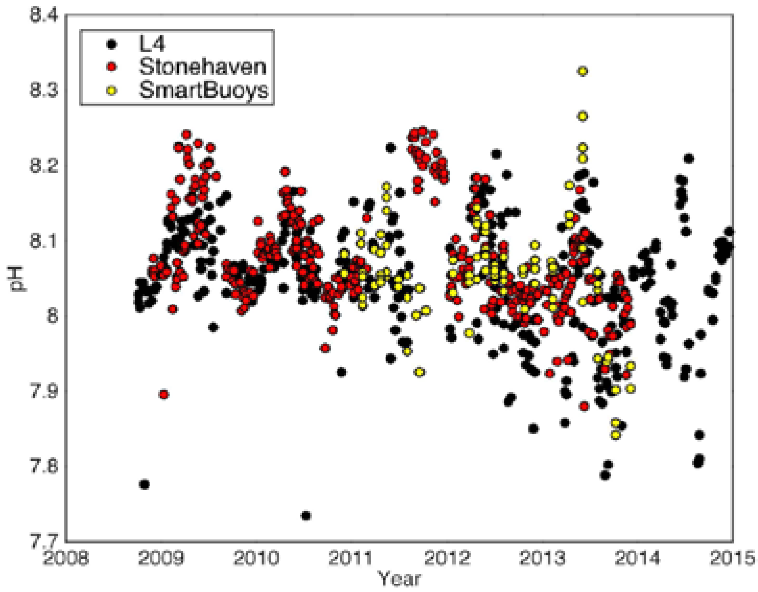
58 DIC is the sum of all of the dissolved forms of inorganic carbon, this is often measured using a coulometric method.

59 TA is the total alkalinity, which is the balance of all of the ionic charges in themarine carbonate system. TA is usually measured using an acidimetric titration.

60 Ostle, C., Williamson, P., et al., *Carbon dioxide and ocean acidification observations in UK waters: Synthesis report with focus on 2010 -2015 (2016)* https://ueaeprints.uea.ac.uk/id/eprint/59604/1/2016_Ostle_et_al_OA_synthesis_LowRes.pdf

61 Ostle, C., Williamson, P., et al., *Carbon dioxide and ocean acidification observations in UK waters: Synthesis report with focus on 2010 -2015 (2016)* https://ueaeprints.uea.ac.uk/id/eprint/59604/1/2016_Ostle_et_al_OA_synthesis_LowRes.pdf

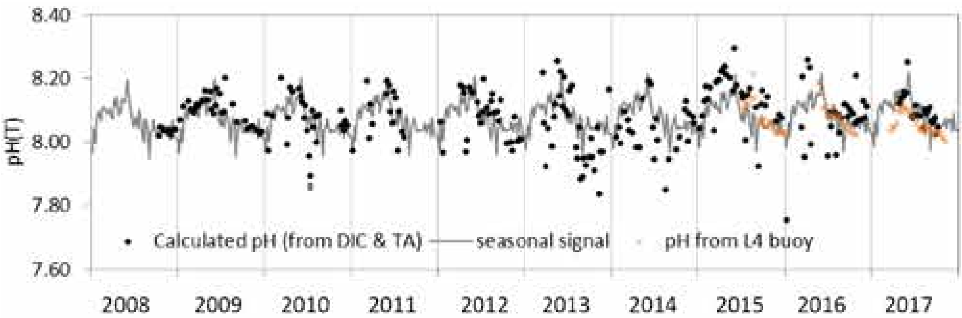
Figure 11: pH calculated from DIC and TA samples collected at fixed-point observatories. L4 = black circles, Stonehaven = red circles, SmartBuoys = yellow circles



Source: Ostle, C., Williamson, P., et al.

A more recent study has also looked at observation from the Western Channel observatory (see Figure 12) and we can see trend following a similar pattern between 2015 and 2017.

Figure 12: Annual pH cycle at the Western Channel Observatory L4 site of Plymouth



Source: Defra[62] based on Kitidis, V. et al.[63]

Based on this limited model evidence an assessment is presented in the Marine Strategy Part 3, where '*between 2010 and 2015, the evidence of ocean acidification for UK waters is consistent with the global trend, which shows the pH of seawater is decreasing. There is a strong seasonal, inter-annual, depth and spatial variability in pH across UK waters.*'[64]

62 Defra, *Recommendations to inform a UK ocean acidification monitoring strategy (2018)* https://www.gov.uk/government/publications/recommendations-to-inform-a-uk-ocean-acidification-monitoring-strategy

63 Kitidis, V. et al., *Seasonal dynamics of the carbonate system in the Western English Channel (2012)* https://www.sciencedirect.com/science/article/pii/S0278434312001008?via%3Dihub

64 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status (2019)* https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

Nutrients

Dissolved inorganic nitrogen and phosphorus concentrations

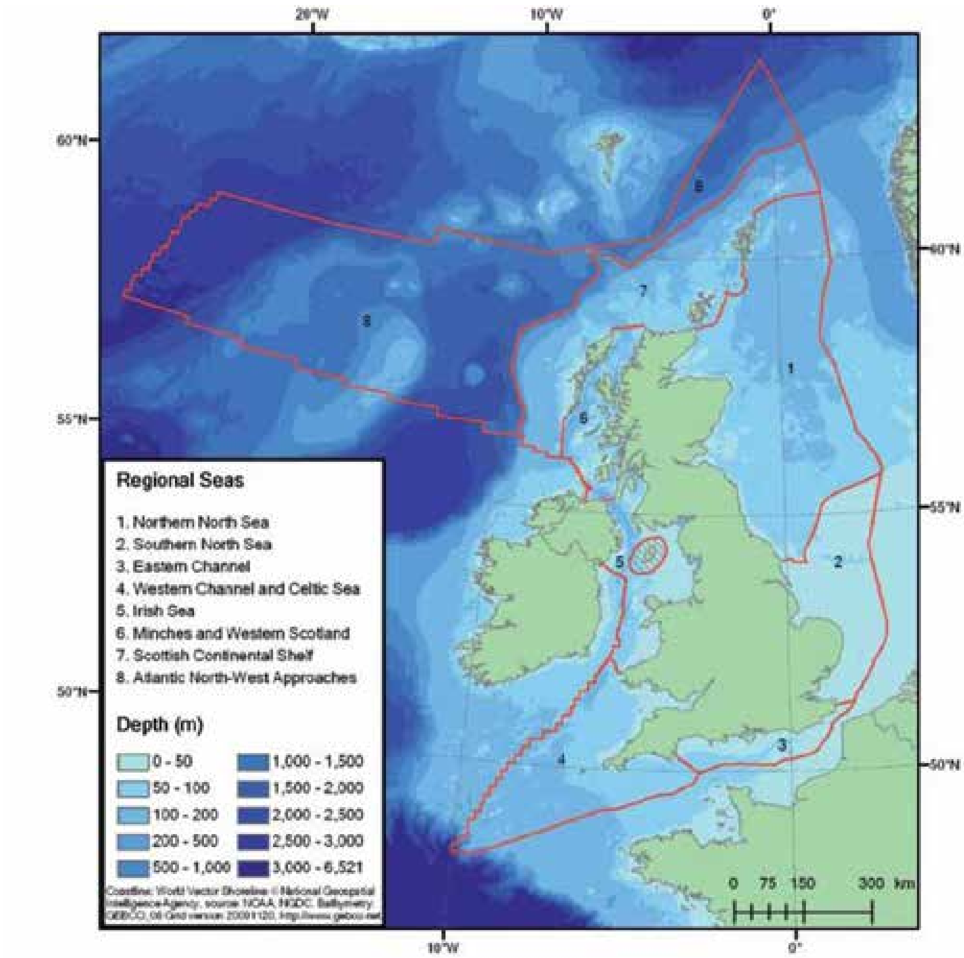
There is limited data on the concentrations of dissolved inorganic nitrogen (DIN) and phosphorus (DIP) in England (or the UK). The most recent evidence covers the period between 1990 and 2014 and is found in the *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report*[65]. Modelled estimates have been compiled on the mean concentration of DIN and DIP for regional seas around the UK. The regional seas under the scope of the *Common Procedure report* are presented in Figure 13 below.

The assessment that follows will focus on two regional seas covering areas 1 and 2. However, evidence is available for regions 1 - 5 (the northern North Sea, southern South Sea, Eastern Channel, Western Channel and the Celtic Sea and the Irish Sea) *in the Common Procedure report annexes*. The evidence presented here should be treated with caution as it may include evidence and data from outside England (e.g. Scotland).

As per Figure 14, normalised mean winter concentrations of DIN (μM) in the northern North Sea have ranged between 7-15 μM for coastal waters[66] and 6-11 μM for offshore waters[67]. These estimates were within the thresholds assessed in the *Common Procedure report* of 18 μM (red line) and 15 μM (dashed red line) respectively.

In terms of DIP, the estimated mean winter DIN:DIP ratios were below the *Common Procedure report* of 24 for both coastal and offshore (as per Figure 15). The highest ratio was found in 2012.

Figure 13: UK regional seas boundaries



Source: Charting Progress 2.[68]

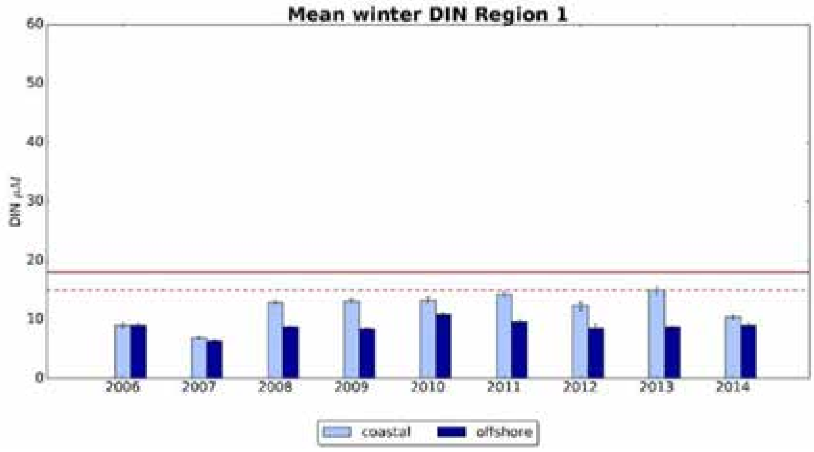
65 Painting, S., et. al., *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report (2016)* https://www.ospar.org/work-areas/hasec/eutrophication/common-procedure

66 Coastal data were normalised to salinity 32.

67 Offshore data were normalised to salinity 34.5.

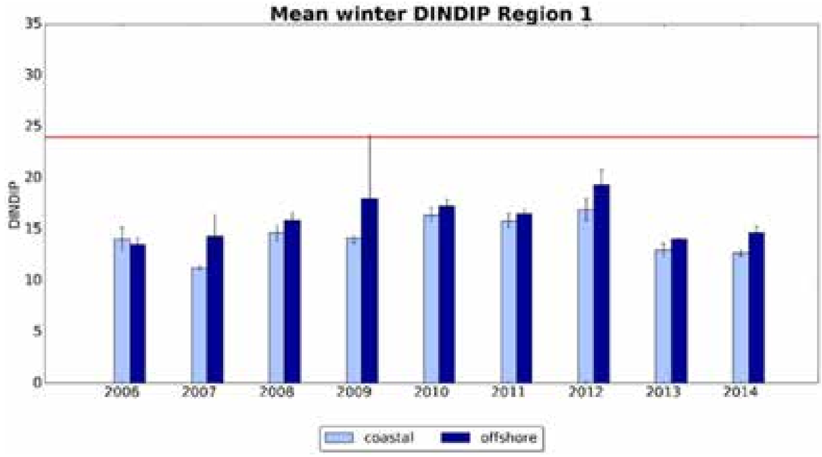
68 UKMMAS, *Charting Progress 2: An assessment of the state of UK seas (2010)* https://www2.gov.scot/Topics/marine/science/atlas/CP2

Figure 14: Normalised mean winter concentration of dissolved inorganic Nitrogen for the northern North Sea region between 2006 and 2014



Source: Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report. [69]

Figure 15: Mean winter ratios of DIN:DIP in the northern North Sea between 2006 and 2014



Source: Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report. [70]

When looking at evidence for the southern North Sea, there is a significant variation between coastal[71] and offshore[72] data as per Figure 16. For coastal waters, the normalised winter mean concentrations ranged between 20 and 59 µM, which exceeded the *Common Procedure report* threshold of 18 µM (red line) for every year assessed between 2006 and 2014. For offshore waters, the normalised winters mean was above the *Common Procedure report* threshold of 15 µM (dashed red line) for three years (2006, 2007, and 2013), and below the threshold for the remaining six years.

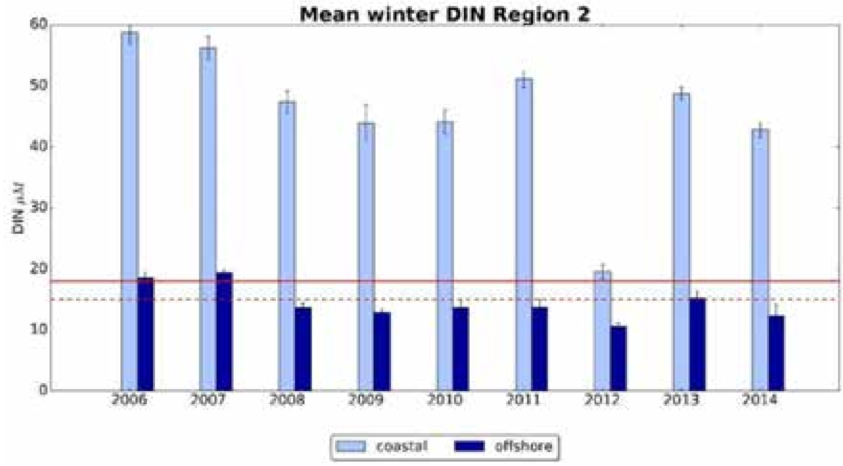
69 Painting, S., et. al., *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report (2016)* https://www.ospar.org/work-areas/hasec/eutrophication/common-procedure

70 Ibid.

71 Coastal data were normalised to salinity 32.

72 Offshore data were normalised to salinity 34.5.

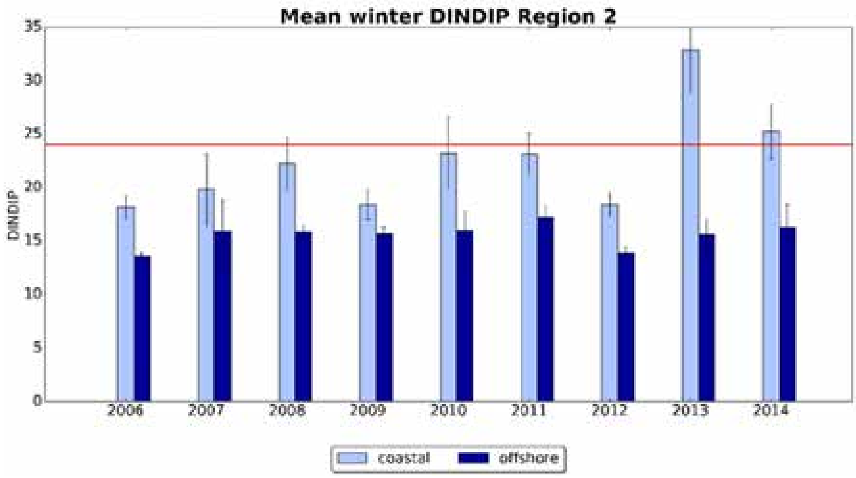
Figure 16: Normalised mean winter concentrations of dissolved inorganic nitrogen in the southern North Sea between 2006 and 2014



Source: Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report. [73]

There was also variation in the DIN:DIP ratio for coastal and offshore areas. The estimated mean was higher for coastal waters and exceeded the *Common Procedure report* threshold (red line) of 24 in 2013 and 2014, which could indicate a potential problem with nitrogen enrichment in coastal waters – see Figure 17 below. The estimated winter mean for offshore was below the *Common Procedure report* of the threshold, remaining below 20 through the whole period.

Figure 17: Mean winter ratios of DIN:DIP in the southern North Sea between 2006 and 2014



Source: Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report. [74]

73 Painting, S., et. al., *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report (2016)* https://www.ospar.org/work-areas/hasec/eutrophication/common-procedure

74 Painting, S., et. al., *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report (2016)* https://www.ospar.org/work-areas/hasec/eutrophication/common-procedure

For sea regions 3-5, a high-level assessment is presented in Table 8 below for coastal and offshore. For completeness, regions 1 and 2 are also summarised. For further details on the individual assessments for each of the seas, see annexes 1-7 and annexes 8-11 from the *Common Procedure for Identification of the Eutrophication Status of the UK Maritime Area: UK National report*[75].

Table 8 High-level assessment by sea region and nutrient

Nutrient	Sea region	High-level assessment
DIN	Northern North Sea (Region 1)	The normalised mean winter concentrations for coastal and offshore areas were below the threshold for all years under the assessment (2006-2014).
DIN:DIP ratio		The DIN:DIP ratio was below the threshold for the all years under the assessment.
DIN	Southern North Sea (Region 2)	The normalised mean winter concentrations for coastal areas were above the threshold for all years. They were also above the threshold for some years in the offshore areas.
DIN:DIP ratio		The DIN:DIP ratio was below the threshold for offshore areas over the whole period of the assessment (2006-2014). For coastal the ratio was above in 2013 and 2014.
DIN	Eastern Channel (Region 3)	Data is only available for offshore for some of the years and normalised mean winter concentrations for four out of the seven estimates were above the threshold. When the mean is above the threshold this could indicate some potential problems with nitrogen enrichment.
DIN:DIP ratio		There were also limited data points for the DIN:DIP ratio. Here, however, all mean winter concentrations were below the threshold value.
DIN	Western Channel and Celtic Sea (Region 4)	There are very limited data points assessed (2008, 2011, 2012 and 2013 – offshore; and 2012 and 2013 for coastal). Coastal normalised mean winter concentrations were above the threshold.
DIN:DIP ratio		As per DIN there is only a limited number of data points in the assessment. In 2013 (latest data) the coastal ratio was above the threshold, while the offshore was below.
DIN	Irish Sea (Region 5)	The data was below the threshold level for both coastal and offshore. However, the winter mean concentration has increased since 2012 for coastal.
DIN:DIP ratio		The DIN:DIP ratio remained below the threshold over the whole period under assessment (2006 -2014)

Chlorophyll-a

In addition to concentrations of nutrients, concentrations of chlorophyll-a are also used to assess eutrophication caused by excessive nutrient loads. The most recent assessment of the level of chlorophyll-a in the UK covers the period between 2006 and 2014. It shows that the UK has met its concentration target for eutrophication 'non-problem area'[76], which is that there should be no increase in the chlorophyll 90th percentile in the growing season (linked to increasing anthropogenic input) based on periodic surveys.[77]

Based on this latest assessment, growing season chlorophyll 90th percentiles were compared against assessment thresholds[78] for coastal waters (15 µg l-1) and offshore waters (10 µg l-1). As can been seen in Figure 18 results from coastal and offshore estimates were below both thresholds for the Greater North Sea and the Celtic Sea.

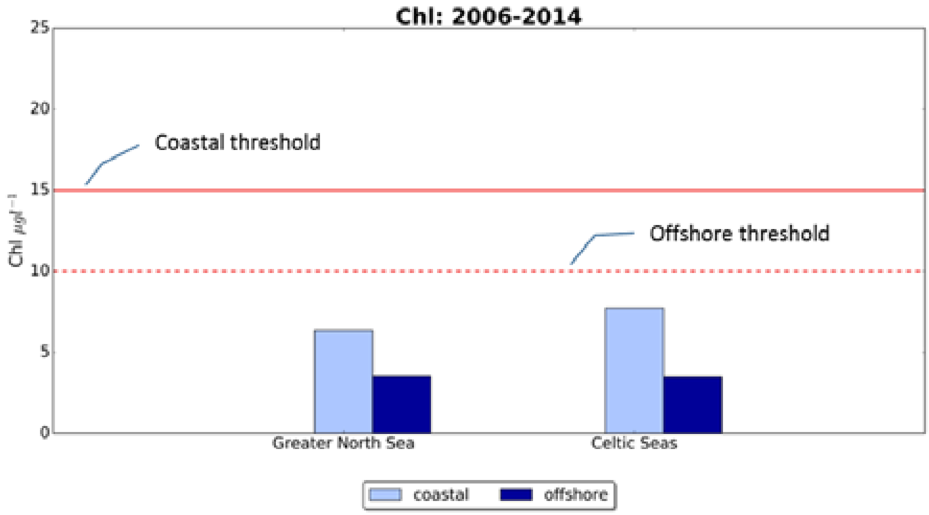
75 Ibid.

76 Human-induced eutrophication in UK seas is minimised and all UK marine waters are 'non-problem areas', where:
- nutrient concentrations do not lead to an undesirable disturbance to the balance of organisms present in the water or to the quality of the water concerned resulting from accelerated growth of algae
- the direct effects of nutrient enrichment associated with algal growth do not constitute or contribute to an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned
- indirect effects of nutrient enrichment associated with growth of macroalgae, sea grasses, and reductions of oxygen concentrations do not constitute an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. Source: https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/

77 UKMMAS, *Chlorophyll Concentrations in the Water Column* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/chlorophyll/

78 Determination of the reference values and thresholds used for chlorophyll in coastal and offshore waters is described here: https://link.springer.com/article/10.1007/s10533-010-9475-9

Figure 18: Chlorophyll-a 90th percentiles over the assessment period (2006-2014)

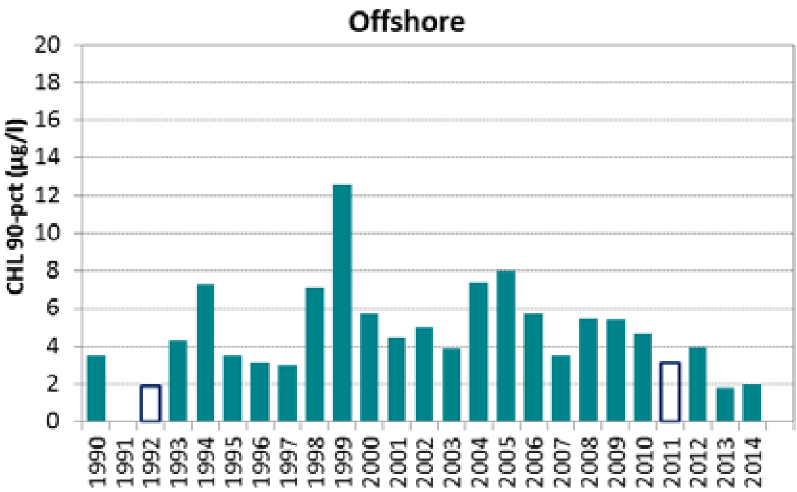


Source: UKMMAS based on OSPAR data[79]

Evidence is also available per sea area from 1990 to 2014. The evidence is presented in the graphs that follow starting with Figures 19 and 20 which presents evidence for the northern North Sea, followed by Figures 21 and 22 for the southern South Sea area, and Figure 23 and 24 for the Celtic Seas. As can be seen from these graphs the highest chlorophyll-a concentrations are found in coastal waters.

There was an increasing trend in offshore concentrations of chlorophyll-a in the northern North Sea between 1990 and 1999. Post-1999, there was a decline in concentrations from over 12μg/l in 1999 to around 2μg/l in 2014. Concentrations have also declined between 2011 and 2014. However, concentrations have slightly increased between 2013 and 2014. For coastal waters there is limited data, with the data available presenting a similar trend, increasing between 2008 and 2010 and then declining between 2010 and 2014. When comparing the levels from 2011 and 2014 we can see a slight increase from under 2μg/l to around 3μg/l respectively. Between 2013 and 2014 there was a decline in concentrations. See Figure 19 and 20 for the historical trends in the northern North Sea.

Figure 19: The 90-percentile growing-season (March–September) chlorophyll-a concentrations northern North Sea offshore (salinity ≥30)

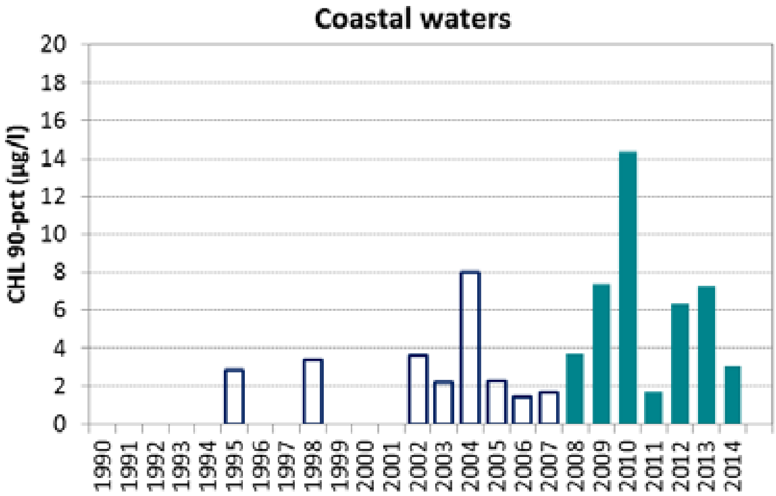


Source: OSPAR[80]

79 UKMMAS, *Chlorophyll Concentrations in the Water Column* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/chlorophyll/

80 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

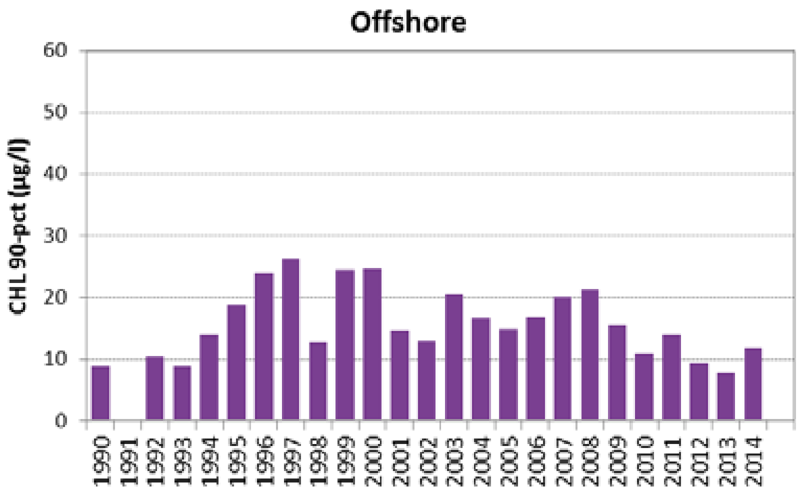
Figure 20: The 90-percentile growing-season (March–September) chlorophyll-a concentrations in northern North Sea coastal salinity zone (salinity 18 to <30)



Source: OSPAR[81]

There has been an increasing trend for offshore concentrations of chlorophyll-a in the southern North Sea between 1990 and 1997. From 1997 onwards, the trend starts to slightly decline from a peak of 27µg/l to around 12µg/l in 2014. Concentrations have also declined between 2011 and 2014. However, concentrations have slightly increased between 2013 and 2014. For coastal waters, after a peak in 1996 of just under 60µg/l, concentrations declined and stabilised between around 20 and around 30µg/l until 2007. In 2008, there was a significant increase and then a steady decline until 2013. Between 2011 and 2014 there was a decline from around 22µg/l to around 16µg/l respectively. Between 2013 and 2014 there was a decline in concentrations. See Figures 21 and 22 for the historical trends in the southern North Sea.

Figure 21: The 90-percentile growing season (March–September) chlorophyll-a concentrations in the southern North Sea offshore (salinity ≥30)

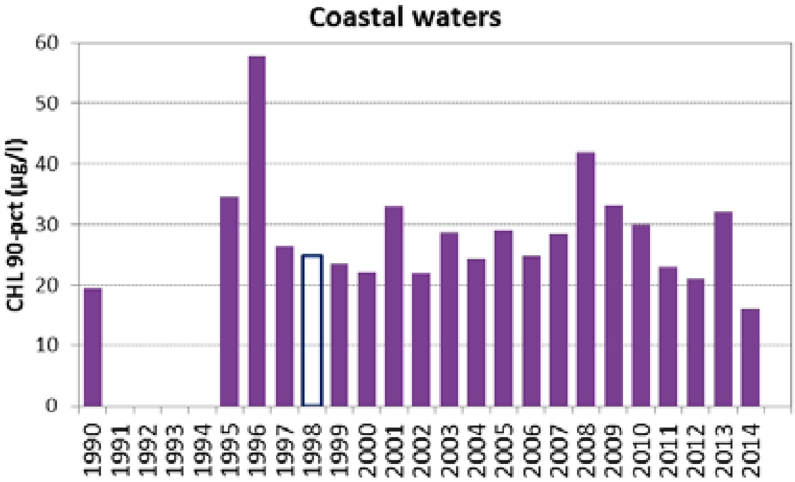


Source: OSPAR[82]

81 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

82 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

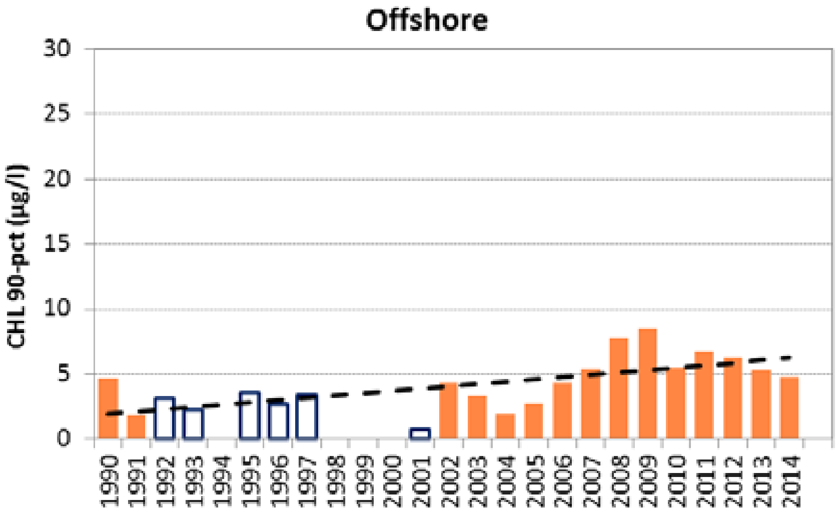
Figure 22: The 90-percentile growing season (March–September) chlorophyll-a concentrations in the southern North Sea coastal salinity zone (salinity 18 to <30)



Source: OSPAR[83]

There has been an increasing trend for offshore concentrations of chlorophyll-a in the Celtic Sea. From 2010 onwards the trend started to decline slightly from a peak of around 8µg/l to around 5µg/l in 2014. Concentrations have also declined between 2011 and 2014. See Figures 23 and 24 for the historical trends in the Celtic Sea.

Figure 23: The 90-percentile growing season (March–September) chlorophyll-a concentrations in the Celtic Sea offshore (salinity ≥30)



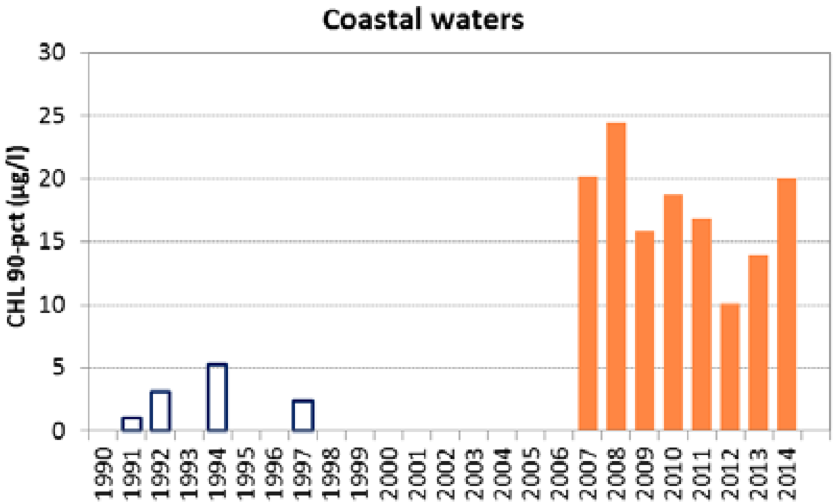
Source: OSPAR[84]

83 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

84 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

For coastal waters concentrations present some variation. There was a declining trend between 2008 and 2012 from around 24µg/l to around 10µg/l respectively – See Figure 24. Concentrations then started increasing again to around 20µg/l in 2014. Between 2011 and 2014 there was a slight increase from around 17µg/l to around 20µg/l. There was an increase between 2013 and 2014.

Figure 24: The 90-percentile growing season (March–September) chlorophyll-a concentrations in the Celtic Sea coastal salinity zone (salinity 18 to <30)



Source: OSPAR[85]

Dissolved oxygen

MCCIP projection based on climate change scenario modelling: '*Dissolved oxygen concentrations will decrease as ocean temperature increases, due to a reduction in the solubility of dissolved oxygen alongside a predicted increase in the strength and duration of stratification. Models predict that by the end of the century, dissolved oxygen concentrations in the global ocean may decline by up to 4%, whilst concentrations in UK regional seas, such as the North Sea could decline by up to 11.5%. Oxygen concentrations in UK seas are projected to decline more than the global average, especially in the North Sea.*'[86]

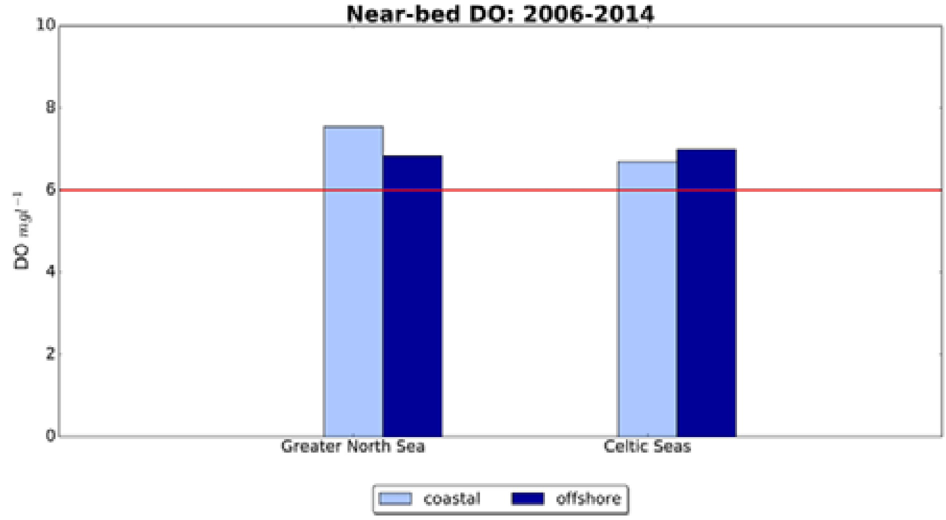
The latest evidence on dissolved oxygen near the seafloor covers the period from 2006 to 2014 and is based on the ICES data.[87] As per Figure 25, average concentrations are above the threshold level of 6mg/l for both coastal and offshore areas and the Greater North Sea and the Celtic Sea. Concentrations in coastal areas were higher than offshore areas in the Greater North Sea, while concentrations at offshore areas were higher in the Celtic Sea.

85 OSAPR, *Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/chlorophyll-concentrations/

86 Marine Climate Change Impacts Partnership, *Report Card 2020 (2020)* http://www.mccip.org.uk/impacts-report-cards/full-report-cards/2020/

87 Data were filtered for analysis by selecting only data within 10 m of the seabed and total water column depth < 500 m during the stratification season (1 July to 31 October) and applying salinity filters to focus on coastal waters (salinity 30 - <34.5 in all sub-regions, except in the Irish Sea, 30 - <34) and offshore waters (salinity ≥34.5 in all sub-regions, except in the Irish sea, salinity ≥34).

Figure 25: Concentrations of dissolved oxygen (mg/l), near the seabed in the Greater North Sea and Celtic Seas: 2006 - 2014 (as average values in the lowest quartile of the data)



Source: UKMMAS[88]

Data is also available as a time series for both the Greater North Sea and the Celtic sea. The time series for the Greater North Sea is presented in Figure 26 where it can be seen that for almost all years concentrations of dissolved oxygen were above the threshold (oxygen concentrations in bottom waters should remain above area-specific oxygen assessment levels (4 to 6 mg l-1), aiming for no benthic species mortality events as a result of oxygen deficiency that are directly related to anthropogenic input of nutrients)[89], with the exception of 2003 for both coastal (blue circles) and offshore (orange circles).

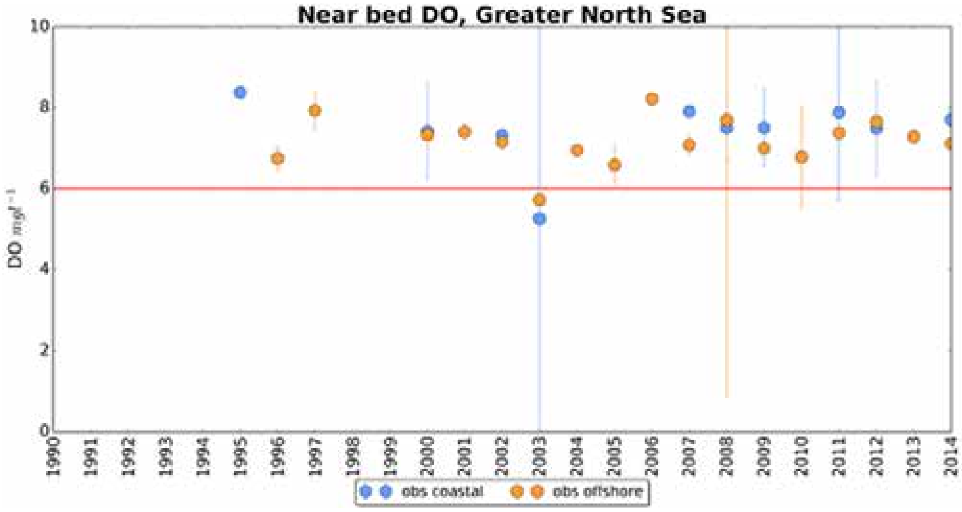
A similar pattern is seen in the Celtic Sea (see Figure 28), where for most years concentrations were above the threshold with the exception of three years (1991 and 2008 - coastal concentrations were below the threshold; and 2005 – offshore concentrations were below the threshold).

Spatial and temporal representativeness (2006-2014) of available near-bed dissolved oxygen concentration data was low.

88 UKMMAS, *Concentrations of dissolved oxygen near the seafloor* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/dissolved-oxygen/

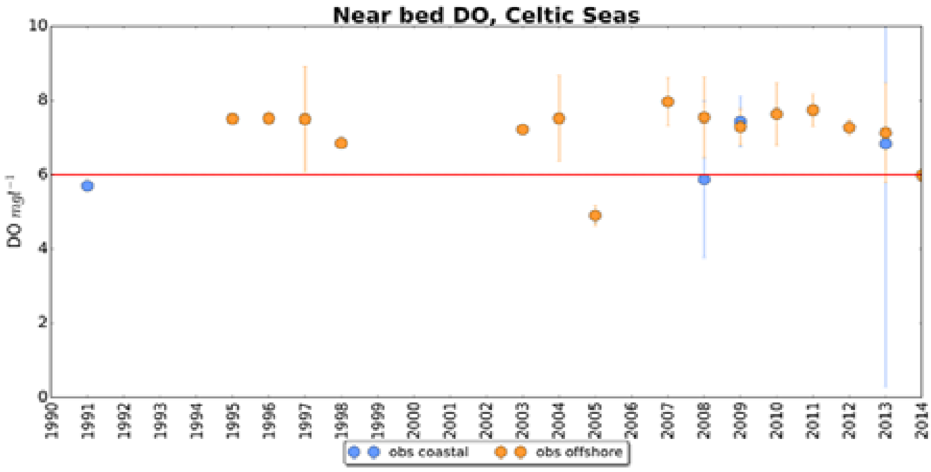
89 CEFAS, *Concentrations of dissolved oxygen near the seafloor* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/dissolved-oxygen/

Figure 26: Time series on concentrations of near-bed dissolved oxygen (DO; mg l^{-1}, as average values in the lowest quartile of the data) in the Greater North Sea: 1990 - 2014



Source: UKMMAS90

Figure 27: Time series on concentrations of near-bed dissolved oxygen (DO; mg l^{-1}, as average values in the lowest quartile of the data) in the Celtic Seas: 1990 - 2014



Source: UKMMAS[91]

Suspended particulate matter (SPM) and turbidity

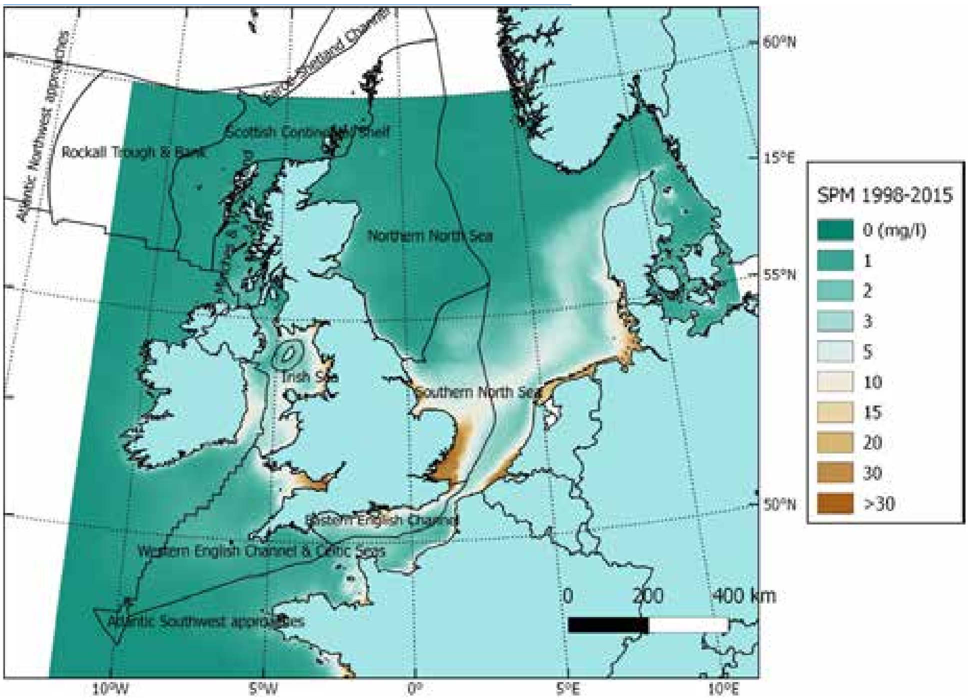
There is limited data on suspended particulate matter (SPM) which in shelf areas determines turbidity in the seawater. Data on the concentration level per annum was not available, only data presenting the concentrations for the whole period 1998-2015. As can be seen from Figure 28 below, the regions with the highest concentrations in England are seen nearer to the coast in:

- East of England in the southern North Sea;
- The Eastern English Channel;
- The Bristol Channel within the Western English Channel and Celtic Seas; and
- The Irish Sea.

90 UKMMAS, *Concentrations of dissolved oxygen near the seafloor* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/dissolved-oxygen/

91 UKMMAS, *Concentrations of dissolved oxygen near the seafloor* https://moat.cefas.co.uk/pressures-from-human-activities/eutrophication/dissolved-oxygen/

Figure 28: Satellite-derived annual mean surface suspended particulate matter (SPM) concentration (mg/l) for the period 1998-2015 and Charting Progress 2 regions



Source: UKMMAS[92]

Around the English coast, the Thames estuary, Humber, the Wash, Severn, and Liverpool Bay the mean values of suspended particulate matter are above 10 mg/l. The southern North Sea generally experiences higher observed concentrations than the northern North Sea, due to its stronger tidal currents and shallower water. In general, the southern North Sea has the highest observed SPM, followed by the Eastern English Channel and the Irish Sea.[93]

The turbidity in UK water varies significantly depending on current, biological influence on sediment properties and seabed characteristics.[94] In addition, there is also variation between seasons, as presented in the *Charting Progress 2 report* (CP2)[95], where higher concentrations were found in winter than in the summer. For further details and historical assessment of turbidity see the CP2 report.

Based on the most recent assessment by Defra found in the updated Marine Strategy part 1, the '*satellite observations over 1998-2015 show significant increases in annual average surface suspended particulate matter in 5 out of 10 UK marine regions'*[96]. The Defra assessment presents a clear increase in the degree of turbidity.

92 UKMMAS, *Sea surface suspended sediments and turbidity* https://moat.cefas.co.uk/ocean-processes-and-climate/turbidity/

93 UKMMAS, *Sea surface suspended sediments and turbidity* https://moat.cefas.co.uk/ocean-processes-and-climate/turbidity/

94 Defra, *Marine strategy part one: UK initial assessment and good environmental status (2012)* https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status

95 Charting Progress 2, *Ocean Processes Feeeder Report: Section 3.7: Suspended Particulate Matter and Turbidity (2010)* https://www2.gov.scot/Topics/marine/science/atlas/CP2

96 Defra, *Marine strategy part one: UK updated assessment and Good Environmental Status (2019)* https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

Water column contaminants

There is limited data on the water column contaminants. The condition of the water column is assessed on a risk-based approach. Progress is measured towards the desired ‘status’ and to demonstrate the extent that ‘Good Environmental Status’ has been achieved. These are the targets that need to be achieved[97]:

1) “Concentrations of substances identified within relevant legislation and international obligations are below the concentrations at which adverse effects are likely to occur (for example, are less than Environmental Quality Standards[98] applied within the Water Framework Directive and Environmental Assessment Criteria[99] applied within OSPAR)”
2) (Biological effects) The intensity of those biological or ecological effects due to contaminants agreed by OSPAR as appropriate for Marine Strategy Framework Directive purposes are below the toxicologically-based standards
3) (Oil/chemical spills) “Occurrence and extent of significant acute pollution effects (e.g. slicks resulting from spills of oil and oil products or spills of chemicals) and their impact on biota affected by this pollution should be minimised through appropriate risk-based approaches”.

Polycyclic aromatic hydrocarbons (PAHs) in biota

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil, and can be formed during the combustion of fossil fuels and organic material, either by humans or naturally such as in forest fires. PAHs enter the marine environment through atmospheric deposition, run-off from roads, industrial discharges and oil spills.[100]

Once in the marine environment, PAHs often end up in marine sediment, or accumulate in shellfish either via direct absorption or food consumption. PAHs taint the taste of fish and shellfish and may have carcinogenic effects on humans.

PAHs are covered by the OSPAR Hazardous Substances Strategy, which has the ultimate aim of achieving concentrations of hazardous substances in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

PAH concentrations are measured in samples from shellfish and from sediment.

PAH concentrations were measured in shellfish samples collected between 1995 and 2015 at 188 monitoring sites throughout much of the Greater North Sea, Celtic Seas, and the Bay of Biscay and Iberian coast, at frequencies ranging from annually to every three years.

Figure 29 presents the mean concentrations measured at UK sites.

The concentrations were compared against two criteria, the OSPAR Background Assessment Concentrations (BACs), and the Environmental Assessment Criteria (EACs). The BACs are the natural levels which OSPAR is aiming for. The EACs are the levels below which adverse effects on marine organisms are rarely observed.

The dots represent the observed mean concentrations and the lines represent the 95% upper confidence limits. On this scale, a value of 1 would mean that the observed mean concentration equals the EAC. All the dots are green, indicating that all the mean concentrations are below the EAC to a statistically significant ($p<0.05$ degree) but not below the BAC to a statistically significant degree.

97 UKMMAS, *Contaminants* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/

98 European Parliament, *Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy Text with EEA relevance (2013)* http://data.europa.eu/eli/dir/2013/39/oj

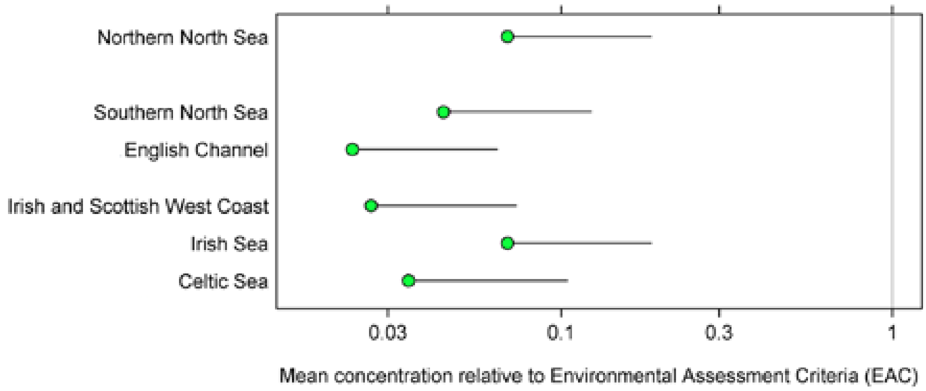
99 OSPAR, *Agreement on CEMP Assessment Criteria for the QSR 2010 (2009)* https://qsr2010.ospar.org/media/assessments/p00390_supplements/09-02e_Agreement_CEMP_Assessment_Criteria.pdf

100 OSPAR, *Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Shellfish* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/status-and-trends-concentrations-polycyclic-aromatic-hydrocarbon/

At all the sites monitored, the observed concentrations of PAHs, although not as low as background levels, were at levels at which adverse effects on marine organisms are rarely observed.

Since 2012, 88% of assessments in the Greater North Sea and 92% in the Celtic Seas have met the associated UK target. Concentrations were found to be stable in all UK regions.[101]

Figure 29: Mean concentrations of PAH in shellfish samples, relative to EAC and BAC: 1995 - 2015



Source: OSPAR[102]

Polychlorinated Biphenyls (PCB) in biota

Polychlorinated biphenyls (PCBs) are man-made chemical compounds that were banned in the mid-1980s due to concerns about their toxicity, persistence, and potential to bioaccumulate in the environment. Since then, global action has achieved large reductions in releases and stocks of PCBs have been phased out. However, releases do continue through diffuse emissions to air and water from building sites and industrial materials. The remaining sources include electrical and hydraulic equipment, waste disposal, the redistribution of historically contaminated sediments, and thermal and chemical industrial processes.[103]

PCBs do not break down easily and are extremely toxic to humans and wildlife.[104]

Since 2012, 83% of the assessments in the Greater North Sea and 74% of assessments in the Celtic Sea have met the associated UK targets. Based on the 329 trend assessments carried out in the Celtic Seas and Greater North Sea for polychlorinated biphenyls, 5 (2%) showed a significant upward trend, while 96 (29%) showed a significant downward trend. Of the 568 status assessments carried out, 442 (78%) were below the Environmental Assessment Criteria.[105]

CB118 was the only PCB congener to fail the Environmental Assessment Criteria in four out of the five sampled biogeographic regions: see Figure 30.

101 UKMMAS, *Status and trends of polycyclic aromatic hydrocarbon concentrations in shellfish* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/pahs-in-biota/

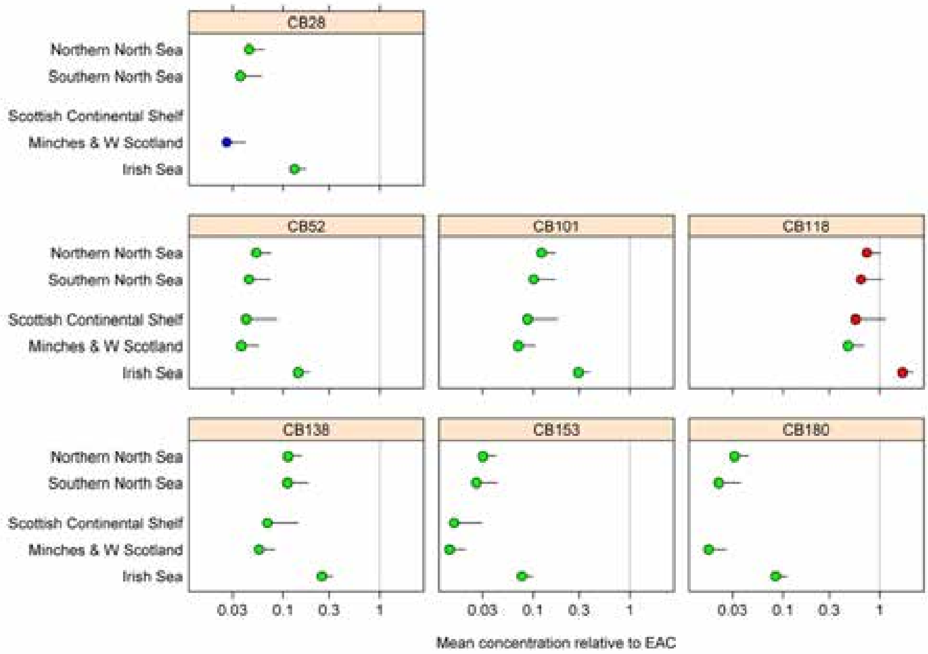
102 OSPAR, *Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Shellfish* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/status-and-trends-concentrations-polycyclic-aromatic-hydrocarbon/

103 OSPAR, *Status and Trends of Polychlorinated Biphenyls (PCB) in Sediment* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pcb-sediment/

104 Ibid

105 UKMMAS, *Status and trends of polychlorinated biphenyls in biota* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/pcbs-in-biota/

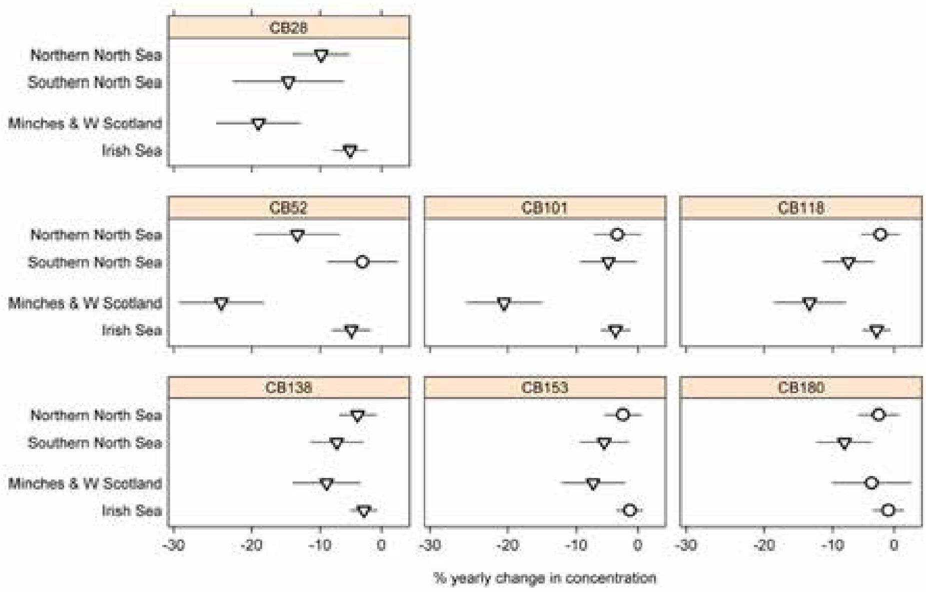
Figure 30: Average PCB concentration in biota in each biogeographic region, relative to the Environmental Assessment Criteria (EAC), by compound, with 95% confidence limits. A value of 1 indicates an average concentration equal to the EAC. *Blue:* below the Background Assessment Concentration to a statistically significant degree. *Green:* below the EAC to a statistically significant degree. *Red:* the estimate of them mean concentration is not below the EAC to a statistically significant degree.



Source: UKMMAS[106]

In the Greater North Sea, of 134 trend assessments, 2% show an upward trend, 67% show no trend, and 32% show a downward trend. In the Celtic Seas, of 195 trend assessments, 1% show an upward trend, 71% show no trend and 2% show a downward trend. All four of the biogeographic regions sampled showed significant downward trends, considering the mean of all seven PCB congeners. Figure 31 shows the average annual trends in PCB concentration in biota, broken down by biogeographic region and congener.[107]

Figure 31: Average annual trends in PCB concentrations in biota by biogeographic region, with 95% confidence limits. Upwards triangle: upward trend. *Downwards triangle*: downward trend. *Circle*: no change.



Source: UKMMAS[108]

106 UKMMAS, *Status and trends of polychlorinated biphenyls in biota* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/pcbs-in-biota/

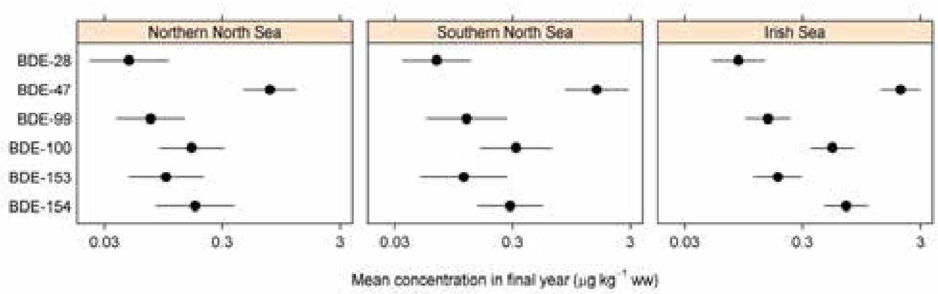
107 Ibid

108 Ibid.

Polybrominated diphenyl ether (PBDE) in biota

Concentrations of polybrominated diphenyl ether PBDE are measured in the tissues of fish livers collected from monitoring stations around the UK as part of the Clean Seas Environment Monitoring Programme. Figure 32 shows the estimated mean concentration profile of PBDE, broken down by region and congener. There are no OSPAR BACs or EACs against which to compare the data.[109]

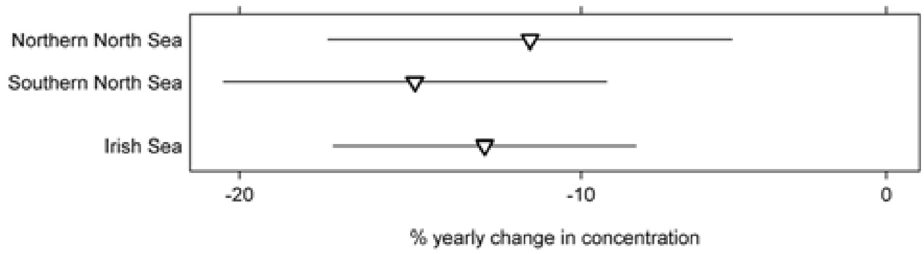
Figure 32: Estimated mean concentration profile of PBDE in final year, with 95% confidence limits



Source: UKMMAS[110]

Trends in PBDE concentrations were assessed in sub-regions where there was at least five years of data, each containing at least one measurement above the detection limit. Significant downward trends in concentrations averaged across all congeners were observed in all three sub-regions: -12.3% per year in the Northern North Sea, -16.3% in the Southern North Sea, and -13.9% in the Irish Sea (see Figure 33).

Figure 33: Average trend in concentrations in biota of PBDE congeners, per sub-region. Downward triangle: significant downward trend



Source: UKMMAS[111]

109 UKMMAS, *Status and trends of polybrominated diphenyl ether flame retardants concentrations in biota* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/pbdes-in-biota/

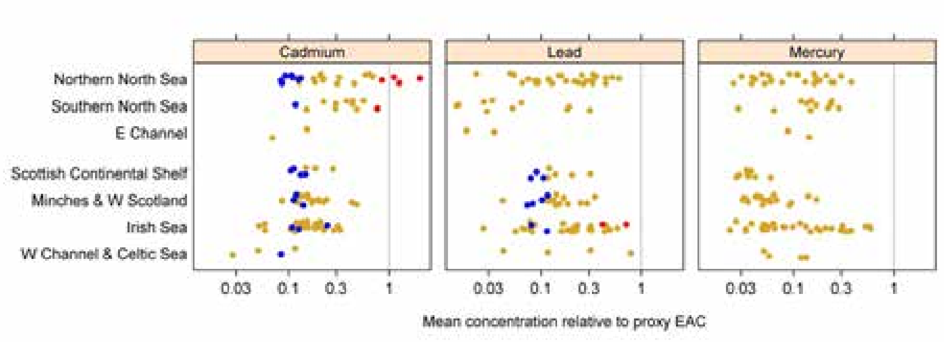
110 UKMMAS, *Status and trends of polybrominated diphenyl ether flame retardants concentrations in biota* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/pbdes-in-biota/

111 Ibid.

Metals in biota

Since 2012, the concentrations of cadmium, lead and mercury measured in samples of fish and shellfish have been broadly stable and below thresholds – see Figure 34. 96% of assessments at the 37 sampling stations monitored in the Greater North Sea, and 99% of the assessments at 58 sampling stations monitored in the Celtic Seas met the individual target thresholds.

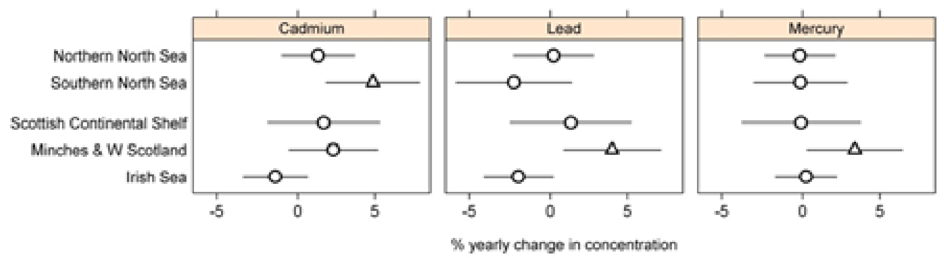
Figure 34: Mean concentrations of cadmium, lead, and mercury relative to individual proxy EACs, by biogeographic sub-region. *Blue:* mean concentration significantly ($p < 0.05$) below the Background Assessment Concentration. *Orange:* mean concentration significantly ($p < 0.05$) below the proxy Environmental Assessment Criteria. *Red:* mean concentration not significantly below the proxy Environmental Assessment Criteria.



Source: UKMMAS[112]

Most sub-regions show static trends where only cadmium in the Southern North Sea, and mercury in the Minches and West Scotland show increasing trends – See Figure 35.

Figure 35: Trends in the mean concentrations of cadmium, lead and mercury in the five UK biogeographic sub-regions for which sufficient data are available. Circle: no trend. Upward triangle: increasing trend.



Source: UKMMAS[113]

112 UKMMAS, *Status and trend of cadmium, lead and mercury in fish and shellfish* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/metals-in-biota/

113 Ibid

Radionuclides

Radioactivity arises from both natural and human-made sources. Radioactive materials can be released into the environment as discharges, emissions and losses from nuclear sites and non-nuclear facilities. Also, small quantities of naturally occurring radioactive material may be released into the environment as discharges from offshore oil and gas industries.[114] The historical trends of radioactivity from discharges, emissions and losses for nuclear and non-nuclear sites are presented yearly on the *Radioactivity in Food and the Environment (RIFE) reports*[115]. Figure 36 below presents the sites monitored in the RIFE report.

Figure 36: Principal nuclear site sources of radioactive waste disposal in the UK in 2018

114 UKMMAS, *Concentrations of radionuclides* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/radionuclides/

115 Defra, *Radioactivity in Food and the Environment (RIFE) reports* https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-rife-reports

Table 9 below summarises the finds of the 2018 RIFE report for the Sellafield site.

Table 9: High-level assessment of key radioactive materials

Radioactive material	Assessment of trend
Technetium-99	• There has been a decline of discharges of technetium-99 from 2002 level. In the past decade the discharge levels have remained stable. • There has been a significant reduction in concentrations of technetium-99 in seaweed in the Sellafield area. • Concentrations of technetium-99 in plaice, lobsters, and winkles have been stable since 2013.
Carbon -14	• Liquid discharges from Sellafield of carbon-14 have been declining since 2013. • The concentrations of carbon-14 in plaice, lobsters, and winkles have also been declining since 2016.
Cobalt-60	• Liquid discharges from Sellafield were somewhat constant between 2012 and 2015, slightly declining thereafter. • While concentrations of cobalt-60 in plaice have remained constant since 2013. Concentrations found in lobsters and winkles have also remained constant since 2012 with a slight decline in 2018.
Caesium-137	• Liquid discharges from Sellafield have been increasing since 2014. • Concentrations of caesium-137 in plaice, lobsters and winkles have declined between 2017 and 2018. The long-term pattern is a declining trend since 2007.
Plutonium-230+240	• Liquid discharges from Sellafield have remained somewhat constant between 2012 and 2018, with a slight increase in 2016. • Concentrations of plutonium-230+240 in plaice, lobsters, and winkles were slightly lower in 2018, with concentrations in lobsters reaching the lowest level since 2007.
Americium-241	• Liquid discharges from Sellafield have been declining since 2013. • Concentrations of americium-241 have continued the declining trend for winkles and plaice. There has been some variability in the concentration levels for lobsters, with no clear pattern.

Based on evidence found in the RIFE report on discharges and on concentrations of radioactive materials present in the environment, there is a persistent decline for most radioactive material from historical levels, and the UK is within the regulatory limits.

Organotin-specific biological effects (imposex in gastropods)

Tributylin is a contaminant present in the marine environment because of its use before 2008 in anti-fouling paints to prevent the growth of marine organisms on ships and marine structures. Tributyltin can cause imposex to occur in sea snails, so the occurrence of imposex can serve as an indicator of the levels of this contaminant. Imposex is when females develop male sex organs.

Since 2012, imposex occurrence has been generally below the UK target threshold and has exhibited a downward trend, indicating an improving situation with respect to tributylin contamination. The target was met in 68% of the assessments carried out in the Greater North Sea and 89% of the assessments carried out in the Celtic Seas.[116]

116 UMMAS, *Organotin-specific biological effects (imposex in gastropods) https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/imposex/*

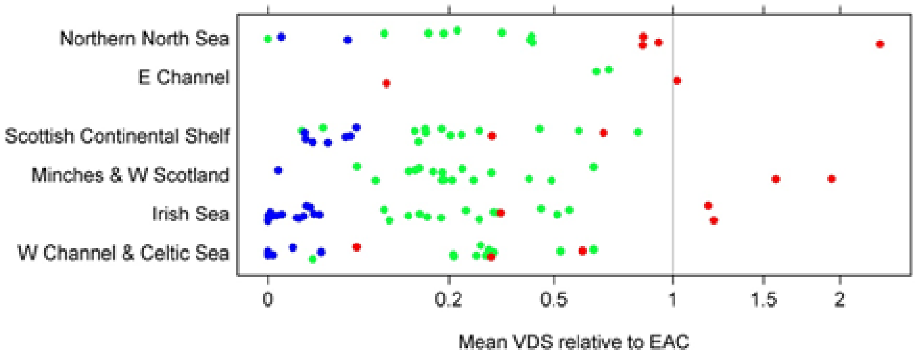
Figure 37 shows estimates of the mean Vas Deferens Sequence (VDS - a measure of imposex occurrence), relative to the EAC, at six of the eight UK biogeographic sub-regions. Most of the monitoring sites where assessments were made recorded mean values of VDS below the EAC to a statistically significant degree, as shown by the preponderance of green and blue dots.

Figure 37: Mean VDS (a measure of imposex occurrence) relative to EAC, by monitoring site

Blue: mean VDS significantly ($p<0.05$) below the BAC

Green: mean VDS significantly ($p<0.05$) below the EAC but not the BAC

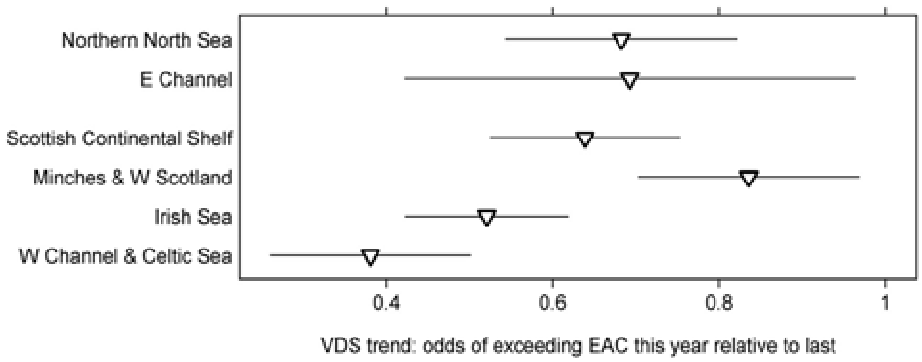
Red: mean VDS not significantly below the EAC



Source: UKMMAS[117]

All six of the UK biogeographic regions assessed showed lower mean VDS scores in the most recent year of data than in the previous year: see Figure 38.

Figure 38: Trend in VDS (a measure of imposex occurrence) by UK biogeographic region



Source: UKMMAS[118]

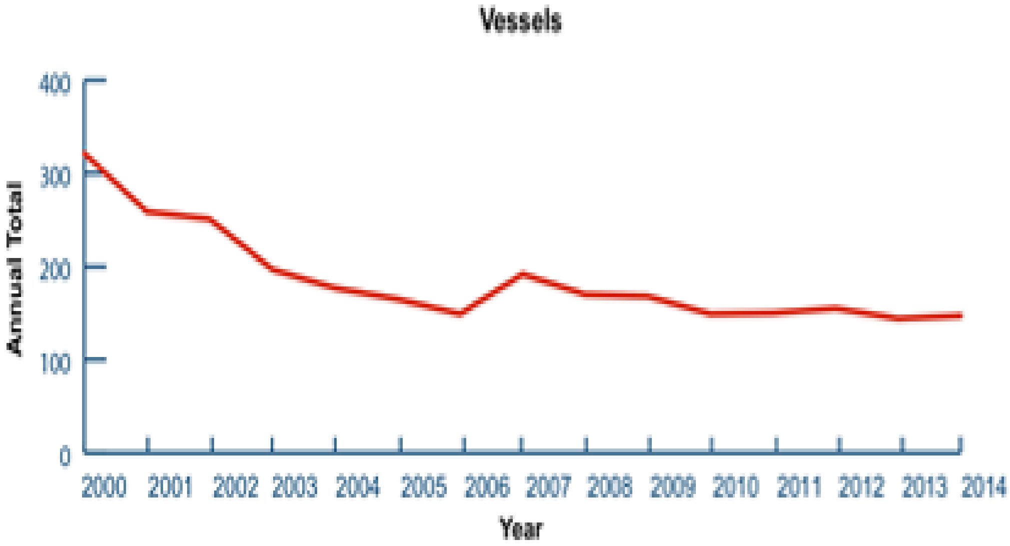
117 Ibid
118 Ibid

Oil and chemical spills

Oil and chemicals spilt by marine traffic and by the oil and gas industry can have highly detrimental impacts on the marine environment. Major spills can cause significant damage to important ecosystems, affecting commercial fishing and aquaculture, and leisure/business use of the marine and coastal environments.[119]

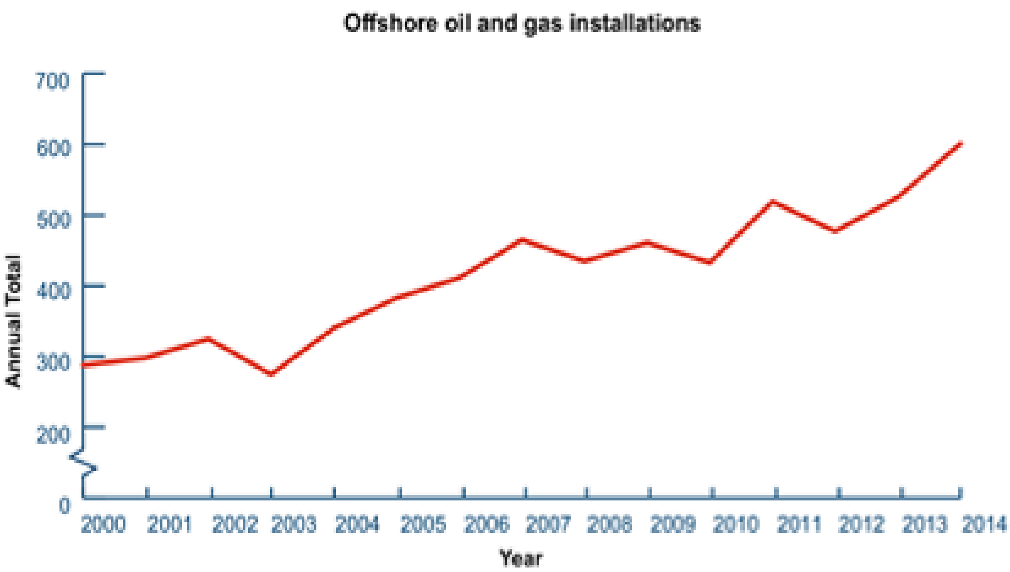
Between 2000 and 2014, the number of reported spills from vessels has steadily reduced from around 300 to below 200 per year (see Figure 39), while the number of the reported spills from offshore oil and gas installations has doubled from around 300 to around 600 per year (see Figure 40). However, the vast majority of spills from offshore oil and gas installations are less than 100kg, so the increase in the total number of spills shown on Figure 41 may not represent an increase in material spilt.

Figure 39: Number of reported oil and chemical spills from vessels in UK waters: 2000 - 2014



Source: UKMMAS[120]

Figure 40: Number of reported oil and chemical spills from offshore oil and gas installations in UK waters: 2000 - 2014



Source: UKMMAS[121]

119 UKMMAS, *Oil and chemical spills* https://moat.cefas.co.uk/pressures-from-human-activities/contaminants/oil-spills

120 Ibid

121 Ibid

Figure 41: Total number of reported oil and chemical spills in UK waters: 2000 - 2014

Source: UKMMAS[122]

Organic carbon in the water column

No robust data has been found to produce an assessment of the quantities of organic carbon.

2. Marine seabed

The marine seabed includes several habitats from sublittoral sediment to sand and mud. This asset provides several ecosystem services such as:

- **Habitat:** Seabed provides habitat and nursery area for algae, seagrass, microorganisms, invertebrates and vertebrates that function as a composite to provide ecosystem services
- **Nutrient cycling:** Seabed and particularly sediment and gravels store, cycle, and moderate the release of nutrients and other chemicals that are essential to organisms within the sediment and in the overlying seawater. This happens due to laminar flow of seawater over the seabed, but particularly due to the organisms living on the seabed and especially in the sediments and gravels. The organisms affect sediment properties such as porosity and dissolved oxygen penetration. They enable nutrient cycling through for example, filtering and pumping overlying water into the sediment, creation of networks of burrows and irrigation channels that enable transport of overlying water and nutrients deep into the sediment, fostering microbial growth and enabling biogeochemical transformation and storage of nutrients including carbon.
- **Water flow:** Seabed type regulates the drainage, flow, and storage of water and solutes.
- **Carbon storage:** Seabed sediments act as long-term repositories of organic and inorganic carbon. Seabed sediment can mitigate greenhouse gas emissions by acting as a carbon sink. There is evidence that human activities can damage these marine habitats in a way that causes their stored carbon to be released. [123]
- **Filtering** and buffering: Seabed sediment acts as a filter that protects the quality of water and living resources
- **Physical stability:** Seabed can reduce wave and storm impact by dampening tidal flows and wave energy close to shore. It can anchor human structures and protect sites of archaelogical interest.
- **Aggregates and building materials:** Coarse sediments provide non-renewable supplies

122 Ibid

123 Luisetti et al, *Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK, (Ecosystem Services, Volume 35), February 2019, pp 67-76* https://www.sciencedirect.com/science/article/pii/S2212041618300536

The heterogeneity of seabed types enables support of rich biodiversity creating diverse habitats that support diverse ecosystem services and marine resources.

Even though this asset plays an important role, there is limited data available to assess the status of this asset, especially on the abiotic components of this asset (and habitats). For a list of components and their respective targets/criteria/threshold see Table 10.

Table 10: List of components and targets

	Seabed feature	Targets/criteria/thresholds
2.1	Sublittoral coarse sediment	Defra's Marine strategy part one includes the following targets for benthic (i.e. seafloor) habitats: • The physical loss of each seabed habitat type caused by human activities is minimised and where possible reversed. • The extent of habitat types adversely affected by physical disturbance caused by human activity should be minimised. • Habitat loss of sensitive, fragile or important habitats caused by human activities is prevented, and where feasible reversed. • The extent of adverse effects caused by human activities on the condition, function and ecosystem processes of habitats is minimised.
2.2	Sands and muddy sands	
2.3	Cohesive mud and sandy mud communities	
2.4	Sublittoral mixed sediments	
2.5	Sublittoral rock	
2.6	Tide-swept channels	No target.
2.7	Subtidal sandbanks	
2.8	Peat and clay exposures	
2.9	Caves	
2.10	Polycyclic aromatic hydrocarbons in sediment	Concentrations of contaminants in sediment should be below the OSPAR Environmental Assessment Criteria, below which harm to sea life is rare and not increasing.
2.11	Polychlorinated biphenyls in sediment	
2.12	Polybrominated diphenyl ether in sediment	
2.13	Metals in sediment	
2.14	Organic carbon in sediment	

The overall assessment of seabed

Based on the data available the overall assessment seabed is 'grey': **unable to assess** - The data on this asset is very limited, consisting mostly of maps of distribution and predicted extent. Where data is available on quality, it refers to a single period, so does not permit comparison across time. For two indicators, data is available for the period 1995-2015. Most, though not all, of the recorded data, complies with threshold levels in these cases. See Table 11 below for an assessment of seabed. The key findings from the NCC assessment are:

- Mean concentrations of polycyclic aromatic hydrocarbons (PAHs) are below the 'effects range-low' criterion (ERL) to a statistically significant degree but not below the OSPAR Background Assessment Concentration (BACs) to a statistically significant degree

Table 11: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
2.1 - Sublittoral coarse sediment	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.
2.2 - Sublittoral sand	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.
2.3 - Sublittoral mud	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.
2.4 - Sublittoral mixed sediments	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the predicted extent is available.
2.5 - Sublitorral rock	No target exists/ was found.	No data is available.	No data is available.	No data is available.
2.6 - Tide-swept channels	No target exists/ was found.	No data is available.	No data is available.	No data is available.
2.7 - Subtidal sandbanks	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the distribution is available.	The data is not sufficient to make a comparison over time: only a map of the distribution is available.
2.8 - Peat and clay exposures	No target exists/ was found.	No data is available.	No data is available.	No data is available.
2.9 - Caves	No target exists/ was found.	The data is not sufficient to make a comparison against the criterion or over time: only a map of predicted extent is available.	The data is not sufficient to make a comparison over time: only a map of the distribution is available.	The data is not sufficient to make a comparison over time: only a map of the distribution is available.

2.10 - Seabed sentiment condition: polycyclic aromatic hydrocarbons (PAHs)	No target exists/ was found.	The observed mean concentrations of PAHs in shellfish samples and sediment samples in all UK assessment areas were below the OSPAR EAC, for the period 1995 – 2015.	The data is not sufficient to make a comparison over time: data is only available as an average over the period 1995 – 2015.	The data is not sufficient to make a comparison over time: data is only available as an average over the period 1995 – 2015.
2.11 - Seabed sediment condition: polychlorinated biphenyls (PCBs)	No target exists/ was found.	The observed mean concentrations of most of the seven PCB congeners assessed were below the OSPAR EAC. However, the observed mean concentrations of one of the congeners were above the EAC in three of the assessment areas.	The data is not sufficient to make a comparison over time: data is only available as an average over the period 1995 – 2015.	The data is not sufficient to make a comparison over time: data is only available as an average over the period 1995 – 2015.
2.12 - Seabed sediment condition: polybrominated diphenyl ether (PBDE)	No target exists/ was found.	No assessment criteria are available, and the data is not sufficient to make a comparison over time.	The data is not sufficient to make a comparison over time.	The data is not sufficient to make a comparison over time.
2.13 - Metals in sediment	No target exists/ was found.	No assessment criteria are available and the data is not sufficient to make a comparison over time.	No assessment criteria are available and the data is not sufficient to make a comparison over time.	No assessment criteria are available and the data is not sufficient to make a comparison over time.
2.14 - Organic carbon in sediment	No target exists/ was found.	The data is not sufficient to make a comparison over time.	The data is not sufficient to make a comparison over time.	The data is not sufficient to make a comparison over time.

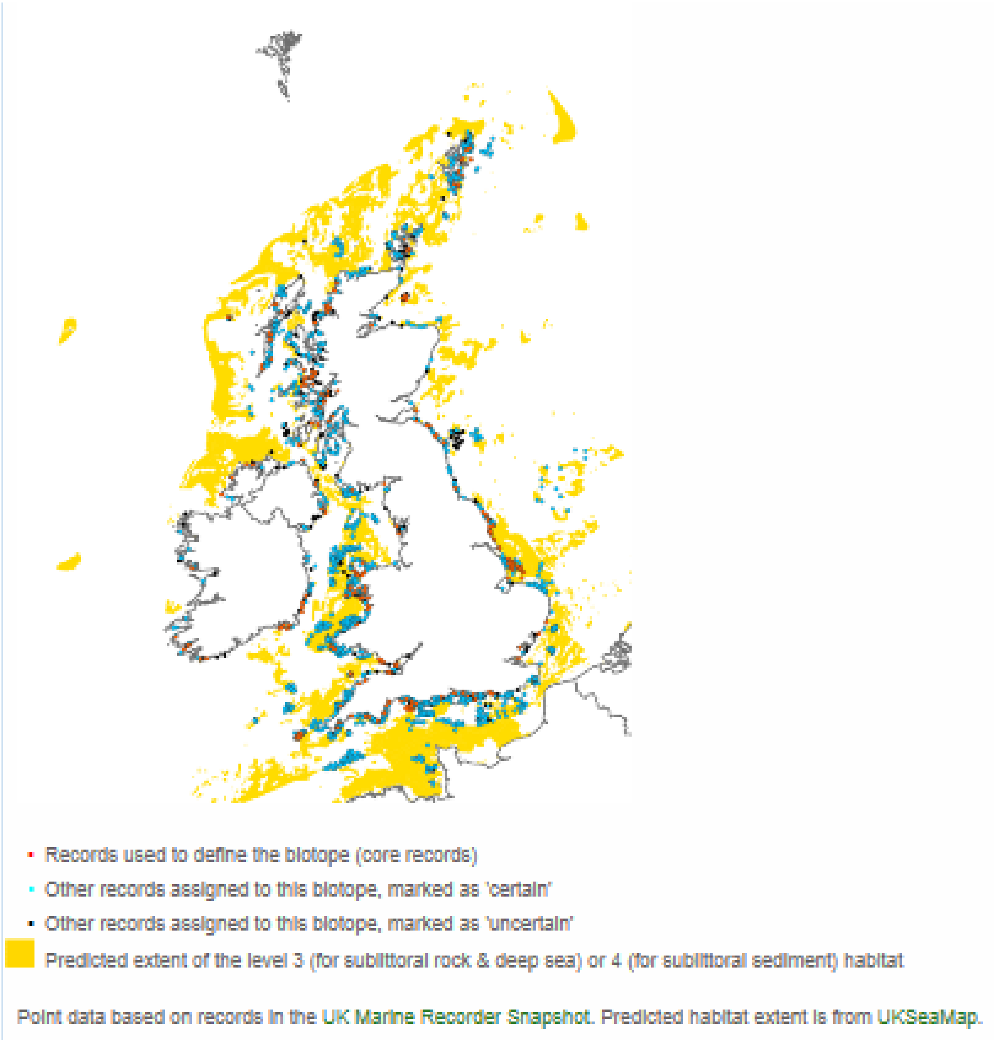
Sublittoral

Coarse sediment

'Coarse sediments include coarse sand, gravel, pebbles, shingle and cobbles which are often unstable due to tidal currents and/or wave action. These habitats are generally found on the open coast or in tide-swept channels of marine inlets. They typically have a low silt content and a lack of a significant seaweed component. They are characterised by a robust fauna including venerid bivalves.'[124]

Figure 42 shows the extent of sublittoral coarse sediments around the British Isles, as predicted by the Joint Nature Conservation Committee.

Figure 42: Predicted extent of sublittoral coarse sediment



Source: JNCC[125]

124 JNCC, *Sublittoral coarse sediment (unstable cobbles and pebbles, gravels and coarse sands)* https://mhc.jncc.gov.uk/biotopes/jnccmncr00002034

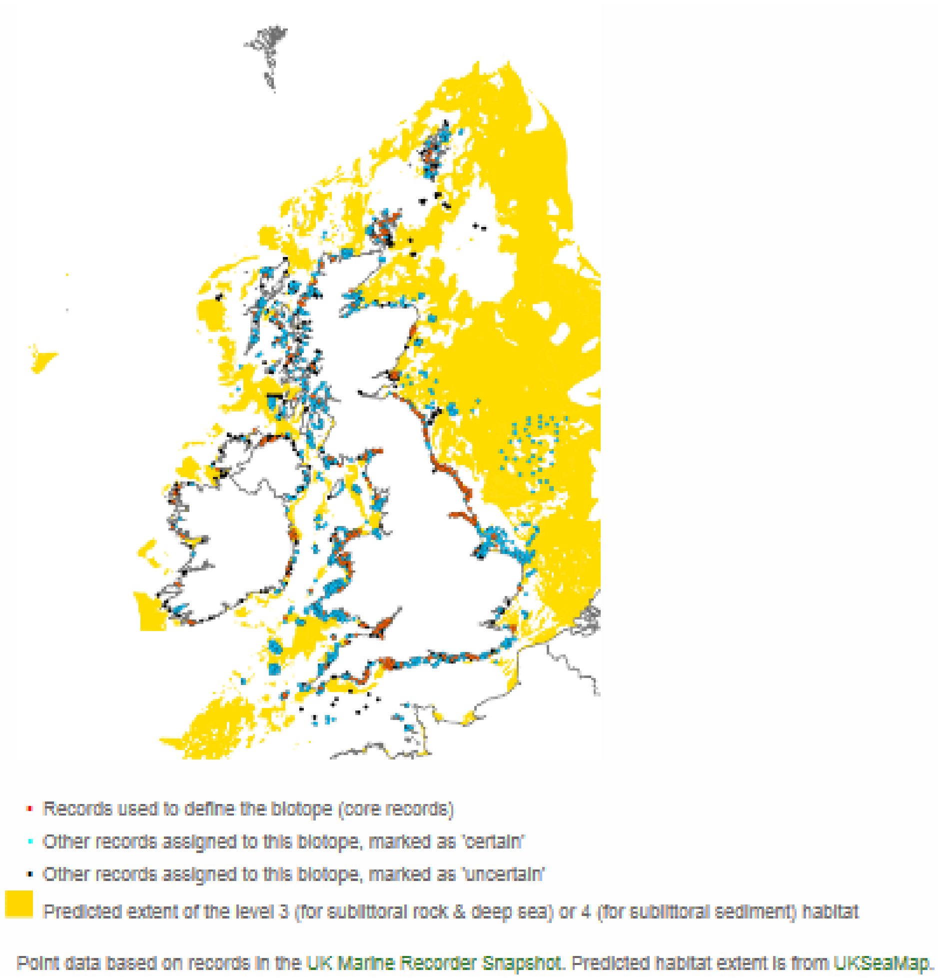
125 Ibid

Sands and muddy sands

This biotope is defined by the JNCC as 'clean medium to fine sands or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets. Such habitats are often subject to a degree of wave action or tidal currents which restrict the silt and clay content to less than 15%. This habitat is characterised by a range of taxa including polychaetes, bivalve molluscs, and amphipod crustacea.'[126]

The JNCC's estimate of the extent of sublittoral and muddy sands is shown in Figure 43.

Figure 43: Predicted extent of sublittoral sands and muddy sands



Source: JNCC[127]

126 JNCC, *Sublittoral sands and muddy sands* https://mhc.jncc.gov.uk/biotopes/jnccmncr00002036

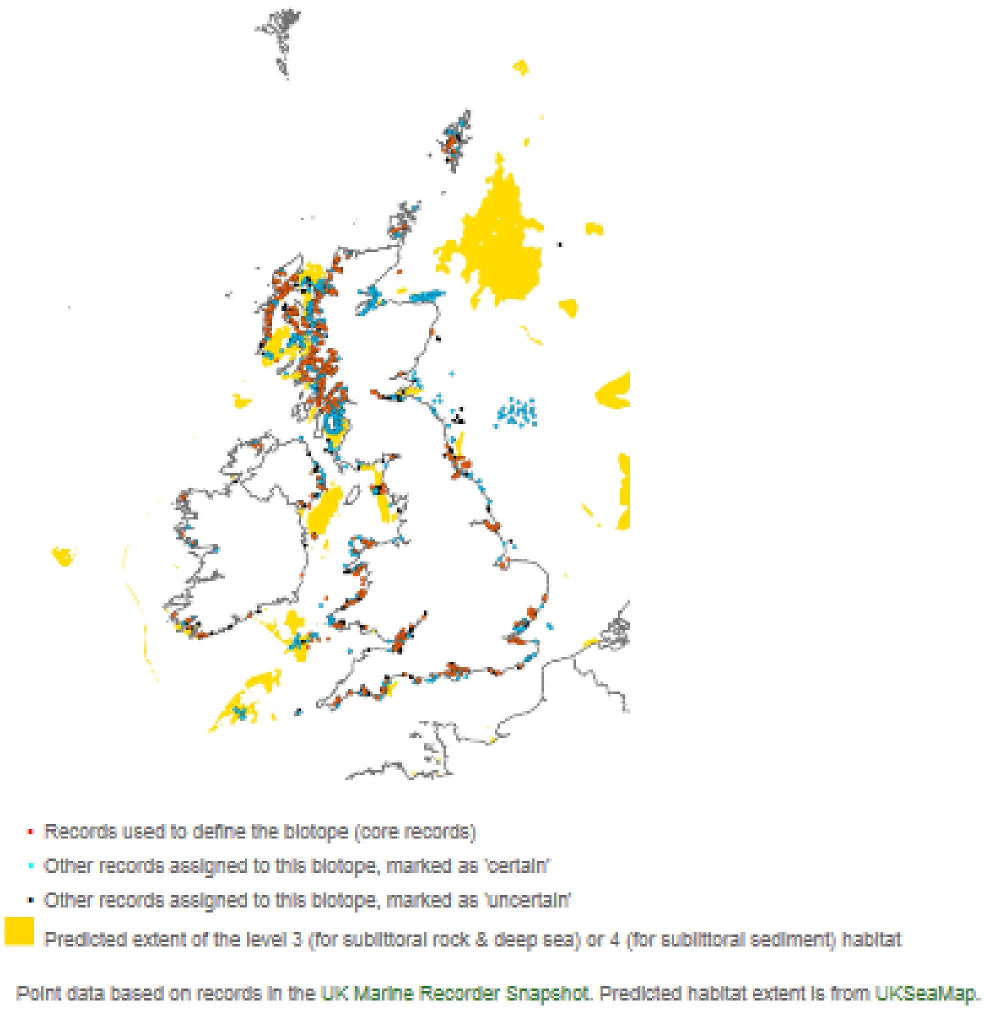
127 Ibid

Cohesive mud and sandy mud communities

The JNCC describes this biotope as ‘Sublittoral mud and cohesive sandy mud extending from the extreme lower shore to offshore, circalittoral habitats. This biotope is predominantly found in sheltered harbours, sealochs, bays, marine inlets and estuaries and stable deeper/offshore areas where the reduced influence of wave action and/or tidal streams allow fine sediments to settle. Such habitats are often dominated by polychaetes and echinoderms, in particular brittlestars such as Amphiura spp. Seapens such as Virgularia mirabilis and burrowing megafauna including Nephrops norvegicus are common in deeper muds. Estuarine muds tend to be characterised by infaunal polychaetes and oligochaetes.’[128]

The extent of this biotope estimated by the JNCC is shown on Figure 44.

Figure 44: Predicted extent of sublittoral cohesive mud and sandy mud communities



Source: JNCC[129]

128 JNCC, *Sublittoral cohesive mud and sandy mud communities* https://mhc.jncc.gov.uk/biotopes/jnccmncr00002037

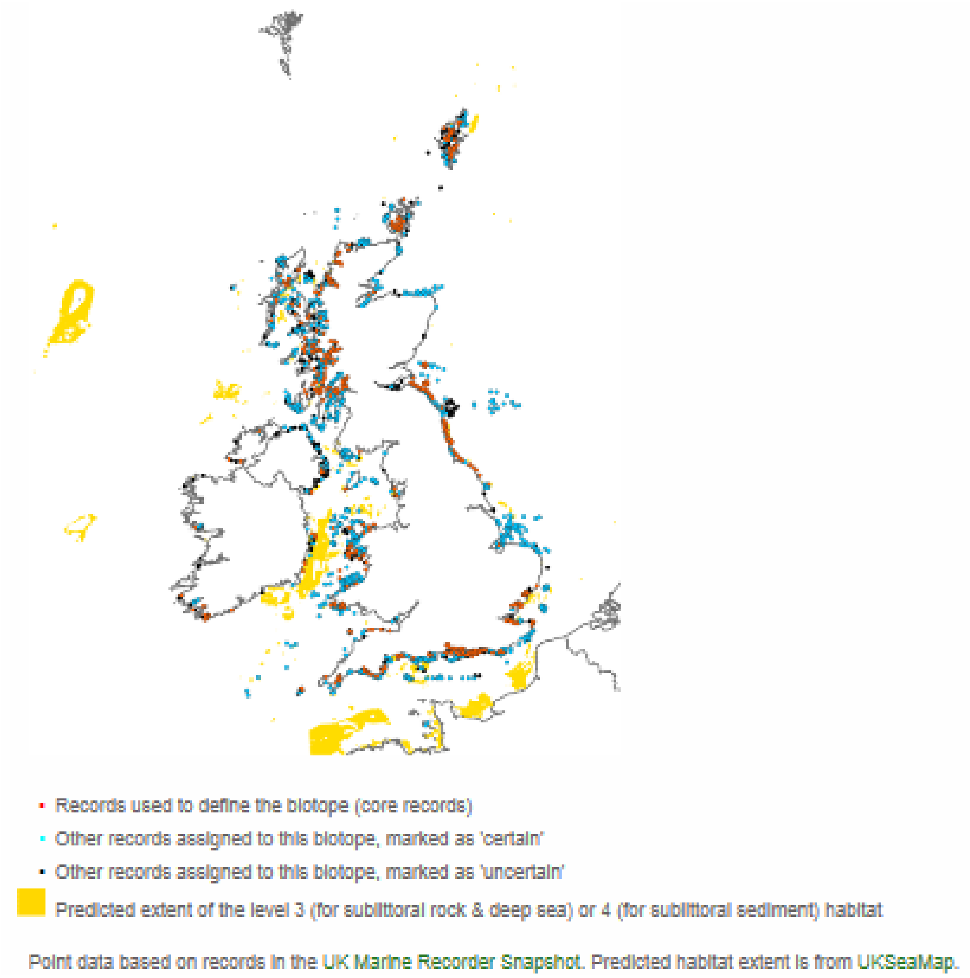
129 Ibid

Mixed sediments

The JNCC defines this biotope as 'Sublittoral mixed (heterogeneous) sediments found from the extreme low water mark to deep offshore circalittoral habitats. These habitats incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud.'[130]

Figure 45 shows the extent of this biotope predicted by the JNCC.

Figure 45: Predicted extent of sublittoral mixed sediment



Source: JNCC[131]

Sublitorral rock

No data has been found on the condition or extent of sublittoral rock.

Tide-swept channels

No data has been found on the condition or extent of tide-swept channels.

Subtidal sandbanks

Subtidal sandbanks, or sandbanks which are slightly covered by sea water all the time, *'consist of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum (but sometimes including channels or other areas greater than 20 m deep). The habitat comprises distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) which may arise from horizontal or sloping plains of sandy sediment'* – JNCC.[132]

130 JNCC, *Sublittoral mixed sediment* https://mhc.jncc.gov.uk/biotopes/jnccmncr00002038

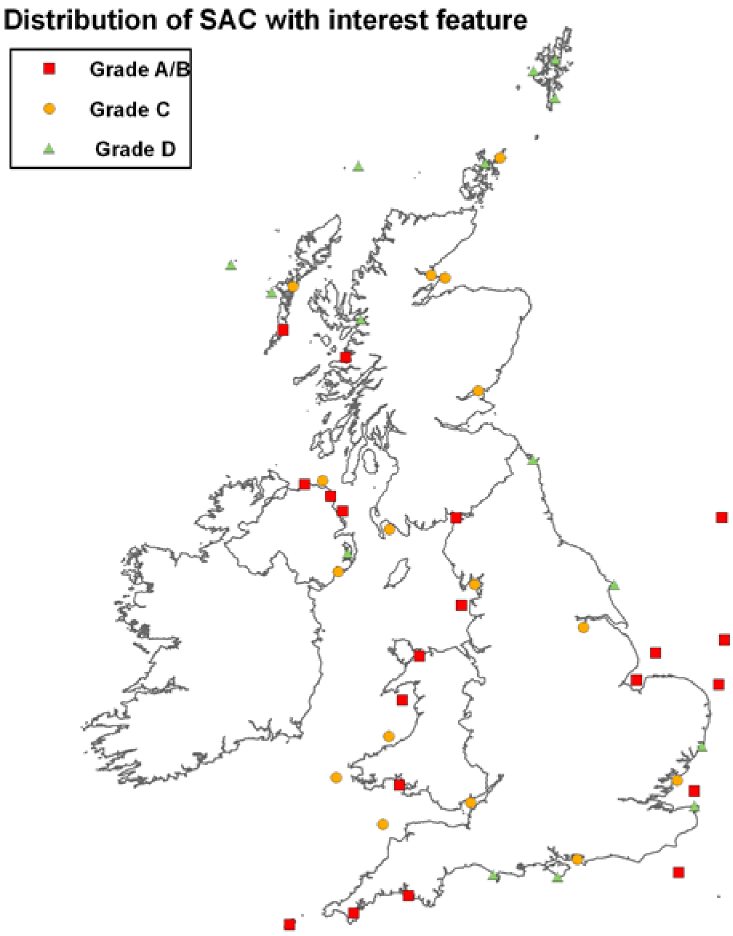
131 Ibid

132 JNCC, Subtidal sandbanks (*Sandbanks which are slightly covered by sea water all the time)* https://sac.jncc.gov.uk/habitat/H1110/

The importance of subtidal sandbanks as a habitat is described by the JNCC as follows. *'Shallow sandy sediments are typically colonised by a burrowing fauna of worms, crustaceans, bivalve molluscs and echinoderms. Mobile epifauna at the surface of the sandbank may include shrimps, gastropod molluscs, crabs and fish. Sand-eels Ammodytes spp., an important food for birds, live in sandy sediments. Where coarse stable material, such as shells, stones or maerl is present on the sediment surface, species of foliose seaweeds, hydroids, bryozoans and ascidians may form distinctive communities. Shallow sandy sediments are often important nursery areas for fish, and feeding grounds for seabirds (especially puffins Fratercula arctica, guillemots Uria aalge and razorbills Alca torda) and sea-duck (e.g. common scoter Melanitta nigra)*.'[133]

Figure 46 shows the distribution of Special Areas of Conservation (SACs) with subtidal sandbanks, graded according to the quality of the subtidal sandbanks.

Figure 46: UK distribution of Special Areas of Conservation (SACs) containing sandbanks which are slightly covered by sea water all the time



Source: JNCC[134]

A: Outstanding example of subtidal sandbanks in a European context.

B: Excellent example of subtidal sandbanks, significantly above the threshold for SSSI (Site of Special Scientific Interest) or ASSI (Area of Special Scientific Interest) designation but of somewhat lower value than grade A sites.

C: Example of subtidal sandbanks which is of at least national importance but not significantly above.

D: Subtidal sandbanks of below-SSSI quality occurring on SACs.

133 Ibid

134 Ibid

Peat and clay exposure

No evidence on exposures of peat and clay is available. However, an indication of the distribution of this feature can be given by looking at the distribution of the biotope of piddocks with a sparse associated fauna in sublittoral very soft chalk or clay. Piddocks are a family of bivalve molluscs similar to clams.

This biotope occurs on circalittoral soft rock, such as soft chalk or clay, most often in moderately exposed tide-swept conditions. As soft chalk and firm clay are often too soft for sessile filter-feeding animals to attach and thrive in large numbers, an extremely impoverished epifauna results on upward-facing surfaces, although vertical faces may be somewhat richer. The rock is sufficiently soft to be bored by bivalves. Species vary with location, but Pholas dactylus is the most widespread borer and may be abundant. Other species present may include the sponges Dysidea fragilis and Suberites carnosus and the polychaete Bispira volutacornis. Foliose red algae may be present on the harder, more stable areas of rock. Mobile fauna often includes the crabs Necora puber and Cancer pagurus.

