Trends Report 2022: Trends in critical load and critical level exceedances in the UK

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Table of Contents

Executive Summary

This contract provides key information to track the effects on ecosystems of policies aimed at meeting national and international air pollution targets, e.g. under the UK Government's Clean Air Strategy 2019 (CAS), the National Emission Ceilings Regulations (NECR), and the United Nations-Economic Commission for Europe Convention on Long-range Transboundary Air Pollution (CLRTAP). It also provides the means to develop targeted action for emission reduction policies to get the maximum improvement in air quality.

Exceedance of critical load or critical level indicates that an ecosystem is at risk from potential harmful effects. When pollution subsequently decreases to below the critical load or level, there may be delays to recovery, but the risk of harm is reduced. Pollution control measures aimed at meeting CLRTAP targets have reduced the extent and magnitude of critical load and level exceedances across the UK. A target for reactive nitrogen (N) deposition in England was included in the CAS to further reduce impacts on ecosystems in response to the UK's new emission reduction targets for ammonia and oxides of nitrogen.

This latest Trends Report incorporates two major changes in the methods used for calculating critical load exceedances: a revision of the habitat maps that are used to assess broad-scale sensitivity to air pollution; and a change in the atmospheric chemistry and transport models used to estimate ammonia concentration and deposition loads of nitrogen and sulphur. Values were recalculated for previous years using the new maps and modelled chemistry, to allow time series to be reported with consistent methodology. Effects of these changes on the values of the reported exceedance metrics are discussed and illustrated. The values of metrics have changed, in some cases considerably, but the trends in air pollution pressure over time are similar using the old and new methods.

- UK habitats at risk from acidification: The area of acid-sensitive habitats with exceedance of acidity critical loads has fallen from 63.4% in 2010, to 52.9% (47,918 km^2) in 2019, due mainly to decreases in NOx and sulphur deposition. Of the total acidifying pollution onto UK woodland in 2019, 73 % was reduced N (ammonia and ammonium), 19 % was NOx, and 8 % was sulphur.
- UK habitats at risk from excess N (eutrophication): The area of N-sensitive habitats with exceedance of nutrient N critical loads fell from 74.4% (69,781 km^2) in 2010, to 67.7% (63,470 km^2) in 2019. This decline was largely driven by changes in Scotland – in England, Wales and Northern Ireland there was little change in area exceeded over this period.
- UK habitats at risk of exceeding the critical levels for gaseous ammonia: In 2018, 6.3% (15,455 km^2) of the UK land area was exposed to ammonia concentrations above the critical level set to protect higher plants (3 $\mu g\ m^{-3}$), and 69.2% (169,409 km^2) exposed to ammonia at concentrations above the critical level set to protect lichens and mosses (1 $\mu g\ m^{-3}$). The area where the critical level for higher plants is exceeded has increased by 2% of UK land area since 2010. The area where the critical level for lichens and mosses is exceeded has increased by 5.1% of UK land area since 2010.

Technical Summary

Critical loads define the rates of acid or nitrogen (N) deposition (e.g. in kiloequivalents per hectare per year, keq ha^{-1} yr^{-1}) below which significant harmful effects are not expected to occur in sensitive habitats. Critical load exceedance is the amount by which acid or N deposition exceeds the critical load.

Critical levels are concentrations of pollutants (e.g. in micrograms per cubic metre, µg m^{-3}) in the atmosphere below which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, are not expected to occur according to present knowledge. Critical level exceedance is the amount by which concentration exceeds the critical level.

Critical load and critical level exceedances are calculated using rolling 3-year mean data sets for deposition rates and gaseous concentrations, which are updated annually. A 3-year mean is used to smooth out inter-annual variability due to the influence of weather on atmospheric chemistry. This report describes critical loads and their exceedances for the period from 2010 to 2019, and critical levels and their exceedances for the period from 2010 to 2018.

This report presents trends in: a) acidity critical load exceedances for UK habitats at risk from acidification by excess sulphur (S) and/or N; b) nutrient-nitrogen critical load exceedances for UK habitats at risk of eutrophication by excess N; c) critical load exceedances for acid- and N-sensitive habitat features of UK designated sites (Special Areas of Conservation: SACs; Special Protected Areas: SPAs; Sites of Special Scientific Interest: SSSIs); and d) exceedances of ammonia critical levels across the UK.

Summary statistics monitor progress in the area of habitats in the UK at risk from acidification and eutrophication from air pollution over time, and are reported in the annual “UK Biodiversity Indicators” summary produced by the Joint Nature Conservation Committee (https://jncc.gov.uk/our-work/ukbi-b5a-air-pollution/; indicator B5a for assessing the pressures from air pollution).

UK habitats at risk from acidification

- The area of acid-sensitive habitats in the UK with exceedance of acidity critical loads continued to decline due mainly to decreases in oxidised N (NOx) and sulphur (S) deposition, having fallen from 63.4% (57,380 km^2) in 2010 to 52.9% (47,918 km^2) in 2019.
- The magnitude of the acidity exceedance (expressed as the Average Accumulated Exceedance) for all UK habitats combined fell between 2010 and 2019, from 0.60 to 0.44 keq ha^{-1} $year^{-1}$.
- The largest reduction in the area of acid-sensitive habitats with exceedance of acidity critical loads was in Scotland, where it fell from 53.5% (29,139 km^2) in 2010 to 38.2% (20,810 km^2) in 2019.
- The smallest reduction in the area of acid-sensitive habitats with exceedance of acidity critical load was in Northern Ireland, falling from 85.9% (3,029km^2) in 2010 to 84.2% (2,970 km^2) in 2019.
- Of the terrestrial acid-sensitive habitats mapped, dwarf shrub heath occupies the largest area across the UK (24%); the area of this habitat with exceedance of acidity critical loads decreased, from 30.6% (6,692km^2) in 2010 to 21.6% (4,708 km^2) in 2019.

UK habitats at risk from eutrophication (i.e. from excessive nutrient availability)

- The area of N-sensitive habitats in the UK with exceedance of nutrient N critical loads decreased from 74.4% (69,781 km^2) in 2010, to 67.7% (63,470 km^2) in 2019.

- Excess Nitrogen (Average Accumulated Exceedance for nutrient N) for all UK habitats combined decreased from 10.1 kg N ha^{-1} $year^{-1}$ in 2010 to 8.8 kg N ha^{-1} $year^{-1}$ in 2019.
- The largest reduction in the area of N-sensitive habitats with critical load exceedance was in Scotland, falling from 57.8% (31,391 km^2) in 2010 to 47.0% (25,525 km^2) in 2019.
- Reductions between 2010 and 2019 in the area of N-sensitive habitats with critical load exceedance in England, Wales and Northern Ireland were less than 4%.
- The nutrient N critical load was exceeded for more than 80% of the areas of seven N-sensitive habitats in all years: calcareous grasslands, coniferous woodland, montane habitats, broadleaved woodland, beech woodland, acidophilous oak woodland, and mixed woodland.
- Although the decline between 2010 and 2019 in area exceeded was small for most habitats (e.g. from 100.0% to 99.5% of beech woodland), the magnitude of exceedance (Average Accumulated Exceedance) for beech woodland decreased more substantially, e.g. from 18.6 kg N ha^{-1} $year^{-1}$ in 2010 to 17.2 kg N ha^{-1} $year^{-1}$ in 2019.

Total N deposition onto protected sensitive habitats

- Since 2020, the Trends Report includes a metric against which progress towards the UK Government's Clean Air Strategy target (Defra, 2019) can be measured, i.e. "to reduce damaging deposition of reactive forms of nitrogen by 17% over England's protected priority sensitive habitats by 2030".
- The mean N deposition rate onto priority habitats in England was 27.9 kg N ha^{-1} yr^{-1} in 2016, and 28.9 kg N ha^{-1} yr^{-1} in 2019, representing a 3.5 % increase.
- The increase appears at odds with the relatively stable trend in reported ammonia emissions. Increased concentrations may have resulted from underreporting of ammonia emissions, changes in the spatial pattern of emissions, interactions with SO_2 and NO_x, or meteorological variations.

Designated sites with acid-sensitive feature habitats

- The percentage of SACs and SPAs in the UK with exceedance of acidity critical loads for one or more features decreased from 79 % and 73.7% (SACs: 385 sites, SPAs: 129 sites) in 2010 to 76.2% (SACs: 371 sites) and 69.7% (SPAs: 122 sites) in 2019.
- The percentage of SSSIs with exceedance of at least one sensitive feature fell from 62.7% (2,935 sites) in 2010 to 57.9% (2,713 sites) in 2019.
- Scotland had the largest reductions in the percentage of designated sites with exceedance of acidity critical loads between 2010 and 2019, e.g. 10.8% of SACs.
- Roughly 50% of designated sites in Scotland and more than 70% of designated sites in other countries had exceedance of acidity critical loads in 2019, with the exception of SSSIs in England, 55.7% of which were exceeded.

Designated sites with nitrogen-sensitive feature habitats

- Increases in the percentage of designated sites in the UK with exceedance of nutrient N critical loads (for one or more features) between 2010 and 2019 were small (2.1 % for SACs, 1.2% for SSSIs, 4.4% for SPAs). This reflects the smaller changes in N deposition during this period.
- Scotland had the largest decreases (1.7%) in the percentage of SSSIs with exceedance of nutrient N critical loads between 2010 and 2019; Wales had the largest increase (7.1%) in the percentage of SPAs with nutrient N critical load exceedance over the same period.
- Of nature conservation sites in England, Wales and Northern Ireland, 78.6-98.0% had exceedance of nutrient N critical loads for one or more features in 2019. Proportionally fewer sites in Scotland (58.9-80.6%, depending on designation) were exceeded in this way.

Exceedance of ammonia critical levels

The trends in ammonia critical levels exceedance are available for the period 2009 to 2018; there have only been small changes in ammonia concentrations over this time period.