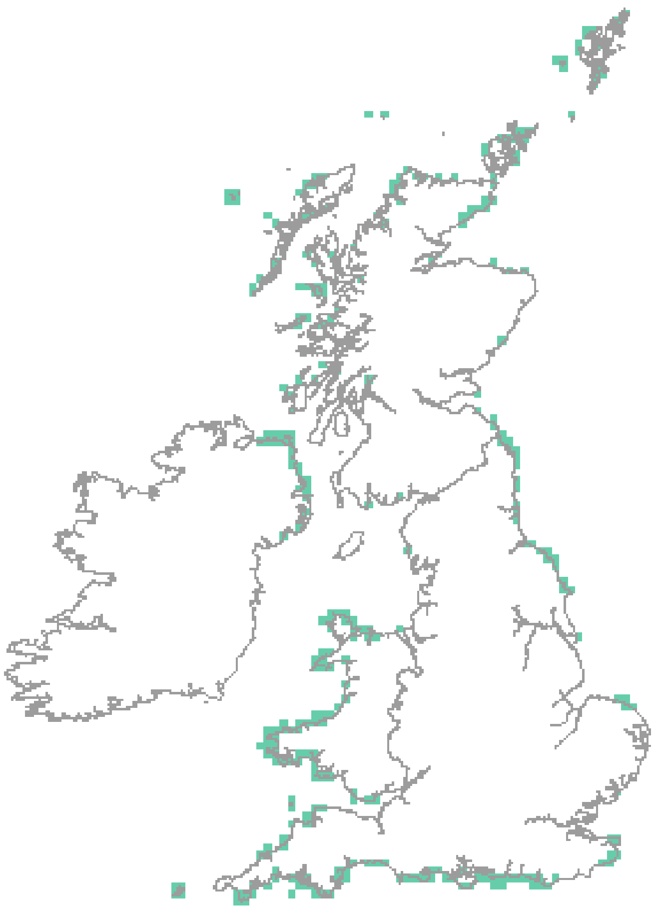
Caves

This feature includes submerged sea caves, as well as partially submerged caves which are only exposed to the sea at high tide. *'Caves vary in size, from only a few metres to more extensive systems, which may extend hundreds of metres into the rock. There may be tunnels or caverns with one or more entrances, in which vertical and overhanging rock faces provide the principal marine habitat.'* – JNCC.[135]

Figure 47 shows where these caves are distributed around the UK.

Figure 48 shows the distribution of special areas of conservation (SACs) containing sea caves, indicating the quality of the caves at each SAC.

Figure 47: UK distribution of sea caves (submerged or partially submerged)

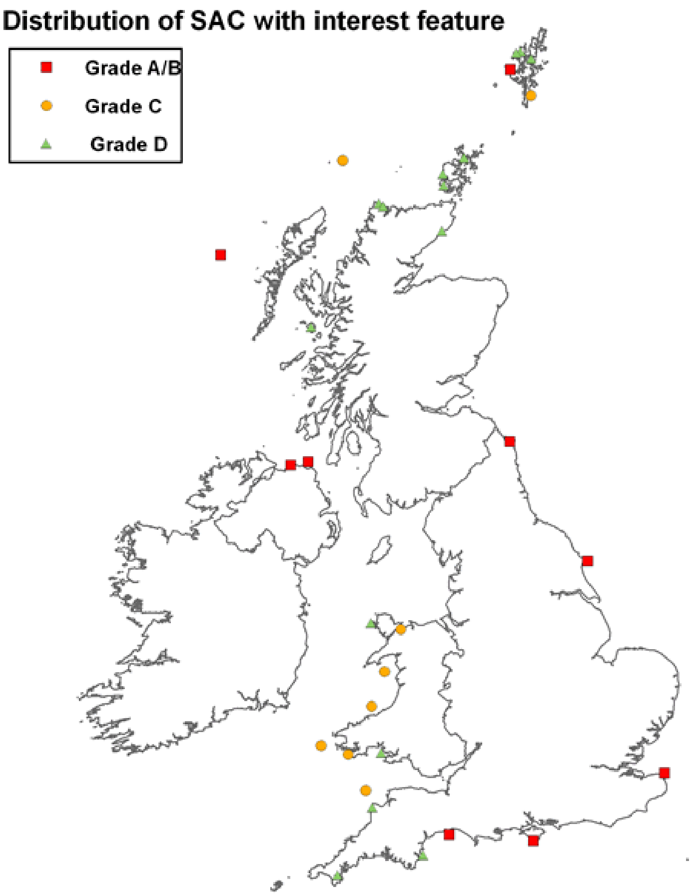


Source: JNCC[136]

135 JNCC, *Submerged or partially submerged sea caves* https://sac.jncc.gov.uk/habitat/H8330/

136 JNCC, *Comparison of UK resource and SAC distribution of Annex I habitat 8330 Sea caves Submerged or partially submerged sea caves,* https://sac.jncc.gov.uk/habitat/H8330/comparison

Figure 48: UK distribution of special areas of conservation (SACs) containing sea caves



Source: JNCC[137]

A: Outstanding example of caves in a European context.

B: Excellent example of caves, significantly above the threshold for SSSI (Site of Special Scientific Interest) or ASSI (Area of Special Scientific Interest) designation but of somewhat lower value than grade A sites.

C: Example of caves which is of at least national importance but not significantly above.

D: Caves of below-SSSI quality occurring on SACs.

Seabed sediment condition

Polycyclic aromatic hydrocarbons in sediment

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil, and can be formed during the combustion of fossil fuels and organic material, either by humans or naturally such as in forest fires. For more background information about PAHs and information about their concentrations see Biota.

PAH concentrations were measured in sediment samples from monitoring sites throughout much of the Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast, at frequencies ranging from annually to every five years.

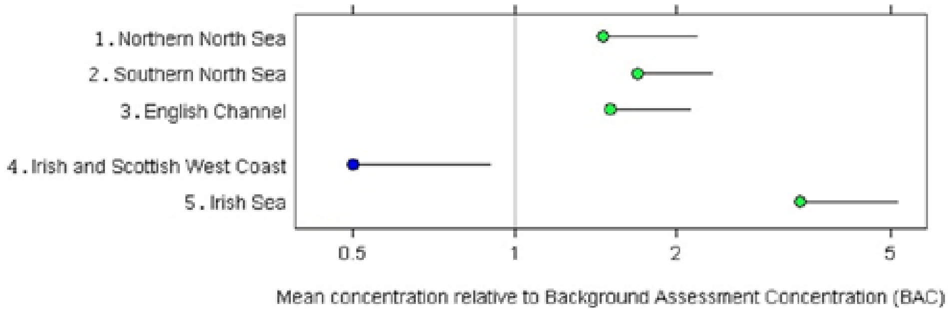
Figure 49 presents the concentrations measured at UK sites. The concentrations are compared against the OSPAR Background Assessment Concentration (BACs) and the 'effects range-low' criterion (ERL) of the United States Environmental Protection Agency. The dots represent the observed mean concentrations and the lines represent the 95% upper confidence limits. On this scale, a value of 1 would mean that the observed mean concentration equalled the ERL.

137 Ibid

Most of the dots are green, indicating that the mean concentrations are below the ERL to a statistically significant degree but not below the BAC to a statistically significant degree. The observed concentrations at sites on the Irish and Scottish West Coast were lower where the mean concentration at these sites was not only below the ERL but also the BAC, earning this category a blue classification.

At all the sets of sites, the mean concentration of PAH was within the range where the effects are likely to be low. At sites on the Irish and Scottish West Coast, the mean concentration was lower than the OSPAR background level.

Figure 49: Mean concentrations of PAH in sediment samples, relative to EAC and BAC: 1995 - 2015



Source: OSPAR[138]

Polychlorinated biphenyls in sediment

Polychlorinated biphenyls (PCBs) are man-made chemical compounds that are toxic and persistent, with the potential to bioaccumulate. For background information on PCBs and for evidence on their concentrations see Biota.

PCB concentrations are measured in sediment samples taken annually or every few years from monitoring sites throughout much of the Greater North Sea, Celtic Seas, Iberian Coast and Bay of Biscay. Seven PCB congeners were selected as indicators of overall PCB contamination.[139]

The data was compared against two criteria: the Background Assessment Concentrations (BACs) and the Environmental Assessment Criteria (EAC). Concentrations below the EAC should not cause chronic effects in sensitive marine species and so should present no significant risk to the environment. BACs are used to assess whether concentrations are close to zero for man-made substances, the ultimate aim of the OSPAR Hazardous Substances Strategy.

Figure 50 shows the mean observed concentrations (indicated by dots) of these seven PCB congeners in each of the OSPAR contaminants assessment areas within the UK. A value of 1 would indicate that the concentration equalled the EAC.

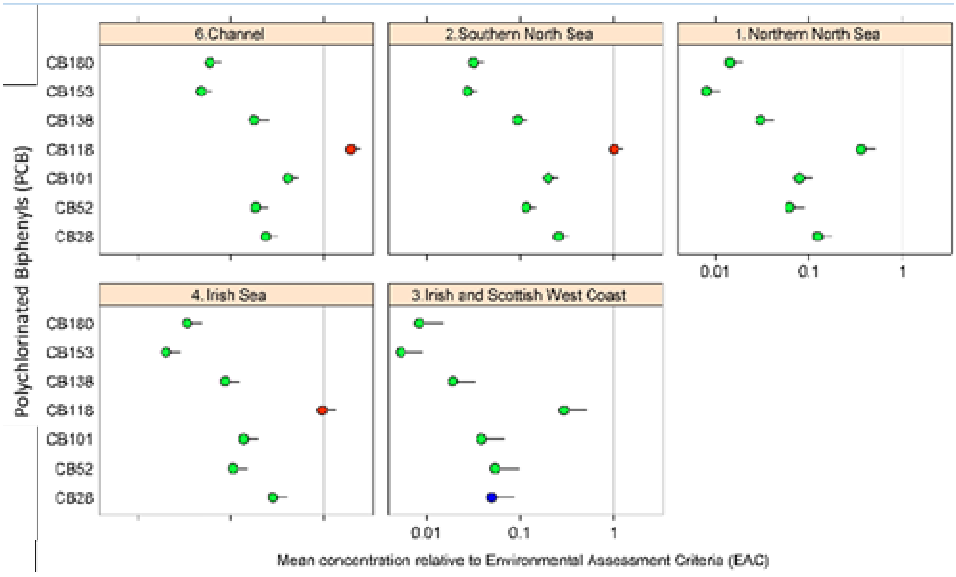
Most of the dots are green, indicating mean concentrations above the relevant congeners' BACs to a statistically significant ($p<0.05$) degree but below the EAC. The observed mean concentration at sites on the Irish and Scottish West Coast of one of the PCB congeners was also below the BAC for that congener to a statistically significant degree, hence it has a blue classification.

However, in three cases, the observed mean concentrations were not below the EAC to a statistically significant degree: these cases are shown as red dots.

138 OSPAR, *Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Sediment* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pah-sediment/

139 Ibid

Figure 50: Mean concentrations of seven PCB congeners in each of the OSPAR contaminants assessment areas within the UK, relative to the EAC: 1995 - 2015



Source: OSPAR[140]

Polybrominated diphenyl ether in sediment

The concentrations of polybrominated diphenyl ether (PBDE) are also measured in sediment samples taken annually or every few years from monitoring sites in the Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast.[141]

Mean PBDE concentrations in sediment are low (<1 μg/kg dry weight), often below detection levels, though not in industrialised areas. PBDE concentrations are measured at very few monitoring sites and there is no assessment criteria available. It is therefore not possible to assess the environmental significance of the concentrations observed. [142]

However, there was enough time series data from some monitoring sites to conclude that PBDE concentrations have been declining in the Irish Sea but show no statistically significant change in the Northern North Sea.[143]

Metals in sediment

The most toxic metals to humans and animals are mercury, cadmium, and lead - known as heavy metals. All of these metals are naturally present in the marine environment but also enter via a number of agricultural and industrial processes.

Figure 51 compares the concentrations of mercury, cadmium and lead to their OSPAR Background Assessment Concentrations (BACs) and United States Environmental Protection Agency Effects Range-Low concentrations (ERLs). A score of 1 would mean that the concentration equalled the BAC.

Blue indicates that a concentration is below the BAC and the ERL to a statistically significant ($p<0.05$) degree. The mean concentrations of cadmium achieved this classification in three of the six assessment areas.

Orange indicates that a concentration is at or above the BAC but below the ERL to a statistically significant degree. Mercury and lead concentrations were of this severity or higher, with the red dots indicating concentrations that are at or above the ERL.

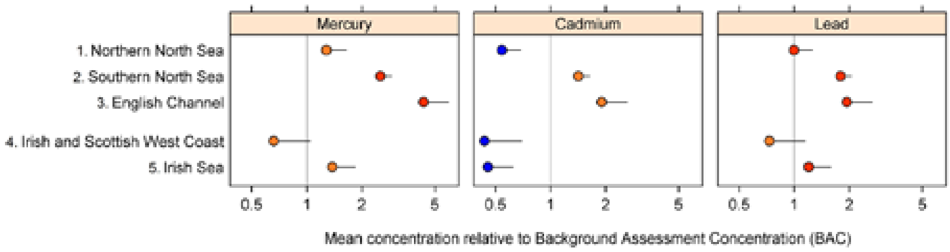
140 OSPAR, *Status and Trends of Polychlorinated Biphenyls (PCB) in Sediment https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pcb-sediment/*

141 Ibid

142 Ibid

143 Ibid

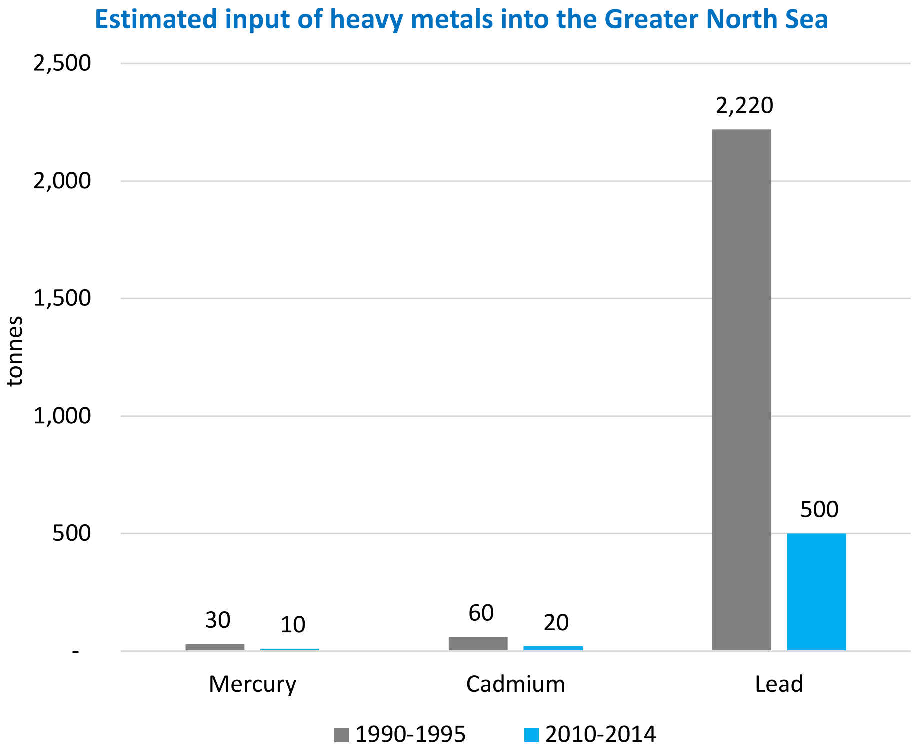
Figure 51: Mean concentrations of three heavy metals in sediment in OSPAR contaminants assessment areas relative to Background Assessment Concentrations (BACs)



Source: OSPAR[144]

Inputs of mercury, cadmium and lead into the Greater North Sea appear to have decreased by more than half since the start of the 1990s: see Figure 52. However, this change is likely overstated, as advances in analytical methods have resulted in lower detection limits.[145]

Figure 52: Estimated input of heavy metals into the Greater North Sea, 1990 - 1995 and 2010 - 2014



Source: OSPAR[146]

144 OSPAR, *Status and Trend for Heavy Metals (Cadmium, Mercury and Lead) in Sediment* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/metals-sediment/

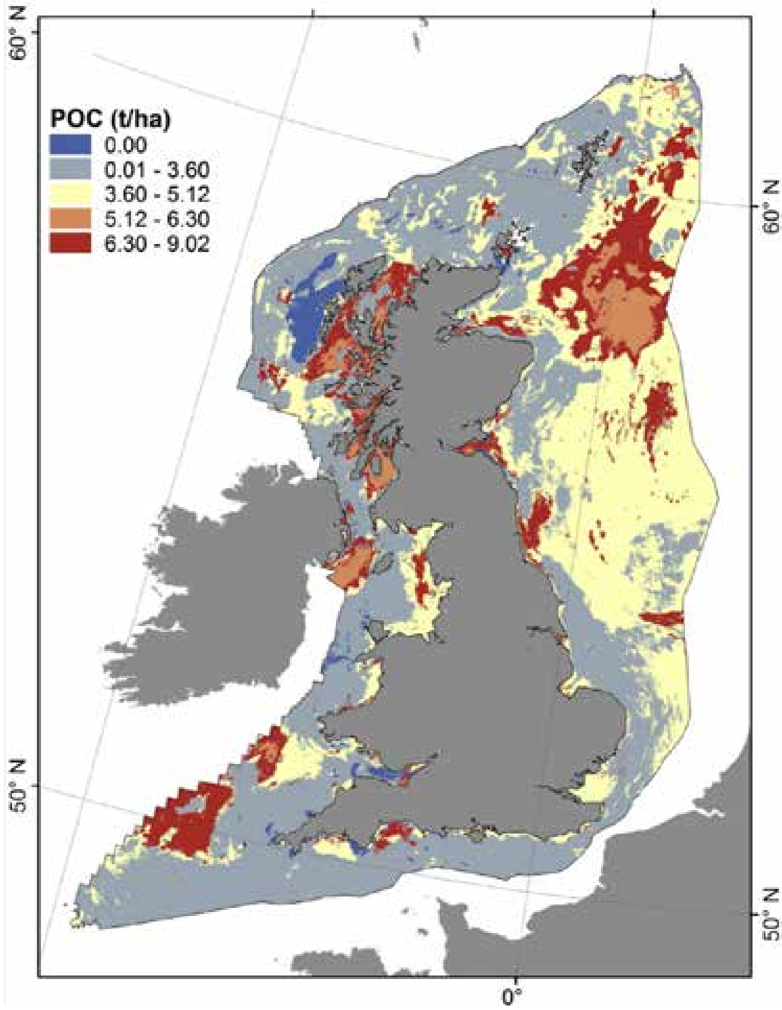
145 OSPAR, *Inputs of Mercury, Cadmium and Lead via Water and Air to the Greater North Sea* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/heavy-metal-inputs/

146 OSPAR, *Inputs of Mercury, Cadmium and Lead via Water and Air to the Greater North Sea* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/heavy-metal-inputs/

Organic carbon in sediment

Marine sediment can mitigate greenhouse gas emissions by acting as a carbon sink. There is evidence that human activities can damage these marine habitats in a way that causes their stored carbon to be released.[147] See Figure 53 for particulate organic carbon (POC) in the UK seas.

Figure 53: Prediction of areal stocks of particulate organic carbon (POC) of the upper 10cm of the sediment column, based on mean POC concentrations and dry bulk densities for different substrate types



Source: Produced by Diesing et al., found in Luisetti et al. (2019)[148]

147 Luisetti et al, *Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK, (Ecosystem Services, Volume 35), February 2019, pp 67-76* https://www.sciencedirect.com/science/article/pii/S2212041618300536

148 Diesing et al, *Predicting the standing stock of organic carbon in surface sediments of the North-West European continental shelf (2017)* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6961524/

3. Coastal

The coastal assets cover several habitats from coastal dunes to coastal waters. However, there is limited data on the abiotic components of this asset. The data and evidence scoped by the NCC cover both abiotic and biotic elements. It has not been possible to disaggregate these biotic elements from the data. On that basis, the following components of the asset are covered in *Annex 5 Land (terrestrial, freshwaters, and coastal margins habitats) asset:*

- Coastal saltmarsh;
- Coastal dunes;
- Maritime cliffs and slopes;
- Mudflats;
- Vegetated shingles; and
- Littoral rock.

The assessment presented in this section focuses on the condition and extent of bathing and coastal waters in England. Table 12 below presents existing targets and thresholds based on the Bathing Water Directive (BWD) and the Water Framework Directive (WFD).

Table 12: List of coastal components and targets/thresholds

	Component	Targets/thresholds
3.1	Bathing water	The EU Bathing Water Directive (2006/7/EC)[149] states that member states shall ensure that, by the end of the 2015 bathing season, all bathing waters are at least 'sufficient'. The overall aim of the directive is to increase the number of bathing waters classified as 'excellent' or 'good'.
3.2	Contaminants in the water column in coastal waters	Water Framework Directive (WFD) (2000/60/EC) establishing a framework for European Community action in the field of water policy[150] The WFD target is to get 100% of water bodies in England to meet good ecological status or potential. However, the WFD has provisions on disproportionate cost and technical feasibility. Given these provisions, the 2015 impact assessment set a lower target with the aim that 75% of surface water bodies in England to have an objective of good ecological status or potential by 2027.[151] There are no specific targets for surface waters in terms of their chemical classification, only limits that need to be met. The WFD target is also a commitment in the 25 Year Environment Plan (25 YEP) has the commitment: "*Improving at least three-quarters of our waters to be close to their natural state as soon as is practicable*"[152]. However, the plan does not define what is meant by soon as practical.

149 European Parliament, *Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EC* (2006) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=GA

150 European Parliament, *Directive 2000/60/EC* (2000) https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF

151 Environment Agency, *Update to the river basin management plans: impact assessment* (2015) https://www.gov.uk/government/publications/update-to-the-river-basin-management-plans-impact-assessment

152 Defra, *25 Year Environment Plan* (2018) https://www.gov.uk/government/publications/25-year-environment-plan

The overall assessment of coastal

Based on the data available the overall assessment coastal is 'red/amber': **deteriorating/mixed**. This RAG rating has been attributed because bathing waters and coastal waters have not met their respective BWD and WFD targets. Also, the condition of coastal waters has declined when looking at the most recent year on year change for both cycle 1 and 2. See Table 13 below for an assessment of bathing waters and contaminants in coastal waters. The key findings from the NCC assessments are:

- Between 1994 and 2019 there has been an increase in the number of bathing waters achieving at least 'sufficient' from 46% to 98%.
- The overall classification of coastal waters (cycle 2) achieving at least 'good' has declined from just over 45% to just under 44% between 2015 and 2018.

Table 13: Summary of assessment of data

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
3.1 - All bathing waters are at least 'sufficient'. The overall aim of the directive is to increase the number of bathing waters classified as 'excellent' or 'good'.	England has not met the Bathing Water Directive (BWD) target. The latest data shows that just under 2% were classified as poor which means not all bathing waters have achieved 'sufficient'.	There has been a significant improvement in the status of bathing waters between 1995 and 2019, from just under 46% to just over 98% achieving 'sufficient' or above status.	Between 2011 and 2019, the number of bathing waters achieving a status of 'sufficient' or above has increased from just under 90% to just over 98% achieving 'sufficient' or above status.	There has been a slight increase between 2018 and 2019. However, this increase has been less than a percentage point. The RAG rating is mixed/no change.
3.2 - Water column contaminants (based on the Water Framework Directive classification)	**Cycle 1:** The UK is currently not meeting the WFD target for 75% of surface water bodies in England to have 'good' ecological status or potential. The latest data for 2016 show that just over 38% achieve at least good.	**Cycle 1:** When comparing the ecological classification from 2009 and 2016 there has been a decline in the number of coastal waters achieving at least 'good' from 43% to just over 38%.	**Cycle 1:** From the data, a declining trend can be seen for all three classifications (overall, chemical, and ecological) between 2011 and 2016. For the overall assessment, there was a decline from 43% in 2011 to just under 37% in 2016.	**Cycle 1:** The data present a declining trend for the overall and ecological classification between 2015 and 2016, and a slight increase in the number of coastal water bodies under the chemical classification.
	Cycle 2: The UK is currently not meeting the WFD target for 75% of surface water bodies in England to have good ecological status or potential. Based on the latest evidence from cycle 2, just over 45% of coastal water bodies achieved 'high' or 'good' ecological status.	**Cycle 2:** When looking at the period between 2013 and 2018 there has been an increase in the number of coastal water bodies achieving at least 'good' overall status from just over 36% to just under 44%.	**Cycle 2:** Data for cycle 2 is not available for 2011, as data only starts from 2013.	**Cycle 2:** Between 2015 and 2016 there has been an increase in the number of coastal water bodies achieving 'good' chemical classification. However, there has been a decline in the numbers of coastal waters achieving at least 'good' in the overall and ecological classification.

Bathing waters assessment

The NCC bathing waters quality assessment is based on data and evidence produced to inform the BWD. In Table 14 below are the BWD classification statuses and the bacterial thresholds that need to be met to achieve these statuses. There are four classifications ranging from 'excellent' to 'poor'.

Table 14: Description of the Bathing Water Directive classification and limits

BWD status	Description	Intestinal enterococci (cfu/100 ml)	Escherichia coli (cfu/100 ml)
Excellent quality	Bathing waters are to be classified as 'excellent' if, in the set of bathing water quality data for the last assessment period, the percentile values for microbiological enumerations are equal to or better than the 'excellent quality' values.	100 (*)	250 (*)
Good quality	Bathing waters are to be classified as 'good' if, in the set of bathing water quality data for the last assessment period, the percentile values for microbiological enumerations are equal to or better than the 'good quality' values.	200 (*)	500 (*)
Sufficient	Bathing waters are to be classified as 'sufficient' if, in the set of bathing water quality data for the last assessment period, the percentile values formicrobiological enumerations are equal to or better than the 'sufficient' values.	185 (**)	500 (**)
Poor	Bathing waters are to be classified as 'poor' if, in the set of bathing water quality data for the last assessment period, the percentile values for microbiological enumerations are worse than the 'sufficient'.	Worse than the sufficient values	Worse than the sufficient values

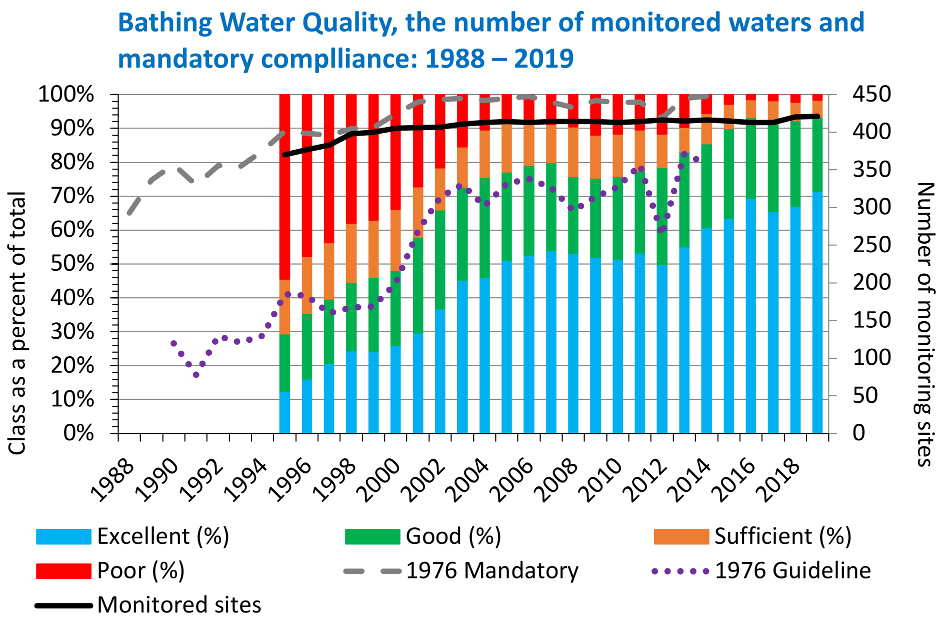
(*) Based upon a 95-percentile evaluation. (**)Based upon a 90-percentile evaluation. See Annex II of the Bathing Waters Directive for further details.[153]

Over the last thirty years, the quality of coastal bathing waters has been on a trend of improvement, reaching a peak in 2016 where just under 99% of bathing waters achieved 'sufficient' or above status. In 2019, just over 98% of bathing waters achieved 'sufficient' or above status (with just over 71% achieving excellent status). This proportion represents a significant increase from 1995 where just 46% achieved 'sufficient' or above status.

Improvements have also happened between 2011 and 2019 where the number of bathing waters achieving a status of 'sufficient' or above has increased from just under 90%. There has also been an increase between 2018 and 2019 estimates of just half a percentage point, from just under 98% to just over 98%. Post 1999, the number of monitored sites has remained above 400, ranging between 400 and 421. See Figure 54 for historical trend and sites being monitored.

153 European Parliament, *Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing ater quality and repealing Directive 76/160/EC* (2006) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=GA

Figure 54: Bathing water quality, monitored sites and mandatory compliance for England: 1988 - 2019



Source: Environment Agency internal estimates[154]

In addition, the evidence is also available spatially. Figure 55 provides a map of the bathing waters in question. The map presents the location of bathing waters that have been designated for and not for bathing.

Figure 55: Map of designated bathing waters on the English coastline

Source: Environment Agency[155]

154 Data is not publicly available for the period between 1995 and 2014. Any classifications pre-2015 are projected classifications and were not formally reported. They have been back calculated using historic data collected for the 1976 bathing water directive (76/160/EEC) which was repealed in 2014.

155 Environment Agency, *Find a bathing water* https://environment.data.gov.uk/bwq/profiles/

Contaminants in the water column in coastal waters

To assess the water column contaminants the NCC has followed the approach from the UKMMAS which uses data from the Water Framework Directive (WFD), which is to classify water bodies based on their status classification, as displayed in Table 15 below.

Table 15: Water Framework Directive (WFD) classification framework of water bodies

Waterbody type	Classification framework	Description
Surface water bodies – coastal	**Ecological status**	"*Ecological status is an assessment of the quality of the structure and functioning of surface water ecosystems. It shows the influence of pressures (e.g. pollution and habitat degradation) on the identified quality elements. Ecological status is determined for each of the surface water bodies of rivers, lakes, transitional waters and coastal waters, based on biological quality elements and supported by physico-chemical and hydromorphological quality elements. The overall ecological status classification for a water body is determined, according to the 'one out, all out' principle, by the element with the worst status out of all the biological and supporting quality elements*" [156.]
	Chemical status	"*For surface waters, good chemical status means that no concentrations of priority substances exceed the relevant EQS established in the Environmental Quality Standards Directive 2008/105/EC (as amended by the Priority Substances Directive 2013/39/EU). EQS aim to protect the most sensitive species from direct toxicity, including predators and humans via secondary poisoning. A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous (present, appearing or found everywhere), persistent, bioaccumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs)*"[157].
	Overall status	It is the combined classification of ecological and chemical assessments.

The WFD uses a scale to define the status of each water body, ranging from 'high' to 'bad'. See Table 16 below for a description of each status.

Table 16: Definition of status in the Water Framework Directive

Status	Definition
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife, or fisheries.
Good	A slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

Source: Environment Agency[158]

156 EEA, *Ecological status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies

157 EEA, *Chemical status of surface water bodies* (2018) https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/chemical-status-of-surface-water-bodies

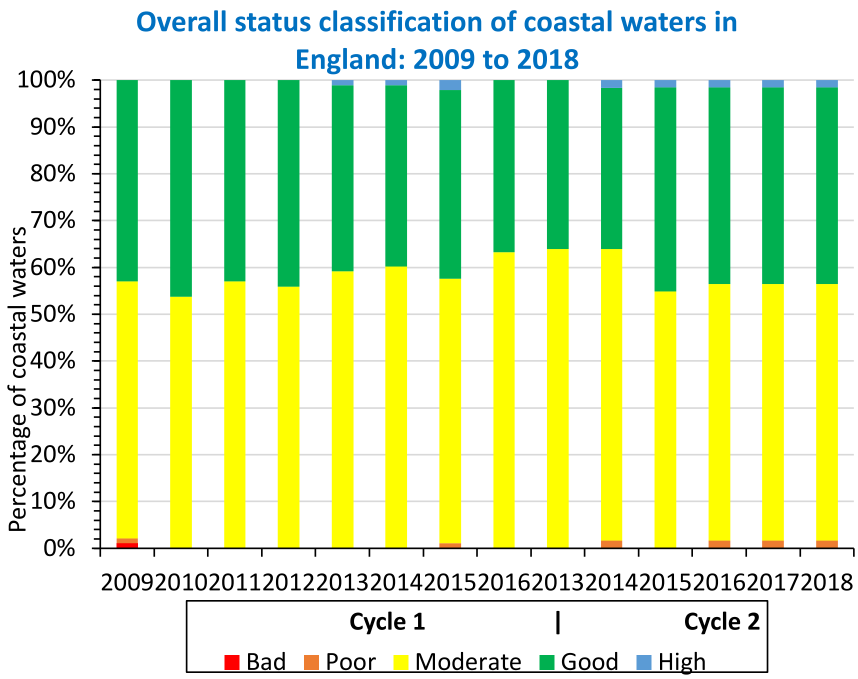
158 Environment Agency, *Catchment data explorer help page https://environment.data.gov.uk/catchment-planning/help*

Based on the WFD classification the NCC has analysed the data to produce an assessment of coastal waters, which are presented in terms of their overall, ecological and chemical classification, starting with the overall classification in Figure 56.

Based on cycle 1 data there was a decline in the number of coastal water bodies achieving 'high' or 'good' overall status from 43% in 2009 to just under 37% in 2016. For cycle 2, there was an increase in the number of coastal water bodies achieving 'high' or 'good' overall status from just over 36% in 2013 to just under 44% in 2018.[159]

There was a decline in both cycle 1 and cycle 2 data for the latest year available. Estimates from cycle 1 present a decline in coastal water bodies achieving 'high' or 'good' overall status from over 42% in 2015 to just under 37% in 2016. Under cycle 2 there is a similar decline in coastal water bodies achieving 'high' or 'good' overall status from just over 45% in 2015 to just under 44% in 2016.

Figure 56: Overall status classification of coastal waters in England between 2009 and 2018



Source: Environment Agency – WFD cycle 1 and 2.[160, 161]

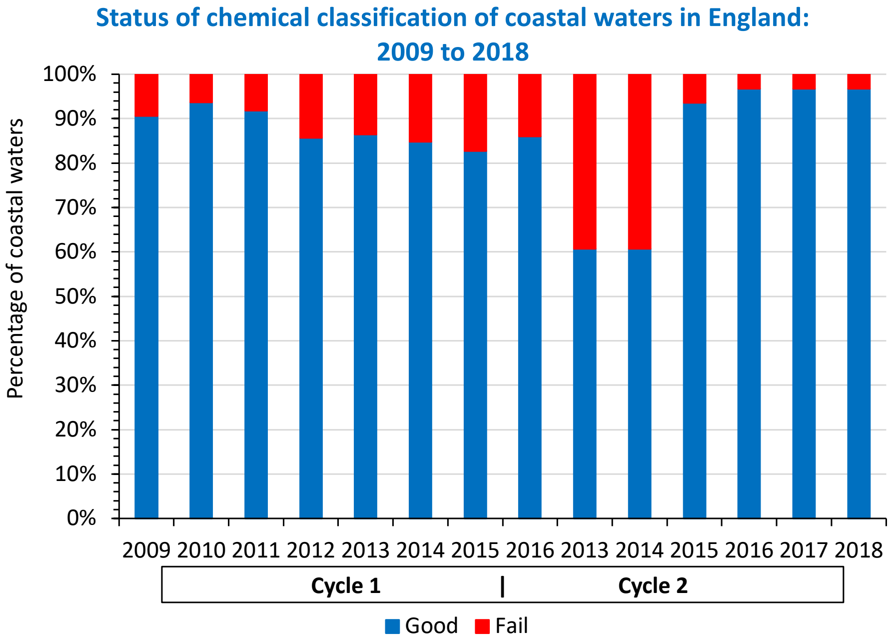
159 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment.

160 Environment Agency, *WFD cycle 1 surface water classification status and objectives (2020)* https://data.gov.uk/dataset/1b96de41-148c-4280-a244-de0124b2bd8e/wfd-cycle-1-surface-water-classification-status-and-objectives

161 Environment Agency, *WFD Classification Status Cycle 2 (2020)* https://data.gov.uk/dataset/41cb73a1-91b7-4a36-80f4-b4c6e102651a/wfd-classification-status-cycle-2

Under the chemical classification, the data presents a steady decline between 2009 and 2015 for cycle 1 in the number of coastal water bodies achieving 'good' status. In 2009 just under 91% achieved good status, falling to just under 83% in 2015 and then slightly increasing to 86% in 2016. Under cycle 2 there has been an increase in the number of water bodies achieving 'good' from just under 61% in 2013 to just under 97% in 2018[162]. There was also an increase in the number of coastal water bodies achieving 'good' between 2015 and 2016 from just under 94% to just under 97%. See Figure 57 for the change over time in the classification of coastal water bodies since 2009.

Figure 57: Status of chemical classification of coastal waters in England between 2009 and 2018



Source: Environment Agency – WFD cycle 1 and 2.[163, 164]

Evidence on the ecological classification is presented in Figure 58. Under cycle 1 there was some fluctuation between 2009 and 2016. Between 2009 and 2016 the has been a decline in the number of coastal water bodies achieving the 'good' or 'high' status, from 43% to just over 38%. There was also a decline between 2015 and 2016, of just over 6 percentage points, from over 44% to just over 38%.

There is a similar declining trend under cycle 2, from just over 54% of coastal water bodies achieving the 'good' or 'high' status in 2013 to just over 45% in 2018.[165] Between 2015 and 2016, there has also been a decline in the number of coastal water bodies achieving 'good' or 'high' status from just under 47% to just over 45%.

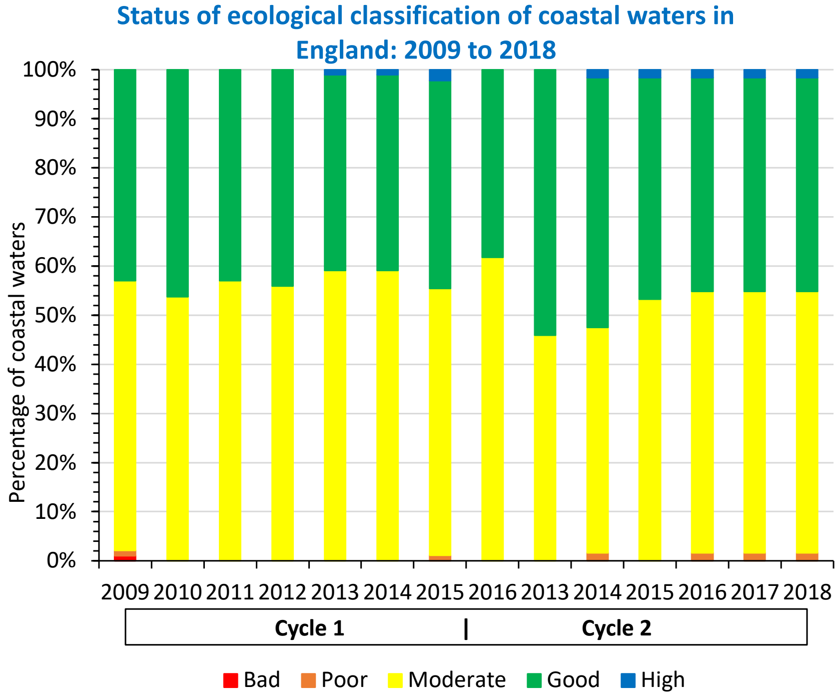
162 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment.

163 Environment Agency, *WFD cycle 1 surface water classification status and objectives (2020)* https://data.gov.uk/dataset/1b96de41-148c-4280-a244-de0124b2bd8e/wfd-cycle-1-surface-water-classification-status-and-objectives

164 Environment Agency, *WFD Classification Status Cycle 2 (2020)* https://data.gov.uk/dataset/41cb73a1-91b7-4a36-80f4-b4c6e102651a/wfd-classification-status-cycle-2

165 In 2016, the Environment Agency moved away from the annual reporting to a triennial reporting system. This means that data for 2017 and 2018 have been carried forward from the 2016 assessment.

Figure 58: Status of ecological classification of coastal waters in England between 2009 and 2018



Source: Environment Agency – WFD cycle 1 and 2.[166, 167]

Based on the WFD evidence coastal waters are not meeting the WFD target of 75% surface water bodies in England to have good ecological status or potential. Based on the latest evidence from cycle 2, just over 45% of coastal water bodies achieved 'high' or 'good' ecological status.

4. Marine and coastal processes

The overall assessment of coastal

Given the limited data available it has not been possible to produce an assessment of marine and coastal processes. The sections that follow provide a sense of key measurements that could form part of a more comprehensive assessment to inform the condition and extent of this asset. The RAG rating here is grey: **unable to assess** – given the limited data available.

Waves

Patterns in the behaviour of waves are important because waves can be dangerous to sea users. Powerful waves are particularly disruptive for the shipping industry, which must avoid storms. Waves can damage coastal facilities but can also be a source of power generation. As climate change causes more extreme weather events it is likely to increase periods of significant waves which may impact on marine habitats and biota.

'Significant wave height' is a measure of the energy in the wave field that is approximately equal to the highest third of wave heights. Figure 59 shows estimates of the fifty-year-return-period SWH (i.e. the SWH likely to occur only once every fifty years in each location) from Bricheno *et al (2015),*[168] to illustrate the differences in wave exposure around the UK.

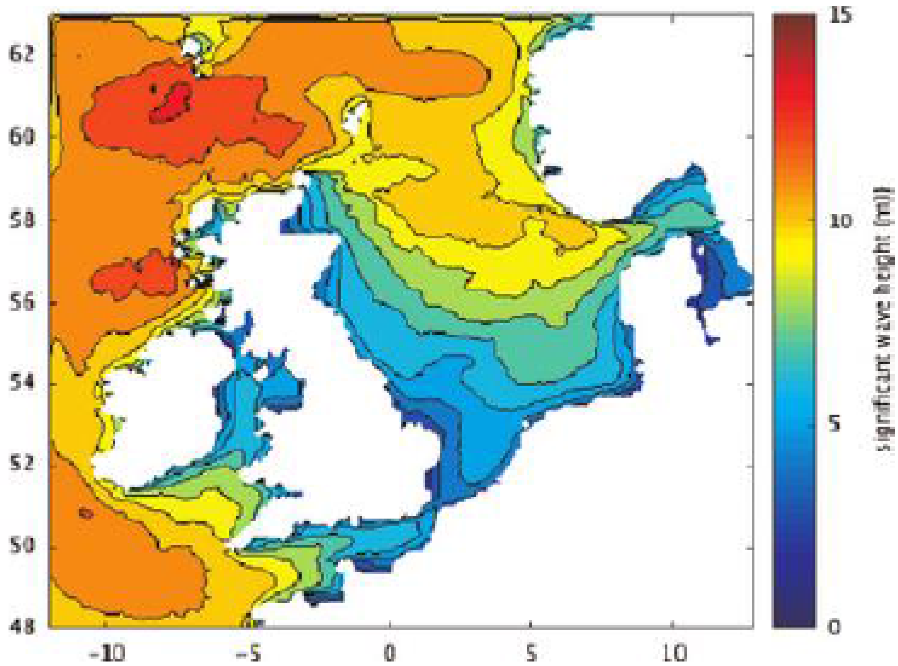
The authors stress that, because Figure 59 was created from too short a sample of model data, it should not be referred to as the best estimate of fifty-year-return-period SWH.

166 Environment Agency, *WFD cycle 1 surface water classification status and objectives (2020)* https://data.gov.uk/dataset/1b96de41-148c-4280-a244-de0124b2bd8e/wfd-cycle-1-surface-water-classification-status-and-objectives

167 Environment Agency, *WFD Classification Status Cylce 2 (2020)* https://data.gov.uk/dataset/41cb73a1-91b7-4a36-80f4-b4c6e102651a/wfd-classification-status-cycle-2

168 Bricheno, L.M., Wolf, J. and Aldridge, J. (2015) *Distribution of natural disturbance due to wave and tidal bed stress around the UK. Continental Shelf Research*, 109, 67–77 https://www.sciencedirect.com/science/article/pii/S0278434315300583

Figure 59: Fifty-year return period significant wave height around UK from ten-year hind-cast: 1999 - 2008. This figure is just an example to show the spatial distribution of wave height around the UK: it should not be referred to as the best estimate of the fifty-year return period as it has been extracted from too short a sample of model data.



Source: Wolf, J; Woolf, D, and Bricheno, L, 2020[169]

Sea level height

Sea level rise is likely to be an increasingly important area to monitor given that it impacts on coastal habitats and biota as well as human infrastructure. Climate change scenario modelling projects that in 2100 sea-level rise ranges from:

- 0.45–0.78 m in London;
- 0.23–0.54 m in Edinburgh;
- 0.43–0.76 m in Cardiff; and
- 0.26–0.58 m in Belfast.

5. Marine and coastal litter and waste

According to the United Nations Environment Programme (UNEP), '*marine litter is any persistent, manufactured, or processed solid material, discarded or unintentionally lost, disposed of or abandoned, that ends up in the marine and/or coastal environment. It includes, but is not limited to, plastic, metal, glass, construction materials, paper and cardboard, rubber, textiles, timber, and hazardous materials (such as munitions, asbestos, and medical waste)*'.[170]

The United Kingdom Marine Monitoring & Assessment Strategy (UKMMAS) further states, '*marine litter can directly harm wildlife by entanglement and ingestion. Entanglement can reduce movement and potentially result in serious injury, death by starvation, drowning or suffocation. Ingestion can lead to internal injuries, a false sense of satiation and reproductive problems.*'[171]

169 Wolf, J; Woolf, D, and Bricheno, L (2020) *Impacts of climate change on storms and waves relevant to the coastal and marine environment around the UK* http://www.mccip.org.uk/media/2010/07_storms_waves_2020.pdf

170 United Nations Environment Plan (UNEP), *Marine Litter: A Global Challenge (April 2009)* http://wedocs.unep.org/bitstream/handle/20.500.11822/7787/-Marine%20Litter_%20A%20Global%20Challenge%20%282009%29-2009845.pdf?sequence=3&isAllowed=y

171 United Kingdom Marine Monitoring & Assessment Strategy (UKMMAS), *Trends in UK beach litter from 2008 to 2015* https://moat.cefas.co.uk/pressures-from-human-activities/marine-litter/beach-litter/

Marine litter also has negative impacts on coastal communities, disrupting the tourism, fishing and water sports on which they depend. Marine litter can spoil fish catches and damage property. Unsightly and unhealthy debris on beaches spoil people's enjoyment of them, impacting tourism, leisure, and recreation.

For these reasons, large amounts of money are spent clearing litter from beaches, funded by local authorities and ultimately taxpayers.[172] Table 17 below presents the components assessed under this section.

Table 17 List of components of marine and coastal litter and respective targets

	Component	Targets/thresholds
Overall objective	• Coastal and marine environment	There is no specific quantitative target to reduce or limit the amount of litter and/or waste in the marine environment. However, there are qualitative provisions under the EU Directive (2008/56/EC) where the Marine Strategy Framework Directive (MSFD) requires EU Member States to ensure that, by 2020, 'properties and quantities of marine litter do not cause harm to the coastal and marine environment'.[173]
5.1	• Floating litter	The UK has no specific target/threshold for floating litter. However, the OSPAR convention[174] has developed ecological quality objectives (EcoQOs) which sets the following threshold: • Less than 10% of beached northern fulmars (Fulmarus glacialis) should have more than 0.1 g plastic particles in their stomachs. This target should be confirmed in samples of 50 to 100 beached fulmars from each of the four to five areas of the North Sea, over a period of at least five years.[175] To measure progress towards this objective the UK has developed an indicator in line with the OSPAR ecological quality objective.
5.2	• Seabed litter	The UK has no quantitative target for seafloor litter. There is however, a target for 'a decrease in the number of items of litter on the seabed'. This target is in place to measure progress towards achieving Good Environmental Status (GES).[176]
5.3	• Coastal (beach) litter	The UK has no quantitative targets on coastal litter. There is however, a target for "overall reduction in the number of visible litter items within specific categories/types on coastlines". [177] This target is in place to measure progress towards achieving GES.

The overall assessment of marine and coastal litter

To produce the assessment of marine and coastal litter the NCC has looked at several datasets, as there is no single source presenting the data and evidence on floating, seabed and coastal (beach) litter. Also, data was not available at the England level, so instead, data for the UK was used as a proxy. Where UK data was not available, data on the Celtic and Greater North Seas[178] was used – this is the data that is produced for reporting into the OSPAR convention. See Table 18 for the assessment of components.

The NCC has also been unable to test the robustness of the datasets used for this assessment, meaning that the evidence presented in the sections that follow should be treated with caution. However, all these datasets have been published elsewhere by reputable organisations.

172 Ibid

173 European Parliament, *Directive 2008/56/EC of the European Parliament and the Council of 17 June 2008 estabilishing a framework for community action in the field of marine environmental policy (Marine Strateggy Framework Directive)* (2008) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

174 OSPAR Convention, *About OSPAR* https://www.ospar.org/about

175 OSPAR Convention, *EcoQO Handbook: handbook for the application of Ecological Quality Objectives in the North Sea – Second Edition – 2009* (2009) https://www.ospar.org/documents?v=7127

176 Defra, *Marine Strategy part one: UK updated assessment and Good Environmental Status* (2019) https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

177 Defra, *Marine Strategy Part Three: UK programme of measures* (2015) https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures

178 The data for the Greater North Sea and Celtic Sea is likely to include devolved admistration and/or international waters.

Based on these limitations and the results from the data/evidence below, the NCC assessment of the marine and coastal litter is **'Red': deteriorating.** Marine and coastal litter continue to be increasing and the UK has not met and is not on track to meet its targets of floating litter or the overall marine litter target. The NCC assessment is supported by Defra's own assessment of marine litter (D10 marine litter indicator) under the Marine Strategy where GES has not been achieved.[179] The key findings from the NCC assessments are:

- The number of fulmars with more than 0.1g of plastic in 2014-2018 was 49%, much higher than the target of 10%.
- The amount of estimated seabed litter has increased between 1992 and 2016, from around 95 items to around 358 per km^2 respectively
- Estimates of litter items per 100m of coast on UK beaches have increased by around 176% between 1994 and 2019, from around 202 to 558 items.

Table 18: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
Floating litter	The UK is not on track to meet the OSPAR target that fewer than 10% of fulmars should have more than 0.1g of plastic in their stomachs. From the latest data available it has been estimated that around 49% fulmars had more than 0.1g of plastic in their stomachs.	Based on the 5 – year period data between 2002-2006 and 2014-2018 there was a decline in the number of fulmars with plastic in their stomachs from 53% to 49%.	There was also a decline between 2011-2015 and 2014-2018 from 66% to 49%.	Year-on-year data is not available but when comparing between the following periods 2013-2017 and 2014-2018 there has been a decline in the number of fulmars having more the 0.1g in their stomachs from 53% to 49% respectively.
Seabed litter	The UK has no quantitative targets on seabed litter.	The amount of litter varied over the period, increasing between 1992 and 2004, then steeply declining between 2004 and 2005 and fluctuating between 2005 and 2010. Between 2010 and 2015 the amount remained somewhat flat. When comparing 1992 and 2016, there has been an increase in the number of litter items in the seafloor.	The number of litter items has increased when comparing 2011 and 2016, from 204 items to 358 items per $km.^2$	Based on estimates from Figure 63 there has been an increase in the number of litter items between 2015 and 2016 from around 141 items to 358 items per km^2. Evidence for the Celtic and Greater North Seas also presents an increase in the mean number of litter items in these seas.
Coastal (beach) litter	The UK has no quantitative targets on coastal litter.	Beach litter has increased both for UK estimates and according to data from the Greater North Sea and Celtic Seas. At the UK level, based on MCS estimates, there has been an increase in the average number of items between 1994 and 2019 from 202 to 558.	There has been an increase from 473 items in 2011 to 558 items in 2019.	There has been a decline in the estimated number of litter items found on beaches in the UK between 2018 and 2019.

179 Defra, Marine strategy part one: UK updated assessment and Good Environmental Status (2019) https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status

Assessment of floating litter

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention, of which the UK is a signature) monitors and assesses the plastic content of the stomachs of fulmars as an indicator of environmental quality.

The plastic content of the stomachs of fulmars is a suitable indicator of environmental quality because fulmars are seabirds that are abundant, widespread, and known to ingest litter.

Fulmars forage near the surface, so the quantity of plastic in their stomachs mainly reflects the abundance of floating litter in their environment. However, their stomachs may also contain items from deeper water or items that may have been ingested indirectly via their prey. OSPAR has established a long-term goal or ecological quality objective (EcoQO) to reduce the proportion of fulmar stomachs containing more than 0.1g to less than 10%.

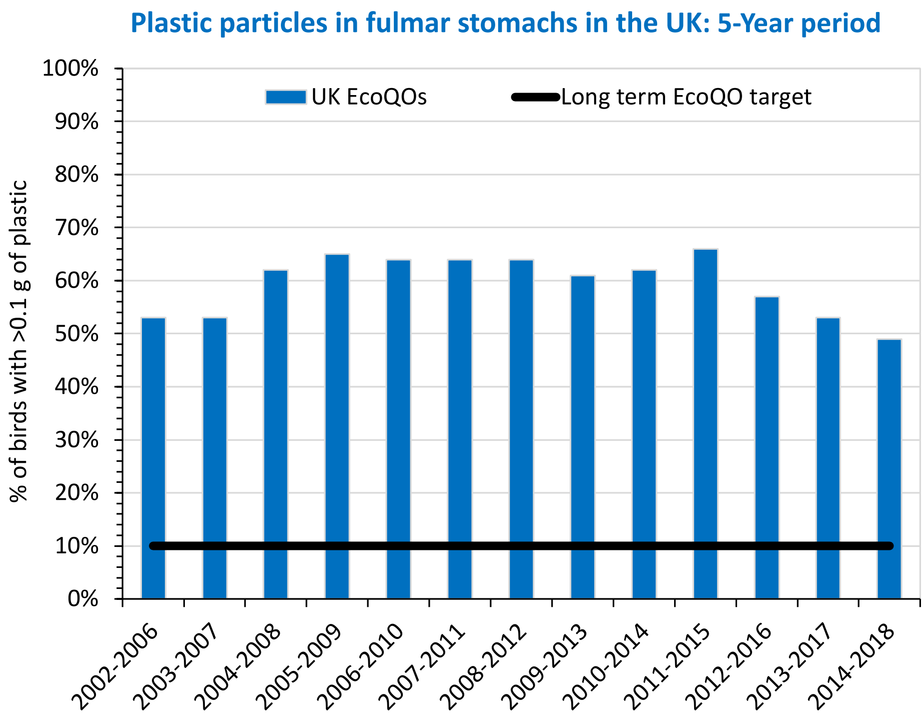
The assessment is made on beached fulmars collected on UK coastlines. The foraging ranges of fulmars cover hundreds of miles, so the assessment gives an indication of environmental quality far out into the sea. The plastic content of the stomachs of 323 fulmars was assessed over the period 2002-2018.

Over the final five-year period for which there is data, 2014-2018, 93 fulmar stomachs were analysed in the UK, comfortably surpassing the recommended minimum sample size for a reliable average of 40. Of these birds, 88% had some ingested plastics and the stomachs of 49% contained more than 0.1g of plastic. The average stomach contained 22.9 plastic particles, mostly small, with a combined average mass of 0.25 gram: see Figure 60.

Looking across the five-year periods, there seems to be a decline in the trend between 2011-2018, with the proportion of fulmar stomachs containing more than 0.1g of plastic fluctuating around 50-60%. This pattern is in line with data collected in the Netherlands and other North Sea locations.

Data from the Netherlands show an increase in plastic content from the 1980s to the 1990s, followed by a decrease back to 1980s levels, where the plastic content has remained since.[180]

Figure 60: Plastic content of the stomachs of fulmars beached in the UK (five-year periods): 2002 - 2018

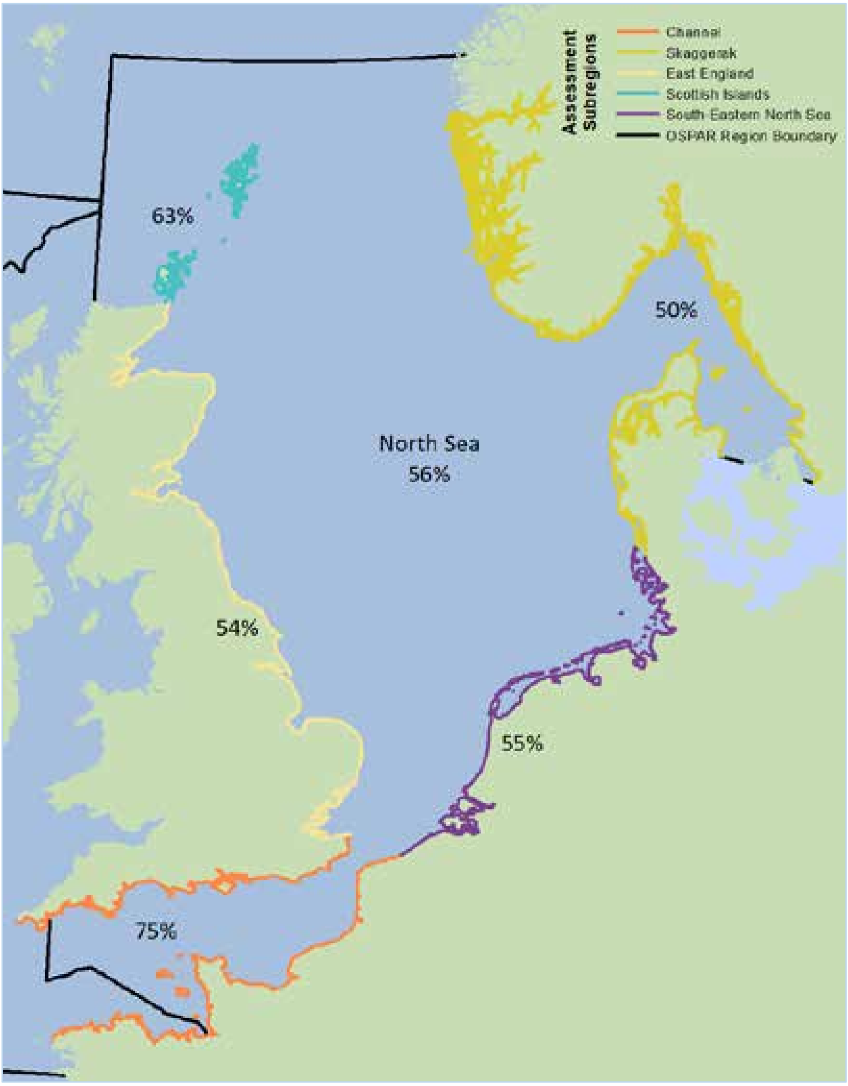


Source: Data provided by Defra

180 UKMMAS, *Plastic particles in fulmar stomachs* https://moat.cefas.co.uk/pressures-from-human-activities/marine-litter/floating-litter/

Figures 61 and 62 present data from across the North Sea, broken down by region. None of the North Sea regions comes close to meeting the EcoQO for the plastic content of fulmar stomachs, and the variation between the regions shows no clear geographical pattern. The time series data (Figure 62) shows no statistically significant change except for a decline in the East of England.

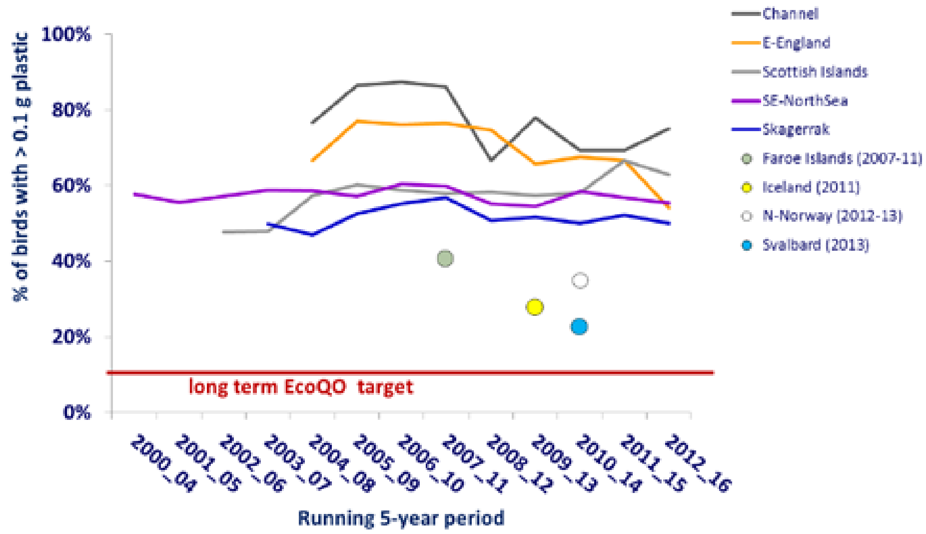
Figure 61: Proportions of assessed fulmars having more than 0.1g of plastic in their stomachs in different sub-regions of the North Sea: 2012 - 2016



Source: OSPAR Assessment Portal[181]

181 OSPAR Convention, *Assessment Portal: Plastic particles in fulmar stomachs in the North Sea* https://oap.ospar.org/en/versions/plastic-particles-in-fulmar-stomachs-north-sea-en-1-0-0/

Figure 62: Running five-year averages for the percentage of fulmars having more than 0.1g of plastic in the stomach: 2000 - 2016



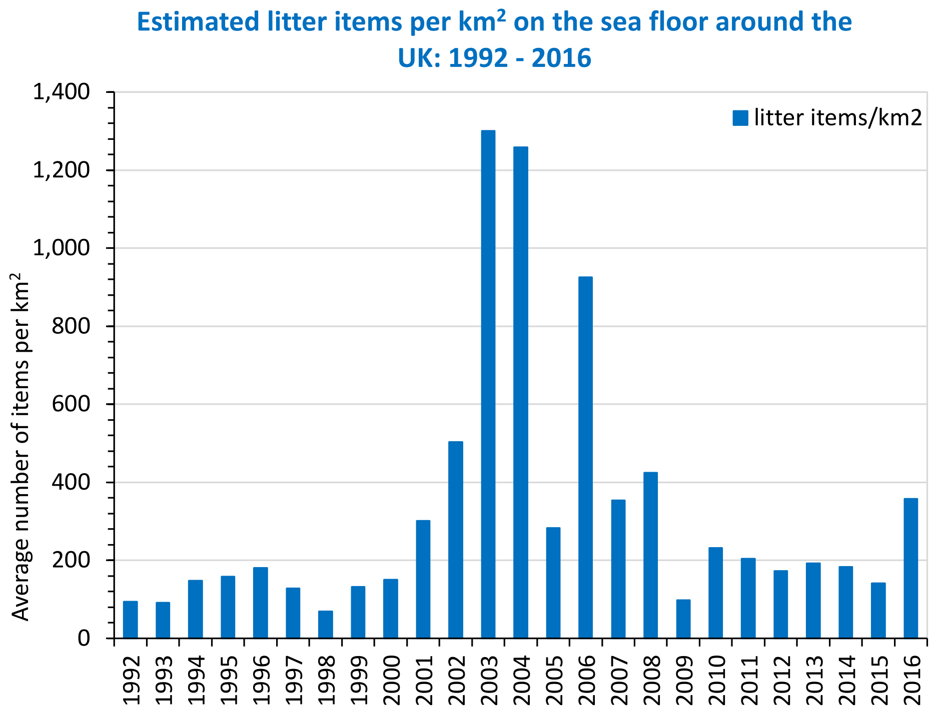
Source: OSPAR Assessment Portal[182]

Assessment of seabed litter

Litter is widespread across the areas assessed.

Estimates of the abundance of litter items on the seafloor around the UK fluctuated from 1992 to 2000 at around 100 items per km^2, before rising sharply to a peak of 1300 items per km^2 in 2003: see Figure 63. The figures then descended sharply, fluctuating around 170-230 items per km^2 from 2010 to 2015. In 2016, the final year for which data is available, the estimated number of litter items on the seafloor around the UK per km^2 was 358, a sharp increase on previous years.

Figure 63: Estimated litter items per km^2 on the seafloor around the UK: 1992 - 2016



Source: Defra[183]

182 OSPAR Convention, *Assessment Portal: Plastic particles in fulmar stomachs in the North Sea* https://oap.ospar.org/en/versions/plastic-particles-in-fulmar-stomachs-north-sea-en-1-0-0/

183 Defra, *England Natural Environment Data 2017 (2017)* https://www.gov.uk/government/statistics/england-natural-environment-indicators

Tables 19 and 20 present data showing the litter items collected in *Grand Ouverture Verticale* trawls over three years. Plastic was by far the most common material of the litter items found: the proportion of the total items found that were made of plastic ranged from 62% to 95%. The concentrations of litter items were generally higher in the Celtic Seas than in the Greater North Sea.

Although the numbers do appear to be increasing over time, at least five years of data are required to be able to make confident statements about trends.

Table 19: Mean number of items per km^2 by type and year from *Grand Ouverture Veritcale* trawl data, Celtic Seas. 95% bootstrap confidence intervals are given in brackets for Total and Plastic, using a wing spread correction of 4.18.

Region	Celtic Seas		
Year	2012	2013	2014
Total	13.794 (10.868, 16.72)	48.07 (30.514, 71.06)	48.906 (35.948, 63.954)
Plastic	11.704 (9.196, 14.212)	44.726 (28.006, 66.044)	46.398 (33.022, 62.7)
Metal	0.29	0.88	0.79
Rubber	0.17	0.79	0.38
Glass	0	0.04	0
Natural	0.67	1.17	0.59
Misc	0.84	0.5	0.54

Source: OSPAR Assessment Portal[184]

Table 20: Mean number of items per km^2 by type and year from *Grand Ouverture Verticale* trawl data, Greater North Sea. 95% bootstrap confidence intervals are given in brackets for Total and Plastic, using a wing spread correction of 4.18.

Region	Greater North Sea		
Year	2012	2013	2014
Total	28.842 (25.08, 32.604)	30.932 (27.588, 34.276)	38.038 (34.276, 41.8)
Plastic	17.974 (15.466, 20.064)	22.99 (20.9, 25.498)	32.186 (28.842, 35.948)
Metal	1.3	0.84	0.96
Rubber	1.13	1.05	1.21
Glass	0.42	0.84	0.38
Natural	6.06	3.51	2.13
Misc	2.09	1.46	1.21

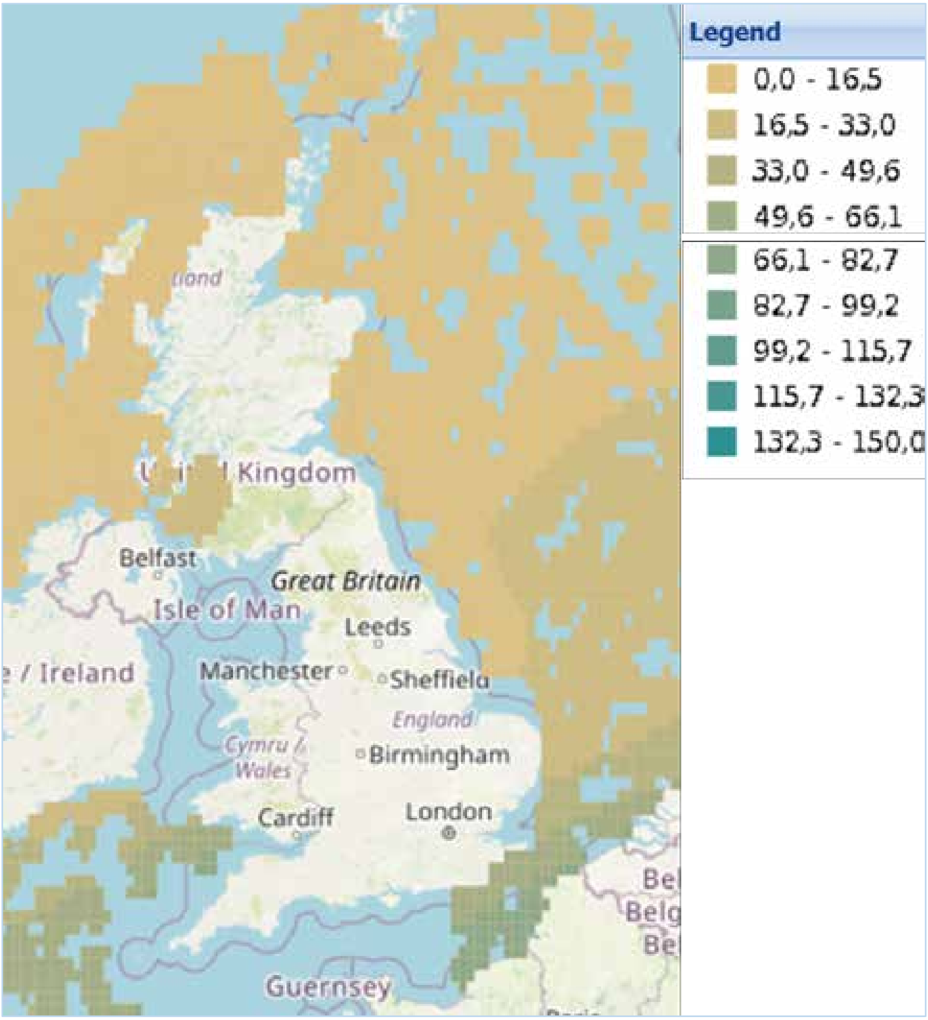
Source: OSPAR Assessment Portal[185]

184 OSPAR Convention, *Assessment Portal: Composition and Spatial Distribution of Litter on the Seafloor* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/marine-litter/composition-and-spatial-distribution-litter-seafloor/

185 OSPAR Convention, *Assessment Portal: Composition and Spatial Distribution of Litter on the Seafloor* https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/marine-litter/composition-and-spatial-distribution-litter-seafloor/

Figure 64 below shows spatially the abundance of litter items across the Greater North Sea and Celtic Seas. The abundance of litter items was generally higher in the Southern Celtic Seas and English Channel (49.6 - 82.7 items per km^2) than in the Greater North Sea (0.0 - 33.0 items per km^2).

Figure 64: Map of abundance of seafloor litter, as measured by number of litter items per km2 of seafloor caught as by-catch in fishing trawls across the Greater North Sea and Celtic Seas: 2010 – 2014



Source: OSPAR Assessment Portal186

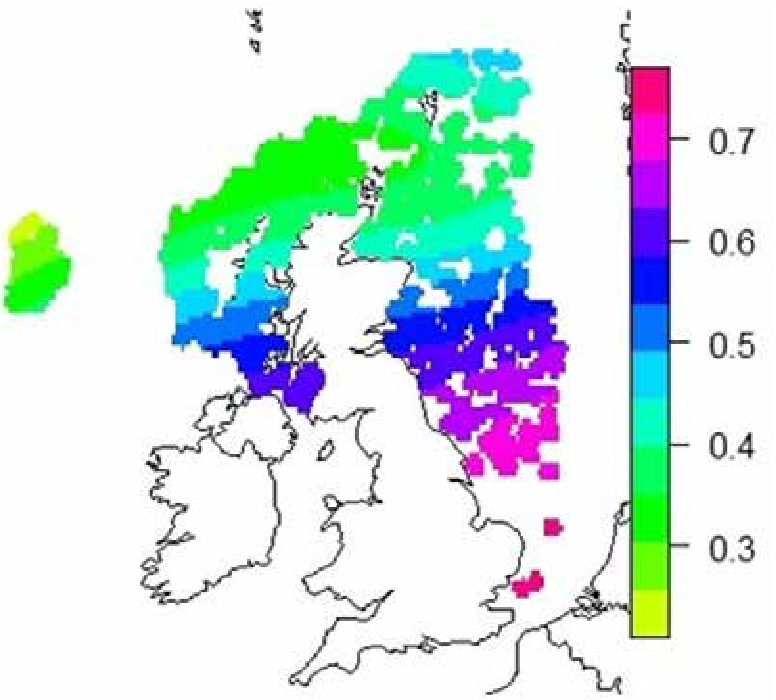
186 OSPAR Convention, *Assessment Portal: Composition and Spatial Distribution of Litter on the Seafloor https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/marine-litter/composition-and-spatial-distribution-litter-seafloor/*

Figures 65 and 66 also show a latitudinal pattern in the abundance of seafloor litter, with the abundance of litter decreasing as one moves north.

In the few areas around East Anglia where data is available, the probability that a haul would contain plastic was 0.75, whereas around the Hebrides this figure was around 0.3: see Figure 65.

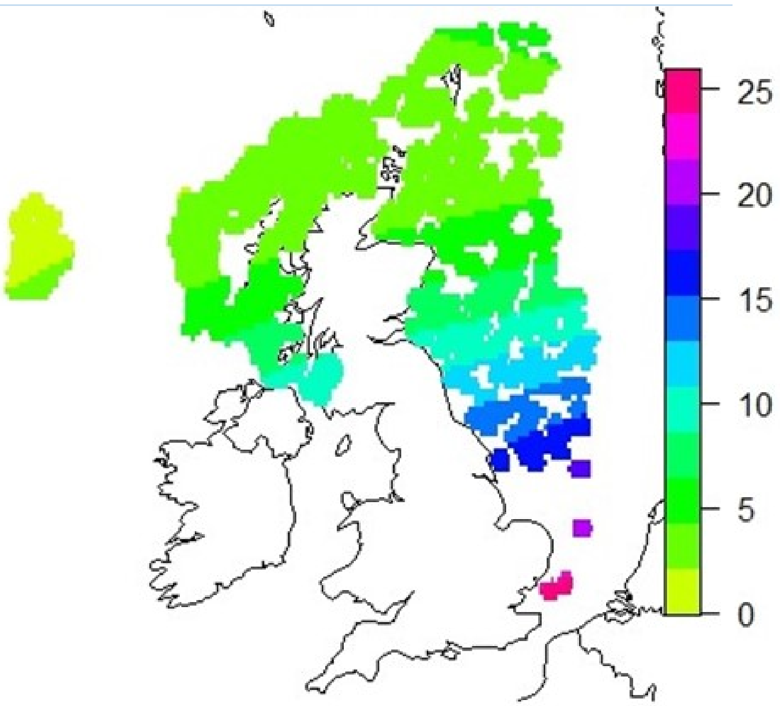
The median total litter per square kilometre was also higher in more southern regions: see Figure 66.

Figure 65: Map of smoothed probability that a haul contained plastic: 2012-2015



Source: UKMMAS based on data from the UK Exclusive Economic Zone trawl surveys.[187]

Figure 66: Map of smoothed median total litter per square kilometre, relative scale: 2012 -2015



Source: UKMMAS based on data from the UK Exclusive Economic Zone trawl surveys.[188]

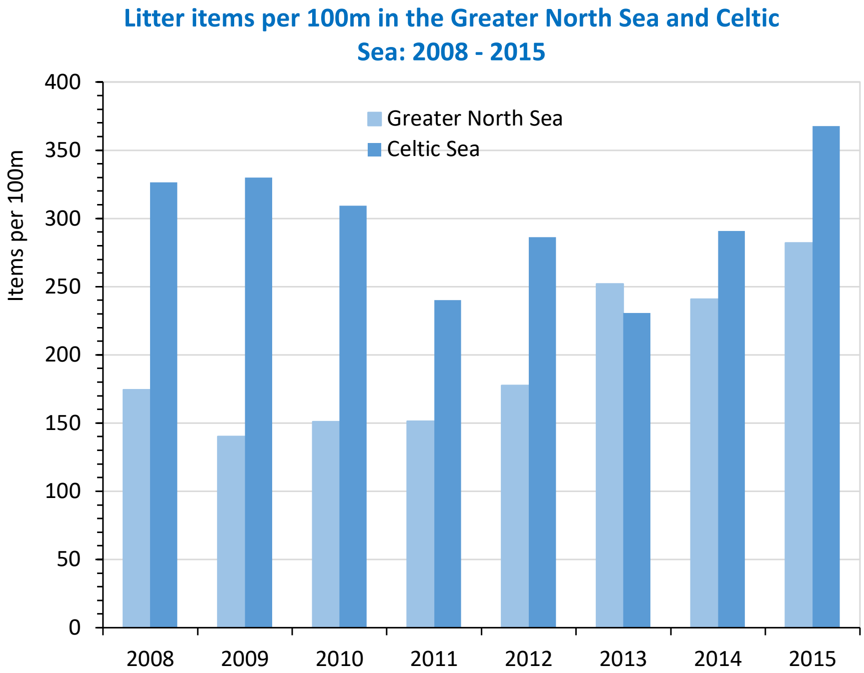
187 UKMMAS, *Trends and status in UK seafloor litter* https://moat.cefas.co.uk/pressures-from-human-activities/marine-litter/seafloor-litter/

188 UKMMAS, *Trends and status in UK seafloor litter* https://moat.cefas.co.uk/pressures-from-human-activities/marine-litter/seafloor-litter/

Assessment of coastal (beach) litter

A greater abundance of litter was recorded in the Celtic Seas (average 298 items/100m, ranging between 231 and 368) than in the Greater North Sea (average 196 items/100m, ranging between 140 and 282): see Figure 67. In the Celtic Seas, the abundance of litter decreased from 2011 to 2013, before returning to 2008 levels by 2015. In the Greater North Sea, there has been an upward trend in litter levels. When comparing estimates between 2011 and 2015 there has been an increase in the number of items for both the Greater North Sea and the Celtic Sea.

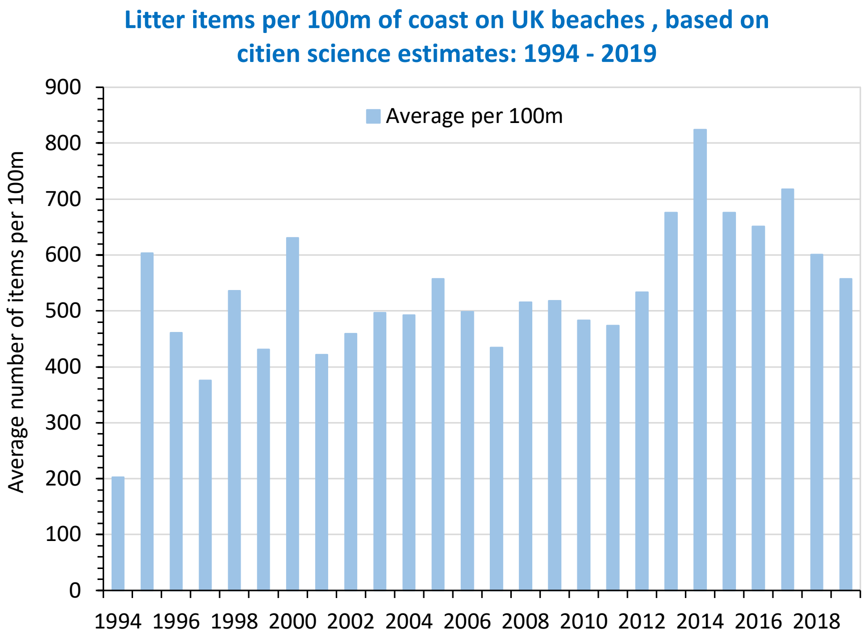
Figure 67: Litter items per 100m of coast in the Greater North Sea and Celtic Seas: 2008 - 2015



Source: UKMMAS based on Marine Conservation Society's Great British Beach Clean.[189]

The abundance of litter found by the Marine Conservation Society's volunteer beach cleaners has steadily increased since 1994, from 202 items per 100m of coast to around 558 items per 100m of coast in 2019. When looking at 2011, there has been an increase from 473 items to 558 items in 2019. While for year on year data between 2018 and 2019 a decline can be seen from an average of 601 items to 558 items. See Figure 68 for historical trend.

Figure 68: Litter items per 100m of coast on UK beaches, based on citizen science estimates: 1994 - 2019



Source: Marine Conservation Society (MSC)[190]

189 UKMMAS, *Trends in UK beach litter from 2008 to 2015* https://moat.cefas.co.uk/pressures-from-human-activities/marine-litter/beach-litter/

190 Data based on MSC internal estimates, which have been published in 2019 Great British Beach Clean found here: https://www.mcsuk.org/media/mcs-gbbc-2019-report-digital.pdf

Annex 4

Soils

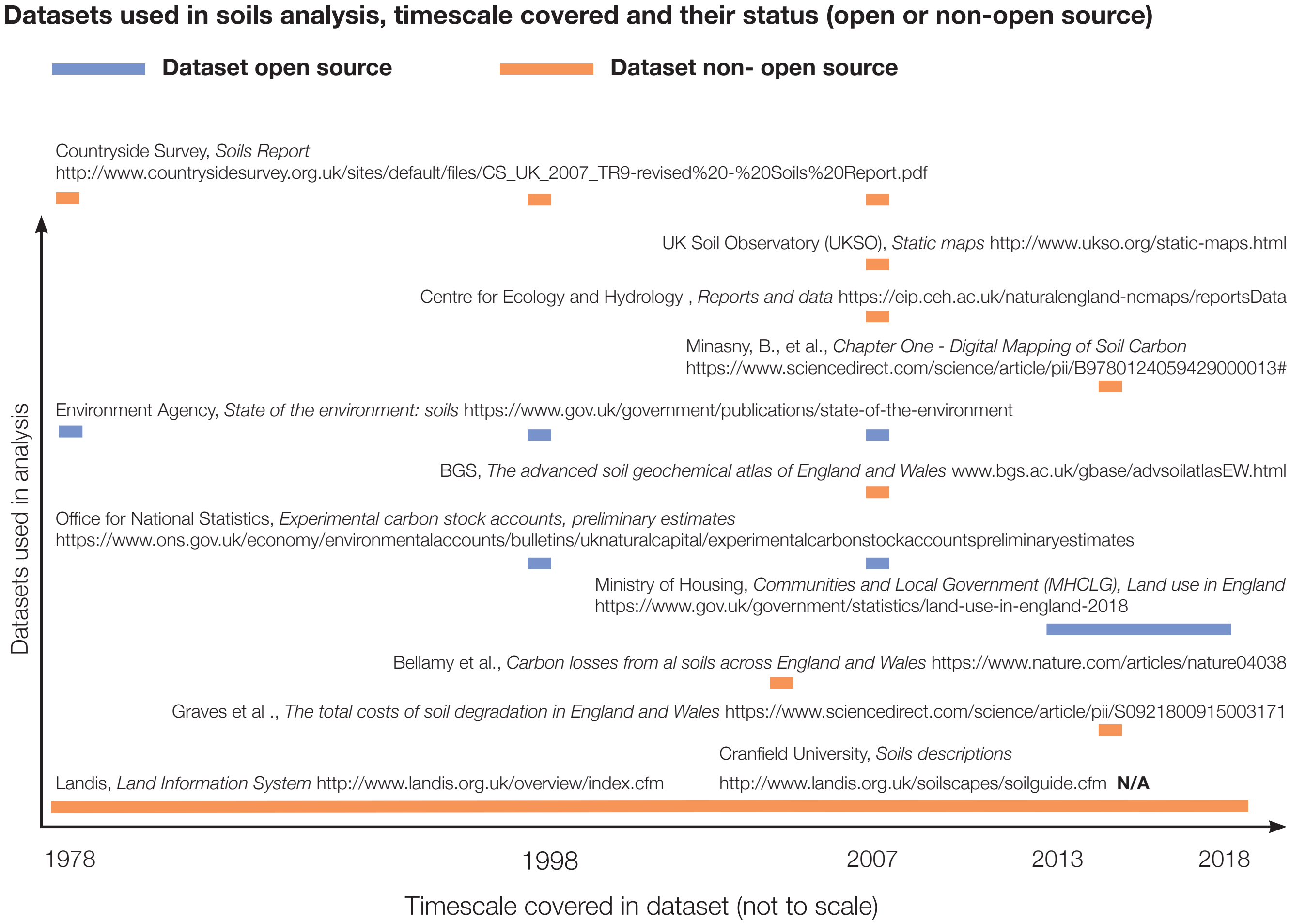
Soils

Background

Improved soil management can bring a multitude of benefits including: nutrient cycling; water regulation; carbon storage; biodiversity; enhanced climate resilience; food and fibre production; waste management; greenhouse gases emission control; and reduced erosion.

With a complex system of pressures and flows driving changes in soils and the services they provide, it is vital to have a clear picture of both the extent and condition of different soil types and also their function/the services they deliver. To do so, robust and comprehensive data is required to enable an assessment of the status of soil assets. To produce the soil assessment the Natural Capital Committee (NCC) has looked at a range of datasets, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the soils asset



Soils asset

The Natural Capital Committee (NCC) has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of the soils asset. In order to produce the soils assessment, the NCC has used datasets and evidence from:

- The Countryside Survey (CS);[1]
- The UK Soils Observatory (UKSO);[2]
- Centre for Ecology and Hydrology (CEH);[3]
- British Geological Survey (BGS);[4]
- Land Information System (LandIS);[5]
- Rothamsted Research;
- The Environment Agency (EA);[6] and
- Defra.

Unlike other assets assessed by the NCC, there are no government national statistics on the state of soils in England. There is only a limited amount of data from two key sources, and these are not based on a long-term time series but on ad hoc sampling. This data is also not current, with the most recent data available from 2007. For example, the Countryside Survey (CS) has only been undertaken three times: in 1978, 1998, and 2007 and this forms the bulk of the evidence that follows.

There is a clear need for the government to develop a monitoring scheme or work with other organisations that collect data on soils. The Environment Agency has acknowledged that *'there is insufficient data on the health of our soils and investment is needed in soil monitoring.'*[7] Without this monitoring scheme, is not possible to assess and measure the condition and extent of soils (health) in England and deliver on the commitment in the 25 Environment Plan (25 YEP) to improve soil health, recover soil fertility and reduce erosion.[8] Given the limited evidence that is available, the NCC has not produced a detailed /comprehensive assessment of soils. The NCC has presented the evidence on key measurements such as soil carbon, pH, and contaminants. These only provide a high-level indication of the state of soils and several other measurements are required to enable a more detailed assessment.

In addition to these key soil measurements, the NCC has also included a list (to supplement the evidence presented when aiming for a more complete picture in the future) of measurements that could be used to monitor the condition and extent of soils in England – see Table 1 below. This list includes measurements that have also have been identified as contributing to soil health (e.g.: macronutrients, toxic elements, and metals) but which are out of the scope of this exercise (broad scoping of soil asset extent and condition based upon available data). These measurements should be considered for inclusion in future asset mapping, as monitoring capabilities and data become available, and could form part of a broad soil health indicator.

1 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

2 UK Soil Observatory (UKSO), *Static maps* http://www.ukso.org/static-maps.html

3 CEH, *Reports and data* https://eip.ceh.ac.uk/naturalengland-ncmaps/reportsData

4 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

5 Landis, *Land Information System* http://www.landis.org.uk/overview/index.cfm

6 Environment Agency, *State of the environment: soils* (2019) https://www.gov.uk/government/publications/state-of-the-environment

7 Environment Agency, *State of the environment: soil* (2019) https://www.gov.uk/government/publications/state-of-the-environment/summary-state-of-the-environment-soil

8 Defra, *A Green Future: Our 25 Year Plan to Improve the Environment* (2018) https://www.gov.uk/government/publications/25-year-environment-plan

Table 1: NCC scoped soil health measurements (indicators)

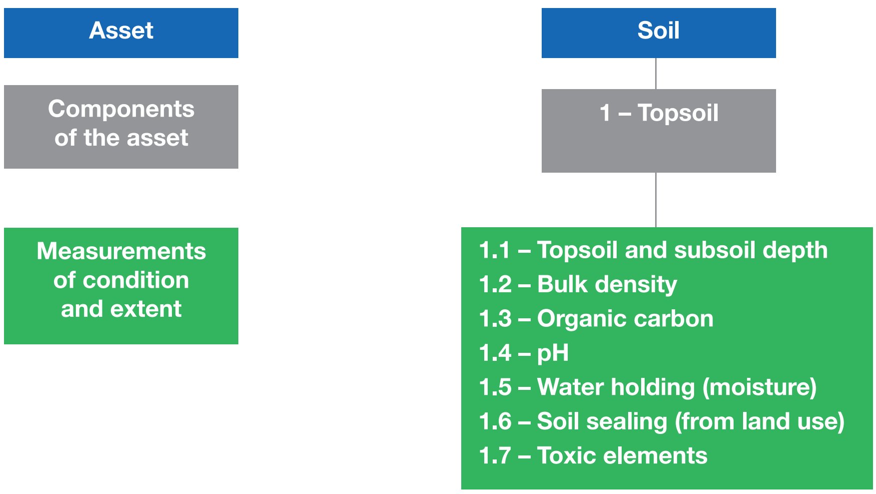
Asset	Potential soil health measurement
Topsoil	Soil organic carbon (30-150cm)
Topsoil	Soil pH (deeper than 15 cm)
Topsoil macronutrients	Total nitrogen stock (0-15cm) (t/ha) / percentage nitrogen (number)
	Potential mineralisable N: total mineral (NO3+NH4) nitrogen concentration (mg N/ kg dry soil)
	Topsoil olsen-phosphorus – total phosphorus concentration (mg/kg)
	Topsoil total calcium concentration (mg/kg)
	Topsoil total magnesium concentration (mg/kg)
	Topsoil total potassium concentration (mg/kg)
	Topsoil total sulphur concentration (mg/kg)
Topsoil - toxic organics	Polychlorinated biphenyls: total PCB concentration (mg/kg)
	Total dioxins/furans concentration (mg/kg)
	Total PAH concentration (mg/kg)
Topsoil - SVG organic compounds	BTEX (Benzene, toluene, ethylbenzene and xylene): total BTEX concentration (mg/kg)
	Total phenol concentration (mg/kg)
Topsoil - other elements and metals	Topsoil total antimony concentration (mg/kg)
	Topsoil total barium concentration (mg/kg)
	Topsoil total beryllium concentration (mg/kg)
	Topsoil total bismuth concentration (mg/kg):
	Topsoiltotal caesium concentration (mg/kg)
	Topsoil total cobalt concentration (mg/kg)
	Topsoil total gallium concentration (mg/kg)
	Topsoil total germanium concentration (mg/kg)
	Topsoil lithium concentration (mg/kg)
	Topsoil total niobium concentration (mg/kg)
	Topsoil rubidium concentration (mg/kg)
	Topsoil stotal scandium concentration (mg/kg)
	Total selenium concentration (mg/kg)
	Topsoil total silver concentration (mg/kg)
	Topsoiltotal strontium concentration (mg/kg)
	Topsoil total thallium concentration (mg/kg)
	Topsoil total tungsten concentration (mg/kg)
	Topsoil total yttrium concentration (mg/kg)
	Topsoil total zirconium concentration (mg/kg)

Other general measurements	Available water capacity (max amount of plant-available water a soil can provide) (AWC)
	Sealing
	Stoniness
	Visual evaluation of soil structure (SRUC method for visual estimation of soil structure) (VESS)
	CEC (cation exchange capacity – capacity of soil to retain cations)
	C:N ratio
	EC (electrical conductivity – available ions)
	Extractable S
	Extractable Ca
	Hot water extractable carbon (HWEC)
	Light fraction organic matter (LFOM)
	Infiltration rates
	Particle density
	Penetrometer resistance
	Permeability – possibly only subsoil as the topsoil permeability is so dynamic
	Porosity/water-filled pore space (WFPS)
	Rate of erosion
	Shear strength (a measure of soil strength)

Source: NCC 2020 – based on various sources and expert knowledge

In line with the approach taken for the other natural capital assets, the NCC has started by scoping out the important components of the soil asset, as presented in Figure 1. There is a single overall component – topsoils – with seven group headings and 22 sub-group measurements (e.g.: arsenic, pH, soil organic carbon). This reflects the data which is mostly available for topsoil sampling covering a depth of 0-15cm, partly due to the higher costs of sampling deeper underground (e.g.: subsoils). Based on this topsoil data, a trend assessment followed (where data was available) to see how the measurements in Figure 1 changed over time and, where possible, try to infer the status of their condition and extent.

Figure 1: Soil components for the assessment



Source: NCC 2020

Summary of overall soils assessment

Given the lack of consistent and long-term data, an indicative assessment has been made by the NCC on the condition and the extent of soils – See Table 2.

Table 2: Indicative assessment of the soil asset

Asset	Data availability	Overall assessment
Soil	Unable to produce a comprehensive assessment as not enough evidence and data is available. What has been done is an indicative assessment based on the limited data available which is somewhat dated and collected sporadically.	The overall assessment is based on the trend from this limited data which shows that the condition and extent of soils has deteriorated.

However, to provide a sense of the condition and extent of soils in England, the NCC has compiled together evidence on the status of key measurements (see points 1-7 below), and these are presented in the sections that follow. These measurements present a snapshot, and could form the basis for a baseline assessment of soils.

1.1. Topsoil and subsoil depth
1.2. Bulk density
1.3. Organic carbon
1.4. pH
1.5. Water holding (moisture)
1.6. Soil sealing (from land use)
1.7. Toxic elements

Based on this limited evidence key findings from the NCC assessments are:

- Based on the evidence from the Countryside Survey (CS):
  - o Carbon stock in England are estimated to be 795 teragrams of carbon (TgC).[9]
  - o Soil pH has increased from 5.89 to 6.51 between 1978 and 2007, which generally could be seen as an improvement as it could reflect less atmospheric depositions of acid.
- Soil degradation through erosion, intensive farming, and development incurs losses estimated at between £0.9 – £1.4 billion per year for England and Wales alone.

It has been estimated that it can take 100 years to form 1cm of topsoil.[10]

Individual soil components assessment: Topsoil and subsoil

Soil is a vital natural asset, not only for food production but for supporting ecosystems in many crucial ways. Soil functions include the following:[11]

i. Nutrient cycling: soil stores, cycles, and moderates the release of nutrients and other chemicals that are essential to organisms.
ii. Water-flow regulation: soil regulates the drainage, flow, and storage of water and solutes.
iii. Habitat: soil supports the growth of plants, and entire food chains that rely on those plants. Soil also provides a habitat for animals, macrofauna (e.g.: insects, worms etc.), and many microorganisms.
iv. Filtering and buffering: soil acts as a filter that protects the quality of water, air, and other resources
v. Physical stability: soil's porous structure allows the passage of air and water, and soil can withstand erosive forces. Soils also anchor human structures and protect sites of archaeological interest.

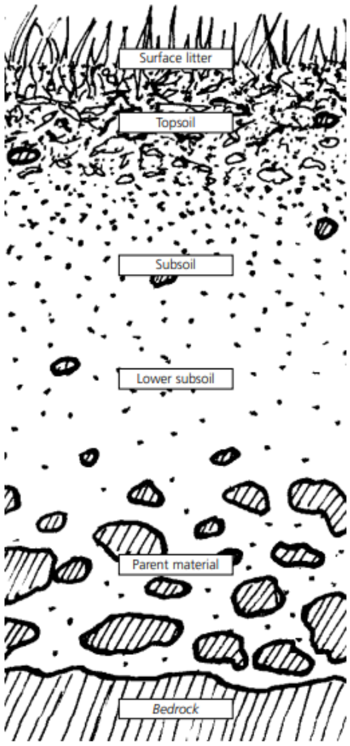
9 1 TgC = 1 MtC

10 European Commission, *Soil security – a call to arms* (2015) https://ec.europa.eu/jrc/en/science-update/soil-security-call-arms

11 Soil Quality for Environmental Health http://soilquality.org/functions.html

‘Soil’ can mean different things for different people. For this report ‘topsoil’[12] refers to the upper layer (0-15cm in depth) while ‘subsoil’[13] refers to the next layer beneath topsoils and above the parent material and bedrock – see Figure 2. For this assessment, the focus is on the abiotic components to maintain healthy functioning soil and is limited to the upper layer (0-15cm).

Figure 2: Soil layers



Source: Michael Hayter[14]

Overall assessment of soil

Based on the limited data available the NCC has not been able to make a comprehensive assessment on the condition and the extent of soils. However, to provide a sense of the condition and extent of soils in England, an indicative assessment has been made. The overall assessment of the soils asset, based on the datasets available, is **‘Red’: deteriorating**. In order to provide a sense of the condition and extent of soils in England, the NCC has looked at key soil measurements (indicators) to assess soil health, as listed in Table 3. These measurements present a snapshot based on available data, and could form the basis for a baseline assessment of soils. The key messages from the NCC’s assessment are as follows:

- Several of the metrics included in the NCC’s assessment which are important for soil health (covering data from 2007 or earlier) indicate a deterioration.
- Many of the soil asset components considered in the NCC’s analysis did not have data available at a sufficient spatial and especially temporal coverage to allow an assessment of the condition/extent of England’s soils. The partial data available, the majority of which is sourced from the 2007 Countryside Survey, shows that important components of soil health are changing. Trend data on soil depth, extent and condition are not available, but pressures on soils have been increasing.
- Carbon is a key metric for determining soil health, yet there is only limited data on carbon in soils.
- The Ministry of Housing, Communities and Local Government (MHCLG) reported in 2018 that 8.3% of England’s land area has been for developed use. Of this total, 7.2% (79,164 hectares) was converted from non developed to developed use between 2013 and 2018.[15] Developed land is very likely to constitute land where soil sealing has occurred through the covering of soil with impermeable materials.

12 Topsoil is the upper layer of soil, usually between 2 to 8 inches in depth, that contains most of the ground’s nutrients and fertility. Source: https://www.onlinesoil.co.uk/knowledge-base/general-info/what-is-topsoil

13 The subsoil is located between the topsoil and the parent rock (or material) below. Aside from being lighter in colour, less fertile, and more compact, it is usually more clayey; that’s because downward water movement has transported some of the tiny clay particles from the topsoil into the subsoil. **Source**:http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0cdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8-00&cl=CL1.89&d=HASH01876852ac4a1ec756aaea90.4.3&gt=1

14 Michael Hayter, found in Soil Association, *Soil management on organic farms* (2003) https://www.soilassociation.org/media/4332/sa-tech-guide-soil.pdf

15 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018

In the sections that follow the NCC have looked at key soil measurements (indicators) to assess soil health. These measurements present a snapshot and could form the basis for a baseline assessment of soils.

The NCC has also researched existing targets, thresholds, and/or objectives for components being assessed under soils. The NCC has found only one commitment for organic carbon and no targets, thresholds, or objectives for the other measurements that could be applied generally to soils. The NCC considered Soil Guideline Values developed by the Environment Agency, and category 4 screening levels (C4SL) developed by Defra, but these are maximum thresholds for chemicals in contaminated land in respect to human health, primarily for use in urban planning, and do not apply more widely to soils – see Table 3 for further details. There are no commitments in the 25 Year Environment Plan or elsewhere for the improvement of the condition and extent of soils.

Table 3: List of components for topsoils and soils

	Asset component	Data availability/overall assessment	Targets/thresholds/objectives
Topsoil	1.3 Organic carbon	Unable to produce an assessment as insufficient evidence and data is available.	The UK has signed up for the '4 per 1,000' initiative:[16] • The initiative aims for an annual 0.4% increase in soil organic matter.[17]
	1.1 – Topsoil and subsoil depth 1.2 – Bulk density 1.4 – pH 1.5 – Water holding (moisture) 1.6 – Arsenic 1.7 – Cadmium (Cd) 1.8 – Chromium (Cr) 1.9 – Lead (Pb) 1.10 – Mercury (Hg) 1.11 – Platinum (Pt) 1.12 – Tin (Sn) 1.13 – Titanium (Ti) 1.14 – Vanadium (V) 1.15 – Boron (B) 1.16 – Chlorine (Cl) 1.17 – Copper (Cu) 1.18 – Iron (Fe) 1.19 – Manganese (Mn) 1.20 – Molybdenum (Mo) 1.21 – Nickel (Ni)	Unable to produce an assessment as insufficient evidence and data is available.	No specific target exists for these components, except where detailed below.

Types of soils and texture in England

The University of Cranfield through the Soilscapes application has defined 27 types of soils in England and Wales. Table 4 below presents the types of soils, their percentage coverage, and the texture types found in England. The most abundant soil textures in England are:

- Loamy: around 34.8%;
- Loamy and clayey: around 33.2%;
- Loamy some clayey: around 15.9%.

In Figure 3 the soil types are presented spatially for England and Wales.