UK land area

- Nearly 69% of the UK currently was exposed to ammonia concentrations above the critical level set to protect lichens and bryophytes (1 µg m^{-3}) in 2018; this represents 94.0% of England, 68.8% of Wales, 22.5% of Scotland and 99.7% of Northern Ireland.
- There was an increase in the UK land area with ammonia concentrations above 1 µg m^{-3}, from 63.5% in 2010 to 69.2% in 2018.
- About 6% of the UK was exposed to ammonia concentrations above the critical level set to protect higher plants (3 µg m^{-3}) in 2018; this ranged from <0.1% of Scotland to 36.0% of Northern Ireland.
- The UK land area with ammonia concentrations above 3 µg m^{-3} increased, from 4.1% in 2010 to 6.3% in 2018.

Nitrogen-sensitive habitats

- 39.0% of the mapped area of N sensitive habitats in the UK was exposed to ammonia concentrations above the critical level of 1 µg m^{-3} in 2018; the percentage area exceeded ranged from 10.9% for Scotland to 95.9% for Northern Ireland.
- 89.6% of the area of calcareous grassland, and ~ 86 - 95 % of the area of some woodland habitats (beech and broadleaved woodland) were in areas exposed to ammonia concentrations above the critical level of 1 µg m^{-3}. Only 19.1 % of dwarf shrub heath was in areas exceeding this critical level, but this equates to 4,095 km^2, a similar area to the 67.0 % (4,589 km^2) of acidophilous oak woodland exceeded.
- 2.4 % of the area of N-sensitive habitats in the UK was exposed to ammonia concentrations above 3 µg m^{-3} in 2018; this ranged from < 0.1 % in Scotland to 23.5 % in Northern Ireland.

Designated sites (SACs, SPAs and SSSIs or ASSIs)

- 53.6% (133) of SPAs, 65.9% (405) of SACs and 78 % (5,308) of SSSIs (ASSIs in Northern Ireland) in the UK were exposed to ammonia concentrations above 1 µg m^{-3} on at least part of the site in 2018.
- 93-97% of the designated sites in England, 99-100% of sites in Northern Ireland, 66-84% of sites in Wales, and 22 - 32% of sites in Scotland, were exposed to ammonia concentrations above 1 µg m^{-3} in 2018.
- 7.5% (46) of SACs, 6% (15) of SPAs and 5.5% (375) of SSSIs in the UK were exposed to ammonia concentrations above 3 µg m^{-3} on at least part of the site in 2018. The percentage of designated sites with exceedance of this critical level rose by almost 3% between 2010 and 2018.
- Less than 1% of sites with these conservation designations in Scotland (and no SACs) were exposed to ammonia concentrations above the critical level of 3 µg m^{-3} on at least part of the site, compared with 0-3.6% of sites in Wales, up to 13% of sites in England and up to 27.8% of sites in Northern Ireland.

Report structure

Section 1 of this report provides an overview of critical loads for acidity and for nutrient N, deposition data, and exceedance calculations and metrics for habitats across the whole area of the UK. This is followed in Section 2 by summaries of these trends for specific habitats and countries, i.e. England, Scotland, Wales, and Northern Ireland. Section 3 focuses on designated sites, the application of "site-relevant critical loads" (SRCL) to these sites, and trends in their exceedances. Section 4 addresses critical levels for ammonia and their exceedances. Finally, Section 5 focuses on N deposition onto sensitive habitats, which is the basis of a target in the UK Government's Clean Air Strategy (Defra, 2019).

Notes on rounded numbers and percentages

Numbers in tables are shown to one decimal place. Numbers reported in the main text were rounded after calculation, so may not always equate precisely to the differences between the numbers in the table. For example, if there is a change of +0.08 units from 72.06 to 72.14, the real change is 72.14 – 72.06 = +0.08, which rounds to +0.1, and the rounded numbers would show as 72.1 – 72.1 = 0.1. This is not an error.

Changes in the area of habitat where critical loads or critical levels are exceeded are always expressed in terms of absolute percentage of the total habitat area, not as a relative percentage change from the previous value, nor as an absolute percentage of total land area for the country. For example, if a habitat occupies 10% of the UK, a change from 40% to 30% of the habitat area being exceeded would be expressed as a decrease of 10% (i.e. 40 minus 30), not as a decrease of 25% (i.e. 100 x (40 – 30) / 40), nor as a decrease of 1% (i.e. 4% of UK area minus 3% of UK area).

Section 1. Pollutant deposition, critical loads, and exceedances

1.1 Overview of deposition and critical loads

Pollutant deposition rates, expressed for example in kg ha^{-1} yr^{-1}, are useful indicators of pressure on ecosystems (Rowe et al., 2017). However, ecosystems are considered able to withstand a certain amount of pollution, and this amount is expressed as the critical load. Critical loads are thus thresholds for effects from atmospheric deposition and are defined as "a quantitative estimate of the exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge" (Nilsson and Grennfelt, 1988).

The methods used to calculate and map UK critical loads are described in detail in Hall et al. (2015). Critical loads are calculated and mapped for UK habitats sensitive to acidification and/or eutrophication (Table 1.1). Here and in Section 2, results are presented for the entire mapped extent of habitats; results for designated sites are presented in Section 3. The critical load methods applied in the UK are based on methods approved at international workshops held under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and published in the "Mapping Manual" (CLRTAP, 2017).