16 4 per 1000, *Welcome to the "4 per 1000"* https://www.4p1000.org/

17 Soil Association, *Measuring soil health* (2018) https://www.soilassociation.org/media/15138/monitoring-soil-health.pdf

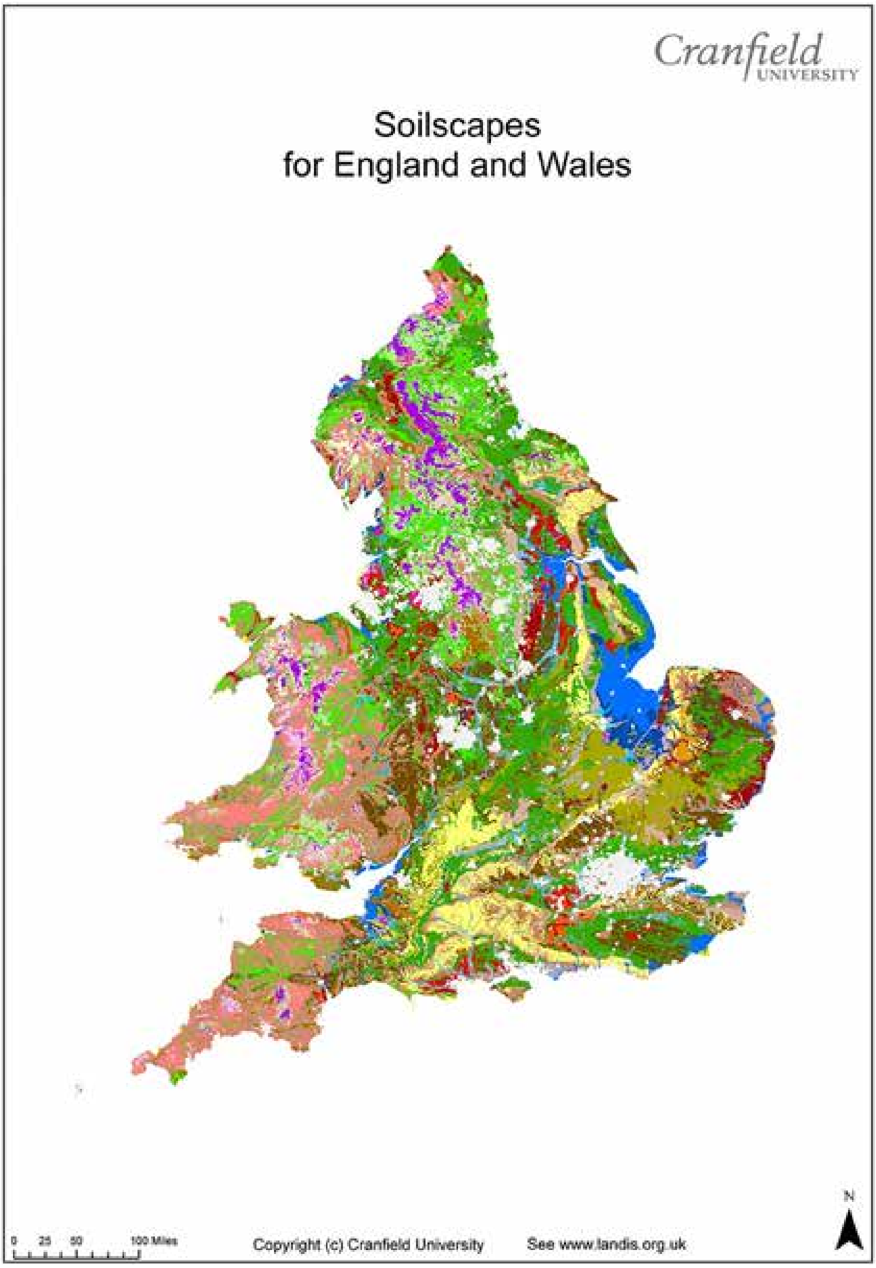
Table 4: Soil legend, types, texture land coverage for England

Legend	ID	Type of Soil	Coverage for England	Texture
	1	Saltmarsh soils	0.2%	Loamy
	2	Shallow very acid peaty soils over rock	0.4%	Peaty
	3	Shallow lime-rich soils over chalk or limestone	7.0%	Loamy
	4	Sand dune soils	0.2%	Sandy
	5	Freely draining lime-rich loamy soils	3.7%	Loamy
	6	Freely draining slightly acid loamy soils	15.5%	Loamy
	7	Freely draining slightly acid but base-rich soils	3.1%	Loamy
	8	Slightly acid loamy and clayey soils with impeded drainage	10.6%	Loamy some clayey
	9	Lime-rich loamy and clayey soils with impeded drainage	5.3%	Loamy some clayey
	10	Freely draining slightly acid sandy soils	2.8%	Sandy
	11	Freely draining sandy Breckland soils	0.3%	Sandy
	12	Freely draining floodplain soils	0.6%	Loamy
	13	Freely draining acid loamy soils over rock	2.6%	Loamy
	14	Freely draining very acid sandy and loamy soils	1.0%	Sandy and Loamy
	15	Naturally wet very acid sandy and loamy soils	1.9%	Sandy and Loamy
	16	Very acid loamy upland soils with a wet peaty surface	1.6%	Peaty
	17	Slowly permeable seasonally wet acid loamy and clayey soils	7.0%	Loamy and clayey
	18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	19.9%	Loamy and clayey
	19	Slowly permeable wet very acid upland soils with a peaty surface	2.9%	Peaty
	20	Loamy and clayey floodplain soils with naturally high groundwater	2.6%	Loamy and clayey
	21	Loamy and clayey soils of coastal flats with naturally high groundwater	3.7%	Loamy and clayey
	22	Loamy soils with naturally high groundwater	1.7%	Loamy
	23	Loamy and sandy soils with naturally high groundwater and a peaty surface	1.5%	Peaty
	24	Restored soils mostly from quarry and opencast spoil	0.4%	Loamy
	25	Blanket bog peat soils	2.1%	Peaty
	26	Raised bog peat soils	0.3%	Peaty
	27	Fen peat soils	0.7%	Peaty

Source: Soilscapes from the University of Cranfield[18]

18 Cransfield University, *Soils descriptions* http://www.landis.org.uk/soilscapes/soilguide.cfm

Figure 3: Types of soils in England and Wales



Source: UKSO based on data from the Cranfield University19

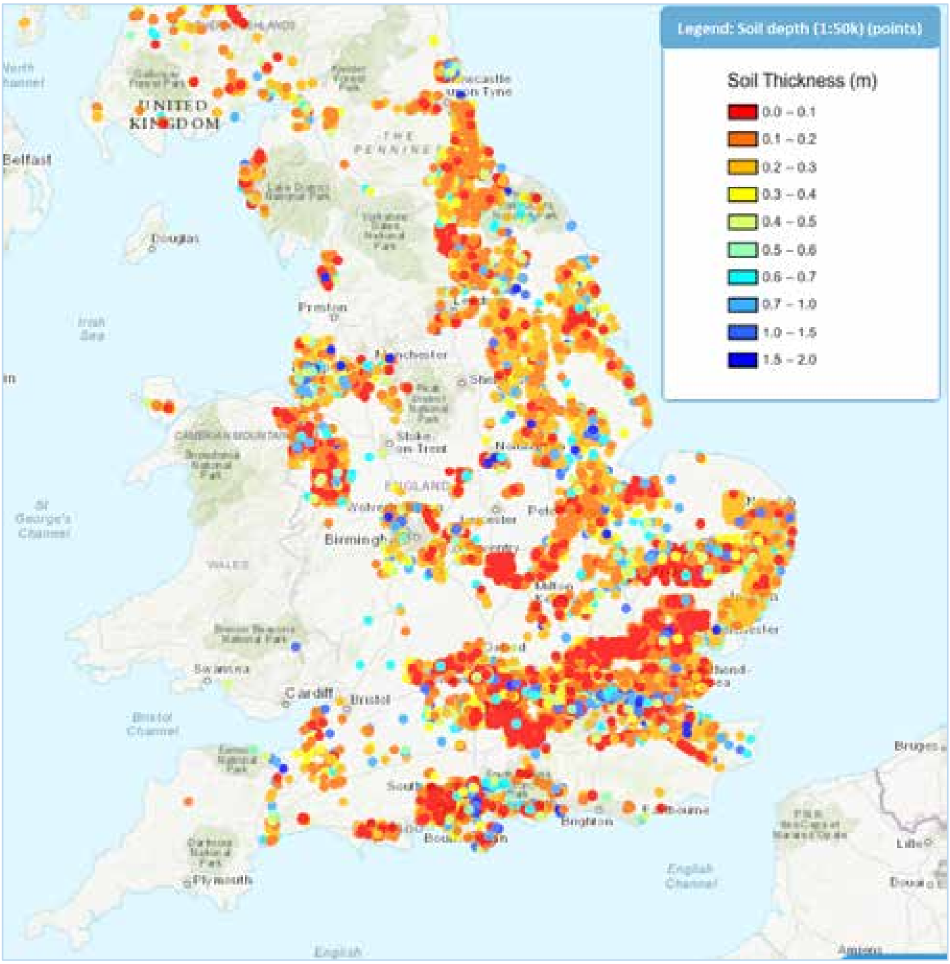
Topsoil and subsoil depth

Soil depth is the thickness of the unconsolidated material immediately below the surface of the earth.[20] The soil depth varies naturally according to local geological conditions, but human practices such as deforestation can lead to soil erosion. As can be seen from Figure 4, most of the data points present a soil thickness ranging between 0.0-0.3m.

19 UKSO, *The soils of England and Wales* http://www.ukso.org/static-maps/soils-of-england-and-wales.html

20 British Society of Soil Science, *What is soil?* https://www.soils.org.uk/1-what-soil

Figure 4: soil depth, UK



Source: UKSO[21]

Soil degradation through erosion, intensive farming, and development incurs losses estimated at between £0.9 –1.4 billion per year for England and Wales alone, mainly linked to loss of organic content of soils (47% of total cost), compaction (39%) and erosion (12%).[22] It has also been estimated that it takes 100 year to form 1cm of topsoil.[23] Until further data becomes available it is possible to use these pressures as proxy indicators for soil extent and condition.

It is possible to calculate an estimate of total erosion rates using water erosion as the dominant driver and estimates of erosion rates for different soilscapes using the methodology described by Graves et al[24]. Due to a lack of direct measured data at the national scale however, the soil erosion rates for each soilscape were derived from observations of erosion rates, peer-reviewed literature, and expert opinion.[25]

Bulk density

Topsoil bulk density is an important parameter, reflecting the soil's ability to function for structural support, water and solute movement, and aeration. Bulk density is also used to convert between weight and volume of soil and it is used to express soil physical, chemical, and biological measurements on a volumetric basis.[26] It is also essential in the estimation of soil carbon (C) densities and is also an indicator of soil compaction[27] (or loosening).

21 UKSO, *Map layers* http://mapapps2.bgs.ac.uk/ukso/home.html

22 Graves et al ., *The total costs of soil degradation in England and Wales (2015)* https://www.sciencedirect.com/science/article/pii/S0921800915003171

23 European Commission, *Soil security – a call to arms* (2015) https://ec.europa.eu/jrc/en/science-update/soil-security-call-arms

24 Graves et al ., *The total costs of soil degradation in England and Wales (2015)* https://www.sciencedirect.com/science/article/pii/S0921800915003171

25 Graves et al., *The total costs of soil degradation in England and Wales (2014)* https://www.sciencedirect.com/science/article/pii/S0921800915003171

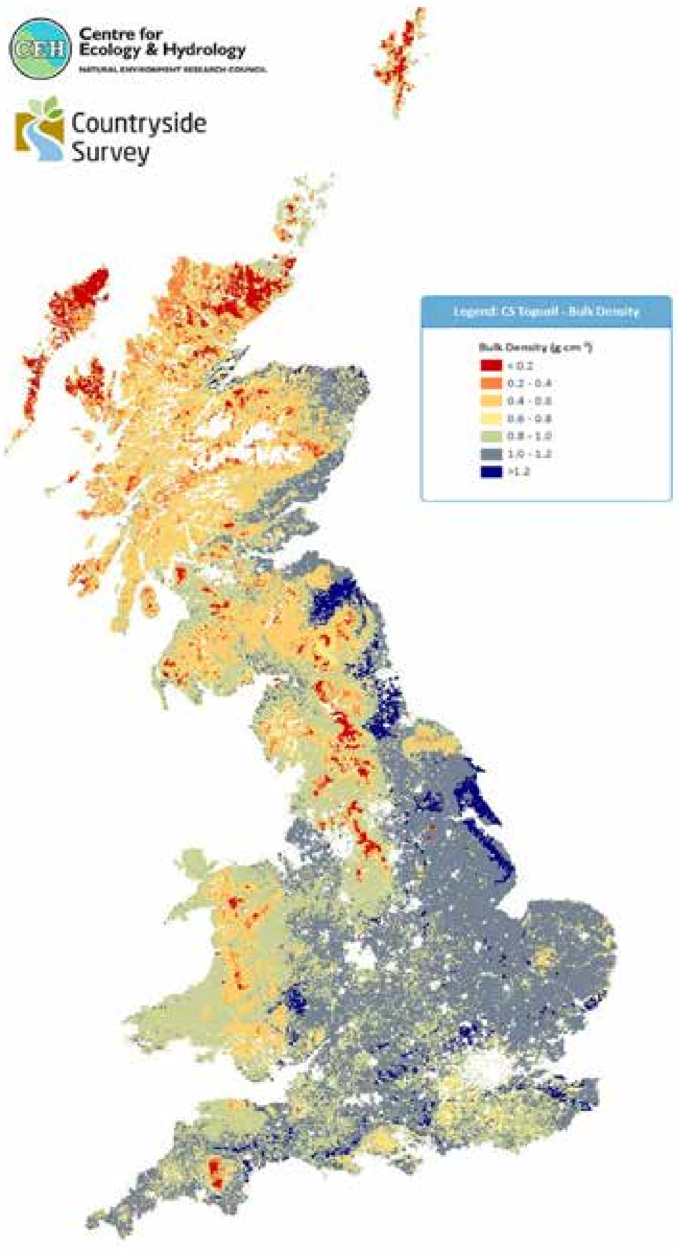
26 Soil Quality for Environmental health, *Bulk Density* http://soilquality.org/indicators/bulk_density.html

27 Compaction is a process that brings about an increase in soil density or unit weight, accompanied by a decrease in air volume. There is usually no change in water content. The degree of compaction is measured by dry unit weight and depends on the water content and compactive effort (weight of hammer, number of impacts, weight of roller, number of passes). **Source:** http://environment.uwe.ac.uk/geocal/SoilMech/compaction/compaction.htm

There is limited topsoil bulk density data and evidence, with the most recent evidence found in the *Countryside Survey Soils report from 2007*.[28] Bulk density in individual samples ranged between 0.02 to 1.95 g cm^{-3} – see Figure 5 below where bulk density estimates are presented spatially in a map of Great Britain – for a higher resolution map see UKSO website. The report does not include a comparison between previous surveys (e.g.: 1978 and 1998), so it not possible to see if there was any change in bulky density overtime.

Given the lack of data comparison in the Countryside Survey and the lack of more recent evidence, the NCC has not been able to produce an assessment of bulk density.

Figure 5: Countryside survey bulk density estimates in 2007 for the UK



Source: UKSO based on data from the Countryside Survey from 2007[29]

28 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

29 UKSO, *Countryside survey topsoil in Great Britain* http://www.ukso.org/static-maps/countryside-survey-topsoil.html

Organic carbon

Carbon is fundamental to the functioning of soils as it is the primary energy source in soils. It also plays an important role in maintaining soil structural condition, resilience, and water retention.[30] Soil is also recognised as the largest store of terrestrial carbon, with storage capacity larger than the atmosphere and vegetation pools, [31] helping to mitigate carbon emissions, and thus to meet the targets set out in the Climate Change Act 2008.[32]

Even though carbon has an important role in soils – and soils have the potential to sequester greenhouse gas emissions, there is limited evidence and data on carbon stocks in England, with the main source being the Countryside Survey (CS). Evidence from the CS is available for 1978, 1998, and 2007.

In the most recent CS, estimates for mean carbon concentrations, density, and stocks were estimated for England and Great Britain. In terms of mean concentration, the CS estimates show that there was no significant change between surveys or over the whole period (1978 and 2007). Concentrations of carbon are generally lower in England than those for the whole of Great Britain (GB).

Mean carbon concentrations (gC/kg soil) were also estimated by Broad Habitats (BH)[33] types. Concentrations (for all habitats) in 2007 were estimated at 75.6 gC/kg, and there was limited variation between 1978 and 2007. However, there was some variation by habitat type (see Table 5). As Table 5 shows, there has been a decline in carbon concentrations in arable soils since 1998. The habitat with the highest concentration was Bog at 398.5 gC/kg while the arable and horticulture habitats have the lowest at 30gC/kg. In addition, data on the mean carbon concentration is also available spatially and is presented in Figure 6 for GB.

- Based on the evidence from the Countryside Survey (CS) soil organic carbon density and concentrations have remained almost unchanged between 1978 and 2007.

Table 5: Change in topsoil carbon concentration in England by Broad Habitats

England - Broad Habitat						
Broad Habitat	Mean carbon concentrations g/kg^{-1}			The direction of significant changes		
	1978	1998	2007	1978-1998	1998-2007	1978-2007
Broadleaved, mixed and yew woodland	54.6	80.4	68.7			
Coniferous woodland	117.3	157.8	131.2			
Arable and horticulture	33.9	32.8	30.0		↓	↓
Improved grassland	50.3	54.2	53.1			
Neutral grassland	60.1	69.3	64.8	↑		
Acid grassland	197.0	200.6	209.8			
Bracken	115.0	127.3	153.5			
Dwaarf shrub heath	298.0	227.5	229.2			
Fen, marsh and swamp	288.8	278.9	273.8			
Bog	197.8	431.3	398.5			
All habitat types	74.4	79.7	75.6			

Source: Table replicated from the Countryside Survey soils report from 2007[34]

30 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

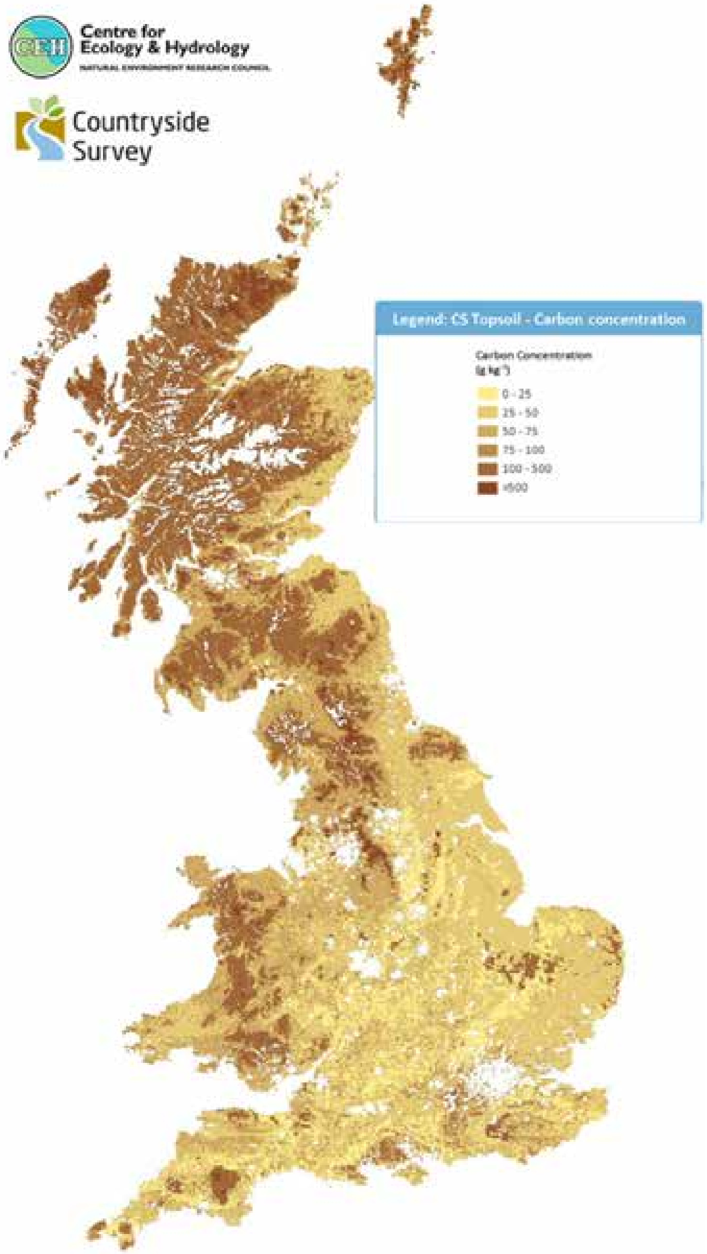
31 Minasny, B., et al., *Chapter One - Digital Mapping of Soil Carbon* (2013) https://www.sciencedirect.com/science/article/pii/B9780124059429000013#!

32 Legislation.gov.uk, *Climate Change Act 2008* (2008) https://www.legislation.gov.uk/ukpga/2008/27/contents

33 The Broad Habitat classification consists of 27 habitats which account for the entire land surface of Great Britain, and the surrounding sea. Countryside Survey reports on 10 major terrestrial habitats.

34 Ibid.

Figure 6: Topsoil carbon concentration for Great Britain



Source: UKSO based on data from the Countryside Survey from 2007[35]

35 UKSO, *Countryside survey topsoil in Great Britain* http://www.ukso.org/static-maps/countryside-survey-topsoil.html

Estimates for soil carbon density (t/ha soil) (for all habitats) have remained stable when comparing between 1978, 1998, and 2007 at around 70t/ha in England. The habitat with the highest carbon density in 2007 was Fen, Marsh and Swamp at 96.7t/ha followed by Dwarf Shrub Heath at 96.6t/ha. The habitats with the lowest carbon density were arable and horticulture at 46.9t/ha. See Table 6 for carbon density estimates for England since 1978 by Broad Habitat.

Carbon density data is also available spatially, as presented in Figure 7. Regions with the highest density were around the southwest and the north of England. The map was produced by the Centre for Ecology and Hydrology (CEH) based on data from the Countryside Survey data.

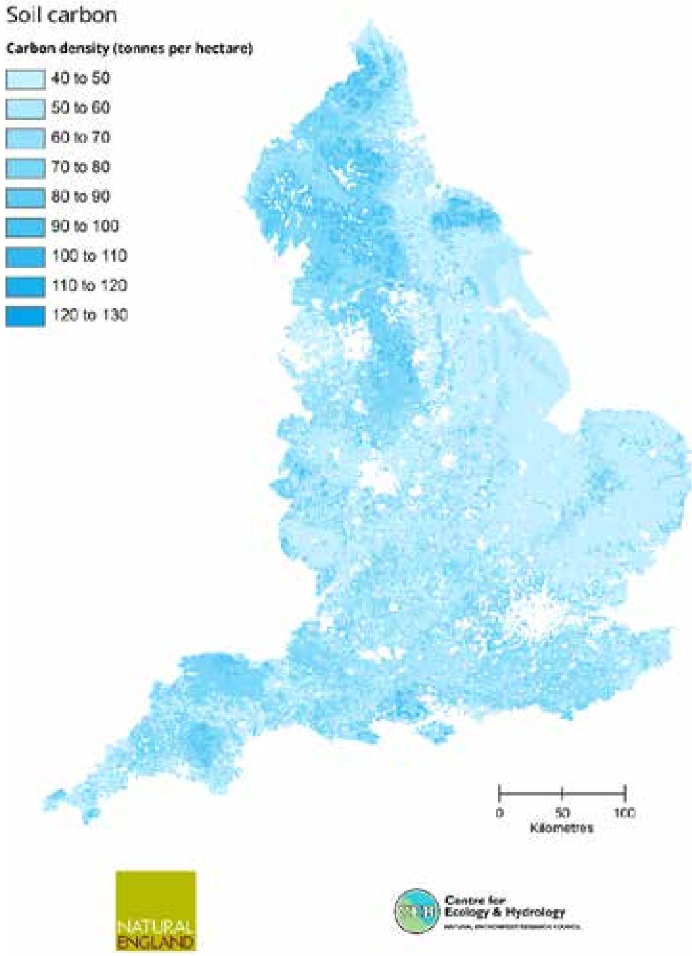
Table 6: Changes in soil carbon density in England by Broad Habitat

England - Broad Habitat						
Broad Habitat	Mean carbon density (t/ha)			Direction of significant changes		
	1978	1998	2007	1978-1998	1998-2007	1978-2007
Broadleaved, mixed and yew woodland	57.8	76.1	68.8	↑		↑
Coniferous woodland	89.6	76.0	77.9			
Arable and horticulture	49.1	49.8	46.9		↓	
Improved grassland	62.9	68.5	64.6	↑	↓	
Neutral grassland	62.4	65.6	65.9			
Acid grassland	76.6	72.0	95.5		↑	↑
Bracken	95.9	72.8	94.1			
Dwarf shrub heath	77.1	101.8	96.6			↑
Fen, marsh and swamp	81.9	94.1	96.7			
Bog	106.0	119.8	85.2			↓
All habitat types	69.6	71.5	70.2	↑		

Source: Table replicated from the Countryside Survey soils report from 2007[36]

36 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

Figure 7: Topsoil carbon density for England



Source: CEH[37]

Estimates of carbon stock for GB and individual countries were estimated in the CS, with England having the highest amount of carbon stocks in GB at 795 teragrams of carbon (TgC)[38]. See Table 7 for carbon stock break down by country. The CS analysis and results suggest that carbon stocks have not changed significantly since 1978. Data on carbon stocks are also available spatially and is presented below in Figure 8.

Table 7: Estimate of soil carbon stock for GB and individual countries

Country	Km^2	Soil C density (0-15 cm) t/ha	Soil C stock (0-15 cm) TgC
GB	228,226	69.31	1,582
England	127,284	62.45	795
Scotland	79,849	78.79	628
Wales	21,091	75.19	159

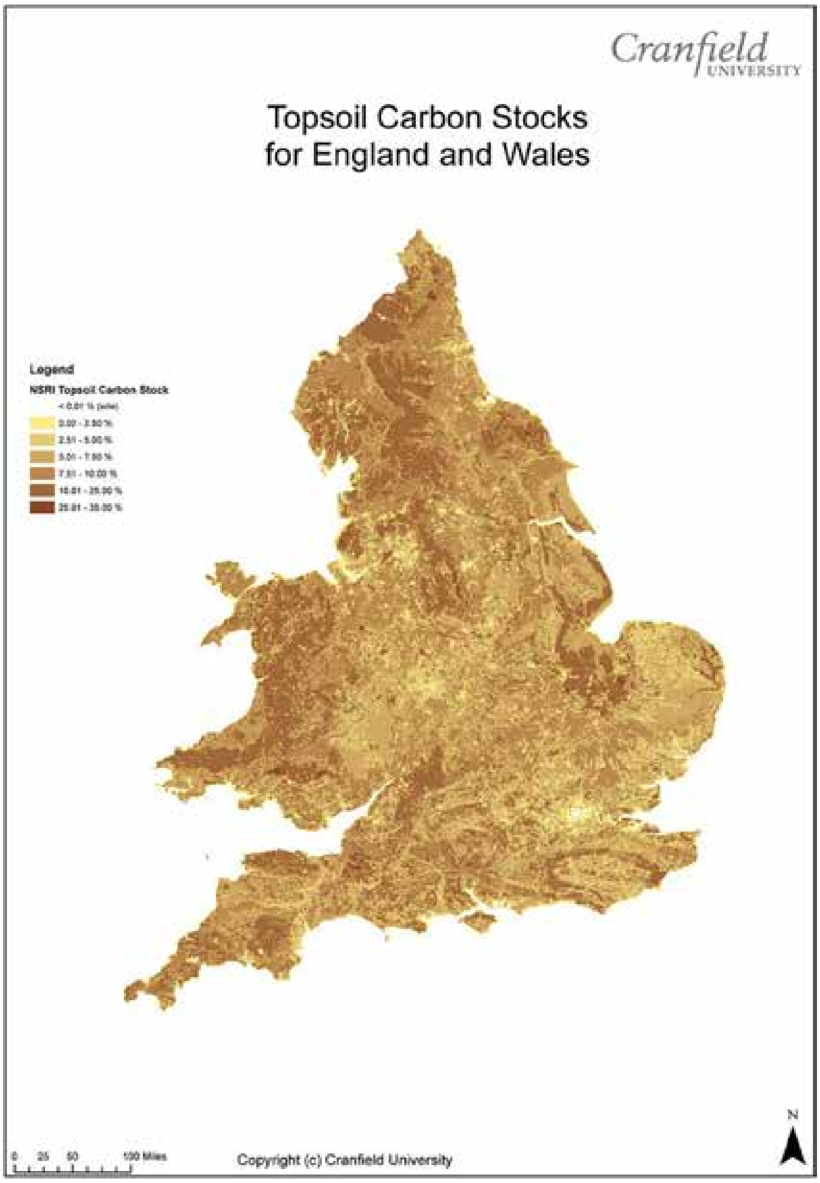
Source: Table replicated from the Countryside Survey soils report from 2007[39]

37 CEH, *Soil_Cdensity* https://eip.ceh.ac.uk/naturalengland-ncmaps/images/maps/soil_Cdensity.png/view

38 1 TgC = 1 MtC

39 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

Figure 8: Topsoil carbon stocks for England and Wales



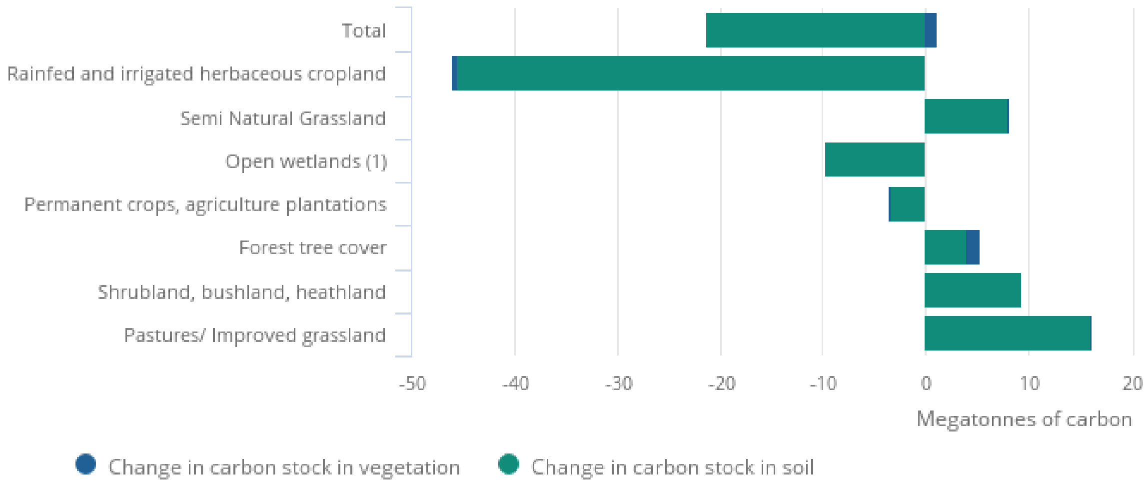
Source: UKSO based on Cranfield National Soils Resources Institute (NSRI)[40]

The Office for National Statistics (ONS) has drawn on the Countryside Survey data, as providing the most disaggregated and up to date soil carbon estimates, to provide estimates for the changes in the total soil stock of each Broad Habitat in the UK, as shown in Figure 9. These estimates were produced by combining the tonnes per hectare by habitat units with land area estimates from the ONS Land Cover Accounts. The ONS note that to provide a more complete estimate of soil carbon stocks, the Countryside Survey mean estimates need to be supplemented with additional data to account for the fact that peat depth can range up to eight meters – so the 15 cm depth reported on by the Countryside Survey would result in significant underestimates.[41]

40 UKSO, *Topsoil carbon stock* http://www.ukso.org/static-maps/soils-of-england-and-wales.html

41 ONS, *Experimental carbon stock accounts, preliminary estimates* (2016) https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapital/experimentalcarbonstockaccountspreliminaryestimates

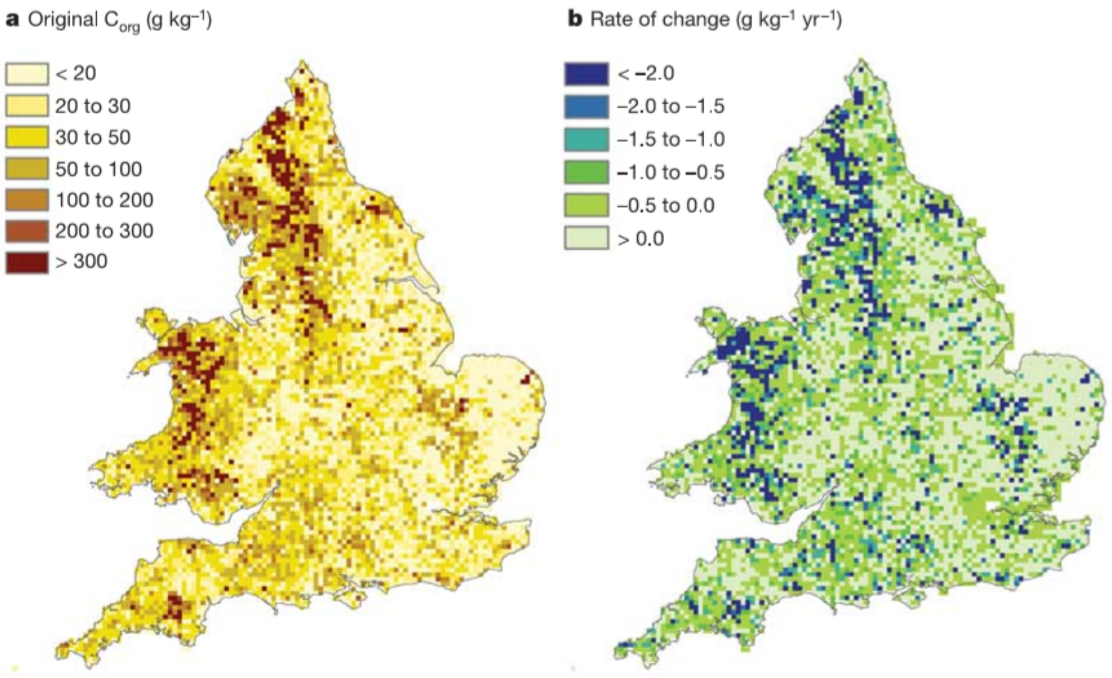
Figure 9: Terrestrial carbon stock change estimates (MtC), by SEEA-EEA habitat class, 1998 to 2007



Source: Centre for Ecology and Hydrology, Office for National Statistics[42]

The only other available data concerning changes in topsoil carbon concentration in England is provided by the National Soils Inventory (NSI). The NSI also collected data on topsoil (0-15cm) organic carbon by taking samples at 5,662 sites at the intersections of a 5km grid across the entire land area. Figure 10a shows the distribution of soil organic carbon measured in the original sampling (1978-83). Resampling at roughly 40% of the original sites (1994-2003) provided sufficient data to indicate rates of change in carbon content as shown in Figure 10b. The changes were negative in all but 8% of the sites.[43]

Figure 10 a and b: National Soil Inventory changes in soil organic carbon contents across England and Wales between 1978 and 2003



Source: National Soil Resources Institute, Cranfield University[44]

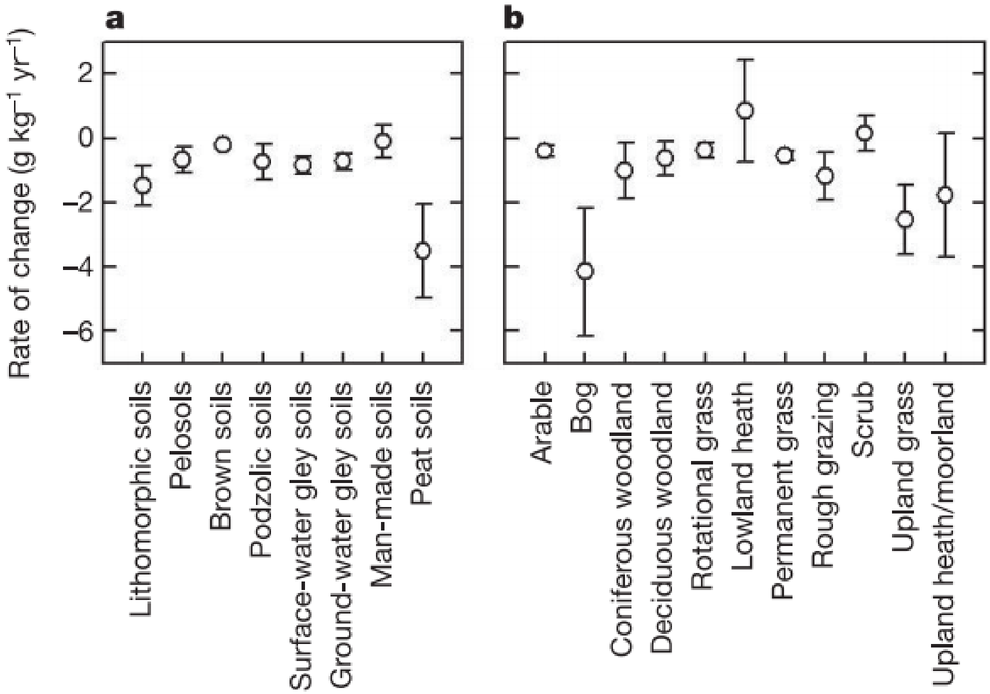
42 Ibid

43 Bellamy et al., *Carbon losses from al soils across England and Wales* (2005) https://www.nature.com/articles/nature04038

44 Bellamy et al, *Carbon losses from all soils across England and Wales 1978–2003* (2005) https://www.nature.com/articles/nature04038

Figure 11a and 11b display the NSI results for changes in soil carbon concentration grouped by soil type and land use, the latter of which is comparable to the Broad Habitat groupings used for the Countryside Survey. These show negative changes across far more than just the arable category, with bog and upland heath, grass and moorland all showing a more rapid decline.

Figure 11: National Soil Inventory rates of change in soil organic carbon content, grouped by soil type and land use. a, Soil type grouping; b, land use grouping. Circles indicate mean values; error bars indicate 95% confidence intervals



Source: Bellamy et al.[45]

Although possible explanations for the difference in the soil carbon data reported across these two surveys, it is unlikely that the differences will be fully resolved without further samples and new data from other monitoring schemes (although subsequent schemes in Scotland have provided support for the Countryside Survey sampling and statistical approach).[46]

The NSI data does however provide some important lessons for future assessments. Significant changes in soil categories besides arable shows that it is important to assess soils more broadly. The varying rates of change across the different groupings shown Figure 12 also illustrates that it is important to look at both soil type and land use.

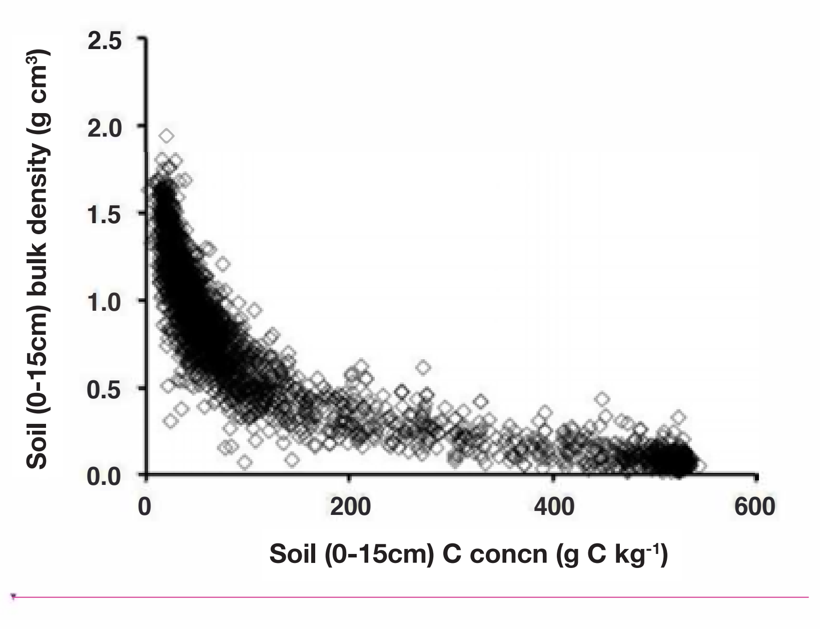
The available data indicates that there is a correlation between soil carbon and other key components of soil health, such that the declines in soil carbon highlight an urgent need for national monitoring programmes to better understand the impacts of environmental change on soil assets. In arable systems, analysis of Countryside Survey data found that comparable rates of loss of C and N suggest erosion losses or deep ploughing are reducing soil condition, and that there was also a strong inverse logarithmic relationship between BD and mean carbon concentration in 2007, as shown in Figure 12.[47]

45 Bellamy et al, *Carbon losses from all soils across England and Wales 1978–2003* (2005) https://www.nature.com/articles/nature04038

46 Reynolds et al., *Countryside Survey: National "Soil Change" 1978–2007 for Topsoils in Great Britain—Acidity, Carbon, and Total Nitrogen Status* (2012) https://pdfs.semanticscholar.org/c82b/f52cea9445059f56d7731ac5b482b9dbcc00.pdf?_ga=2.209199314.1920020945.1600952235-1426265642.1600952235

47 Reynolds et al., *Countryside Survey: National "Soil Change" 1978–2007 for Topsoils in Great Britain—Acidity, Carbon, and Total Nitrogen Status* (2012) https://pdfs.semanticscholar.org/c82b/f52cea9445059f56d7731ac5b482b9dbcc00.pdf?_ga=2.209199314.1920020945.1600952235-1426265642.1600952235

Figure 12: Countryside Survey, plot of soil (0–15 cm) bulk density against carbon concentration in 2007.



Source: Reynolds et al.[48]

Soil carbon is a key metric for determining soil health, yet there is only limited data on extent, condition and trends for this asset. The fact that the limited data available indicates declines in several areas highlights the need to conduct a national survey to better understand the extent and condition of soil assets, to inform management of soil carbon sequestration and storage and related components of soil health into the future.

pH

Soil measurements of pH give an indication of soil acidity or alkalinity and can also affect the concentrations of trace elements in soils.[49] The pH scale ranges from 0 to 14, where a pH of 7 is neutral, anything below is acidic and anything above is alkaline. Soil pH is an important variable to predict the mobility and bioavailability of metals in soils. Soil pH is a commonly measured soil parameter.[50] The most comprehensive evidence on a national level is from the Countryside Survey report from 2007.

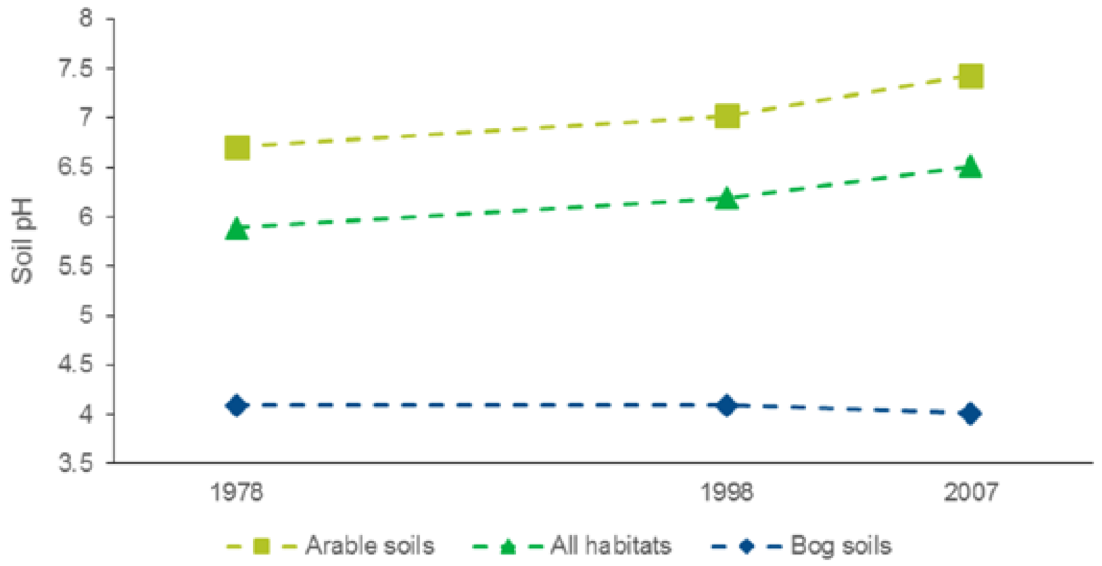
The Environment Agency has presented the soil pH trend (from sampling plot) for England since 1978. From Figure 13 it can be seen that soil in England became less acidic with soil pH levels increasing for all habitats including arable between 1978 and 1998; this increase continued between 1998 and 2007.

48 Reynolds et al., *Countryside Survey: National "Soil Change" 1978–2007 for Topsoils in Great Britain—Acidity, Carbon, and Total Nitrogen Status* (2012) https://pdfs.semanticscholar.org/c82b/f52cea9445059f56d7731ac5b482b9dbcc00.pdf?_ga=2.209199314.1920020945.1600952235-1426265642.1600952235

49 CEH, *Soil pH: Mean estimates of topsoil pH* https://eip.ceh.ac.uk/naturalengland-ncmaps/reports/topsoilpH_report.pdf

50 Countryside Survey, *Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

Figure 13: Changes in the average pH of soils (0-15cm) from sampling plots in England between 1978 and 2007



Source: Environment Agency based on Countryside Survey data from 2007[51]

This change has likely "*occurred because of decreases in industrial emissions and subsequent deposition of sulphur*".[52] While this change is positive in representing a reduction in this pressure on soil assets, the impact of changing pH on soils and the services they provide depends on the type of soil and what it is being used for. The variation in pH change spatially and across different soil types, as displayed in Figure 8 and Table 14 below, highlights the need to further develop national-scale monitoring to better understand these trends at both national and local scales.

The Countryside Survey measured soil pH (0-15cm) levels by broad habitat: the mean ranged from 4.00 to 6.71 in 1978 and from 4.01 to 7.43 in 2007. The mean pH level increased for almost all broad habitats between 1978 and 2007 with the exception of coniferous woodland, bog, and fen, marsh and swamp habitats. For all habitats, the increase was from 5.89 to 6.51, an increase of just under 11%. See Table 8 below for mean pH by broad habitat in England.

Table 8: Changes in mean soil pH (0-15cm) across England

England - Broad Habitat						
Broad Habitat	**Mean pH**			**Direction of significant changes**		
	1978	**1998**	**2007**	**1978-1998**	**1998-2007**	**1978-2007**
Broadleaved, mixed and yew woodland	5.23	5.83	6.07	↑		↑
Coniferous woodland	4.31	4.13	4.44			
Arable and horticulture	6.71	7.02	7.43	↑	↑	↑
Improved grassland	6.14	6.29	6.58	↑	↑	↑
Neutral grassland	5.72	6.18	6.41	↑	↑	↑
Acid grassland	4.04	4.51	4.74	↑	↑	↑
Bracken	4.11	4.08	4.89		↑	↑
Dwarf shrub heath	4.00	4.12	4.40		↑	↑
Fen, marsh and swamp	5.15	5.83	5.48			
Bog	4.09	4.09	4.01			
All habitat types	5.89	6.19	6.51	↑	↑	↑

Source: Table replicated from the Country Side Survey report from 2007

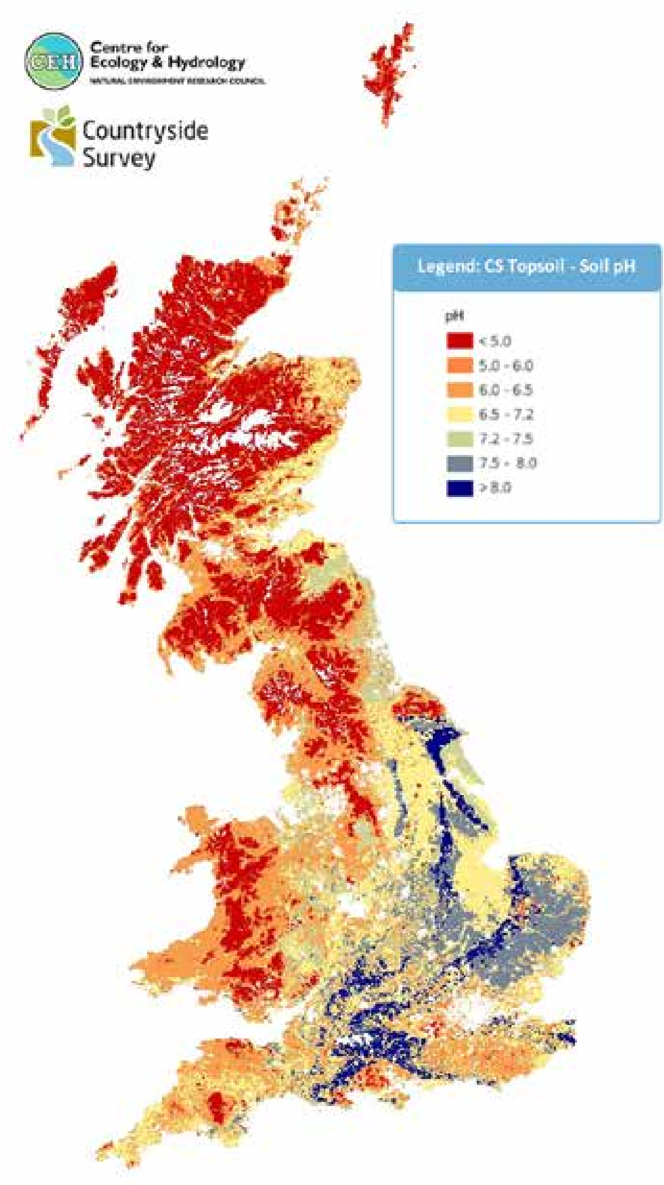
51 Environment Agency, *State of the environment: soils* (2019) https://www.gov.uk/government/publications/state-of-the-environment

52 Environment Agency, *State of the environment: soils* (2019) https://www.gov.uk/government/publications/state-of-the-environment

This evidence of soil pH for 2007 is also available spatially and is presented in Figure 14.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of soil pH in England.

Figure 14: Countryside Survey pH estimates for Great Britain in 2007



Source: UKSO based on data from the Countryside Survey from 2007[53]

Mean soil pH increased significantly in less acidic soils from 1978 through 1998 to 2007. In more acidic, organic-rich soils mean pH increased significantly from 1978 to 1998 but not between 1998 and 2007. This indicates spatial trends in both sulphur deposition reductions and soil sensitivity. This variation spatially and across different soil types highlights the need to further develop national scale monitoring to better understand these trends at both national and local scales and their potential impact on soil function.

53 UKSO, *Countryside survey topsoil in Great Britain* http://www.ukso.org/static-maps/countryside-survey-topsoil.html

Water-holding capacity (moisture)

The moisture level in the soil is determined by a complex set of factors.

Most water enters the soil surface as precipitation, either rain or melting snow. The amount of water infiltrating the soil depends not only on the amount of precipitation but on the properties and structure of the soil, which can also be modified by weather. The extent to which moisture will drain from soil depends upon its structure and properties, and the features around it.[54] The infiltration capacity of a soil and the drainage from it determine its water-holding capacity. Water holding capacity is the total amount of water a particular volume of soil can hold. Soils with lower water holding capacity may more quickly approach permanent wilting point between rainfall, where soil moisture falls to a level at which plants wilt and fail to recover. Land management practices that lead to poor water holding capacity include those that limit soil organic matter, and/or increase soil compaction.[55]

Water also leaves the soil by either evaporating from the surface or being transpired by plants, that is, being brought up from the soil to then evaporate from the plants' aerial parts. The amount of moisture in the soil is thus partly determined by the soil biota, which in turn is affected by the moisture content.[56] The dependence of soil moisture on the amount of rainfall and the amount of plant growth means that it exhibits significant seasonal variation: soils in the UK are far moister in winter than in summer.[57]

In order for healthy plant growth, the soil must not be too moist or too dry, so the level of soil moisture is very important for agriculture and general ecosystem health. The storage of water by soils also acts as an important regulator of the passage of water from rainfall to the sea, purifying it in the process. Evapotranspiration (evaporation and transpiration of water from the soil) means that the moisture content of soil affects local weather.[58]

Irrigation and land drainage are two ways in which human activity can seriously affect soil moisture levels. [59] It is important to monitor soil moisture levels to identify whether these activities may be leading to unhealthy moisture levels. See Figure 15 for moisture estimates in England. Estimates of mean values within selected habitats and parent material characteristics across GB were made using CS data from 1998 and 2007 using a mixed model approach. These model estimates were derived from 2614 cores collected from 591 1km x 1km squares in 2007. This does not provide sufficient data for an assessment of mean annual moisture, which would help account for variations year on year, and only gives an indication of possible soil moisture levels across different habits and soil types.

54 COSMOS-UK *What is soil moisture?* https://cosmos.ceh.ac.uk/soilmoisture

55 Soil Quality, *Available Water Capacity* (2020) http://soilquality.org/indicators/available_water_capacity.html

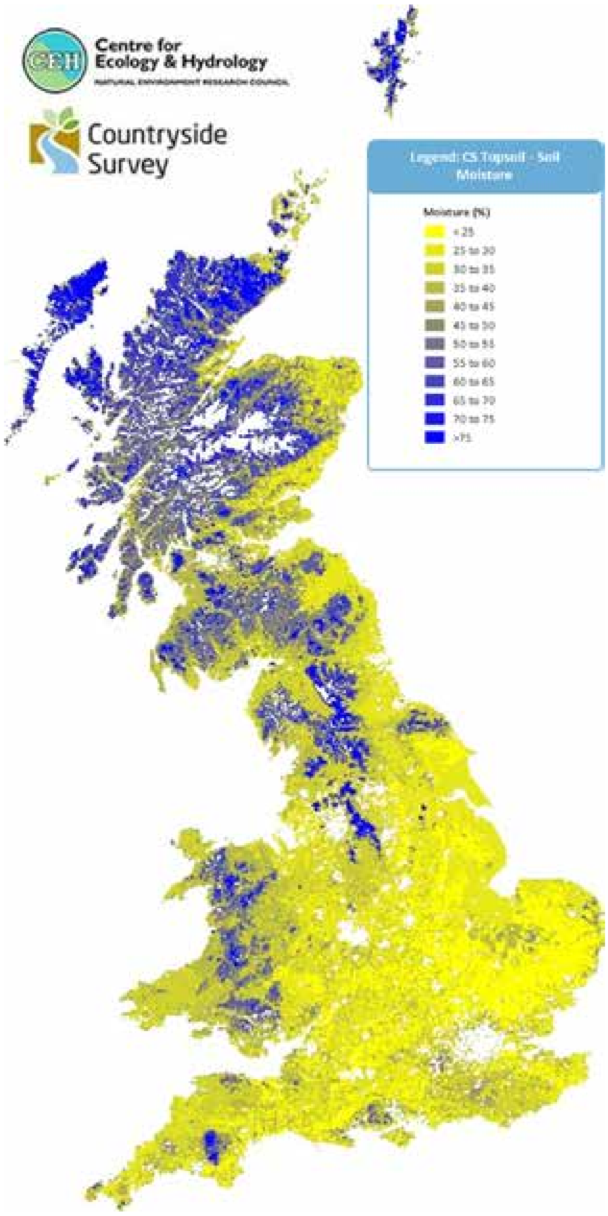
56 COSMOS-UK *What is soil moisture?* https://cosmos.ceh.ac.uk/soilmoisture

57 Ibid

58 COSMOS-UK *Why measure soil moisture?* https://cosmos.ceh.ac.uk/whymeasuresoilmoisture

59 Ibid

Figure 15: Countryside Survey moisture estimates for Great Britain for 2007



Source: UKSO based on data from the Countryside Survey from 200760

Soil sealing from land use

Due to limited data on the extent of soils in England, the NCC has looked at data on the land lost to development – a pressure on soil assets – as a possible proxy. Soil sealing is the covering of soil with partly or completely impermeable material (asphalt, concrete, etc.) as a result of development,[61] destroying or drastically reducing soil assets and compromising their ability to provide benefits such as water flow regulation.

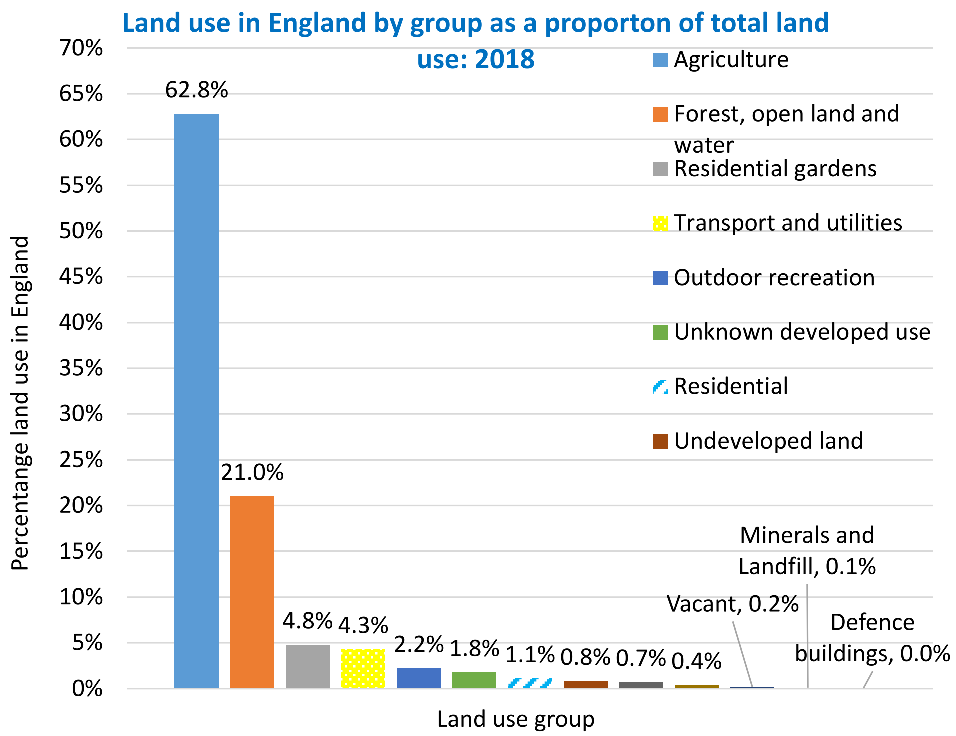
The Ministry of Housing, Communities and Local Government (MHCLG) reported that in 2018 8.3% of England's land area, or 1,105,570 hectares, is of a developed use. Of this total, 7.2% (79,164 hectares) was converted from non developed to developed use between 2013 and 2018.[62] Figure 16 shows the proportion of total land area currently under each usage category. Land categorised as 'developed' is very likely to constitute land where soil sealing has occurred through the covering of soil with impermeable materials.

60 UKSO, *Countryside survey topsoil in Great Britain* http://www.ukso.org/static-maps/countryside-survey-topsoil.html

61 European Commission, *Soil Sealing* (2020) https://ec.europa.eu/environment/soil/sealing_guidelines.htm

62 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018

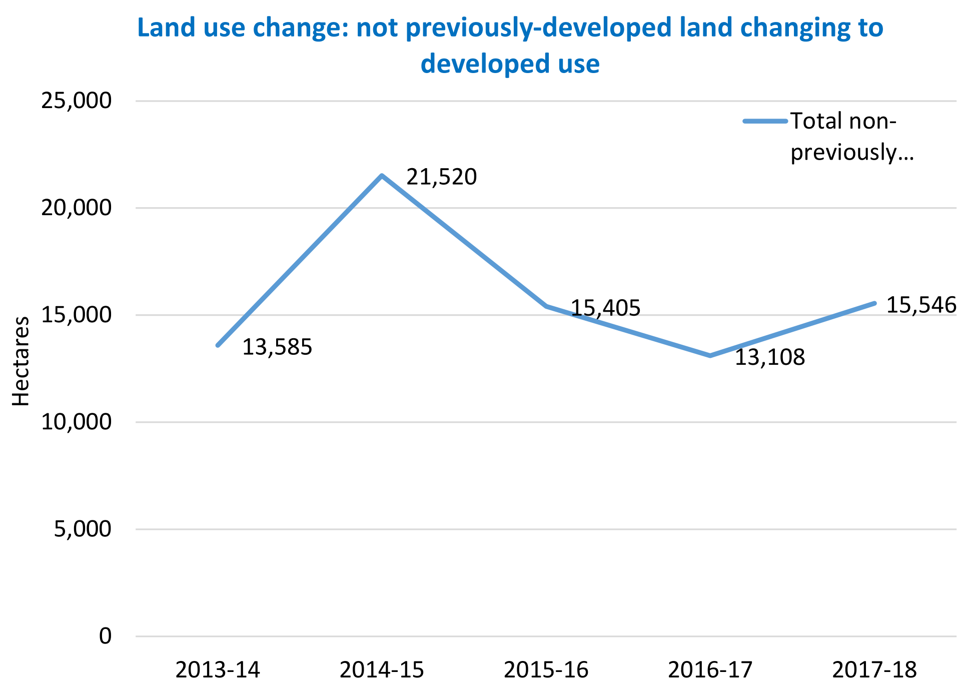
Figure 16: Land use in England 2018 by group as a proportion of total land-use area



Source: Ministry of Housing, Communities and Local Government[63]

MHCLG land use data includes historic data on the amount of undeveloped land being converted to developed land each year from 2013/14-2017/18, as shown in Figure 17. This indicates that pressures on soil due to land sealing have been increasing in recent years.

Figure 17: Total not previously-developed land changing to developed use (hectares)



Source: Ministry of Housing, Communities and Local Government[64]

63 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018
64 MHCLG, *Land use in England, 2018* (2020) https://www.gov.uk/government/statistics/land-use-in-england-2018

The MHCLG reports do not provide historic data on total land use area by land use groups, but this should be calculable and could be used as a proxy dataset for the overall historic extent of soil assets.

This could also be combined with the post 1988 Agricultural Land Classification (ALC) data,[65,66] used by Defra and Natural England to inform proposals for development on agricultural land, to provide a more complete picture of the loss of soils. This data is most readily available for Best and Most Versatile (BMV)1 agricultural land, Grades 1, 2 and 3a on the ALC system, which is land most suitable for growing a range of crops at consistent and high yields at the lowest maintenance costs. Planning policy in England states that the presence of this should be taken into account in making decisions about planning applications.[67] ALC data is limited however to a scale of 1:250,000, with a relative lack of site data and uneven spatial distribution, providing only a crude indicator of agricultural land quality with only partial coverage of England's land area.

Toxic elements

Topsoil contaminants: metals and metalloids

This section considers concentrations of key metals and metalloids. The evidence is based on the soil samples collected for the National Soils Inventory (NSI)[68] by the Soil Survey of England and Wales – now Cranfield University. The soil samples were taken between 1978 and 1982 and were limited to the upper first 15cm of the topsoil (or less if rock intervened) or of peat. Litter layers did not form part of the sampling. The actual sampling depth was recorded as was the total number of samples being collected (5,691 samples). For further details on the sampling process and the analysis see *The advanced soils geochemical atlas of England and Wales*.[69]

The maps presented for each of the key metals and metalloids below are presented as a percentile scale (for higher resolution maps please see the UKSO[70] website). The intervals are estimated as deciles of the cumulative frequency distribution (e.g.: 10^{th} percentile, 20^{th} percentile, ..90^{th} percentile). The concentration intervals are not equal. The concentrations of lower abundance elements are expressed in milligrams per kilogram (mg/kg) while elements with the most abundance are expressed as percentages in soil (%).[71]

Other surveys have targeted contaminated land, incentivised by a capital grant for the clean-up of sites which was withdrawn by Defra in 2017, but as with contaminants in soils more generally there is not sufficient data to provide a national assessment, despite there being 325,000 potentially contaminated sites across England and Wales.[72]

Arsenic (As)

Arsenic (As) is a chemical element (metalloid) that is found naturally in the environment (in trace amounts). It is an abundant element in rocks (1-2 mg/kg). In general, the highest concentrations of As are found in arsenic sulphide and iron pyrites (FeS_2) minerals. A major source of As released into the surface environment is the oxidation of sulphide minerals. The BGS has estimated As topsoil ranges of <0.5 – 15,000 mg/kg in England, with a mean of 18 mg/kg.[73]

65 Defra, *Agricultural Land Classification Data* https://environment.data.gov.uk/DefraDataDownload/?mapService=NE/AgriculturalLandClassificationGradesPost1988Survey&Mode=spatial

66 Natural England, *Provisional Agricultural Land Classification (ALC)* (2020) https://data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc

67 Defra, *Defra soil research programme* http://randd.defra.gov.uk/Document.aspx?Document=9905_SP1501finalreport.pdf

68 Now the National Soil Resources Institute (NSRI) based in the University of Cranfield.

69 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

70 UKSO, *Map layers* http://mapapps2.bgs.ac.uk/ukso/home.html

71 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

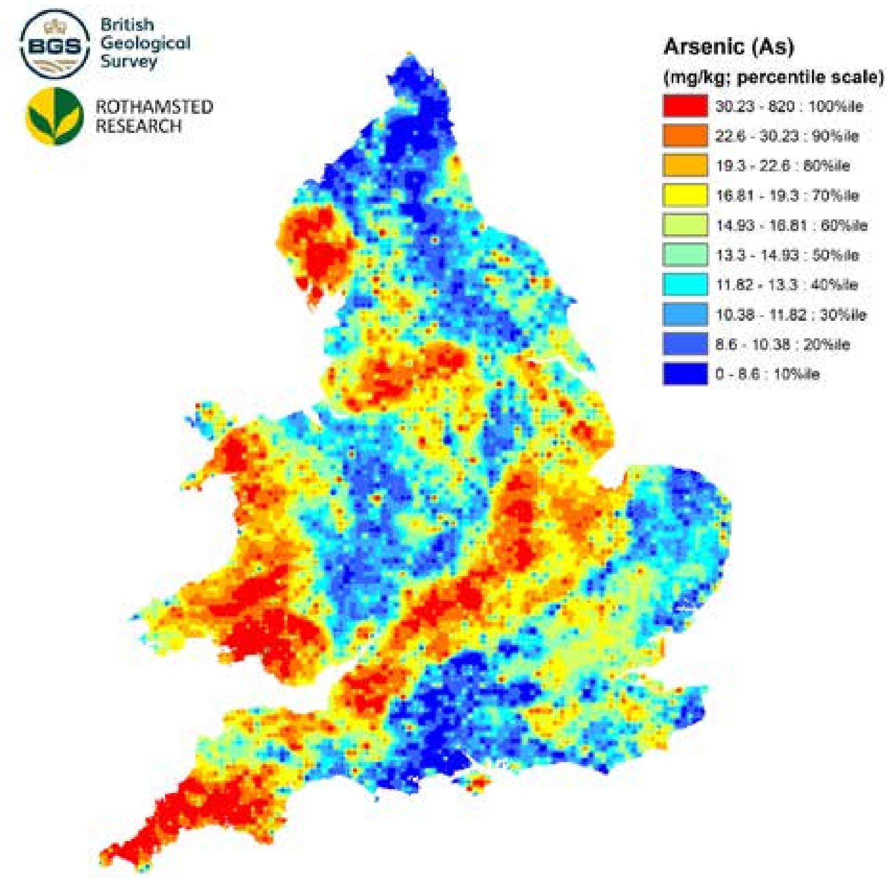
72 NCC, *Advice on soil management* (2019) https://www.gov.uk/government/publications/natural-capital-committee-advice-on-soil-management

73 Defra, *Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils: Arsenic* (2012) http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17768&FromSearch=Y&Publisher=1&SearchText=sp1008&SortString=ProjectCode&SortOrder=Asc&Paging=10

Figure 18 presents the concentration levels from the NSI sampling for England and Wales. The regions in which much higher concentrations of As are found are in parts of Cornwall, Devon, the Lake District, and Wales. These higher concentrations levels are due to mineralisation, mining and smelting of minerals. About half of the topsoil in England and Wales contains less than 15 mg/kg.[74]

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of As in soils in England.

Figure 18: Arsenic (As) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[75]

74 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

75 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

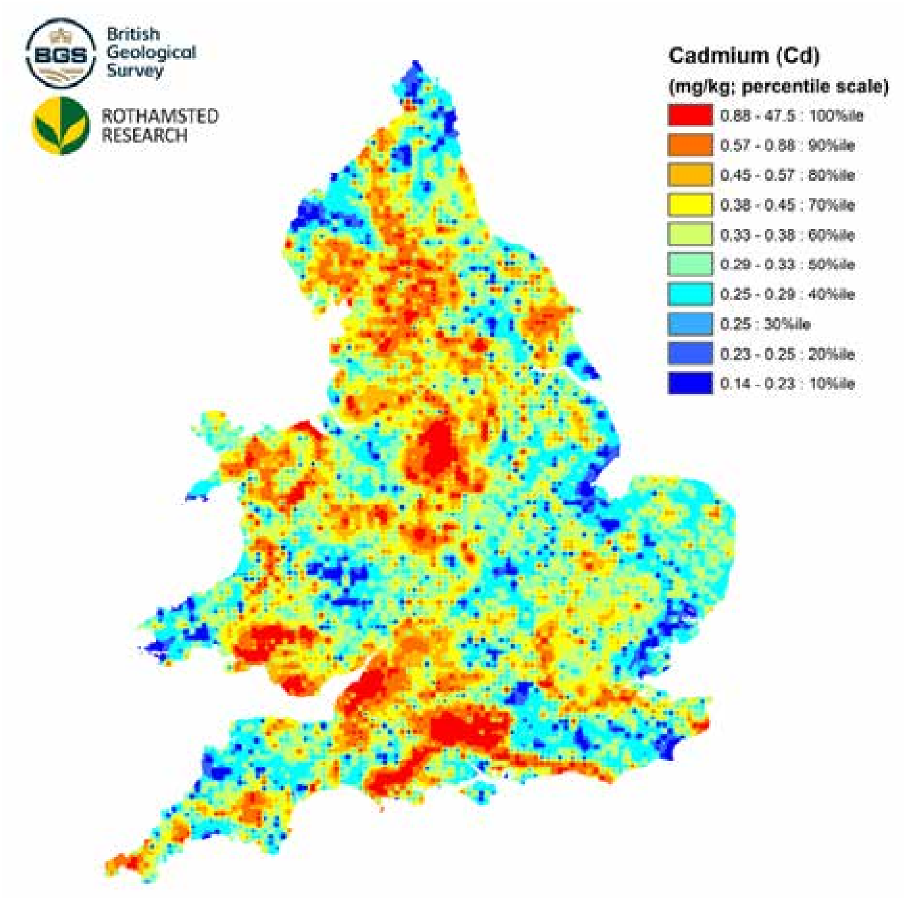
Cadmium (Cd)

Cadmium (Cd) is a rare metallic element naturally occurring in trace amounts at the upper continental rocks at around 0.1 mg/kg. It is a toxic element and biologically non-essential and is known to be a human carcinogen. Cd is also found in igneous and sedimentary rocks at generally low levels, not exceeding 0.3 mg/kg.[76] The Environment Agency has adopted a concentration of 10 mg/kg (for sandy loam soil) for the Soil Guideline Value for residential soils.

The BGS has estimated range values of Cd in topsoil for England, ranging from 0.5- 165mg/kg, with a mean of 0.85 mg/kg.[77] Figure 19 below presents the concentration levels from the NSI sampling for England and Wales.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Cd in soils in England.

Figure 19: Cadmium (Cd) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[78].

76 Defra, Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils : cadmium (Cd) (2012) http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17768&FromSearch=Y&Publisher=1&SearchText=sp1008&SortString=ProjectCode&SortOrder=Asc&Paging=10

77 Ibid.

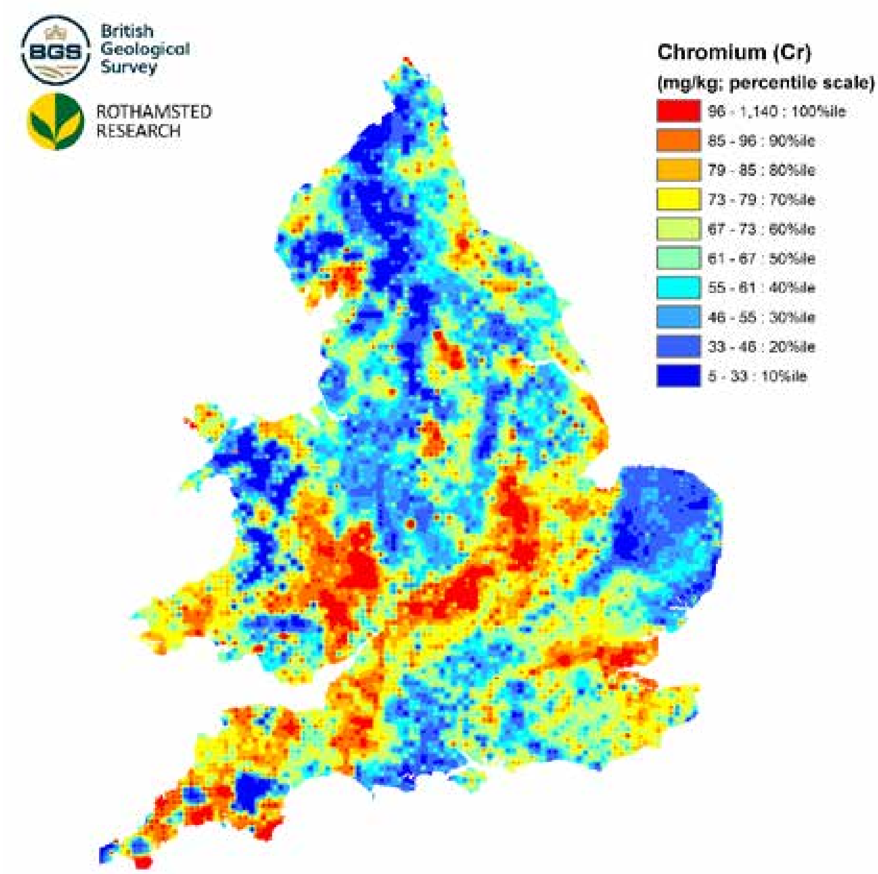
78 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Chromium (Cr)

Chromium (Cr) is a metallic element found at the upper continental crust, ranging from 10-35 mg/kg in granites and sandstones up to 2,300 mg/kg in ultrabasic[79] rock.[80] As per Figure 20, areas with high concentrations of Cd are found in some parts of the south-west of England, and across central England. These high concentrations could be due to serpentine parent material. In addition, there are also areas of high Cr which is most likely anthropogenic, such as Sheffield.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Cr in soils in England.

Figure 20: Chromium (Cr) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[81]

79 Said of an igneous rock having a silica content lower than that of a basic rock. Percentage limitations are arbitrary; the upper limit was originally set at 44%. The term is frequently used interchangeably with ultramafic. Source: https://www.mindat.org/glossary/ultrabasic

80 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

81 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Lead (Pb)

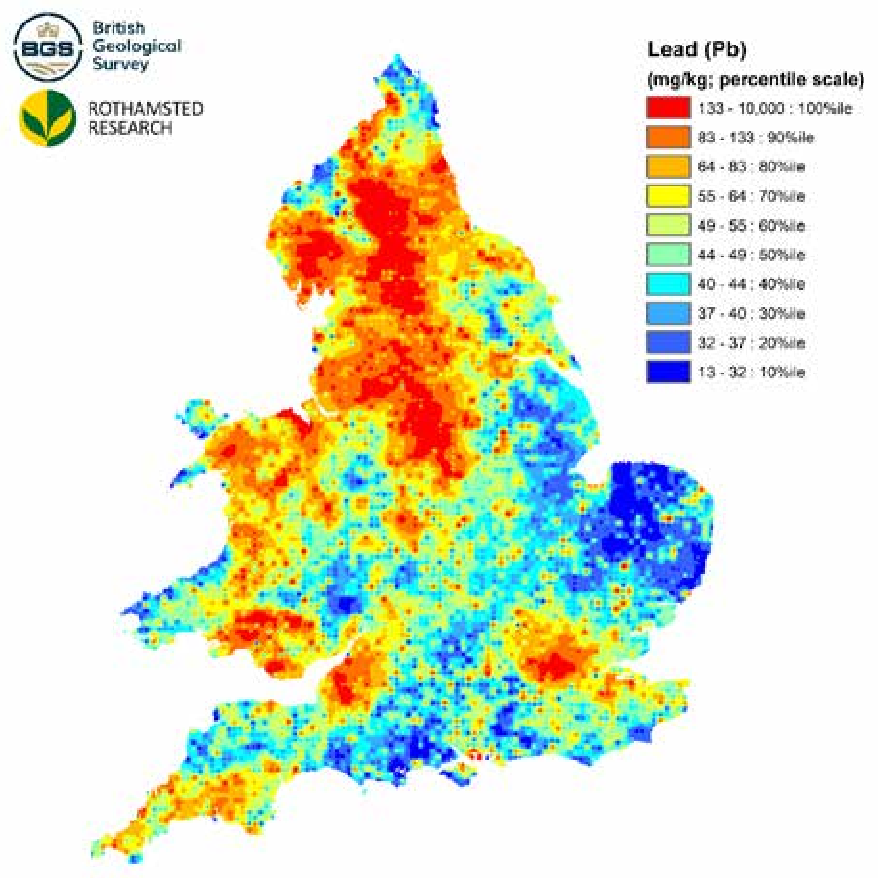
Lead (Pb) is a metallic element naturally occurring in trace amounts in the surface environment, with an abundance in rocks of about 15 mg/kg. It is less abundant in basic igneous rocks (1-4 mg/kg) than in granites (20 mg/kg) and shale (22 mg/kg).[82] It is considered a non-essential element and is toxic to humans and wildlife through the food chain and soil inhalation and ingestion.[83]

The BGS has estimated concentrations of Pb in topsoil in England ranging between 2 and 10,200 mg /kg, with a mean of 114 mg/kg.[84] Regions with soils with the highest Pb concentrations are all close to historical areas of mining and smelting such as Avonmouth, Derbyshire, the northern Pennies, and part of Wales.[85] Figure 21 below presents estimated mean concentrations levels of Pb in England and Wales spatially.

The Countryside Survey report has also assessed mean concentrations of Pb for Great Britain which were estimated at 80.4 mg/kg in 2007, a slight decrease from 1998 estimates of 82.5 mg/kg.[86] This decrease in concentrations could be linked to the move towards using unleaded petrol over the past two decades.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Pb in soils in England.

Figure 21: Lead (pB) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[87]

82 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

83 Defra, *Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils : lead (Pb)* (2012) http://randd.defra.gov.uk/Default. aspx?Menu=Menu&Module=More&Location=None&ProjectID=17768&FromSearch=Y&Publisher=1&SearchText=sp1008&SortString=ProjectCode&SortOrder=Asc&Paging=10

84 Ibid.

85 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

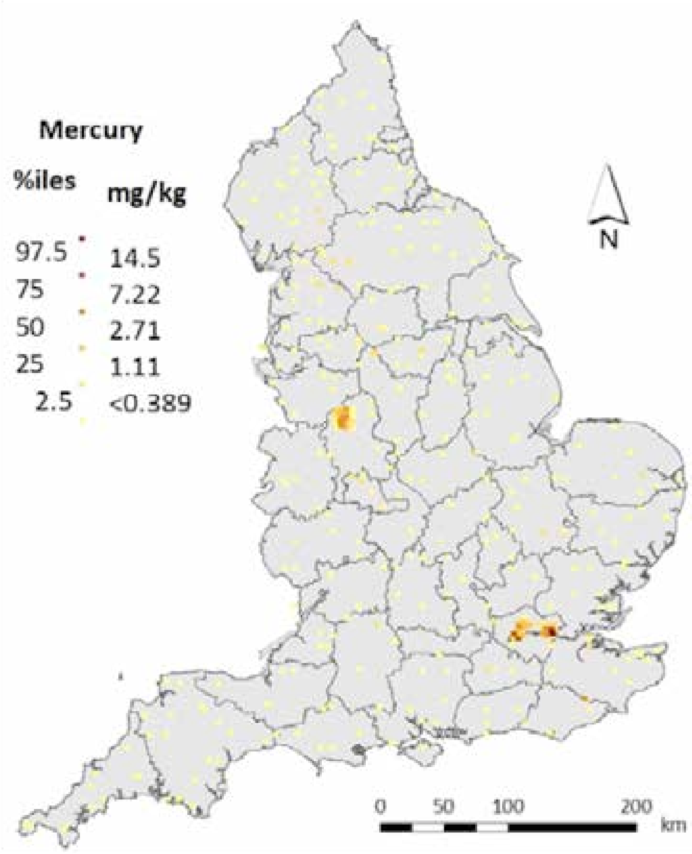
86 Countryside *Survey, Soils Report 2007* (2010 revised) http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR9-revised%20-%20Soils%20Report.pdf

87 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Mercury (Hg)

Mercury (Hg) is a metallic element present in the Earth's Crust in small quantities (0.02 mg/kg) and is highly toxic. Hg occurs naturally in the environment and is the most abundant form being metallic form Hg such as cinnabar (HgS) and Hg chloride ($HgCl_2$). Anthropogenic sources of Hg are mainly processes that involve atmospheric deposition such as combustion (e.g. coal-burning). The BGS has estimated concentrations of Pb in topsoil in England ranging between <0.01 and 30.8 mg/kg, with the highest value and median of 0.522 mg/kg being recorded in the London area. See Figure 22 for Hg estimates in England.

Figure 22: Mercury (Hg) in topsoil as a percentile classified for England and Wales



Source: Defra[88]

Platinum (Pt)

There is almost no evidence on the concentrations of platinum (Pt) in UK soils. The Environment Agency has estimated concentrations of Pt in rural soils. For England, these have a range of 0.02 - 0.09 mg/kg (with a mean and median of 0.02).[89]

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Pt in soils in England.

88 Defra, *Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils: Mercury (Hg)* (2012) http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17768&FromSearch=Y&Publisher=1&SearchText=sp1008&SortString=ProjectCode&SortOrder=Asc&Paging=10

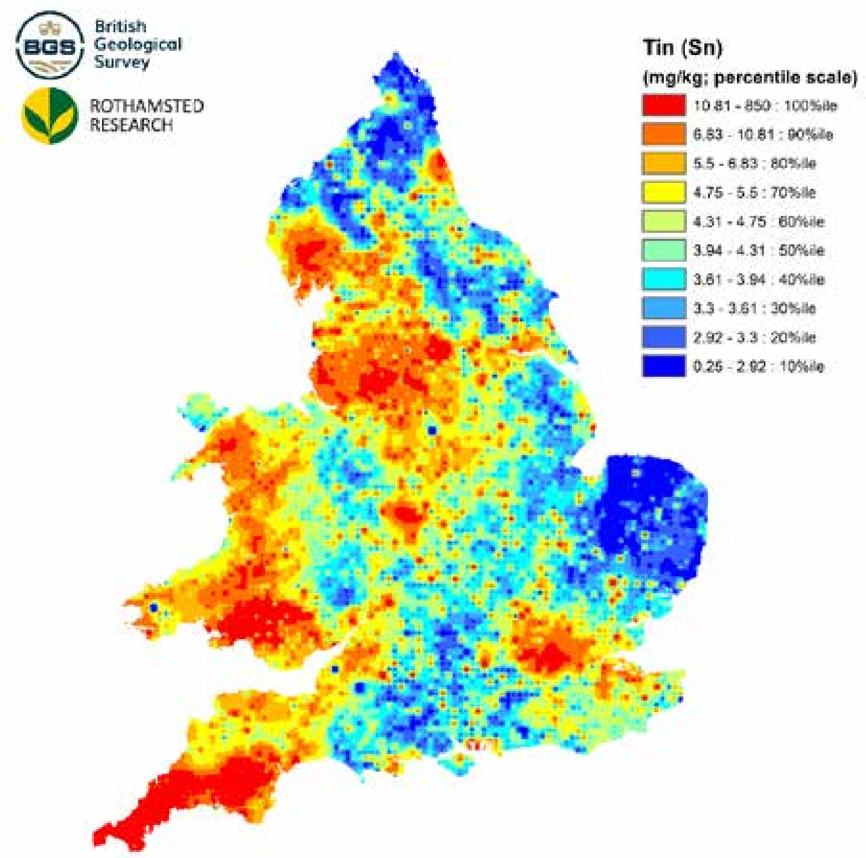
89 Environment Agency, *UK soil and herbage pollutant survey (UKSHS) Report 7L Environmental concentrations of heavy metals in UK soil and herbage* (2007) https://www.gov.uk/government/publications/uk-soil-and-herbage-pollutant-survey

Tin (Sn)

Tin (Sn) is a metallic element, which is found in the upper continental crust, with an estimated abundance of 2.5-5.5 mg/kg. Sn is more common in granites at around 3.6 mg/kg than in igneous rocks at 0.9 mg/kg. The BGS has estimated concentrations of Sn in topsoil in England and Wales with a mean and median of 8.2 mg/kg and 4.3 mg/kg respectively. As per Figure 23, the upper 10% of the data ranged over almost two orders of magnitude from just under 11 to 850 mg/kg. The highest concentrations of Sn in soil are found in the Cornwall region in the south-west of England.[90] See Figure 23 for spatial concentrations of tin in England and Wales.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Sn in soils in England.

Figure 23: Tin (Sn) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[91]

90 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

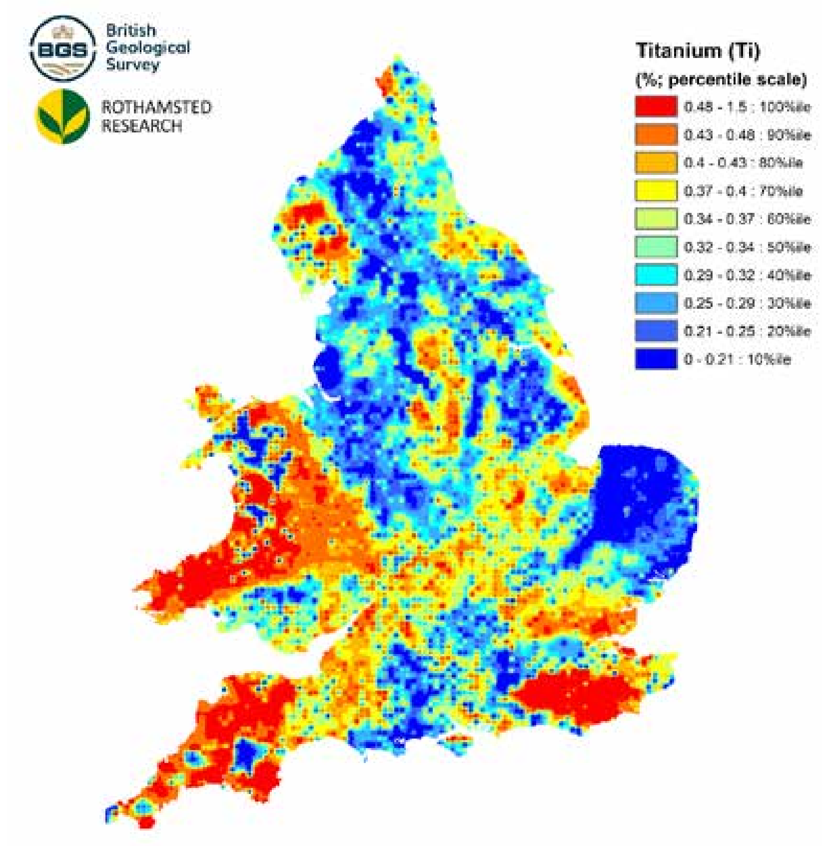
91 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Titanium (Ti)

The estimated average concentration of Titanium (Ti) in upper continental crust is between 0.3 and 0.31% by weight, being more abundant in basic igneous rocks (1%) than in granites (0.3%). The BGS has estimated Ti concentrations for England and Wales with a mean and median of 0.34 and 0.35% respectively.[92] See Figure 24 for spatial estimates.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Pb in soils in England.

Figure 24: Titanium (Ti) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[93]

92 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

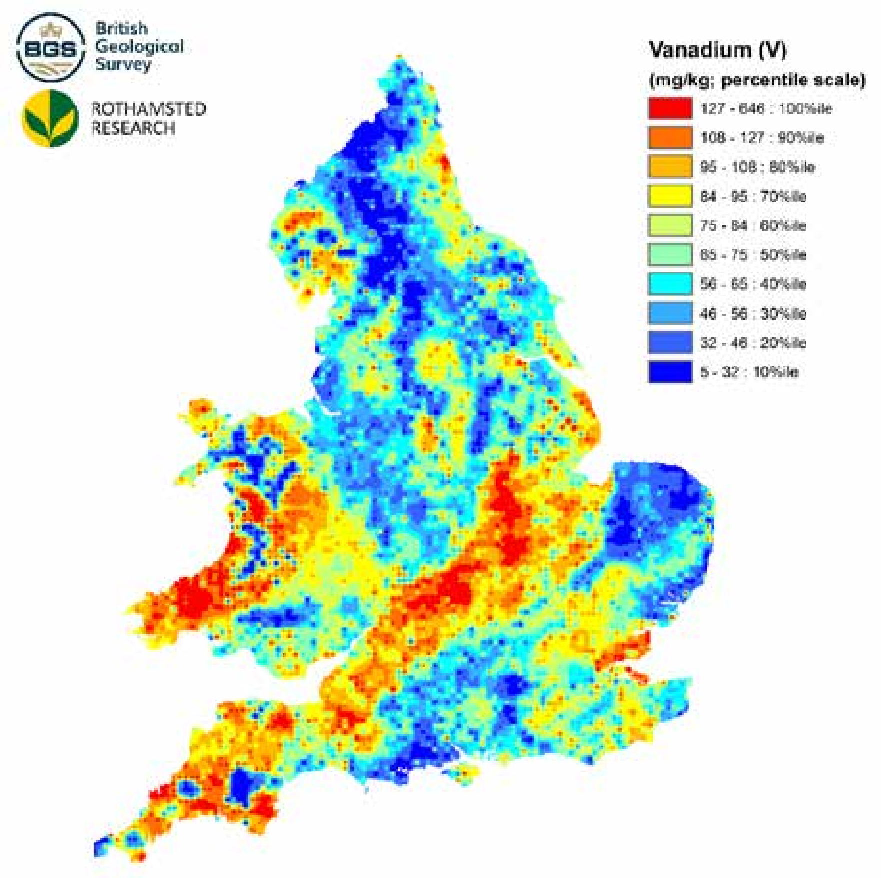
93 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Vanadium (V)

Vanadium is a fairly abundant transition metal, with an estimated average upper continental crust abundance of 53 to 60 mg/kg. It is more abundant in basic igneous rocks (260 mg/kg) than in granites (70 mg/kg), sandstones (20 mg/kg), and limestones (15 mg/kg). The mean and median concentration estimated from the NSI soils sampling is higher than the estimated average found in the upper continental crust, at 79 and 75 mg/kg respectively. The lowest concentration levels of V (< 40 mg/kg) were found in East Anglia, southern England, parts of Cornwall, and central and northern England (in particular the Pennines).[94] See Figure 25 for V estimates across England and Wales.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of V in soils in England.

Figure 25: Vanadium (V) in topsoil as a percentile classified for England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[95]

94 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

95 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Topsoil micronutrients

This section considers the concentrations of micronutrients in the soils across England. These micronutrients, including metallic and non-metallic elements, are important for plant health, with both deficiency and toxicity being possible. The importance of correct concentration levels for plant health means that they impact agriculture, as well as general ecosystem functioning.

Differences in local geology cause significant natural variations in the topsoil concentrations of these micronutrients. Human activities, especially the extraction of these elements from bedrock, can also increase concentrations.

For all the relevant micro-nutrients except boron, maps are available from the UK Soil Observatory, showing the estimated concentrations across the country. A paper from the British Geological Survey[96] provides information on the reasons behind the distributions seen.

Boron (B)

Boron is an essential micronutrient for plants. It controls metabolic processes via the regulation of cell membranes and is an important structural component of cell walls. Deficiency and toxicity are both observed problems.[97]

The boron content of soils varies from 2 to 100mg/kg, with a mean value of 10mg/kg.[98]

No data is available on how boron concentrations vary across the country, but sandy soils are likely to contain low levels. Boron in soil arises from natural sources, such as rainfall, and anthropogenic sources, such as coal burning.[99]

In Scotland, the predicted risk of boron deficiency in crops has been mapped using information such as local geology and proximity to the sea.[100] If a similar exercise were to be conducted in England it could serve as proxy data for the actual distribution of boron concentrations. However, it would not consider the distribution of high-boron soils where boron toxicity is the risk.

96 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

97 Roques, S; Kendall, S; Smith, K; Newell Price, P; Berry, P, *A review of the non-NPKS nutrient requirements of UK cereals and oilseed rape* (August 2013) https://www.researchgate.net/profile/Susie_Roques/publication/277669269_Review_of_the_non-NPKS_nutrient_requirements_of_UK_cereals_and_oilseed_rape/links/55701f9208aeccd777417731/Review-of-the-non-NPKS-nutrient-requirements-of-UK-cereals-and-oilseed-rape.pdf?origin=publication_detail

98 Ibid

99 Ibid

100 Sinclair, A; Edwards, T; Coull, M (March 2017) *Management of boron in soils for crops https://webcache.googleusercontent.com/search?q=cache:vk_gWmgnhi8J:https://www.sruc.ac.uk/download/downloads/id/3328/technical_note_tn671_management_of_boron_in_soils_for_crops.pdf+&cd=1&hl=en&ct=clnk&gl=uk*

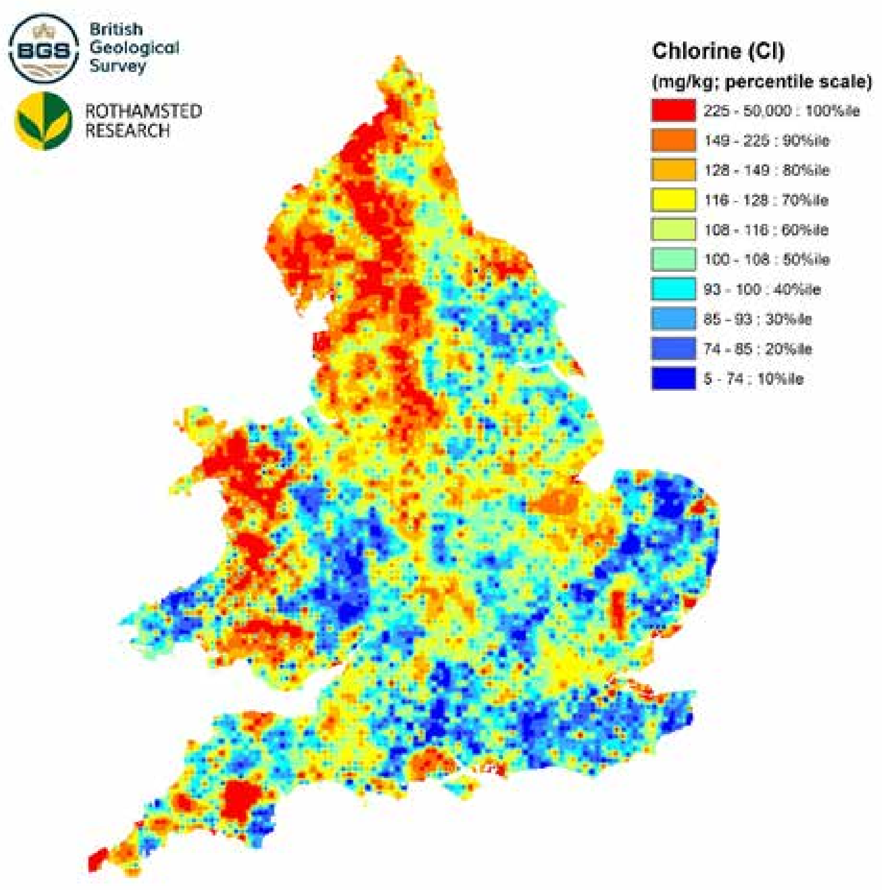
Chlorine (Cl)

'Chlorine is [a] nonmetallic, gaseous element forming a wide range of ionic compounds – chlorides, for example – and is an essential element in the biosphere… The dominant factors which are likely to control the spatial distribution of total Cl concentrations across England and Wales are inputs from marine aerosols in areas close to the coast with large annual average rainfall, and Cl derived from geological deposits of marine origin or recent marine incursions.' [101]

High chlorine concentrations (>225mg/kg) are found in the upland areas of the North, Wales, Devon, and Cornwall, while the lowest concentrations (<75mg/kg) are found in south-east Wales, the Welsh Borders, south-East Devon, and over the Weald: see Figure 26.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Cl in soils in England.

Figure 26: Estimated concentrations of chlorine in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[102]

101 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

102 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales* http://www.ukso.org/static-maps/advanced-soil-geochemical-atlas-of-england-and-wales.html

Copper (Cu)

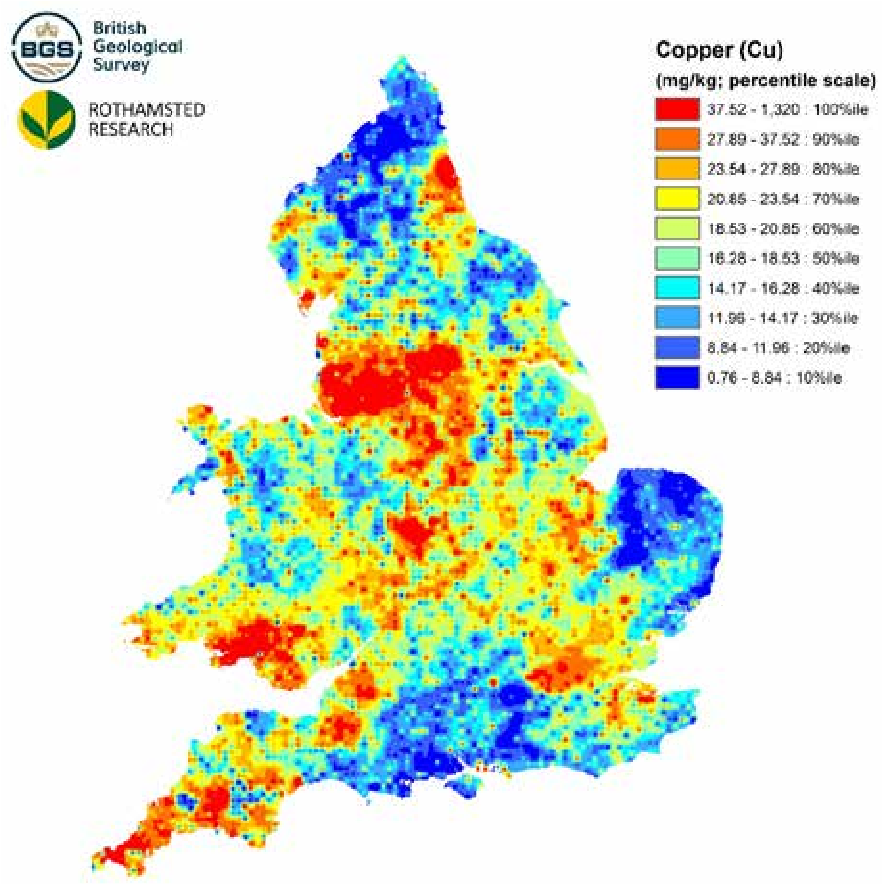
'Copper is a biologically essential metallic micronutrient element'.[103]

High copper concentrations are found in the soils of areas where copper has been mined, smelted or used industrially for long periods, such as South Cornwall, the Tamar Valley, Anglesey and Snowdonia, South Wales, Bristol, Birmingham, and northern industrial towns in a wide area in the North West and a smaller area in the North East: see Figure 27.[104]

Soils with low copper concentrations are found mainly on high moorlands with organic soils, such as in North Yorkshire and Dartmoor, or in lowland areas with sandy or thin chalk soils, such as East Anglia, and the New Forest.[105]

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Cu in soils in England.

Figure 27: Estimated concentrations of copper in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[106]

103 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.) www.bgs.ac.uk/gbase/advsoilatlasEW.html

104 Ibid

105 Ibid

106 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales*

Iron (Fe)

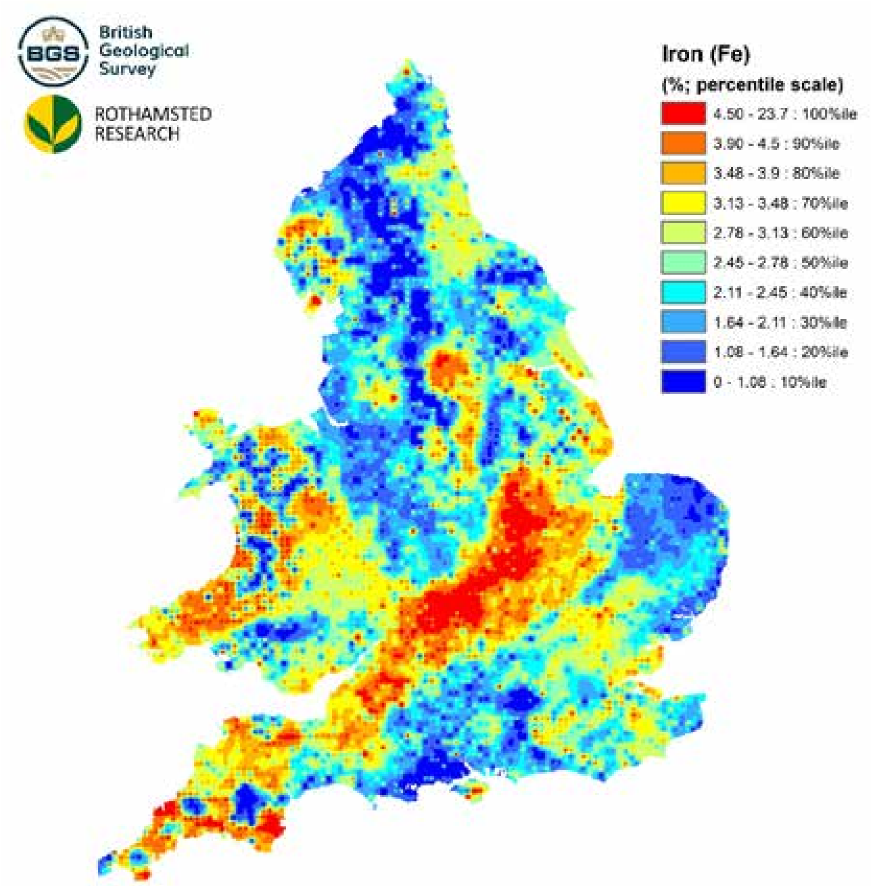
Iron is an abundant element in the Earth's crust and in topsoil, though only a small proportion of it is bioavailable. [107]

Relatively high concentrations of iron (>3.5%) occur in the soils in a thick band running across England from Somerset to Lincolnshire: see Figure 28. The highest of these concentrations may be associated with the occurrence of ironstones and iron-rich clays, limestones, and sandstones. High concentrations of iron in some areas may be associated with an industrial activity such as steelmaking.[108]

Low concentrations of iron (<1%) occur in many upland areas of the North, Wales, and the south-west peninsular, possibly due to the leaching of iron from topsoil or to the presence of soils dominated by organic matter, such as peats. Low iron concentrations are also found in lowland heath, and sandy soils and tills, such as in the New Forest and East Anglia. [109]

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Fe in soils in England.

Figure 28: Estimated concentrations of iron in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[110]

107 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.)

108 Ibid

109 Ibid

110 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales*

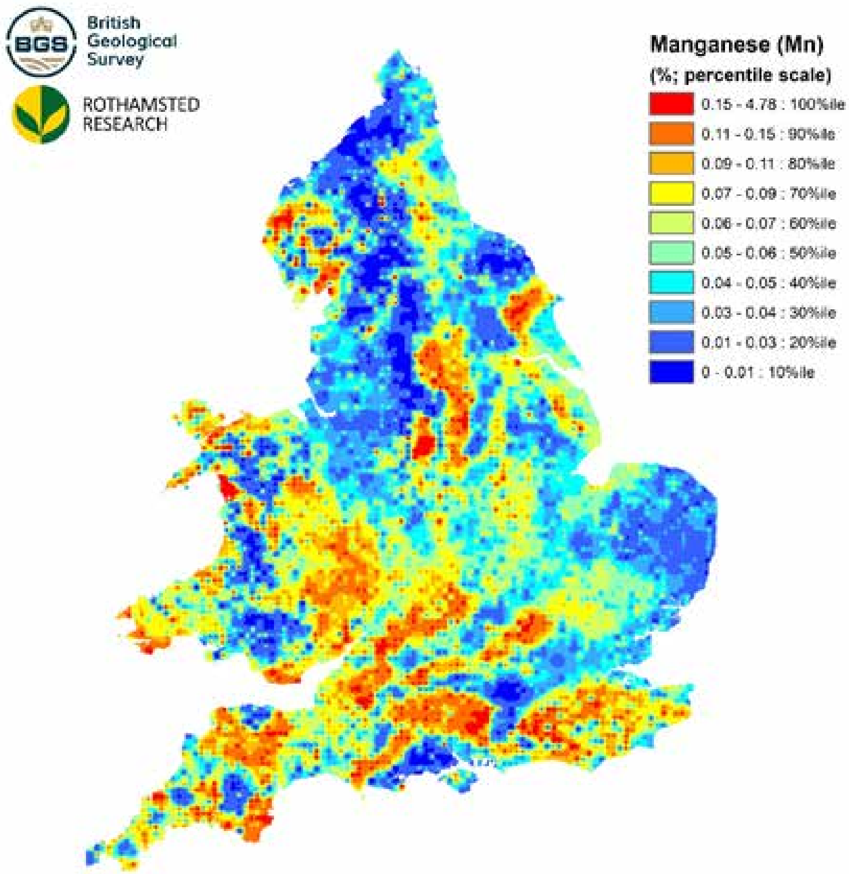
Manganese (Mn)

Manganese is a common metallic element, essential for all organisms, with deficiency problems far more likely than toxic effects. [111]

High manganese concentrations (0.11%) are found in the soils of areas where manganese has been extracted and processed in the past, such as West Wales and Derbyshire. Elevated manganese concentrations are also associated with limestone soils in Cumbria, Devon, Yorkshire, and the Cotswolds, as well as chalk areas and shales. Low manganese concentrations are found in high moorlands, low heathlands and the sandy soils of East Anglia.[112] Figure 29 shows the distribution of manganese concentrations in the topsoils of England and Wales.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Mn in soils in England.

Figure 29: Estimated concentrations of manganese in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[113]

111 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.)

112 Ibid

113 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales*

Molybdenum (Mo)

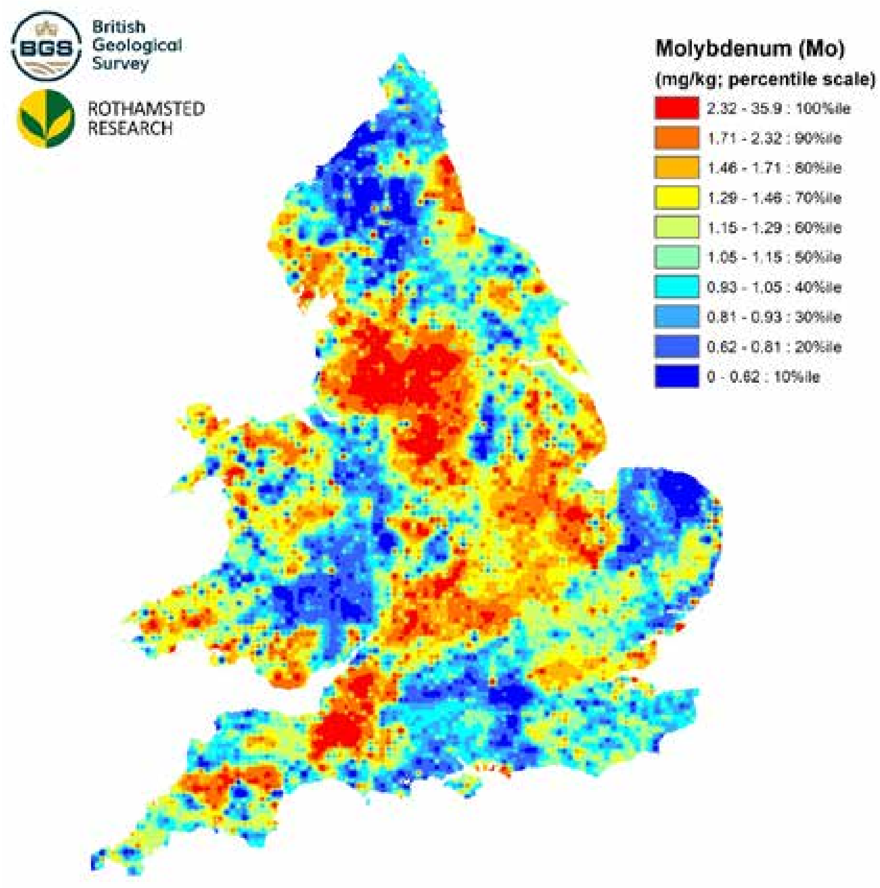
Molybdenum is a relatively rare metallic element but is essential for almost all organisms. Both deficiency and toxicity are possible and well documented.[114]

The highest concentrations of molybdenum are found in Somerset, where naturally high (up to 37.5mg/kg) concentrations of molybdenum can induce copper deficiency in grazing ruminants. Concentrations in South Derbyshire and the Craven Basin can reach 16.5mg/kg. The high concentrations in these areas are most likely due to underlying black shales, and possibly peaty soils.[115]

Elevated molybdenum concentrations (>2mg/kg) also occur in the region of the northern industrial cities, due to coal burning and the industrial use of molybdenum. Low concentrations are found in the soils of the high Pennines, and the low sandy soils of the Midlands, the Brecklands, and East Anglia.[116] See Figure 30 for concentrations across England.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Mo in soils in England.

Figure 30: Estimated concentrations of molybdenum in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[117]

114 Rawlins, B G, McGrath, S P, Scheib, A J, Breward, N, Cave, M, Lister, T R, Ingham, M, Gowing, C and Carter, S., *The advanced soil geochemical atlas of England and Wales* (2012) (Keyworth, Nottingham: British Geological Survey.)

115 Ibid

116 Ibid

117 BGS and Rothamsted Research, *Advanced soil geochemical atlas of England and Wales*

Nickel (Ni)

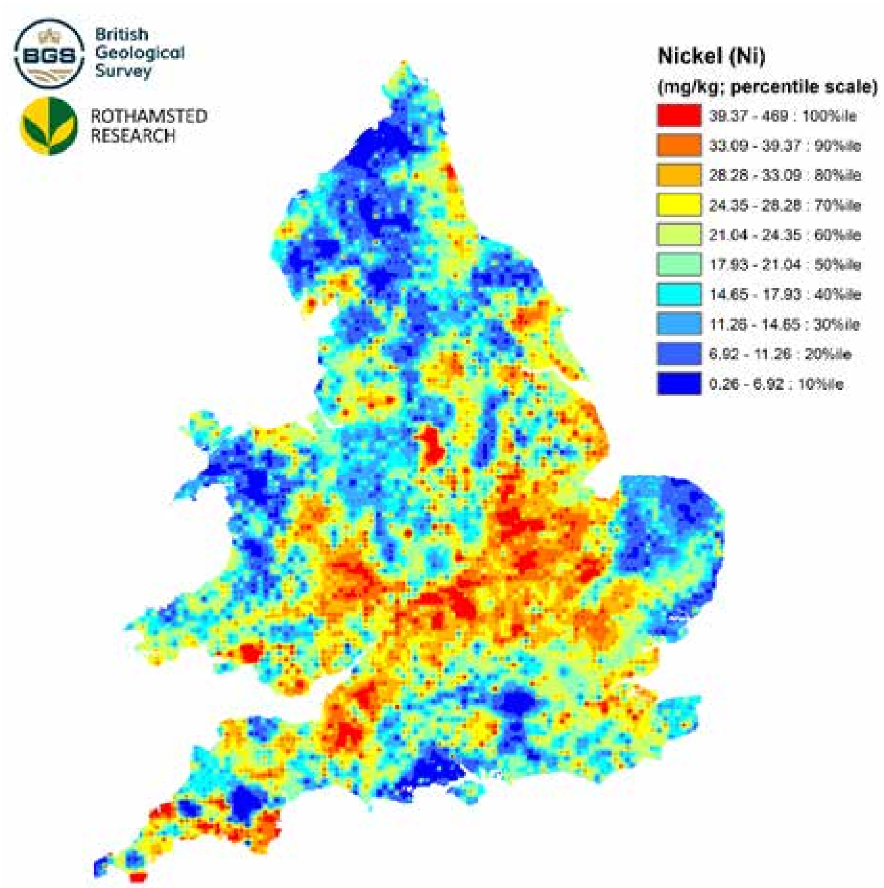
Nickel is a metallic element, closely related to iron, which is essential for some organisms. It is also widely used in metallurgy for alloying and plating, in batteries, in pigments, and as a catalyst. The median concentration of nickel in the soils under observation is near the average concentration in the Earth's crust, 20mg/kg. [118]

High concentrations of nickel (>30mg/kg) are found, among other places, in a vague band across England from Somerset to Lincolnshire, and also in south-east Wales (see Figure 31). In some cases, high concentrations of nickel are due to natural causes: the high concentrations in Oxfordshire, for example, are associated with Jurassic ironstone of the Marlstone Rock Formation. South Wales is an example of high concentrations caused by anthropogenic factors: nickel smelting took place near Swansea for many decades.

Relatively low concentrations of nickel occur in many of the upland areas of the North, Wales, and the South-West, where there is granite bedrock, and also in the sandy soils of the New Forest, the heaths between Reading and Woking, and the sandy soils and tills of East Anglia.

Given the limited data available and the lack of recent data, the NCC has not been able to produce a comprehensive assessment of concentrations of Ni in soils in England.

Figure 31: Estimated concentrations of nickel in topsoil, England and Wales



Source: UKSO based on data from data collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales[119]

Annex 5

Land

Land

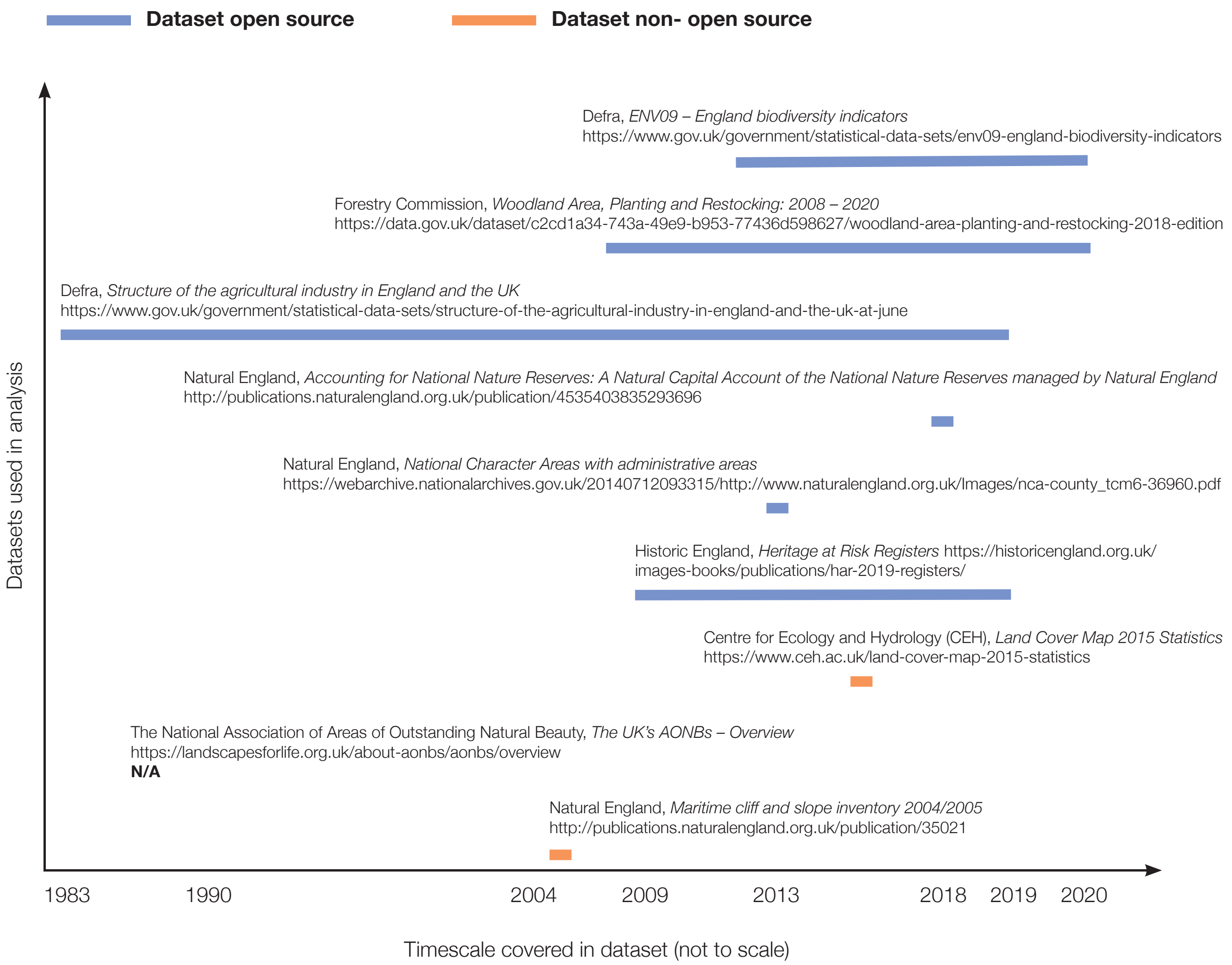
Background

The UK Biodiversity Broad Habitat classification[1] sets out a framework for commonly defining habitat types across the whole of the UK. In this assessment, the NCC has identified the most important habitats from this list for ecosystem services where the biotic and non-biotic elements need to be considered together in order to accurately describe the ecosystem services provided.

In order to understand where changes in the status of the land asset and how these will affect human health or the environment, it is important to first understand their condition and extent. To do so, robust and comprehensive data is required to enable an assessment of the status of the land asset. To produce the land assessment the Natural Capital Committee (NCC) has looked at a range[2] of datasets, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the land asset

Datasets used in land analysis, timescale covered and their status (open or non-open source)



Source: NCC 2020

1 JNCC *Terrestrial habitat classification schemes* https://jncc.gov.uk/our-work/terrestrial-habitat-classification-schemes/

2 Given the limited resources available to the NCC the list of datasets is not comprehensive and further work is required to scope additional datasets to complement this assessment.

Land (terrestrial, freshwater and coastal margins habitats)

This annex presents information on the condition and extent of the habitats for which the only available data assesses both biotic and non-biotic elements together. Connectivity between habitats is also important to consider as it helps to to maintain condition and functioning and flows of services, but it has not been possible to assess connectivity given the lack/limited availability of data. The NCC has focused on data on priority habitats only, consolidating and assessing historical trend data, something that has not been done previously by Defra, which only presents the most recent year data. By doing so the NCC has been able to present the change in the condition and limited change in the extent (in terms ha).

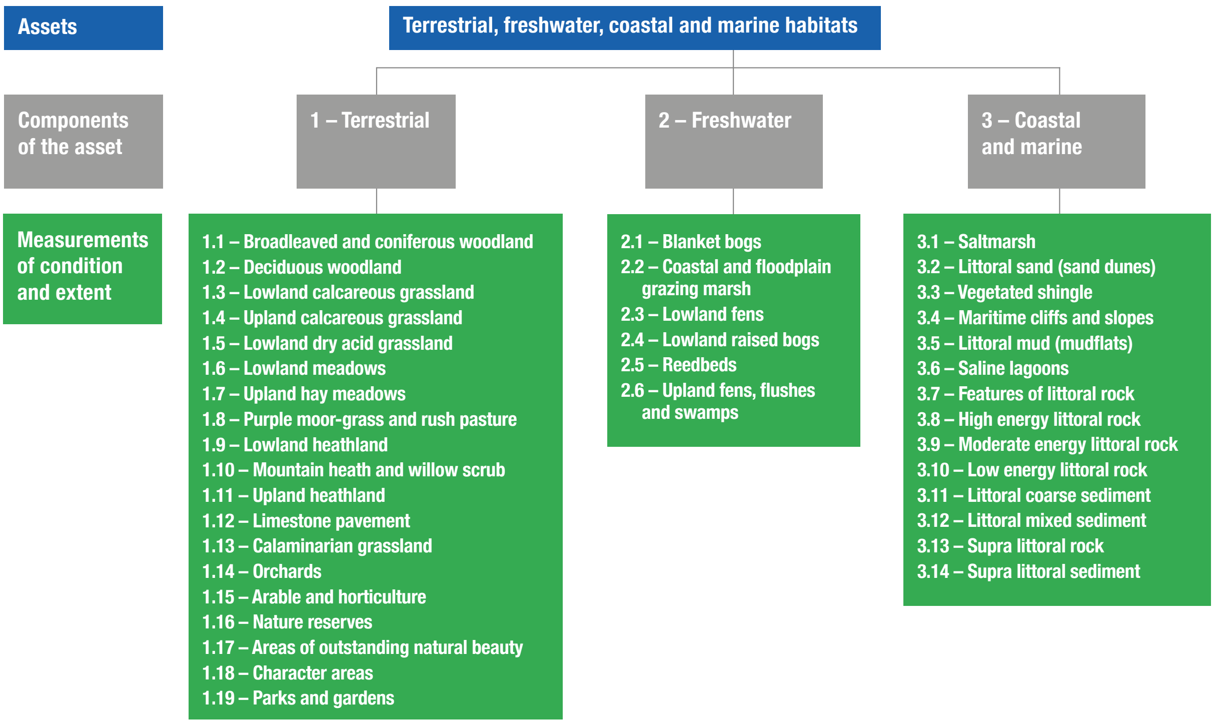
Ideally, the physical features of the environment would be treated as separate assets to the biotic elements. The NCC's assessment has been presented in this way where the data allows. For example, the chemical classifications of freshwater environments has been presented in Annex 2, Freshwaters, whereas the data on freshwater species has been presented in Annex 6, Biota. This annex presents the information that cannot be separated in this way because it considers the biotic and non-biotic elements of each habitat together.

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of terrestrial, freshwater and coastal margins and marine habitats. In order to produce the land assessment, the NCC has used datasets and evidence from:

- Natural England[3];
- Defra statistics[4,5,6];
- The Forestry Commission[7];
- UK Soils Observatory (UKSO)[8]; and
- The National Association of Areas of Outstanding Natural Beauty[9].

For each of the habitats shown in Figure 1, this annex assesses its condition and extent, and the trends in both.

Figure 1: Terrestrial, freshwater and coastal margins habitats



Source: NCC

3 Several sources see sections that follow for specific sources of data/evidence.

4 Defra, *Extent and condition of priority habitats (2019)* https://www.gov.uk/government/statistics/england-biodiversity-indicators

5 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

6 Defra, *Structure of the agricultural industry in England and the UK at June* https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

7 Forestry Commission, *Woodland Area, Planting and Restocking: 2008 – 2020 – based on various weblinks see 2018 source here:* https://data.gov.uk/dataset/c2cd1a34-743a-49e9-b953-77436d598627/woodland-area-planting-and-restocking-2018-edition

8 UKSO, *Land cover map 2015 (2017)* http://www.ukso.org/static-maps/land-cover-map.html

9 The National Association of Areas of Outstanding Natural Beauty, *The UK's AONBs – Overview* https://landscapesforlife.org.uk/about-aonbs/aonbs/overview

Summary of overall (partial) terrestrial, freshwater, coastal and marine habitats asset assessment

The NCC has produced a partial assessment on the condition and extent of terrestrial, freshwater and coastal margins habitats asset.

The assessment uses a 'RAG' rating approach to indicate the status of the terrestrial, freshwater and coastal margins habitats asset and associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. Table 1 shows the RAG scale – note that the 'grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'amber' rating ('no change' / 'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 1: RAG rating scale for terrestrial, freshwater, coastal and marine habitats assessment

RAG rating	Colour
Unable to assess	Grey
Declined	Red
No change/mixed	Amber
Improved	Green

The overall assessment of the terrestrial and coastal margins and marine habitats annex, based on the datasets available, is 'Red': **deteriorating** – this is based on the fact that the majority of priority habitats does not meet the England Biodiversity target, that only 51% of National Nature Reserves (NNR) are in favourable condition, and that the number of parks in the risk register has increased between 2018 and 2019. This assessment is based on the three group headings (see points 1-3 below) and is underpinned by the trend assessment made to the measurements assessed in this annex.

1. Terrestrial
2. Freshwaters
3. Coastal margins habitats

Based on the datasets available, the NCC findings are presented in Table 2 with a RAG rating for each of the three heading groups provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the measurements. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC assessments are:

- The government is not meeting, and is not on track to meet, the Biodiversity 2020 Strategy target to have '90% of priority habitats to be in 'Favourable' or 'Unfavourable recovering' 'condition'.
- Of the 24 priority habitats types only 1/3 achieved the individual target of 80% of 'Favourable' or 'Unfavourable recovering' condition.
- There has been almost no change in the extent (in terms of area (hectares (ha))) of individual priority habitats since 2011.

Table 2: Indicative assessment of the habitats assessed in this annex

Habitat type	Data availability	Overall assessment
1. Terrestrial	For most of the terrestrial habitats, the data is comprehensive. However, there are the following limitations: • The NCC has presented data from 2011, but only the 2019 data has been previously published. • The data for 'arable and horticulture' is limited to the total area covered by these two land uses. What is particularly missing is information on the condition and extent of arable field margins, a priority habitat. • The data for parks and gardens is limited to estimates of the total numbers, rather than the area covered or their condition. • Ideally, biotic and non-biotic elements would be assessed separately.	Most terrestrial habitats have been deteriorating for the last several years (e.g.: traditional orchard, coastal and floodplain grazing marsh) though some are better than they were in 2011.
2. Freshwater	For most of the freshwater habitats assessed, the data is comprehensive. However, there are the following limitations. • The NCC has presented data from 2011, but only the 2019 data has been previously published. • There is no historic data on the extent of wetlands. • Ideally, biotic and non-biotic elements would be assessed separately.	Most of the freshwater habitats assessed have been deteriorating for the last several years, though some are better than they were in 2011.
3. Coastal and marine	For most of the coastal and marine habitats assessed, the data is comprehensive. However, there is no data available on the condition or extent of littoral rock habitats. Ideally, biotic and non-biotic elements would be assessed separately.	Most of the coastal habitats assessed have been deteriorating for the last several years, though some are better than they were in 2011.

Summary RAG rating for individual measurements

The overall assessment, based on the three groups set out above, is underpinned by an analysis of measurements used to asses these habitats (as displayed in Figure 1). A full summary assessment of the condition, extent and pressures of these measurements, grouped by the three overall components, are presented in Table 3. The assessment follows the same approach of the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. The assessment is split into four categories, with a RAG rating assigned for each, as follows:

1. **Compliance against target/commitment** is the comparison of the target or commitment baseline against the most recent data. For example, assessing the reduction of ammonia from 2005 levels (target baseline) against the 2020 target of 8% reduction;
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/evidence. For example, comparing the change between 1970 and 2018;
3. **The NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when Government first committed: *"to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses".*[10] Here, the 2011 baseline (where data is available) is compared against the most recent data/evidence. This also relates to the NCC census advice[11], and its interim response to the 25 YEP Progress Report, for a need to have a common base year to assess progress against;
4. **The short-term, trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

10 Defra, *The natural choice: securing the value of nature – Full Text (2011)* https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

11 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan (2019)* https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

The overall assessment RAG rating is based on each measurement's RAG rating presented in Table 3 below. There is significant variation in the condition of priority habitats, with some achieving both the individual target of 80% (e.g.: upland calcareous grassland, limestone pavements, upland fens, flushes and swamps) and overall target of 90% (e.g.: saltmarsh), however of the priority habitats 2/3 do not achieve either of these targets (e.g.: deciduous woodlands, lowland meadows, coastal and floodplain grazing marsh, saline lagoons, etc…). The points below summarise the key findings:

- Between 2011 and 2020 there was a declining condition of mountain heaths and willow scrub from 94% achieving 'favourable' and 'unfavourable recovering' to just over under 71%.
- The latest data shows that only 6% of lowland raised bogs (SSSI) had achieved favourable condition against a target of 50% by 2020.
- Based on the latest data from Natural England in 2020 only 32% of coastal and floodplain grazing marsh achieved 'Favourable' or 'Unfavourable recovering' condition against a target of 80%.
- 90% of saltmarsh priority habitats achieved Favourable' or 'Unfavourable recovering' condition in 2020.

The key RAG ratings for the individual measurements are presented in Table 3 below.

Table 3: Assessment of individual habitats, with RAG ratings

Habitat types and individual habitats		Assessment			
		Compliance with target or commitment	Long-term trend	Against NCC baseline (2011)	Short-term trend
Terrestrial	1.1 – Broadleaved and coniferous woodland	N/A	G	G	A
	1.2 – Deciduous woodland	R	G	G	R
	1.3 – Lowland calcareous grassland	R	G	G	R
	1.4 – Upland calcareous grassland	G	R	R	R
	1.5 – Lowland dry acid grassland	R	A	A	R
	1.6 – Lowland meadows	R	G	G	R
	1.7 – Upland hay meadows	R	G	G	R
	1.8 – Purple moor-grass and rush pasture	R	G	G	R
	1.9 – Arable and horticulture	N/A	G	R	A
	1.10 – Lowland heathland	G	R	R	R
	1.11 – Mountain heath and willow scrub	R	R	R	R
	1.12 – Upland heathland	G	G	G	R
	1.13 – Limestone pavement	G	G	G	R
	1.14 – Calaminarian grassland	N/A	N/A	N/A	N/A
	1.15 – Traditional orchard	R	R	R	R
	1.16 – Nature reserves	N/A	N/A	N/A	N/A
	1.17 – Areas of outstanding natural beauty	N/A	N/A	N/A	N/A
	1.18 – Character areas	N/A	N/A	N/A	N/A
	1.19 – Parks and gardens	N/A	G	G	A
Freshwater	2.1 – Blanket bogs	G	G	G	R
	2.2 – Coastal and floodplain grazing	R	G	G	R
	2.3 – Lowland fens	R	G	G	R
	2.4 – Lowland raised bogs	R	G	G	A
	2.5 – Reedbeds	R	R	G	R
	2.6 – Upland fens, flushes and swamps	G	G	G	R

Coastal margins	3.1 – Saltmarsh	G	R	R	R
	3.2 – Littoral sand (sand dunes)	R	A	A	G
	3.3 – Vegetated shingle	G	R	R	R
	3.4 – Maritime cliffs and slopes	R	G	G	R
	3.5 – Littoral mud (mudflats)	R	R	R	R
	3.6 – Saline lagoons	R	R	R	R
	3.7 – Features of littoral rock	N/A	N/A	N/A	N/A
	3.8 – High energy littoral rock	N/A	N/A	N/A	N/A
	3.9 – moderate energy littoral rock	N/A	N/A	N/A	N/A
	3.10 – Low energy littoral rock	N/A	N/A	N/A	N/A
	3.11 – Littoral coarse sediment	N/A	N/A	N/A	N/A
	3.12 – Littoral mixed sediment	N/A	N/A	N/A	N/A
	3.13 – Supra littoral rock	N/A	N/A	N/A	N/A
	3.14 – Supra littoral sediment	N/A	N/A	N/A	N/A

Individual terrestrial, freshwaters, and coastal and marine habitats assessment: analysis

The sections that follow present the assessment for each of the measurements underpinning each of the three headings (e.g.: freshwaters), starting with terrestrial and ending with coastal and marine habitats. The assessment of each measurement follows the approach and RAG rating presented in Table 1 above and the approach scoped in the previous section.

1. Terrestrial habitats

This section assesses the condition and extent of the various types of non-urban land cover in England, listed in Table 4. Figure 2 shows the distribution of these habitats across the UK in 2015, and Table 5 sets out how much land they cover.

Table 4: List of terrestrial habitats

	Habitat	Targets
Terrestrial habitats	1.1 – Broadleaved and coniferous woodland	No evidence of a target or commitment has been found for these habitats.
	1.2 – Deciduous woodland	
	1.3 – Lowland calcareous grassland	The England Biodiversity 2020 Strategy includes a target for ‘90% of priority habitats to be in ‘Favourable’ or ‘unfavourable recovering’ condition and at least 50% of SSSIs in ‘Favourable’ condition, while maintaining at least 95% in ‘Favourable’ or recovering condition’.[12]
	1.4 – Upland calcareous grassland	
	1.5 – Lowland dry acid grassland	
	1.6 – Lowland meadows	
	1.7 – Upland hay meadows	
	1.8 – Purple moor-grass and rush pasture	
	1.9 – Arable and horticulture (arable field margins)	
	1.10 – Lowland heathland	
	1.11 – Mountain heath and willow scrub	
	1.12 – Upland heathland	
	1.13 – Limestone pavement	
	1.14 – Calaminarian grassland	
	1.15 – Traditional orchard	
	1.16 – Nature Reserves	No evidence of a target or commitment has been found for these habitats.
	1.17 – Areas of outstanding natural beauty	
	1.18 – National character areas	
	1.19 – Parks and gardens	

12 Defra, *Biodiversity 2020: A strategy for England’s wildlife and ecosystem services* (2011) https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

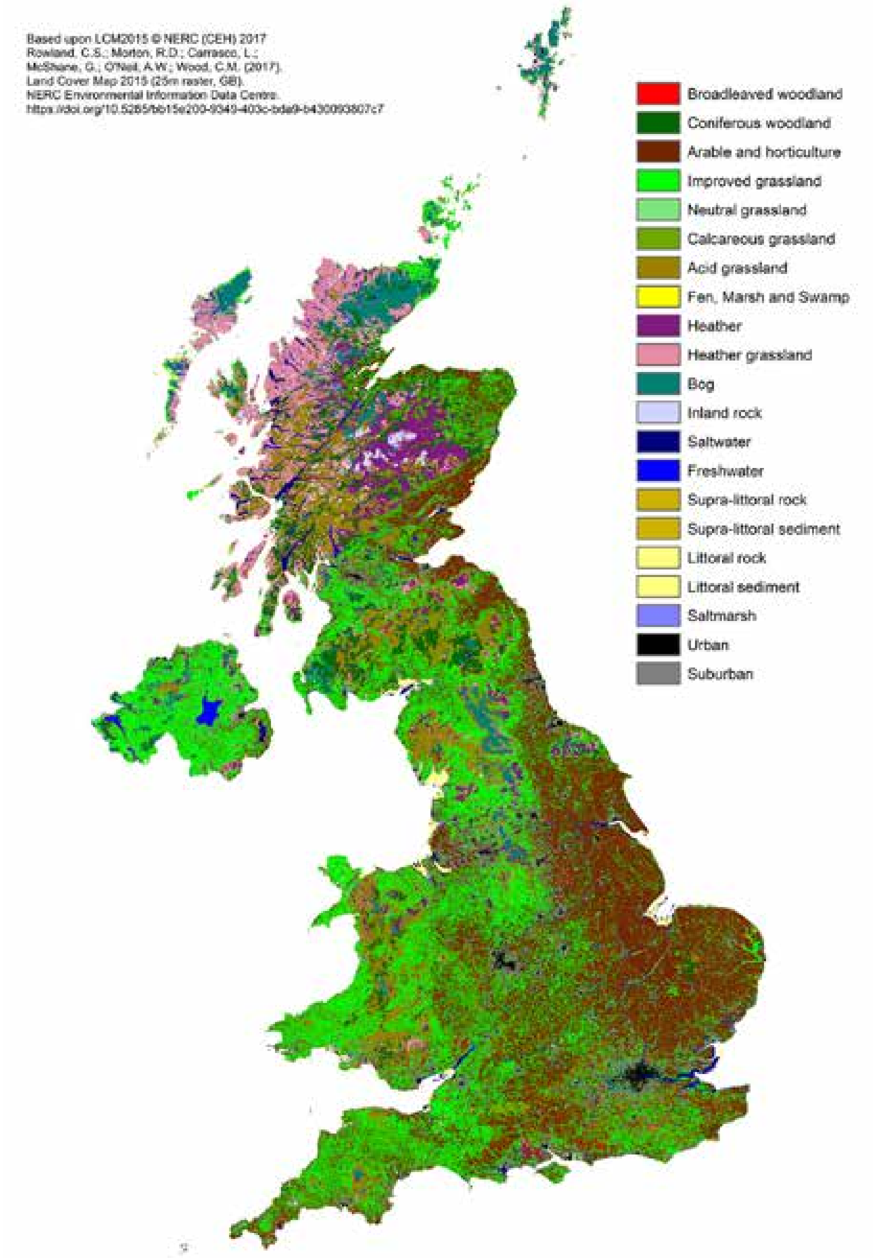
Table 5: UK Land cover in km² based on LCM2015

LCC	Land cover class	UK	England	Scotland	Wales	Northern Ireland
1	Broadleaved woodland	15011	9763	3129	1656	463
2	Confierous woodland	15593	2971	10270	1616	737
3	Arable	56506	47749	6799	1003	954
4	Improved grassland	74466	42865	13630	9884	8088
5	Neutral grassland	1147	608	24	97	418
6	Calcareous grassland	830	814	0	13	3
7	Acid grassland	21336	4691	12104	4153	389
8	Fen	185	119	17	49	1
9	Heather	9697	1739	7268	428	262
10	Heather grassland	15331	956	13528	226	620
11	Bog	9602	1960	6465	262	916
12	Inland rock	1827	234	1501	71	22
13	Saltwater	291	153	115	11	12
14	Freshwater	3236	965	1559	115	596
15	Supra-littoral rock	232	37	160	33	2
16	Supra-littoral sediment	548	183	235	95	36
17	Littoral rock	177	37	128	7	5
18	Littoral sediment	322	146	124	30	21
19	Saltmarsh	668	456	108	104	0
20	Urban	3993	3350	372	185	85
21	Suburban	13655	10864	1432	871	489
	total area (km²)	244654	130658	78967	20909	14120

Source: CEH[13]

13 Rowland, C.S.; Morton, R.D.; Carrasco, L.; McShane, G.; O'Neil, A.W.; Wood, C.M., *Land Cover Map (LCM) 2015 (25m raster, GB)* https://www.ceh.ac.uk/land-cover-map-2015-statistics

Figure 2: Map of UK land cover in 2015



Source: UKSO based on the Centre for Ecology and Hydrology (CEH)[14]

14 UKSO, Land cover map 2015 (2017) http://www.ukso.org/static-maps/land-cover-map.html

The overall assessment of terrestrial habitats

The NCC's overall assessment of the terrestrial habitats presented in this annex is that they are 'Red': **deteriorating/mixed**. Most of the habitats in the assessment did not meet the 80% habitat-specific target and were a long way off the 90% all-habitats target, as shown by the preponderance of red in the first column of Table 6. Although the condition of these habitats appears to have generally improved since 2011, there appears to be a deterioration in all but two cases since 2019. The key findings from the NCC assessments are:

- Between 2011 and 2020 there was a declining condition of mountain heaths and willow scrub from 94% achieving 'favourable' and 'unfavourable recovering' to just over under 71%.
- Around 51% of National Nature Reserves (NNR) Sites of Special Scientific Interest (SSSIs) are in 'Favourable' condition.

Table 6: NCC assessment of progress and RAG rating

Habitat	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
1.1 – Broadleaved and coniferous woodland	No target or commitment was found/exist.	No data on the condition of this habitat was found. The assessment is based on the extent the total area covered by broadleaved or coniferous woodland was 1,311 hectares in 2020, compared with 1,127 in 2008.	The total area covered by broadleaf or coniferous woodland was slightly higher in 2020 (1,311 hectares) than in 2011 (1,294 hectares).	The change in the total area covered by broadleaf or coniferous woodland between 2019 and 2020 was minimal and falls within a 1% change.
1.2 – Deciduous woodland	The proportion of the total area of deciduous woodland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was well below its 80% habitat-specific target and its 90% all-habitats target every year since 2011 (51% in 2020).	The proportion of the total area of deciduous woodland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 51% in 2020, compared with 45% in 2011.	See cell to the left which covers the same period.	The proportion of the total area of deciduous woodland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 51% in 2020, compared with 53% in 2019.
1.3 – Lowland calcareous grassland	The proportion of the total area of lowland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was below its 80% habitat-specific target in 2020 (79%).	The proportion of the total area of lowland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 79% in 2020, compared with 75% in 2011.	See cell to the left which covers the same period.	The proportion of the total area of lowland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 79% in 2020, compared with 87% in 2019.
1.4 – Upland calcareous grassland	The proportion of the total area of upland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was above its 80% habitat-specific target (82%).	The proportion of the total area of upland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 82% in 2020, compared with 84% in 2011.	See cell to the left which covers the same period.	The proportion of the total area of upland calcareous grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was 82% in 2020, compared with 90% in 2019.

1.5 – Lowland dry acid grassland	The proportion of the total area of lowland acid grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was 69%, below its 80% habitat-specific target.	The proportion of the total area of lowland acid grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was slightly higher in 2020 (69%) than in 2011 (68%).	See cell to the left which covers the same period.	The proportion of the total area of lowland acid grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (69%) than in 2019 (75%).
1.6 – Lowland meadows	The proportion of the total area of lowland meadows classified as being in a 'Favourable' or 'Unfavourable recovering' condition was well below its 80% habitat-specific target every year since 2011 (55% in 2020).	The proportion of the total area of lowland meadows classified as being in a 'Favourable' or 'Unfavourable recovering' condition was higher in 2020 (55%) than in 2011 (52%).	See cell to the left which covers the same period.	The proportion of the total area of lowland meadows classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (55%) than in 2019 (64%).
1.7 – Upland hay meadows	The proportion of the total area of upland hay meadow classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was 77%, below its 80% habitat-specific target.	The proportion of the total area of upland hay meadow classified as being in a 'Favourable' or 'Unfavourable recovering' condition was higher in 2020 (77%) than in 2011 (60%).	See cell to the left which covers the same period.	The proportion of the total area of upland hay meadow classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (77%) than in 2019 (87%).
1.8 – Purple moor-grass and rush pasture	The proportion of the total area of purple moor-grass and rush pasture classified as being in a 'Favourable' or 'Unfavourable recovering' condition was below its 80% habitat-specific target every year since 2011 (60% in 2020).	The proportion of the total area of purple moor-grass and rush pasture classified as being in a 'Favourable' or 'Unfavourable recovering' condition was higher in 2020 (60%) than in 2011 (52%).	See cell to the left which covers the same period.	The proportion of the total area of purple moor-grass and rush pasture classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (60%) than in 2019 (73%).
1.9 – Arable and horticulture	No target or commitment was found/exist.	Since 1983 the total utilised agricultural area in England has decreased from 9,624,000 hectares to 9,059,000 hectares in 2019. The area covered by horticultural crops has decreased from 207,000 hectares to 137,000.	Since 2011 the total utilised agricultural area in England has increased from 8,863,000 hectares to 9,059,000 hectares in 2019. The area covered by horticultural crops has, however, decreased from 152,000 hectares to 137,000 hectares.	Between 2018 and 2019 the changes in the total utilised agricultural area in England and in the area covered by horticultural crops were minor.

1.10 – Lowland heathland	Every year since 2011, the proportion of the total area of lowland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was above its 80% habitat-specific target but below its 90% all-habitats target (83% in 2020).	The proportion of the total area of lowland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (83%) than in 2011 (84%) by just under 2%.	See cell to the left which covers the same period.	The proportion of the total area of lowland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (83%) than in 2019 (84%).
1.11 – Mountain heath and willow scrub	The proportion of the total area of mountain heath and willow scrub classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was 71%, below its 80% habitat-specific target.	The proportion of the total area of mountain heath and willow scrub classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (71%) than in 2011 (94%).	See cell to the left which covers the same period.	The proportion of the total area of mountain heath and willow scrub classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (71%) than in 2019 (80%).
1.12 – Upland heathland	The proportion of the total area of upland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was 85%, above its 80% habitat-specific target	The proportion of the total area of upland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was higher in 2020 (85%) than in 2011 (80%).	See cell to the left which covers the same period.	The proportion of the total area of upland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (85%) than in 2019 (88%).
1.13 – Limestone pavement	The proportion of the total area of limestone pavement classified as being in a 'Favourable' or 'Unfavourable recovering' condition in 2020 was 82%, above its 80% habitat-specific target.	The proportion of the total area of upland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition was higher in 2020 (82%) than in 2011 (78%).	See cell to the left which covers the same period.	The proportion of the total area of limestone pavement classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (82%) than in 2019 (84%).
1.14 – Calaminarian grassland	No target or commitment was found/exist.	No data was found on this habitat.	No data was found on this habitat.	No data was found on this habitat.
1.15 – Traditional orchard	The proportion of the total area of traditional orchard classified as being in a 'Favourable' or 'Unfavourable recovering' condition was well below its 80% habitat-specific target every year since 2011 (11% in 2020).	The proportion of the total area of traditional orchard classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (11%) than in 2011 (14%).	See cell to the left which covers the same period.	The proportion of the total area of limestone pavement classified as being in a 'Favourable' or 'Unfavourable recovering' condition was lower in 2020 (11%) than in 2019 (18%).
1.16 – Nature reserves	No target or commitment was found/exist.	No data was found on this habitat.	No data was found on this habitat.	No data was found on this habitat.

1.17 – Areas of outstanding natural beauty	No target or commitment was found/exist.	No data was found on this habitat.	No data was found on this habitat.	No data was found on this habitat.
1.18 – Character areas	No target or commitment was found/exist.	No data was found on this habitat.	No data was found on this habitat.	No data was found on this habitat.
1.19 – Parks and gardens	No target or commitment was found/exist.	The total number of parks and gardens increased from around 1,600 in 2009 to around 1,670 in 2019.	The total number of parks and gardens increased from around 1,600 in 2011 to around 1,670 in 2019.	The change in the number of parks and gardens between 2018 and 2019 was minor.

Woodland

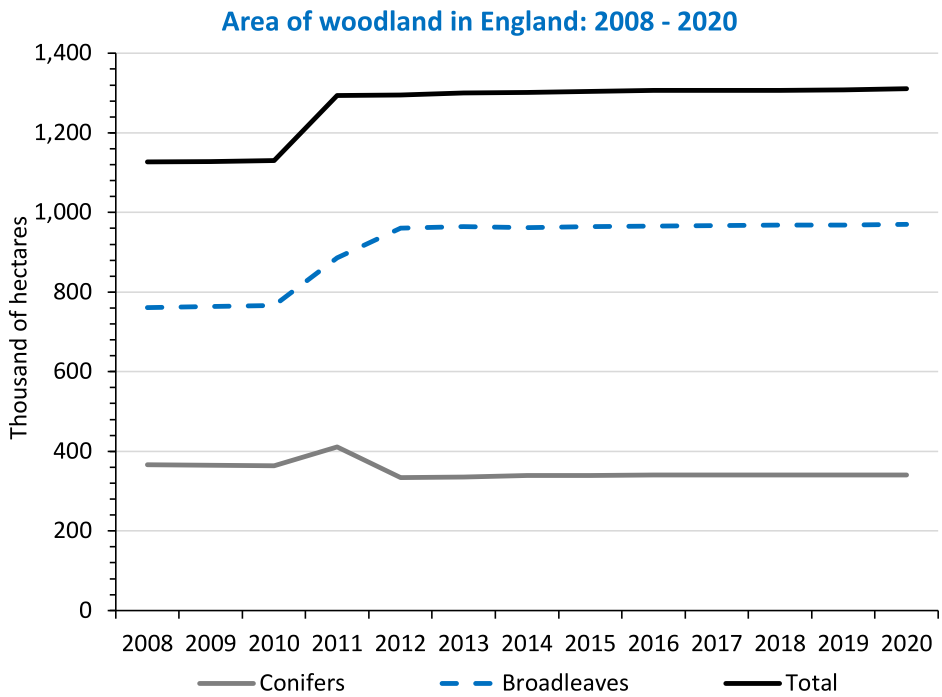
Broadleaved and coniferous woodland

The difference between broadleaved and coniferous woodland is that broadleaved woodland is characterised by trees that do not have needles.[15]

The total area of woodland in England, represented by the black line on Figure 3, has been fairly stable since 2008 apart from between 2010 and 2011. Between these two years, the coverage expanded from around 1.1 million hectares to around 1.3 million hectares. The increase in the total area of woodland was largely driven by an expansion in the coverage of broadleaved woodland, from around 760,000 hectares between 2008 and 2010 to around 900,000 hectares from 2012 onwards.

The area covered by coniferous woodland in England increased from around 360,000 hectares between 2008 and 2010 to 411,000 hectares in 2011, before dropping down to around 340,000 hectares for the rest of the period.

Figure 3: Area of woodland in England by type: 2008 - 2020



Source: Forestry Commission[16]

15 Woodland Trust, *Broadleaved woodland* https://www.woodlandtrust.org.uk/trees-woods-and-wildlife/habitats/broadleaved-woodland/

16 Forestry Commission, *Woodland Area, Planting and Restocking: 2008 – 2020 – based on various weblinks see 2018 source here:* https://data.gov.uk/dataset/c2cd1a34-743a-49e9-b953-77436d598627/woodland-area-planting-and-restocking-2018-edition

Deciduous woodland

Since 2011, the condition of England's deciduous woodland has varied. The proportion of deciduous woodland with its condition classed either as 'Favourable' or as 'Unfavourable recovering' was 45% in 2011 and 48% in 2012: see Table 7. This then plunged into the low twenties, before rising/stabilising at around 52% in 2017.

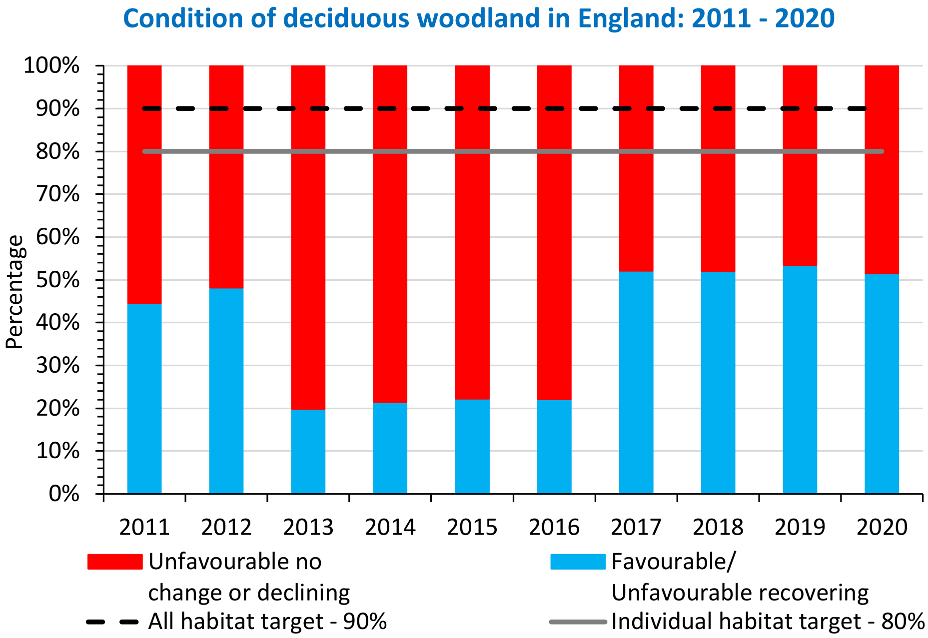
This proportion has been well below the 80% target every year for which there is data: see Figure 4.

Table 7: Condition of deciduous woodland in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Deciduous Woodland	2011	45%	55%
	2012	48%	52%
	2013	20%	80%
	2014	21%	79%
	2015	22%	78%
	2016	22%	78%
	2017	52%	48%
	2018	52%	48%
	2019	53%	47%
	2020	51%	49%

Source: Natural England estimates published by Defra – data only available for latest year[17]

Figure 4: Condition of deciduous woodland in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[18]

17 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

18 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The condition of the deciduous woodland designated as belonging to a SSSI has slightly improved, with 43% of its area classified as being in 'Favourable' condition in 2011, and 48% by 2020. See Table 8 for the trend since 2011.

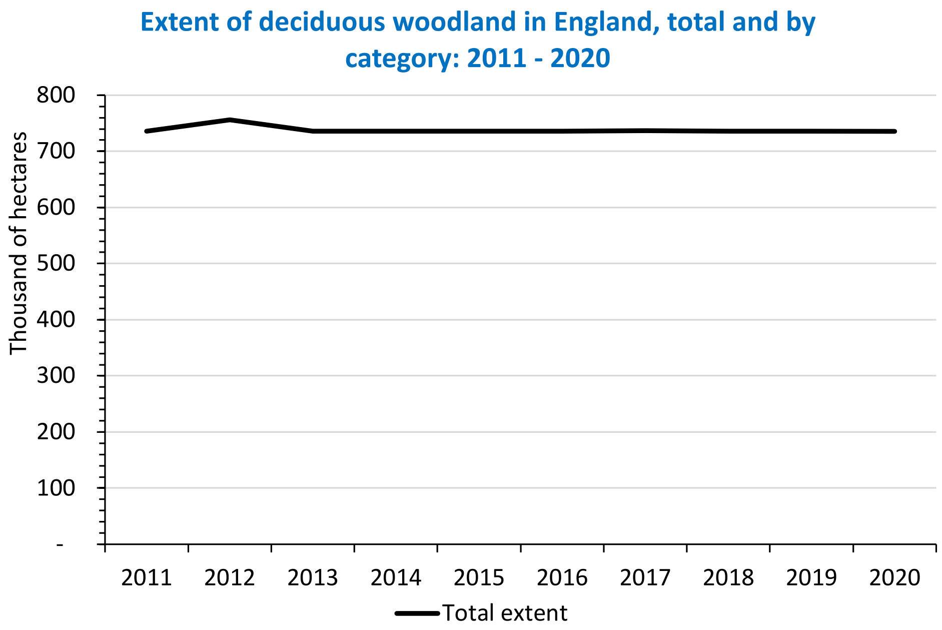
Table 8: Condition of deciduous woodland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Deciduous Woodland - SSSI	2011	43%	57%
	2012	44%	56%
	2013	44%	56%
	2014	45%	55%
	2015	45%	55%
	2016	46%	54%
	2017	46%	54%
	2018	47%	53%
	2019	47%	53%
	2020	48%	52%

Source: Natural England estimates published by Defra – data only available for latest year[19]

The total extent of deciduous woodland in England has been fairly constant since 2011 at around 740,000 hectares, apart from 2012 when it was slightly higher, at 760,000 hectares. See Figure 5 for the change in the extent of deciduous woodland since 2011.

Figure 5: Extent of deciduous woodland in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available fo latest year[20]

19 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

20 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Grassland

Lowland calcareous grassland

'Lowland calcareous grasslands are developed on shallow lime-rich soils generally overlying limestone rocks, including chalk. These grasslands are now largely found on distinct topographic features such as escarpments or dry valley slopes and sometimes on ancient earthworks in landscapes strongly influenced by the underlying limestone geology. The definition of calcareous grasslands covers a range of plant communities in which lime-loving plants are characteristic.' – UK Biodiversity Action Plan[21]

The condition of England's lowland calcareous grassland has fluctuated since 2011. Between 2011 and 2015, the proportion of grassland classified as being in a 'Favourable' or 'Unfavourable recovering' condition increased from 75% to 88%, before falling back to 79% by 2020: see Table 9. This proportion was above its 80% target for most of this period but fell short in 2011 and 2020: see Figure 6.

Table 9: Condition of lowland calcareous grassland in England, proportion of the total area receiving each classification: 2011 - 2020

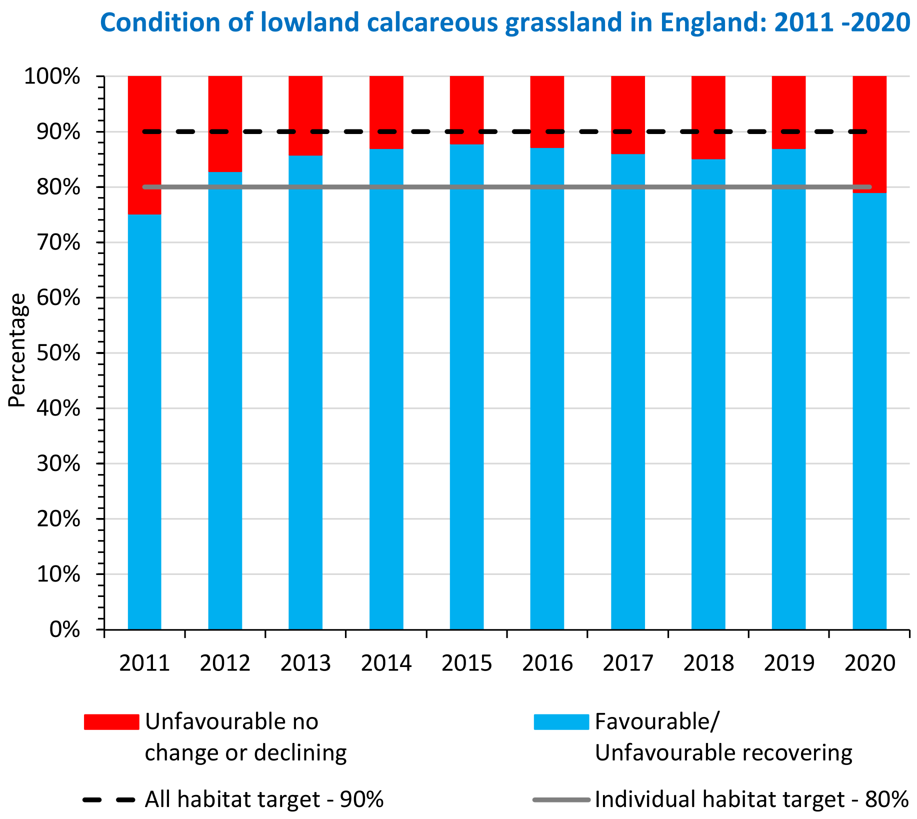
	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Lowland Calcareous Grassland	2011	75%	25%
	2012	83%	17%
	2013	86%	14%
	2014	87%	13%
	2015	88%	12%
	2016	87%	13%
	2017	86%	14%
	2018	85%	15%
	2019	87%	13%
	2020	79%	21%

Source: Natural England estimates published by Defra – data only available for latest year[22]

21 The National Archives, *UK Biodiversity Action Plan: Lowland calcerous grassland https://webarchive.nationalarchives.gov.uk/20110303150119/http://www.ukbap.org.uk/UKPlans.aspx?ID=12*

22 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 6: Condition of lowland calcareous grassland in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[23]

The condition of the lowland calcareous grassland designated as belonging to a SSSI has improved steadily since 2011. The proportion of this area classified as being in a 'Favourable' condition increased from 32% in 2011 to 47% in 2020. See Table 10 for historical trend.

Table 10: Condition of lowland calcareous grassland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change or declining/ recovering
Lowland Calcareous Grassland - (SSSI)	2011	32%	68%
	2012	32%	68%
	2013	33%	67%
	2014	33%	67%
	2015	33%	67%
	2016	46%	54%
	2017	45%	55%
	2018	47%	53%
	2019	47%	53%
	2020	47%	53%

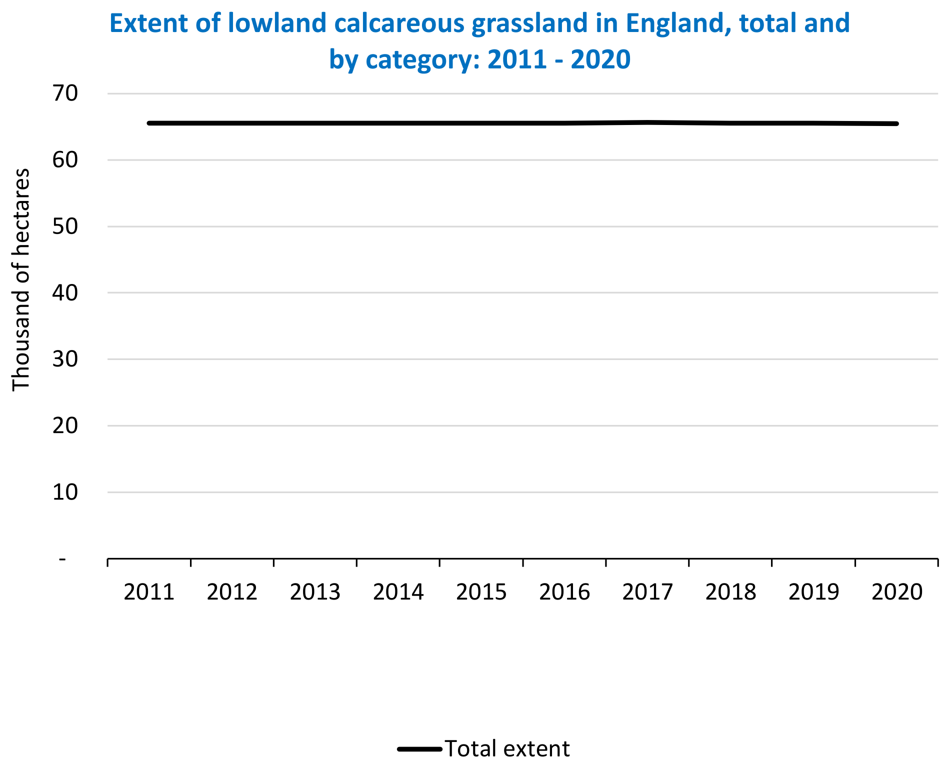
Source: Natural England estimates published by Defra – data only available for latest year[24]

23 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

24 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of lowland calcareous grassland in England has been fairly stable over the period at around 65,600 hectares. See Figure 7 of the change in the extent of lowland calcareous grassland since 2011.

Figure 7: Extent of lowland calcareous grassland in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[25]

Upland calcareous grassland

Upland calcareous grasslands occur on lime-rich soils situated above the upper limit of the agricultural enclosure, both in the sub-montane and montane zones. Most examples occur above 250-300m altitude, but the habitat is also found within unenclosed moorland at lower elevations and descends to sea level in north-west Scotland. Upland calcareous grasslands typically occur as components of habitat mosaics, which are generally managed as rough grazing land for domestic livestock. These are relatively rare upland vegetation types which support a wide range of uncommon species.' – UK Biodiversity Action Plan.[26]

Since 2011, the condition of upland calcareous grassland has followed a similar pattern to the condition of lowland calcareous grassland in England. Between 2011 and 2015, the proportion of the coverage classed as in a 'Favourable' or 'Unfavourable recovering' condition rose from 84% in 2011 to 92% in 2015, before falling back to 82% by 2020: see Table 11.

Unlike the equivalent proportion for lowland calcareous grassland, this percentage exceeded its 80% target every year over this period. However, it was below the 90% target for half the period: see Figure 8.

25 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

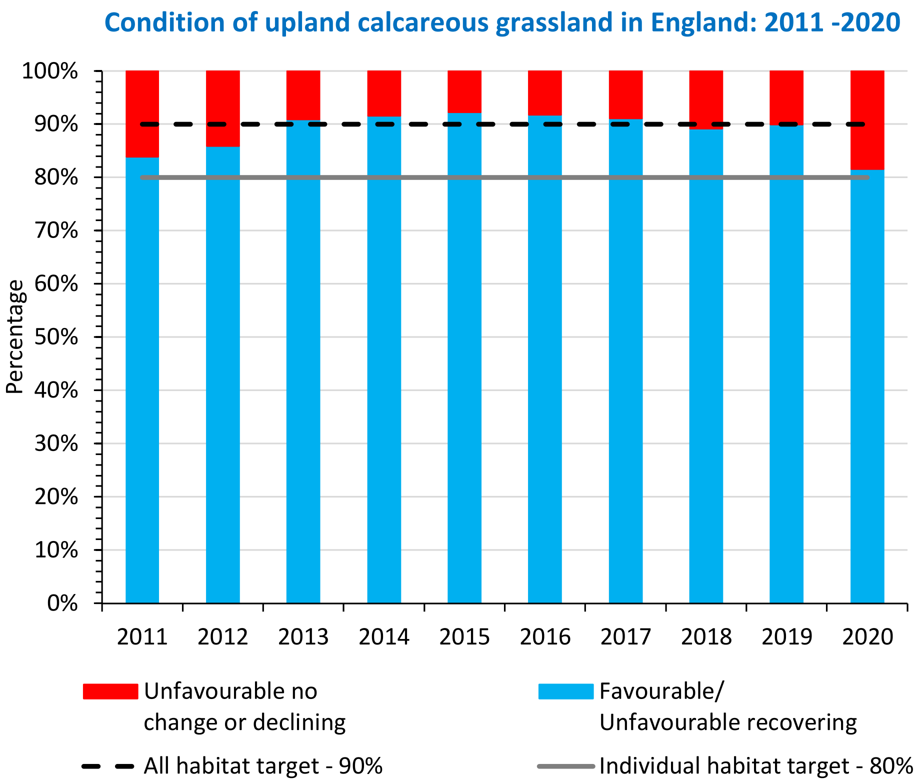
26 The National Archives, *UK Biodiversity Action Plan: Lowland calcerous grassland https://webarchive.nationalarchives.gov.uk/20110303150119/http://www.ukbap.org.uk/UKPlans.aspx?ID=12*

Table 11: Condition of upland calcareous grassland in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Upland Calcareous Grassland	2011	84%	16%
	2012	86%	14%
	2013	91%	9%
	2014	92%	8%
	2015	92%	8%
	2016	92%	8%
	2017	91%	9%
	2018	89%	11%
	2019	90%	10%
	2020	82%	18%

Source: Natural England estimates published by Defra – data only available for latest year[27]

Figure 8: Condition of upland calcareous grassland in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[28]

27 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

28 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The upland calcareous grassland designated as belonging to a SSSI is in a poor condition, though it has improved slightly since 2020. The proportion of this land classified as being in a 'Favourable' condition has increased from 22% in 2011 to 28% in 2020: see Table 12.

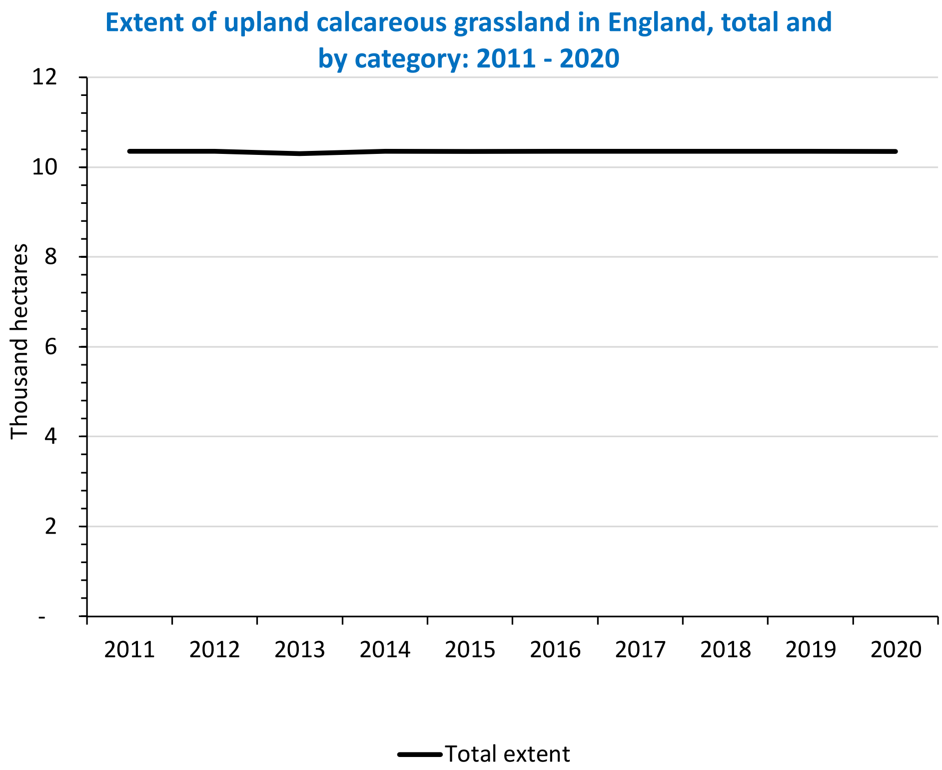
Table 12: Condition of upland calcareous grassland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Upland Calcareous Grassland - SSSI	2011	22%	78%
	2012	21%	79%
	2013	23%	77%
	2014	27%	73%
	2015	28%	72%
	2016	27%	73%
	2017	28%	72%
	2018	28%	72%
	2019	28%	72%
	2020	28%	72%

Source: Natural England estimates published by Defra – data only available for latest year[29]

The extent of upland calcareous grassland has been fairly stable at around 10,400 hectares: see Figure 9.

Figure 9: Extent of upland calcareous grassland in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[30]

29 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

30 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Lowland dry acid grassland

'Lowland acid grassland typically occurs on nutrient-poor, generally free-draining soils with pH ranging from 4 to 5.5 overlying acid rocks or superficial deposits such as sands and gravels.'[31]

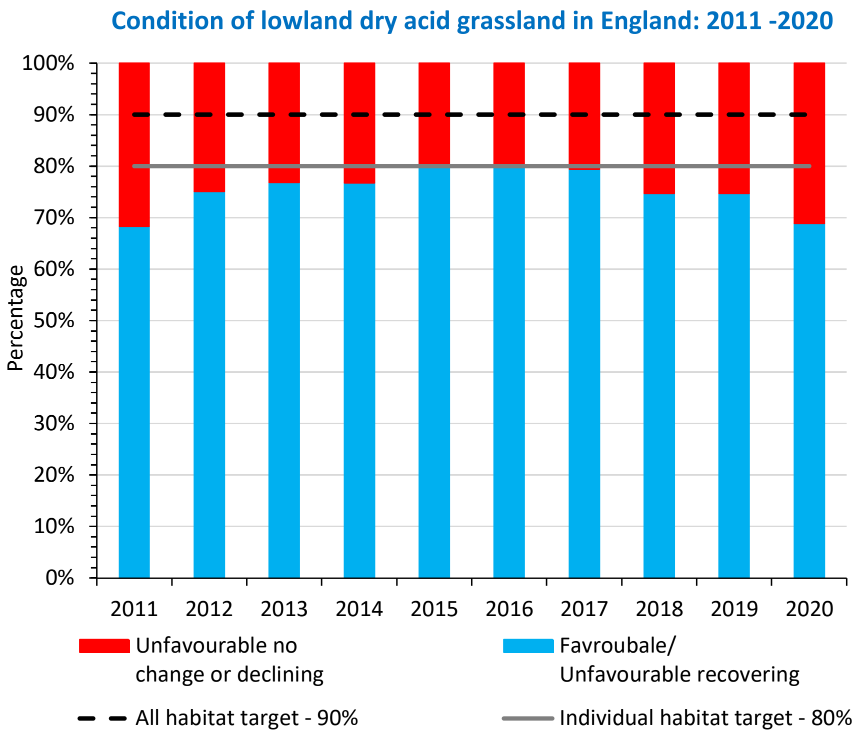
Since 2011, the condition of lowland dry acid grassland in England has followed a similar pattern to the condition of calcareous grassland, though from a lower base. The proportion of this type of grassland classed as being in a 'Favourable' or 'Unfavourable recovering' condition increased from 68% in 2011 to 81% in 2015, before falling to 69% in 2020: see Table 13. The 90% target has not been met and for the bulk of the period it was below its 80% target: see Figure 10.

Table 13: Condition of lowland dry acid grassland in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Lowland Dry Acid Grassland	2011	68%	32%
	2012	75%	25%
	2013	77%	23%
	2014	77%	23%
	2015	81%	19%
	2016	80%	20%
	2017	79%	21%
	2018	75%	25%
	2019	75%	25%
	2020	69%	31%

Source: Natural England estimates published by Defra – data only available for latest year[32]

Figure 10: Condition of lowland dry acid grassland in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available forlatest year[33]

31 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat* Descriptions (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

32 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

33 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The condition of the lowland dry acid grassland designated as belonging to a SSSI has been fairly stable since 2011. The proportion classified as 'Favourable' has stayed around 38%: see Table 14.

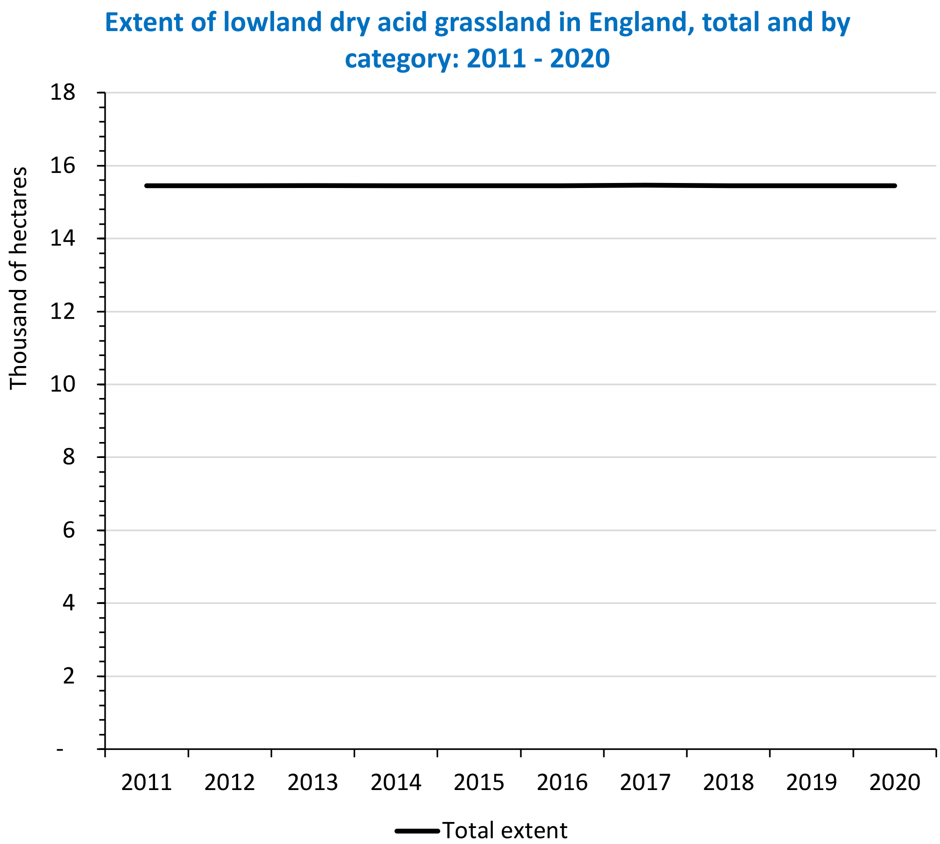
Table 14: Condition of lowland dry acid grassland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Lowland Dry Acid Grassland - SSSI	2011	38%	62%
	2012	38%	62%
	2013	40%	60%
	2014	37%	63%
	2015	37%	63%
	2016	37%	63%
	2017	38%	62%
	2018	38%	62%
	2019	38%	62%
	2020	38%	62%

Source: Natural England estimates published by Defra – data only available for latest year[34]

The extent of lowland dry acid grassland in England has been fairly stable since 2011 at around 15,500 hectares: see Figure 11.

Figure 11: Extent of lowland dry acid grassland in England: 2011 - 2020



Source: Natural England estimates – data is only published for the latest year

34 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Neutral grassland

Three types of neutral grassland are assessed in this sub-section: lowland meadows, upland hay meadows, and purple moor-grass and rush pasture.

Lowland meadows

The Biodiversity Action Plan uses a wide definition, taking lowland meadows to include 'most forms of unimproved neutral grassland across the enclosed lowland landscapes of the UK.'[35]

Since 2011 in England, the condition of lowland meadows has followed a similar pattern to the condition of calcareous grassland and lowland dry acid grassland, though from a lower base. From 2011 to 2015, the proportion of lowland meadow rated as being in a 'Favourable' condition rose from 52% to 71%, before falling to 55%: see Table 15. The 90% target has not been met and for the bulk of the period it was below its 80% target: see Figure 12.

Table 15: Condition of lowland meadows in England, proportion of the total area receiving each classification: 2011 - 2020

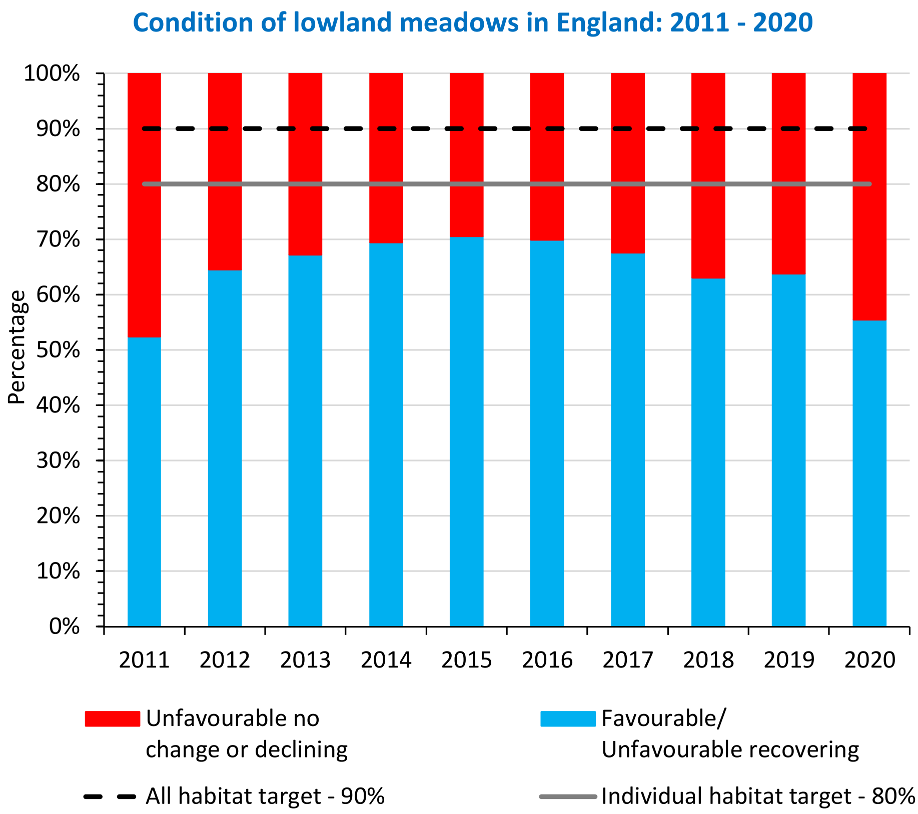
	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Lowland Meadows	2011	52%	48%
	2012	65%	35%
	2013	67%	33%
	2014	69%	31%
	2015	71%	29%
	2016	70%	30%
	2017	68%	32%
	2018	63%	37%
	2019	64%	36%
	2020	55%	45%

Source: Natural England estimates published by Defra – data only available for latest year[36]

35 UK Biodiveristy Action Plan, UK Biodiversity Action Plan Priority Habitat Descriptions (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

36 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 12: Condition of lowland meadows in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[37]

Of the lowland meadow designated as belonging to a SSSI, the proportion rated as being in a 'Favourable' condition has fluctuated around 45% since 2011: see Table 16.

Table 16: Condition of lowland meadow in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Lowland Meadows - SSSI	2011	43%	57%
	2012	46%	54%
	2013	45%	55%
	2014	46%	54%
	2015	46%	54%
	2016	47%	53%
	2017	47%	53%
	2018	44%	56%
	2019	45%	55%
	2020	45%	55%

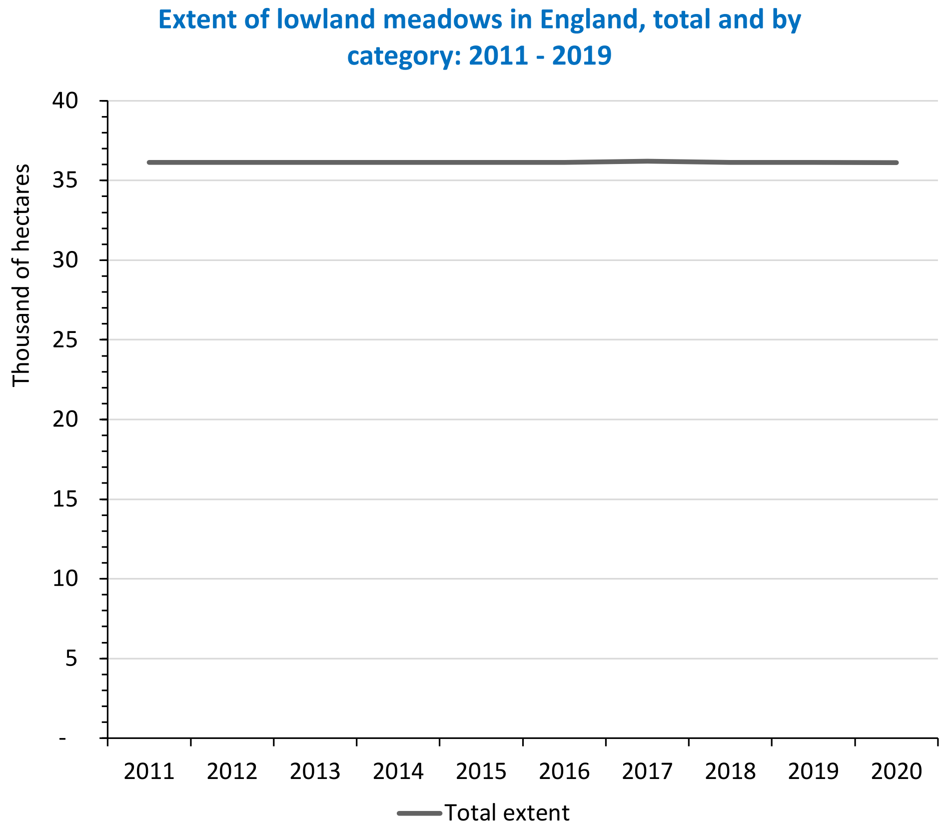
Source: Natural England estimates published by Defra – data only available for latest year[38]

37 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

38 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of the lowland meadows in England has been fairly stable since 2011 at around 36,100 hectares: see Figure 13.

Figure 13: Extent of lowland meadows in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[39]

Upland hay meadows

This habitat comprises *Anthoxanthum odoratum - Geranium sylvaticum grassland and 'is characterised by a dense growth of grasses and herbaceous dicotyledons up to 60 - 80 cm high.' – Biodiversity Action Plan*[40]

The condition of upland hay meadows in England has followed the same inverted-U pattern as the other grassland habitats, though in a more pronounced way. Between 2011 and 2015, the proportion of this habitat classified as being in a 'Favourable' or 'Unfavourable recovering' condition rose from 60% to 93%, before falling to 77% by 2020: see Table 17.

This habitat was above the 90% all-habitat target for the bulk of the period (2011-2020) but is now below even the 80% individual-habitat target: see Figure 14.

39 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

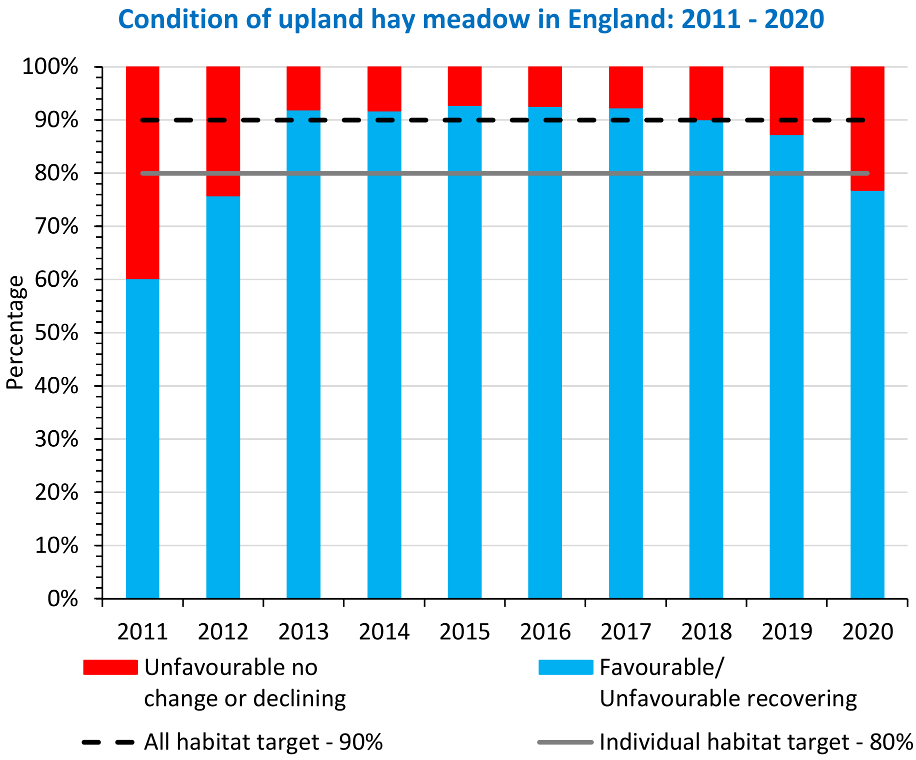
40 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

Table 17: Condition of upland hay meadows in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Upland Hay Meadow	2011	60%	40%
	2012	76%	24%
	2013	92%	8%
	2014	92%	8%
	2015	93%	7%
	2016	93%	7%
	2017	92%	8%
	2018	90%	10%
	2019	87%	13%
	2020	77%	23%

Source: Natural England estimates published by Defra – data only available for latest year[41]

Figure 14: Condition of upland hay meadow in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[42]

41 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

42 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Of the upland hay meadows designated as belonging to a SSSI, the proportion classed as being in a 'Favourable' condition has been fairly stable since 2011, fluctuating around 56%: see Table 18.

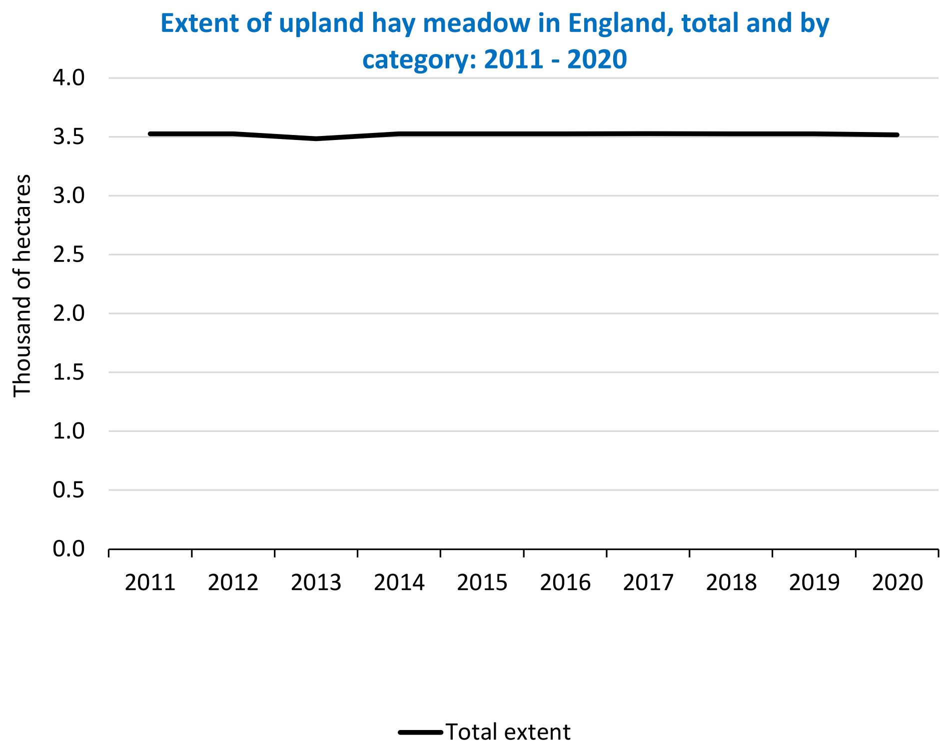
Table 18: Condition of upland hay meadows in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Upland Hay Meadow - SSSI	2011	55%	45%
	2012	57%	43%
	2013	55%	45%
	2014	55%	45%
	2015	55%	45%
	2016	57%	43%
	2017	56%	44%
	2018	56%	44%
	2019	56%	44%
	2020	56%	44%

Source: Natural England estimates published by Defra – data only available for latest year[43]

The extent of upland hay meadows in England has been stable over this period at around 3,500 hectares: see Figure 15.

Figure 15: Extent of upland hay meadow in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[44]

43 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

44 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Purple moor-grass and rush pasture

'Purple moor grass and rush pastures occur on poorly drained, usually acidic soils in lowland areas of high rainfall in western Europe.' – Biodiversity Action Plan[45]

This habitat is found in south-west England, particularly in Devon.[46]

The condition of purple moor-grass in England has followed a similar inverted-U pattern to other grassland habitats, from a low base: see Figure 16. The proportion of the purple moor-grass and rush pasture in England classified as being in a 'Favourable' or 'Unfavourable recovering' condition increased from 52% in 2011 to 76% in 2015, before trending down to 60% in 2020: see Table 19.

Unlike for many other grassland habitats, this proportion did not descend back to its starting value, finishing the period significantly higher (60%) than it was in 2011 (52%). Unlike for other grassland habitats, the recent downward trend of this proportion was interrupted by an upward blip between 2018 and 2019 from 69% to 73%.

Table 19: Condition of purple moor-grass and rush pastures in England, proportion of the total area receiving each classification: 2011 - 2020

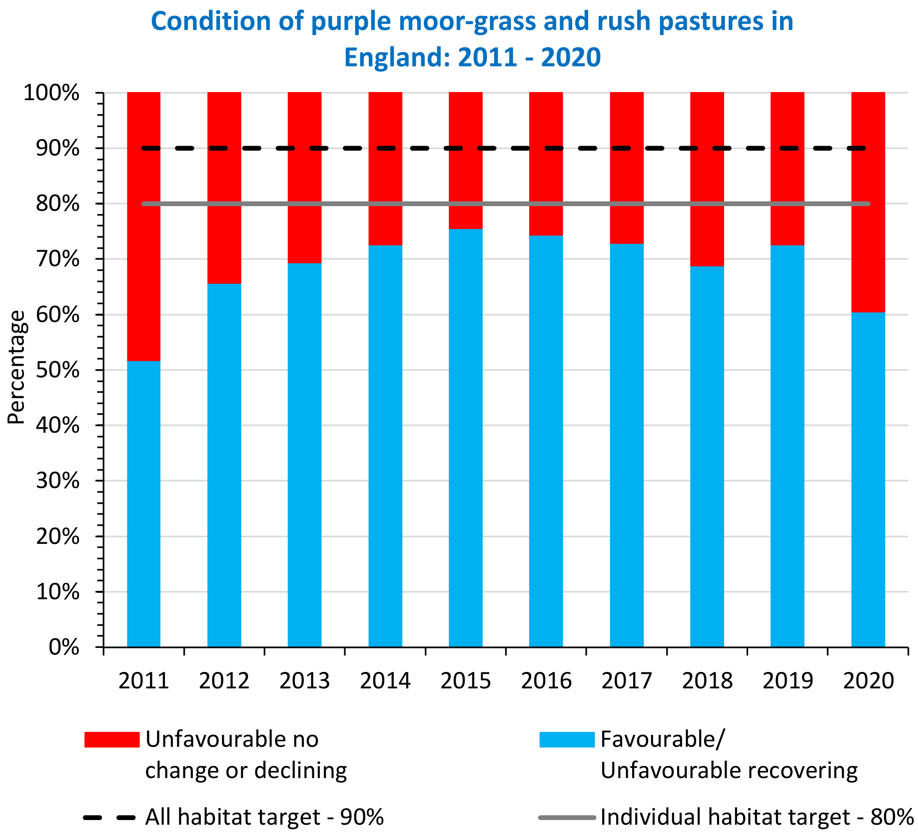
	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Purple Moor-grass and Rush Pastures	2011	52%	48%
	2012	66%	34%
	2013	69%	31%
	2014	73%	27%
	2015	76%	24%
	2016	74%	26%
	2017	73%	27%
	2018	69%	31%
	2019	73%	27%
	2020	60%	40%

Source: Natural England estimates – data is only published for the latest year

45 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

46 Ibid

Figure 16: Condition of purple moor-grass and rush pastures in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[47]

Of the purple moor-grass and rush pasture designated as belonging to a SSSI, the proportion classified as being in a 'Favourable' condition decreased from 45% in 2011 to 38% in 2013, before stabilising at 40% from 2015 onwards: see Table 20.

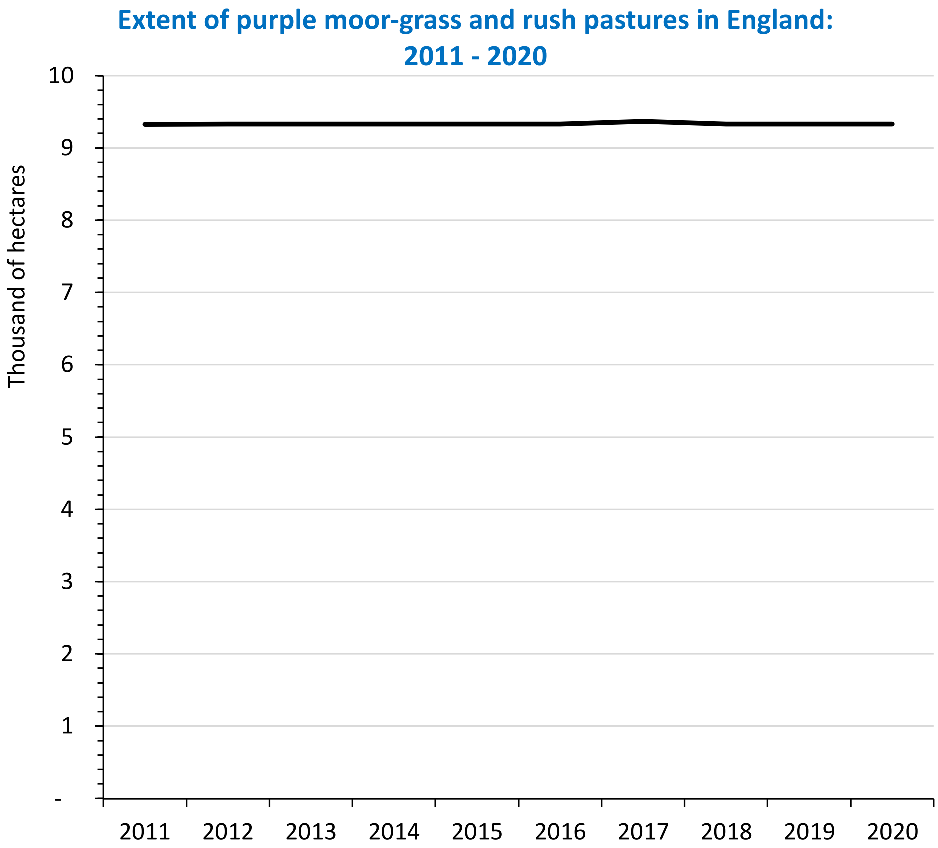
Table 20: Condition of purple moor-grass and rush pasture in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Purple Moor- grass and Rush Pastures - SSSI	2011	45%	55%
	2012	40%	60%
	2013	38%	62%
	2014	39%	61%
	2015	40%	60%
	2016	40%	60%
	2017	40%	60%
	2018	40%	60%
	2019	40%	60%
	2020	40%	60%

47 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of purple moor-grass and rush pastures in England has been stable since 2011 at around 9,330 hectares: see Figure 17.

Figure 17: Extent of purple moor-grass and rush pastures in England: 2011 - 2020



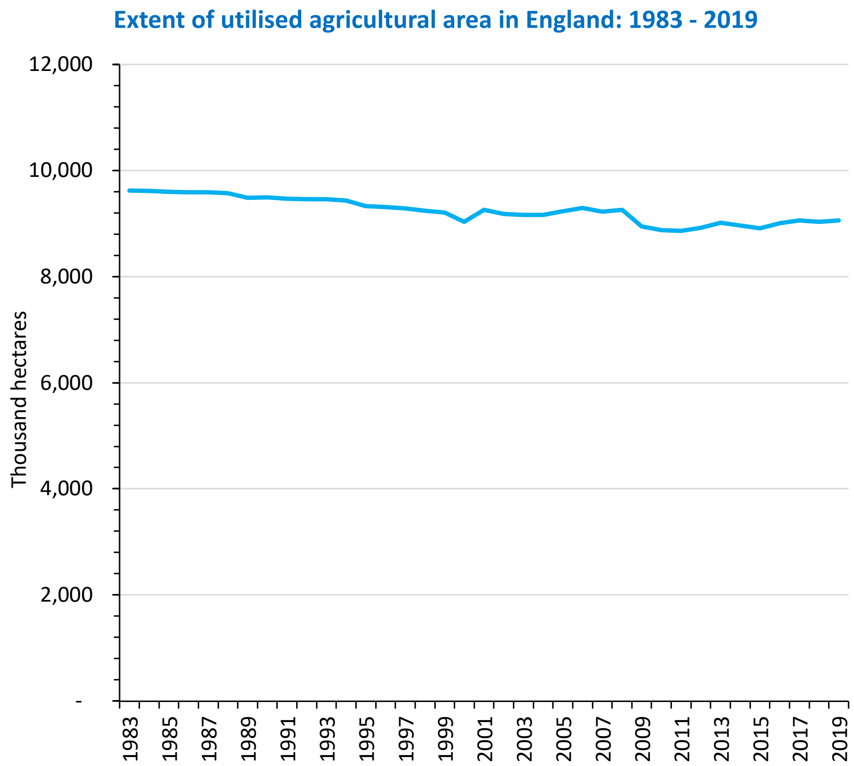
Source: Natural England estimates published by Defra – data only available for latest year[48]

Arable and horticulture

Figure 18 shows how the total area of agricultural land in England has changed since 1983. From 1983, it has decreased from 9,624,000 hectares to 8,874,000 hectares in 2010. Since 2010, it has been stable at around 9 million hectares.

48 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

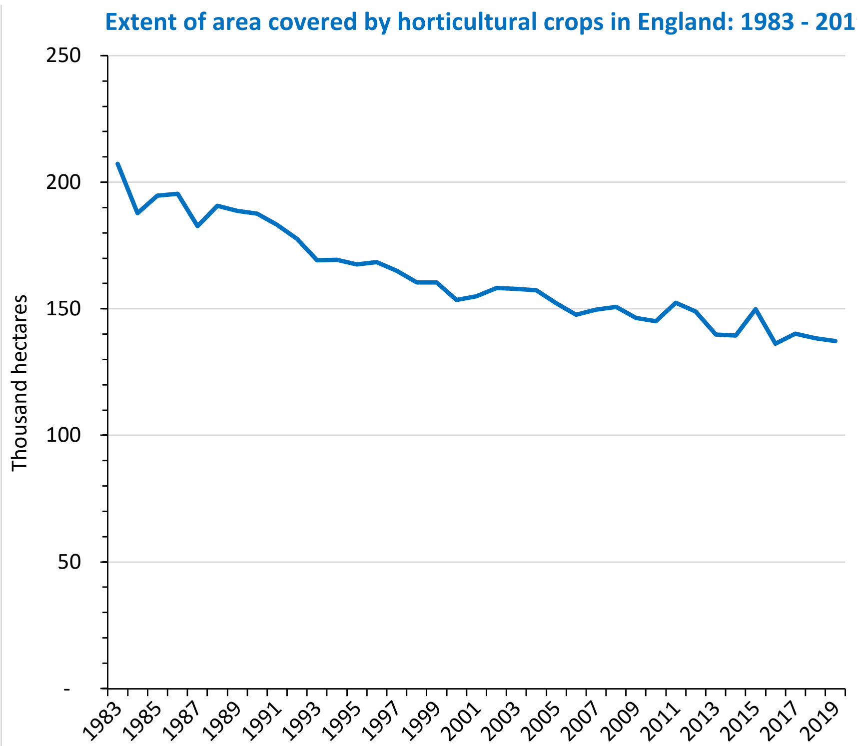
Figure 18: Utilised agricultural area in England: 1983 - 2019. Includes cropped area, uncropped arable land, common rough grazing, temporary and permanent grassland and land used for outdoor pigs (excludes woodland and other land).



Source: Defra[49]

The area covered by horticultural crops is far smaller: 137,000 hectares in 2019. Since 1983, this area has shrunk consistently from a starting value of 207,000 hectares: see Figure 19.

Figure 19: Extent of area covered by horticultural crops in England: 1983 - 2019



Source: Defra[50]

49 Defra, *Structure of the agricultural industry in England and the UK at June (2020)* https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

50 Defra, *Structure of the agricultural industry in England and the UK at June* https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

Arable field margins

'Arable field margins are herbaceous strips or blocks around arable fields that are managed specifically to provide benefits for wildlife.'[51] Though arable field margins are a priority habitat, no data has been found on their condition or extent.

Heathland

Three types of heathland are assessed in this sub-section: lowland heathland, mountain heath and willow scrub, and upland heathland.

Lowland heathland

Lowland heathland is 'a broadly open landscape on impoverished, acidic mineral and shallow peat soil, which is characterised by the presence of plants such as heathers and dwarf gorses. It is generally found below 300 metres in altitude in the UK, but in more northerly latitudes the altitudinal limit is often lower.'[52]

The condition of lowland heathland in England has been relatively stable since 2011. The percentage of the lowland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition has stayed in the mid-eighties: see Table 21. In 2020, this proportion was 83%.

Every year since 2011, this percentage of the lowland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition has been above the 80% habitat-specific target but below the 90% all-habitats target: see Figure 20.