A metric has been included to illustrate progress towards the aim of the UK Government's Clean Air Strategy (Defra, 2019), to develop a target to achieve a "reduction of damaging deposition of reactive forms of nitrogen by 17% over England's protected, priority, sensitive habitats by 2030". The metric is here defined as "total deposition of reactive N onto nutrient-N sensitive priority habitat", i.e. including priority habitat that is not within protected sites. Total N deposition does not take into account critical load, but is a readily-understood indicator of overall pressure on sensitive ecosystems. The baseline year against which the 17% reduction will be assessed is 2016. The derivation of this metric is discussed further in section 1.4.

The Devolved Administrations are considering whether to develop nitrogen deposition reduction targets for their own countries. Progress towards country-specific targets may be presented in future Trends Reports.

1.1.1 Habitat mapping

Until the Trends Report 2021 (Rowe et al., 2021), habitat distribution maps for exceedance calculations were based principally on the UKCEH Land Cover Map 2000 (LCM2000: Fuller et al., 2002) and additional data sets such as species distribution data and altitude. The habitat maps have now been updated and are now based principally on a more recent Land Cover Map, LCM2019, as described in Carnell et al. (2022). Montane habitat was not mapped in LCM2019, so the original map, based on altitude and latitude, was used for this habitat. A recent map of UK peat distribution (Evans et al., 2017) was used to apply distinct methods for woodland on peat and non-peat soils (see Section 1.1.2) and to refine the bog map. Areas mapped as bog but not occurring on peat were reassigned as wet heath. The update has resulted in some changes to the habitat categories used:

a) Managed and unmanaged broadleaved woodland are no longer distinguished, because the National Forest Inventory (GB) and Agri-Food and Biosciences Institute woodland register (Northern Ireland) no longer map these separately. However, even commercial forestry in the

UK is increasingly managed for multiple objectives. Exceedance of critical loads is likely to limit nature conservation value of any woodland, so it was considered appropriate to include all broadleaved woodland within the sensitive area.

b) Broadleaved woodland was mapped as priority habitat if it occurred within 10 x 10 km grid cells that according to the National Vegetation Classification (NVC) dataset contain H9190 or H91A0 woodland types (i.e. acidophilous oak woodland); or W12, W14 or W15 woodland types (i.e. beech woodland). For NVC squares that contained both beech woodland and oak woodland, it was assumed that 50 % of the Broadleaved woodland area was oak woodland and 50 % was beech woodland
c) Coniferous woodland in areas where scots pine is native was considered to be unmanaged. All coniferous woodland within 10 x 10 km grid cells in Scotland that according to the National Vegetation Classification (NVC) dataset contain W18 (*Pinus sylvestris–Hylocomium splendens* woodland) was mapped as unmanaged priority-habitat woodland, and assessed for exceedance of nutrient-N critical load separately from managed coniferous woodland. This approach presumably overestimates the area of scots pine woodland, but coniferous woodland within the native range of scots pine has the potential to become priority habitat and was treated as such. All coniferous woodland in grid cells where W18 does not occur was considered to be managed. Different critical loads for nutrient N were assigned to managed coniferous woodland and scots pine woodland. The same approach to calculating acidity critical load was used for both types of coniferous woodland.
d) Wet and dry heath are no longer mapped separately, since they have the same critical loads for acidity and for nutrient-N.

The changes to habitat mapping have increased the total mapped area of habitats sensitive to nutrient-N in the UK by 28 % (Figure 1.1).