Table 21: Condition of lowland heathland in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Lowland Heathland	2011	84%	16%
	2012	86%	14%
	2013	87%	13%
	2014	87%	13%
	2015	87%	13%
	2016	87%	13%
	2017	86%	14%
	2018	84%	16%
	2019	84%	16%
	2020	83%	17%

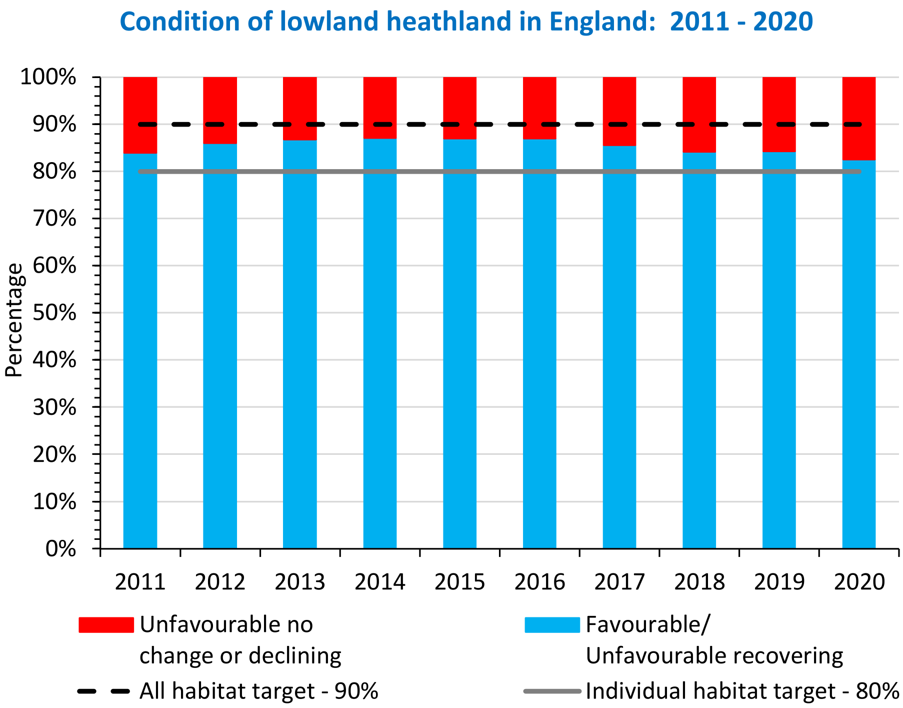
Source: Natural England estimates published by Defra – data only available for latest year[53]

51 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

52 UK Biodiversity Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

53 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 20: Condition of lowland heathland in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[54]

The condition of the lowland heathland that has been designated as belonging to a SSSI has improved steadily since 2011. The proportion of this area classified as being in a 'Favourable' condition has increased from 28% in 2011 to 47% in 2020: see Table 22.

Table 22: Condition of lowland heathland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

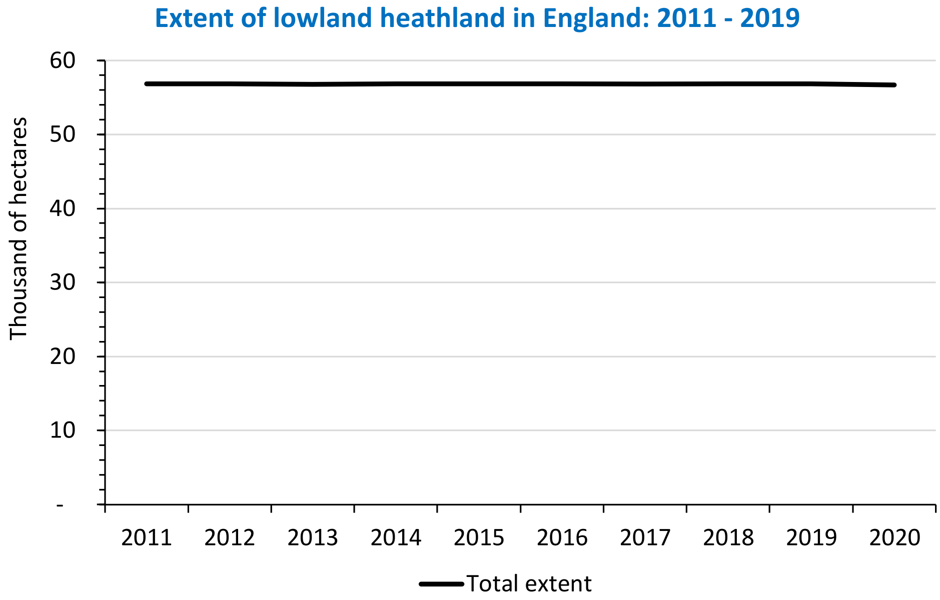
	Year	Favourable	Unfavourable, no change, or declining/recovering
Lowland Heathland - (SSSI)	2011	28%	72%
	2012	34%	66%
	2013	38%	62%
	2014	39%	61%
	2015	40%	60%
	2016	41%	59%
	2017	45%	55%
	2018	46%	54%
	2019	46%	54%
	2020	47%	53%

Source: Natural England estimates – data is only published for the latest year

54 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of lowland heathland in England has been fairly stable since 2011 at just below 57,000 hectares: see Figure 21.

Figure 21: Extent of lowland heathland in England: 2011 - 2020



Source: Natural England estimates – data is only published for the latest year

Mountain heath and willow scrub

'This habitat encompasses a range of natural or near-natural vegetation occurring in the montane zone, lying above or beyond the natural tree-line. It includes dwarf-shrub heaths, grass-heaths, dwarfherb communities, willow scrub, and snowbed communities.' [55]

The condition of mountain heaths and willow scrubs in England was good and rising until 2018 when it began to fall sharply. The proportion of this habitat classified as being in a 'Favourable' or 'Unfavourable recovering' condition grew from 94% in 2011 to 99% in 2018, before falling sharply to 71% by 2020: see Table 23.

Having been comfortably above both the 80% habitat-specific target and the 90% all-habitats target, in 2020 this percentage fell short of both targets: see Figure 22.

Table 23: Condition of mountain heaths and willow scrubs in England, proportion of the total area receiving each classification: 2011 - 2020

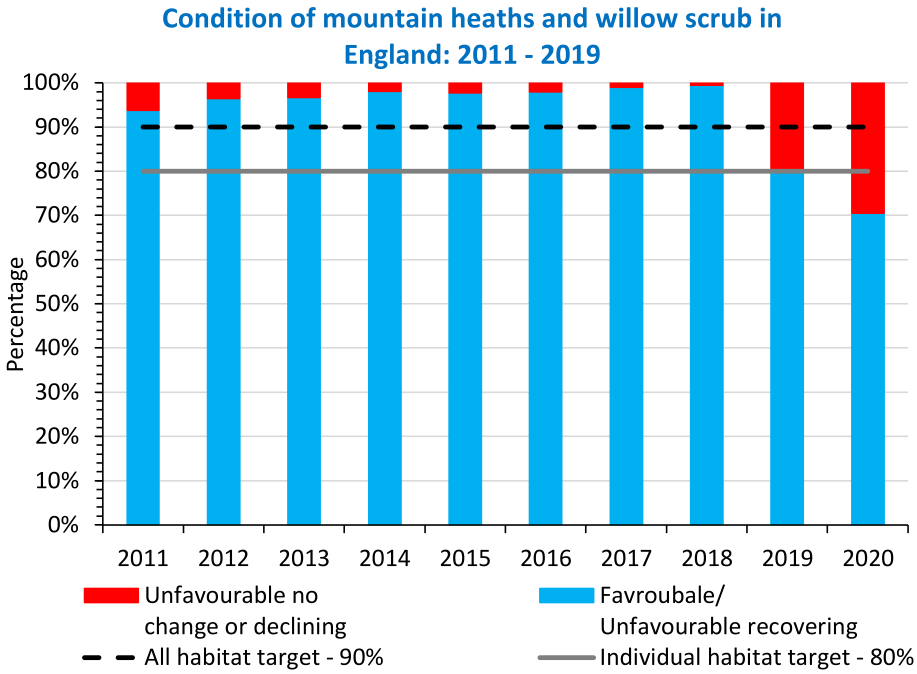
	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Mountain Heaths and Willow Scrub	2011	94%	6%
	2012	96%	4%
	2013	97%	3%
	2014	98%	2%
	2015	98%	2%
	2016	98%	2%
	2017	99%	1%
	2018	99%	1%
	2019	80%	20%
	2020	71%	29%

Source: Natural England estimates published by Defra – data only available for latest year[56]

55 UK Biodiversity *Action Plan, UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

56 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 22: Condition of mountain heaths and willow scrubs in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[57]

Of the mountain heaths and willow scrub designated as belonging to a SSSI, very little is in a 'Favourable' condition: see Table 24. Of 5,151 hectares, less than 2 were classified as being in a 'Favourable' condition every year apart from 2016. In 2016, 56 hectares were classified as being in a 'Favourable condition'.

Table 24: Condition of mountain heaths and willow scrub in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Mountain Heaths and Willow Scrub - SSSI	2011	0%	100%
	2012	0%	100%
	2013	0%	100%
	2014	0%	100%
	2015	0%	100%
	2016	1%	99%
	2017	0%	100%
	2018	0%	100%
	2019	0%	100%
	2020	0%	100%

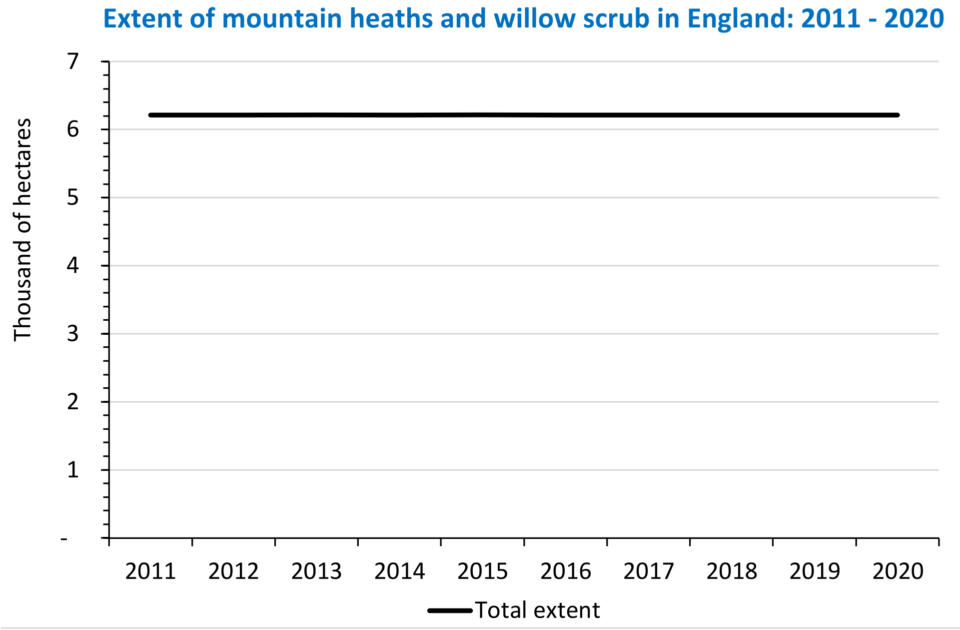
Source: Natural England estimates published by Defra – data only available for latest year[58]

57 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

58 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of mountain heaths and willow scrub in England has been 6,216 hectares every year since 2011, apart from 2013 when it was 6,215 hectares: see Figure 23.

Figure 23: Extent of mountain heaths and willow scrub in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[59]

Upland heathland

'Heathland vegetation is characterised by the presence of dwarf shrubs at a cover of at least 25%. Blanket bog vegetation may also contain substantial amounts of dwarf shrubs, but is distinguished from heathland by its occurrence on deep peat (>0.5m).' [60]

Upland heathland 'is defined as lying below the alpine or montane zone (at about 600-750m) and usually above the upper edge of enclosed agricultural land (generally at around 250-400m, but descending to near sea-level in northern Scotland).'[61]

Like the condition of the grassland habitats, the condition of upland heathland in England increased between 2011 and 2015 but has since decreased. The proportion of upland heathland classified as being in a 'Favourable' or 'Unfavourable recovering' condition rose from 80% in 2011 to 91% in 2015, before decreasing to 85% in 2020: see Table 25.

This proportion has been above the habitat-specific 80% target every year since 2011 but only above the 90% all-habitats target in 2015 and 2016: see Figure 24.

59 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

60 UK Biodiversity Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

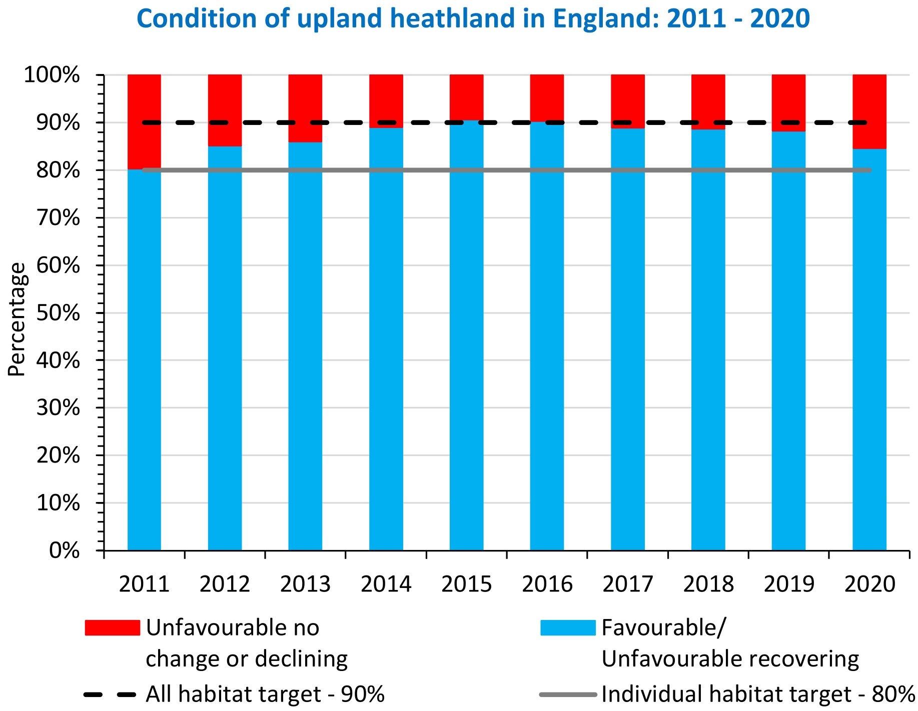
61 Ibid

Table 25: Condition of upland heathland in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Upland Heathland	2011	80%	20%
	2012	85%	15%
	2013	86%	14%
	2014	89%	11%
	2015	91%	9%
	2016	90%	10%
	2017	89%	11%
	2018	89%	11%
	2019	88%	12%
	2020	85%	15%

Source: Natural England estimates published by Defra – data only available for latest year[62]

Figure 24: Condition of upland heathland in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates – data is only published for the latest year

62 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Of the upland heathland designated as belonging to a SSSI, the proportion designated as being in a 'Favourable' condition has been very low since 2011, around 13%: see Table 26.

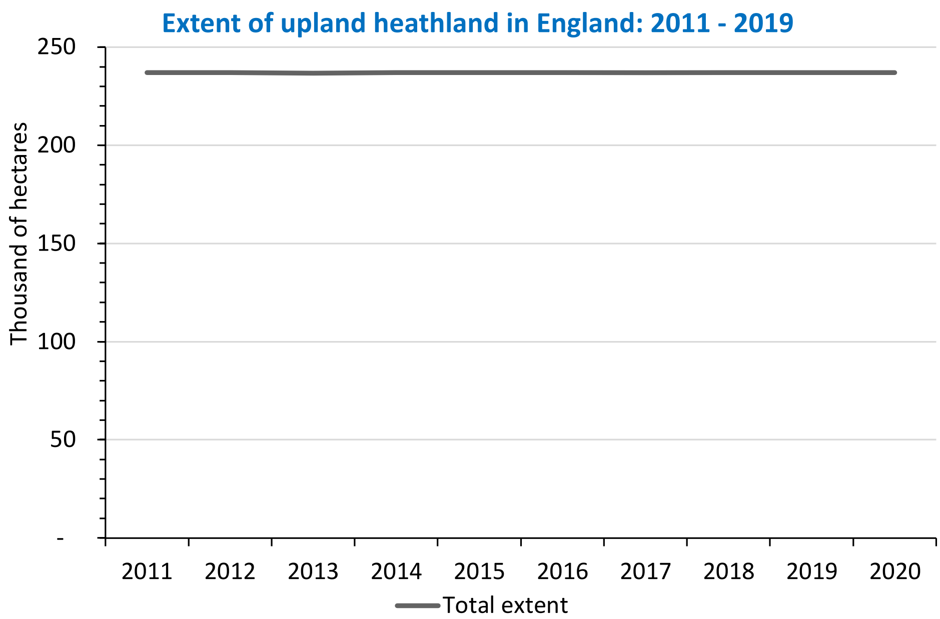
Table 26: Condition of upland heathland in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Upland Heathland - SSSI	2011	13%	87%
	2012	13%	87%
	2013	13%	87%
	2014	12%	88%
	2015	12%	88%
	2016	13%	87%
	2017	13%	87%
	2018	13%	87%
	2019	13%	87%
	2020	14%	86%

Source: Natural England estimates published by Defra – data only available for latest year[63]

The extent of upland heathland in England has been fairly stable since 2011 at around 237,000 hectares: see Figure 25.

Figure 25: Extent of upland heathland in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[64]

63 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

64 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Inland rock

Two types of inland rock are included in this sub-section: limestone pavements and calaminarian grasslands.

Limestone pavements

'A limestone pavement is a flat expanse of exposed limestone formed by a combination of chemical weathering and erosion.'[65] Since the formation of the pavements, water action has widened their cracks to form complex patterns of crevices known as 'grikes' between large blocks of worn limestone, known as 'clints'. These unusual features make limestone pavements an important habitat for certain plants and other species.[66]

Like the condition of the grassland habitats, the condition of England's limestone pavements exhibited an inverted-U pattern, peaking in 2015. The proportion of the total area of limestone pavement classified as being in a 'Favourable' or 'Unfavourable recovering' condition rose from 78% in 2011 to 86% in 2015, before decreasing to 82% in 2020: see Table 27.

Since 2012, this proportion has been above its 80% habitat-specific target but below the 90% all-habitats target: see Figure 26.

Table 27: Condition of limestone pavements in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Limestone Pavement	2011	78%	22%
	2012	83%	17%
	2013	84%	16%
	2014	86%	14%
	2015	86%	14%
	2016	84%	16%
	2017	84%	16%
	2018	83%	17%
	2019	84%	16%
	2020	82%	18%

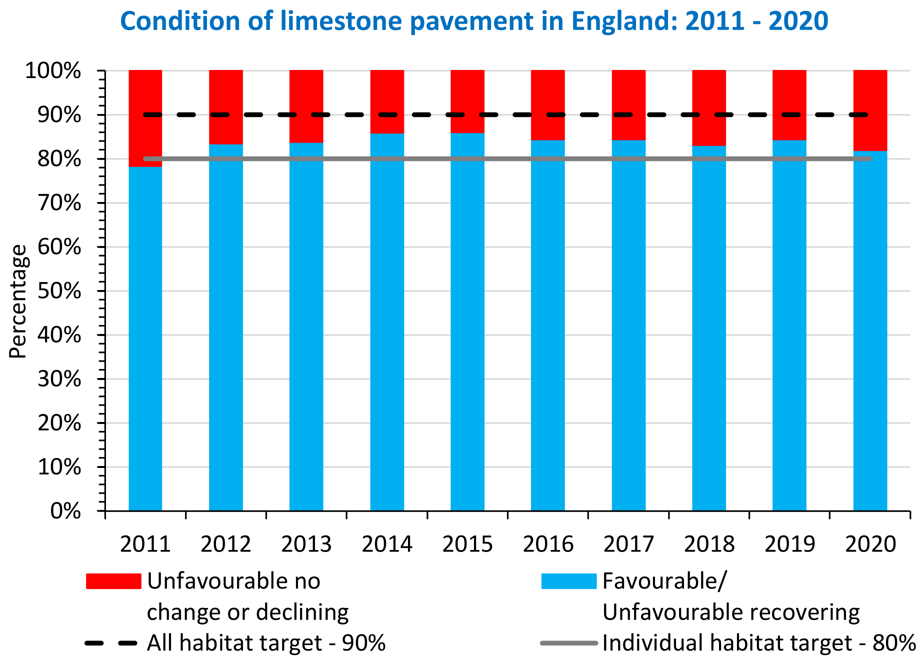
Source: Natural England estimates published by Defra – data only available for latest year[67]

65 British Geological Survey, *Limestone pavement* https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/limestoneLandscapes/limestoneTopography/LimestonePavement.html

66 UK Biodiversity *Action Plan, UK Biodiversity Action Plan Priority Habitat Descriptions* (2011) http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

67 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 26: Condition of limestone pavements in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[68]

Of the limestone pavement designated as belonging to a SSSI in England, the proportion classified as being in a 'Favourable' condition has been low, around 23% since 2011, and 24% since 2016: see Table 28.

Table 28: Condition of limestone pavements in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Limestone Pavement - SSSI	2011	23%	77%
	2012	22%	78%
	2013	22%	78%
	2014	22%	78%
	2015	23%	77%
	2016	24%	76%
	2017	24%	76%
	2018	24%	76%
	2019	24%	76%
	2020	24%	76%

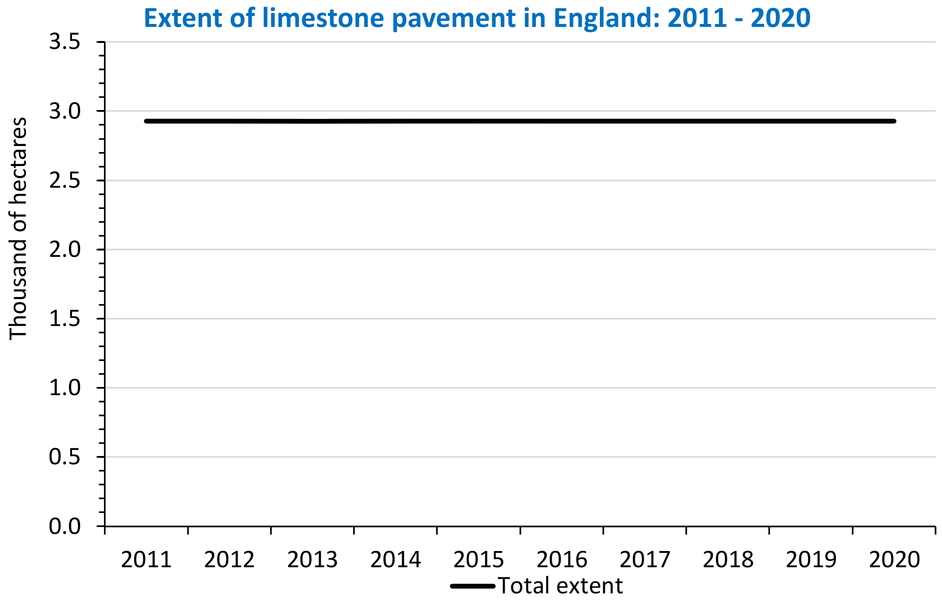
Source: Natural England estimates published by Defra – data only available for latest year[69]

68 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

69 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of the limestone pavements in England has been 2,928 hectares every year since 2011, apart from 2013 when it was 2,927 hectares: see Figure 27.

Figure 27: Extent of limestone pavements in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[70]

Calaminarian grasslands

'Calaminarian grasslands include a range of semi-natural and anthropogenic sparsely vegetated habitats on substrates characterised by high levels of heavy metals such as lead, chromium and copper, or other unusual minerals.' [71] No data has been found on the condition or extent of this habitat.

Traditional orchards

'Traditional orchards are structurally and ecologically similar to wood-pasture and parkland, with open-grown trees set in herbaceous vegetation, but are generally distinguished from these priority habitat complexes by the following characteristics: the species composition of the trees, these being primarily in the family Rosaceae; the usually denser arrangement of the trees; the small scale of individual habitat patches; the wider dispersion and greater frequency of occurrence of habitat patches in the countryside. Traditional orchards include plantings for nuts, principally hazelnuts, but also walnuts.' [72]

The condition of this habitat in England is poor. The proportion of this habitat classified as being in a 'Favourable' or 'Unfavourable recovering' condition is far lower than any of the other priority habitats. In 2020, this percentage was 11%: see Table 29.

This percentage was very far below both the habitat-specific 80% target and the 90% all-habitats target: see Figure 28.

70 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

71 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)* http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

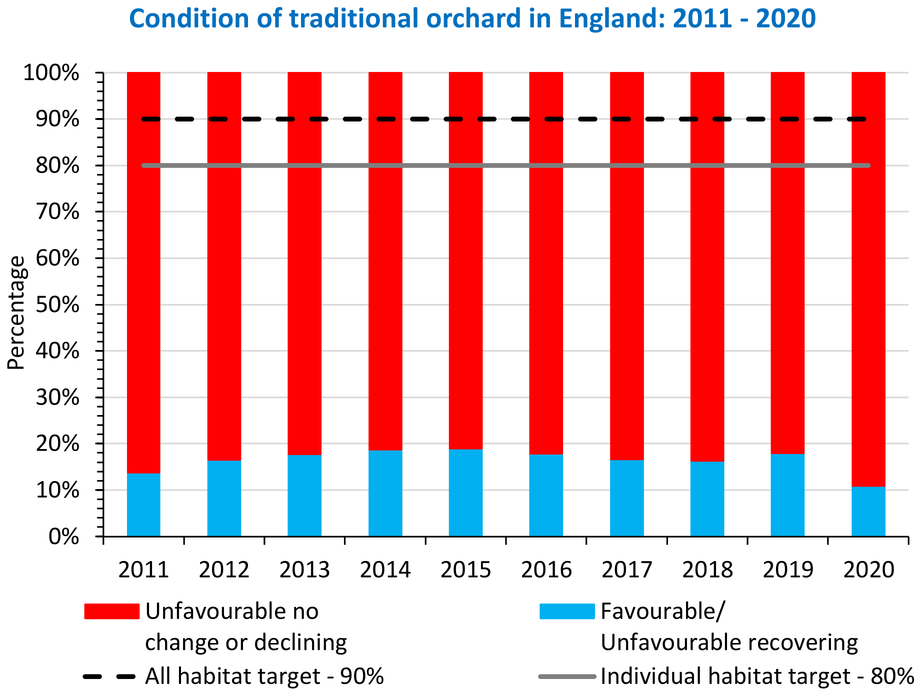
72 UK Biodiveristy *Action Plan, UK Biodiversity Action Plan Priority Habitat Descriptions (2011)* http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

Table 29: Condition of traditional orchard in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Traditional Orchard	2011	14%	86%
	2012	16%	84%
	2013	18%	82%
	2014	19%	81%
	2015	19%	81%
	2016	18%	82%
	2017	17%	83%
	2018	16%	84%
	2019	18%	82%
	2020	11%	89%

Source: Natural England estimates published by Defra – data only available for latest year[73]

Figure 28: Condition of traditional orchard in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[74]

73 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

74 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

However, the condition of the traditional orchard designated as belonging to a SSSI is much higher than the overall average for this habitat. The proportion of traditional orchard classified as being in a 'Favourable' condition rose between 2011 and 2014 from 63% to 70%, before declining in the years since to 68% in 2020: see Table 30.

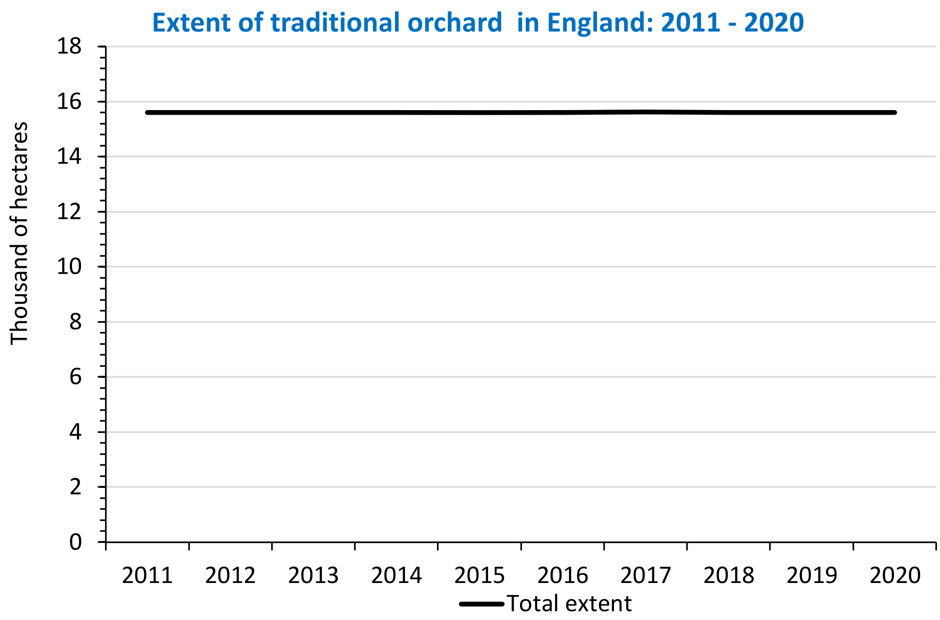
Table 30: Condition of traditional orchards in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Traditional Orchard - SSSI	2011	63%	37%
	2012	64%	36%
	2013	66%	34%
	2014	70%	30%
	2015	69%	31%
	2016	71%	29%
	2017	71%	29%
	2018	69%	31%
	2019	68%	32%
	2020	68%	32%

Source: Natural England estimates published by Defra – data only available for latest year[75]

The extent of traditional orchards in England has been stable since 2011 at around 15,600 hectares: see Figure 29.

Figure 29: Extent of traditional orchard in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[76]

75 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

76 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Other key types of land use

National Nature Reserves

There is limited evidence on the condition and extent of nature reserves in the UK. The evidence available is compiled by Natural England, national nature reserves (NNRs) were established under the National Parks and Access to the Countryside Act 1949, which specified that they were for "preserving flora, fauna or geological or physiographical features of special interest in the area and/or for providing opportunities for the study of, and research into, those features". The Natural Environment & Rural Communities Act 2006 extended the role of NNRs to include the provision of opportunities for public enjoyment of nature and/or open-air recreation. The 'three pillars' of nature conservation, research and access are fundamental to NNRs.[77]

Natural England has estimated that there are around 224 NNRs in England covering around 94,000 ha which corresponds to around 0.7% of England's land surface[78]. Of these 224 NNRs, around 141 are managed by Natural England or jointly with others, and the remainder is managed by Approved Bodies. Around 95% of this area comprises Sites of Special Scientific Interest (SSSIs).[79] See Figure 30 for the extent of national nature reserves managed by Natural England (2019).

Figure 30: Extent of national nature reserves managed by Natural England as of 2019

Source: Natural England[80]

77 Natural England, *Natural England Standard National Nature Reserve (NNR) Management (2017)* http://publications.naturalengland.org.uk/publication/5642141770448896

78 Natural England, *Accounting for National Nature Reserves: A Natural Capital Account of the National Nature Reserves managed by Natural England (NERR078) (2019)* http://publications.naturalengland.org.uk/publication/4535403835293696

79 Natural England, *Natural England Standard National Nature Reserve (NNR) Management (2017)* http://publications.naturalengland.org.uk/publication/5642141770448896

80 Natural England, *Accounting for National Nature Reserves: A Natural Capital Account of the National Nature Reserves managed by Natural England (NERR078) (2019)* http://publications.naturalengland.org.uk/publication/4535403835293696

Natural England has also estimated the condition, services, benefits and the economic value provided by NNRs. In Table 31, the condition and extent of NNRs managed by Natural England is displayed. As can be seen from the table only a limited number of water bodies achieve good status (WFD) and just 51% of SSSIs are in 'Favourable' condition and 42% in 'Unfavourable Recovering' condition.

Table 31: National Nature Reserves condition and extent

Asset attribute	Indicator	Evidence
Extent	Total area	66,839.7 ha
Hydrology	Groundwater status water Framework Directive (WFD)	24.1%
	Surface water status (WFD)	18.6%
Nutrient/chemical status	Mean sulphur dioxide concentration	0.32 $\mu g\ m^{-3}$
	Mean nitrogen acid deposition	12.3 kg N ha^{-1} $year^{-1}$
Soil	Mean estimates of Soil Organic Carbon in 30cm Topsoil (5 of total) from NATMAP	9.13
Vegetation	% of NNR under a Site of Special Scientific Interest (SSSIs) which is in favourable condition	51.3 %
Species composition	Nectar plant diversity – Mean estimates of Number of Nectar Plant Species of Bees (per 2x2m plot)	5.05
	Soil invertebrates abundance – Mean estimates of total abundance of invertebrates in topsoil (0-8cm depth soil core)	65.3
Cultural	Tranquillity (mean score)	13.8
	Scheduled monument at risk	74.7 ha

Source: Natural England[81]

Areas of outstanding natural beauty (AONBs)

There is also limited evidence on the condition and extent of areas of outstanding natural beauty (AONB). There are 46 AONBs in the UK of which 34 are found in England[82]. In the UK AONBs cover about 18% of the countryside and just over 1/5 of the English coast.[83] Figure 31 below presents the AONBs in England (and Wales) with most found in the South West and East regions.

81 Natural England, *Accounting for National Nature Reserves: A Natural Capital Account of the National Nature Reserves managed by Natural England (NERR078) (2019)* http://publications.naturalengland.org.uk/publication/4535403835293696

82 Defra, *Areas of outstanding natural beauty (AONBs): designation and management (2018)* https://www.gov.uk/guidance/areas-of-outstanding-natural-beauty-aonbs-designation-and-management

83 The National Association of Areas of Outstanding Natural Beauty, *About AONBs* https://landscapesforlife.org.uk/about-aonbs/about-aonbs

Figure 31: Dark green areas are the AONBs in England and Wales

Source: The National Association of Areas of Outstanding Natural Beauty[84]

National Character areas

There are 159 national character areas in England as per Figure 32 below. Character areas are areas that share similar landscape characteristics, following natural lines in the landscape. There is a significant amount of evidence on character areas (of which is somewhat dated - 2014), however this evidence is presented at the local level and there is no evidence at the national level. Local evidence is collated by Natural England and can be found under the *National Character Area profiles.*[85]

Given this lack of national data and the limited resources available to the NCC, it has not been possible to produce an assessment on the status of national character areas.

84 The National Association of Areas of Outstanding Natural Beauty, *The UK's AONBs – Overview* https://landscapesforlife.org.uk/about-aonbs/aonbs/overview

85 Defra, *Corporate report: National Character Area profiles (2014)* https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making/national-character-area-profiles

Figure 32: National character area in England

Source: Natural England[86]

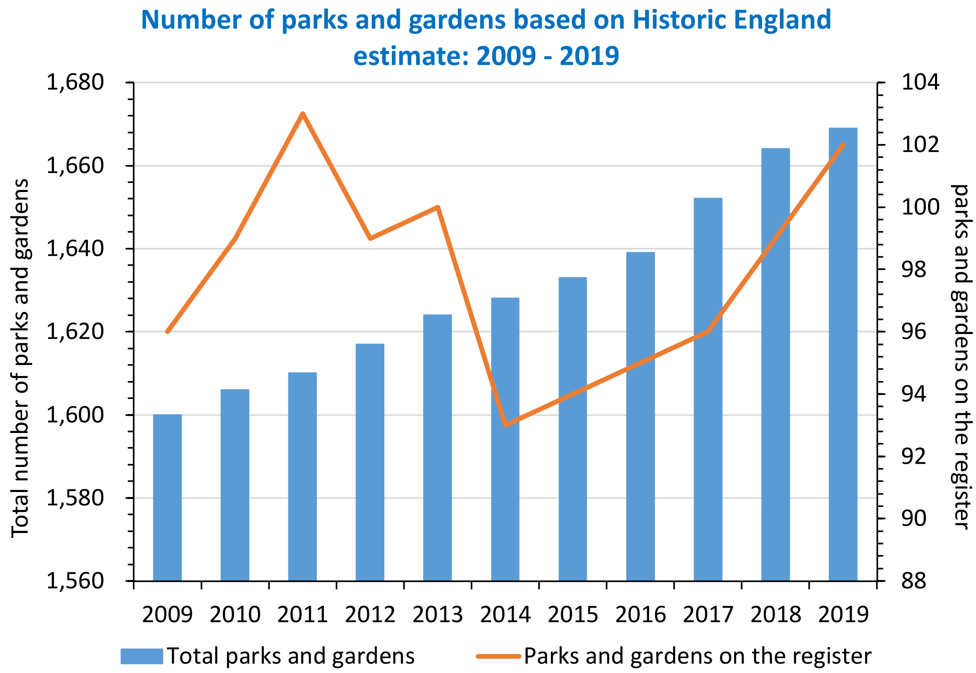
86 Natural England, *National Character Areas with administrative areas (2013)* https://webarchive.nationalarchives.gov.uk/20140712093315/http://www.naturalengland.org.uk/Images/nca-county_tcm6-36960.pdf

Parks and gardens

Figure 33 shows Historic England's estimates of the total number of parks and gardens each year from 2009 to 2019. This number has trended slightly upwards from around 1,600 in 2009 to around 1,670 in 2019.

The graph also shows the number of parks and gardens on Historic England's register of sites assessed to be of particular significance. This number has also trended slightly upwards. Despite a period of decline between 2011 and 2014, the number of parks and gardens on Historic England's register increased from around 95 in 2009 to 102 in 2019.

Figure 33: Number of parks and gardens, Historic England estimates: 2009 -2019



Source: Historic England[87]

2. Freshwaters habitats

This section addresses the freshwater habitats for which the only available data assesses biotic and non-biotic elements together, as listed in Table 32.

Water bodies such as rivers, lakes, and ponds are assessed in Annex 2, Freshwaters, with a high-level assessment of their species presented in Annex 6, Biota.

Table 32: List of freshwater habitats assessed in this section, and relevant targets

	Habitat	Target
Freshwater habitats	2.1 – Blanket bogs	The England Biodiversity 2020 Strategy includes a target for '90% of priority habitats to be in 'Favourable' or 'unfavourable recovering' condition and at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or recovering condition'.88
	2.2 – Coastal and floodplain grazing marsh	
	2.3 – Lowland fens	
	2.4 – Lowland raised bogs	
	2.5 – Reebeds	
	2.6 – Upland fens, flushes and swamps	

87 Historic England, *Heritage at Risk 2019 Registers (2019)* https://historicengland.org.uk/images-books/publications/har-2019-registers/

88 Defra, *Biodiversity 2020: A strategy for England's wildlife and ecosystem services* (2011) https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

The overall assessment of freshwater habitats

Based on the data available, the overall assessment of the wetlands (and their individual habitats) is 'Red': **deteriorating**. Only two types of wetland (blanket bogs, and upland fens, flushes and swamps) are achieving their target of 80% of the area being classified as being in a 'Favourable' or 'Unfavourable recovering' condition. All other types of wetlands are declining or need significant improvement to meet the target from the Biodiversity Strategy of priority habitats in 'Favourable' or 'Unfavourable recovering' condition. See Table 33 below for an assessment of each type of wetland. The key findings from the NCC assessments are:

- The latest data shows that only 6% of lowland raised bogs (SSSI) had achieved 'Favourable' condition against a target of 50% by 2020.
- Based on the latest data from Natural England in 2020, only 32% of coastal and floodplain grazing marsh achieved 'Favourable' and 'Unfavourable recovering' condition against a target of 80%.

Table 33: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
2.1 – Blanket bogs	England is meeting its biodiversity target of 80% in 'Favourable'/ 'Unfavourable recovering' condition by 2020, with 83% of blanket bogs in 'Favourable'/ 'Unfavourable recovering' condition.	There has been an increase between 2011 and 2020 in the proportion of blanket bogs that are in a 'Favourable'/ 'Unfavourable recovering' condition from 79% to 83%. However, since 2015 the condition has deteriorated.	See cell to the left which covers the same period.	Between 2019 and 2020 there was a decline in the condition of blanket bogs from 89% to 83% in 'Favourable'/ 'Unfavourable recovering' condition.
2.2 – Coastal and Floodplain Grazing	England is not on track to meet its biodiversity target of 80% in a 'Favourable'/ 'Unfavourable recovering' condition by 2020, with only 32% of grazing marsh in 'Favourable'/ 'Unfavourable recovering' condition.	Between 2011 and 2020 there was an increase in grazing marsh achieving 'Favourable'/ 'Unfavourable recovering' condition from 23% to 32%. However, since 2015 the condition has deteriorated.	See cell to the left which covers the same period.	Between 2019 and 2020 there was a decline in the condition of grazing marsh from 42% to 32% in 'Favourable'/ 'Unfavourable recovering' condition.
2.3 – Lowland Fens	Based on evidence from 2020 lowland fens are not meeting the 80% target, with only 65% of lowland fens achieving 'Favourable'/ 'Unfavourable recovering' condition.	Comparing the level between 2011 and 2020, there was an increase in lowland fens achieving 'Favourable'/ 'Unfavourable recovering' condition from 61% to 65%. However, there has been a steady declining trend since 2015.	See cell to the left which covers the same period.	There was a decline in the number of lowland fens achieving 'Favourable'/ 'Unfavourable recovering' condition from 70% to 65%.

2.4 – Lowland raised bogs	There has been an increase in the area of lowland raised bog that is achieving ‘Favourable’/ ‘Unfavourable recovering’ condition between 2011 and 2020, from 70% to 77%. However, this proportion is not meeting its 80% target.	Between 2011 and 2020 there was an increase in lowland raised bog that was achieving ‘Favourable’/ ‘Unfavourable recovering’ condition from 70% to 77%.	See cell to the left which covers the same period.	There was no change between 2019 and 2020.
2.5 – Reedbeds	Between 2011 and 2020 there was an increase in reedbeds achieving ‘Favourable’/ ‘Unfavourable recovering’ condition from 63% to 69%. However, this falls short of the 80% targets. However, England is on track to meeting its SSSI target.	Comparing the level between 2011 and 2020 it can be that there was an increase in reedbeds achieving ‘Favourable’/ ‘Unfavourable recovering’ condition from 63% to 69%. However, there has been some decline since 2017.	See cell to the left which covers the same period.	There has been a steep decline between 2019 and 2020 from 76% to 69%.
2.6 – Upland Fens, Flushes and Swamps	England is meeting its priority habitat target of 80% but is not meeting its SSSI target. There has been an increase in upland fens, flushes and swamps achieving ‘Favourable’/ ‘Unfavourable recovering’ condition between 2011 and 2020 from 72% to 87%.	There has been an increase in upland fens, flushes and swamps achieving ‘Favourable’/ ‘Unfavourable recovering’ condition between 2011 and 2020 of around 15 percentage points.	See cell to the left which covers the same period.	There has been a small decline between 2019 and 2020, from 89% to 87%.

Wetlands condition and extent

Blanket bogs

There are various definitions for blanket bogs, Natural England defines blanket bogs as an upland habitat that forms in areas with high rainfall, low evapotranspiration and flat or gently sloping land. In England, large areas of blanket bog are in a degraded condition.[89] The most recent evidence from Natural England is that around 83% are in ‘Favourable’/ ‘Unfavourable recovering’ condition. When comparing 2011 and 2020 there has been a small increase of around 4%. However, since the peak in 2015 where 92% were in ‘Favourable’/ ‘Unfavourable recovering’ condition, the condition of blanket bogs has been deteriorating: see Table 34.

89 Natural England, *Climate Change Adaptation Manual (NE751) (2020)* http://publications.naturalengland.org.uk/publication/5679197848862720

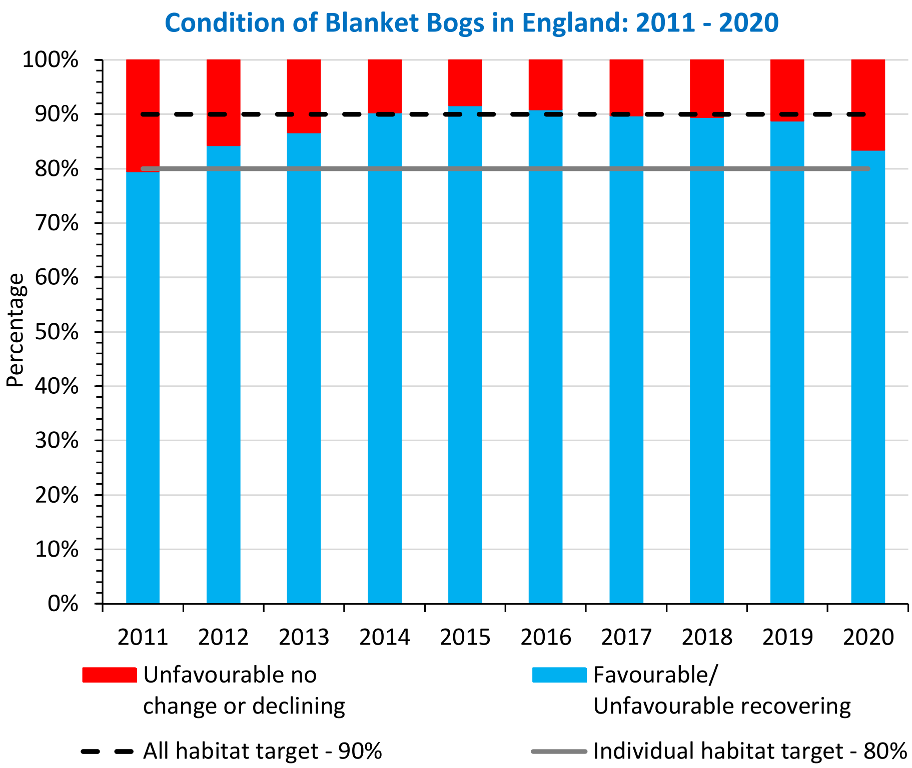
Table 34: Condition of blanket bogs in England, proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Blanket Bog	2011	79%	21%
	2012	84%	16%
	2013	87%	13%
	2014	90%	10%
	2015	92%	8%
	2016	91%	9%
	2017	90%	10%
	2018	89%	11%
	2019	89%	11%
	2020	83%	17%

Source: Natural England estimates published by Defra – data only available for latest year[90]

As shown by Figure 34, England is not meeting its Biodiversity 2020 Strategy target of “90% of priority habitats in ‘Favourable’ or recovering condition” and is also not meeting its SSSI target of “at least 50% of SSSIs in ‘Favourable’ condition, while maintaining at least 95% in ‘Favourable’ or ‘unfavourable recovering’ condition”[91] as per Table 35. In 2020 (March) only 13% of SSSI were in ‘Favourable’ condition. England is only achieving the individual habitat target of 80% for blanket bogs.

Figure 34: Condition of blanket bogs in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[92]

90 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

91 Defra, *Biodiversity 2020: Strategy for England's wildlife and ecosystem services (2011)* https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

92 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

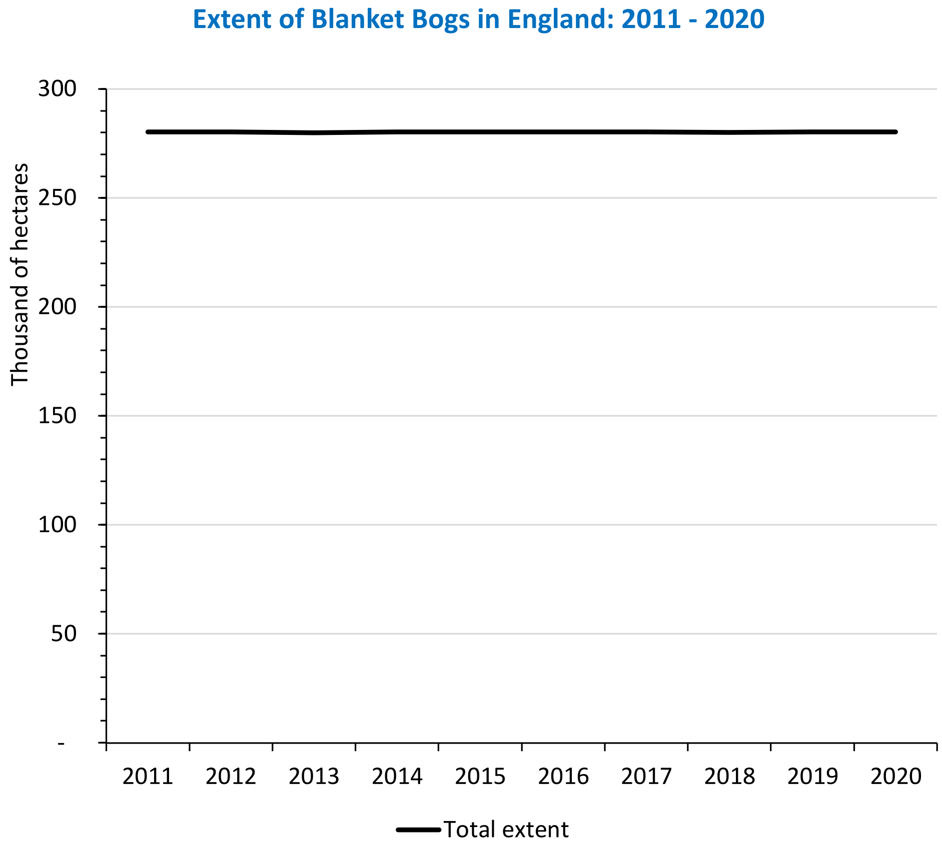
Table 35: Condition of blanket bogs in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Blanket Bog (SSSI)	2011	13%	87%
	2012	13%	87%
	2013	14%	86%
	2014	13%	87%
	2015	13%	87%
	2016	13%	87%
	2017	13%	87%
	2018	13%	87%
	2019	13%	87%
	2020	13%	87%

Source: Natural England estimates published by Defra – data only available for latest year[93]

The extent of blanket bogs has remained constant since 2011, at 280,000 hectares: see Figure 35.

Figure 35: Extent of blanket bogs in England: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[94]

93 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

94 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Coastal and floodplain grazing marsh

Coastal and floodplain grazing marsh is not a specific habitat but more a landscape which supports various habitats. The UK biodiversity action plan has defined grazing marsh as periodically inundated pasture, or meadow with ditches which contain standing brackish or freshwaters.[95] As per Table 36, between 2011 and 2015 there was an improvement in the condition of grazing marsh from around 23% to around 39% achieving 'Favourable'/ 'Unfavourable recovering' condition. While between 2015 and 2019 the trend was stable, however, the most recent data for 2020 shows a steep decline in the condition with 32% of grazing marsh in 'Favourable'/ 'Unfavourable recovering' condition – See Figure 36 for historical trend.

Table 36: Condition of coastal and floodplain grazing marsh in England, proportion of the total area receiving each classification: 2011 – 2020

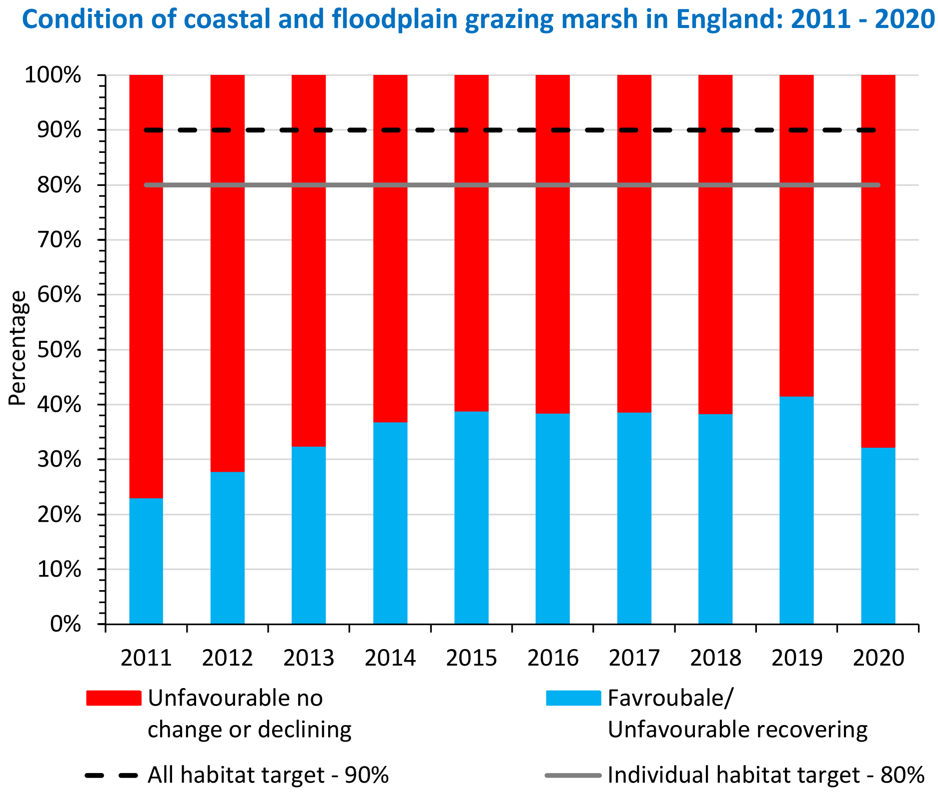
	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Coastal and Floodplain Grazing Marsh	2011	23%	77%
	2012	28%	72%
	2013	32%	68%
	2014	37%	63%
	2015	39%	61%
	2016	38%	62%
	2017	39%	61%
	2018	38%	62%
	2019	42%	58%
	2020	32%	68%

Source: Natural England estimates published by Defra – data only available for latest year[96]

95 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)* http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

96 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 36: Condition of coastal and floodplain grazing marsh in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[97]

England is not meeting and is not on track to meet the 90% target of priority habitats in 'Favourable' or 'Unfavourable recovering' condition, or the 80% target for individual habitats. With the latest data presenting that only 32% were in 'Favourable'/ 'Unfavourable recovering' condition. In terms of SSSI, England is meeting its target of at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or 'Unfavourable recovering' condition by 2020. As per the latest data, in the 2020 around 50% of grazing marsh SSSI's were in 'Favourable' condition – see Table 37.

Table 37: Condition of coastal and floodplain grazing marsh in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Coastal and Floodplain Grazing Marsh - SSSI	2011	49%	51%
	2012	51%	49%
	2013	50%	50%
	2014	51%	49%
	2015	51%	49%
	2016	51%	49%
	2017	50%	50%
	2018	50%	50%
	2019	50%	50%
	2020	50%	50%

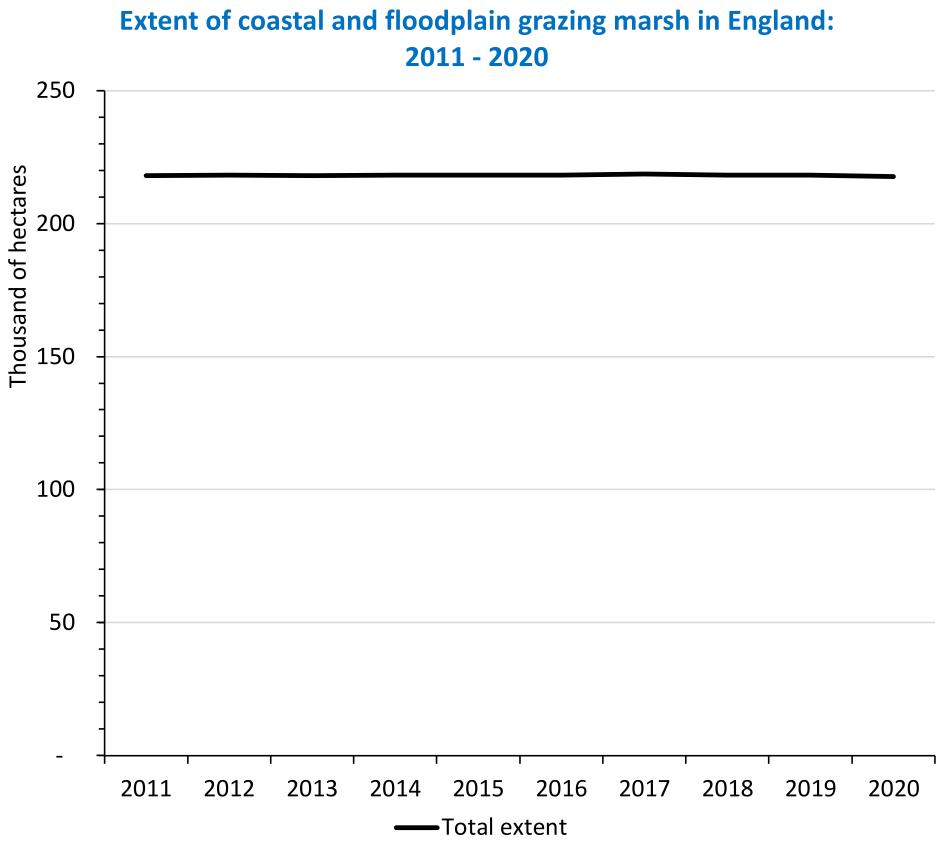
Source: Natural England estimates published by Defra – data only available for latest year[98]

97 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

98 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The extent of coastal and floodplain grazing marsh has remained almost constant since 2011, ranging between 217, 727 and 218,693 hectares between 2011 and 2020: see Figure 37.

Figure 37: Extent of coastal and floodplain grazing marsh in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[99]

Lowland fens

Lowland fens are wetlands that occur in peat and mineral soil. Fens differ from bogs, which only received water from precipitation, while fens can receive water from groundwater, surface run-off and river flooding, and rainfall. [100] Based on the latest data from Natural England, the amount of lowland fen achieving 'Favourable'/ 'Unfavourable recovering' condition has slightly increased between 2011 and 2020. There was an increasing trend in the condition between 2011 and 2016, since then it has been stable until 2019, but there was a steep decline in 2020. See Table 38 for trend since 2011.

99 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

100 Natural England, *Climate Change Adaptation Manual (NE751) (2020)* http://publications.naturalengland.org.uk/publication/5679197848862720

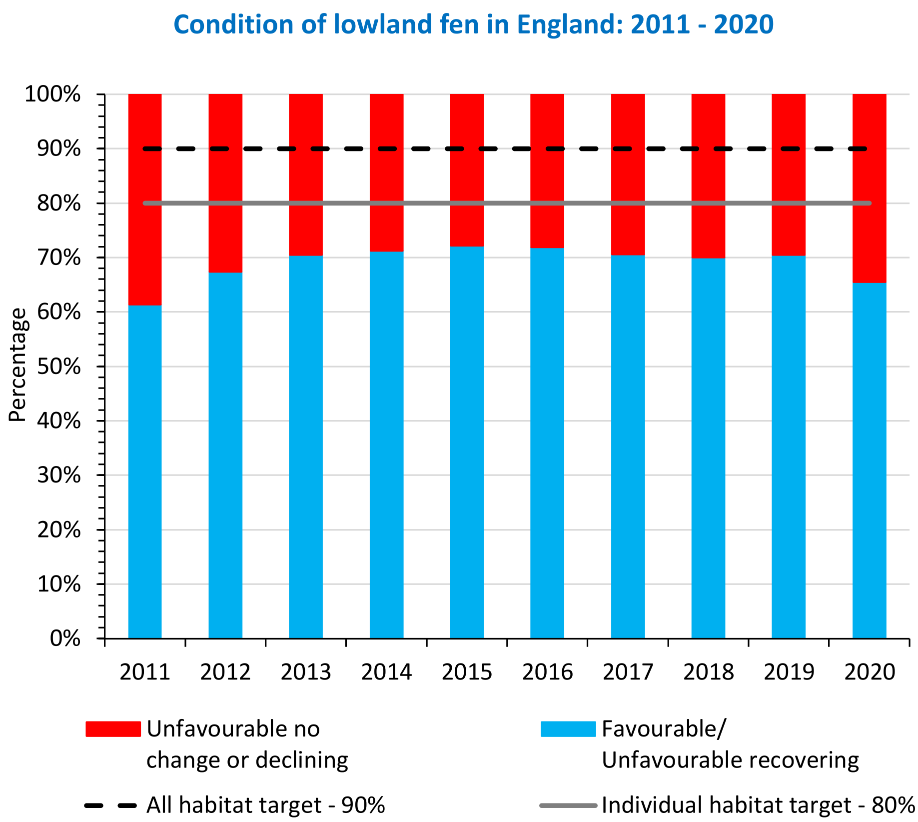
Table 38: Condition of lowland fens in England, proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Lowland Fens	2011	61%	39%
	2012	67%	33%
	2013	70%	30%
	2014	71%	29%
	2015	72%	28%
	2016	72%	28%
	2017	71%	29%
	2018	70%	30%
	2019	70%	30%
	2020	65%	35%

Source: Natural England estimates published by Defra – data only available for latest year101

Between 2011 and 2020 England has not once met its target of 80% of lowland fens priority habitat in 'Favourable' or 'Unfavourable recovering' condition. The closest it has been to achieving these targets was in 2015 and 2016 at 72% of lowland fens achieving 'Favourable' / 'Unfavourable recovering' condition. Between 2019 and 2020 there was a steep decline from 70% to 65%. See Figure 38 for the change in the condition of lowland fens since 2011.

Figure 38: Condition of lowland fens in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[102]

101 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

102 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

England is also not meeting , and is unlikely to be on track to meet, its SSSI target of "at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or recovering condition". In 2020, only 43% of lowland fens SSSIs were in 'Favourable' condition. Looking at the whole trend, there was limited fluctuations in the percentage of lowland fens achieving 'Favourable' condition, ranging between 39% (in 2011) to 45% (in 2018). This can be seen in Table 39.

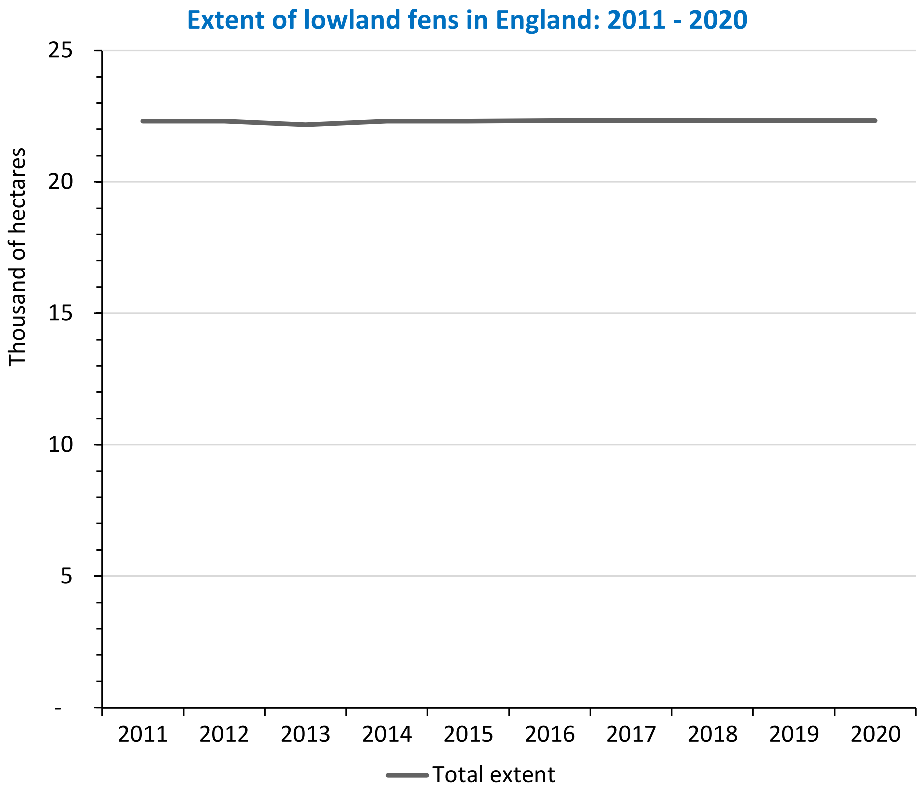
Table 39: Condition of lowland fens in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Lowland Fens - SSSI	2011	39%	61%
	2012	39%	61%
	2013	41%	59%
	2014	43%	57%
	2015	43%	57%
	2016	43%	57%
	2017	44%	56%
	2018	45%	55%
	2019	43%	57%
	2020	43%	57%

Source: Natural England estimates published by Defra – data only available for latest year[103]

The extent of lowland fens has remained almost the same between 2011 and 2020, ranging between 22,177 (in 2013) and 22,339 (in 2017) hectares: see Figure 389.

Figure 39: Extent of lowland fens in England: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[104]

103 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

104 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Lowland raised bogs

Lowland raised bogs are found mainly in lowland areas such as the head of estuaries, along river flood-plains and in topographic depressions. In these locations, drainage is impeded by high groundwater table or low permeability of the substrata. Due to this water logging, there is an accumulation of peat which over time elevates the bog surface above groundwater levels to form a gently-curving dome from where the term 'raised bogs' is derived.[105] As per Table 40, between 2011 and 2020, there has been an increase in the percentage of lowland raised bogs achieving 'Favourable'/ 'Unfavourable recovering' condition from 70% to 77%, which is the highest level achieved over this period.

Table 40: Condition of lowland raised bog in England, proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Lowland Raised Bog	2011	70%	30%
	2012	70%	30%
	2013	72%	28%
	2014	75%	25%
	2015	71%	29%
	2016	77%	23%
	2017	76%	24%
	2018	76%	24%
	2019	77%	23%
	2020	77%	23%

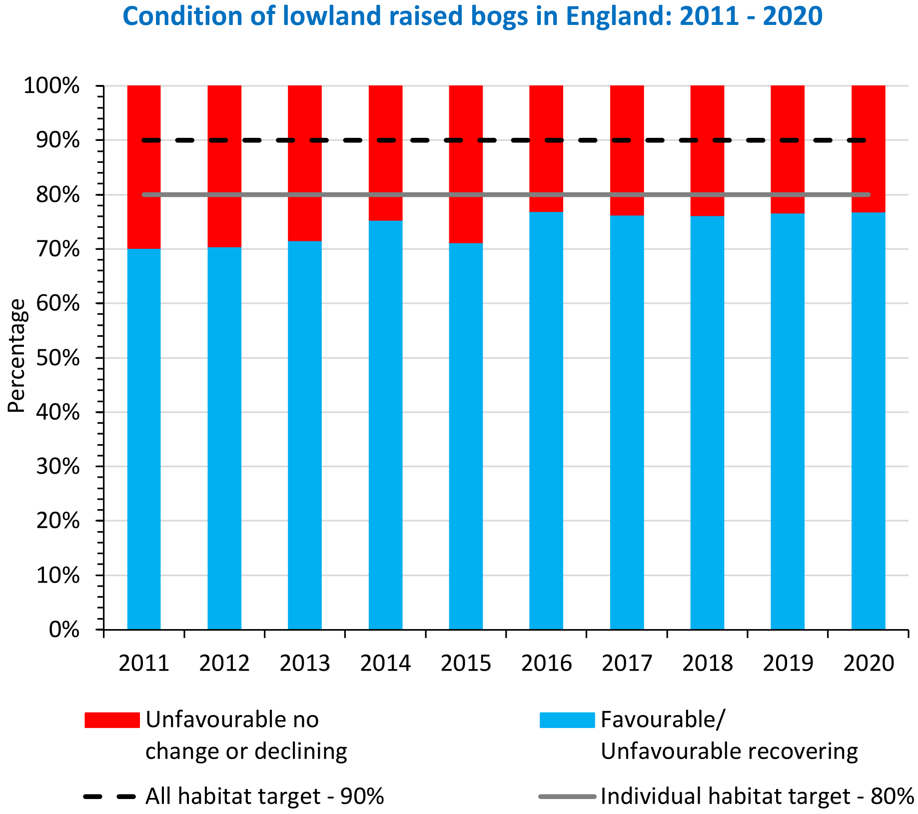
Source: Natural England estimates published by Defra – data only available for latest year[106]

England has not once met its target of 80% of priority habitats in 'Favourable' or 'Unfavourable recovering' condition. The highest level it has achieved was in 2016, 2019 and 2020 where 77% achieved 'Favourable' / 'Unfavourable recovering' condition. See Figure 40 for the change in the condition of lowland raised bog since 2011.

105 Natural England, *Climate Change Adaptation Manual (NE751) (2020)* http://publications.naturalengland.org.uk/publication/5679197848862720

106 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 40: Condition of lowland raised bog in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[107]

England is also not meeting, and is unlikely to meet, its SSSI target of "at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or 'Unfavourable recovering' condition by 2020". From the latest data, in 2020 only 6% of lowland raised bog SSSIs were in 'Favourable' condition. Looking at the whole trend, there was a limited fluctuation in the percentage of lowland raised bog achieving 'Favourable' condition, ranging between 5% and 7%. See Table 41 below for the change in the SSSI condition since 2011.

Table 41: Condition of lowland raised bog in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Lowland Raised Bog - SSSI	2011	5%	95%
	2012	5%	95%
	2013	6%	94%
	2014	6%	94%
	2015	5%	95%
	2016	7%	93%
	2017	6%	94%
	2018	6%	94%
	2019	6%	94%
	2020	6%	94%

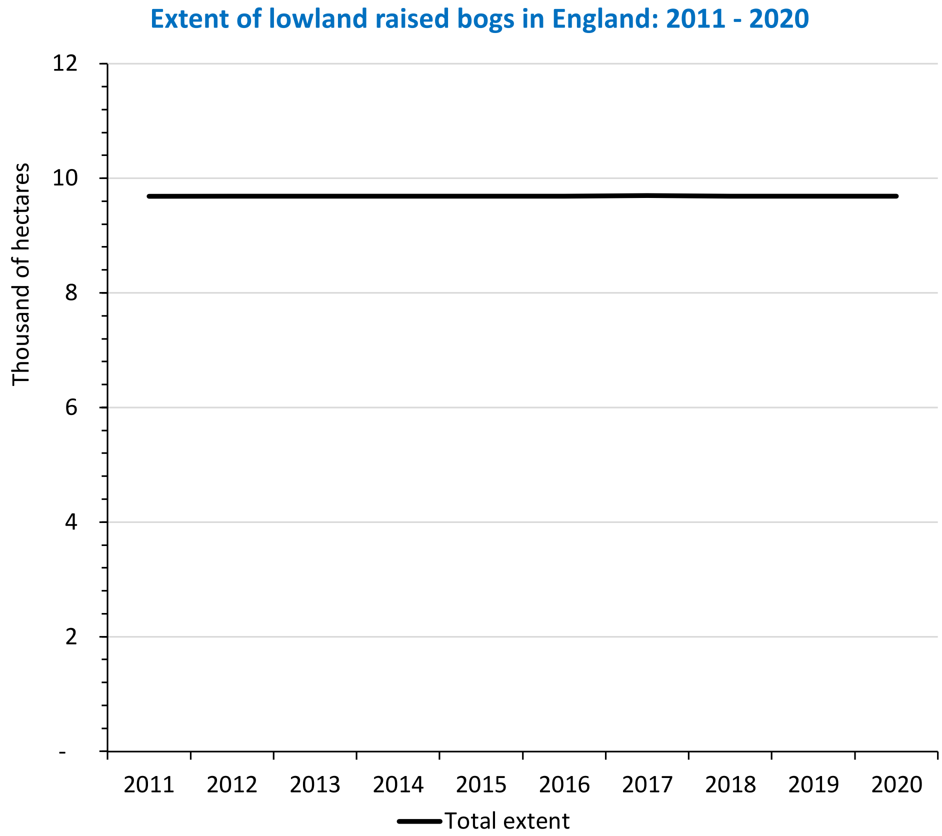
Source: Natural England estimates published by Defra – data only available for latest year[108]

107 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

108 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

There has been almost no change in the extent of lowland raised bogs between 2011 and 2020, with the number of hectares ranging between 9,687 (2011) and 9,700 (2017). See Figure 41 for the trend in extent since 2011.

Figure 41: Extent of lowland raised bogs in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[109]

Reedbeds

Reedbeds tend to incorporate areas of open waters such as ditches and wet grassland. [110] These are early successional wetlands where the water table is at or above ground level for most of the year. It is normally dominated by stands of common reed *Phragmites australis.* [111] There has been limited change in the condition of reedbeds between 2011 and 2020. As per Table 42 there has been an increased in reedbeds achieving 'Favourable' / 'Unfavourable recovering' condition between 2011 and 2020, from 63% to 69% respectively. However, there was a steep decline between 2019 and 2020 from 76% to 69%.

109 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

110 UK Biodiveristy Action Plan, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)* http://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

111 Natural England, *Climate Change Adaptation Manual (NE751) (2020)* http://publications.naturalengland.org.uk/publication/5679197848862720

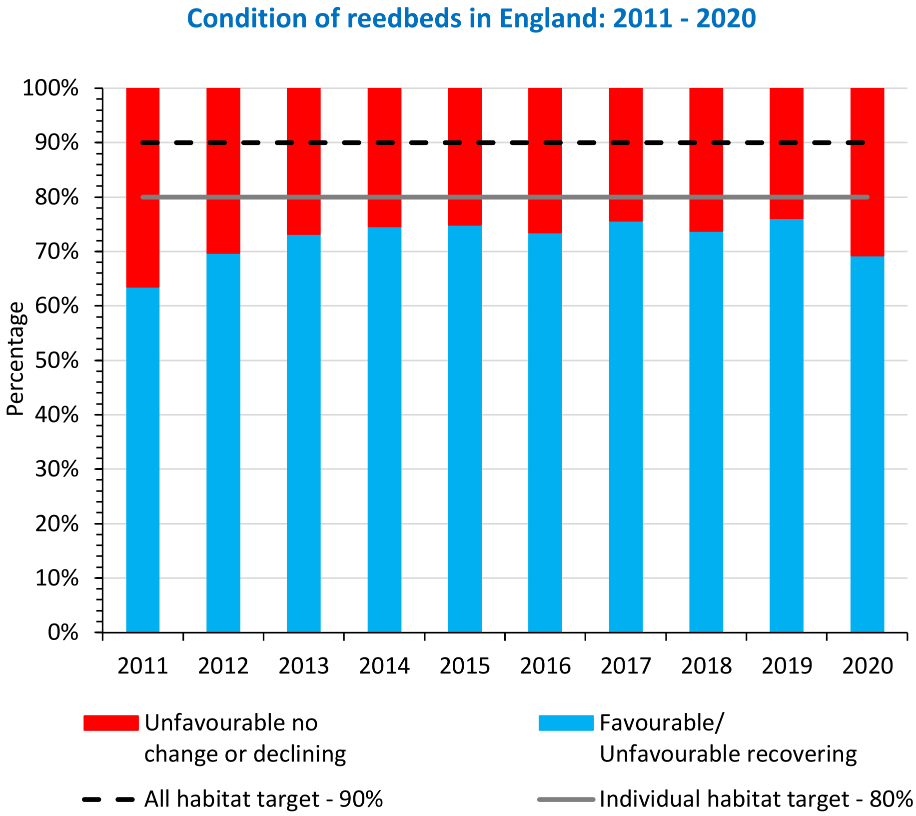
Table 42: Condition of reedbed in England, proportion of the total area receiving each classification: 2011 – 2020.

	Year	Favourable/ unfavourable recovering	Unfavourable no change or declining
Reedbeds	2011	63%	37%
	2012	70%	30%
	2013	73%	27%
	2014	75%	25%
	2015	75%	25%
	2016	73%	27%
	2017	76%	24%
	2018	74%	26%
	2019	76%	24%
	2020	69%	31%

Source: Natural England estimates published by Defra – data only available for latest year[112]

The condition of reedbeds in England is below the target of 80% for individual priority habitat. In 2020 only 69% achieved 'Favourable' / 'Unfavourable recovering' condition. See Figure 42 for the change in the condition of reedbeds since 2011.

Figure 42: Condition of reedbeds in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[113]

112 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

113 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

England, however, is meeting and is likely to meet its SSSI target of “at least 50% of SSSIs in ‘Favourable’ condition, while maintaining at least 95% in ‘Favourable’ or recovering condition” by 2020. Based on data from 2020, 57% of reedbeds SSSIs were in ‘Favourable’ condition. Looking at the whole trend, there has been limited change since 2011. See Table 43 below for the change in the SSSI condition since 2011.

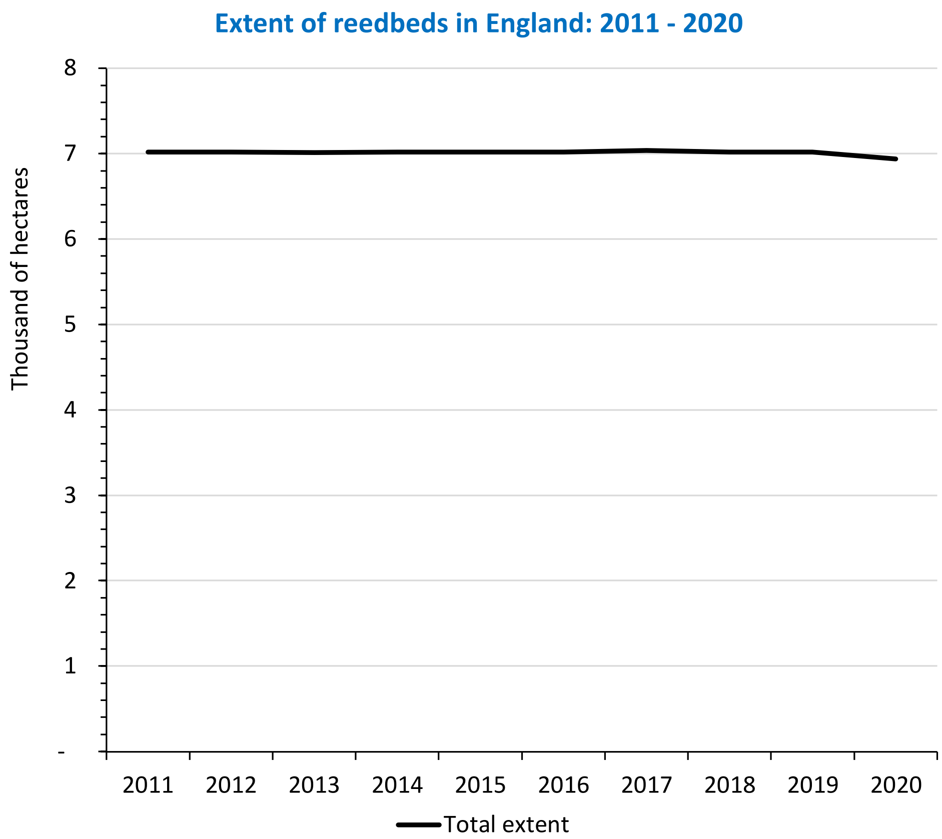
Table 43: Condition of reedbeds in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Reedbeds - SSSI	2011	57%	43%
	2012	58%	42%
	2013	58%	42%
	2014	58%	42%
	2015	58%	42%
	2016	58%	42%
	2017	58%	42%
	2018	56%	44%
	2019	58%	42%
	2020	57%	43%

Source: Natural England estimates published by Defra – data only available for latest year[114]

Between 2011 and 2017 the area of reedbeds ranged between 7,018 and 7,038 hectares, while in 2020 there was a decline to 6,938 hectares. See Figure 43 below for the change in the extent and the condition of reedbeds since 2011.

Figure 43: Extent of reedbeds in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[115]

114 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

115 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Upland fens, flushes and swamps

Upland fens, flushes and swamps are peat or mineral-based wetlands in upland areas, which receive water and nutrients from surface and/or groundwaters.[116] Upland fens, flushes and swamps habitats are one of the two priority freshwaters habitats that are meeting the individual target of 80% of priority habitats in 'Favourable' or 'recovering' condition. In 2020, just under 87% of upland fens, flushes and swamps were in 'Favourable' or 'recovering' condition, an increase from 2011 levels. However, since the 94% peak in 2015, the percentage has been on a declining trend. See Table 44 for the change in condition since 2011.

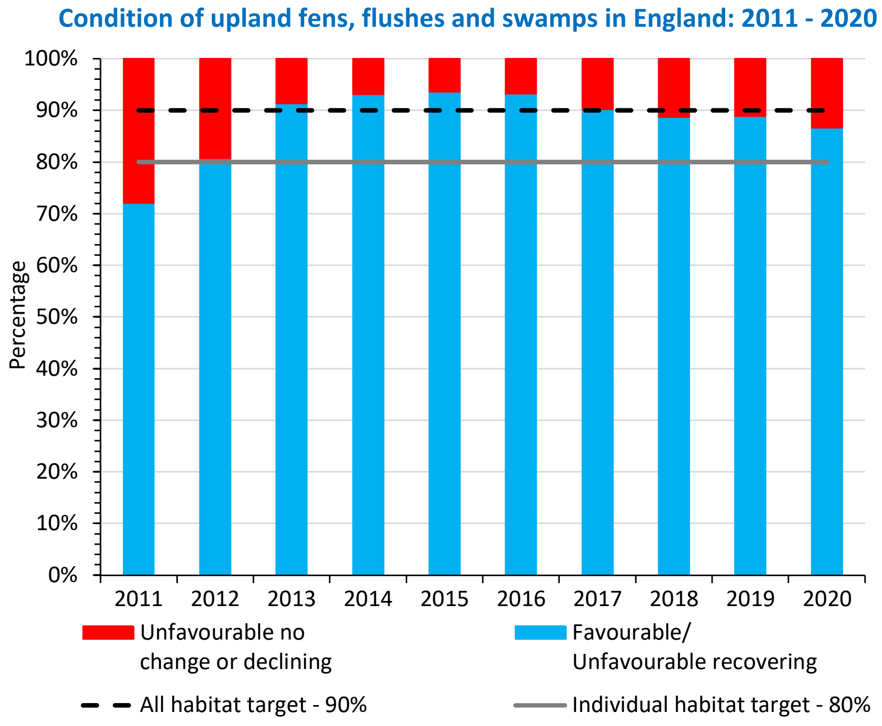
Table 44: Condition of upland fens, flushes and swamps in England, proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Upland Fens Flushes and Swamps	2011	72%	28%
	2012	81%	19%
	2013	91%	9%
	2014	93%	7%
	2015	94%	6%
	2016	93%	7%
	2017	90%	10%
	2018	89%	11%
	2019	89%	11%
	2020	87%	13%

Source: Natural England estimates published by Defra – data only available for latest year[117]

Between 2013 and 2020 England met its target of "80% of priority habitats in 'Favourable' or Unfavourable recovering condition" However, over this time period there has been a slight decline from above 90% to 87%. See Figure 44 for the change in the condition of upland fens, flushes and swamps since 2011.

Figure 44: Condition of upland fens, flushes and swamps in England, proportion of the total area receiving each classification: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[118]

116 Natural England, *Climate Change Adaptation Manual (NE751) (2020)* http://publications.naturalengland.org.uk/publication/5679197848862720

117 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

118 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

England however, is not meeting and is not likely to meet its SSSI target of "at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or Unfavourable recovering condition" by 2020. Based on data from 2020, only 30% of upland fens, flushes and swamps SSSIs were in 'Favourable' condition. Looking at the whole trend, there was a limited change since 2011. See Table 45 below for the change in the SSSI condition since 2011.

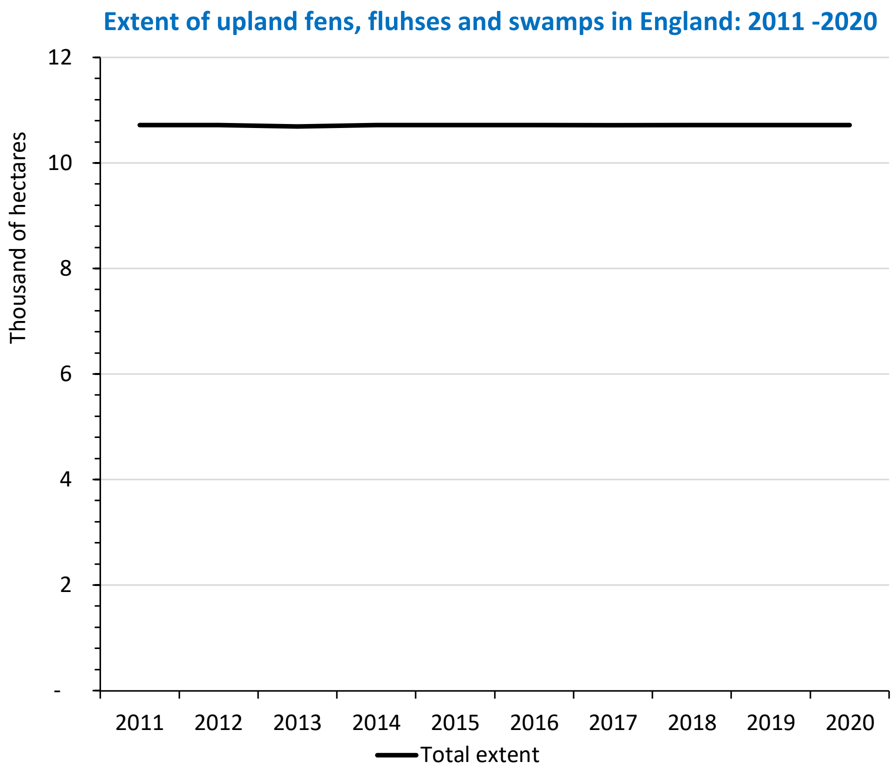
Table 45: Condition of upland fens in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Upland Fens Flushes and Swamps - SSSI	2011	33%	67%
	2012	33%	67%
	2013	33%	67%
	2014	31%	69%
	2015	31%	69%
	2016	31%	69%
	2017	31%	69%
	2018	31%	69%
	2019	31%	69%
	2020	30%	70%

Source: Natural England estimates published by Defra – data only available for latest year[119]

There has been almost no change in the extent of upland fens, flushes and swamps in England between 2011 and 2020, with the exception of 2013 where there was a small decline of 24 hectares. See Figure 45 for change in extent and condition since 2011.

Figure 45: Extent of upland fens, flushes and swamps in England: 2011 – 2020



Source: Natural England estimates published by Defra – data only available for latest year[120]

119 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

120 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

3. Coastal margins habitats

This section addresses the coastal margins habitats for which the only available data assesses biotic and non-biotic elements together. Covered here are the coastal margin habitats, including areas which are fully saline, areas which are subject to inundation by saline waters, and areas which are regularly sprayed or misted by humid saline aerosols. Subtidal habitats were not included in this analysis. Table 46 below shows the coastal and marine habitats covered in this annex and their respective existing targets.

For open seas, information on the state of non-biotic elements are presented in Annex 3 - *Marine*. Information on the state of the species of the open sea are presented in Annex 6 - Biota.

Table 46: List of coastal habitats and targets/thresholds

	Measurement of condition and extent	Targets
Coastal and marine habitats	3.1 – Saltmarsh	The England Biodiversity 2020 Strategy includes a target for '90% of priority habitats to be in 'Favourable' or 'Unfavourable recovering' condition and at least 50% of SSSIs in 'Favourable' condition, while maintaining at least 95% in 'Favourable' or recovering condition'.121
	3.2 – Littoral sand (sand dunes)	
	3.3 – Vegetated shingle	
	3.4 – Maritime cliffs and slopes	
	3.5 – Littoral mud (mudflats)	
	3.6 – Saline lagoons	
	3.7 – Features of littoral rock	No evidence of a target or threshold has been found for these habitats.
	3.8 – High energy littoral rock	
	3.9 – moderate energy littoral rock	
	3.10 – Low energy littoral rock	
	3.11 – Littoral coarse sediment	
	3.12 – Littoral mixed sediment	
	3.13 – Supra littoral rock	
	3.14 – Supra littoral sediment	

The overall assessment of marine habitats

The NCC's overall assessment of coastal margins habitats is that they are 'Red': **deteriorating**. This assessment is based on the limited data available and on some habitats as it was not possible to assess all habitats given the lack of data for the different types of rocks. Four of the six priority habitats assessed where data is available are failing to meet the target that at least 80% of each priority habitat should be in a 'Favourable' or 'Unfavourable recovering' condition. Most of the trends since 2011 and since 2019 have been downward: see Table 47. The key findings from the NCC assessments are:

- 90% of saltmarsh priority habitats achieved Favourable' or 'Unfavourable recovering' condition in 2020.
- The condition of mudflats has worsened from 91% in 2011 achieving 'Favourable' and 'Unfavourable recovery' to 76% in 2020.

121 Defra, *Biodiversity 2020: A strategy for England's wildlife and ecosystem services* (2011) https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

Table 47: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	NCC baseline (2011)	Short-term trend
3.1 – Saltmarsh	The proportion of coastal saltmarsh in England that was in a 'Favourable' or 'Unfavourable recovering' condition was above the target of 80% every year since 2011.	The proportion of coastal saltmarsh in a 'Favourable' or 'Unfavourable recovering' condition has declined from 96% in 2011 to 90% in 2020.	See cell to the left which covers the same period.	The proportion of coastal saltmarsh in a 'Favourable' or 'Unfavourable recovering' condition declined from 91% in 2019 to 90% in 2020.
3.2 – Littoral sand (sand dunes)	The proportion of littoral sand in England that was in a 'Favourable' or 'Unfavourable recovering' condition was below the target of 80% every year since 2011.	The proportion of littoral sand in England that was in a 'Favourable' or 'Unfavourable recovering' condition was approximately the same in 2011 as in 2020, at 74%.	See cell to the left which covers the same period.	The proportion of littoral sand in England that was in a 'Favourable' or 'Unfavourable recovering' condition was slightly higher in 2020, 74%, than in 2019, 73%.
3.3 – Vegetated shingle	The proportion of coastal vegetated shingle in England that was in a 'Favourable' or 'Unfavourable recovering' condition was above the target of 80% every year since 2011. In 2020 this was 81%	The proportion of coastal vegetated shingle in England that was in a 'Favourable' or 'Unfavourable recovering' condition declined from 86% in 2011 to 81% in 2020.	See cell to the left which covers the same period.	The proportion of coastal vegetated shingle in England that was in a 'Favourable' or 'Unfavourable recovering' condition declined from 83% in 2019 to 81% in 2020.
3.4 – Maritime cliffs and slopes	The proportion of the area covered by maritime cliffs and slopes in England that was in a 'Favourable' or 'Unfavourable recovering' condition was below the target of 80% every year since 2011. In 2020 this was estimated to be at 72%.	The proportion of the area covered by maritime cliffs and slopes in England that was in a 'Favourable' or 'Unfavourable recovering' condition was 68% in 2011 but 72% in 2020.	See cell to the left which covers the same period.	The proportion of the area covered by maritime cliffs and slopes in England that was in a 'Favourable' or 'Unfavourable recovering' condition declined from 74% in 2019 to 72% in 2020.
3.5 – Littoral mud (mudflats)	The proportion of littoral mud in England that was in a 'Favourable' or 'Unfavourable recovering' condition has been declining since 2011, falling below the 80% target in 2019.	The proportion of littoral mud in England that was in a 'Favourable' or 'Unfavourable recovering' condition was 91% in 2011 but 76% in 2020.	See cell to the left which covers the same period.	The proportion of littoral mud in England that was in a 'Favourable' or 'Unfavourable recovering' condition declined from 80% in 2019 to 76% in 2020.

3.6 – Saline lagoons	The proportion of the area covered by saline lagoons that was in a 'Favourable' or 'Unfavourable recovering' condition was just above its 80% target in 2011 but has been below ever since.	The proportion of the area covered by saline lagoons that were in a 'Favourable' or 'Unfavourable recovering' condition declined from 80% in 2011 to 61% in 2020.	See cell to the left which covers the same period.	The proportion of the area covered by saline lagoons that was in a 'Favourable' or 'Unfavourable recovering' condition declined from 62% in 2019 to 61% in 2020.
3.7 – Features of littoral rock	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.8 – High energy littoral rock	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.9 – moderate energy littoral rock	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.10 – Low energy littoral rock	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.11 – Littoral coarse sediment	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.12 – Littoral mixed sediment	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.13 – Supra littoral rock	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.
3.14 – Supra littoral sediment	No target or commitment was found/exist.	No data was found.	No data was found.	No data was found.

Saltmarsh

Coastal saltmarshes comprise of the upper, vegetated portions of intertidal mudflats, lying approximately between mean high-water neap tides and mean high-water spring tides.[122]

The condition of England's coastal saltmarsh has been stable between 2011 and 2017, and declining after 2017. The proportion of the total area of saltmarsh rated as 'Favourable' or 'Unfavourable recovering' has declined from 96% in 2017 to 90% in 2020: see Table 48. This proportion is still above the target of 80% for each habitat: see Figure 46.

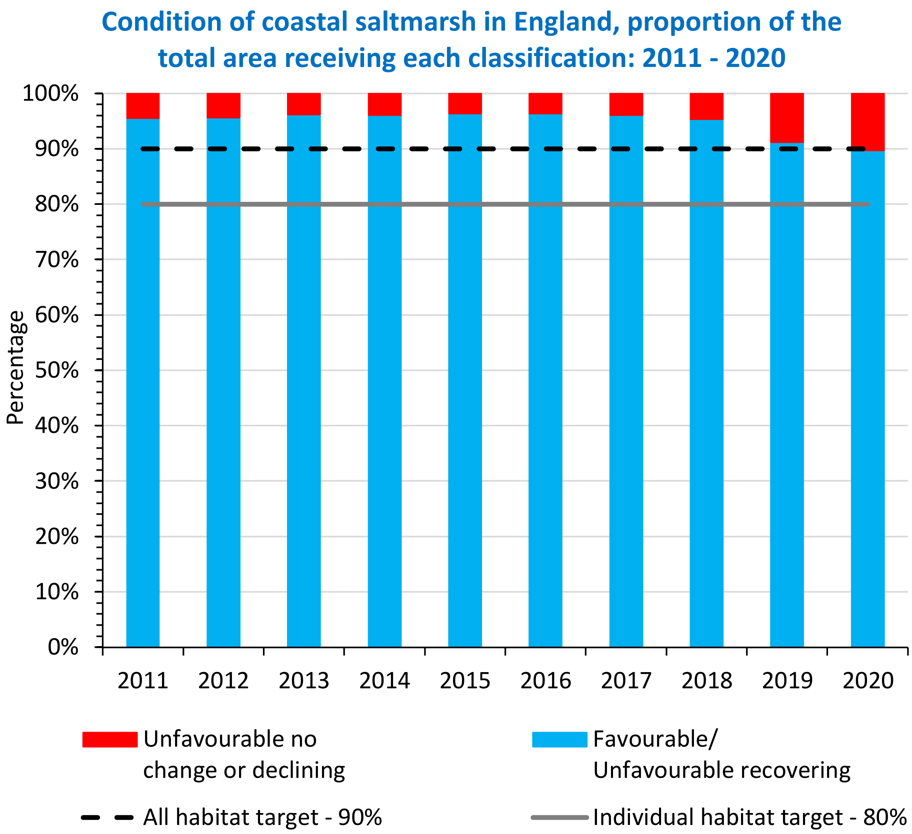
122 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

Table 48: Condition of coastal saltmarsh in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Coastal Saltmarsh	2011	96%	4%
	2012	96%	4%
	2013	96%	4%
	2014	96%	4%
	2015	96%	4%
	2016	96%	4%
	2017	96%	4%
	2018	95%	5%
	2019	91%	9%
	2020	90%	10%

Source: Natural England estimates published by Defra – data only available for latest year[123]

Figure 46: Condition of coastal saltmarsh in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[124]

123 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

124 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Of the area of saltmarsh designated as belonging to a SSSI, the proportion rated as being in a 'Favourable' condition has been fairly stable, varying between 73% and 75% since 2011: see Table 49.

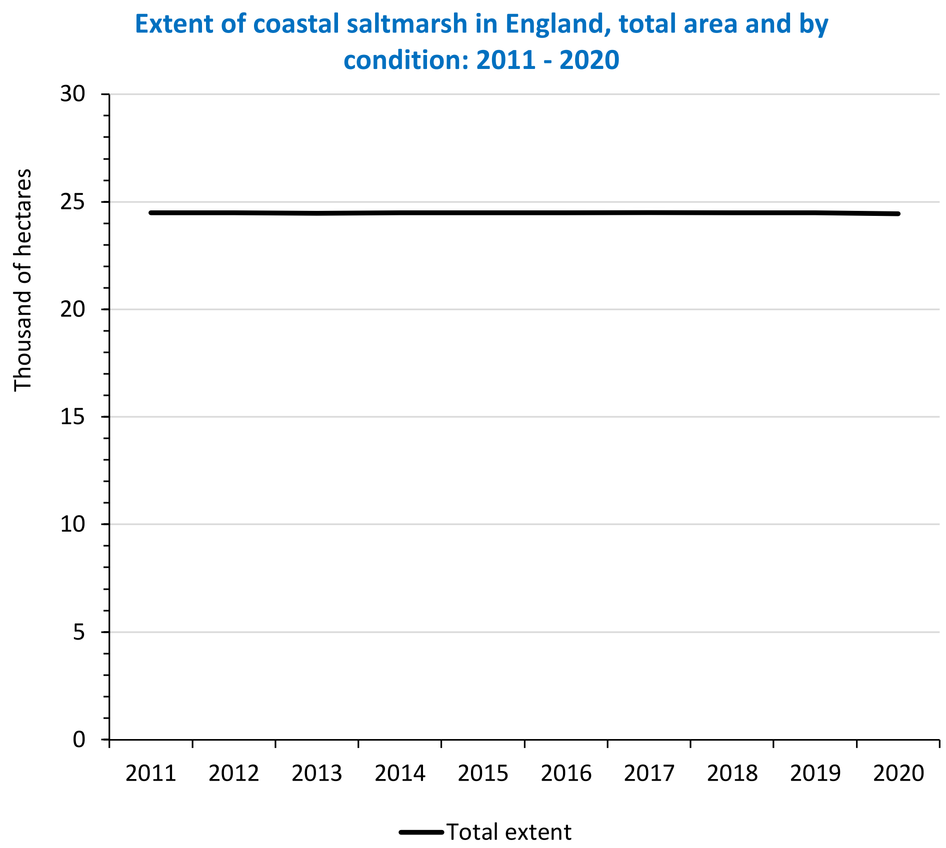
Table 49: Condition of coastal saltmarsh in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 – 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Coastal Saltmarsh	2011	73%	27%
	2012	74%	26%
	2013	75%	25%
	2014	75%	25%
	2015	75%	25%
	2016	75%	25%
	2017	75%	25%
	2018	75%	25%
	2019	74%	26%
	2020	74%	26%

Source: Natural England estimates published by Defra – data only available for latest year[125]

The total extent of coastal saltmarsh in England has been fairly stable since 2011 at around 24,500 hectares: see Figure 47.

Figure 47: Extent of coastal saltmarsh in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[126]

125 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

126 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Littoral sand (sand dunes)

'Coastal sand dunes develop where there is an adequate supply of sand (sediment within the size range 0.2 to 2.0 mm) in the intertidal zone and where onshore winds are prevalent. The critical factor is the presence of a sufficiently large beach plain whose surface dries out between high tides. The dry sand is then blown landwards and deposited above high water mark, where it is trapped by specialised dune-building grasses which grow up through successive layers of deposited sand.' – JNCC[127]

The condition of England's coastal sand dunes has remained fairly constant since 2011. The proportion of the total area of sand dunes that is classified as 'Favourable' or 'Unfavourable recovering' has fluctuated between 72% and 77%: see Table 50. This proportion has been below the target of 80% every year since 2011: see Figure 48.