a) **b)**

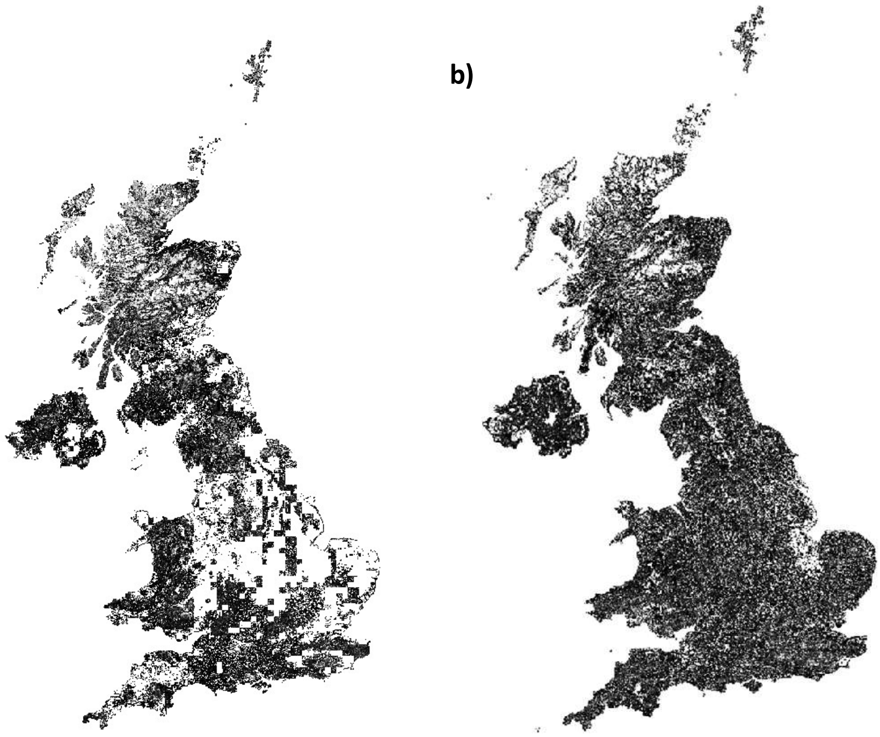

Figure 1.1. Areas of habitat sensitive to nutrient-nitrogen in the UK, as mapped using a) mainly LCM2000 data, as used for Trends Reports until 2021; and b) mainly LCM2019 data, as used for the current report.

It should be noted that the habitat distribution maps and areas used to calculate exceedances: a) only include areas where data exist for the calculation or derivation of critical loads; and b) may differ from other national habitat distribution maps or estimates of habitat areas.

Published correspondence tables (available from: http://jncc.defra.gov.uk/page-1425) are used to relate broad habitats to the European Nature Information System (EUNIS: Moss and Davies, 2002) hierarchical habitat classification scheme, developed for pan-European applications. The codes used for EUNIS habitats are those outlined in 2012, and will be updated to use the 2021 codes in a future report.

1.1: Habitat distributions mapped for acidity and for nutrient nitrogen critical loads. See section 1.4 for definition of N_{sens}.

Habitat	EUNIS habitat class(es) assigned[1]	Mapped for acidity	Mapped for nutrient-N	Included in N_{sens} calculation
Acid grassland	E1.7 & E3.52	Yes	Yes	Yes
Calcareous grassland	E1.26	Yes	Yes	Yes
Dwarf shrub heath	F4.11 & F4.2	Yes	Yes	Yes
Montane	E4.2	Yes	Yes	Yes
Bog	D1	Yes	Yes	Yes
Scots Pine woodland	G3.4	Yes	Yes	Yes
Managed coniferous woodland	G3	Yes	Yes	No
Beech woodland	G1.6	Yes	Yes	Yes
Acidophilous oak woodland	G1.8	Yes	Yes	Yes
Other broadleaved woodland	G1	Yes	Yes	Yes
Mixed woodland	G4	Yes	Yes	Yes
Freshwaters[2]	C1 & C2	Yes	No	No
Dune grassland	B1.4	No	Yes	Yes
Saltmarsh	A2.53/54/55	No	Yes	Yes

[1] EUNIS class (using 2012 EUNIS codes) closest to broad habitat and critical loads habitat; class used for assigning empirical nutrient nitrogen critical loads and for classifying UK critical loads data for submission to the CCE.

[2] Critical loads are calculated for 1752 freshwater sites across the UK (see Section 1.1.2); habitat areas are based on the catchment areas of these sites.

1.1.2 Acidity critical loads

Two methods are used in the UK for calculating acidity critical loads for terrestrial habitats: the empirical approach is used to provide estimates for non-woodland habitats on mineral and organomineral soils; and simple-mass-balance equations are used for woodland habitats and for habitats that occur on peat. The CLmaxS, CLmaxN and CLminN values that define the critical load function (see Figure 1.3) are derived from the acidity critical load value, taking into account the deposition of anthropogenic base cations and chloride, and inputs and losses of nitrogen (Hall et al., 2015).

In the empirical approach used for non-woodland habitats on mineral and organomineral soils, critical loads for acidity are assigned to each 1 x 1 km grid square of the UK based on the amount of acid deposition that could be neutralised by the base cations produced by mineral weathering of the dominant soil type in the grid square (Hornung et al., 1995).

For woodland habitats a simple mass balance (SMB) equation, based on balancing the acidic inputs to and outputs from the ecosystem, is used to derive a critical load that ensures that a specified critical chemical limit is not exceeded (Sverdrup and De Vries, 1994; Sverdrup et al., 1990). In the UK, the(Hall et al., 2015) limit used is a calcium to aluminium molar ratio of 1 (Hall et al., 2015). Below this value, aluminium has significant toxic effects. Critical loads are calculated for both managed (productive) and unmanaged woodlands to protect the long-term ecosystem function of these woodland habitats; this approach also aims to protect the land under managed coniferous forest for possible future non-forest use and reversion to semi-natural land uses.

A simpler mass balance approach is used for habitats on acid peat soils, because of the absence of inputs of alkalinity and of aluminium from mineral weathering (Gammack et al., 1995; Smith et al., 1992). Critical loads of acidity for peat soils are set to the value corresponding to the amount of acid deposition that would give rise to an effective rain pH value of 4.4 (Calver, 2003; Calver et al., 2004; Skiba and Cresser, 1989); the choice of threshold pH value reflects the buffering effects of organic acids on the pH of peat drainage water. This method is applicable to acid peat soils, but not to peats in lowland fen areas that receive mineral inputs from groundwater and are less sensitive to acidification, where a relatively high critical load of 4.0 keq ha^{-1} yr^{-1} is applied (Hall et al., 2015).

Acidity critical loads for freshwaters are calculated using the catchment-based First-Order Acidity Balance (FAB: Henriksen and Posch, 2001) model. FAB is currently applied to 1752 sites across the UK, comprising a mixture of mainly upland, lakes, reservoirs and first-order streams (i.e. streams that feed into other larger streams, but do not have any other streams draining into them). The critical load calculations are based on the water chemistry of samples collected in the 1990s to provide an estimate of the annual mean water chemistry. The FAB model generates the acidity critical load values CLmaxS, CLminN and CLmaxN (see Part 2).

1.1.3 Nutrient nitrogen critical loads

Both empirical and mass-balance methods can be used for calculating critical loads for eutrophication (i.e. an excess of nutrients, in this case N). Empirical critical loads are based on experimental or field evidence of thresholds for changes in species composition, plant growth, plant tissue chemistry or soil processes. The empirical approach is suited to semi-natural communities for which the long-term protection of biodiversity and/or ecosystem function is the key concern. In the UK, the empirical approach is applied to natural and semi-natural habitats, based on critical load values agreed at international workshops (Bobbink and Hettelingh, 2011; Hall et al., 2015). Managed and unmanaged broadleaved woodlands are not now distinguished (see Section 1.1.1), and empirical critical loads have been applied to all broadleaved woodlands. For managed coniferous woodland, a mass-balance approach was applied, taking into account the long-term inputs and outputs of N from the ecosystem, with the critical load being exceeded when a specified critical rate of N leaching is exceeded. This approach is suitable for managed ecosystems with relatively low biodiversity, in which the inputs and outputs can be quantified with some confidence and in which a key concern is nitrate leaching. As with acidity, in the UK this approach is applied to managed coniferous woodlands to ensure that long-term ecosystem functions (e.g. of soils, soil biological resources, trees, or linked aquatic systems) are protected.

1.2 Deposition data and trends

The S, N and base cation deposition data used in the UK calculations of critical loads and their exceedances are based on the “Concentration Based Estimated Deposition” (CBED) methodology (RoTAP, 2012). Site-based measurements of air concentrations of sulphur and nitrogen, as gases and particulates (Tang et al., 2018a; Tang et al., 2018b), are interpolated to generate 5 x 5 km maps of concentrations for the UK. Ion concentrations in precipitation from the UK Eutrophying and Acidifying Pollutants (UKEAP) network (Braban et al., 2021; Conolly et al., 2018) are combined with the Met Office annual precipitation map to generate maps of wet deposition. The wet deposition values include direct deposition of cloud droplets to vegetation (known as “occult” deposition), and orographic enhancement to take account of the “seeder-feeder” effect in upland regions (Fowler et al., 1988). A map of gaseous ammonia concentration is combined with spatially distributed estimates of vegetation-specific deposition velocities (Smith et al., 2000) to generate dry deposition. Combining these data sets produces 5 x 5 km maps of total (wet + cloud + dry) deposition of S (non-marine), oxidised N and reduced N. Two different sets of deposition values are calculated for critical load and exceedance applications: i) deposition onto “moorland”, i.e. unfertilised open (non-wooded) habitats; and ii) deposition onto “woodland”, which has greater deposition velocities due to the greater roughness of the land surface.

For previous Trends Reports, the gaseous ammonia map was calculated using the UK Fine Resolution Atmospheric Multi-pollutant Exchange (FRAME) model. For the deposition estimates used in the current report, the spatial distribution of gaseous ammonia was derived from the European Monitoring and Evaluation Programme (EMEP) model. The change of model for ammonia concentration is discussed in more detail in Section 4.2.

Significant inter-annual variations in deposition can occur due to the natural variability in annual precipitation (which influences wet deposition) as well as the general circulation of air which can increase or decrease the amount of polluted air imported from the European continent. The CBED deposition data used to calculate critical load exceedances is therefore averaged over a three-year period; this has been demonstrated to be a suitable time period to smooth out inter-annual variations in deposition. Figure 1.1 shows the CBED data for 2018-20.