Table 50: Condition of coastal sand dunes in England, proportion of the total area receiving each classification: 2011 - 2020

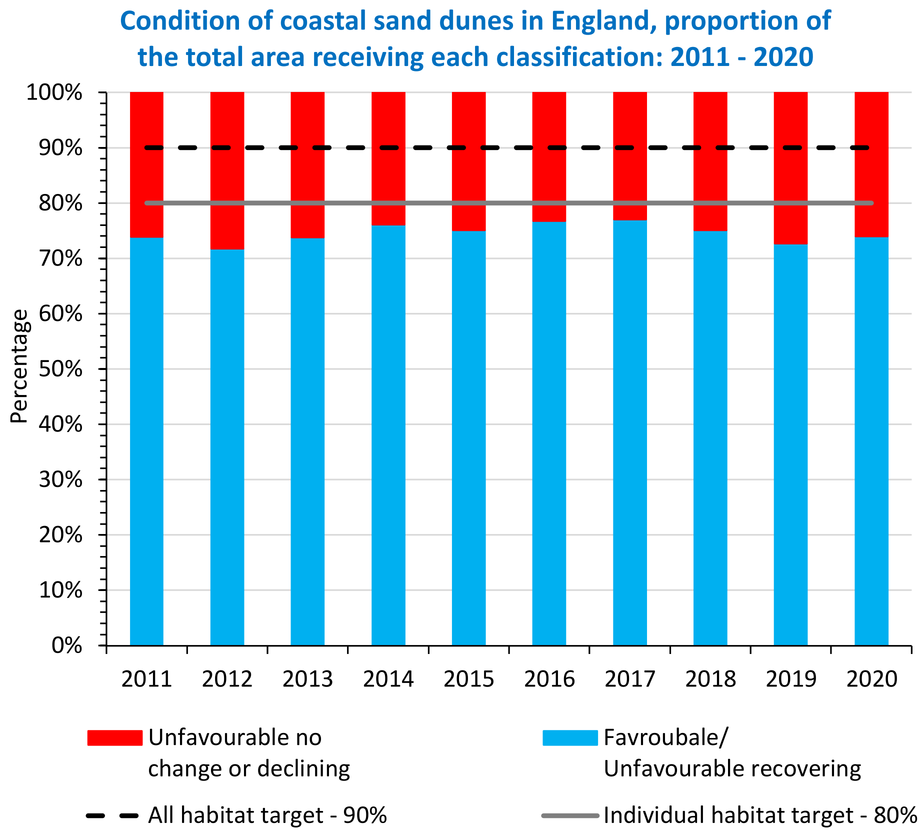
	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Coastal Sand Dunes	2011	74%	26%
	2012	72%	28%
	2013	74%	26%
	2014	76%	24%
	2015	75%	25%
	2016	77%	23%
	2017	77%	23%
	2018	75%	25%
	2019	73%	27%
	2020	74%	26%

Source: Natural England estimates published by Defra – data only available for latest year[128]

127 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

128 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Figure 48: Condition of coastal sand dunes in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[129]

Of the sand dunes designated as belonging to an SSSI, the proportion of the area being classed as in 'Favourable' condition has declined over the period from 38% in 2011 to 27% in 2020: see Table 51.

Table 51: Condition of coastal sand dunes in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Coastal Sand Dunes - SSSI	2011	38%	62%
	2012	34%	66%
	2013	33%	67%
	2014	34%	66%
	2015	33%	67%
	2016	33%	67%
	2017	32%	68%
	2018	27%	73%
	2019	27%	73%
	2020	27%	73%

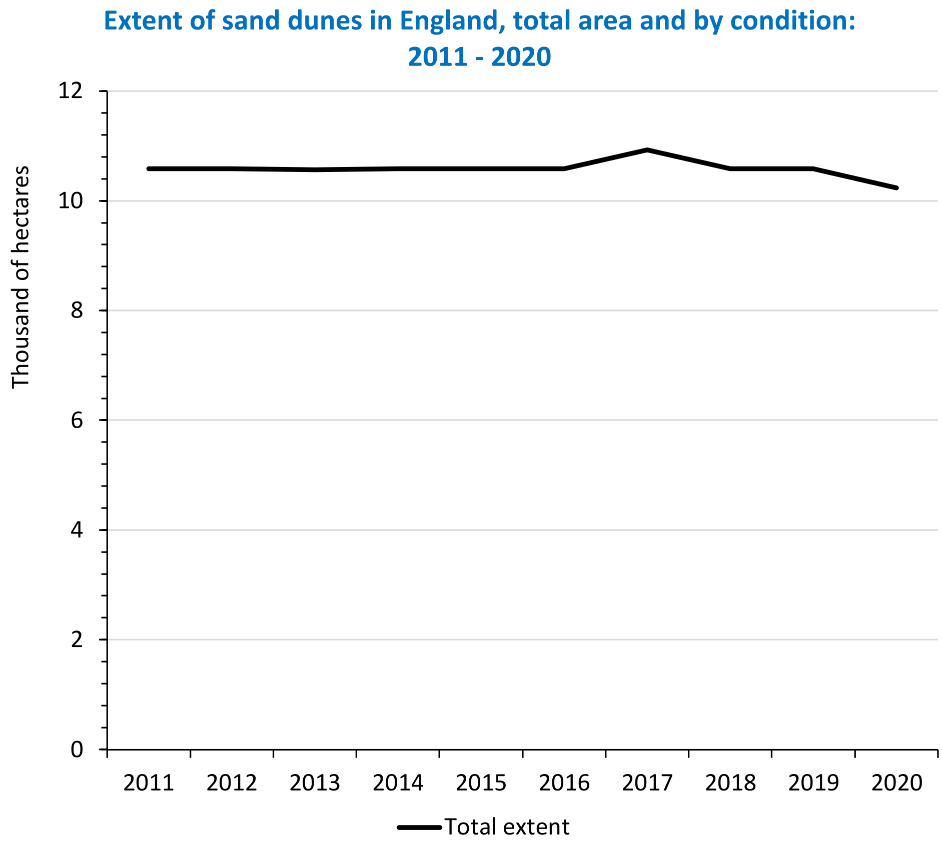
Source: Natural England estimates published by Defra – data only available for latest year[130]

129 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

130 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The total area of sand dunes in England was fairly constant at around 10,600 hectares between 2011 and 2016, before rising to 10,929 hectares in 2017, and then falling over the next three years to 10,236 in 2020: see Figure 49.

Figure 49: Extent of sand dunes in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[131]

Vegetated shingle

'Shingle is defined as sediment with particle sizes in the range 2-200 mm. It is a globally restricted coastal sediment type with few occurrences outside north-west Europe, Japan and New Zealand. Shingle beaches are widely distributed round the coast of the UK, where they develop in high energy environments. In England and Wales it is estimated that 30% of the coastline is fringed by shingle. However most of this length consists of simple fringing beaches within the reach of storm waves, where the shingle remains mobile and vegetation is restricted to temporary and mobile strandline communities.' – JNCC[132]

The condition of England's coastal vegetated shingle has deteriorated gradually since 2011. The proportion of the total area of coastal vegetated shingle classed as being in a 'Favourable' or 'Unfavourable recovering' condition has fallen from 86% in 2011 to 81% in 2020: see Table 52. This proportion has been below the 90% target every year and is in danger of falling below the 80% target: see Figure 50.

131 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

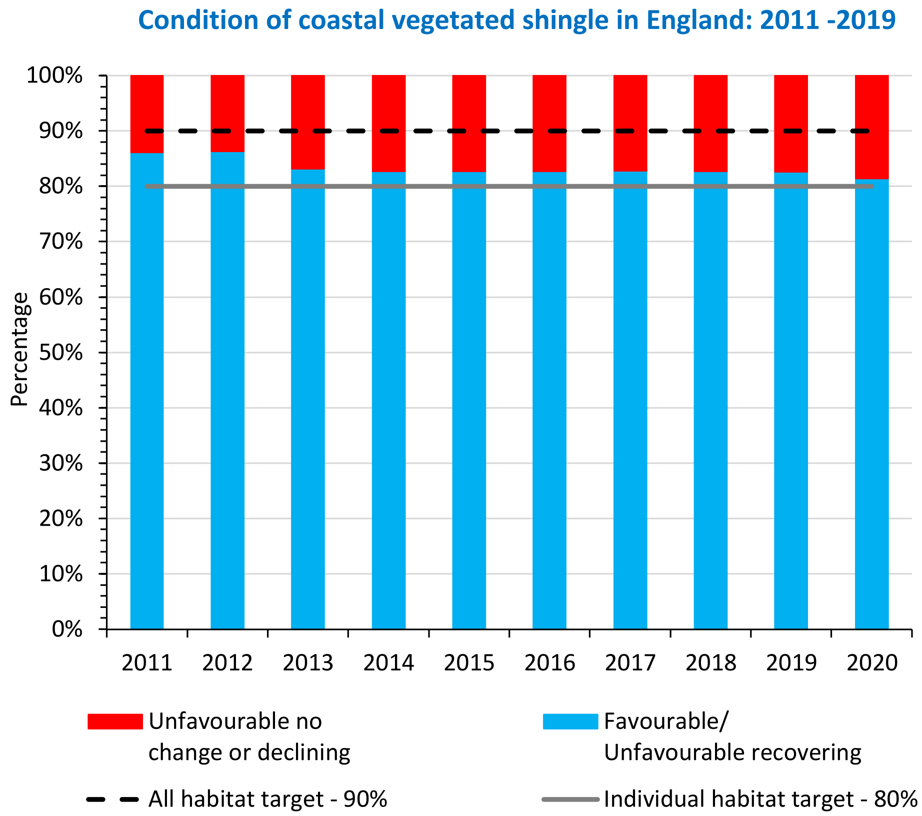
132 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

Table 52: Condition of coastal vegetated shingle in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Coastal Vegetated Shingle	2011	86%	14%
	2012	86%	14%
	2013	83%	17%
	2014	83%	17%
	2015	83%	17%
	2016	83%	17%
	2017	83%	17%
	2018	83%	17%
	2019	83%	17%
	2020	81%	19%

Source: Natural England estimates published by Defra – data only available for latest year[133]

Figure 50: Condition of coastal vegetated shingle in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[134]

133 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

134 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Of the coastal vegetated shingle designated as belonging to a SSSI, the proportion of the area classified as being in 'Favourable' condition has fallen from 52% in 2011 to 41% in 2020: see Table 53.

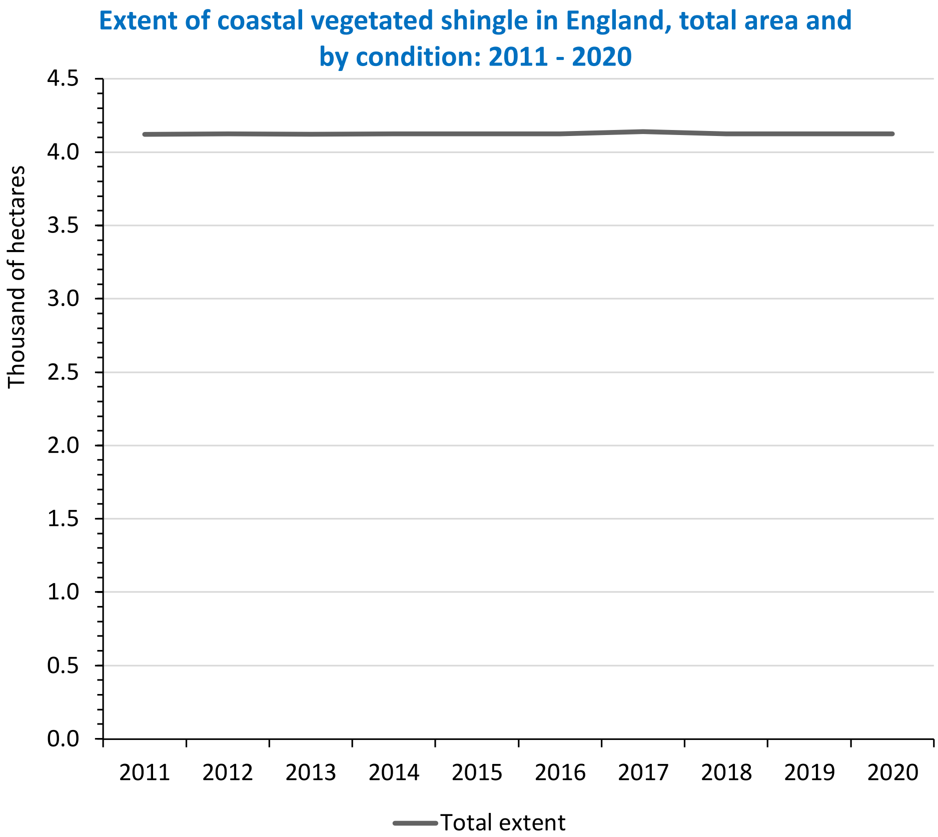
Table 53: Condition of coastal vegetated shingle in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Coastal Vegetated Shingle - SSSI	2011	52%	48%
	2012	52%	48%
	2013	47%	53%
	2014	41%	59%
	2015	41%	59%
	2016	41%	59%
	2017	41%	59%
	2018	41%	59%
	2019	40%	60%
	2020	41%	59%

Source: Natural England estimates published by Defra – data only available for latest year[135]

The extent of coastal vegetated shingle in England has been near-constant since 2011 at around 4,120 hectares: see Figure 51.

Figure 51: Extent of coastal vegetated shingle in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[136]

135 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

136 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Maritime cliffs and slopes

'Maritime cliffs and slopes comprise sloping-to-vertical faces on the coastline where a break in slope is formed by slippage and/or coastal erosion. There appears to be no generally accepted definition of the minimum height or angle of slope which constitutes a cliff, but the zone defined as cliff-top (also covered in this plan) should extend landward to at least the limit of maritime influence (i.e. limit of salt spray deposition), which in some exposed situations may continue for up to 500 m inland. This plan may therefore encompass entire islands or headlands, depending on their size. On the seaward side, the plan extends to the limit of the supralittoral zone and so includes the splash zone lichens and other species occupying this habitat. Approximately 4,000 km of the UK coastline has been classified as cliff.' – JNCC[137]

The condition of this habitat has been fairly constant since 2011. The proportion of the total area classed as being in a 'Favourable' or 'Unfavourable recovering' condition increased gradually for the first few years from 68% in 2011 to 75% in 2015: see Table 54. The proportion then decreased gradually to 72% by 2020. The 90% and 80% targets have been missed every year since 2011: see Figure 52.

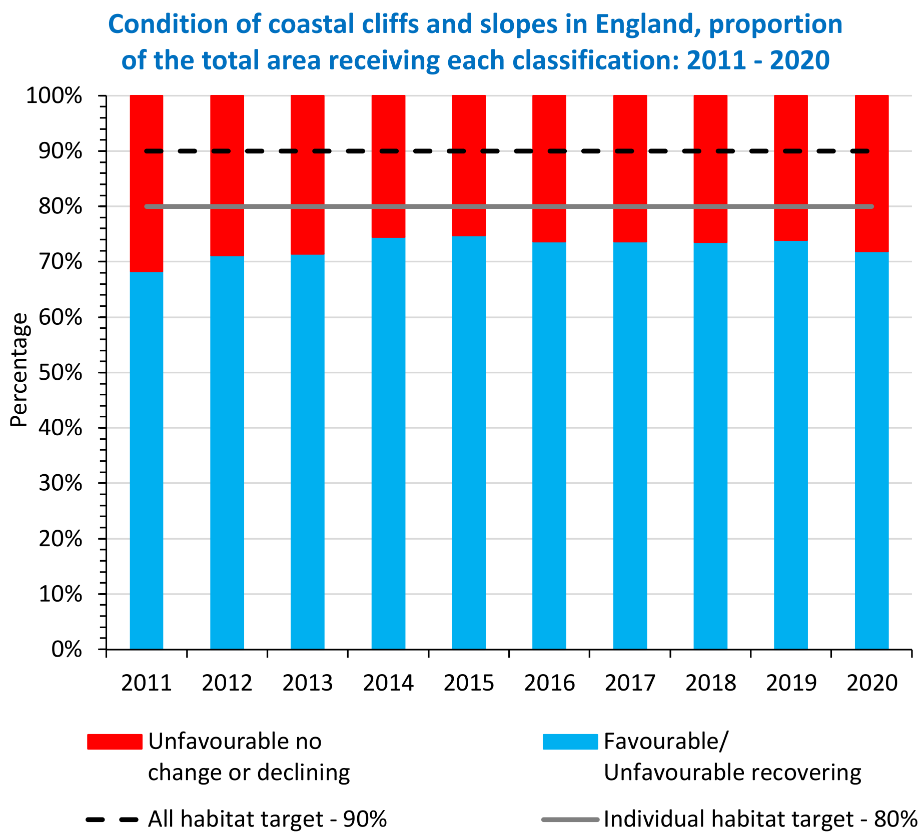
Table 54: Condition of maritime cliffs and slopes in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable no change or declining
Maritime Cliffs and Slopes	2011	68%	32%
	2012	71%	29%
	2013	71%	29%
	2014	74%	26%
	2015	75%	25%
	2016	74%	26%
	2017	74%	26%
	2018	74%	26%
	2019	74%	26%
	2020	72%	28%

Source: Natural England estimates – data is only published for the latest year

137 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

Figure 52: Condition of coastal cliffs and slopes in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[138]

Of the area of coastal cliffs and slopes designated as belonging to a SSSI in England, the proportion classified as being in a 'Favourable' condition has been gradually decreasing, from 72% in 2011 to 68% in 2020 – See Table 55 for the trend since 2011.

Table 55: Condition of coastal cliffs and slopes in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/ recovering
Maritime Cliff and Slope - SSSI	2011	72%	28%
	2012	71%	29%
	2013	71%	29%
	2014	70%	30%
	2015	70%	30%
	2016	69%	31%
	2017	69%	31%
	2018	68%	32%
	2019	68%	32%
	2020	68%	32%

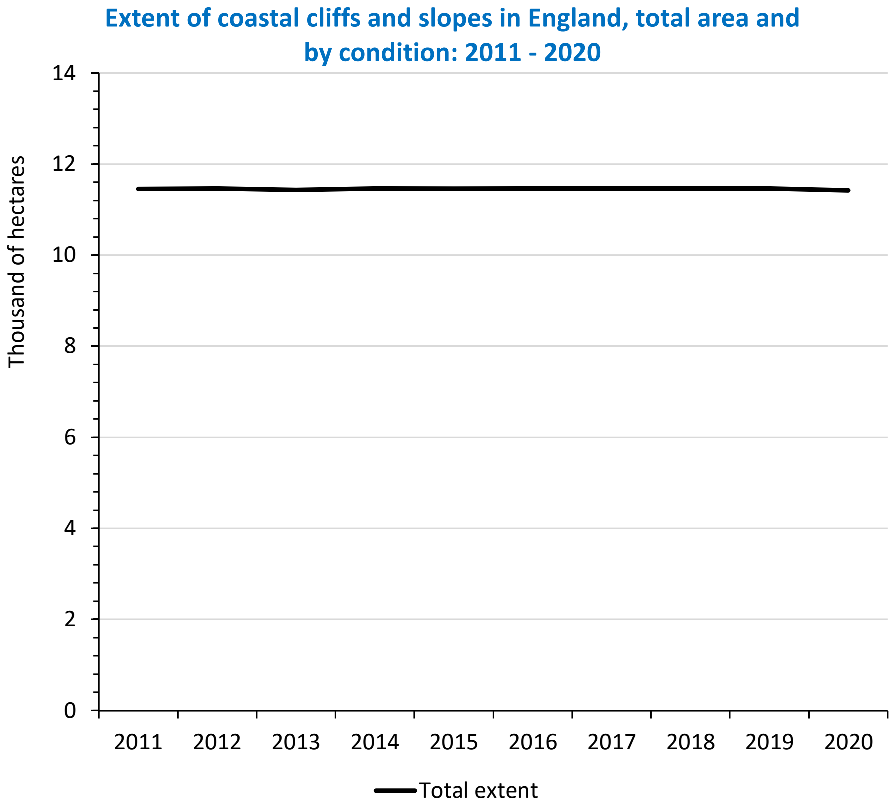
Source: Natural England estimates published by Defra – data only available for latest year[139]

138 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

139 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The total extent of coastal cliffs and slopes in England has been fairly constant since 2011 at around 11,400 hectares: see Figure 53.

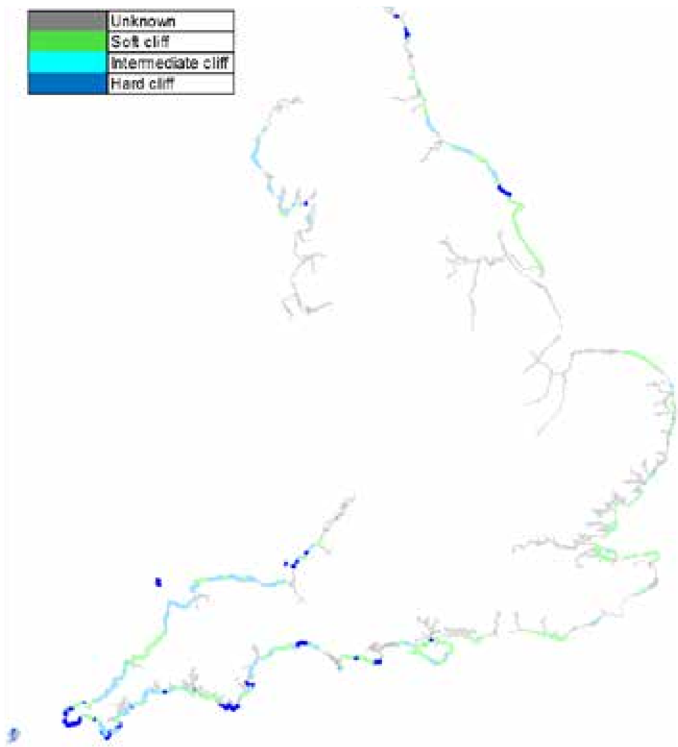
Figure 53: Extent of coastal cliffs and slopes in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[140]

Figure 54 shows how the different types of cliff were distributed in 2004/5.

Figure 54: Extent of maritime cliffs and slopes in 2004/2005



Source: Natural England[141]

140 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

141 Natural England, *Maritime cliff and slope inventory 2004/2005 (NERR003) (2007)* http://publications.naturalengland.org.uk/publication/35021

Littoral mud (mudflats)

'Mudflats are sedimentary intertidal habitats created by deposition in low energy coastal environments, particularly estuaries and other sheltered areas. Their sediment consists mostly of silts and clays with a high organic content. In large estuaries, they may be several kilometres wide and commonly form the largest part of the intertidal area of estuaries. However, in many places they have been much reduced by land claim.' – JNCC[142]

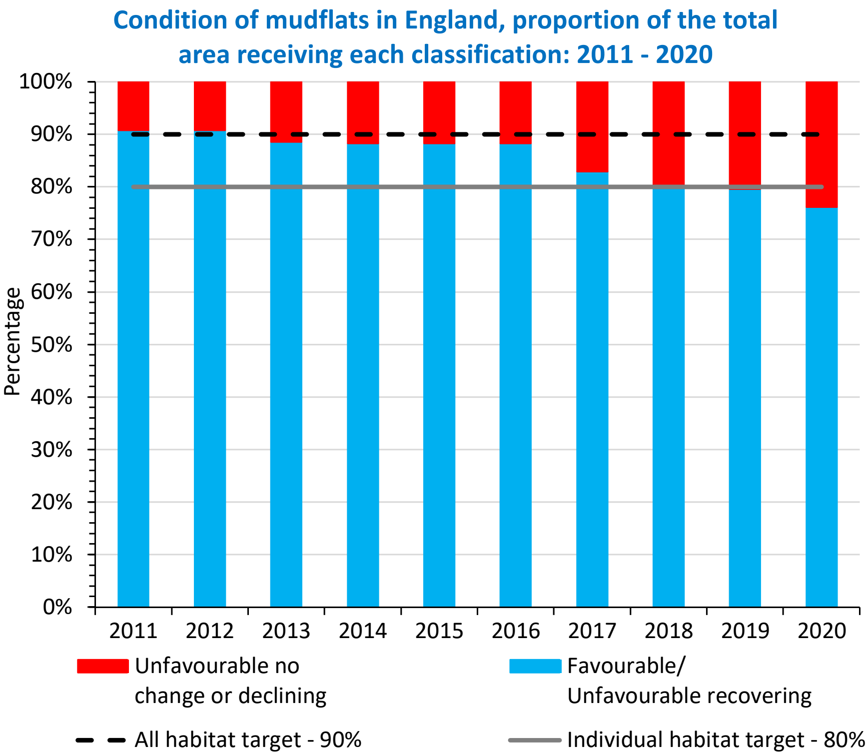
The condition of England's mudflats has deteriorated significantly since 2011. In 2011, the proportion of their area classed as being in a 'Favourable' or 'Unfavourable recovering' condition was 91% (see Table 56), above both the 80% and 90% targets. However, this proportion has declined steadily since, reaching 76% in 2020, which is below both targets: see Figure 55.

Table 56: Condition of mudflats in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Mudflats	2011	91%	9%
	2012	91%	9%
	2013	89%	11%
	2014	88%	12%
	2015	88%	12%
	2016	88%	12%
	2017	83%	17%
	2018	80%	20%
	2019	80%	20%
	2020	76%	24%

Source: Natural England estimates published by Defra – data only available for latest year[143]

Figure 55: Condition of mudflats in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[144]

142 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

143 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

144 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The condition of those mudflats which have been designated as SSSIs has also deteriorated. The proportion of their area classed as being in a 'Favourable' condition has decreased from 55% in 2011 to 51% in 2020: see Table 57.

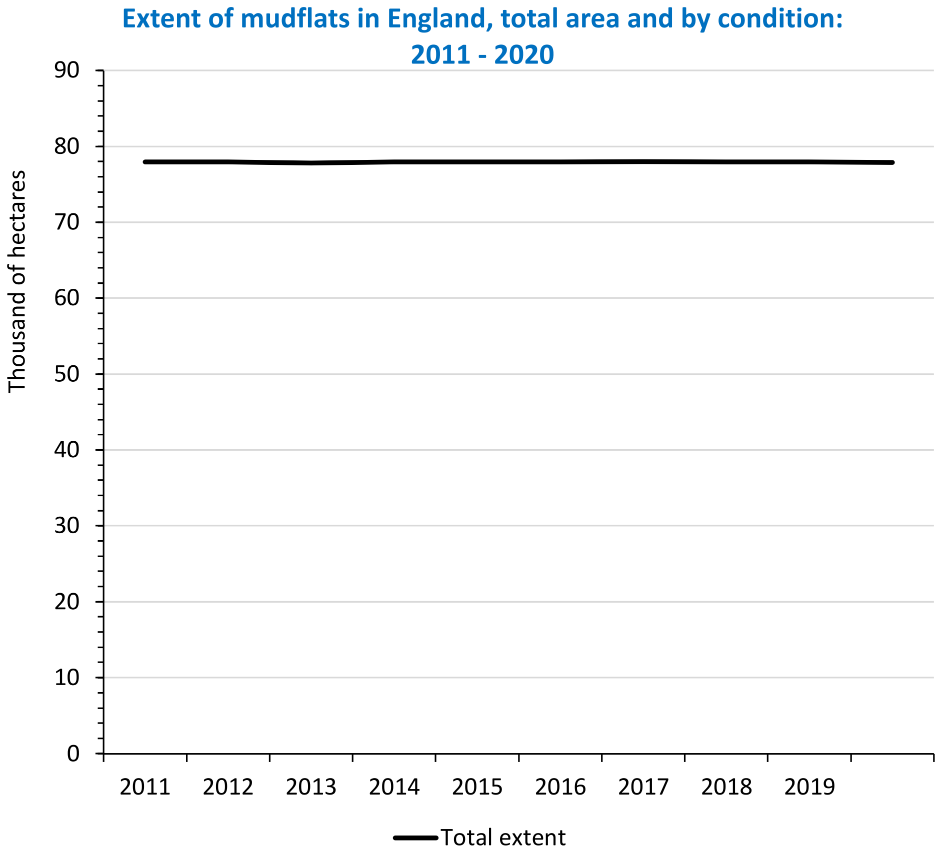
Table 57: Condition of mudflats in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Mudflats - SSSI	2011	55%	45%
	2012	55%	45%
	2013	54%	46%
	2014	54%	46%
	2015	54%	46%
	2016	54%	46%
	2017	54%	46%
	2018	52%	48%
	2019	53%	47%
	2020	51%	49%

Source: Natural England estimates published by Defra – data only available for latest year[145]

The total area covered by mudflats in England has, however, remained fairly constant since 2011 at just under 78,000 hectares: see Figure 56.

Figure 56: Extent of mudflats in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[146]

145 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

146 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Saline lagoons

A lagoon is a natural or artificial body of saline water partially separated from adjacent sea.[147]

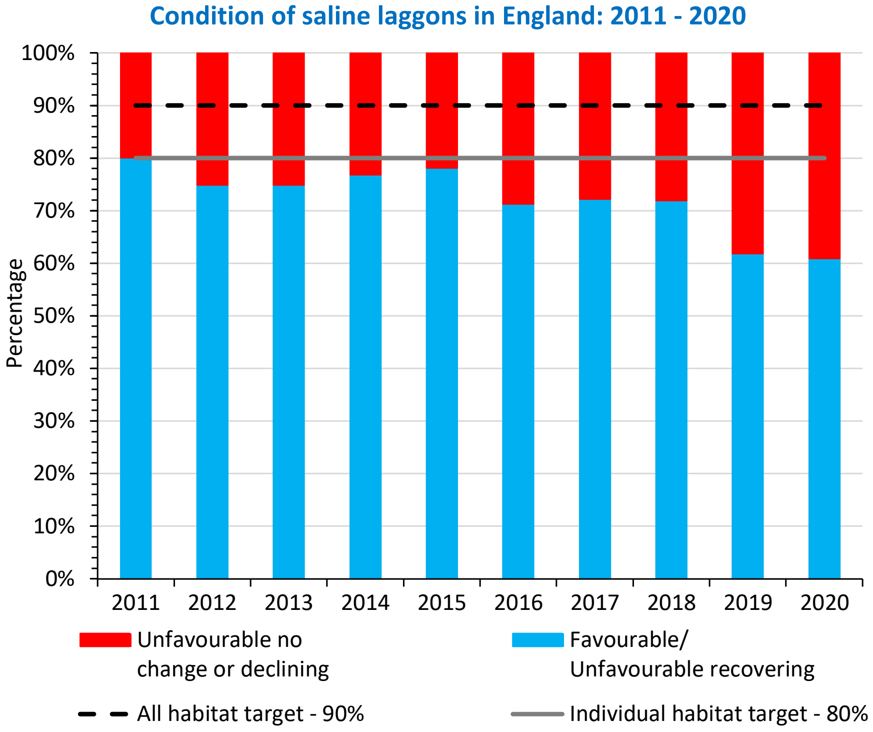
The condition of England's saline lagoons has deteriorated significantly since 2011. In 2011, the proportion of the total area classed as having a 'Favourable' or 'Unfavourable recovering' condition was just above the 80% target (though below the 90% target): see Figure 57. This proportion has since trended downward, reaching as low as 61% in 2020: see Table 58.

Table 58: Condition of saline lagoons in England, proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable/ Unfavourable recovering	Unfavourable, no change, or declining
Saline lagoons	2011	80%	20%
	2012	75%	25%
	2013	75%	25%
	2014	77%	23%
	2015	78%	22%
	2016	71%	29%
	2017	72%	28%
	2018	72%	28%
	2019	62%	38%
	2020	61%	39%

Source: Natural England estimates published by Defra – data only available for latest year[148]

Figure 57: Condition of saline lagoons in England, proportion of the total area receiving each classification: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[149]

147 JNCC, *UK Biodiversity Action Plan Priority Habitat Descriptions (2011)*https://data.jncc.gov.uk/data/2728792c-c8c6-4b8c-9ccd-a908cb0f1432/UKBAP-PriorityHabitatDescriptions-Rev-2011.pdf

148 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

149 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

The condition of saline lagoons designated as belonging to a SSSI has also deteriorated significantly. The proportion of their area rated as being in a 'Favourable' condition has fallen from 80% in 2011 to 65% in 2020: see Table 59.

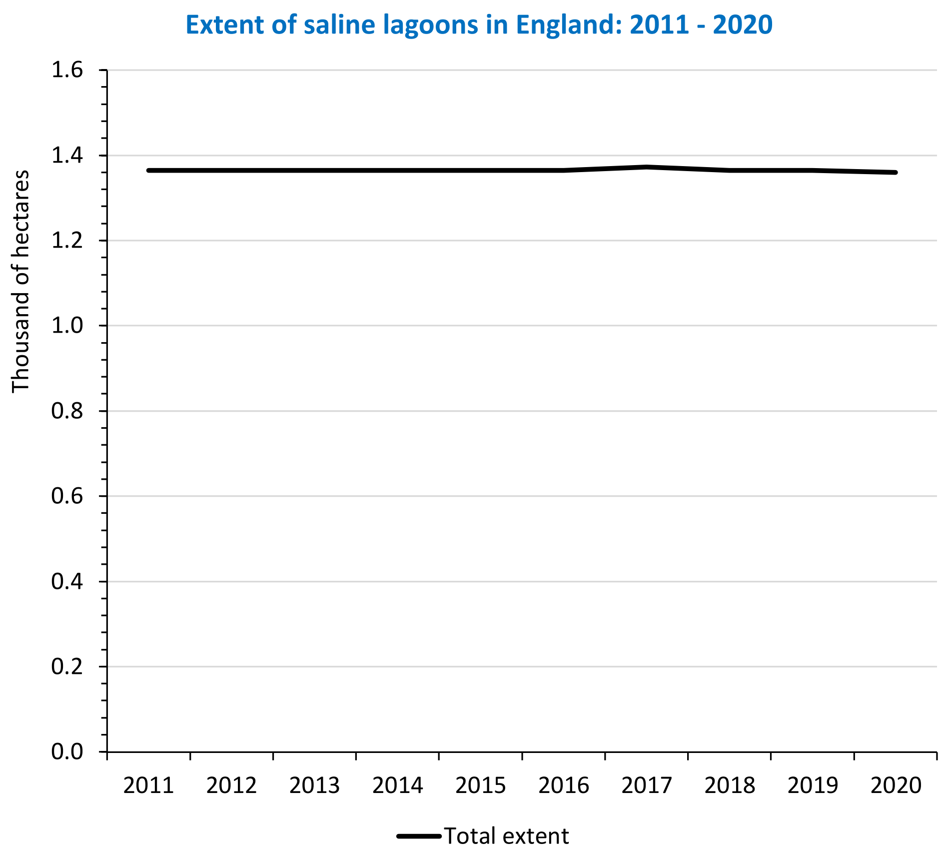
Table 59: Condition of saline lagoons in England designated as belonging to a Site of Special Scientific Interest (SSSI), proportion of the total area receiving each classification: 2011 - 2020

	Year	Favourable	Unfavourable, no change, or declining/recovering
Saline lagoons - SSSI	2011	80%	20%
	2012	80%	20%
	2013	80%	20%
	2014	80%	20%
	2015	80%	20%
	2016	76%	24%
	2017	76%	24%
	2018	76%	24%
	2019	65%	35%
	2020	65%	35%

Source: Natural England estimates published by Defra – data only available for latest year[150]

The area covered by saline lagoons in England has been fairly constant since 2011 at around 1,370 hectares: see Figure 58.

Figure 58: Extent of saline lagoons in England: 2011 - 2020



Source: Natural England estimates published by Defra – data only available for latest year[151]

150 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

151 Defra, *ENV09 - England biodiversity indicators (2019)* https://www.gov.uk/government/statistical-data-sets/env09-england-biodiversity-indicators

Littoral rock

No data has been found on the condition or extent of these habitats, because their importance was overlooked when the priority habitats were designated. The following habitats are areas where people enjoy rock-pooling. Except in very high-energy zones they have high growths of algae, primary producers which fix carbon dioxide. Much of this carbon dioxide is then subducted and sequestered offshore. These habitats are important as nursery areas, as feeding areas, and as potential sources of biofuels.

Features of littoral rock

'Littoral rock features includes lichens and algae crusts in the supralittoral zone and rockpools, ephemeral algae and caves in the intertidal zone (the area of the shore between high and low tides).' – JNCC[152]

High-energy littoral rock

This habitat consists of 'Extremely exposed to moderately exposed or tide-swept bedrock and boulder shores. Extremely exposed shores [are] dominated by mussels and barnacles, occasionally with robust fucoids or turfs of red seaweed. Tide-swept shores support communities of fucoids, sponges and ascidians on the mid to lower shore.' – JNCC[153]

Moderate-energy littoral rock

This habitat consists of 'Moderately exposed shores (bedrock, boulders and cobbles) characterised by mosaics of barnacles and fucoids on the mid and upper shore; with fucoids and red seaweed mosaics on the lower shore.' – JNCC[154]

Low-energy littoral rock

This habitat consists of 'Sheltered to extremely sheltered rocky shores with very weak to weak tidal streams… typically characterised by a dense cover of fucoid seaweeds which form distinct zones.' – JNCC[155]

Littoral coarse sediment

'Littoral coarse sediments include shores of mobile pebbles, cobbles and gravel, sometimes with varying amounts of coarse sand. The sediment is highly mobile and subject to high degrees of drying between tides. As a result, few species are able to survive in this environment. Beaches of mobile cobbles and pebbles tend to be devoid of macroinfauna, while gravelly shores may support limited numbers of crustaceans, such as Pectenogammarus planicrurus.' – JNCC[156]

Littoral mixed sediment

This habitat consists of 'Shores of mixed sediments ranging from muds with gravel and sand components to mixed sediments with pebbles, gravels, sands and mud in more even proportions. By definition, mixed sediments are poorly sorted. Stable large cobbles or boulders may be present which support epibiota such as fucoids and green seaweeds more commonly found on rocky and boulder shores. Mixed sediments which are predominantly muddy tend to support infaunal communities which are similar to those of mud and sandy mud shores.' – JNCC[157]

152 JNCC, *Description of biotype or habitat type: Features of littoral rock* https://mhc.jncc.gov.uk/biotopes/jnccmncr00000369

153 JNCC, *Description of biotype or habitat type: High energy littoral rock*https://mhc.jncc.gov.uk/biotopes/jnccmncr00000780#:~:text=Extremely%20exposed%20to%20moderately%20exposed,the%20mid%20to%20lower%20shore.

154 JNCC, Description of biotype or habitat type: Moderate energy littoral rock https://mhc.jncc.gov.uk/biotopes/jnccmncr00000737

155 JNCC, *Description of biotype or habitat type: Low energy littoral rock*https://mhc.jncc.gov.uk/biotopes/jnccmncr00000495

156 JNCC, *Description of biotype or habitat type: Littoral coarse sediment*https://mhc.jncc.gov.uk/biotopes/jnccmncr00000269

157 JNCC, *Description of biotype or habitat type: Littoral mixed sediment*https://mhc.jncc.gov.uk/biotopes/jnccmncr00000313

Annex 6

Biota

Biota

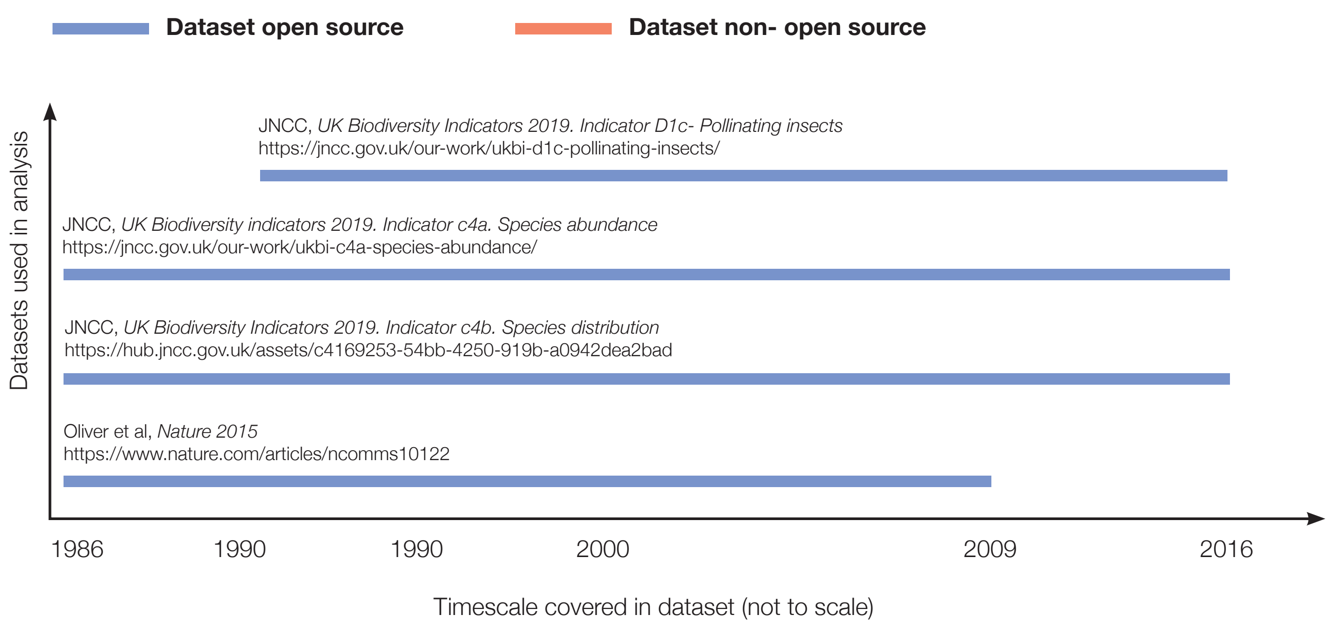
Background

Species and ecological communities deliver a multitude of benefits to humans and ensure ecosystems continue to function, for example they have a role in: decomposition and nutrient cycling, predation, carbon storage and sequestration, pollination, recreation, clean air and water, water purification and pest control. There is plenty of evidence that species and the ecological communities they inhabit are in decline and targets to prevent this happening are not being met. For example, the recent Convention on Biological Diversity report states that "*none of the Aichi Biodiversity Targets will be fully met*".[1] This has implications not only for the species themselves but also for the wealth of benefits to humans that they provide; both are at risk.

In order to illustrate the biota framework the Natural Capital Committee (NCC) have presented in this analysis, several datasets have been used, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the biota asset

Datasets used in biota asset analysis, timescale covered and their status (open or non-open source)



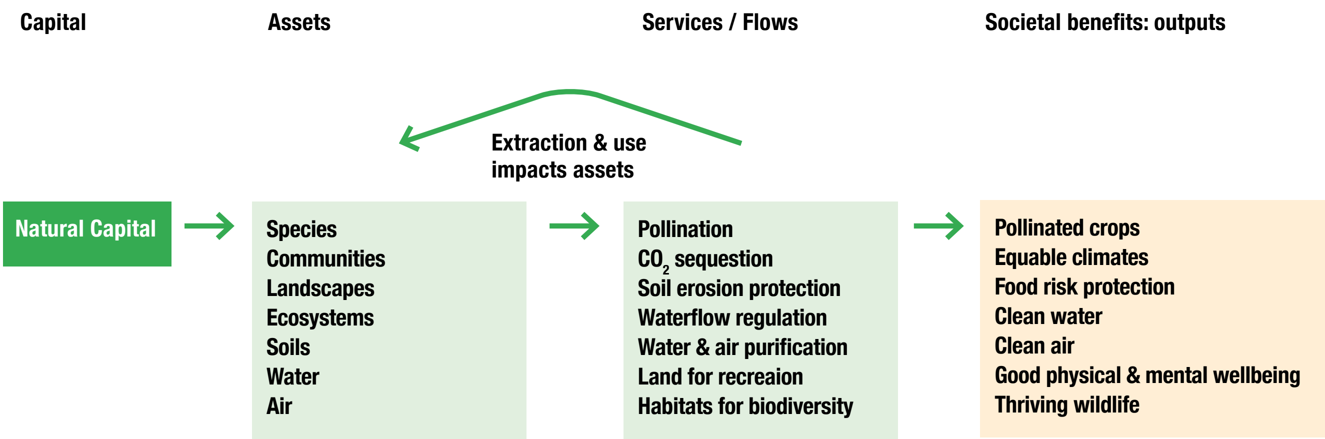
Source: NCC 2020

1 Convention on Biological Diversity, *Global Biodiversity Outlook 5* (2020): https://www.cbd.int/gbo5

The biota framework

The NCC has developed the following high level framework to categorise and measure the components of the species asset. It has illustrated its approach with terrestrial examples of how an analysis can be undertaken but it has not completed a full and extensive search for datasets which could have been used. Other biotic assets, such as, freshwaters and marine should follow the same framework, the Committee has not included examples of datasets which could be used against these assets. Nor has it reviewed and categorised all species into its suggested groups. These outstanding tasks should be carried out by the Office for Environmental Protection (OEP), once it is established.

Figure 1: the relationship between natural capital assets and the services and benefits they provide



Souce Willis et al[2]

The NCC's 2014 paper, 'Towards a framework for defining and measuring changes in natural capital' defines species as: "*all living organisms including plants, animals, fungi and microorganisms"* and ecological communities as "*a group of actually or potentially interacting species living in the same physical environment e.g. wildlife habitats*."[3] This definition of species identifies that, at its simplest level, the components of the asset should be all species which are established in England. However, assessing all species using taxonomic categories has multiple issues and would lead to a large, complex and difficult to interpret analysis. It is therefore necessary to develop a natural capital method to categorise which species should form part of this assessment. The NCC's assessment has focused on a number of terrestrial species and ecological communities that are known to underpin critical ecosystem services and therefore any decline would result in a loss of the important societal benefits that they provide (Figure 1; and the infographic on page 20). The components identified by the Committee in this analysis should be developed further to examine in detail all biotic asset componenets in ecosystems that are known to support key ecosystem services. To ensure these are captured, the NCC recommend measuring species using the following three categories:

1. Species which are critical for ecosystem function;
2. Species which support other flows / ecosystem services, and;
3. Rare, iconic or protected species.

By using these three categories, it is possible to capture the species which underpin the various ecosystem services[4] (Figure 1). This assessment attempts to consider all services species directly or indirectly provide and whether they result in private and public goods.[5] It is important to recognise that species can support a variety of ecosystem services and goods; for example, trees can provide timber, fuel, carbon storage and sequestration, water flow regulation, soil erosion protection and recreation. There is likely to be overlap in species between the three categories set out above – which underlies their importance in supporting multiple ecosystem services.

2 Willis, K.J., et al., (unpubished)

3 NCC, Working paper: Towards a framework for defining and measuring changes in natural capital (March 2014): https://www.gov.uk/government/publications/natural-capital-committee-initial-term-working-papers- 2012-to-2015

4 Ecosystem services or flows as defined in the NCC terminology document are: The current flow of ecosystem services provided by natural capital stocks and the systems within which they are embedded. These yield the welfare-bearing goods and services which provide actual or potential benefits to humans. Flows can be split between ecosystem and abiotic services.

5 Goods as defined in the NCC terminology document are: Fish, timber, farmed food and drinking water are all examples of goods that deliver benefits or are of 'value' to humans. However, other types of goods and services can produce wellbeing even without a direct use. For example, the knowledge that a valued species continues to exist can generate wellbeing.

1. Species which are critical to ecosystem function

Core functioning species such as those which support production, decomposition and nutrient cycling are fundamental to the functioning of ecosystems. These species can rarely be directly valued for their contribution in natural capital assessments but without these species the asset would cease to function.

Examples are: microorganisms for their role in decomposition and nutrient cycling; primary producers (plants on land and in water and phytoplankton, algae and other autotrophic micro-organisms in water) for biomass and carbon; top predators and parasites for population regulation; pollinators for stability of non-agricultural systems; biogenic habitat generators and maintainers for biomass, carbon storage and sequestration, and stability of seabed systems.

2. Species which support other flows / ecosystem services and goods

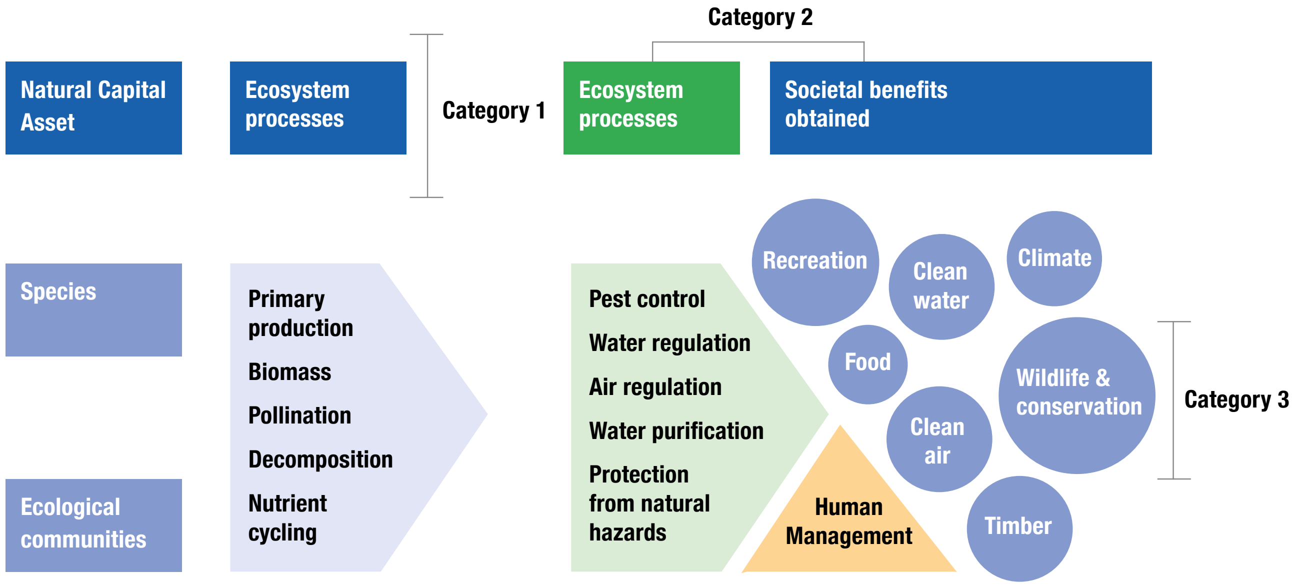
Other flows and goods include protection from natural hazards, recreation, clean air and water, pollination, pest control and water purification. These often result in direct goods and can often be valued for their contribution and their direct and important benefits to humans.

Examples include: wild crop and livestock relatives for genetic diversity; pollinators for food crop security; species which make up biogenic reefs for flood defence and extreme weather mitigation.

3. Rare, iconic or protected species

Species can be assessed in two different categories when undertaking natural capital assessments. They are both an asset in themselves but there are also species which have direct benefits to people through conservation priorities, as illustrated in Figure 2 below:

Figure 2: Schematic of biota asset components and a selection of ecosystem processes, services and goods illustrating the categories in this analysis



Source: NCC 2020

This category should seek to monitor the species which are classified rare or iconic.

Examples include: large vertebrates, birds, mammals, flowering plants; flagship or umbrella species which provide protection for wider communities or habitats; phylogenetically distinct species; endangered species.

How and what should be measured?

The first required step in the NCC's approach is to assign species to the three identified categories. The NCC provides some examples detailing this approach below but has not done this comprehensively. The OEP should urgently begin the process of reviewing and assigning species to the categories, which will then reveal where there are gaps in data collection. The Committee believe that there are many gaps in both spatial knowledge of species in these categories and temporal variations. There are also clear biases in the way that the data collected. The recent UK National Ecosystem Assessment (NEA), for example, found the quality of data was highest for groups considered important for cultural value. The NEA also demonstrated that there is currently very little information on the distribution and population trends of microorganisms, lower plants and micro-invertebrates.[6] These species fall within the NCC's first category and gaps in this data should be urgently rectified.

The NCC advise that measuring the condition of these underpinning assets is essential to ensuring the continuity of ecosystem services they provide.[7] Even if depleted or degraded, these assets can still deliver a multitude of ecosystem services. However, it also indicates where restoration work is required to enhance the services they provide.[8] This is a challenge in below ground assets such as soil microbiology where it is hard to easily determine the specific state.

To quickly advance the collection of data, the OEP should consider the additional use of asset data collected by volunteers and citizen scientists. Recent advances in modelling have greatly improved the quality of this data and removed forms of bias including uneven recording intensity over time and uneven detectability.[9] Further work is required to assess how much of the data held in recording schemes can be used to assess the occupancy of species.

To measure any asset (stock) it is necessary to record both its extent and condition. Table 1 below suggests measures which could be used to achieve this.

Table 1: Proposed measures the species asset.

	Proposed measures
Extent	Extent metrics in terrestrial systems to include occupancy data and trends over time. For marine abundance to include unit area on or in seabed or per unit volume in the water column.
Condition	Measuring the condition of a species should aim to include population size and landscape connectivity between individuals/populations. Marine condition should be measured via individual / population / habitat function e.g. in sediments how well and to what depth species bioturbation oxygenates the sediments, the rates of nutrient flow across the sediment water interface and organic carbon loadings in water and in sediment. Condition can also be measured by assessing overall diversity or functional diversity. Diversity as a measure, for example, has a role in delivering some ecosystem services as well as ensuring resilience of the service delivery. Phenology, particularly for marine and the timings of phytoplankton and zooplankton blooms – the timing of these events can be used as a measure of condition.

6 UK National Ecosystem Assessment, *Concepts (2020):* http://uknea.unep-wcmc.org/EcosystemAssessmentConcepts/tabid/98/Default.aspx

7 Mace, G. M. *et al Biodiversity and ecosystem services: a multi-layered relationship (2012):* https://www.sciencedirect.com/science/article/pii/S0169534711002424

8 NCC, *State of natural capital: restoring our natural assets (2014):* https://www.gov.uk/government/publications/natural-capital-committees-second-state-of-natural-capital-report

9 Outhwaite *et al Annual estimates of occupancy for bryophytes, lichens and invertebrates in the UK, 1970-2015 (2019):* https://www.researchgate.net/publication/337032974_Annual_estimates_of_occupancy_for_bryophytes_lichens_and_invertebrates_in_the_UK_1970-2015

Methodology

There are currently records for around 27,000 species of plants, animals, fungi and microorganisms in the UK. These are available via the following open-source databases:

- The National Biodiversity Network atlas data[10];
- The Ocean Biodiversity Information System database[11];
- The Patheon database[12], and;
- The JNCC taxon designations dataset.[13]

However, to identify which of these species fall into the three categories is a major undertaking and something we recommend the OEP takes forward. For this annex and to gain a broad oversight of the trends in the three natural capital categories described above, the Committee used the following datasets and indexes to illustrate our approach as follows:

- Oliver *et al*[14];
- JNCC pollinator index[15], and;
- JNCC priority species index.[16]

Summary of biota assessment

The overall assessment of the biota annex – based on the examples provided – **is 'Red': species are declining over the timescale in which they were assessed**. This assessment is based on the examples used for each of the four categories:

1. Species which are critical for ecosystem function
   a. Pollinators
2. Species which support other flows / ecosystem services and goods
   a. Natural pest control
3. Rare / iconic / protected species
   a. Priority species

The assessment uses a 'RAG' rating approach to indicate the status of the biota asset and associated components. The RAG rating is based on a trend assessment (historical). The timeframe over which these records were assessed varied greatly – making comparisons between the different trends in data problematic at times (see Diagram 1) but most enabled us to determine a trend of the past few decade. See Table 1 for the RAG scale – note that the 'Grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'Amber' rating ('no change' / 'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 1: RAG rating scale for biota assessment

RAG rating	Colour
Unable to assess/data not available	Grey
Decline in abundance or distribution	Red
No change/mixed	Amber
Increase in abundance or distribution	Green

10 National Biodiversity Network, *NBN atlas (2020):* https://nbnatlas.org/

11 Ocean Biodiversity Information system :https://obis.org/

12 Environmental Information Data Centre, *The Pantheon database (2020):* https://data.gov.uk/dataset/98bf1f81-548b-4273-853f-a354cb00e713/the-pantheon-database-habitat-related-traits-conservation-status-and-taxa-associations-for-invertebrates-in-england

13 Joint Nature Conservation Committee, *Conservation designations for UK taxa (2020):* https://jncc.gov.uk/our-work/conservation-designations-for-uk-taxa/

14 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

15 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (2020):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

16 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance (2019):* https://jncc.gov.uk/our-work/ukbi-c4a-species-abundance/ and JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution (2019):* https://jncc.gov.uk/our-work/ukbi-c4b-species-distribution/

Based on the datasets available, the NCC findings are presented in Table 2 with a RAG rating for each of the examples provided. The key findings from the NCC assessments are:

- Two categories have been classified as 'Red' (species which are critical for ecosystem function and rare, iconic or protected species) and one as 'Amber' (species which support other flows/ecosystem services and goods).
- Based on the evidence assessed:
  - Pollinator species have declined in abundance and distribution across the UK between 1970 and 2016.
  - Between 1970-2009 there has been a 16% decline in some species that provide pest control in the UK. However, the negative impact of this decline on pest control has been offset by the fact that over the same interval in time there have been increases (17%) in other species that perform the same function.
  - Rare, iconic and protected species (Priority species[17]) in the UK have declined in both abundance and distribution with the biggest decreases seen for priority moth species.
- These apparent declines are extremely concerning because loss of species abundance and distribution will negatively impact the ecosystem services and goods these species provide.

Table 2: Partial assessment of Biota

Components of the asset	Example used	Data availability	NCC partial assessment
Species which are critical for ecosystem function	Pollinators	Long-term index for some pollinators is available. Limited to distribution data.	The distribution of UK pollinators is in decline, this trend is fairly uniform across both of the taxonomic groups involved in pollination.
Species which support other flows/ecosystem services and goods	Natural pest control	Some long-term datasets available from the volunteer recording schemes and standardised monitoring available for some taxonomic groups. Need to review data availability against identified natural pest control species.	Of the pest control species monitored 16% have statistically significantly declined in frequency of occurrence from 1970 to 2009, comparatively 17% have statistically significantly increased in frequency of occurrence. This trend is not uniform across the taxonomic groups.
Rare, iconic or protected species	Priority species	Long-term index is available for priority species, it covers a small subset of the species on the UK biodiversity list.	Priority species assessed have declined in both abundance and distribution, although this trend is not uniform across the taxonomic groups: • Moths and butterflies have declined in abundance whereas birds and mammals have remained relatively stable. • Bryophytes and lichens have increased in distribution whereas bees, wasps and ants, other insects and moths have declined.

1. Species which are critical to ecosystem function

The NCC has used pollinator data as an example for how the analysis should be undertaken for each of the functional groups in this category. Pollinators are critical for ecosystem function because they maintain plant reproduction and therefore are important for crops and wildflower biodiversity. Given over 75% of the world's food crops require pollination, they are a group of species which is globally in supporting this function.

17 Priority species are defined by JNCC as species which require actions to conserve them or species which are included within the respective countries' biodiversity or environment strategies. There are 2,890 species on the combined UK countries list however only a small proportion of these have enough data available to measure abundance and/or distribution.

EXAMPLE: Overall assessment of pollinators

In assessment of the state of pollinating species, from a literature review the NCC identified and examined the following datasets and papers; JNCC pollinator index and Oliver *et al*.[18,19] The overriding trend that emerges from these data is that pollinators have declined in distribution across the UK between 1970 to 2016. This is fairly uniform across all taxonomic groups although some have declined more than others, with the greatest declines apparent in hoverflies, moths and butterflies.

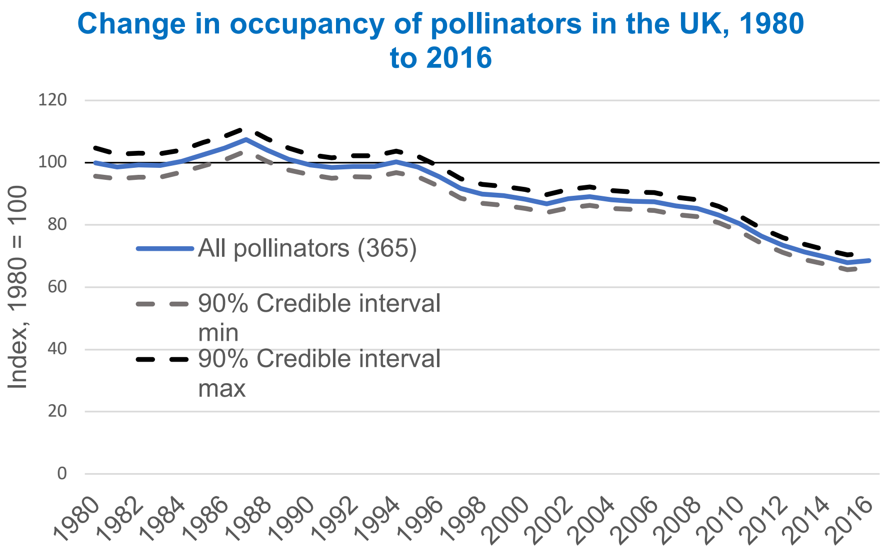
JNCC Pollinator index

One particularly useful dataset to examine longer term trends in UK pollinators is the pollinator index, created by JNCC[20]. This uses occurrence records from 1980 to 2016 of 365 bee and hoverfly species extracted from the Bees, Wasps and Ants Recording Society and the Hoverfly Recording Scheme.[21,22] Further information on the methodology used to create the index is available from JNCC.[23] The data shows the average relative change in the area over which the 365 pollinator species have been found, as measured by the number of 1km grid squares across the UK in which they were recorded.[24]

As shown in Figure 3, the pollinator index data shows a gradual decline in the occurrence of pollinators from 1987 onwards. In addition, the area of land occupied by pollinators in 2016 was reduced by 31% compared to the land where pollinators occupied in 1980.

The pollinator index can be broken down into taxonomic group; wild pollinating bees and hoverflies. Wild bee species occupancy indicates that the number of areas of land across the UK where wild bees have been identified between 1980-2016 (Figure 4). Overall, it shows a decline in wild bee occurrence – with the areas demonstrating wild bee occupancy declining by 17% during the last 36 years. The JNCC hoverfly species index, as shown in Figure 5, also shows a downward trend in occupancy at sites in the UK from 1987 to 2002. The hoverfly occupancy was 39% less in 2016 when compared to its 1980 value.

Figure 3: Change in occupancy of pollinators in the UK, 1980 to 2018



Source: JNCC[25]

18 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (2020):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

19 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

20 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (2020):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

21 Bees, Wasps and Ants Recording Society (2020): https://www.bwars.com/home

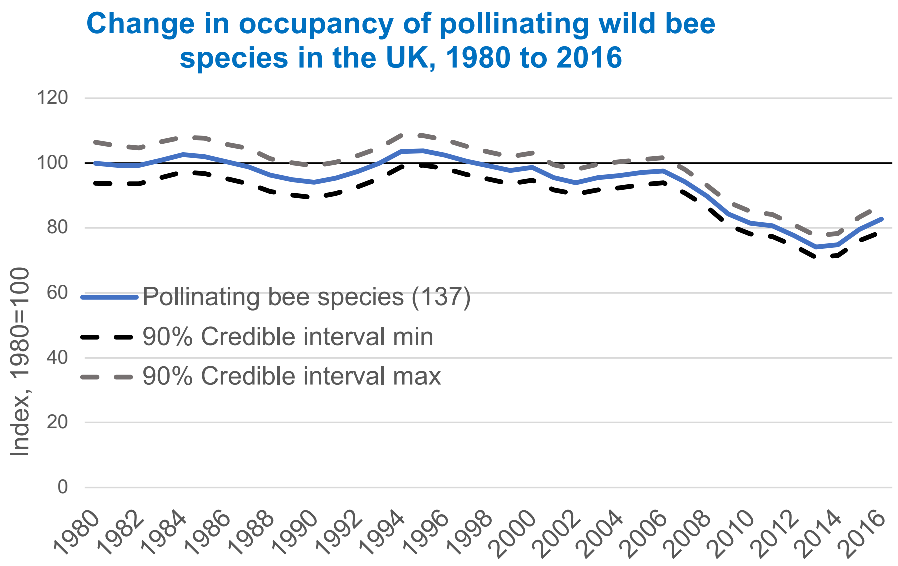
22 Dipterists, *Hoverfly Recording Scheme (2020):* https://www.dipterists.org.uk/hoverfly-scheme/home

23 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (2020):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

24 Powney *et al, UK Biodiversity Indicators 2019. Technical background document. (2020):* http://data.jncc.gov.uk/data/3de3abe1-d7d1-417e-9684-1348dd8b9a5a/UKBI2019-TechBG1-D1c.pdf

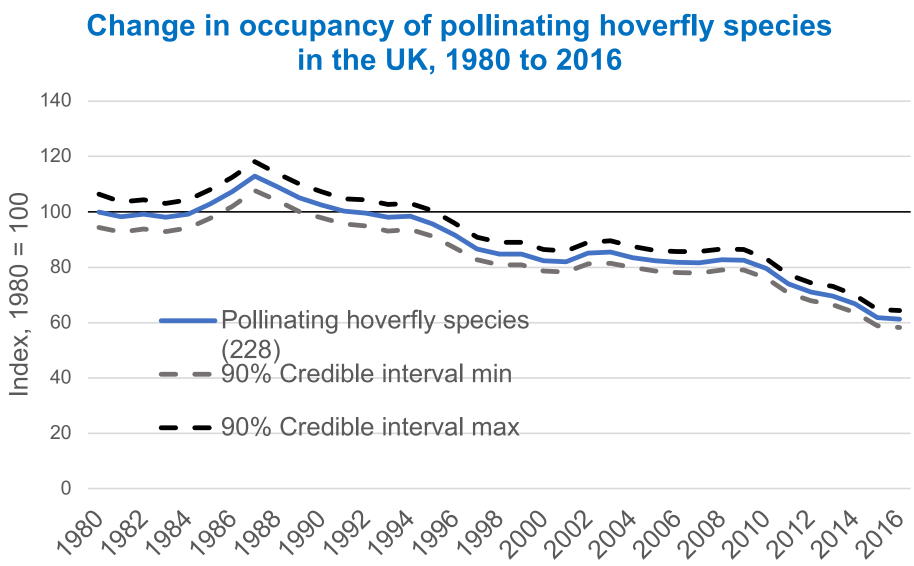
25 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (datasheet) (2019):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

Figure 4: Change in the occupancy of pollinating wild bee species in the UK, 1980 to 2016



Source: JNCC[26]

Figure 5: Change in occupancy of pollinating hoverfly species in the UK, 1980 to 2016



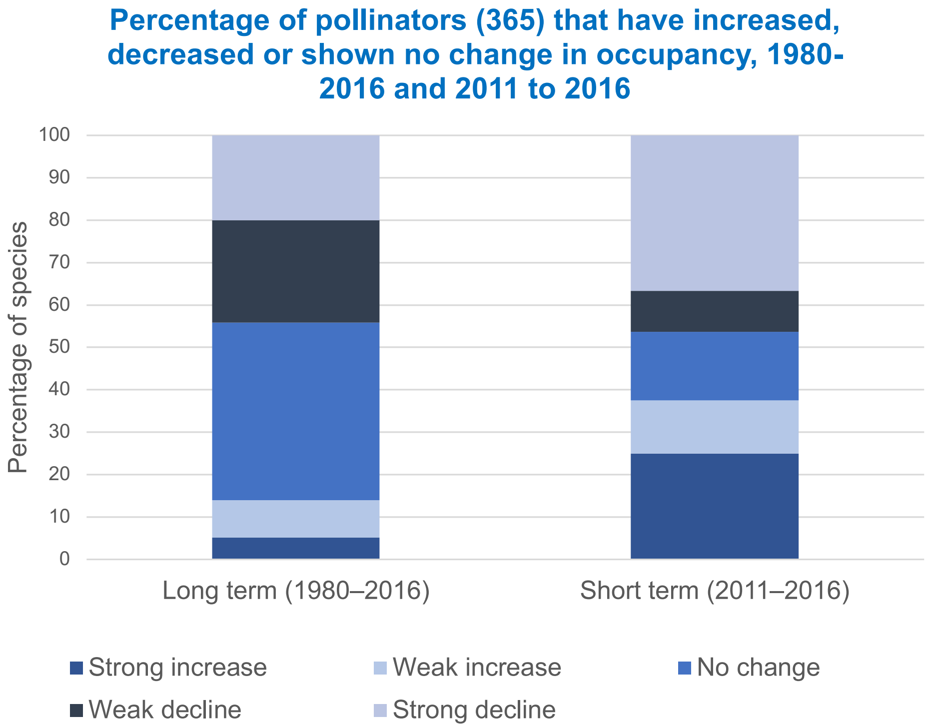
Source: JNCC[27]

Given the declines seen in the occupancy data, it is unsurprising therefore to see overall a decline in pollinator species between 1980 to 2016 (Figure 6). In the long-term, 44% of pollinator species became less widespread, 14% became more widespread and 42% showed no change. From 2011 to 2016, 46% species decreased, 38% of species increased and 16% showed no change.

26 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (datasheet) (2019):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

27 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (datasheet) (2019):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

Figure 6: Percentage of pollinators that have increased, decreased or shown no change in occupancy, 1980 to 2016 and 2011 to 2016



Source: JNCC[28]

2. Species which support other flows / ecosystem services and goods

The Committee has used natural pest control as an example of how this category could be completed. It should be noted, however, that there are many other flows which could be assessed, for example, protection from natural hazards, recreation, clean air and water and water purification.

Natural pest control has many benefits including food security and reduction in externalised costs of food production. In many agricultural systems pest control by natural enemies has been replaced by the use of pesticides, which is not only damaging to the environment but also further reduces the ability of systems to provide natural pest control.[29] The maintenance of natural pest control is also strongly dependent on a diverse species assemblage. Future analysis should assess the diversity of the groups involved in delivering this service.[30]

EXAMPLE: Overall assessment of species which have a role in natural pest control

A useful study Oliver *et al* (2015) which analysed 1458 species involved in natural pest control provided trends in abundance in the UK from 1970-2009.[31]

The NCC's overall assessment of species which have a role in pest control in the UK is 'Amber': deteriorating/mixed. This is very much a partial assessment based on species selected by Oliver which had enough volunteer collected data to be modelled for occupancy.

28 JNCC, *UK Biodiversity Indicators 2019. Indicator D1c – Pollinating insects (datasheet) (2019):* https://hub.jncc.gov.uk/assets/3de3abe1-d7d1-417e-9684-1348dd8b9a5a

29 Millennium Ecosystem Assessment, *Ecosystems and human well-being, synthesis:* https://www.millenniumassessment.org/en/Synthesis.html

30 Millennium Ecosystem Assessment, *Ecosystems and human well-being, synthesis:* https://www.millenniumassessment.org/en/Synthesis.html

31 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

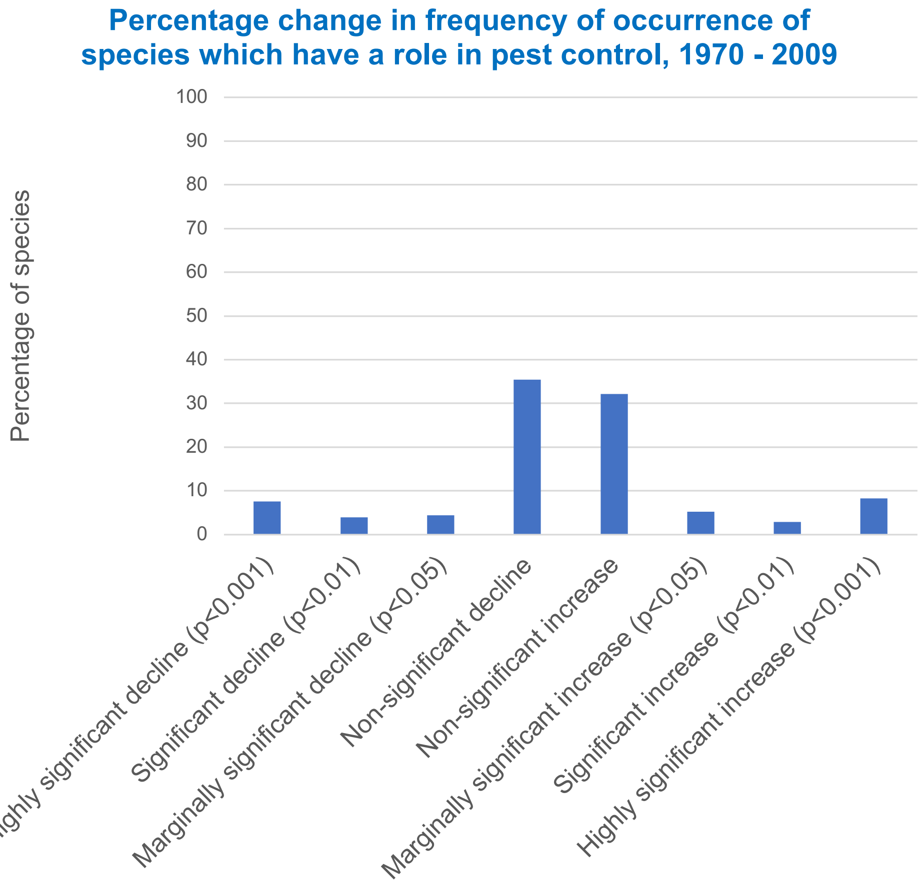
There are other sources of data which could have been used to assess the stock of species involved in pest control, the bird indexes or UK bat data, for example. These datasets have not been used because the NCC has not undertaken a review on which species should be included as natural pest control.

Oliver et al Change in frequency of occurrence of species which have a role in pest control between 1970 and 2009

Oliver *et al* (2015) estimated trends to 4,424 species in the UK between 1970 and 2009. These species have been grouped into the primary ecosystem functions they underpin, including species with a role in pest control which resulted in a subset of 1458 species. Further information on the methods and data produced is available from Nature.[32]

Over this period Oliver found that of 1458 species known to be important in pest control 16% have declined and 17% have increased in frequency of occurrence (assessed at p=0.05) (Figure 7).[33] This trend is not uniform across all of the taxonomic groups for pest control assessed and when split into taxonomic groups this research indicated large differences between different groups (see Figure 8) .

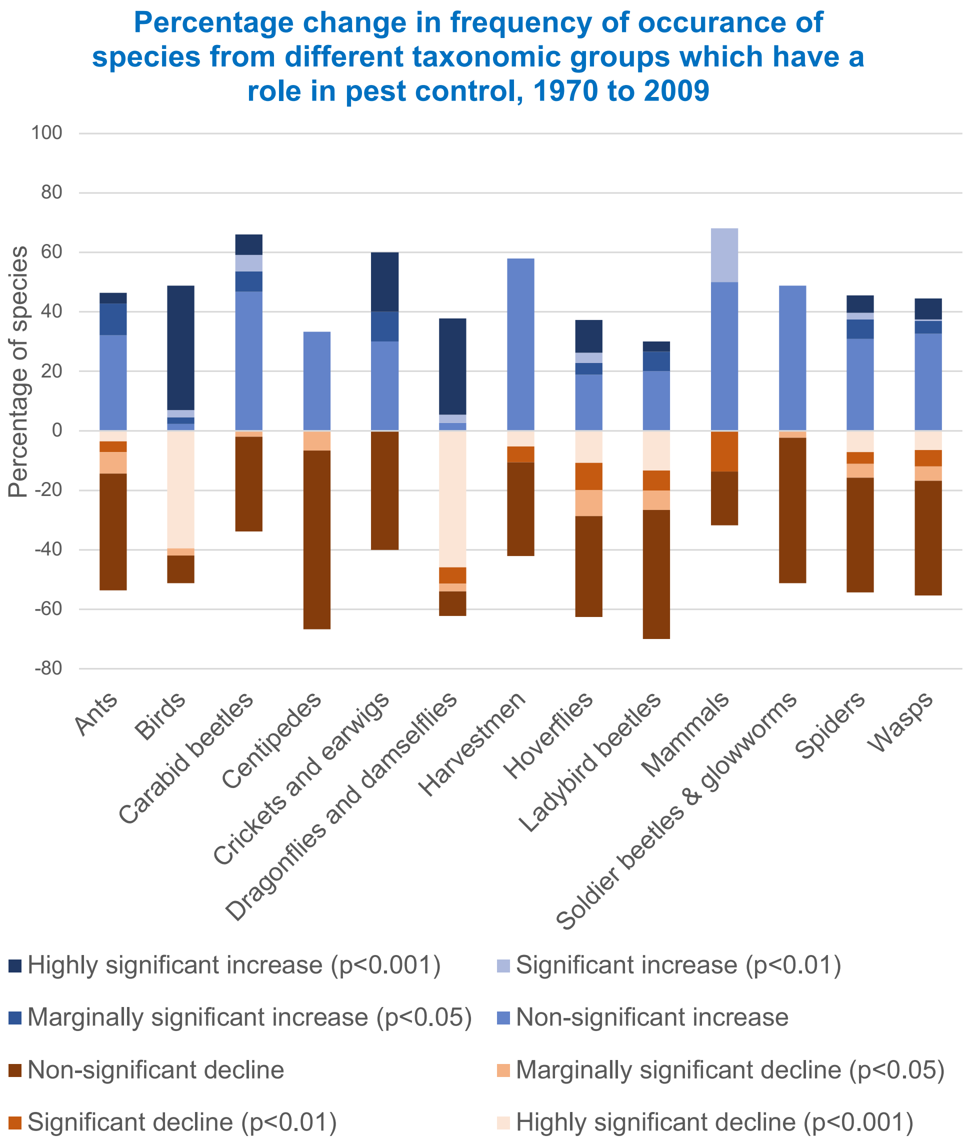
Figure 7: Percentage change in frequency of occurrence of species which have a role in natural pest control, 1970 - 2009



32 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

33 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

Figure 8: Percentage change in frequency of occurrence of species from different taxonomic groups which have a role in pest control, 1970 - 2009 Source Oliver et al[34]



3. Rare / iconic / protected species

Rare, iconic and protected species have a cultural value to humans and are often of conservation interest. There are several existing lists of protected and rare species, for example, the IUCN red list and the UK Biodiversity Action Plan species list.[35,36] Each of the four countries in the UK also has its own biodiversity list.[37] These provide a useful resource for identifying the species for this category.

The NCC has used the JNCC priority species index as an example for how this analysis should be undertaken for this category.

34 Oliver *et al, Declining resilience of ecosystem functions under biodiversity loss (2015):* https://www.nature.com/articles/ncomms10122

35 IUCN, *The IUCN Red List of endangered species (2020):* https://www.iucnredlist.org/

36 JNCC, *UK BAP priority species (2020): https://jncc.gov.uk/our-work/uk-bap-priority-species/#uk-bap-priority-species-list*

37 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, technical background document (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

EXAMPLE: Overall assessment of priority species

To assess rare and iconic species and their trends over time the NCC examined the JNCC protect species index.[38] This index has collated the data for 2890 species on the UK biodiversity list, not all species have enough data to be assessed so a subset of species are used for each index (214 for abundance and 395 for distribution) with records dating between 1970 – 2016.

The overall trend of this index suggests a decline in the abundance index to 40% of its baseline value in 1970. However, this decline in abundance is not uniform across the taxonomic groups; moths and butterflies have substantially declined whereas birds and mammals have remained relatively stable or slightly increased. Overall, 63% of species have declined in relative abundance.

The overall distribution index also shows a decline in the proportion of occupied sites from 1970 to 2016. Again, this decline has not been uniform across the taxonomic groups; bees, wasps and ants and other insects have undergone slight declines, moths have declined substantially with the index being 57 compared to 100 in 1970. In comparison bryophytes and lichens have increased when compared to the 1970 baseline.

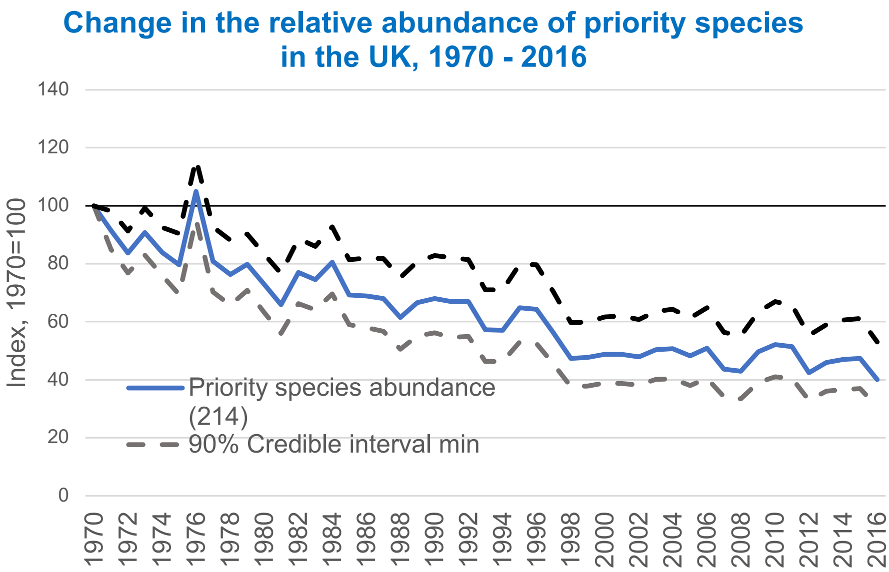
JNCC UK priority species abundance and distribution

The UK has 2,890 species on its biodiversity list, a breakdown of these is available from JNCC.[39] 214 species from the taxonomic groups birds, butterflies, mammals and moths are both on the country biodiversity list and meet the criteria for being used in the relative abundance indicator, as published by JNCC.[40] Although largely terrestrial based, some of the bird species are sea birds. The data shows the estimated population of species against the baseline year, 1970.[41]

As shown in Figure 9, from 1970 to 2016 the 214 priority species have declined in abundance with the 2016 index being 40% of its baseline value in 1970.

The abundance indicator can be broken down into different taxonomic groups; birds, mammals, moths and butterflies. Figure 10 and 11, shows the index for birds and mammals have remained roughly stable since 1970 and 1993, respectively. Both moths and butterflies have undergone significant declines, as displayed in Figure 12 and 13, butterflies are 17% of the baseline value set in 1976 and moths are 14% of the baseline set in 1970. It is worth noting that the different taxonomic groups have different starting points, 1970, 1976 and 1993.

Figure 9: Change in the relative abundance of priority species in the UK, 1970-2016



Source JNCC[42]

38 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance (2019):* https://jncc.gov.uk/our-work/ukbi-c4a-species-abundance/ and JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution (2019):* https://jncc.gov.uk/our-work/ukbi-c4b-species-distribution/

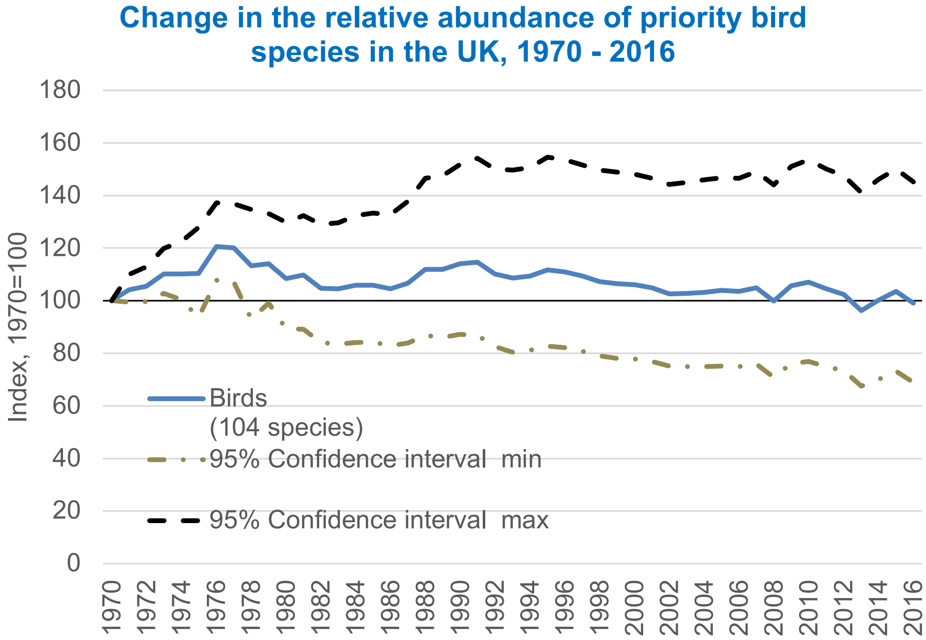
39 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, technical background document (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

40 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, technical background document (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

41 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, technical background document (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

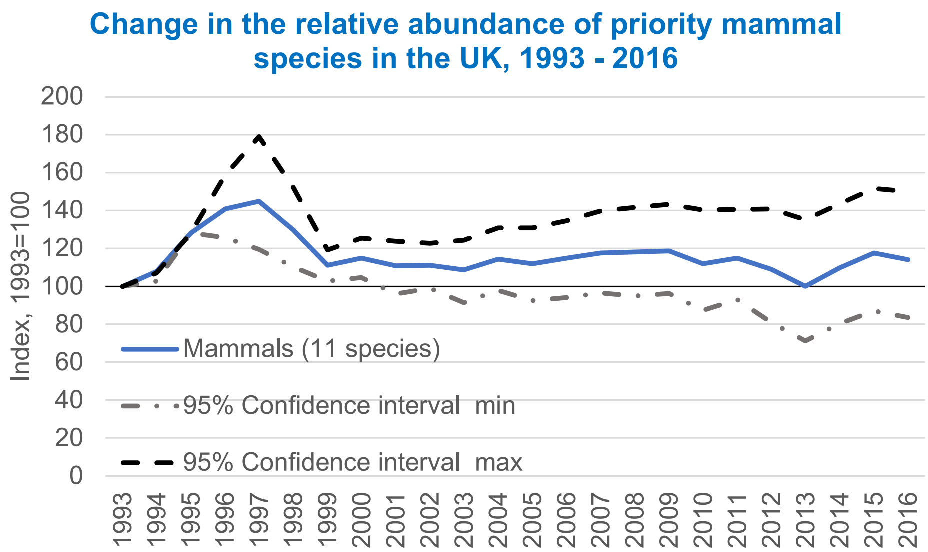
42 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

Figure 10: Change in the relative abundance of priority bird species, 1970 - 2016



Source: JNCC[43]

Figure 11: Change in the relative abundance of priority mammal species in the UK, 1993 - 2016

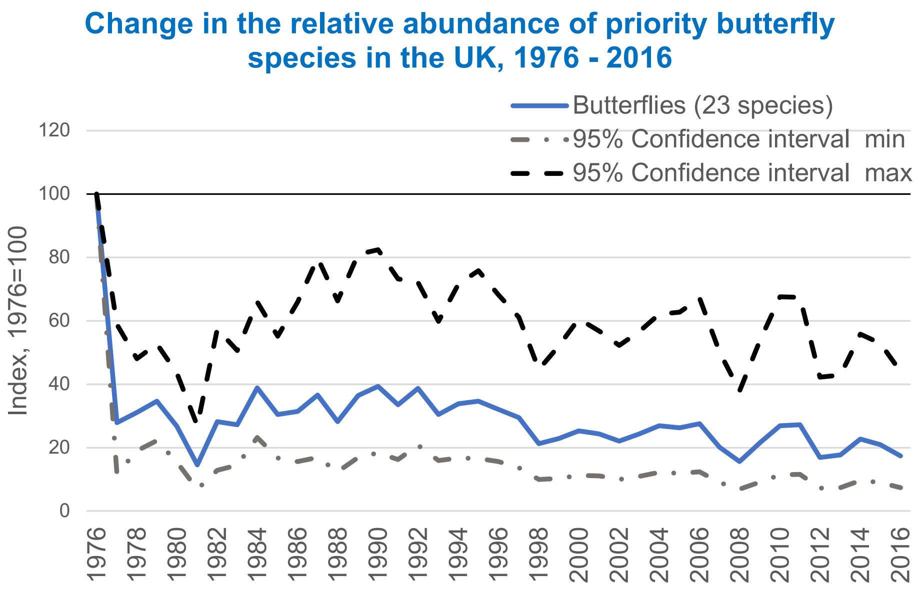


Source JNCC[44]

43 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

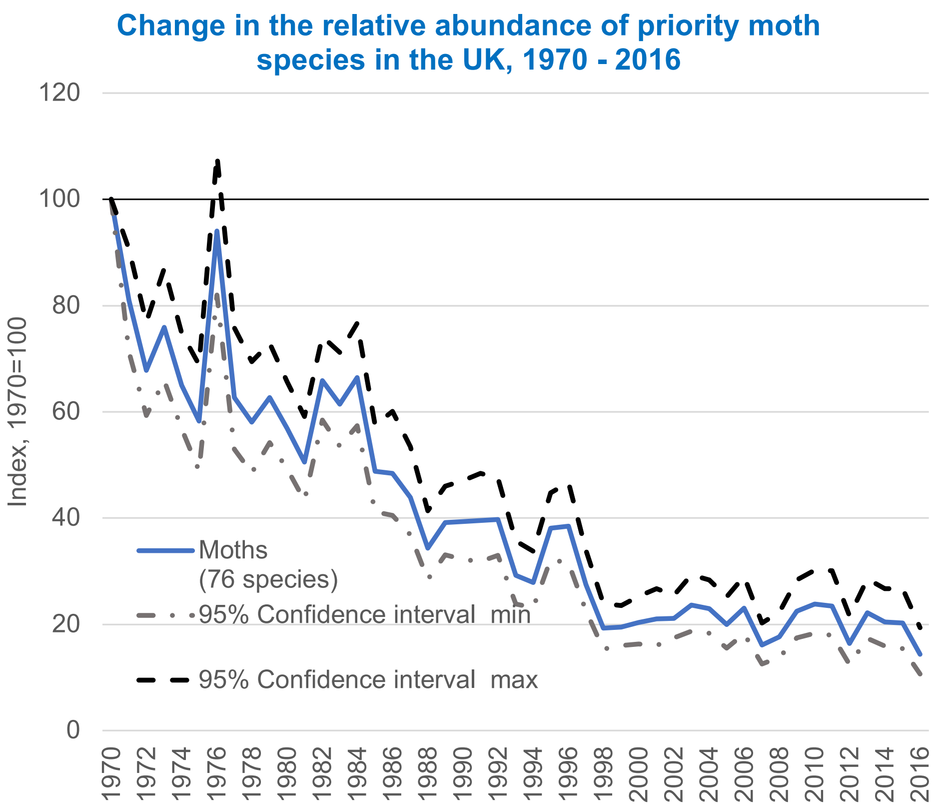
44 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

Figure 12: Change in the relative abundance of priority butterfly species in the UK, 1976 - 2016



Source JNCC[45]

Figure 13: Change in the relative abundance of priority moth species in the UK, 1970 - 2016



Source: JNCC[46]

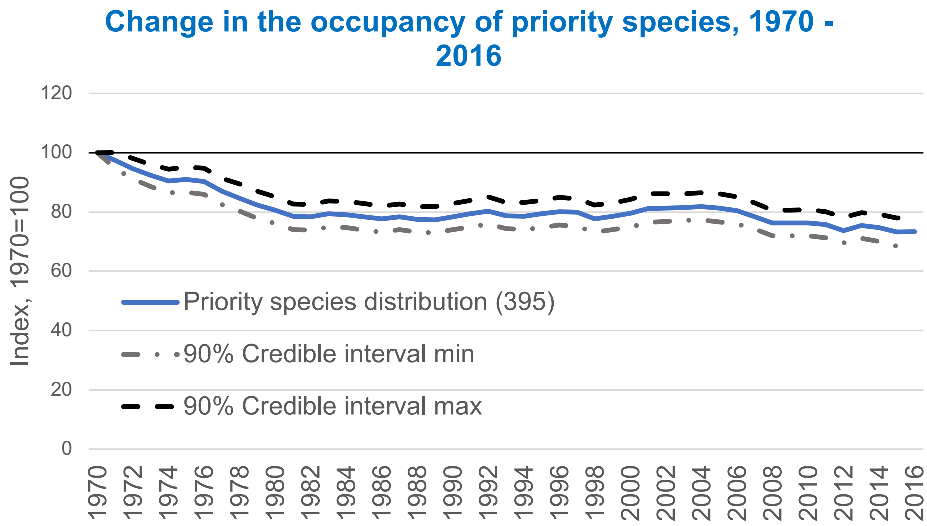
45 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

46 JNCC, *UK Biodiversity Indicators 2019. Indicator c4a – species abundance, Datasheet C4a (2019):* https://hub.jncc.gov.uk/assets/1f47d611-dbfc-421a-bc26-b019433306d1

The other half of the indicator assesses UK priority species distribution, 395 species from the UK biodiversity list met the criteria to be used, as published by JNCC.[47] This includes species from the following taxonomic groups; bees, wasps and ants, bryophytes and lichens, moths and other insects (carabids, crane flies, flies, fungus gnats, hoverflies, leaf and seed beetles, lacewings, grasshoppers, crickets, plant bugs, rover beetles, shield bugs, soldier beetles, soldier flies and weevils). The 395 species are terrestrial and freshwater based and does not include any marine species.

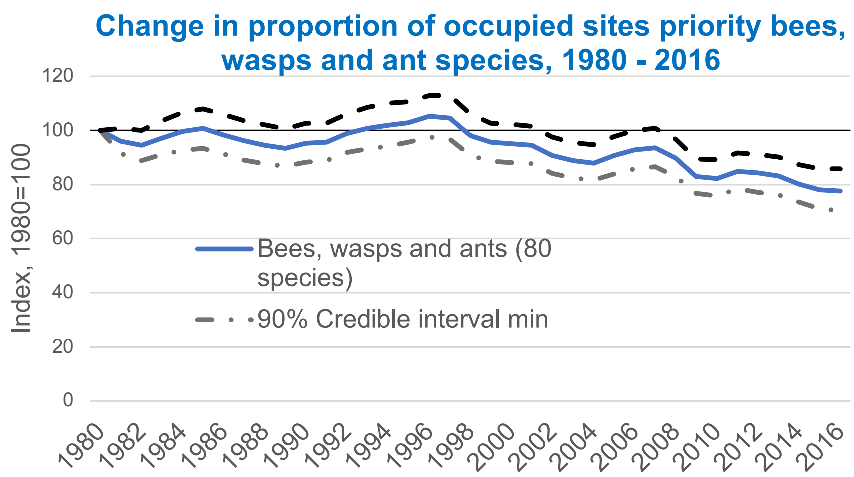
Figure 14 shows an overall decline in the proportion of occupied sites between 1970 and 2016; in 2016 the index was 31% lower than the baseline value in 1970. Figures 15, 16, 17 and 18 show the variation in the different taxonomic groups; the 2016 index was 22% lower than the 1980 baseline for bees, wasps and ants. The 2016 value 20% higher than the 1970 baseline for bryophytes and lichens. Other insects declined, in 2016 the value was 82 when compared to the 1970 index. Moth species declined steadily from 1970 to 2016 with the index being only 57 in 2016.

Figure 14: Change in the occupancy of priority species, 1970 - 2016



Source: JNCC[48]

Figure 15: Change in proportion of occupied sites priority bees, wasps and ant species, 1970 - 2016



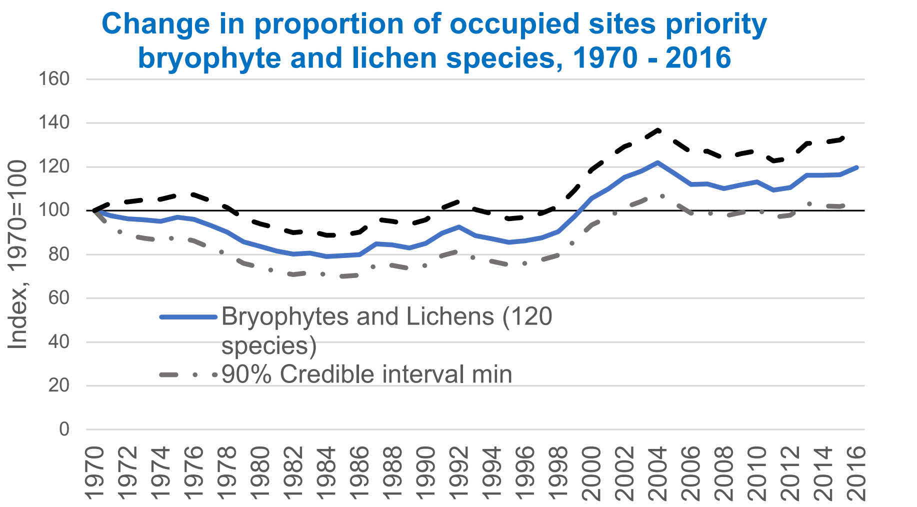
Source: JNCC[49]

47 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Technical background document 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

48 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Datasheet C4b 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

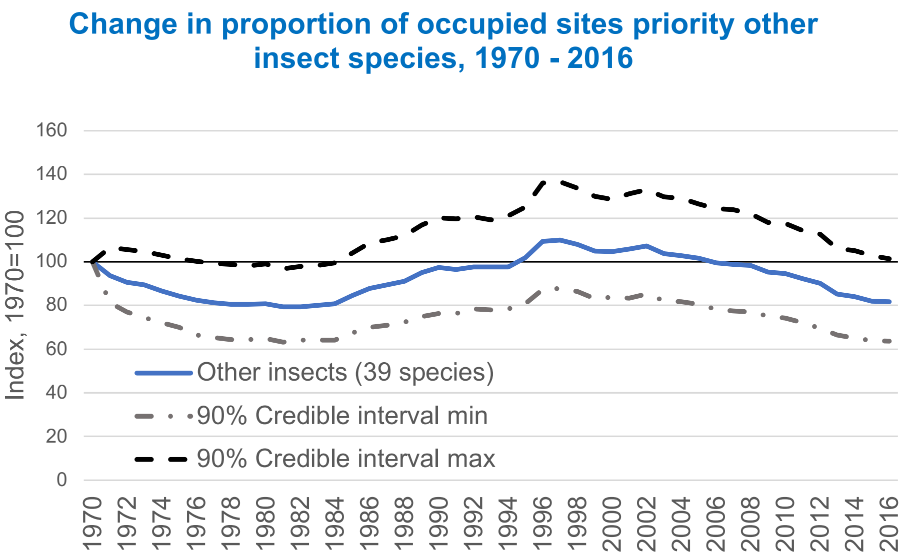
49 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Datasheet C4b 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

Figure 16: Change in the proportion of occupied sites priority bryophyte and lichen species, 1970 - 2016



Source JNCC[50]

Figure 17: Change in the proportion of occupied sites priority other insect species, 1970 - 2016

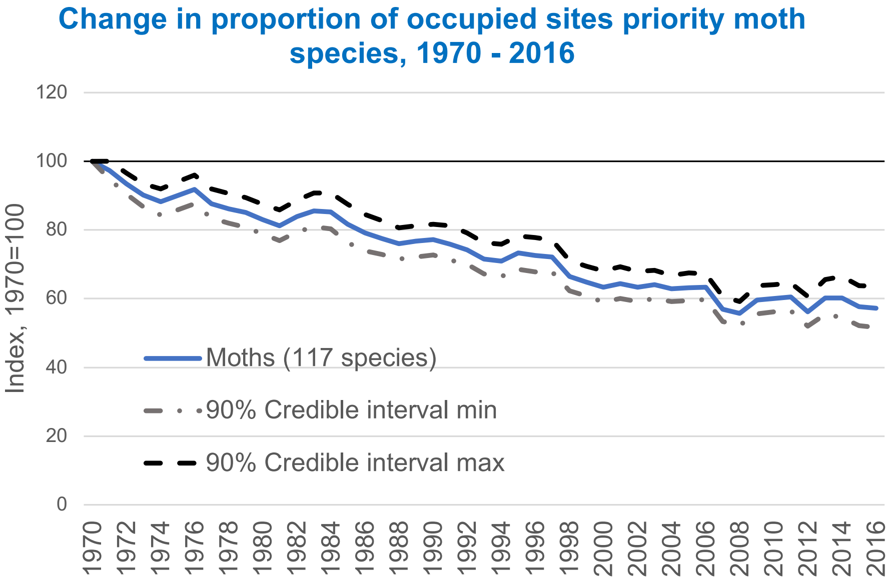


Source JNCC[51]

50 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Datasheet C4b 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

51 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Datasheet C4b 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

Figure 18: Change in the proportion of occupied sites priority moth species, 1970-2016



Source JNCC[52]

52 JNCC, *UK Biodiversity Indicators 2019. Indicator c4b – species distribution, Datasheet C4b 1 (2019):* https://hub.jncc.gov.uk/assets/c4169253-54bb-4250-919b-a0942dea2bad

Annex 7

Minerals and resources

Minerals and resources

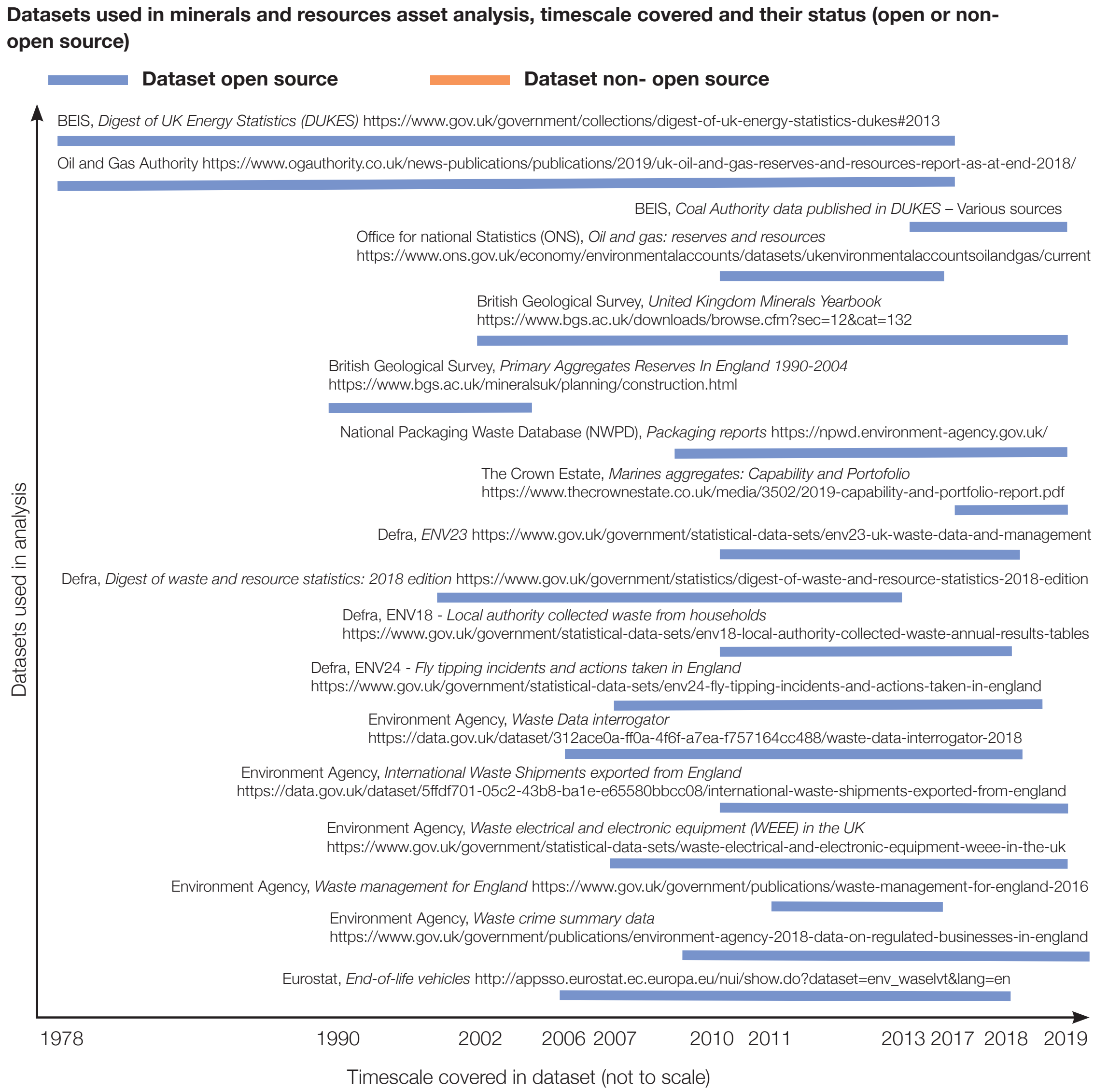
Background

Minerals and resources are classified as a natural capital asset, made up of individual components that occur naturally within the UK. The focus for this assessment is:

- Non-renewable energy resources (coal, oil and natural gas), minerals and metals commonly extracted in the UK (e.g. sand, gravel, limestone, aluminium, tin, etc.); and
- Waste and the resources derived from waste (e.g.: recyclates; energy).