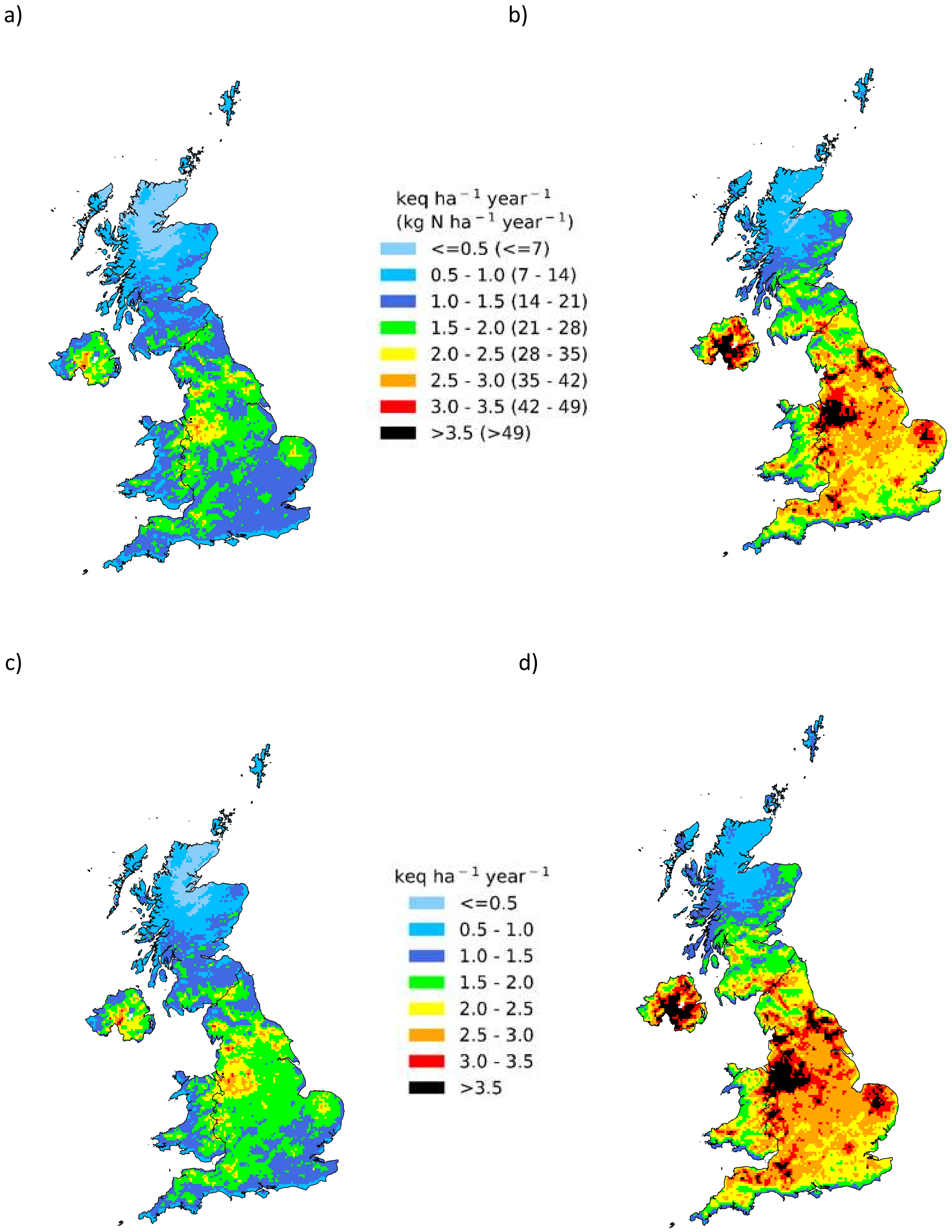

Figure 1.2: CBED deposition for 2018-2020: a) nitrogen (oxidised plus reduced) deposition to moorland; b) nitrogen (oxidised plus reduced) deposition to woodland; c) acid (sulphur + nitrogen) deposition to moorland; d) acid (sulphur + nitrogen) deposition to woodland. Deposition is mapped for N and acidity using the same units (keq ha^{-1} yr^{-1}) and class intervals. For the N maps, deposition rates are also shown in kg N ha^{-1} yr^{-1}.

Since critical loads for terrestrial habitats are mapped on a 1 km grid, for exceedance calculations deposition is assumed to be constant for all 1 km squares within each 5 km square. For freshwater exceedance calculations catchment-weighted mean S and N deposition values are calculated by overlaying land cover (moorland *vs*. forest) and catchment boundaries onto the 5 km deposition maps.

1.2.1 Summary of trends in CBED deposition

To understand trends in critical load exceedances, it is useful to look at trends in deposition. Deposition estimates using CBED deposition data derived from the FRAME map for ammonia exist for all 3-year rolling intervals from 2002 to 2018 (reminder: the 3-year time periods are referred to in brief using the *middle year* of the period), plus data for three earlier time periods: 1995-1997, 1998-2000 and 1999-2001. The CBED deposition data derived from the EMEP map for ammonia are available from 2010 to 2020. These trends in CBED deposition to moorland and to woodland using alternative ammonia concentration models are summarised in Figure 1.2. Deposition onto woodland is higher than that onto moorland due to greater deposition velocities of gases (e.g. NH_3 and HNO_3), as well as particulates, onto tall vegetation. Grid-average deposition[1] of non-marine S (NMS) for the UK decreased by 5% over the study period from 2010 to 2019.