Together these constitute a resource from which societal value can be created. For example, extraction of resources creates jobs, provides energy and materials for a wide range of activities all of which help to grow the UK economy, but they are also finite and in some instances their extraction and/or use can lead to negative impacts on other natural capital assets, such as the atmosphere or freshwater. To understand the extraction, use and the negative effects that can arise from their use, robust and comprehensive data is required to enable an assessment of the status of the minerals and resources asset. To produce the minerals and resources assessment the Natural Capital Committee (NCC) has looked at a range[1] of datasets, these are presented in Diagram 1 below.

Diagram 1: Datasets used to produce the assessment on the status of the minerals and resources asset



Source: NCC 2020

1 Given the limited resources available to the NCC the list of datasets is not comprehensive and further work is required to scope additional datasets to complement this assessment.

Minerals and resources asset

The NCC has undertaken a desk-based literature review to scope out measurements (datasets) to assess the condition and extent of mineral resources[2] and resources from waste. The assessment uses data and evidence from:

- The Department for Business, Energy, and Industrial Strategy (BEIS) Digest of UK Energy Statistics (DUKES)[3];
- The Coal Authority;
- The Oil and Gas Authority[4];
- Office for National Statistics (ONS)[5];
- The British Geological Survey (BGS) UK Minerals Yearbook evidence and data[6];
- The Crown Estate evidence on offshore aggregates;
- Defra Waste Statistics;
- The Environment Agency data;
- National Waste Packaging Database data[7]; and
- Eurostat data.

To produce the assessment of minerals and resources the NCC has started by scoping out the components of the asset, as presented in Figure 1. A data trend assessment followed (where data was available) to see how these components and subcomponents changed over time and where possible, try to infer the status of their condition and extent.

2 Mineral resources here refers to: metals, rocks, sand, and minerals and it also includes energy minerals.

3 BEIS, *Digest of UK Energy Statistics (DUKES)* (2019) https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes#2013

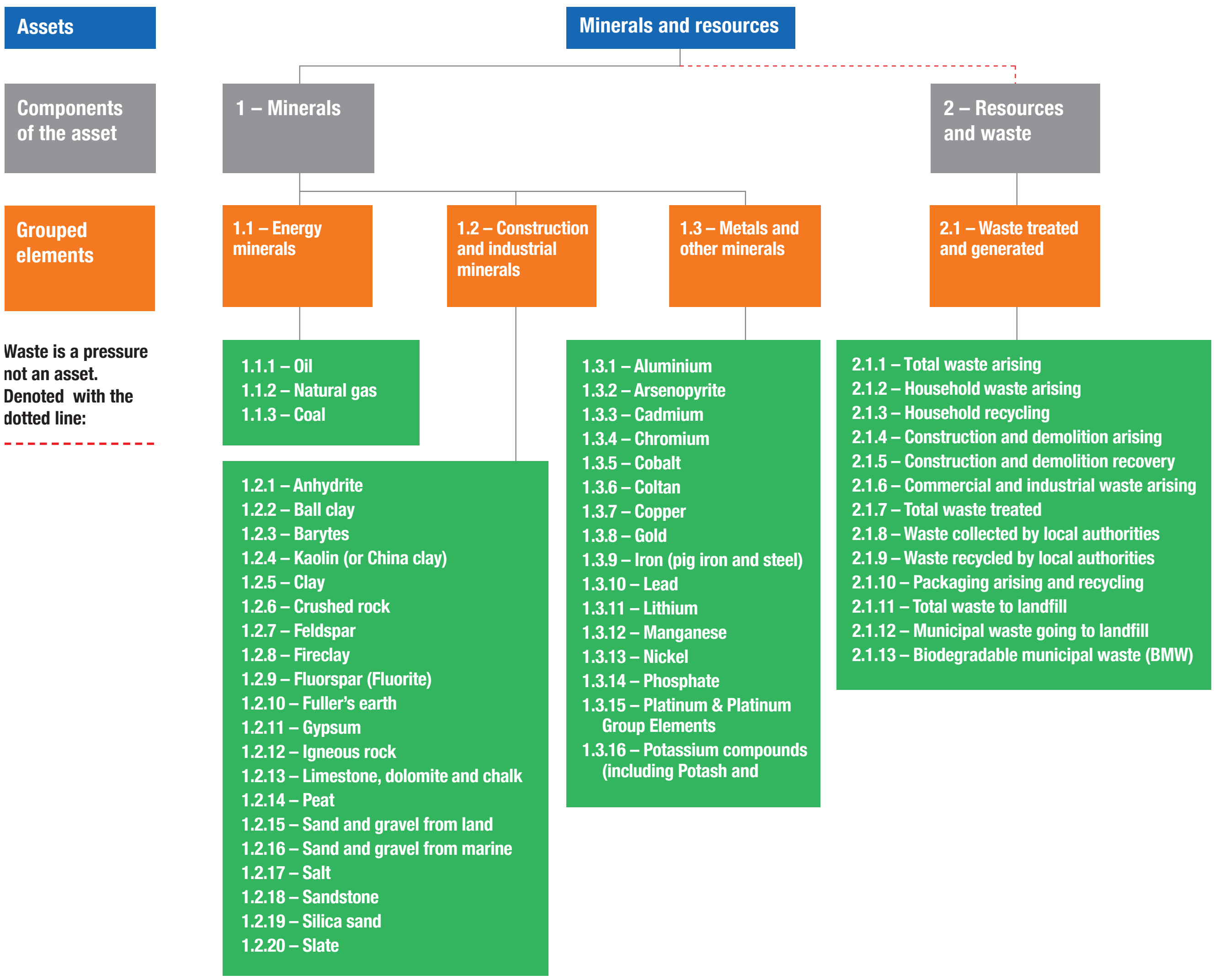
4 Oil and Gas Authority, *UK Oil and Gas Reserves and resources Report as at end 2018* (2018) https://www.ogauthority.co.uk/news-publications/publications/2019/uk-oil-and-gas-reserves-and-resources-report-as-at-end-2018/

5 Office for national Statistics (ONS), *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas/curren

6 British Geological Survey, *United Kingdom Minerals Yearbook 2002 – 2019* https://www.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

7 National Packaging Waste Database (NWPD), *Public reports* https://npwd.environment-agency.gov.uk/

Figure 1: Minerals and resources assessment



Source: NCC 2020

Summary of overall (partial) minerals and resources assessment

The NCC has produced a partial assessment of the minerals and resources assets.

The assessment uses a 'RAG' rating approach to indicate the status of the atmosphere asset and associated components. The RAG rating is based on a trend assessment (historical) and the progress made towards compliance with existing targets and/or other commitments. See Table 1 for the RAG scale – note that the 'grey' rating is added to highlight instances where an assessment was not possible, due to factors including limited data availability. The 'amber' rating ('no change' / 'mixed') reflects instances where there is a change in the trend of a small magnitude (equal to or less than 1%), or where the evidence is inconclusive.

Table 1: RAG rating scale for minerals and resources assessment

RAG rating	Colour
Unable to assess/data not available	(grey)
Deteriorating	(red)
No change/mixed	(amber)
Improving	(green)

The overall assessment of the minerals and resources annex, based on the datasets available – is 'Amber': **mixed** – this is based on waste targets not being met, such household recycling and recovery of end of life vehicles (ELVs), the continued extraction of minerals (for construction and industrial use) and the recent increase in the consumption of oil/decline in reserves. On the other hand, progress has been made such as increases in the collection of portable batteries, reduction in gas consumption and production of some minerals (e.g.: iron). This assessment is based on the three group headings (see points 1-3 below) and the trend assessment is made to the measurements underpinning these group headings.

1. Non-renewable energy.
2. Minerals.
3. Resources and waste.

The NCC findings are presented in Table 2 with a RAG rating for each of the three groups provided. The RAG rating issued is partly subjective as it is based on a bottom-up assessment of each of the measurements underpinning these groups. In the sections that follow in this annex, a more in-depth assessment of the historical trend and compliance with targets/commitments is presented. The key findings from the NCC's assessment are as follows:

- Waste targets have not being met, such as household recycling and recovery of end-of-life vehicles (ELVs).
- Household waste recycling rates have plateaued since 2013 at around 44%.
- Construction waste recovery rates have plateaued since 2010.
- There were 715,000 flytipping incidents in England in 2012/13 and this increased to 1,070,000 incidents in 2018/19.
- In the UK alone, an estimated 10 million tonnes of food and drink are wasted post-farm gate annually, worth around £20 billion.
- Waste related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

Table 2: Indicative assessment of the minerals and resources asset

Components of the asset	Data availability	Overall assessment
1. Non-renewable energy	There is data on the reserves and resources of oil and gas, and data is available from 1973. There is limited data on the resources of coal, with data only being available from 2016.	Based on this limited data, gas and oil proven (1P) and probable (2P) reserves continue to steadily decline. Coal resources have increased, but trend data starts in 2016 which limits what can be inferred.
2. Minerals	There is almost no data on reserves and resources of minerals for either England or the UK. There is some limited data on offshore reserves of natural aggregates and some historical data on land natural aggregates. There is data on the production for some years of several minerals, however, this data is often based on estimates.	Given the limited evidence available on reserves and resources of minerals, the assessment here is based mostly on the production of these which limits what can be inferred. Some of the minerals saw a reduction in their production levels such as iron and clay. While, for other minerals, there has been an increase such as natural aggregates, gypsum, and silica sand.
3. Resources and waste	There is a significant amount of data on resources and waste ranging from data on waste arising from portable batteries to recycling and recovery rates for construction and demolition.	The overall assessment for waste is mixed, this is based on several waste types having higher levels of waste arisings and not meeting recycling and recovery targets, such as waste from household and end-of-life vehicles. Also, a significant amount of waste is exported from the UK to third party countries which leaves considerable uncertainty about whether these actually get recycled.

Summary RAG rating for individual measurements

The overall assessment based on the three groups set out above is underpinned by an analysis of datasets on reserves, production, consumption, and changes in quantity/rates (as displayed in Figure 1). A full summary assessment of the condition, extent and pressures of these measurements, grouped by the three overall groups are presented in Table 3. The assessment follows the same approach of the overall assessment, i.e. analysing the trend (historical data) and the progress made towards compliance with existing targets and/or commitments. The assessment is split into four categories, with a RAG rating assigned for each, as follows:

1. **Compliance against target/commitment** is the comparison of the target or commitment baseline against the most recent data. For example, assessing the reduction of ammonia from 2005 levels (target baseline) against the 2020 target of 8% reduction;
2. **The long-term trend assessment** is based on the earliest available data point against the most recent data/evidence. For example, comparing the change between 1970 and 2018;
3. The **NCC baseline trend assessment** uses 2011 as the starting point for the assessment ('NCC baseline'), as this was when Government first committed: "*to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision making – in Government, local communities and businesses*."[8] Here the 2011 baseline (where data is available) is compared against the most recent data/evidence. This also relates to the NCC census advice[9] and its interim response to the 25 YEP Progress Report for a need to have a common base year to assess progress against;
4. **The short-term, trend assessment** compares the change to the most recent data/evidence (year on year change). For example, comparing the change between 2017 and 2018. Looking at short-term trend data is important, as it makes recent progress more transparent, whereas this can be masked by focusing on historic trends.

The overall assessment RAG rating is based on each measurement RAG rating presented in Table 3 below. There is variation in terms of status for each of the measurements underpinning the three groups and between the period assessed (e.g.: long-term vs short-term) with no clear pattern. The points below summarise the key findings:

- Waste targets have not being met, such as household recycling and recovery of end-of-life vehicles (ELVs).
- Household waste recycling rates have plateaued since 2013 at around 44%.
- Construction waste recovery rates have plateaued since 2010.
- There were 715,000 flytipping incidents in England in 2012/13 and this increased to 1,070,000 incidents in 2018/19.
- In the UK alone, an estimated 10 million tonnes of food and drink are wasted post-farm gate annually, worth around £20 billion.
- Waste related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

The key RAG ratings for the individual measurements are presented below and in Table 3 below.

8 Defra, *The natural choice: securing the value of nature – Full Text* (2011) https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature

9 NCC, *Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan* (2019) https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

Table 3: Measurements assessment and respective RAG ratings

Compliance with target or commitment		Assessment			
		Component and subcomponents of the asset	Long-term trend	Against the NCC baseline (2011)	Short-term trend
Energy minerals energy	1.1.1 - Oil	N/A	R	R	A
	1.1.2 - Natural gas	N/A	A	A	G
	1.1.3 - Coal	N/A	G	N/A	G
Construction and industrial Minerals	1.2.1 - Anhydrite	N/A	N/A	N/A	N/A
	1.2.2 - Ball clay	N/A	G	G	R
	1.2.3 - Barytes	N/A	G	R	A
	1.2.4 - Kaolin (or China clay)	N/A	G	G	R
	1.2.5 - Clay	N/A	G	G	G
	1.2.6 - Crushed rock	N/A	G	R	R
	1.2.7 - Feldspar	N/A	N/A	N/A	N/A
	1.2.8 - Fireclay	N/A	N/A	N/A	N/A
	1.2.9 - Fluorspar (Fluorite)	N/A	N/A	N/A	N/A
	1.2.10 - Fuller's earth	N/A	N/A	N/A	N/A
	1.2.11 - Gypsum	N/A	G	R	R
	1.2.12 - Igneous rock	N/A	N/A	N/A	N/A
	1.2.13 - Limestone, dolomite and chalk	N/A	N/A	N/A	N/A
	1.2.14 - Peat	N/A	N/A	N/A	N/A
	1.2.15 - Sand and gravel from land	N/A	G	R	R
	1.2.16 - Sand and gravel from marine	N/A	G	R	R
	1.2.17 - Salt	N/A	G	G	A
	1.2.18 - Sandstone	N/A	N/A	N/A	N/A
	1.2.19 - Silica sand	N/A	R	R	R
	1.2.20 - Slate	N/A	R	R	A
Metals and other minerals	1.3.1 - Aluminium	N/A	G	G	A
	1.3.2 - Arsenopyrite	N/A	N/A	N/A	N/A
	1.3.3 - Cadmiun	N/A	N/A	N/A	N/A
	1.3.4 - Chromium	N/A	N/A	N/A	N/A
	1.3.5 - Cobalt	N/A	N/A	N/A	N/A
	1.3.6 - Coltan	N/A	N/A	N/A	N/A
	1.3.7 - Copper	N/A	N/A	N/A	N/A
	1.3.8 - Gold	N/A	N/A	N/A	N/A
	1.3.9 - Iron (pig iron and steel)	N/A	G	G	G
	1.3.10 - Lead	N/A	G	R	G
	1.3.11 - Litihium	N/A	N/A	N/A	N/A
	1.3.12 - Manganese	N/A	N/A	N/A	N/A

Metals and other minerals	1.3.13 - Nickel	N/A	R	R	R
	1.3.14 - Phosphate	N/A	N/A	N/A	N/A
	1.3.15 - Platinum & Platinum Group Elements	N/A	N/A	N/A	N/A
	1.3.16 - Potassium compounds (including Potash and Polyhalite)”	N/A	G	G	G
	1.3.17 - Pyrite	N/A	N/A	N/A	N/A
	1.3.18 - Quartz	N/A	N/A	N/A	N/A
	1.3.19 - Rare Earth elements	N/A	N/A	N/A	N/A
	1.3.20 - Silver	N/A	N/A	N/A	N/A
	1.3.21 - Sulphur	N/A	G	G	G
	1.3.22 - Talc	N/A	G	G	G
	1.3.23 - Tin	N/A	G	N/A	G
	1.3.24 - Titanium	N/A	R	A	G
	1.3.25 - Tungsten	N/A	N/A	N/A	N/A
	1.3.26 - Zinc	N/A	G	R	R
Resources and waste	2.1.1 - Total waste arising	N/A	R	N/A	R
	2.1.2 - Household waste arising	N/A	A	A	G
	2.1.3 - Household recycling	N/A	G	A	A
	2.1.4 - Construction and demolition arising	N/A	R	R	R
	2.1.5 - Construction and demolition recovery	N/A	A	A	A
	2.1.6 - Commercial and industrial waste arising	N/A	R	R	R
	2.1.7 - Total waste treated	N/A	G	N/A	G
	2.1.8 - Waste collected by local authorities	N/A	A	A	G
	2.1.9 - Waste recycled by local authorities	N/A	G	G	R
	2.1.10 - Packaging arising and recycling	G	G	N/A	G
	2.1.11 - Total waste to landfill	N/A	G	G	G
	2.1.12 - Municipal waste going to landfill	N/A	G	G	A
	2.1.13 - Biodegradable municipal waste (BMW) going to landfill	G	G	G	G
	2.1.14 - Energy from waste (EfW) Incineration	N/A	G	G	G
	2.1.15 - Exports of refuse-derived fuel (RDF)	N/A	N/A	N/A	N/A
	2.1.16 - Exports of solid recovered fuel (SRF)	N/A	N/A	N/A	N/A
	2.1.17 - Waste exports and imports	N/A	N/A	N/A	N/A

Resources and waste	2.1.18 - End-of-life vehicles (ELVs) waste generated	N/A	R	R	R
	2.1.19 - End-of-life vehicles (ELVs) recovery and recycling	A	G	G	G
	2.1.20 - Waste Electrical and Electronic Equipment (WEEE)	R	G	A	A
	2.1.21 - Portable batteries collection rate in the UK	G	G	G	A
	2.1.22 - Hazardous waste deposited and managed	N/A	R	R	R
	2.1.23 - Hazardous waste deposited and managed	N/A	G	N/A	G
	2.1.24 - Waste crime	N/A	A	R	R
	2.1.25 - Fly-tipping	N/A	G	R	R

1. Non-renewable energy

The NCC has focused on three key sources for the assessment of non-renewable energy: oil, gas, and coal. These three types of energy have several negative impacts on the environment and human health. For example, unearthing, processing, and moving underground oil, gas, and coal deposits require a vast amount of land for the infrastructure required to extract, produce, and supply fossil fuels. These changes to our landscapes and ecosystems destroy critical wildlife habitats.[10] Table 4 presents the non-renewable energy minerals components of this natural capital asset and their respective targets to address the negative impacts of fossil fuels.

Table 4: List of components for the energy minerals

	Type of energy	Targets
1.1. Energy minerals	1.1.1 - Oil	There are no specific targets or regulations to reduce the consumption of oil, gas, or coal in England or the UK. However, there is a target and regulation (Climate Act 2008) to reduce greenhouse gas emissions which will impact the amount of fossil fuels that are extracted for consumption.
	1.1.2 - Gas	
	1.1.3 - Coal	

Overall assessment of non-renewable energy

The assessment of the non-renewable energy – based on the datasets available – is 'Amber': **mixed**, oil and gas reserves have continued to decline from their peak levels. A significant amount continues to be extracted for consumption. In addition to the negative environmental impacts of extraction, there are also impacts from the consumption of fossil fuels such as health and climate change. See Table 5 for the individual measurement level assessment. The key findings from the NCC assessments are:

- Coal consumption has reduced by just under 89% between 1990 and 2018, from 111 million tonnes to 13 million tonnes – this is a positive effect on the environment.

10 Natural Resources Defence Council (NRDC), *Fossil Fuels: The Dirty Facts* (2018) https://www.nrdc.org/stories/fossil-fuels-dirty-facts

Table 5: NCC assessment of progress and RAG rating

Measurable commitment	Compliance with target or commitment	Long-term trend	Against the NCC baseline (2011)	Short-term trend
1.1.1 - Oil – No specific commitment or target exists.	There is no long-term target or commitment to reduce the amount of extraction of oil from the environment.	Even though there is a decline in the amount of oil being produced since its peak, production has started to increase again since 2014. Oil reserves of proven (1P) and probable (2P) continue to steadily decline since 2004, with minor upticks in 2011 and 2012.	When compared to 2011 oil reserves of proven (1P) and probable (2P) has declined from 788 million tonnes to 507 million tonnes in 2018.	There has been an increase in the estimated amount of oil reserves from 2017 from 93 million tonnes to 120 million tonnes of possible reserves and no change in proven (1P) and probable (2P). However, production has increased by 3 million tonnes.
1.1.2 – Natural gas – No specific commitment or target exists.	There is no long-term target or commitment to reduce the amount of extraction of gas from the environment.	Gas production has been declining since its peak in 2000. Gas reserves of proven (1P) and probable (2P) have declined since their peak in 1994. However, these have been flat seen 2016.	Gas production has declined by around 5 billion cubic metres (12%) since 2011. However, gas reserves have also declined over the same period from 493 billion cubic metres to 279 (44% decline) for proven and probable reserves.	Gas production between 2017 and 2018 has remained stable with a small decline of 3%. Reserves for proven and probable have also remained constant at 279 billion cubic metres.
1.1.3 - Coal – No specific commitment or target exists.	There is no long-term target or commitment to reduce the amount of extraction of coal from the environment.	Coal resources have increased when compared to 2016 which is the earliest data is available. Production and consumption have also declined from their peaks.	Data is not available for 2011.	Coal production has declined by 15% between 2017 and 2018. Estimated resources of UK coal have also increased by just over 1% between 2018 and 2019.

Assessment of oil

Asset data from oil reserves[11] is used to provide an indication of the amount of oil that is available. To complement this data, the NCC also presents data on consumption and production to show much of this resource has already been used. Data on reserves are compiled by the Oil and Gas Authority. The data used here is based on two datasets: for the period between 1973 - 2015 the data is based on the Oil and Gas Authority[12], and data from 2016 is based on the Office for National Statistics[13]. The starting point for the analysis is 1973, which is the earliest point in the data that is available/found.

11 Reserves refer to an estimate of the amount of oil or gas that can technically and economically be expected to be produced from a geological formation. **Source:** https://www.ogauthority.co.uk/media/2784/resources_vs_reserves_-_note_-_27-6-13.pdf

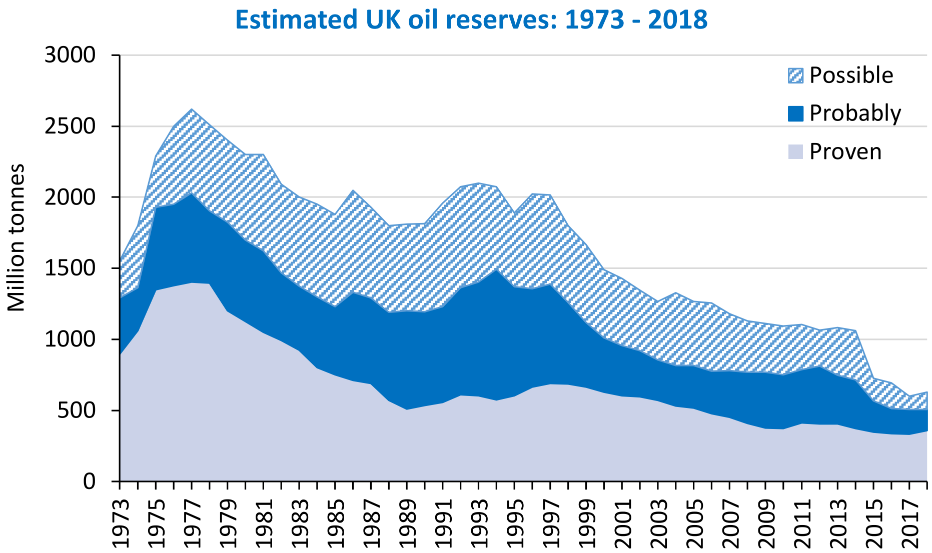
12 Oil and Gas Authority, *Oil and gas: field data* (2016) https://www.gov.uk/guidance/oil-and-gas-uk-field-data

13 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

From the most recent data, it has been estimated that there are around 507 million tonnes of proven (1P)[14] and probable (2P)[15] oil reserves at the end of 2018. Of these, 360 million tonnes are of proven (1P) reserves. In addition to proven (1P) and probable (2P) reserves, there are also estimates of possible (3P)[16] reserves, these have a lower chance of being technically and commercially produced. If including possible resources (120 million tonnes), the total reserves increase to around 627 million tonnes.

As can be seen from Figure 2 below, proven (1P) and probable (2P) reserves have generally been on the decline since 1994.

Figure 2 Estimates oil reserves since 1973



Source: Oil and Gas Authority[17]/ONS[18]

The production of crude oil and natural gas liquids (NGLs) have generally been on the decline since 1998, from around 133 million tones to around 50 million tonnes (-62%) in 2018. Between 2011 and 2018 there has been a small decline in production of around 1.5 million tonnes, with production over this period staying at around 40-50 million tonnes per annum. Since 1973, the cumulative amount of oil produced has been 3,812 million tonnes – see Figure 3 for historical trends. The Oil and Gas Authority projections up to 2024 estimate that oil production will continue to decline to around 40 million tonnes[19].

14 Proven (1P): Reserves that, on the available evidence, are virtually certain to be technically and commercially producible, i.e. have a better than 90% chance of being produced. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

15 Probable (2P): Reserves that are not yet proven, but which are estimated to have a better than 50% chance of being technically and commercially producible. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

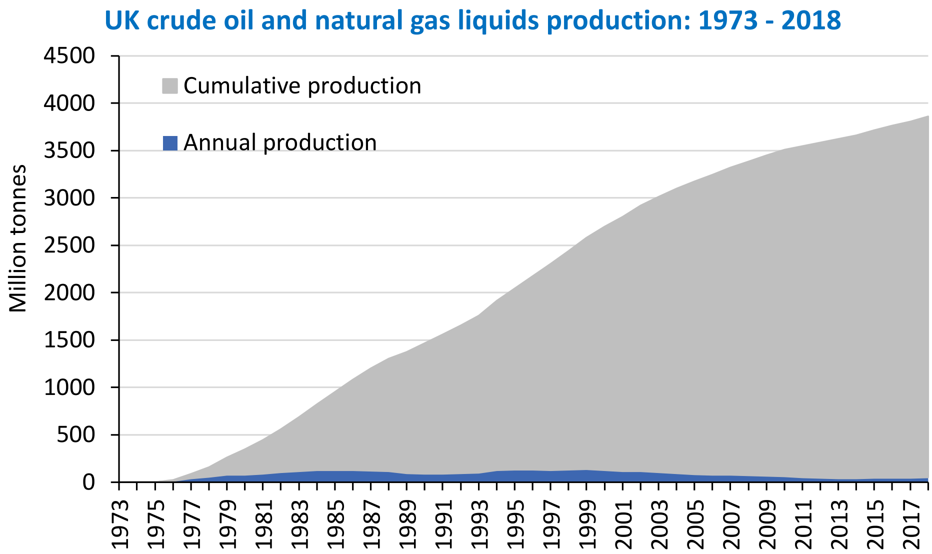
16 Possible (3P): Reserves that at present cannot be regarded as probable, but which are estimated to have a significant – more than 10% but less than 50% – chance of being technically and commercially producible. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

17 Oil and Gas Authority, *Oil and gas: field data* (2016) https://www.gov.uk/guidance/oil-and-gas-uk-field-data

18 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

19 Oil and gas Authority, *Projections of UK Oil and Gas Production and Expenditure* (2019) https://www.ogauthority.co.uk/media/5391/oga_projections_of_uk_oil_and_gas_production_and_expenditure.pdf

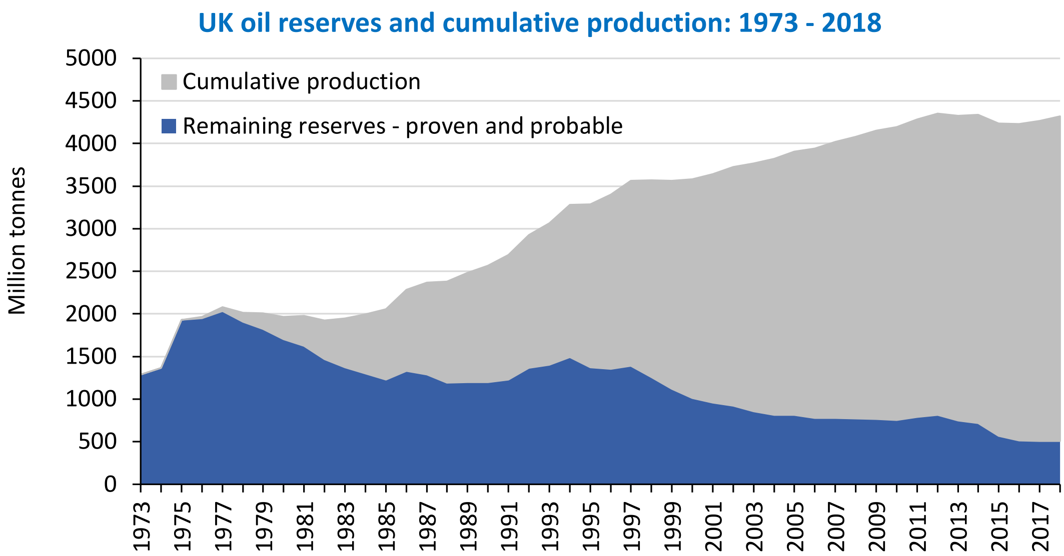
Figure 3 Crude oil and natural gas liquids production since 1973



Source: BEIS DUKES[20]

Figure 4 shows the cumulative oil production, proven (1P) and probable (2P) reserves. As can be seen there has been a substantial increase between 1973 and 2018 of the total oil production and reserve of 235%. The increases reflect new technology and the inclusion of already-known fields that either entered production or moved from prospective to probable status. The apparent decline in reserves in 2015 was due to the re-classification[21] of some reserves[22].

Figure 4 UK oil reserves and cumulative production since 1973



Source: Oil and Gas Authority[23]/ONS[24]/BEIS DUKES[25]

20 BEIS, *Digest of UK Energy Statistics (DUKES): petroleum - Crude oil and Natural Gas Liquids production (DUKES F.1)* (2019) https://www.gov.uk/government/statistics/petroleum-chapter-3-digest-of-united-kingdom-energy-statistics-dukes

21 Some reserves had not yet been sanctioned, these will be included in future as and when sanctioned.

22 BEIS, *Digest of UK Energy Statistics (DUKES) 2019* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

23 Oil and Gas Authority, *Oil and gas: field data* (2016) https://www.gov.uk/guidance/oil-and-gas-uk-field-data

24 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

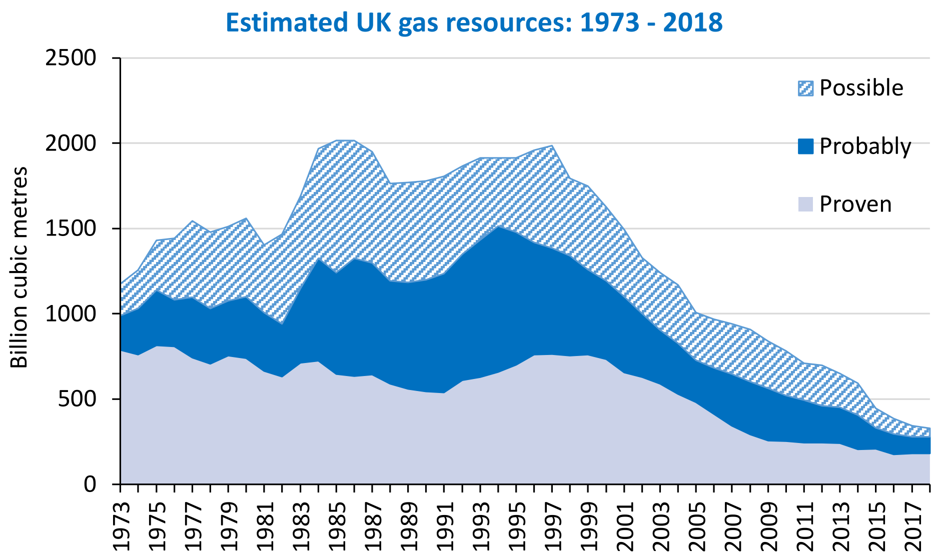
25 BEIS, *Digest of UK Energy Statistics (DUKES): petroleum - Crude oil and Natural Gas Liquids production (DUKES F.1)* (2019) https://www.gov.uk/government/statistics/petroleum-chapter-3-digest-of-united-kingdom-energy-statistics-dukes

Assessment of natural gas resources

As per the oil assessment above, the gas assessment uses the same data sources and datasets, but the data in this case covers resources[26]. The first dataset covers the period between 1973 - 2015 and is based on the Oil and Gas Authority[27] estimates. For the period beyond 2015, the data is based on the Office for National Statistics[28]. From the most recent estimates, there are 279 billion cubic metres of gas resources available as proven (1P)[29] and probable (2P)[30], of which 181 billion cubic metres are proven (1P). In addition to proven (1P) and probable (2P) reserves, there are also estimates of possible (3P)[31] reserves, these have a lower chance of being technically and commercially producible. If possible reserves (50 billion cubic metres) are included this brings the total reserves to around 329 billion cubic metres – see Figure 5 below for trend since 1973.

The amount of proven (1P) gas resources have generally declined since around 1997 from a peak of 765 billion cubic metres.

Figure 5 Estimated UK gas resources since 1973



Source: ONS[32]

The production of gas has generally been on the decline since the 2000 peak, from around 108 billion cubic metres to around 37 billion cubic metres (reduction of 66%) in 2018. Between 2011 and 2018 there has been a decline in production of around 5.1 billion cubic metres, with production over this period staying at around 33-38 billion per annum. Since 1973, the cumulative amount of gas produced has been of just under 2,626 billion cubic metres – see Figure 6 for historical trends.

26 Resources refers to an estimate of the amounts of oil and gas that are believed to be physically contained in the source rock – in this case, the Bowland-Hodder shale formation. **Source:** https://www.ogauthority.co.uk/media/2784/resources_vs_reserves_-_note_-_27-6-13.pdf

27 Oil and Gas Authority, *Oil and gas: field data* (2016) https://www.gov.uk/guidance/oil-and-gas-uk-field-data

28 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

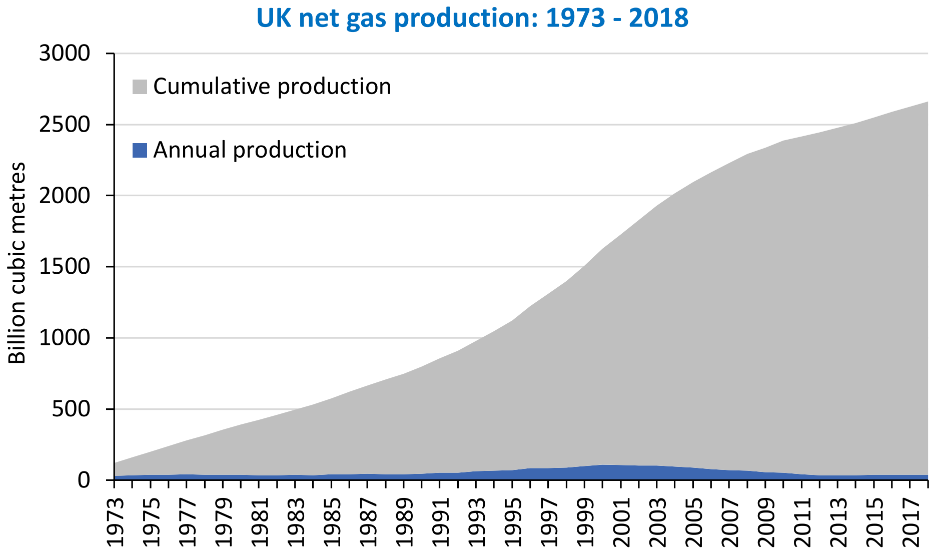
29 Proven (1P): Reserves that, on the available evidence, are virtually certain to be technically and commercially producible, i.e. have a better than 90% chance of being produced. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

30 Probable (2P): Reserves that are not yet proven, but which are estimated to have a better than 50% chance of being technically and commercially producible. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

31 Possible (3P): Reserves that at present cannot be regarded as probable, but which are estimated to have a significant – more than 10% but less than 50% – chance of being technically and commercially producible. **Source:** https://www.ogauthority.co.uk/media/5942/oga_reserves__resources_report_2019_jk.pdf

32 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

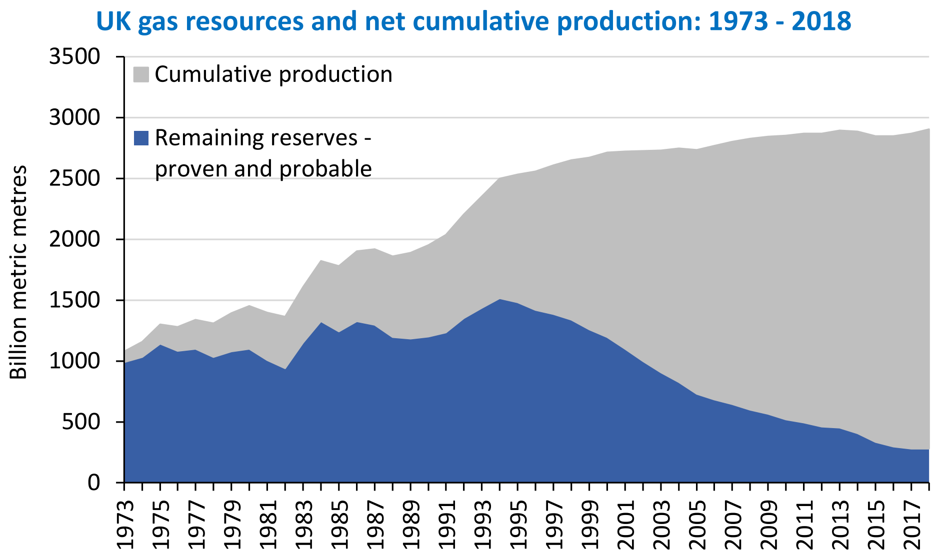
Figure 6 UK net gas production since 1973



Source: BEIS DUKES[33]

Figure 7 shows the cumulative gas production, proven (1P) and probable (2P) reserves. As can be seen there has been a substantial increase between 1973 and 2018 of the total gas production and reserve of 169%. In terms of the amount of the gas that has been extracted, if aggregating both production and proven (1P) and probable (2P) reserves, we can see that around 90% has already been extracted from the environment. The apparent decline in reserves in 2015 was due to the re-classification[34] of some reserves[35].

Figure 7 UK gas resources and net cumulative production since 1973



Source: ONS[36]/ BEIS DUKES[37]

33 BEIS, *Digest of UK Energy Statistics (DUKES): natural gas - Gas production (DUKES F.2)* (2019) https://www.gov.uk/government/statistics/natural-gas-chapter-4-digest-of-united-kingdom-energy-statistics-dukes

34 Some reserves had not yet been sanctioned, these will be included in future as and when sanctioned.

35 BEIS, *Digest of UK Energy Statistics (DUKES) 2019* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

36 ONS, *Oil and gas: reserves and resources* (2019) https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsoilandgas

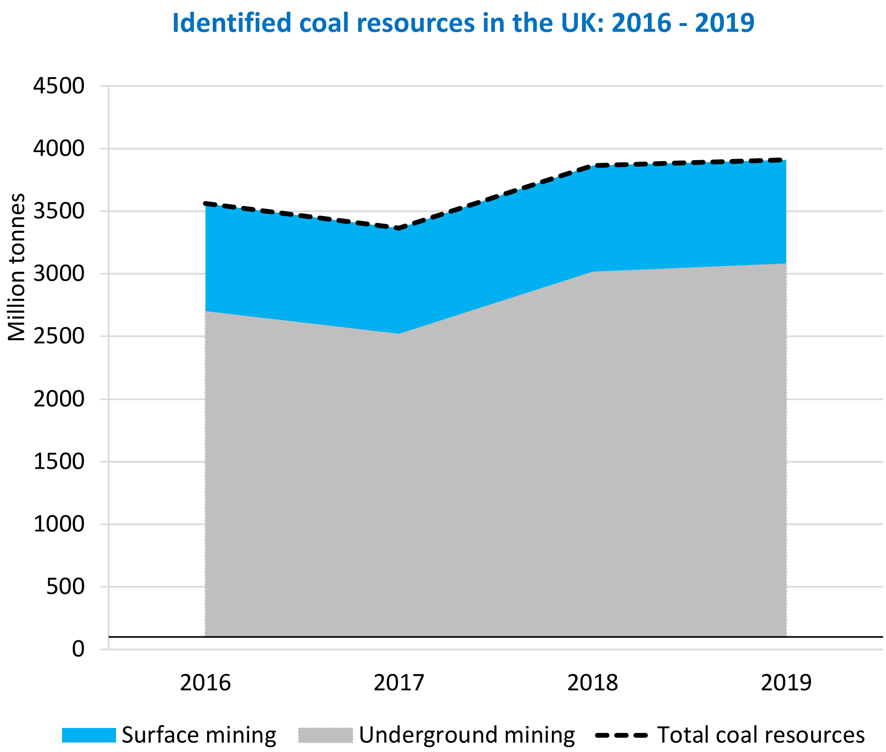
37 BEIS, *Digest of UK Energy Statistics (DUKES): natural gas - Gas production (DUKES F.2)* (2019) https://www.gov.uk/government/statistics/natural-gas-chapter-4-digest-of-united-kingdom-energy-statistics-dukes

Assessment of coal resources, production, and consumption

There is limited availability of data for coal resources, unlike gas and oil estimates which have a long historical trend, coal data is only available from 2016 which limits the assessment that can be made. To supplement the resources data, this section also includes data in production and consumption which dates back to 1990. The estimated resources of coal have been produced by the Coal Authority and are presented in the Department for Business, Energy, and Industrial Strategy (BEIS) Digest of UK Energy Statistics Data reports[38].

The most recent estimates in 2019, as presented in Figure 8, show that in the UK there are around 3,910 million tonnes of coal resources, including prospects. When comparing this to 2016 estimates of 3,560 million tonnes, we can see that there has been an increase of 350 million tonnes. Of the 3,910 million tonnes in 2019, around 1082 million tonnes are economically recoverable and minable, of which around 1,033 million tonnes are in underground mines and 49 million tonnes on surface mines[39].

Figure 8 Identified UK coal resources since 1996



Source: Coal Authority data published in BEIS DUKES statics reports (2016-2019)[40]

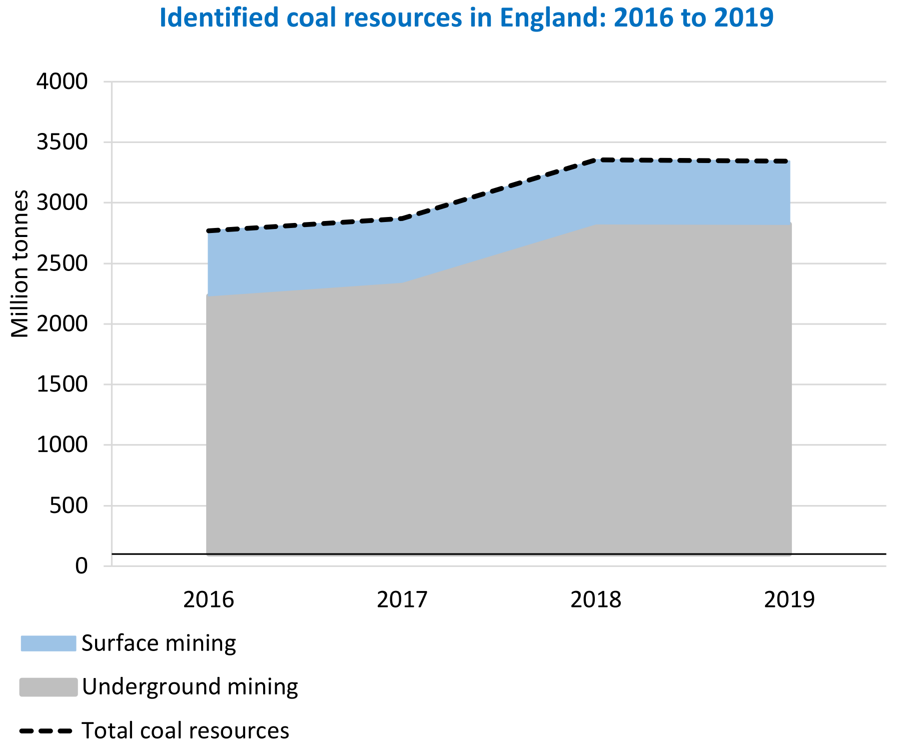
Data is also available at the England level and devolved administrations. In England, it is estimated there are around 2,825 million tonnes found in underground mines and 521 million tonnes in surface mines, this equates to around 3,346 million tonnes (86% of the UK). See Figure 9 for coal resources in England.

38 BEIS, *Digest of UK Energy Statistics (DUKES) 2019* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

39 BEIS, *Digest of UK Energy Statistics (DUKES) 2019* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

40 BEIS, *Digest of UK Energy Statistics (DUKES) 2019: Digest of United Kingdom Energy Statistics (DUKES) 2019: main chapters and annexes A to D* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

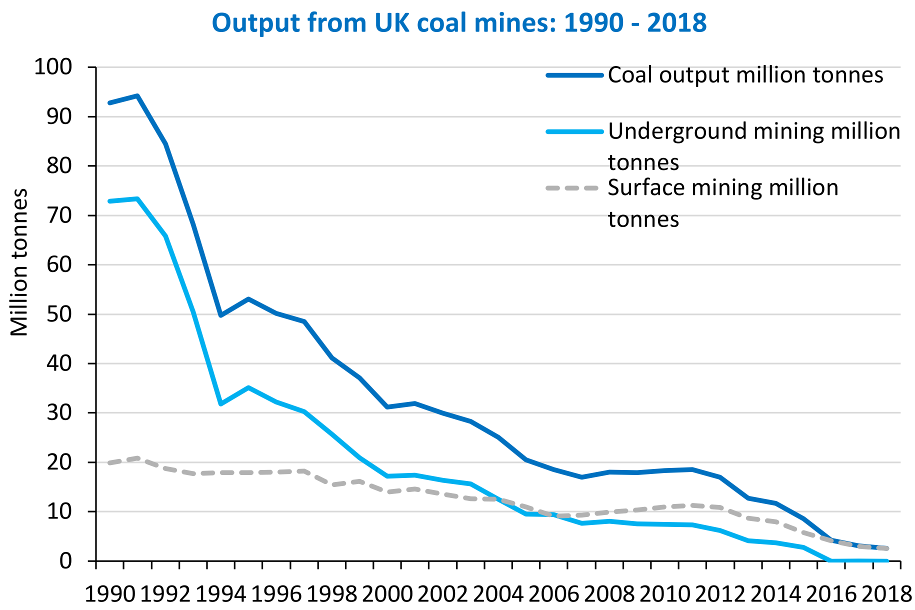
Figure 9 Identified coal resources in England since 2016



Source: Coal Authority data published in BEIS DUKES statics reports (2016-2019)[41]

While coal resource estimates have increased, the production of coal has declined from both underground and surface mining. In 2018, the production was 2.6 million tonnes, an all time low, this is a fraction (2.8%) of what was mined in 1990 when the data starts. This is also a significant decline on the amount that was produced in 2011 of 18.6 million tonnes. Even between 2017 and 2018, there has been a significant decline of 15% in the production of coal, this is mainly due to lower demand for coal-fired electricity and one of the large surface mines not producing since April 2017[42]. See Figure 10 coal production since 1990.

Figure 10 Coal production since 1990



Source: BEIS[43]

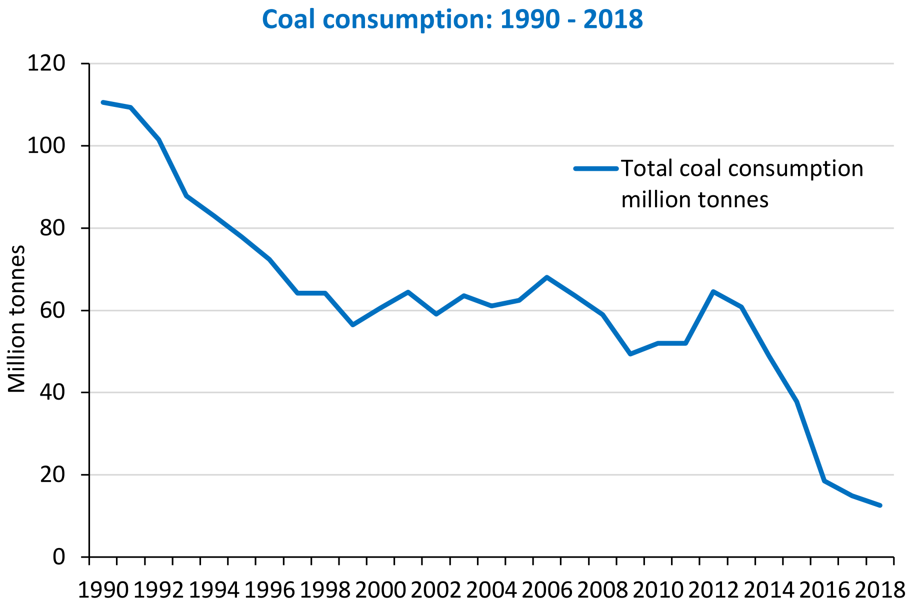
41 BEIS, *Digest of UK Energy Statistics (DUKES) 2019: Digest of United Kingdom Energy Statistics (DUKES) 2019: main chapters and annexes A to D* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

42 BEIS, *Digest of UK Energy Statistics (DUKES) 2019* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

43 BEIS, *Historical coal data: coal production, availability and consumption* (2020) https://www.gov.uk/government/statistical-data-sets/historical-coal-data-coal-production-availability-and-consumption

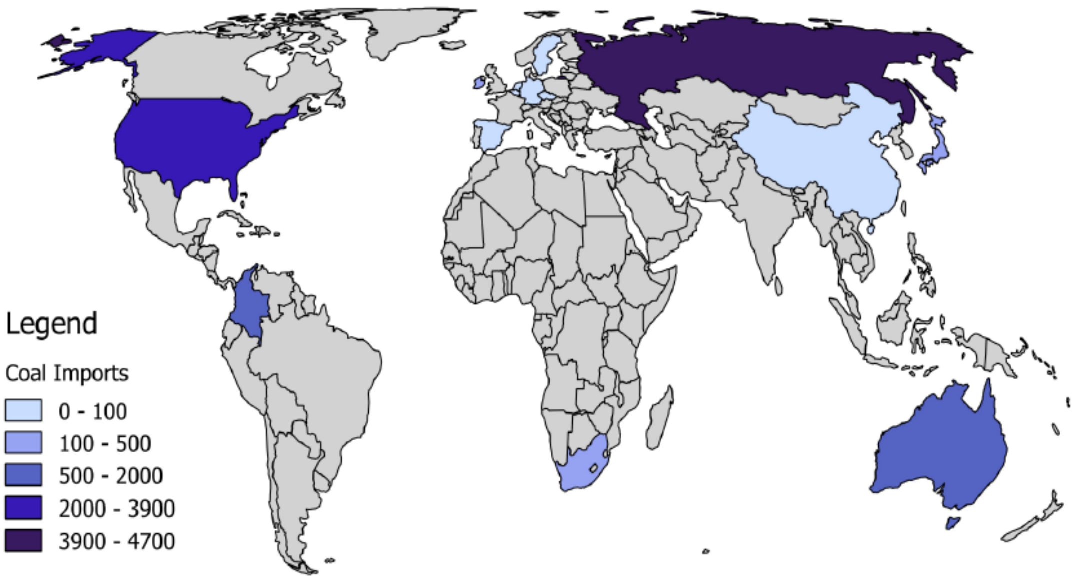
In line with the decline of coal production, there has also been a decline in consumption, which has declined by just over 89% since the peak in 1990 of 110.6 million tonnes to just over 12.6 million tonnes in 2018 – see Figure 11 for consumption trend since 1990. The shortfall between consumption and production is made up of imports of coal. In 2018, the UK imported around 10.1 million tonnes of coal. The majority of the imports come from four countries: Russia (4.7 million tonnes), the United States of America (3.6 million tonnes), Australia (0.6 million tonnes), and Colombia (0.3 million tonnes) - See Figure 12 for imports data.

Figure 11 Coal consumption since 1990



Source: BEIS[44]

Figure 12 UK coal imports in 2018 (in thousand tonnes)



Source: Digest of UK Energy Statistics (DUKES) 2019[45]

44 BEIS, *Historical coal data: coal production, availability and consumption* (2020) https://www.gov.uk/government/statistical-data-sets/historical-coal-data-coal-production-availability-and-consumption

45 BEIS, *Digest of UK Energy Statistics (DUKES) 2019: Digest of United Kingdom Energy Statistics (DUKES) 2019: main chapters and annexes A to D* (2019) https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019

2. Minerals

There are several minerals and metals that are extracted in the UK. For the assessment that follows, the focus has been on key minerals and metals – see Table 6 for the full list of minerals and metals that have been assessed. This is by no means a comprehensive list and there is limited data and evidence available on these.

There is no recent and comprehensive evidence on the resources of minerals in England or the UK. The most recent evidence on reserves is on primary aggregates and the evidence is from 2004, presented by the British Geological Survey (BGS) in their ***Primary Aggregates Reserves In England 1990-2004***[46]and estimates from The Crown Estate on offshore reserves of aggregates found in ***Marine aggregates: Capability and Portfolio***[47] reports.

In addition to reserves evidence, there is also spatial evidence presented as maps by regions in England, covering onshore and offshore resources. Onshore maps are somewhat dated as these were published between 1995 and 2006 and can be found at the BGS website under *Onshore mineral resource maps*[48]*.*

Given this limitation, to get an indication of the amount that is being extracted from the environment, ***data and evidence on production are used instead***. The sole source of these estimates is the United Kingdom Minerals Yearbooks published by the BGS[49]. The data produced by the BGS for most of the minerals is based on estimates instead of actual production figures. For this assessment, the starting point is 1997, but earlier data is available and can be found on the BGS website[50].

For simplicity, these minerals and metals are grouped and assessed under two subheadings:

- Construction and industrial minerals; and
- Metals and other minerals.

Table 6 List of minerals and their respective targets

	Type of minerals	Target
Construction and industrial minerals	• Sand and gravel from land • Sand and gravel from marine • Crushed rock	There are no specific targets to reduce the extraction of construction and industrial minerals. However, to reduce the impact of extraction of minerals from the natural environment government on the 1st of April 2002 introduced the Aggregates Levy (at 1.60/ tonne) of material. As of 2020, the Levy is at (£2.00/ tonne)[51]. The Levy applies to sand and gravel, and crushed rocks that are used for construction purposes.
	• Anhydrite • Ball clay • Barytes • Kaolin (or China clay) • Clay • Feldspar • Fireclay • Fluorspar (Fluorite) • Fullers earth • Gypsum	There are no specific targets to reduce the extraction of construction and industrial minerals.

46 British Geological Survey, *Primary Aggregates Reserves In England 1990-2004* (2006) https://www.bgs.ac.uk/mineralsuk/planning/construction.html

47 The Crown Estate, *Portfolio and Capability reports* https://www.thecrownestate.co.uk/en-gb/downloads-results/?q=capability+and+portfolio

48 British Geological Survey, *Onshore mineral resource maps* https://www.bgs.ac.uk/mineralsuk/planning/resource.html#MRM

49 British Geological Survey, *United Kingdom Minerals Yearbook 2002 – 2019* https://www.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

50 British Geological Survey, *Economic memoirs* https://www.bgs.ac.uk/data/publications/pubs.cfc?method=listResults&topic=EM&series=NA&subseries=NJ&pageSize=100

51 HMRC, *Aggregates Levy: rates and reliefs* https://www.gov.uk/guidance/aggregates-levy-rates-and-reliefs

Construction and industrial minerals	• Igneous rock • Limestone, dolomite, and chalk • Peat • Salt • Sandstone • Silica sand • Slate	There are no specific targets to reduce the extraction of construction and industrial minerals.
Metals and other minerals	• Aluminium • Arsenopyrite • Cadmium • Chromium • Cobalt • Coltan (short for columbite–tantalites) • Copper • Gold • Iron (pig iron and steel) • Lead • Lithium • Manganese • Nickel • Phosphate • Platinum & Platinum Group Elements • Potassium compounds (including Potash and Polyhalite) • Pyrite • Quartz • Rare Earth elements • Silver • Sulphur • Talc • Tin • Titanium • Tungsten • Zinc	There are no specific targets to reduce the extraction of metals and other minerals.

Overall assessment of minerals

The assessment of the minerals – based on the datasets available – is 'Amber': **mixed**, the mixed RAG rating reflects that there is no recent comprehensive data on reserves and resources of minerals, and that evidence and data available is only available on some of the minerals scoped by NCC, and these are mostly based on estimates which should be treated with caution. Further details can be found in the sections that follow and in Table 7 below. The key findings from the NCC assessments are:

- The production of natural aggregates has fallen by 18% from its peak in 2004 of 244 million tonnes to 198 million tonnes in 2018 – which is a positive effect in the environment.

Table 7 NCC assessment of progress and RAG rating

Component and subcomponents of the asset		Assessment			
		Compliance with target or commitment	Long-term trend	Against the NCC baseline (2011)	Short-term trend
Construction and industrial Minerals	1.2.1 - Anhydrite	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.2 - Ball clay	No target/ commitment was found/exist.	The production of ball clay has reduced between 1997 and 2018 by just over 5%, from just under 916,00 to 867,000 tonnes.	There has also been a reduction in the production of ball clay between 2011 and 2018 of just under 7%.	Between 2017 and 2018 there was an increase in production of 2%, from 850,000 to 867,000 tonnes.
	1.2.3 - Barytes	No target/ commitment was found/exist.	Between 1997 and 2018 there was a reduction in the production of barytes of just under 26%, from 74,000 to 55,000 tonnes.	However, between 2011 and 2018, there was an increase in production from 31,000 to 55,000 tonnes.	As per the BGS estimates there was no change in the production level of barytes.
	1.2.4 - Kaolin (or China clay)	No target/ commitment was found/exist.	The latest data estimated the BGS shows that there was a decline in the production of kaolin between 1997 and 2018, from 2,360,000 to 996,000 tonnes.	There was also a decline in the production between 2011 and 2018 from 1,290,000 to 996,000 a reduction of just under 23%.	Between 2017 and 2018 there was a slight increase of just under 3%.
	1.2.5 - Clay	No target/ commitment was found/exist.	Clay production between 1997 and 2018 there was a decline of just over 59% from 11,322,000 to 4,606,000 tonnes.	There was also a decline between 2011 and 2018 of just over 25%	Between 2017 and 2018 there was a decrease in clay production of just under 17% from 5,544,000 to 4,606,000 tonnes.
	1.2.6 - Crushed rock	No target/ commitment was found/exist.	There was a small decline in the production of crushed rock between 1997 and 2018 of just under 4%.	While between 2011 and 2018 there was an increase in the production of crushed rock from 102,800,000 to 128,600,000.	There was also an increase of just over 2% between 2017 and 2018.

Construction and industrial Minerals	1.2.7 - Feldspar	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.8 - Fireclay	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.9 - Fluorspar (Fluorite)	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.10 - Fuller's earth	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.11 - Gypsum	No target/ commitment was found/exist.	The BGS estimates present a decline in the amount of production of gypsium between 1997 and 2018 of 30% from 2,000,000 to 1,400,000 tonnes.	However, between 2011 and 2018 there was an increase in the production of gypsum from 1,200,000 to 1,400,000 tonnes.	There was also increase in the estimated production between 2017 and 2018 of just under 8%.
	1.2.12 - Igneous rock	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.13 - Limestone, dolomite and chalk	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.14 - Peat	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.15 - Sand and gravel from land	No target/ commitment was found/exist.	Between 1997 and 2018 there was a decline in the production of sand and gravel from land of just over 35%, from 79,500,000 to 51,500,000 tonnes.	However, between 2011 and 2018 there was an increase in the production between 2011 and 2018 of 11%, from 46,400,000 to 51,500,000 tonnes.	There was also an increase in production between 2017 and 2018 of just 3%.
	1.2.16 - Sand and gravel from marine	No target/ commitment was found/exist.	Sand and gravel (marine) production between 1997 and 2018 there was a decline of just under 6% from 18,900,000 to 17,800,000 tonnes.	However, between 2011 and 2018 the BGS estimates present an increase in the production of sand and gravel from marine sources of just under 3%.	There was also an increase between 2017 and 2018 from 17,400,000 and 17,800,000 tonnes.
	1.2.17 - Salt	No target/ commitment was found/exist.	The BSG estimates present a decline in the amount of production of salt between 1997 and 2018 of just over 29% from 6,661,000 to 4,700,000 tonnes. There was	There was also a decline in the production of salt between 2011 and 2018 of just over 22%.	There was no change in the production estimates between 2017 and 2018.

Construction and industrial Minerals	1.2.18 - Sandstone	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.2.19 - Silica sand	No target/ commitment was found/exist.	Between 1997 and 2018 there was an increase inf the production of silica sand from 4,704,000 to 4,863,000 tonnes.	There was also an increase between 2011 and 2018 of just under 23% from 3,969,000 to 4,863,000 tonnes.	When comparing 2017 and 2018 production estimates, there was an increase of just over 8%, from 4,490,000 to 4,863,000 tonnes.
	1.2.20 - Slate	No target/ commitment was found/exist.	There was a significant increase in the production of slate between 1997 and 2018 of just over 136%, from 347,000 to 820,000 tonnes.	Between 2011 and 2018 there was an increase in the production of slate of just over 7% from 763,000 to 820,000 tonnes.	There was no change in the production estimates between 2017 and 2018.
Metals and other minerals	1.3.1 - Aluminium	No target/ commitment was found/exist.	There was a decline in the production of aluminium between 1997 and 2018 from 490,000 to 197,000 tonnes.	When looking at the BGS estimates between 2011 and 2017 there was also a decline in production from 312,000 to 196,000 tonnes.	There was no change in the production estimates between 2017 and 2018.
	1.3.2 - Arsenopyrite	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.3 - Cadmiun	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.4 - Chromium	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.5 - Cobalt	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.6 - Coltan	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.7 - Copper	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.8 - Gold	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.9 - Iron (pig iron and steel)	No target/ commitment was found/exist.	Between 1997 and 2018 there was a decrease in the production of the iron of just over 59%, from 31,555,000 to 12,856,000 tonnes.	There was also a decline in the production of iron between 2011 and 2018 from 16,103,000 to 12,856,000 tonnes.	Between 2017 and 2018 there was also a decline in the production of iron from 13,488,000 to 12,856,000 tonnes.

Metals and other minerals	1.3.10 - Lead	No target/ commitment was found/exist.	Lead production between 1997 and 2018 there was a decline of just under 16%, from 424,000 to 357,000 tonnes.	However, when assessing between 2011 and 2018 there was an increase in production from 311,000 to 357,000 tonnes.	When comparing 2017 and 2018 estimates there was a decline of just over 1% in the production of lead.
	1.3.11 - Litihium	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.12 - Manganese	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.13 - Nickel	No target/ commitment was found/exist.	Production of nickel between 1997 and 2018 has increased by just over 14%, from 36,100 to 41,200 tonnes.	There was also an increase in production between 2011 and 2018 of just over 10%, from 37,400 to 41,200 tonnes.	When comparing between 2017 and 2018 there was an increase of just over 8% in the production of nickel.
	1.3.14 - Phosphate	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.15 - Platinum & Platinum Group Elements	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.16 - Potassium compounds (including Potash and Polyhalite)"	No target/ commitment was found/exist.	Estimates from the BGS on the production of potassium compounds show a decline of just over 35% between 1997 and 2018, from 941,000 to 610,000 tonnes.	Between 2011 and 2018 there was a decrease in the production of potassium compounds from 770,000 to 610,000 tonnes.	When comparing between 2017 and 2018 there was a decrease of just under 15% in the production of potassium compounds
	1.3.17 - Pyrite	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.18 - Quartz	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.19 - Rare Earth elements	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.20 - Silver	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.21 - Sulphur	No target/ commitment was found/exist.	There has been a reduction in the production of sulphur of just over 27%, from 177,000 to 129,000 tonnes.	When assessing between 2011 and 2018 there was also a decline in the level of production of sulphur from 167,000 to 129,000 tonnes.	Between 2017 and 2018 there was also a decline in the production of sulphur of 3%

Metals and other minerals	1.3.22 - Talc	No target/ commitment was found/exist.	Between 1997 and 2018 the production of talc declined by just over 71%, from 5,749 to 1,640 tonnes.	There has also been a decline in the production of talc between 2011 and 2018, of just under 56% from 3,708 to 1,640 tonnes.	When comparing data from 2017 and 2018 there was a decrease of just over 49% in the production talc.
	1.3.23 - Tin	No target/ commitment was found/exist.	When comparing the BGS estimates of 1997 and 2018, there has been a reduction in the production of tin of just over 90% from 2,396 to 230 tonnes.	N/A – Data is not available	There has also been a reduction in the production between 2017 and 2018 of just under 10%, from 255 to 230 tonnes.
	1.3.24 - Titanium	No target/ commitment was found/exist.	Between 1997 and 2018 there was an increase of just over 20%, from 233,000 to 280,000 tonnes.	There was no change in the production estimates between 2011 and 2018.	When assessing between 2017 and 2018 there was a slight decrease in the production of just over 3%.
	1.3.25 - Tungsten	No target/ commitment was found/exist.	N/A – Data is not available	N/A – Data is not available	N/A – Data is not available
	1.3.26 - Zinc	No target/ commitment was found/exist.	There has been a reduction in the production of zinc of just under 3% between 1997 and 2018, from 107,700 to 104,800 tonnes.	When comparing BGS estimates between 2011 and 2018 there was an increase of just under 21%.	There was also an increase in production of zinc between 2017 and 2018 of just under 4%, from 101,200 to 104,800 tonnes.

Construction and industrial minerals

The minerals assessed under the construction and industrial section are based on the same minerals presented in the British Geological Survey (BGS) UK Minerals Yearbooks. For the assessment that follows these minerals have been grouped under three groups:

- Natural Aggregates [52, 53];
- Igneous rocks[54], sandstone[55], limestone[56], dolomite[57] and chalk[58]; and
- Remaining construction and industrial minerals[59].

52 Natural Aggegates are normally defined as aggregates from mineral sources which have been subject to nothing more than physical processesing, such as crushing and sizing. **Source:** https://www.bgs.ac.uk/downloads/search.cfm?SECTION_ID=0&MIME_TYPE=0&SEARCH_TXT=construction+aggregates&dlBtn=search

53 Aggregates are normally defined as being hard, granular materials which are suitable for use either on their own or with the addition of cement, lime or a bituminous binder in construction. **Source:** https://www.bgs.ac.uk/downloads/search.cfm?SECTION_ID=0&MIME_TYPE=0&SEARCH_TXT=construction+aggregates&dlBtn=search

54 Igneous rocks: A rock that originated when a molten magma or lava cooled and solidified. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

55 Sandstone: sandstone is formed of sand that has been turned to stone. The grains of this sedimentary are mainly quartz or feldspar and are cemented together with minerals such as calcite, silica or iron to form a rock. The grains are as small as 0.06 mm (1/16th mm) and as large as 2.0 mm in size. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

56 Limestone: A hard sedimentary rock that is composed of over 50% carbonate minerals. A true limestone is over 90% calcite, but there are often other carbonates (including dolomite) and impurities in the form of sand grains, clay minerals, etc. Limestone is laid down in layers or 'beds' separated by 'bedding planes' and divided up into blocks by a series of joints (fissures created during the rock formation process) at approximately, right angles to each other. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

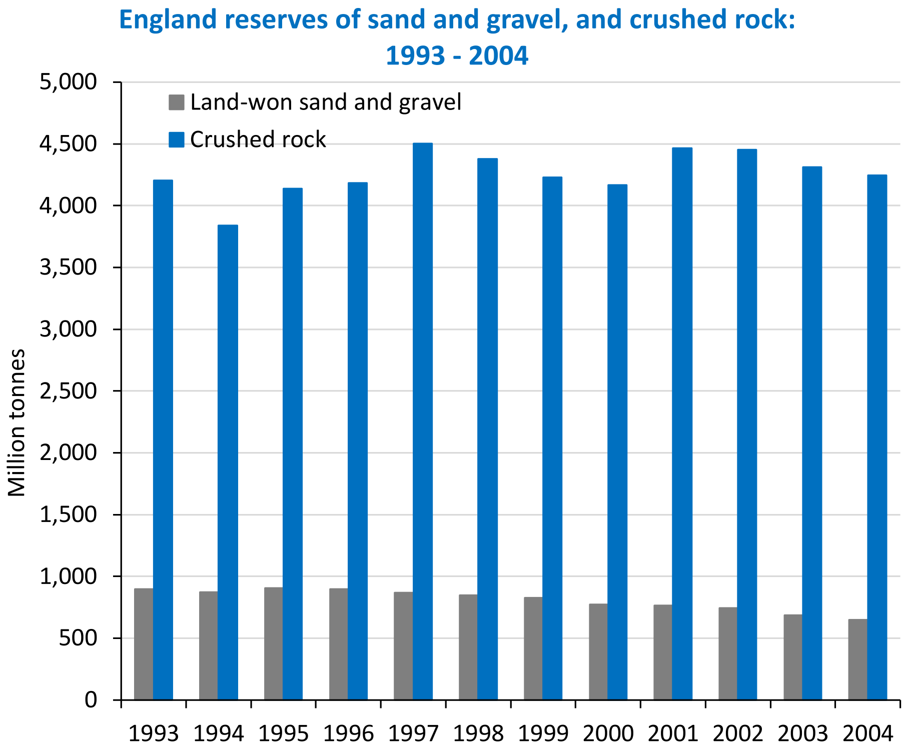
57 Dolomite: A mineral of magnesium carbonate. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

58 Chalk: A soft limestone formed mainly of coccolith skeletons. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

59 These have been grouped together in four groups based on their tonnage and are discussed in the sections below.

There is historical evidence on the reserves of sand and gravel, and crushed rock in England covering the period between 1993-2004. This is somewhat dated evidence but to provide a sense of the reserves available these are presented in Figure 13 below. Reserves of land-won sand and gravel declined over this period from 897 million tonnes in 1993 to around 648 million tonnes in 2004. While reserves of crushed rock fluctuated over the same period, with reserves in 2004 slightly higher than in 1993, reserves were estimated to have increased between 1993 and 2004, by 43 million tonnes from 4,204 million to 4,247 million tonnes. Further evidence on reserves can be found at the *Primary Aggregates Reserves In England 1990-2004*[60]

Figure 13 England reserves of land sand and gravel, and crushed rock in 1993 and 2004



Source: BGS - Primary Aggregates Reserves In England 1990-200461

In addition to the BGS estimate on on-shore reserves, the Crown Estate estimated the reserves of marine primary[62] aggregates. These estimates are presented in their *Portfolio and Capability* reports. Data on reserves is only available from 2017 and presented in Table 8.

Table 8 Offshore reserves of natural aggregates since 2017 in England

Million tonnes	2017[63]	2018[64]	2019[65]
Offshore aggregates reserve – England	349.57	342.88	347.21

Source: Crown Estate capability and portofolio reports

60 British Geological Survey, *Primary Aggregates Reserves In England 1990-2004* (2006) https://www.bgs.ac.uk/mineralsuk/planning/construction.html

61 British Geological Survey, *Primary Aggregate Reserves inEngland 1990–2004* (2006) http://nora.nerc.ac.uk/id/eprint/7458/1/CR06168N.pdf

62 The BGS definition for primary aggregates: are produced from naturally occurring minerals deposites, extracted specifically for use as aggregates and used for the first time. Source:

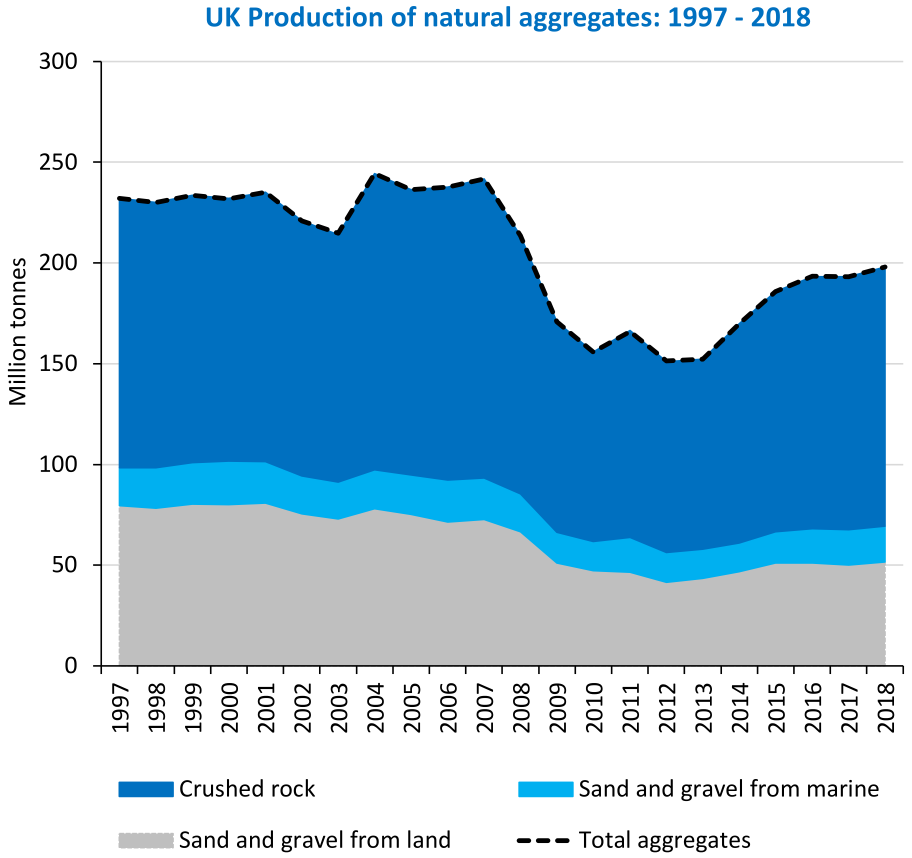
63 The Crown Estate, *Marines aggreagtes: Capability and Portofolio 2017* (2017) https://www.thecrownestate.co.uk/media/2483/marineplusaggregates_2017_web.pdf

64 The Crown Estate, *Marines aggreagtes: Capability and Portofolio 2018* (2018) https://www.thecrownestate.co.uk/media/2753/2018-the-crown-estate-marine-aggregates-report.pdf

65 The Crown Estate, *Marines aggreagtes: Capability and Portofolio 2019* (2019) https://www.thecrownestate.co.uk/media/3502/2019-capability-and-portfolio-report.pdf

Natural aggregates are the sum of sand and gravel from marine and land and crushed rocks[66, 67]. In 2018 crushed rocks accounted for around 65% of the total natural aggregates. The estimated production of natural aggregates has declined from the 2004 peak of 244 million tonnes to around 198 million tonnes in 2018. When comparing 2011 and 2018, there has been an increase of just over 19% in the production of natural aggregates. Of the total sand and gravel production, the majority is sourced from land, in 2018 this accounted for 74% of the total. See Figure 14 for a historical trend since 1997.

Figure 14 UK production of natural aggregates since 1997



Source: BGS UK Minerals Yearbooks[68]

There is limited trend data on the estimated production of igneous rocks[69], sandstone[70], limestone, dolomite and chalk[71]. The data is only available up to 2014, as this data was reliant on estimates from the Office for National Statistics (ONS) Annual Mineral Raised Inquiry (AMRI) annual survey. The AMRI survey ceased in 2016 and the latest data available is from 2014.[72] This is the last year where data is available in the BGS yearbooks.

66 These are hard, strong rock formations that have been crushed to produce crushed rocks. **Source:**https://www.bgs.ac.uk/downloads/search.cfm?SECTION_ID=0&MIME_TYPE=0&SEARCH_TXT=construction+aggregates&dlBtn=search

67 Includes estimates for Northern Ireland for some years.

68 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

69 Includes estimates for Northern Ireland for some years and in some years excludes a small production of granite in Northern Ireland.

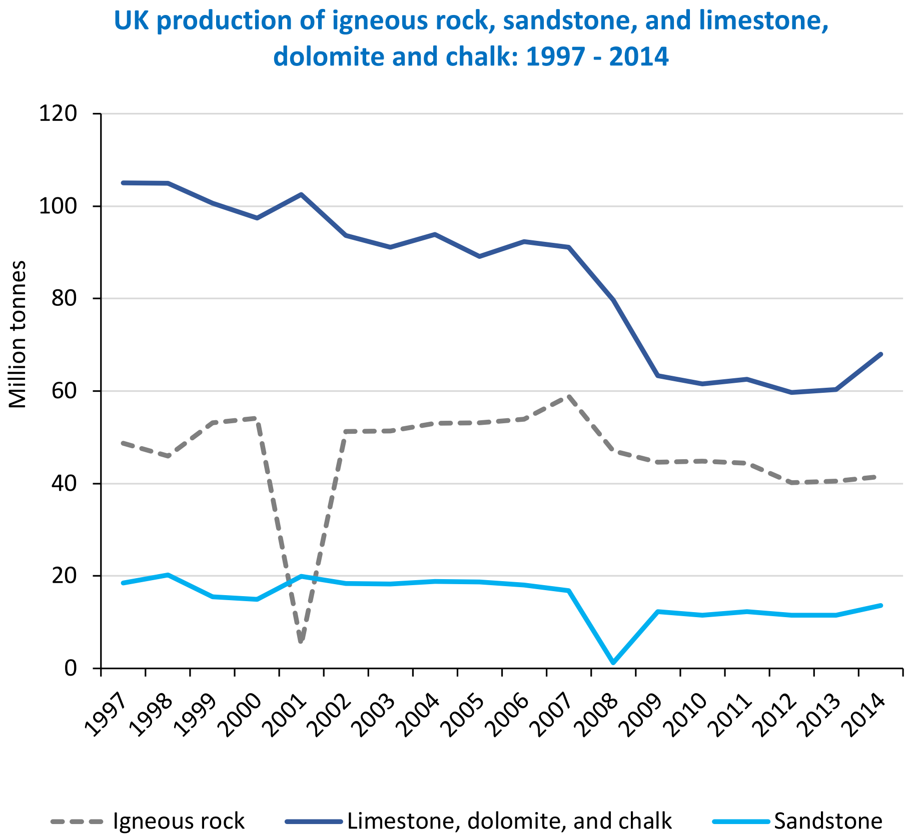
70 Includes estimates for Northern Ireland for some years.

71 Includes estimates for Northern Ireland for some years.

72 British Geological Survey, *United Kingdom Minerals Yearbook 2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

Based on the 2014 evidence the production of limestone, dolomite, and chalk, and have steadily declined. In 1997 production was around 105 million tonnes declining to just under 67.9 million tonnes in 2014, a 35% decline. Production has also declined from 1997 levels for both igneous rock and sandstone, by 15% and 26% respectively. When comparing 2011 production levels to 2014, there is only a decline in production of igneous rock of just under 7%. While the production of limestone, dolomite and chalk increased from 62.5 million tonnes in 2011 to just over 67.9 million tonnes in 2014. Sandstone production also increased over this period from just under 12.3 million tonnes to just over 13.6 million tonnes. See Figure 15 for the change in production between 1997- 2014.

Figure 15 UK production of rocks and stones



Source: BGS UK Minerals Yearbooks[73]

73 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

The remaining construction and industrial minerals have been subgrouped under four graphs based on their tonnage.

1. Kaolin (or China clay)[74], clay[75], salt, and silica sand[76];
2. Ball clay[77], fireclay[78], gypsum[79], and slate[80];
3. Barytes[81], feldspar[82], fluorspar (fluorite)[83], and fullers earth[84]; and
4. Peat[85].

Staring with group 1, Figure 16 below presents the change since 1997, where it can be seen that there has been a reduction in the production of kaolin[86], clay[87], and salt[88] between 1997 and 2018 of 58%, 59% and 29% respectively. While for silica sand[89] there has been an increase of just over 3%.

When comparing the change in production levels between 2011 and 2018, a similar trend can be seen where kaolin, clay and salt production has declined by 23%, 25% and 22% respectively. The trend for silica sand has also increased in line with the longer-term trend, increasing by just under 23%.

74 Kaolin: China clay or kaolin is a commercial clay composed principally of the hydrated aluminosilicate clay mineral kaolinite. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

75 Clay: A sedimentary rock with grains smaller than 0.002 millimeters in diameter and plastic when wet. Its main mineral is hydrated silicates of aluminium. It is often used to manufacture bricks and pottery. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html

76 Silica sand: Is defined, as sand which normally has a silica content of more than 95%, usually in the form of quartz sand grains. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

77 Ball clays: are fine-grained, highly plastic sedimentary clays, which fire to a light or near white colour. They are used mainly in the manufacture of ceramic whiteware and are valued for their key properties of plasticity, which makes them easy to mould, their unfired strength and the fact that when fired they have a light colour. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

78 Fireclay: are sedimentary mudstones that occur as the ‘seatearths’ that underlie almost all coal seams. Seatearths represent the fossil soils on which coal-forming vegetation once grew and are distinguished from associated sediments by the presence of rootlets and the absence of bedding. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

79 Gypsum: Gypsum (CaSO4.2H2O) are hydrated forms of calcium sulphate. In nature it occurs in beds of nodular masses up to a few metres thick and are the prodcuts of the evaporation of seawater. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

80 Slate: A metamorphic rock that was originally deposited as clay, but due to intense pressure, the platy clay minerals were orientated at right angles to the direction of pressure, resulting in the characteristic ‘slaty cleavage’. The rock appears to be made of many leaves, like the pages in a book. The rock can be split into thin sheets and used to roof buildings. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html#G

81 Barytes: Barytes (barium sulphate, BaSO4), also referred to as barite or baryte, is the most abudant and economically important barium mineral produced in the UK. Barytes, when pure, contains 58>8% barium and 41.2% sulphate and wth a specifci gravity (SG) of 4.5 is often reffered to as ‘heavy spar’. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html.

82 Feldspar: It is an aluminium silicate combined with varying proportions of calcium, sodium and/or potassium. **Source:** https://www.geologynorth.uk/the-cheviot-hills/minerals-in-the-cheviot-rocks/feldspar/

83 Fluorspar (fluorite): Is a commercial term for the mineral flourite (calcium flouride, Caf2), which, when pure, contains 51.1% Ca and 48.9% F. Is the most important and only UK source of the elements flourine (F). **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

84 Fuller’s earth: is a sedimentary clay that contains a high proportion of clay minerals of the smectite group. **Source:** https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

85 Peat: A thickness of partially decayed vegetation, formed in wet anaerobic ground. **Source:** https://www.bgs.ac.uk/discoveringGeology/glossary.html#G

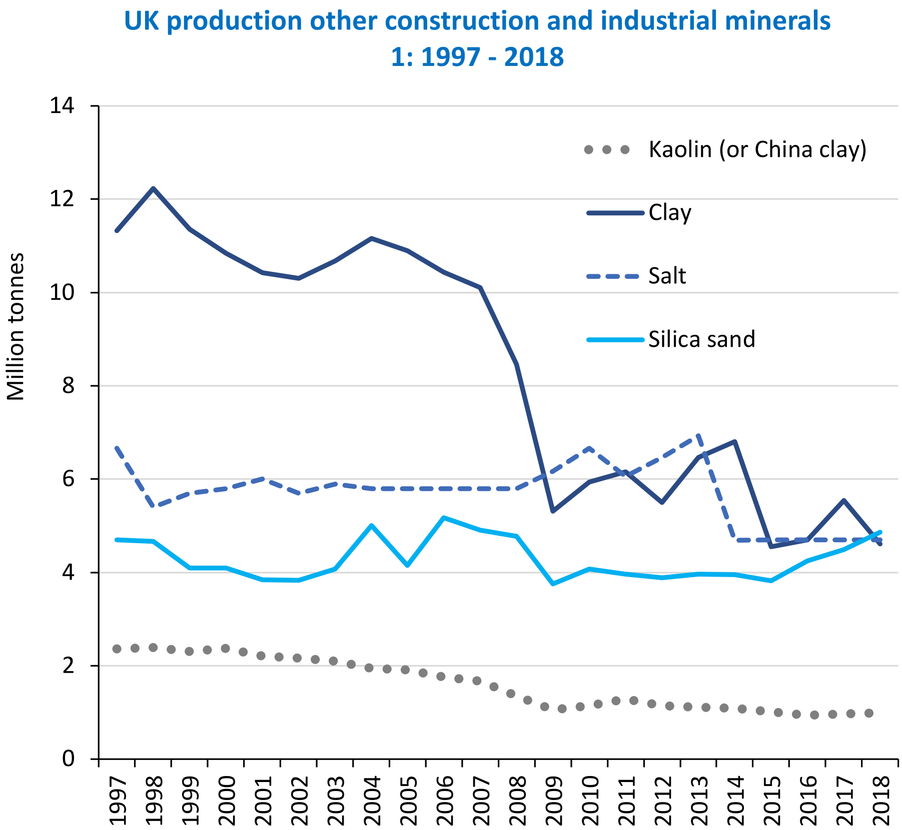
86 Includes estimates from the British Geological Survey and data from the Kaolin and Ball clay association. For some years.

87 Includes estimates from the British Geological Survey. For some years data is only for Great Britain. There is a small, undisclosed production in Northern Ireland.

88 British Geological Survey estimates from 2014 based on last reported figure for 2014.

89 Between 2013-2017 Office for National Statistics, 2018 comprehensive survey by the Silica and Moulding Sands Association and British Geological Survey.

Figure 16 UK production of other construction and industrial minerals (group 1) since 1997



Source: BGS UK Minerals Yearbooks[90]

Under group 2 the production level has only increased for slate when comparing 1997 and 2018, from 347 kilotonnes to 820 kilotonnes (136% increase). Production over the same period has declined for ball clay[91] and gypsum[92] by just over 5% and 30% respectively. Data for fireclay[93] is only available up to 2014 as this data was reliant on estimates from the Office for National Statistics (ONS) Annual Mineral Raised Inquiry (AMRI) annual survey. The AMRI survey ceased in 2016 and the latest data available is from 2014.[94] This is the last year where data is available in the BGS yearbooks.

90 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

91 British Geological Survey estimates for some years.

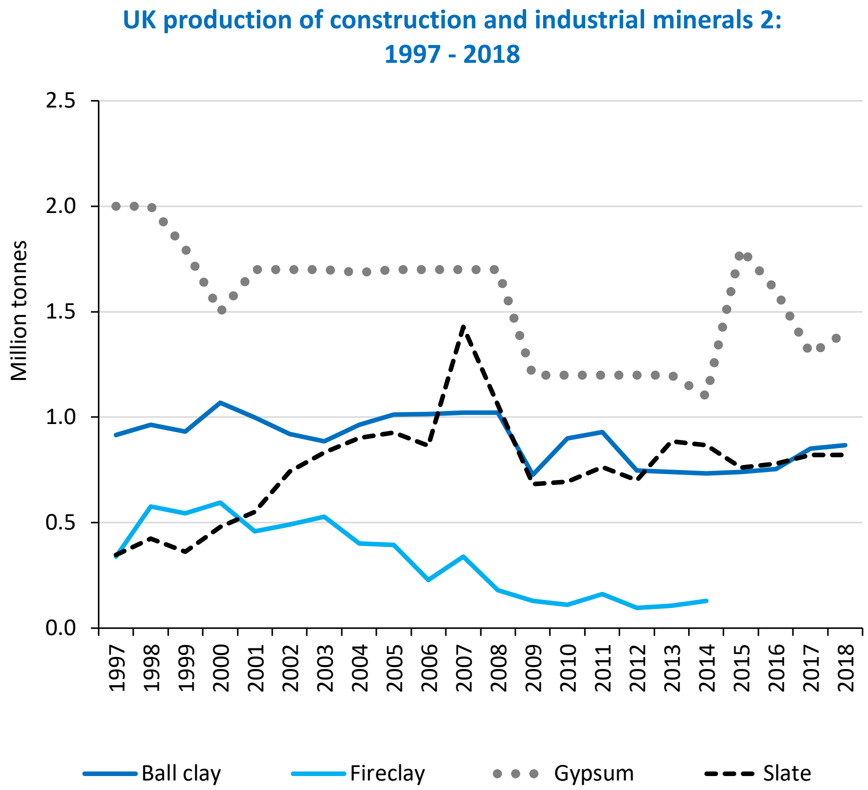
92 British Geological Survey estimates for some years.

93 Great Britain only. There is a small, undisclosed production in Northern Ireland.

94 British Geological Survey, *United Kingdom Minerals Yearbook 2019* (2020) https://www.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

When compared to 2011 production levels, production has increased for gypsum and slate[95] by just under 17% and 7% respectively. While for ball clay production has reduced by just under 7% between 2011 and 2018, from 930 kilotonnes to 867 kilotonnes. Data is not available for fireclay for 2018, but when comparing 2011 with 2014 there has been a decline of just over 20% in production as per Figure 17 below.

Figure 17 UK production of construction and industrial minerals (group 2) since 1997



Source: BGS UK Minerals Yearbooks

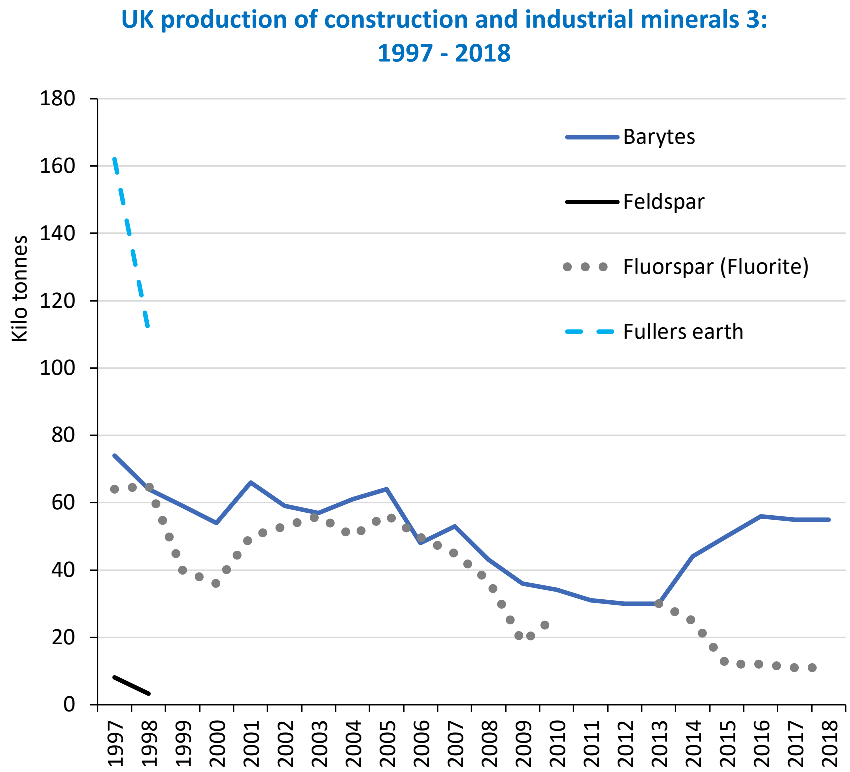
Under group 3, as presented in Figure 18, for some of the minerals data is only available for the early years of the trend. Given this limitation, it has not been possible to produce an assessment of feldspar and fuller's earth. Evidence is available for the barytes[96] and fluorspar[97], where the production of barytes declined between 1997 and 2012, increased between 2013 and 2016 and has remained constant since then. Comparing 2018 to 1997 production levels, there was a decline of just under 26%. Between 2011 and 2018 there has been an increase in production of 77% from 31 kilotonnes to 55 kilotonnes. Production of fluorspar has also declined between 1997 and 2018, from 64 kilotonnes to 11 kilotonnes. Data is not available for 2011. Estimates production between 2015 and 2018 was stable at around 11-12 kilotonnes.

95 British Geological Survey estimates for some years.

96 British Geological Survey estimates for some years.

97 British Geological Survey estimates for some years.

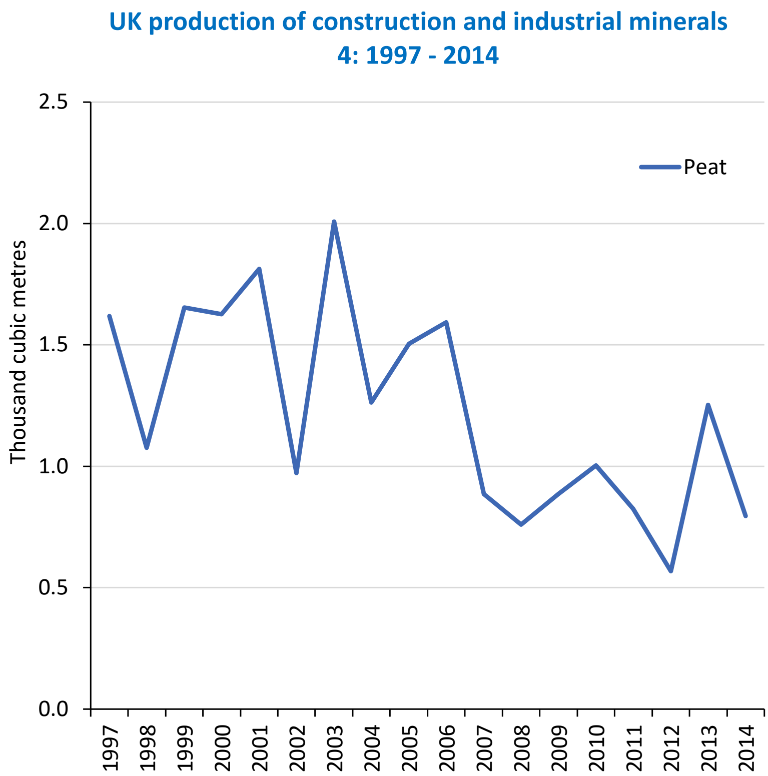
Figure 18 UK production of construction and industrial minerals (group 3) since 1997



Source: BGS UK Minerals Yearbooks[98]

The estimated production of peat has fluctuated since 1997, with a declining trend. The peak between 1997 and 2018, was in 2003 where 2,008 cubic thousand metres were produced. Data is not available after 2014. For the historical trend see Figure 19 below.

Figure 19 UK production of construction and industrial minerals (group 4) since 1997



Source: BGS UK Minerals Yearbooks[99]

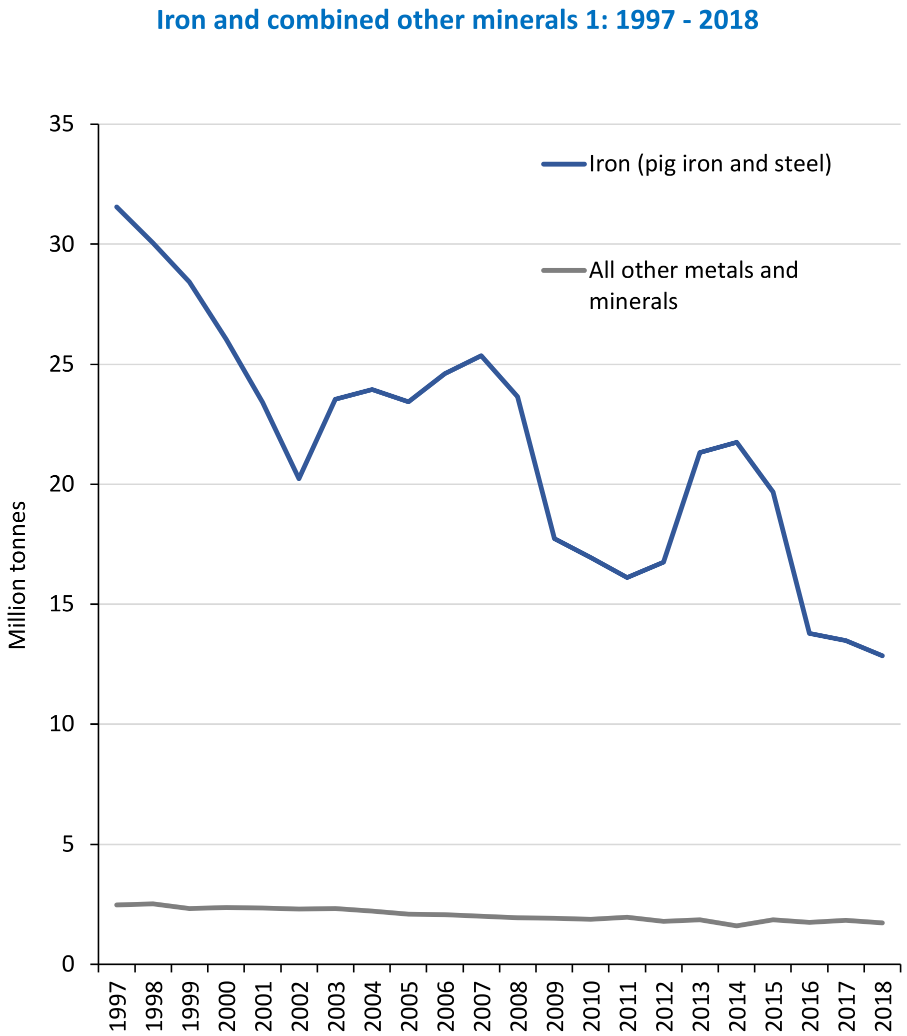
98 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

99 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

Metals and other minerals

Under the metals and other minerals, the NCC has scoped 26 minerals and metals for the assessment. Of these, data on production is only available for 14 which furthers limit the assessment. For these 14 minerals and metals, the assessment is based on the BGS evidence from the *United Kingdom Minerals Yearbooks*. These 14 minerals have been grouped based on their production tonnage. As can be seen from Figure 20, the highest production is from iron (12.9 million tonnes), which is much larger than the production of the remaining minerals and metals (1.7 million tonnes).

Figure 20 UK production of iron and other minerals since 1997



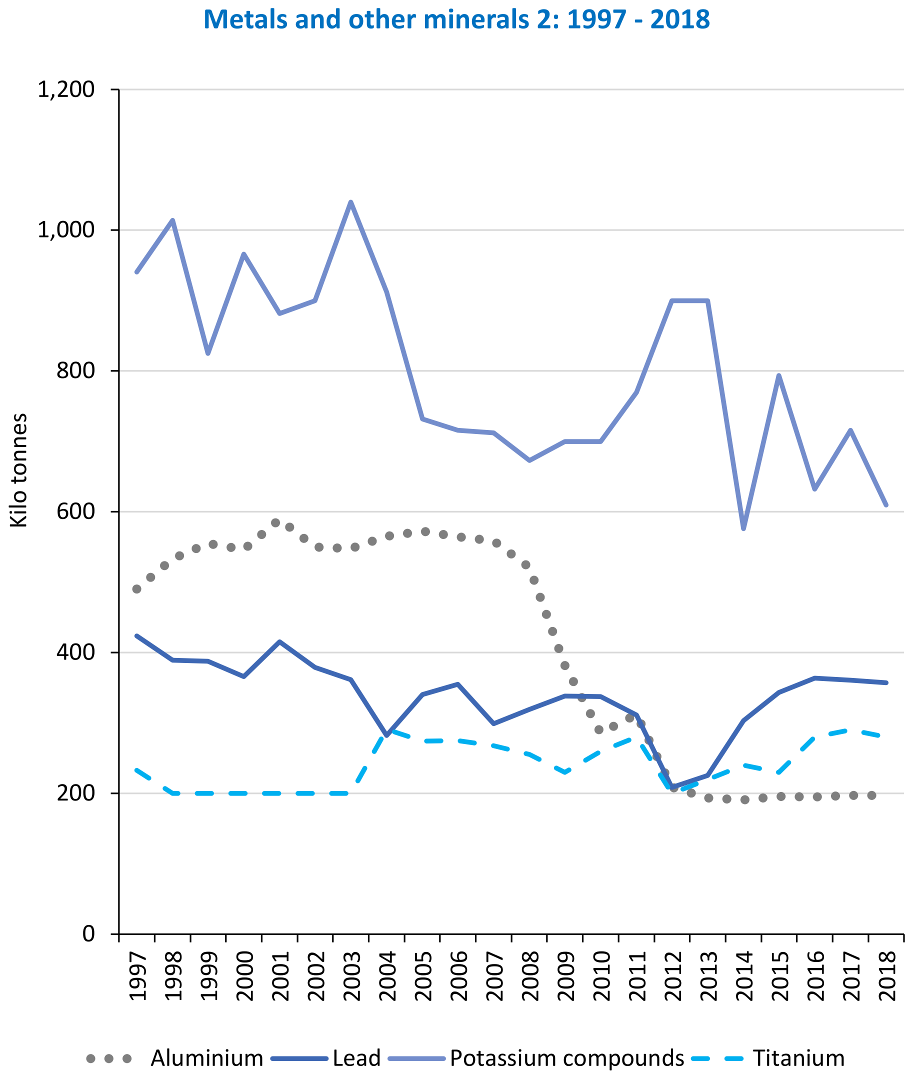
Source: BGS UK Minerals Yearbooks[100]

100 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

The production of iron has generally been declining since 1997 with some upwards fluctuations which could be linked to economic downturns over those periods. For the remaining metals and minerals grouped under the 'all other metals and minerals', these are presented in the graphs that follow below. In Figure 21 we start with the metals and minerals that had the highest estimated production tonnage. It can be seen that the production of potassium compounds[101] and aluminium has declined since 1997 levels, in 1997 it was estimated that around 941 kilotonnes of potassium compounds and 490 kilotonnes of aluminium were produced, while in 2018 this declined to 610 kilotonnes and 197 kilotonnes respectively. The production of both has also declined since 2011.

The estimated production of lead has also declined when compared to 1997 by around 16%, however, it increased from 311 kilotonnes in 2011 to 357 kilotonnes in 2018. While the estimated production of titanium[102] has increased between 1997 and 2018 by just over 20% and remained constant when compared to 2011.

Figure 21 Metals and other minerals (group 2) since 1997



Source: BGS UK Minerals Yearbooks[103]

101 Pottassium compounds also include Potash and Polyhalite estimates. British Geological Survey estimates for some years.

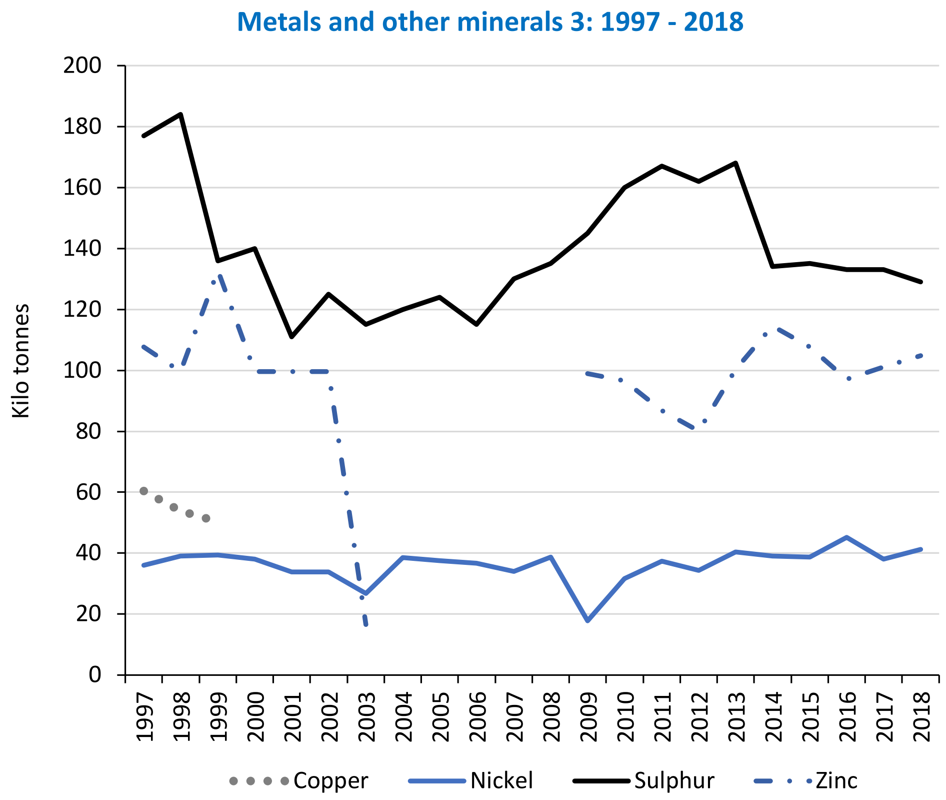
102 Estimates of titanium will vary from year to year and are based on either hte British Geological Survey (BGS) or the Articol estimates. Further specific in year source see the BGS Yearbooks.

103 British Geological Survey, *United Kingdom Minerals Yearbook 2002-2019* (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

In the next group of metals in Figure 22, the production of sulphur[104] has fluctuated since 1997, it has declined between 1998 and 2006, increasing between 2007 and 2013, and then declining again until 2018. The estimated tonnage in 1997 was 177 kilotonnes declining to 129 kilotonnes in 2018. Production has also declined between 2011 and 2018 by just under 23%. The production of zinc has also fluctuated, when comparing 1997 with 2018 there was a minor reduction of just under 3%.

The estimated production of nickel[105] has remained somewhat constant between 1997 and 2018, with some minor decline in production between 2008-10. When comparing between 1997 and 2018 there has been a 14% increase in production. There has also been a small increase between 2011 and 2018, from around 37.4 kilotonnes to 41.2 kilotonnes respectively. The production of copper in 2018 was zero and this has been the case since 2000 when production ceased.

Figure 22 UK production of metals and minerals (group 3) since 1997



Source: BGS UK Minerals Yearbooks[106]

104 Produced from oil refineries.

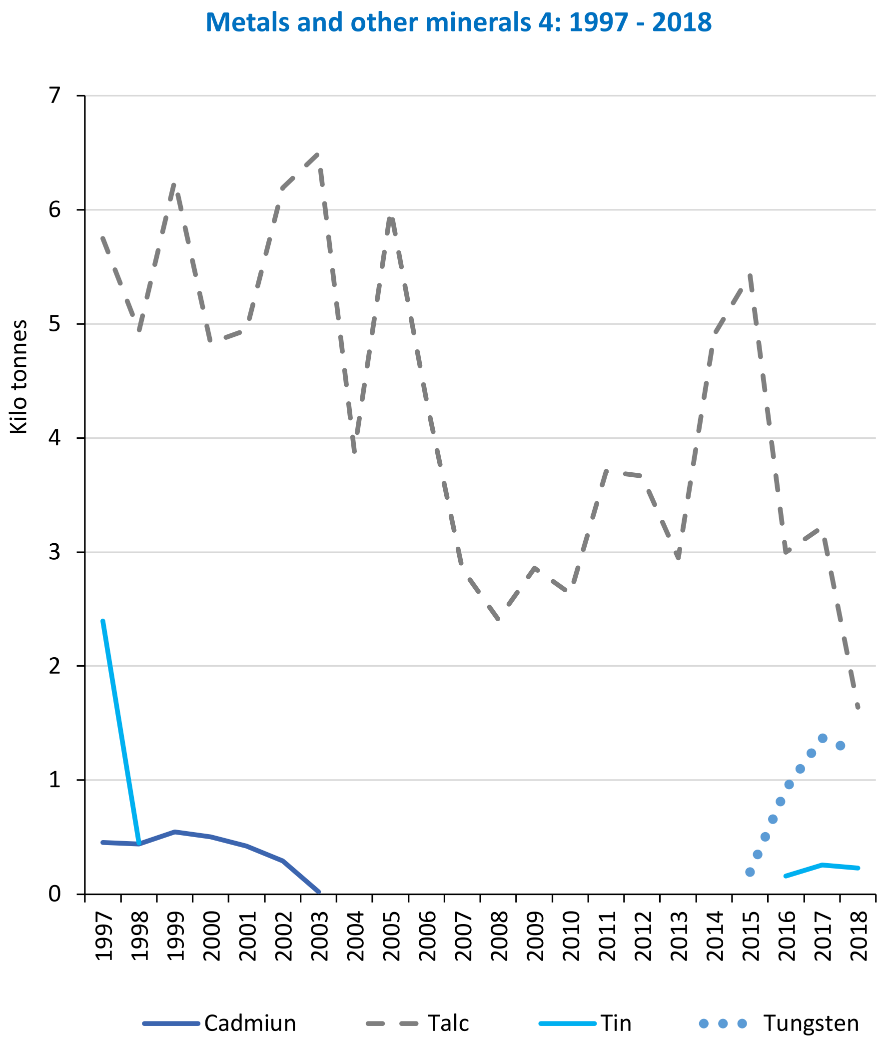
105 Nickel content of refinery products.

106 British Geological Survey, United Kingdom Minerals Yearbook 2002-2019 (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

The remaining four metals and minerals are displayed in Figure 23, these had the smallest tonnage of the 14 minerals and metals. The estimated production of talc has fluctuated between 1997 and 2018, with a declining trend. In 1997 the production of talc was estimated to be under 5.8 kilotonnes, declining to just over 1.6 kilotonnes in 2018.

Tungsten[107] production has ben flat until 2015, reaching 1.2 kilotonnes in 2018. There was a small production of cadmium, but since 2004 estimates have been zero. There is a similar trend with tin[108] which has declined to zero in 1999, but with production restarting in 2016, with a total of 230 tonnes being produced in 2018.

Figure 23 UK production of metals and other minerals (group 4) since 1997



Source: BGS UK Minerals Yearbooks[109]

107 British Geological Survey estimates for some years.

108 British Geological Survey estimates for some years.

109 British Geological Survey, United Kingdom Minerals Yearbook 2002-2019 (2020) https://www2.bgs.ac.uk/downloads/browse.cfm?sec=12&cat=132

3. Resources and Waste

Waste and the resources that can be derived from waste through recycling, recovery, re-use, and energy generation are not a natural capital asset, but a pressure to the natural environment. However, waste has an important role in the mitigation of the extraction of virgin materials[110] from the natural environment and in the production of energy through incineration and anaerobic digestion.

The higher the amount of waste that can be recycled and re-used, the lower the amount of virgin material that needs to be extracted from the natural environment. For example, there are no limits on the number of times aluminium can be recycled; the same can be said for glass and metals. Also, recycling is more energy-efficient: recycling glass is around 33% more energy-efficient than producing glass from virgin materials.[111]

In addition to the reduction of the need for more virgin material, recycling, reuse and recovery of resources also reduces the damage to the natural environment. When waste is landfilled it can have negative impacts on the environment and to humans including:

- Air pollution and damage atmospheric processes (e.g.: acid gases from flaring; methane and carbon dioxide)[112];
- Leachate entering water streams[113];
- Soils and land pollution; and
- Damage to wildlife.

To minimise and address these environmental impacts from waste, the UK has several targets in place. In Table 9 a list of current targets ranging from the increase of recycling materials to reducing the amount of waste going to landfill is presented. In addition to targets, there is also the Landfill Tax[114] which has contributed to the reduction of waste ending up in landfills.

110 Materials sourced directly from nature in their raw form, such as wood or metal ores. Manufacturing products using virgin materials uses much more energy and depletes more natural resources, as opposed to producing goods using recycled materials. **Source:** https://recyclenation.com/green-glossary/virgin-materials/

111 Recycling Nation, How Many Times Can Recyclables Be Recycled? https://recyclenation.com/2017/06/how-many-times-can-recyclables-be-recycled/

112 Public Health England, RCE-18: impact on health of emissions from landfill sites (2011) https://www.gov.uk/government/publications/landfill-sites-impact-on-health-from-emissions

113 WWT online, Getting to Grips with… landfill leachate (2018) https://wwtonline.co.uk/features/getting-to-grips-with-landfill-leachate

114 HMRC, Landfill Tax https://www.gov.uk/green-taxes-and-reliefs/landfill-tax

Table 9: List of resource and waste targets

	Measure of waste	Target
Waste treatment	Household waste	The EU Waste Framework Directive (WFD) Council Directive (2008/98/EC) [115] sets a target for 50% or more of the household waste generated to be recycled or re-used by 2020.
	Construction and demolition waste	The EU Waste Framework Directive (WFD) (2008/98/EC) [116] sets a target for at least 70% of the construction and demolition waste generated to be recovered, recycled, and re-used.
	Biodegradable municipal waste (BMW)	The Landfill Directive (199/31/EC)[117] sets targets on the amount of BMW that can be sent to landfill based on the amount generated in 1995 (baseline): • No greater than 75% of the 1995 baseline by 2010. • No greater than 50% of the 1995 baseline by 2013. • No greater than 35% of the 1995 baseline by 2020.
	Packaging waste	The Packaging and Packaging Waste Directive (94/62/EC)[118] sets targets for the amount of packaging that needs to be recovered or incinerated: • No later than 31st of December 2008 between 55% as a minimum and 80% as a maximum by weight of packaging waste will be recycled; • No later than 31st of December 2008 the following minimum recycling targets for materials contained in packaging waste will be attained: o 60% by weight for glass; o 60% by weight for paper and board; o 50% by weight for metals; o 22.5% by weight for plastics, counting exclusively material that is recycled back into plastics; and o 15% by weight for wood. For earlier targets see Directive.
	End-of-life vehicles (ELVs)	The End-of-Life Vehicles Directive (2000/53/EC)[119] sets targets on the level of re-use and recovery: • A minimum of 85% re-use and recovery and 80% re-use and recycling based on the average weight per vehicle and year. Achieved by the 1st of January 2006. • Increasing to 95% for re-use and recovery and 85% for re-use and recycling by the 1st of January 2015.
	Waste Electrical and Electronic Equipment (WEEE)	The EU Directive (2012/19/EU) [120] on WEEE sets collection rates targets: • Between 2016 and 2018, the target is set at 45% calculated on the basis of the total weight of WEEE collected. • From 2019, this target is 65%.
	Portable batteries collection rate	The EU Directive (2006/66/EC)[121] waste batteries sets collection rates: • 25% by 26th of September 2012; and • 45% by 26th of September 2016. The collection rate target is set each year for the mass of portable batteries waste to be collected, as a percentage of the mass of portable batteries placed on the market that year. The target is changed each year.[122] See Figure 44 for yearly values.

115 European Parliament, Council Directive 2008/98/EC of the European Parliament and the Council of the 19 November 2008 on waste and repealing certain directives (2008) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

116 European Parliament, Council Directive 2008/98/EC of the European Parliament and the Council of the 19 November 2008 on waste and repealing certain directives (2008) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

117 European Parliament, Council Directive 1999/31/EC of the 26 April 1999 on the landfill of waste (1999) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999L0031&from=en

118 European Parliament, Council Directive 1994/53/EC of the European Parliament and the Council of the 20 December 1994 on packaging and packaging waste (1994) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01994L0062-20150526&from=EN

119 European Parliament, Council Directive 2000/53/EC of the European Parliament and the Council of the 18 September 2000 on end-of-life vehicles (2000) https://eur-lex.europa.eu/resource.html?uri=cellar:02fa83cf-bf28-4afc-8f9f-eb201bd61813.0005.02/DOC_1&format=PDF

120 European Parliament, *Council Directive of the European Parliament and the Council of the 4 July 2012 on waste electrical and electronic equipment (WEEE) (2012) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN*

121 European Parliament, Council Directive 2006/66/EC of the European Parliament and the Council of the 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (2006) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006L0066-20131230&rid=1

122 National Packaging Waste Database - https://npwd.environment-agency.gov.uk/Public/Batteries/PublishedReports.aspx

Overall assessment of resources and waste

The assessment of waste – based on the datasets available – is 'Amber': **mixed**, this is due to the fact that total waste generated (including household, construction and demolition, and commercial and industrial waste), landfilling, end of life vehicles (ELVs) waste have increased. This rating is also driven by targets such as household recycling and ELVs recovery rates not being met. While in other areas, such as packaging recycling and recovery rates, portable batteries collection, and biodegradable municipal waste (BMW) targets are being met. The assessment for each measurement assessed is presented in summary Table 10. The key findings from the NCC's assessment is as follows:

- Household waste recycling rates have plateaued since 2013 at around 44%.
- Construction waste recovery rates have plateaued since 2010.
- There were 715,000 flytipping incidents in England in 2012/13 and this increased to 1,070,000 incidents in 2018/19.
- In the UK alone, an estimated 10 million tonnes of food and drink are wasted post-farm gate annually, worth around £20 billion.
- Waste related criminal activity costs the economy hundreds of millions of pounds each year. Rogue operators undermine legitimate businesses. There were 556 active illegal sites in 2013/14 and the number increased to 685 in 2018/19.

Table 10: Summary of assessment of data

Measurable commitment	Compliance with target or commitment	Long-term trend	Against the NCC baseline (2011)	Short-term trend
2.1.1 - Total waste generated	No target/ commitment was found/exist.	The amount of waste generated in England in 2016 (187 million tonnes) was higher than the same figures for 2010 and 2012 (168 million and 167 million tonnes respectively).	n/a – Data is not available for 2011.	The amount of waste generated in England in 2016 (187 million tonnes) was higher than the amount generated in the previous year for which data is available, 2014 (182 million tonnes).
2.1.2 - Household waste generated and recycling in England	No target/ commitment was found/exist.	The amount of household waste in England was slightly lower in 2018 when compared to 2010 (the earliest point where data is available). However, this change was less than 1%.	The amount of household waste generated in England in 2018 was within 1% of the amount of household waste that arose in England in 2011.	The amount of household waste generated in England in 2018 (22.0 million tonnes) was slightly lower than the amount that arose in 2017 (22.4 million tonnes).

2.1.3 - The recycling rate[123] for household waste: The European Union (EU) target is for 50% or more of the household waste generated to be recycled.	The recycling rate for household waste in England was below 50% every year between 2010 - 2018.	Data is not available for 2011 unless incineration bottom ash and metals (IBAm) are excluded. There was an increase of just over 6% in the recycling rate between 2010 and 2018 from 41.2% to 43.8% in England.'	Data is not available for 2011 unless incineration bottom ash and metals[124] (IBAm) are excluded. The recycling rate in England when IBAm is excluded was very slightly higher in 2018 (43.8%) than in 2011 (43.3%). However, this was still much lower than the EU recycling target of 50%.	The recycling rate for household waste in England in 2018 including IBAm was slightly lower in 2018 (44.7%) than it was in 2017 (45.2%).
2.1.4 - Construction and demolition waste generated No target/ commitment	No target/ commitment was found/exist.	The latest data from 2016 when compared to 2010 presents an increase of just over 11% in waste arising.	The amount of non-hazardous construction and demolition waste generated in England in 2016 (59.6 million tonnes) was higher than the amount that arose in 2011 (54.9 million tonnes).	The amount of non-hazardous construction and demolition waste generated in England in 2016 (59.6 million tonnes) was higher than the amount generated the previous year (57.7 million tonnes).
2.1.5 - Construction and demolition Recovery[125] rate The EU target is for 70% of construction and demolition waste to be recovered.	The recovery rate in England for this type of waste was over 90% for every year covered.	There was a small reduction in the recovery rate between 2010 and 2016 of less than 1%.	The was also a small reduction in the recovery rate in England between 2011 and 2016, this reduction was less the 1% of its 2011 value.	The change in the recovery rate in England between 2015 and 2016 was less than 1%.
2.1.6 - Commercial and industrial[126] waste generation	No target/ commitment was found/exist.	The 2018 estimate of commercial and industrial waste presents an increase: when compared to 2010 estimates, there was an increase of just over 16%, equal to 5.2 million tonnes.	The amount of commercial and industrial waste generated in England was 37.2 million tonnes in 2018, compared with 33.4 million tonnes in 2011: this equates to an increase of over 11%.	The amount of commercial and industrial waste generated in England in 2018 (37.2 million tonnes) was higher (just over 3%) than the amount generated in 2017 (36.1 million tonnes).

123 The recycling rate is the proportion of municipal waste that is subject to any recovery operation by which waste materials are reprocessed into products, materials, or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations. **Source:** https://www.gov.uk/government/statistics/uk-waste-data

124 This is the residual material in the combustion chamber and consists of the non-combustible constituents of the waste feed. The bottom ash typically represents around 20%-30% of the original waste feed by weight, and only about 10% by volume. The bottom ash is continually discharged from the combustion chamber and is then cooled. The amount of ash will depend on the level of waste pre-treatment prior to entering the Incinerator and will also cometals that can be recovered for recycling. **Source:** https://www.gov.uk/government/publications/incineration-of-municipal-solid-waste

125 Recovery means 'any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function.' **Source:** https://www.gov.uk/government/statistics/uk-waste-data

126 'Commercial and industrial' spans a range of economic activities (based on the European NACE statistical classification of economic activities in the European Community) including manufacturing, industrial processes and service based enterprises, but excluding sewage sludge. **Source:** https://www.gov.uk/government/statistics/uk-waste-data

2.1.7 - Total waste treated (by all methods): No target/ commitment	No target/ commitment was found/exist.	The amount of waste treated in England in 2016 was higher than in 2010 (182 million tonnes and 171 million tonnes respectively).	n/a – Data is not available for 2011.	182 million tonnes of waste was treated in England in 2016 compared with 178 million tonnes in 2014, the previous year for which data is available.
2.1.8 - Waste collected by local authorities: No target/ commitment	No target/ commitment was found/exist.	The amount of waste collected by local authorities in 2018 was slightly lower than in 2010, however, this was less than 1%.	The amount of waste collected by local authorities in 2018 was slightly lower than in 2011, however, this was less than 1%.	Less waste was collected by local authorities in 2018 (22 million tonnes) than in 2017 (22.4 million tonnes).
2.1.9 - Waste recycled by local authorities: No target/ commitment	No target/ commitment was found/exist.	The amount of waste recycled by local authorities in 2018 was higher than the amount recycled in 2010, 9.8 million tonnes from 9.1 million tonnes.	The amount of waste recycled by local authorities in 2018 (9.8 million tonnes) was slightly higher than the amount they recycled in 2011 (9.6 million tonnes).	The amount of waste recycled by local authorities in 2018 (9.8 million tonnes) was slightly lower than the amount they recycled in 2018 (10.1 million tonnes).
2.1.10 - Packaging arising and recycling The EU target is 55% as a minimum and 80% as a maximum by weight of packaging waste will be recycled	In 2017 the UK has met the packaging recycling rate of 55%, achieving just under 64%.	The total amount of recovered and recycled packaging has increased between 2012 and 2019 by just under 15%, from just under 7.4 million tonnes to just under 8.5 million tonnes.	n/a – Data is not available for 2011.	There was also in increase the amount of recovered and recycled packaging between 2018 and 2019 of just over 4%.
2.1.11 - Total waste going to landfill: No target/ commitment	No target/ commitment was found/exist.	There has been a significant reduction in the amount of waste being sent to landfill between 2006 and 2018, from 69 million tonnes to 44.1 million tonnes, a decline of just over 36%.	The total amount of waste that went to landfill in 2018 (44.1 million tonnes) was slightly lower than the amount in 2011 (44.7 million tonnes).	44.1 million tonnes of waste went to landfill in 2018, compared with 45.4 million tonnes in 2017, corresponding to a decline of just 3%.
2.1.12 - Municipal waste[127] going to landfill in England: No target/ commitment	No target/ commitment was found/exist.	There has been a significant decline in the amount of municipal waste sent to landfill, from 20.3 million tonnes in 2010 to 11.7 million tonnes in 2018, a decrease of over 42%.	The amount of municipal waste that went to landfill in 2018 (11.7 million tonnes) was significantly lower than the amount that went to landfill in 2011 (18.4 million tonnes).	The amount of municipal waste sent to landfill in 2018 was within 1% of the amount sent to landfill in 2017.

127 'Municipal waste' covers household waste and waste similar in nature and composition to household waste. **Source:** https://ec.europa.eu/eurostat/documents/342366/351811/Municipal+Waste+guidance/bd38a449-7d30-44b6-a39f-8a20a9e67af2

2.1.13 - Biodegradable municipal waste (BMW) [128] going to landfill: The target has been for the amount of BMW sent to landfill to be no more than 35% of the amount of BMW generated in 1995.	Though the amount of BMW sent to landfill started the period in 2010 slightly above the target, it has been below it every year since. The BMW sent to landfill rate for 2018 was just over 19% in England.	Between 2010 the percentage of BMW sent to landfill in England has declined from just under 36% to just over 19% in 2018.	The amount of BMW sent to landfill was significantly lower in 2018 (5.6 million tonnes) than in 2011 (9.4 million tonnes).	The amount of BMW sent to landfill in England was slightly lower in 2018 (5.6 million tonnes) than in 2017 (5.7 million tonnes).
2.1.14 - Energy from Waste (EfW) Incineration: No target/ commitment	No target/ commitment was found/exist.	There has been a significant increase in the amount of incineration since 2006, from 4.7 million tonnes to 14.1 million tonnes. The RAG rating here is green as incineration is above disposal in the waste hierarchy: See Figure 39. However, there needs to be a move away from incineration to recycling and reuse.	The amount of waste incinerated in EfW facilities in England in 2018 (14.1 million tonnes) was over double the amount incinerated in 2011 (6.6 million tonnes).	The amount of waste incinerated in EfW facilities in England was higher in 2018 (14.1 million tonnes) than in 2017 (13.2 million tonnes).
2.1.15 - Exports of refuse-derived fuel (RDF)[129]: No target/ commitment	No target/ commitment was found/exist.	Between 2010[130] and 2019 there has been a significant increase in RDF sent for export, from around 11.1 kilotonnes to under 2.3 million tonnes.	The amount of RDF exported from England in 2019 (2.3 million tonnes) was considerably higher than the amount exported in 2011 (250,000 tonnes).	The amount of RDF exported from England in 2019 (2.3 million tonnes) was lower than the amount exported in 2018 (2.6 million tonnes).
2.1.16 - Exports of solid recovered fuel (SRF)[131]: No target/ commitment	No target/ commitment was found/exist.	When comparing the latest data from 2019 to the earliest data of 2014, there has been a significant increase from 19.6 kilotonnes to 336.4 kilotonnes.	n/a – Data is not available for 2011.	The amount of SRF exported from England in 2019 (336.4 kilotonnes) was higher than the amount exported in 2018 (322.5 kilotonnes)
2.1.17 - Waste exports and imports No target/ commitment	No target/ commitment was found/exist.	Net waste exports have significantly increased since 2002, from around 7 million tonnes to around 15 million tonnes in 2016.	Net exports of waste from the UK were higher in 2016 (around 15 million tonnes) than they were in 2011 (just under 13 million tonnes).	Net exports of waste from the UK were higher in 2016 (around 15 million tonnes) than they were in 2015 (around 14 million tonnes).

128 BMW is the fraction of municipal waste that will decompose in landfill to produce methane, a potent greenhouse gas. **Source:** https://www.gov.uk/government/statistics/uk-waste-data

129 Refuse-Derived Fule (RDF) is waste typically from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising, etc). RDF consists largely of combustible components of both municipal and commercial industrial waste, such as plastics and biodegradable waste. **Source:** https://data.gov.uk/dataset/18594948-d111-4dd4-a8f1-0df55eb8a94a/international-waste-shipments-exported-to-england

130 Estimates are from July to December, as data is not available between January and June in 2010.

131 Solid Recovery Fuel (SRF) is a high-quality product made from residual waste left behind once all commodities and contaminants have been removed – a more refined fuel than RDF. **Source:** https://enva.com/resource-recovery/energy/solid-recovered-fuel

2.1.18 - End-of-life vehicles (ELVs) [132] waste generated:	No target/ commitment was found/exist.	The amount of waste generated in the form of ELVs has significantly increased between 2006 and 2017, from just under 1 million tonnes to just under 1.6 million tonnes.	The amount of waste generated in the form of ELVs in 2017 (1.6 million tonnes) was higher than the same figure for 2011 (1.2 million tonnes).	The amount of waste generated in the form of ELVs in 2017 (1.6 million tonnes) was higher than the same figure for the previous year (1.2 million tonnes).
2.1.19 - End-of-life vehicles (ELVs) waste recovery and recycling: The EU target is set at 95% for reuse and recovery and 85% for re-use and recycling	The government has met the recycling target of 85% since 2013. However, the government is not meeting the recovery target of 95%, it has only done once since 2006 in 2015. The recovery rate in 2017 was just over 94%.	Between 2006 and 2017 there was an increase in the amount of ELVs that were recycled and recovered. In 2006 81% of ELVs were recycled while in 2017 the recycling rate had increased to just under 87%. While for recovery rate increased from just over 82% in 2006 to just over 94% in 2017.	The amount of ELV waste that was recovered in 2017 (1.5 million tonnes) was higher than the amount recovered in 2011 (1.0 million tonnes). Over the same period, there was also an increase in the amount being recycled from under 1.0 million ton to just under 1.4 million tonnes.	The amount of ELV waste that was recovered in 2017 (1.5 million tonnes) was higher than the amount that was recycled in 2016 (1.1 million tonnes). There was also an increase in the recycling amount from just under 1.1 million tonnes in 2016 to just under 1.4 million tonnes in 2017.
2.1.20 - Waste Electrical and Electronic Equipment (WEEE): Between 2016 and 2018, the EU target for WEEE was at least 45% calculated on the basis of the total weight of WEEE collected. From 2019, this target is 65%.	For the last three years, the amount of separately collected WEEE was below its target level of 45%.	Between 2007 and 2019 there was an increase in the WEEE collected by 167%, from 186 to just under 497 tonnes.	The amount of WEEE separately collected in 2019 was within 1% of the corresponding figure for 2011.	The amount of WEEE separately collected in 2019 (496.5 kilotonnes) was slightly higher than the amount collected in 2018 (493.3 kilotonnes), a change of less than 1%.
2.1.21 - Portable batteries collection rate in the UK: The EU target is 45% by the 26th of September 2016.	The collection rate has been above its target level for all but two of the years since 2010.	The collection rate has increased from just over 9% in 2010 to just over 45% in 2019.	There was also an increase in the collection rate between 2011 and 2019, from 18% to just over 45% respectively.	There was a slight increase in the collection rate between 2018 and 2019, but this was less than 1%.
2.1.22 - Hazardous waste[133] deposited in England: No target/ commitment	No target/ commitment was found/exist.	The amount of hazardous waste deposited in 2017 (5.3 million tonnes) was higher than the amount deposited in 2011 (4.4 million tonnes).	See column to the left for assessment, as covers the same period.	The amount of hazardous waste deposited and managed in 2017 (5.3 million tonnes) was higher than the amount deposited in 2016 (4.9 million tonnes).

132 End-of-life vehicles (ELVs) are motor vehicles categorised as waste, generally due to age or accident: **Source:** https://www.gov.uk/guidance/elv

133 Hazardous waste: Waste is considered 'hazardous' under environmental legislation when it contains substances or has properties that might make it harmful to human health or the environment. This does not necessarily mean it is an immediate risk to human health, although some waste can be. **Source:** https://www.hse.gov.uk/waste/hazardouswaste.htm

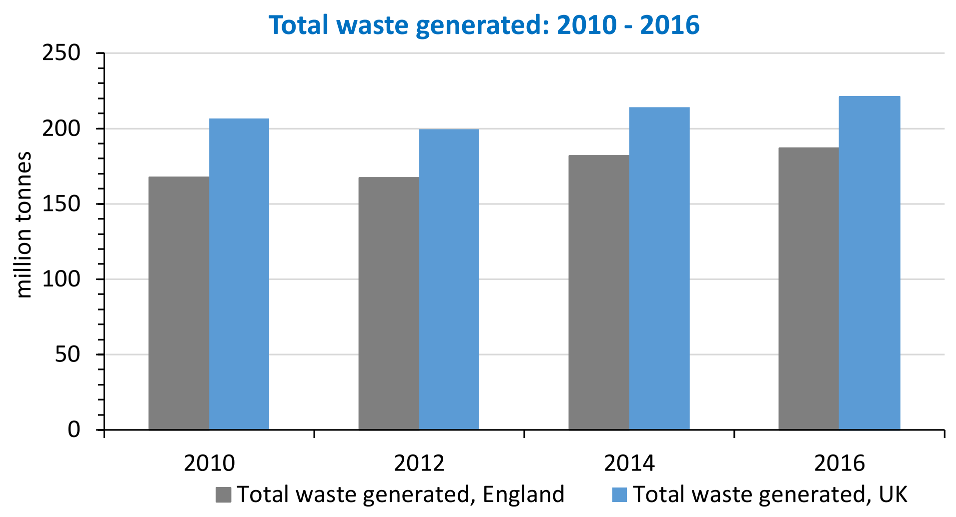
2.1.23 - Hazardous waste[134] managed in England: No target/ commitment	No target/ commitment was found/exist.	The amount of hazardous waste managed in 2017 (5.0 million tonnes) was higher than the amount managed in 2013 (3.7 million tonnes).	n/a – Data is not available for 2011.	The amount of hazardous waste managed in 2017 (5.0 million tonnes) was higher than the amount managed in 2016 (4.6 million tonnes).
2.1.24 - Waste crime: number of active illegal waste sites No target/ commitment	No target/ commitment was found/exist.	The number of active illegal waste sites in 2019/20 (685) was higher than the number in 2009/10 (680).	The number of active illegal waste sites in 2019/20 (685) was higher than the number in 2010/2011 (618).	The number of active illegal waste sites in 2019/20 (685) was higher than the number in 2018/19 (673).
2.1.25 - Fly-tipping No target/ commitment	No target/ commitment was found/exist.	Fly-tipping incidents in 2018/19 have declined when compared to 2007/08 by over 16%.	Fly-tipping incidents in 2018/19 have increased when compared to 2011/12 by just over 44%.	Fly-tipping incidents in 2018/19 have increased when compared to 2017/18 by just under 8%.

Waste arising (generated)

Total waste generated in England and the UK

Defra's UK waste statistics[135] only provide information on the total amount of waste generated for 2010, 2012, 2014, and 2016. The estimates were fairly stable across the period, showing no clear trend. In 2016, a total of 221 million tonnes of waste was generated in the UK, 187 million (85%) of which was in England. These totals are slightly higher than their 2010 values, 207 million and 168 million respectively. The value for England grew by a greater proportion than the total for the UK over the period: in 2010 only 81% of the waste generated in the UK was generated in England. However, it is not possible to conclude that the data is following a particular trend, giving the limited number of observations available. See Figure 24 for waste generated estimates.

Figure 24: Total waste generated: 2010-2016



Source: Defra[136]

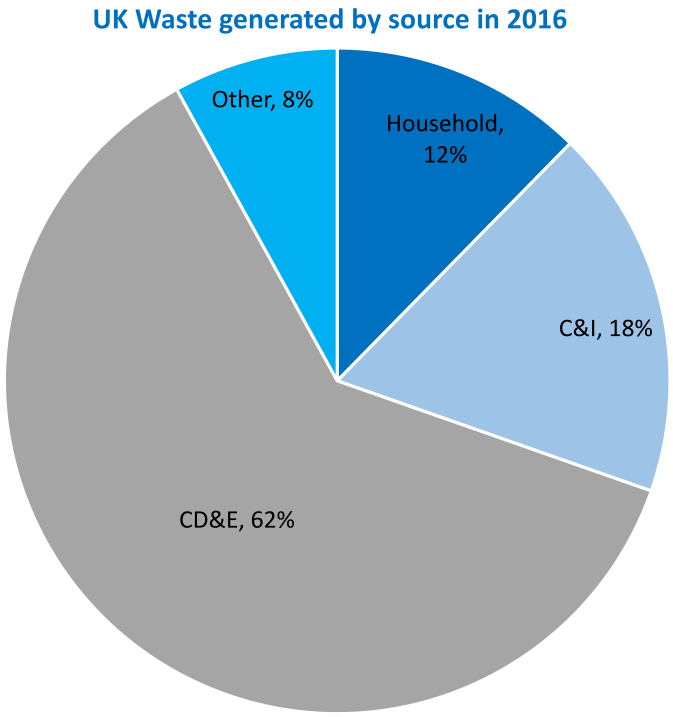
134 Hazardous waste: Waste is considered 'hazardous' under environmental legislation when it contains substances or has properties that might make it harmful to human health or the environment. This does not necessarily mean it is an immediate risk to human health, although some waste can be. **Source:** https://www.hse.gov.uk/waste/hazardouswaste.htm

135 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

136 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Defra has estimated waste generation by source. In 2016 just under 62% came from Construction, Demolition, and Excavation (CD&E). The second highest source was Commercial and Industrial (C&I) waste, followed by Household waste and other[137]. See Figure 25 for the breakdown of waste by source.

Figure 25 UK waste generation split by source in 2016



Source: Defra[138]

Household waste arising and recycling

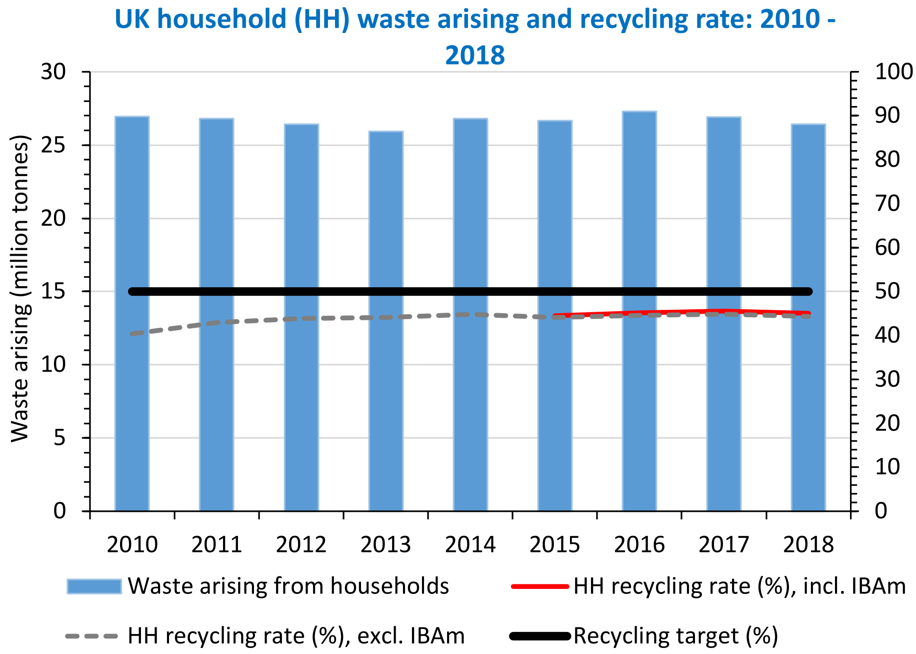
Based on Defra waste statistics[139], the estimates for household waste followed a similar pattern in England as they did for the United Kingdom at large. Between 2010 and 2018, the amount of household waste arising each year fluctuated around 27 million tonnes for the UK and 22 million for England. The two sets of figures moved together without showing any particular trend. When comparing the year on year change between 2017 and 2018 there has been a small decline of just over 1.8% (0.5 million tonnes) in the UK and 1.8% (0.4 million tonnes) in England. See Figure 26 for UK and Figure 27 for England household waste arising and recycling since 2010.

137 Other inncludes estimates from agriculture, forestry, mining and quarrying.

138 Defra, ENV23 - *UK statistics on waste* (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

139 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Figure 26: UK household (HH) waste generated and recycling rate: 2010 - 2018

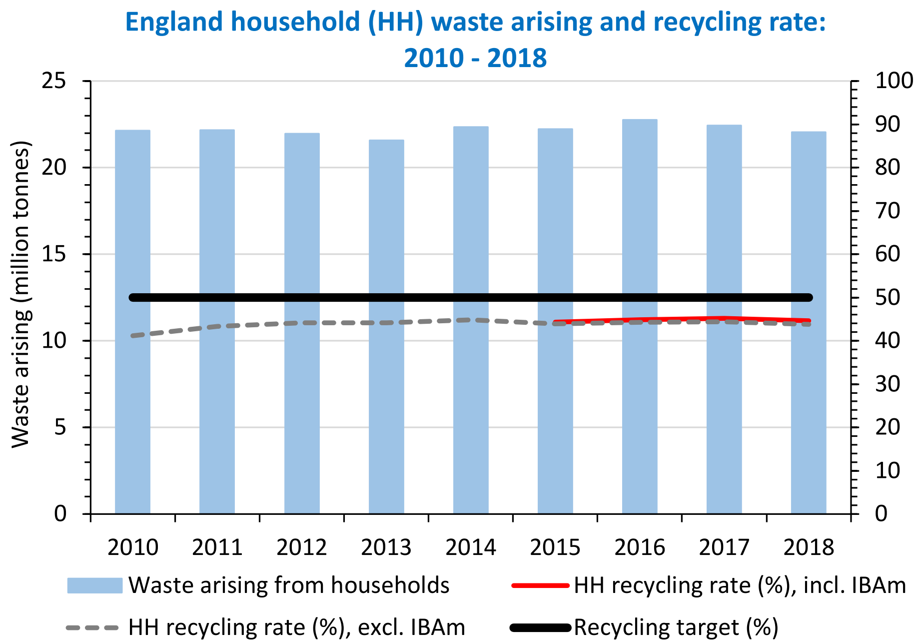


Source: Defra[140]

From April 2015 Defra started including incineration bottom ash metal (IBAm) to recycling rate estimates, which increases the level slightly. In 2018 for England, this addition accounts for just under 1 percentage point, an increase from 43.8% without IBAm to 44.7% when including IBAm.

Overall, the figures are very similar when incineration bottom ash metal is excluded, and are available from 2010. In both England and the United Kingdom at large, the household recycling rate increased gently from around 40% in 2010, before fluctuating around 44% from 2012 onwards. The EU 2020 recycling target of 50% was not met in any given year and the UK is not on track to meet this target.

Figure 27: England household (HH) waste arising and recycling rate: 2010 - 2018



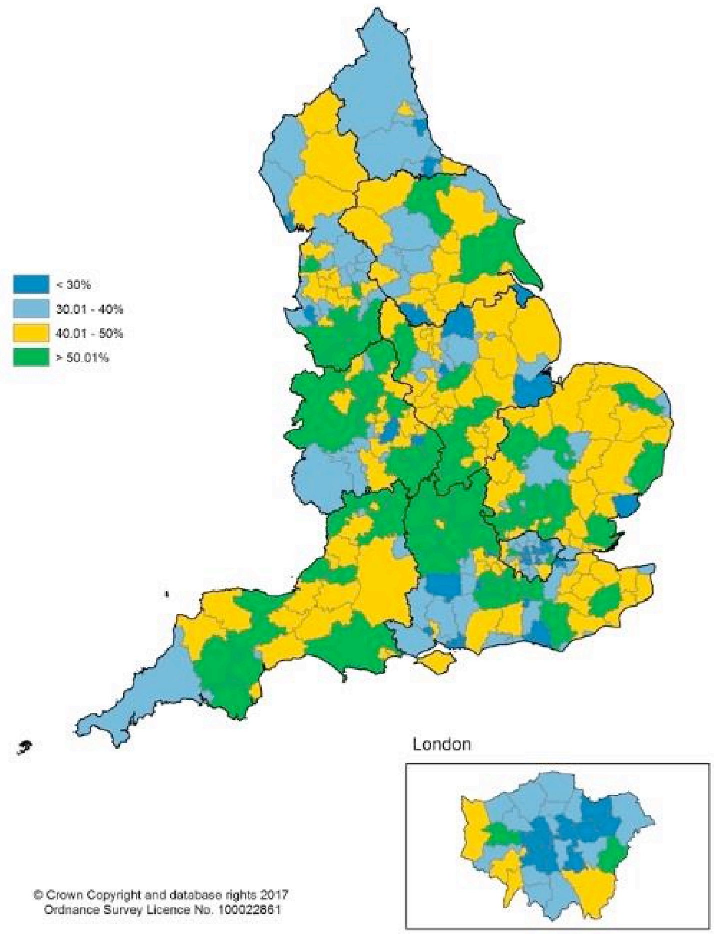
Source: Defra[141]

140 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

141 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Recycling data is also available spatially for England, at the local authority level. The map is only available for data covering the period 2016/17, and the recycling rates ranged from 14% to 65%, which shows a significant variation between local authorities. See Figure 28 below for the estimated recycling rates by local authorities.

Figure 28 Percentage of household waste sent for recycling, preparation for reuse or composting in England 2016/17



Source: Defra[142]

Construction and demolition waste and recycling rates

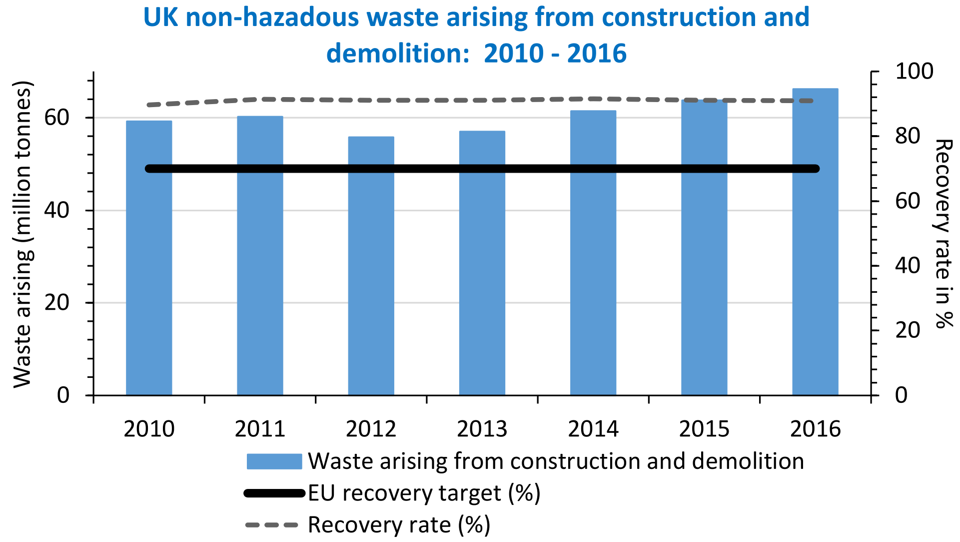
The estimates for construction and demolition waste follow a similar pattern for England as for the UK at large. The total amount estimated by Defra[143] of non-hazardous waste arising from construction and demolition in the UK each year increased slightly for the rest of the period after a trough in 2012 of 56 million tonnes. In 2016, the last year for which data is available, 66 million tonnes of non-hazardous waste arose from construction and demolition in the UK, an increase of just under 10% when compared to 2011 when waste arising was estimated to be just over 60 million tonnes.

The UK recovery rate for this type of waste changed very little over the period, staying around 91% for the UK as a whole. The UK comfortably exceeded the EU target of 70% recovery target by 2020. However, more could be done as there are around 6 million tonnes that are not being recovered. See Figure 29 for construction and demolition waste arising and recovery rate.

142 Defra, Digest of waste and resource statistics: 2018 edition (2018) https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2018-edition

143 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Figure 29: UK non-hazardous waste arising from construction and demolition: 2010 - 2016

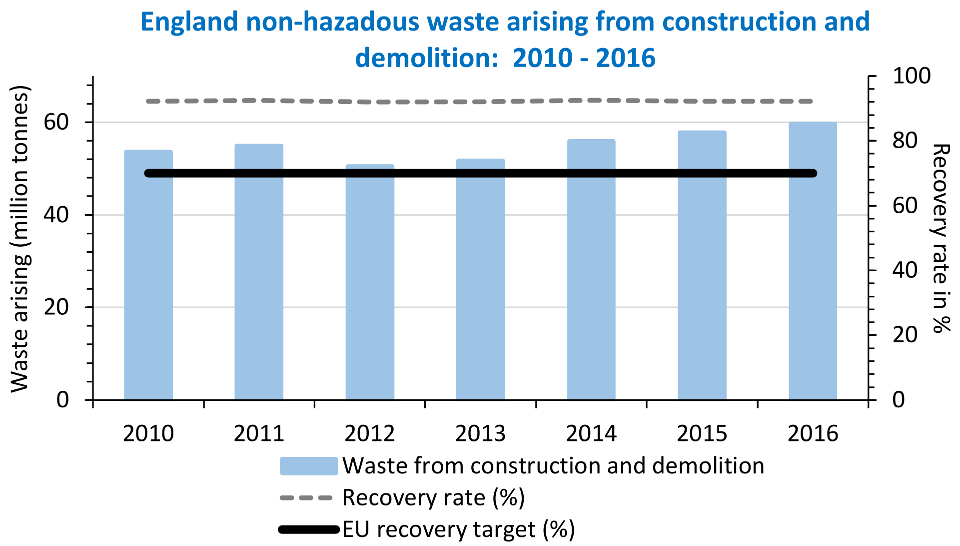


Source: Defra[144]

The estimated total amount of non-hazardous waste arising from construction and demolition in England followed a similar trend as the UK, reaching its lowest point in 2012 at just under 51 million tonnes. When comparing the latest estimates from 2016 to the NCC baseline point of 2011, it can be seen that the amount of construction and demolition waste arising increased by just under 5 million tonnes (9%).

The recovery rate for this type of waste changed very little over the period, staying around 92%. However, this means that just 5 million tonnes for construction and demolition waste are not being recovered, which is a significant amount of resources that could be ending up in landfills and increasing the need for virgin materials. See Figure 30 for construction and demolition waste in England since 2010.

Figure 30: England non-hazardous waste arising from C&D: 2010 – 2016



Source: Defra[145]

144 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

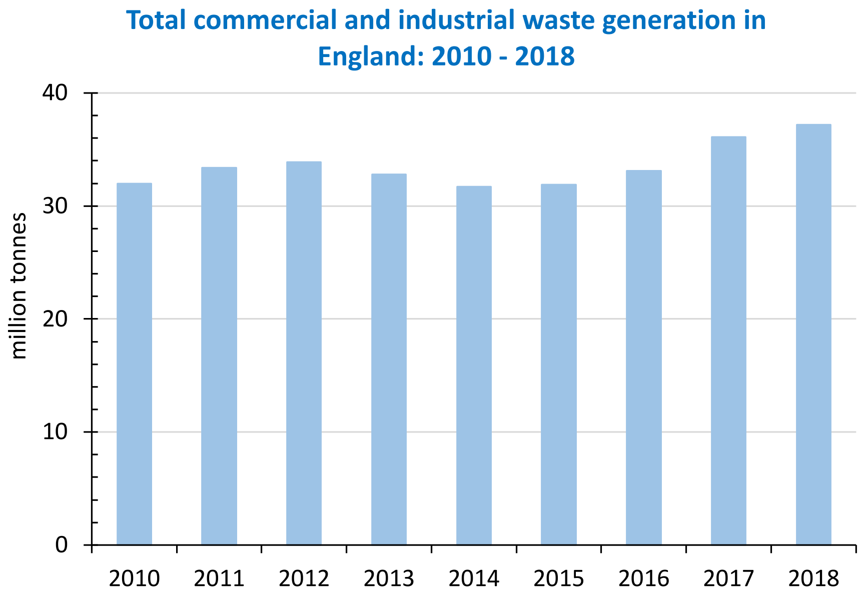
145 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Commercial and industrial waste

According to Defra estimates[146], the amount of commercial and industrial waste generated in England fluctuated around 34 million tonnes per year. The figure was higher at the end of the period (37 million tonnes) than at the start (32 million tonnes), an increase of over 16%. There are no specific targets for the recycling of commercial and industrial waste. See Figure 31 for commercial and industrial waste trends since 2010.

Estimates for the commercial and industrial waste generated in the UK as a whole are only available for 2010, 2012, 2014 and 2016, so are not shown but can be found in the Defra UK statistics on waste – ENV23.[147]

Figure 31: Total commercial and industrial waste generation in England: 2010 - 2018



Source: Defra[148]

Waste treatment

This section presents the methods for waste treatment which include:

- Recycling (see the previous section for household and construction and demolition recycling);
- Incineration; and
- Landfill (disposal).

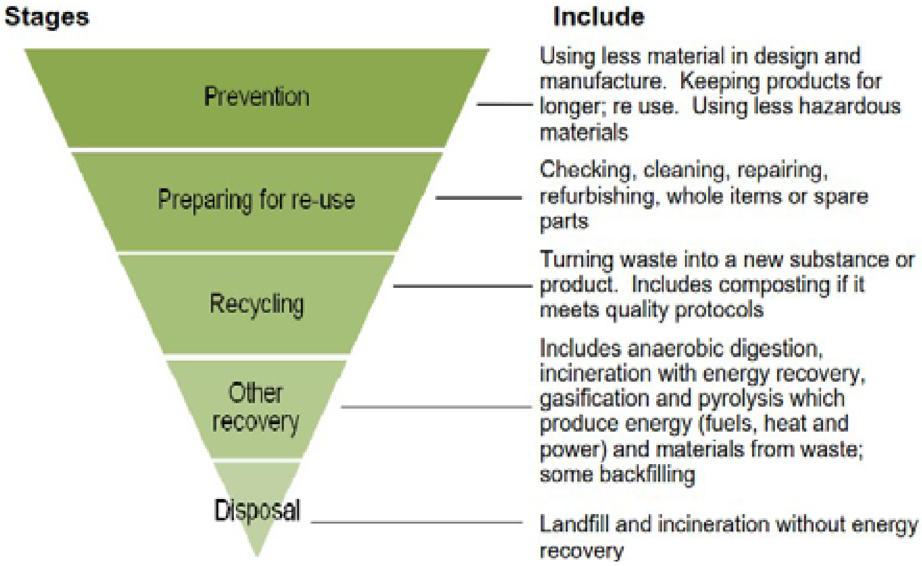
These methods follow the waste hierarchy, which gives priority to preventing waste to disposal. The hierarchy is presented in Figure 32:

146 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

147 Defra, ENV23 – UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

148 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Figure 32 Waste hierarchy



Source: Defra[149]

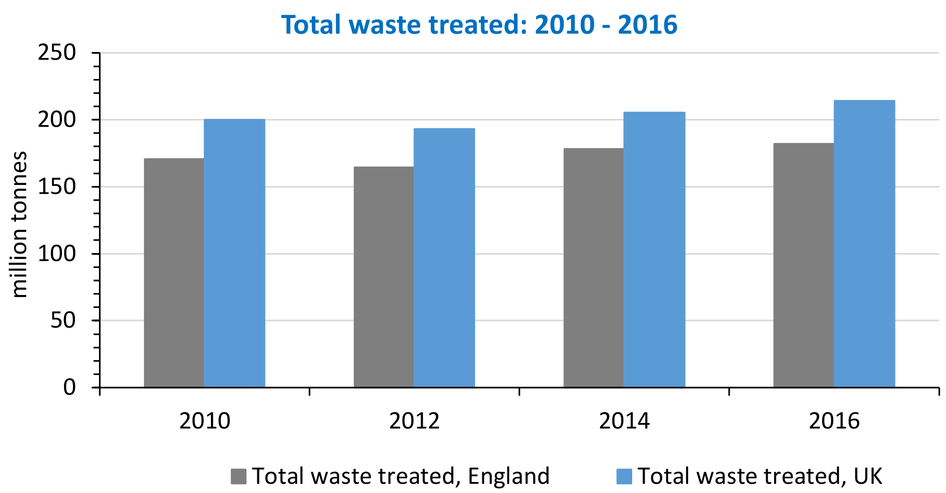
Total waste treated

As with the total amount of waste generated, Defra's UK waste statistics[150] only provide information on the total amount of waste treated for 2010, 2012, 2014, and 2016. A fairly stable proportion of the waste generated was treated each year, around 98% in England and around 97% for the UK as a whole. The figures for waste treatment therefore closely track the figures for waste generation.

In 2010 the amount of waste reported by Defra as having been treated in England was 3 million tonnes higher than the amount of waste reported as having been generated. This surprising result could be due to waste being treated in England after being generated elsewhere, and/or being generated in previous years.

Like the estimates for waste generation, the waste treatment estimates were fairly stable across the period, showing no clear trend. 214 million tonnes of waste was treated in the UK in 2016, 182 million of which were treated in England. These estimates are slightly higher than the corresponding estimates for the start of the period: 200 million and 171 million respectively. See Figure 33 for the waste treated trend.

Figure 33: Total waste treated: 2010 - 2016



Source: Defra[151]

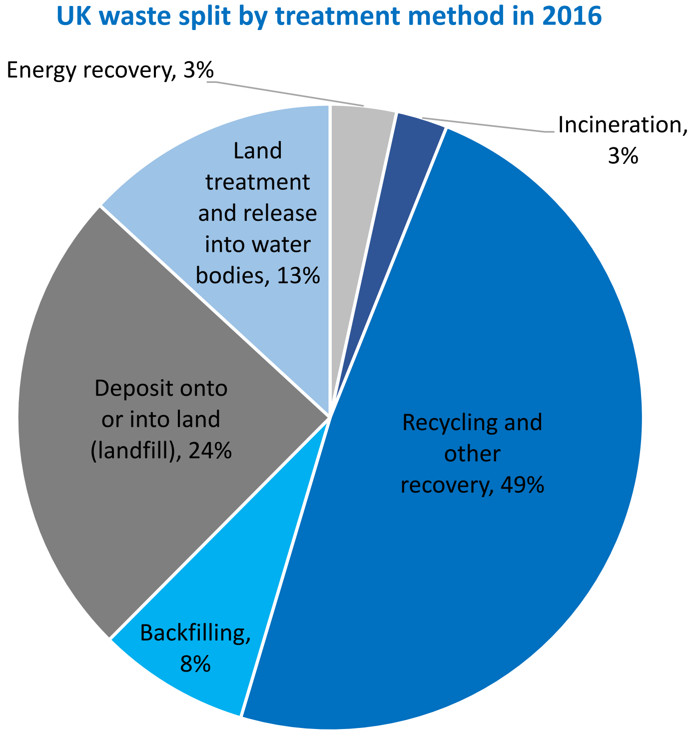
149 Defra, Incineration of municipal solid waste (2013) https://www.gov.uk/government/publications/incineration-of-municipal-solid-waste

150 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

151 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

Defra has estimated waste treatment by the method. In 2016 the method with the highest treatment method was recycling and other recovery at just under 49%, followed by landfill at just over 24%, and land treatment and release into water bodies at just under 13%. See Figure 34 for the full breakdown by the method of treatment.

Figure 34 UK waste split by the final treatment method in 2016



Source: Defra[152]

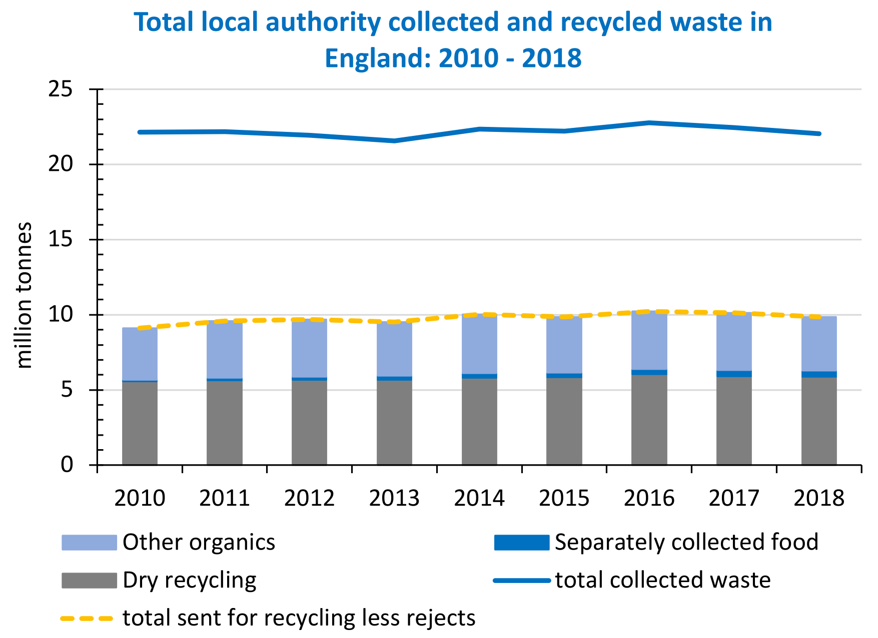
Local Authority collected and recycling estimates

The total Defra-estimated[153] amount of waste collected by local authorities in England fluctuated around 22 million tonnes between 2010 and 2018 - see Figure 35 for the historical trend. The total amount of waste sent for recycling (less the rejects) fluctuated around 10 million tonnes over the same period. The stacked columns indicate the composition of this material, though they do not equal the values shown by the dotted line exactly because they show only what is collected in recycling streams, which is not the same as what is sent for recycling.

152 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

153 Defra, ENV18 - Local authority collected waste from households from January 2010 to March 2019 England data (2019) https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

Figure 35: Waste collected and recycled by local authorities in England: 2010 - 2018



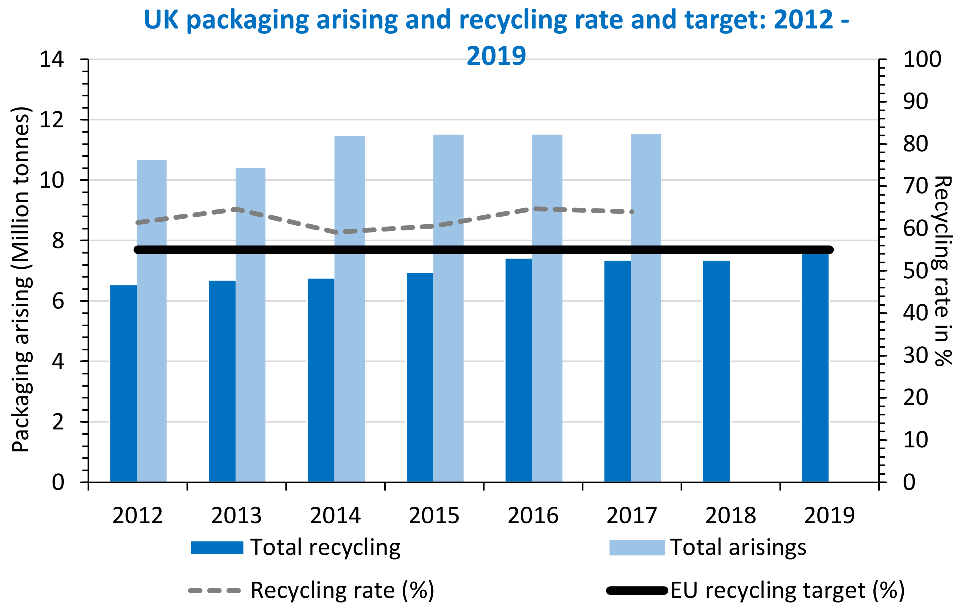
Source: Defra[154]

Packaging waste and recycling

The total amount of packaging waste has increased since 2012 from around 10.7 million tonnes to 11.5 million tonnes in 2017. There has also been a slight increase between 2016 and 2017 of 27.5 kilotonnes. There is no data for 2011. See Figure 36 for change since 2012.

The recycling rate[155] and amount has also increased between 2012 and 2019, from 6.5 million tonnes to 7.8 million tonnes in 2019. Recycling has also increased between 2018 and 2019, by 476 kilotonnes. The recycling rate has increased from over 61% in 2012 to just under 64% in 2017, which is above the EU target of 55%. Data is not available for 2011.

Figure 36 UK packaging waste arising and recycling since 2012



Source: Defra[156]

154 Defra, *ENV18 - Local authority collected waste: annual results tables* (2020) https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

155 The packaging recycling rate excluded estimates destined to Energy from Waste (EfW) plants.

156 Defra, UK statistics on waste data – March 2020 (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

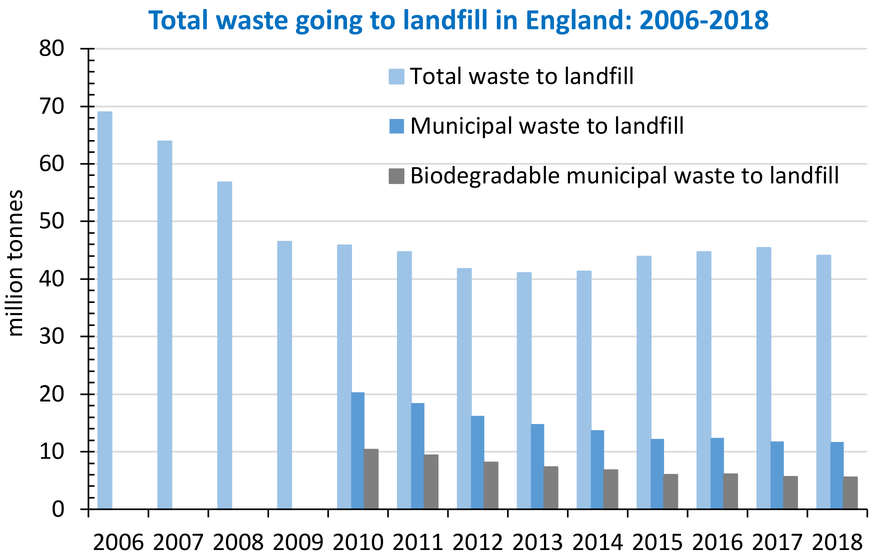
Waste sent to landfill

Estimates on the total amount of waste going to landfill in England from the Environment Agency[157] are available from as far back as 2006. The amount fell significantly in the first few years of the period from 69 million tonnes in 2006 to 47 million tonnes in 2009. From 2009 onwards, the waste going to landfill in million tonnes fluctuated in the mid-/low-40s. These fluctuations were in line with the fluctuations in the amount of household waste generated and the amount of commercial and industrial waste generated.

In 2018, the last year for which there is data, 44 million tonnes of waste was sent to landfill in England.

Estimates on the amount of municipal waste going to landfill and, more specifically, the amount of biodegradable municipal waste sent to landfill are only available from 2010: these are based on Defra statistics[158]. Between 2010 and 2018, these two series loosely followed the fluctuations in the amount of total waste, though with more significant decreases than increases. 20 million tonnes of municipal waste went to landfill in England in 2010, 10 million of which was biodegradable. In 2018, 12 million tonnes of municipal waste went to landfill in England, 6 million of which was biodegradable. See Figure 37 for historical trend.

Figure 37: Total waste going to landfill in England: 2006 - 2018



Source: Environment Agency[159] / Defra[160]

Biodegradable Municipal Waste (BMW)

The amount of biodegradable municipal waste (BMW) sent to landfill in the UK declined steadily over the period from 13 million tonnes in 2010 to 7.2 million tonnes in 2018 – this data is based on Defra statistics[161]. When comparing the level of BMW in 2011 and 2018 there has been a decline of 39%, which is equal to just over 4.5 million tonnes. In the last few years, the rate of decline has slowed and in 2016, the amount of BMW sent to landfill was slightly higher than in 2015.

157 Environment Agency, Waste Data interrogator 2018 (2020) https://data.gov.uk/dataset/312ace0a-ff0a-4f6f-a7ea-f757164cc488/waste-data-interrogator-2018

158 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

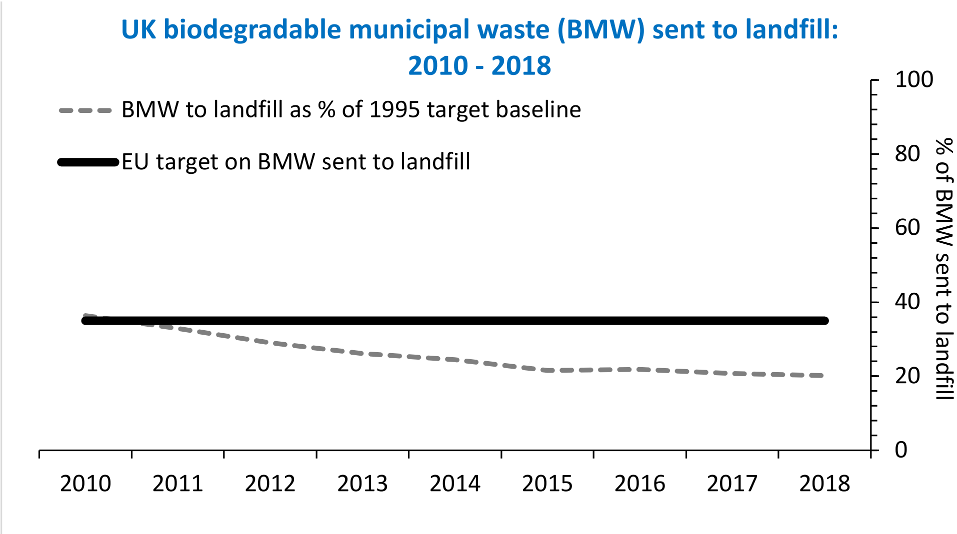
159 Environment Agency, Waste Data interrogator 2018 (2020) https://data.gov.uk/dataset/312ace0a-ff0a-4f6f-a7ea-f757164cc488/waste-data-interrogator-2018

160 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

161 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

The EU target is that the amount of BMW sent to landfill each year should be less than 35% of the total amount of BMW generated in the UK in 1995 (35.7 million tonnes). Though the amount of BMW sent to landfill started the period slightly above the target (just over 36%), it has been below every year since, reaching its lowest level in 2018 (just over 20%). See Figure 38 for the change in BMW being sent to landfill since 2010.

Figure 38: Biodegradable municipal waste (BMW) sent to landfill: 2010 - 2018

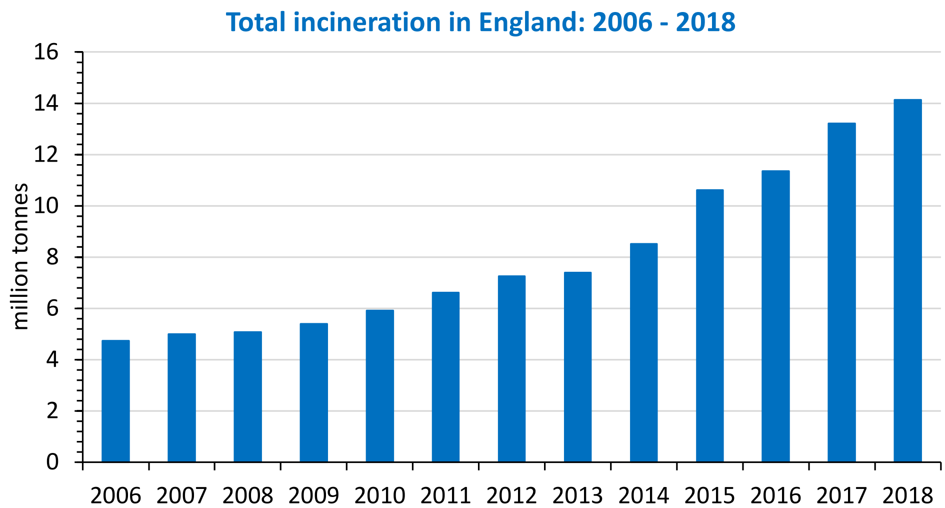


Source: Defra[162]

Incineration including Energy from Waste (EfW)

Using data from the Environment Agency[163], the amount of waste incinerated in England increased significantly between 2006 and 2018, finishing the period almost three times higher than at the start (14 million tonnes in 2018, compared with 4.7 million tonnes in 2006). When 2018 is compared to 2011 there is also a significant increase of just under 114%. The amount of incineration has been increasing at the fastest rate in the last few years, since 2014. One of the reasons for this increase is the cost of disposing of waste to landfill which has increased since the creation of the landfill tax. The waste that was previously sent to landfill is now sent for incineration (and other methods of treatment). See Figure 39 for the historical trend on the tonnage of incineration.

Figure 39: Incineration in England: 2006 - 2018



Source: Environment Agency[164]

162 Defra, ENV23 - UK statistics on waste (2020) https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

163 Environment Agency, Waste Data interrogator 2018 (2020) https://data.gov.uk/dataset/312ace0a-ff0a-4f6f-a7ea-f757164cc488/waste-data-interrogator-2018

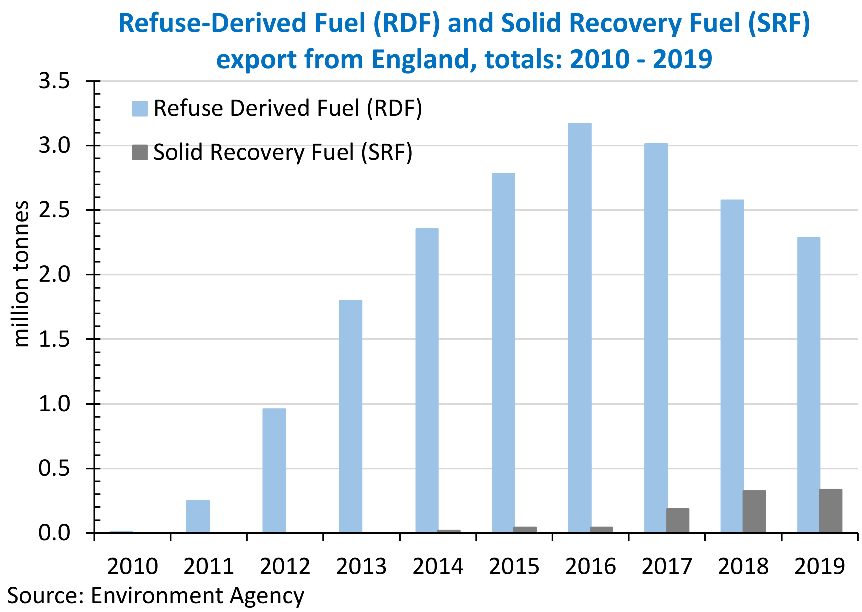
164 Environment Agency, Waste Data interrogator 2018 (2020) https://data.gov.uk/dataset/312ace0a-ff0a-4f6f-a7ea-f757164cc488/waste-data-interrogator-2018

Refuse-Derived Fuel (RDF) and Solid Recovery Fuel (SRF)

The amount of Refuse-Derived Fuel (RDF) exported from England increased from around 10 thousand in 2010 to a peak of 3.2 million tonnes in 2016, before declining significantly over the next three years, finishing the period at 2.3 million tonnes in 2019.

In the first year for which data is available, 2014, the amount of Solid Recovery Fuel (SRF) exported from England was only 20,000 tonnes. The figure increased over the following few years, first slowly and then more rapidly, reaching 322,000 tonnes in 2018. In 2019, the figure finished at 336,000. Data on RDF and SRF is available from the Environment Agency international waste shipments[165]. See Figure 40 for the change in exports of RDF and SRF since July 2010.

Figure 40: Refuse-derived fuel (RDF) and solid recovery fuel (SRF) exported from England: 2010 - 2019



Source: Environment Agency[166]

Waste export and imports of scrap materials

A significant amount of recycled material is exported to the EU and countries in Asia for reprocessing. Figure 41 presents the export and import of scrap materials[167] based on HMRC estimates[168]. The NCC has not produced this graph, as evidence has not been found on what specific Harmonised System (HS) codes underpin this graph.

Between 2002 and 2016, more waste was exported each year from the UK than was imported. Throughout the period, waste imports were a small fraction of the size of waste exports, so net exports followed just below gross exports, which approximately doubled over the period. Just below 16 million tonnes of waste were exported from the UK in 2016, compared with just below 8 million tonnes in 2002.

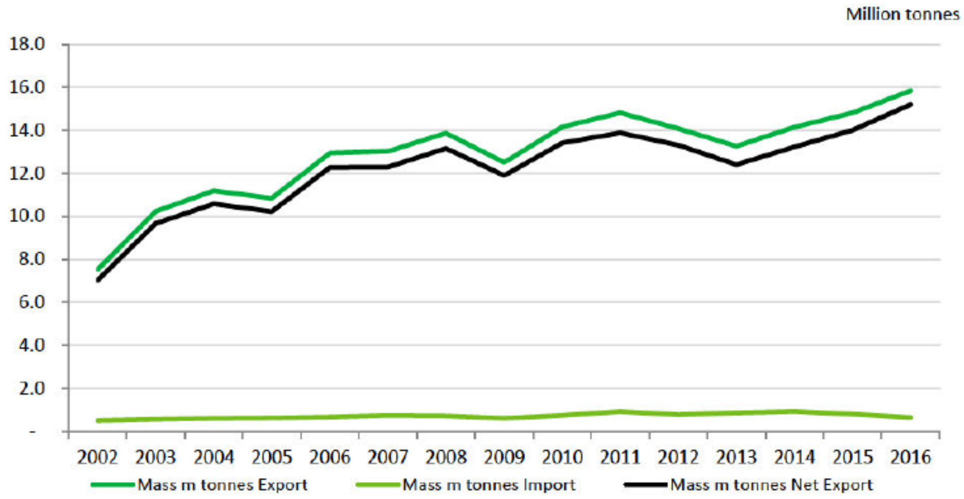
165 Environment Agency, International Waste Shipments exported from England (2020) https://data.gov.uk/dataset/5ffdf701-05c2-43b8-ba1e-e65580bbcc08/international-waste-shipments-exported-from-england

166 Environment Agency, International Waste Shipments exported from England (2020) https://data.gov.uk/dataset/5ffdf701-05c2-43b8-ba1e-e65580bbcc08/international-waste-shipments-exported-from-england

167 Scrap materials: recyclable materials left over from product manufacturing and consumption, which has amonetary value. Included here are: municipal waste, clinical waste, textiles, rubber, plastic, paper, copper, aluminium, nickel, lead, zinc, tin, tungsten, gallium, hafnium, and ferrous metals.

168 HMRC, Data by commodity code https://www.uktradeinfo.com/Statistics/BuildYourOwnTables/Pages/Table.aspx

Figure 41: Waste exports and imports, UK: 2002 - 2016



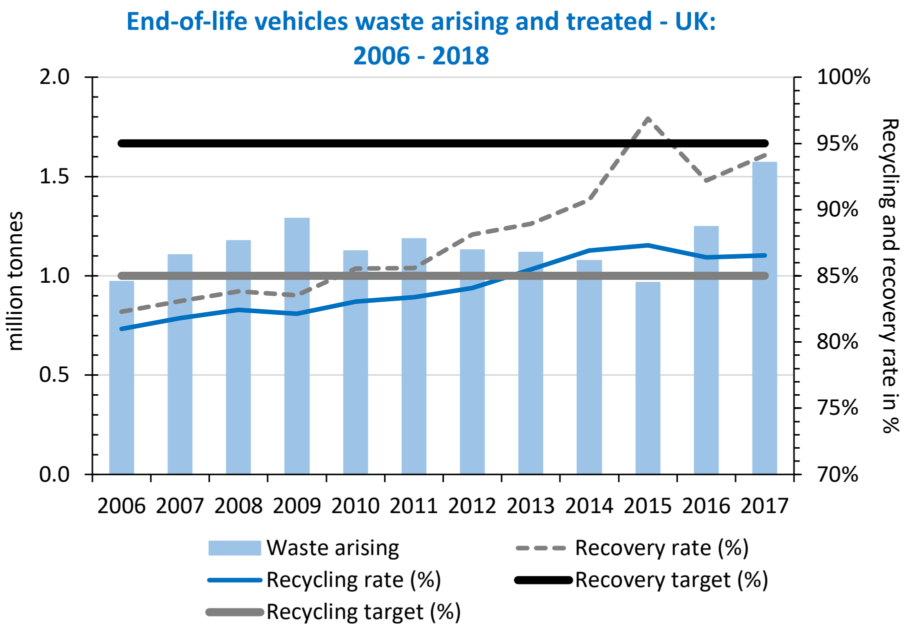
Source: Defra[169]

End-of-Life Vehicles (ELVs)

Based on Eurostat estimates[170], the amount of waste arising from end-of-life vehicles was just under 1.0 million tonnes in 2006. This figure then rose over the next three years to a peak of 1.3 million tonnes in 2009, before decreasing gradually back to 0.97 million tonnes in 2015. In the last two years, for which data is available, the amount of waste has been rising as end-of-life vehicles has risen sharply, finishing the period at a high of just under 1.6 million tonnes in 2017.

The amount of end-of-life vehicles waste recovered and recycled each year have approximately followed the movements in the total amount of end-of-life vehicles waste arising. However, over this period the proportion of waste arising that is recovered and the proportion that is recycled have risen gradually, from 82% and 81% in 2006 to just over 94% and 87% in 2017, respectively. This rate of recovery is below the EU target of 95%. The recycling target from 2006 is 85%. The UK has met the recycling target in 2017. See Figure 42 for ELVs waste arising, recovery and recycling rates, and targets since 2006.

Figure 42: End-of-life vehicles waste arising and treated, UK: 2006 - 2018



Source: Eurostat[171]

169 Defra, Digest of waste and resource statistics: 2018 edition (2018) https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2018-edition

170 Eurostat, End-of-life vehicles - reuse, recycling and recovery, totals (2020) http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_waselvt&lang=en

171 Eurostat, End-of-life vehicles - reuse, recycling and recovery, totals (2020) http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_waselvt&lang=en

Waste of Electrical and Electronic Equipment (WEEE)

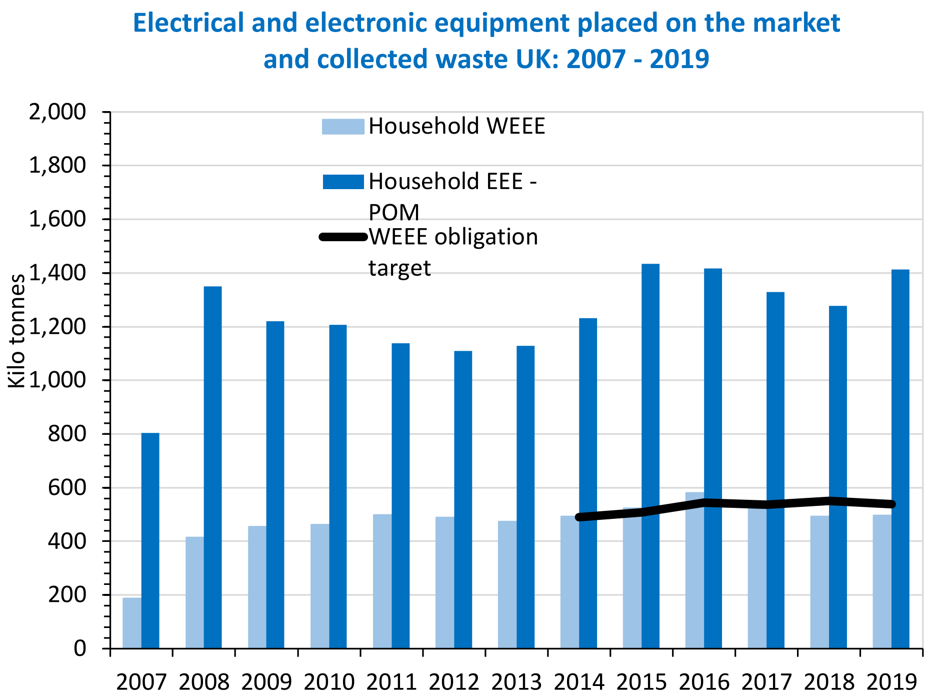
The most recent data from the Environment Agency[172] shows that the amount of household waste electrical and electronic equipment (WEEE) collected separately in the UK fluctuated over the period 2007-2019, on a generally upward trend. The total amount arising of this type of waste was 497 kilotonnes in 2019, compared with only 186 kilotonnes in 2007.

The EU target for household WEEE separately collected is calculated as a proportion of the household electrical and electronic equipment (EEE) placed on the market. The amount of household EEE placed on the market each year is shown for reference. The higher the amount of WEEE collected separately as a proportion of the amount of EEE placed on the market the better, because the less WEEE is therefore disposed of improperly.

Between 2016 and 2018, the EU target for separate collection of WEEE was at least 45%, calculated on the basis of the total weight of WEEE collected. From 2019, this target is 65%.

The amount of household WEEE arising was above the target level for the first three years for which target information is available, but has been slightly below the target in the last three years, representing a worsening. See Figure 43 for WEEE placed on the market, collection, and obligation target over time.

Figure 43: Waste electrical and electronic equipment (WEEE) in the UK: 2007 - 2019



Source: Environment Agency[173]

172 Environment Agency, Waste electrical and electronic equipment (WEEE) in the UK (2020) https://www.gov.uk/government/statistical-data-sets/waste-electrical-and-electronic-equipment-weee-in-the-uk

173 Environment Agency, Waste electrical and electronic equipment (WEEE) in the UK (2020) https://www.gov.uk/government/statistical-data-sets/waste-electrical-and-electronic-equipment-weee-in-the-uk

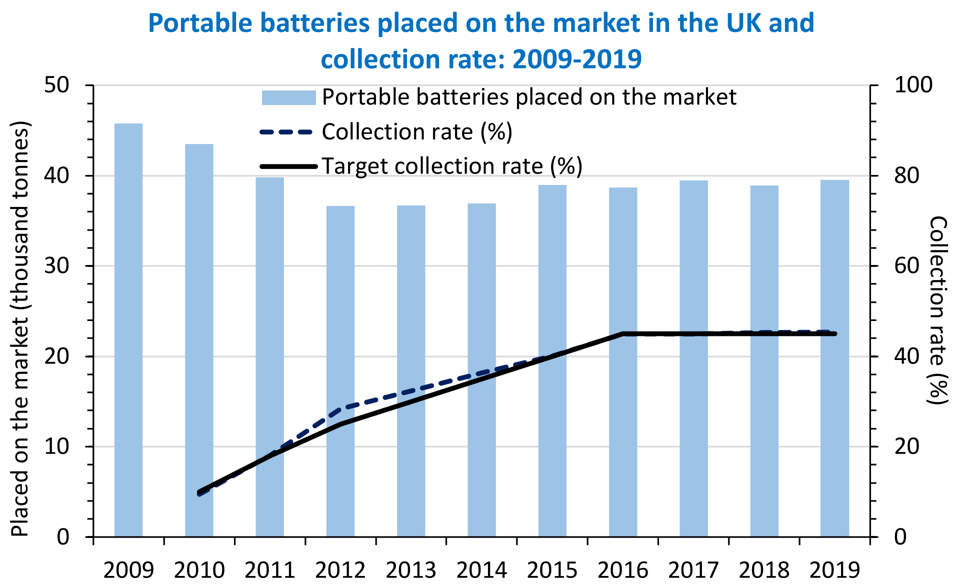
Portable batteries

A target is set each year for the mass of portable batteries waste to be collected, as a percentage of the mass of portable batteries placed on the market that year. This percentage has risen significantly since 2010, from 10% to 45% in 2019. However, since 2016, this increase has been much more gradual. See Figure 44 for the trend in portable batteries since 2009.

The collection rate has been above its target level for all but two of the years (2010 and 2017) since 2010. The UK is currently meeting the EU portable batteries target of 45%.

Data on estimates of portable batteries placed on the market (POM) and the collection rate is available from the National Waste Packaging Database (NWPD)[174]. The collection rate of portable batteries increased significantly from 9.5% in 2010 to 45% in 2016, where it levelled off. When comparing to 2011 (the NCC baseline), there has been an increase in the collection rate from 18%, to just over 45% in 2019.

Figure 44: Portable batteries placed on the market in the UK and collection rate: 2009 - 2019



Source: National Waste Packaging Database[175]

174 National Waste ackaging Database, Public Batteries Reports https://npwd.environment-agency.gov.uk/Public/Batteries/PublishedReports.aspx

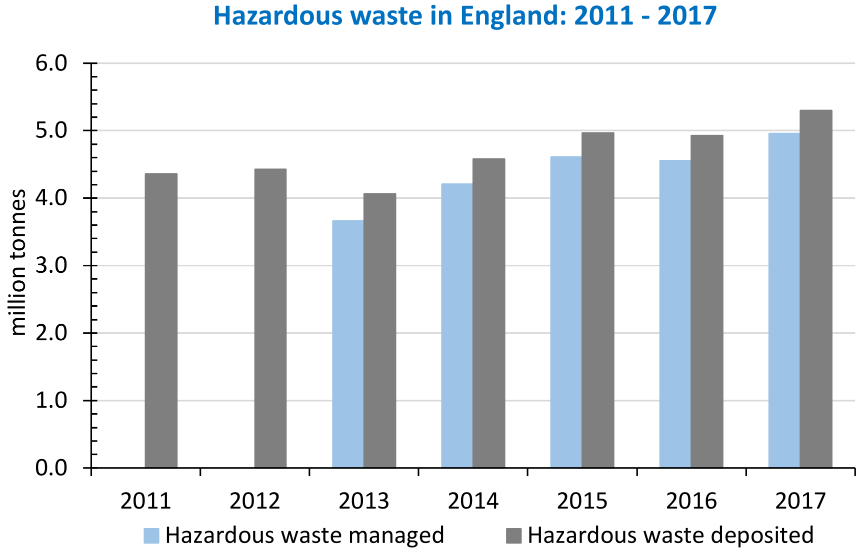
175 National Waste Packaging Database, Public Batteries Reports https://npwd.environment-agency.gov.uk/Public/Batteries/PublishedReports.aspx

Hazardous waste

Based on the Environment Agency waste management data[176], from 2011 to 2017, the estimated amount of hazardous waste[177] data waste deposited in England fluctuated but exhibited a generally upward trend. In 2017, a total of 5.3 million tonnes of hazardous waste was deposited in England, compared with 4.4 million tonnes in 2011, an increase of just under 22%.

In the years for which data is available, the amount of hazardous waste managed in England followed the amount of hazardous waste deposited. In 2017, a total of 5.0 million tonnes of hazardous waste were managed in England, compared with 3.7 million tonnes in 2013, an increase of just over 35%. See Figure 45 for the trend of managed and deposited hazardous waste in England.

Figure 45: Hazardous waste in England: 2011 - 2017



Source: Environment Agency[178]

Waste incidents

This section looks at the number of waste crime sites and fly-tipping incidents in England.

Waste Crime

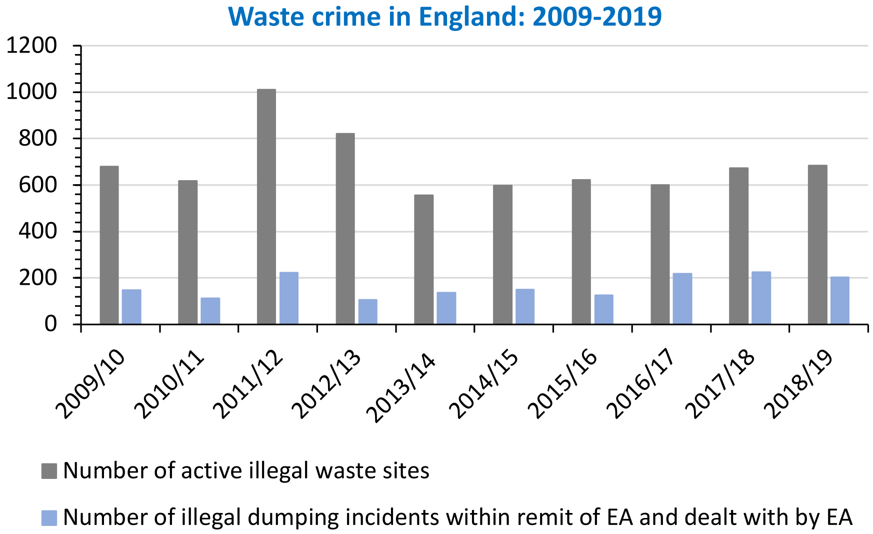
The number of active illegal waste sites fluctuated at around 600 over the period, apart from in 2011/12 and 2012/2013 when it was 1,011 and 820 respectively. The number of illegal dumping incidents within the remit of the Environment Agency and dealt with by the Environment Agency fluctuated between a low of 107 in 2012/13 and a high of 226 in 2017/18. See Figure 46 for breakdown since 2009/10.

176 Environment Agency, Waste management for England https://www.gov.uk/government/publications/waste-management-for-england-2016

177 Hazardous waste: Waste is considered 'hazardous' under environmental legislation when it contains substances or has properties that might make it harmful to human health or the environment. This does not necessarily mean it is an immediate risk to human health, although some waste can be. **Source:** https://www.hse.gov.uk/waste/hazardouswaste.htm

178 Environment Agency, Waste management for England https://www.gov.uk/government/publications/waste-management-for-england-2016

Figure 46: Waste crime in England: 2009 - 2019



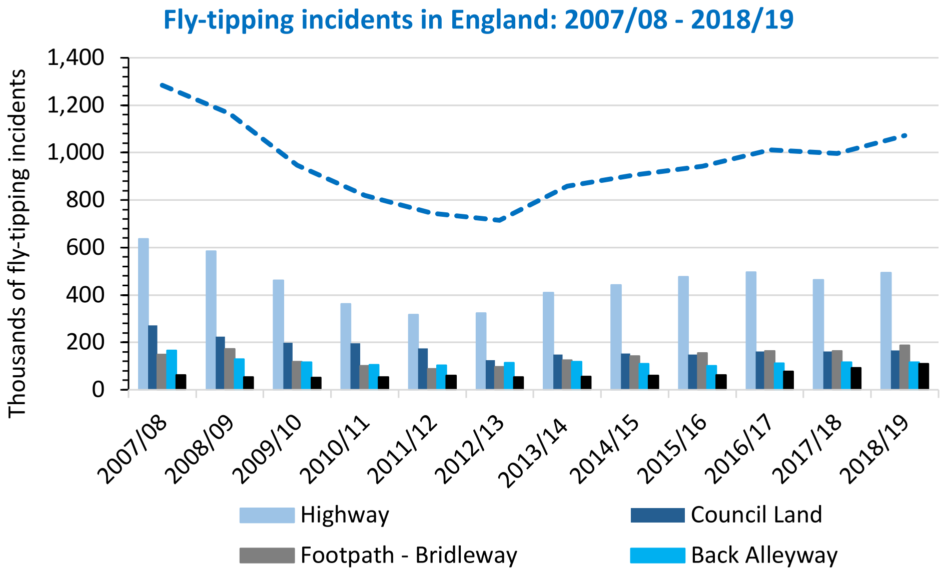
Source: Environment Agency[179] (no data on dumping incidents for 2019)

Fly-tipping

Based on evidence from Defra[180], fly-tipping[181] incidents in England have fluctuated between 2007/08 and 2018/19, between 2007/08 and 2012/13 there was a decline in the number of incidents from 1.28 million to just under 715 thousand incidents (just over a 44% reduction). Since then, incidents have steadily increased, reaching a peak in 2018/19 of just over 1.07 million incidents. Between 2017/18 and 2018/19, there was an increase of 8% in incidents. When comparing to 2011/12, incidents have increased by over 44%.

In 2018/19 the majority of the fly-tipping incidents occurred at highways, accounting for just under 46% of the total, followed by footpaths/bridleways (just over 17%) and council land (just under 16%). To address the fly-tipping issue, local authorities carried out 499,000 enforcement actions and issued 76,000 fixed penalty notices in 2018/19.[182] See Figure 47 for fly-tipping evidence since 2007/08.

Figure 47 Fly-tipping incidents in England since 2007/08



Source: Defra[183]

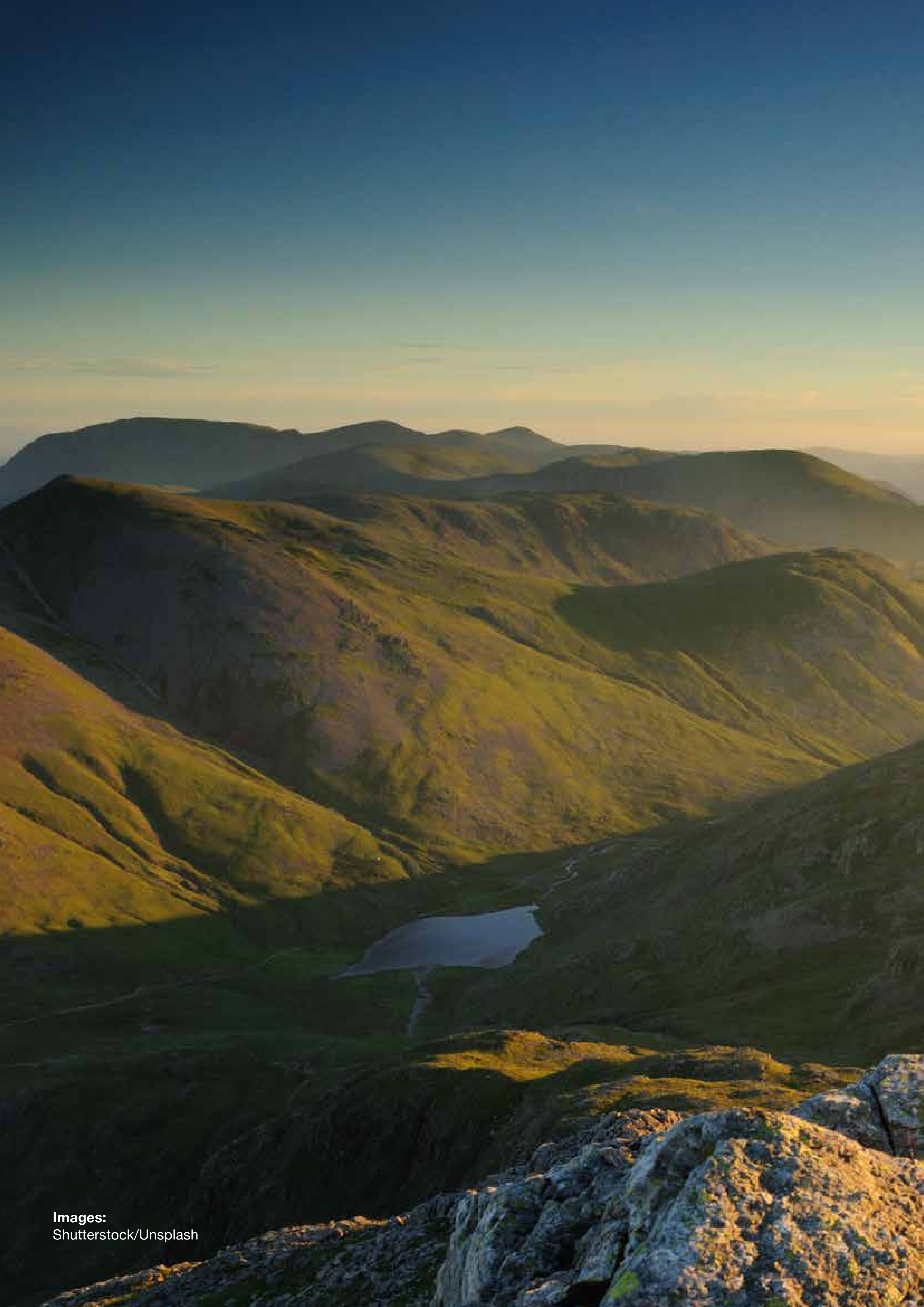
179 Environment Agency, Waste crime summary data 2018 (2020) https://www.gov.uk/government/publications/environment-agency-2018-data-on-regulated-businesses-in-england

180 Defra, ENV24 - Fly tipping incidents and actions taken in England (2019) https://www.gov.uk/government/statistical-data-sets/env24-fly-tipping-incidents-and-actions-taken-in-england

181 Fly-tipping: is illegal dumping of liquid or solid waste on land or in water. The waste is usually dumped to avoid disposal costs. **Source:** https://www.gov.uk/guidance/fly-tipping-council-responsibilities

182 Defra, Fly-tipping statistics for England, 2018/19 (2019) https://www.gov.uk/government/statistics/fly-tipping-in-england

183 Defra, Fly-tipping statistics for England, 2018/19 (2019) https://www.gov.uk/government/statistics/fly-tipping-in-england



Images:
Shutterstock/Unsplash