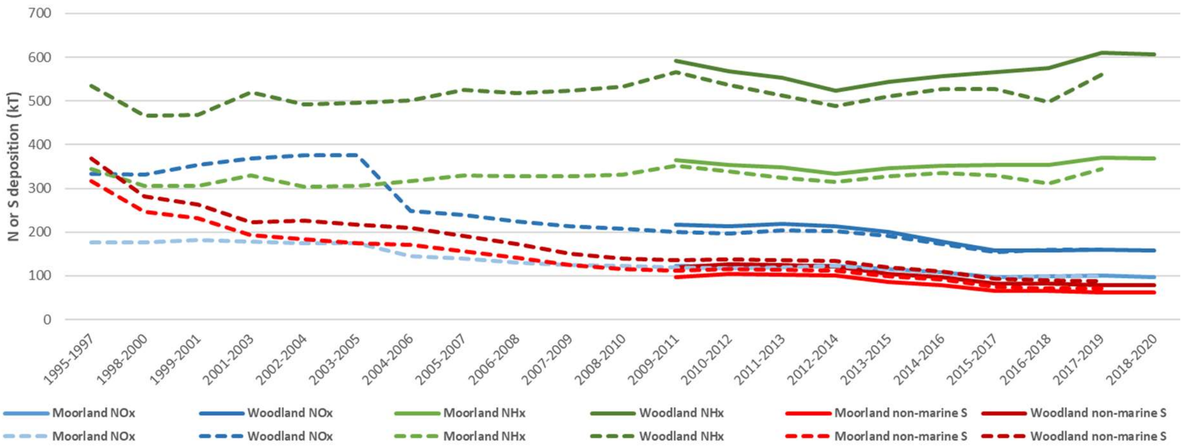

Figure 1.3: Deposition budgets (kilotonnes S or N per year) calculated by CBED using ammonia concentration maps from FRAME (dashed lines) or EMEP (solid lines) assuming UK area is a) woodland or b) moorland or other unfertilised open habitat. NMS = non-marine sulphur, NOx = oxidised nitrogen, NHx = reduced nitrogen. Some changes to the methods used for FRAME calculations were made during the period shown – see Rowe et al. (2021) for details.

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[1] Grid-average deposition is deposition weighted by the amounts of woodland, urban land, arable, fertilised grassland and unfertilised open vegetation (termed "moorland") within each grid cell. Arable and fertilised grassland are net emitters of ammonia, so grid-average deposition may be negative. See Hall et al. (2015).

1.3 Overview of the calculation of critical load exceedances

Critical load exceedances are the amount of excess deposition above the critical load; for nutrient N the calculation is simply total N deposition (derived from N oxides and ammonia) minus the critical load. For acidification, deposition of both S and N compounds can contribute to the exceedance of critical loads. The Critical Load Function, developed under the UNECE CLRTAP (Hettelingh et al., 1995; Posch et al., 1999; Posch et al., 1995; Posch and Hettelingh, 1997), defines combinations of S and N deposition that will not cause harmful effects. In its simplest form, an acidity critical load can be defined graphically by a 45 degree diagonal line on a sulphur-nitrogen deposition plot (Figure 1.3a), where both types of deposition are expressed in chemical equivalents, i.e. moles of charge. The line intercepts the x-axis (representing N deposition) and y-axis (representing S deposition) at the same value in equivalents, each representing the N or S deposition equal to the critical load for acidity. Each point along the diagonal line represents the critical load in terms of some combination of S and N deposition.

To allow for the long-term N removal processes by the soil and through harvesting of vegetation, the simple diagonal line is shifted along the N axis to increase the N values across the entire Critical Load Function (Figure 1.3b). More N can then be deposited before the acidity critical load is exceeded. There are no similar removal processes that need to be considered for S.

The intercepts of the Critical Load Function on the S and N axes (Figure 1.3c) define the following terms:

1. The "maximum critical load of S" (CLmaxS): the critical load for acidity expressed in terms of S only, i.e. when N deposition is zero.
2. The "maximum critical load of N" (CLmaxN): the critical load for acidity expressed in terms of N only (when S deposition is zero).
3. The "minimum critical load of N" (CLminN): represents long-term N removal processes in the soil (e.g. N uptake and immobilisation) and harvesting of vegetation.

These critical loads are calculated from the acidity critical loads described in Section 1.1 and additional soil-specific or habitat-specific data.

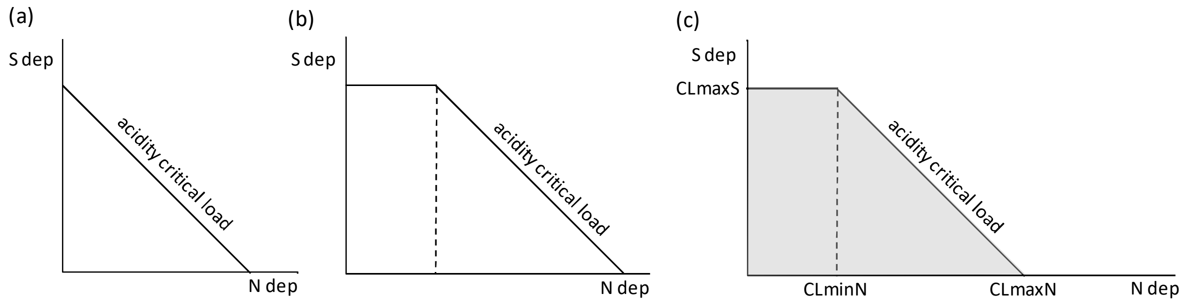


Figure 1.4: Development of the Critical Load Function: a) acidity critical load defined by equal amounts of sulphur and nitrogen deposition; b) shifting the acidity critical load diagonal line to allow for nitrogen removal processes; c) the 3 intercepts of the Critical Load Function: CLmaxS, CLminN and CLmaxN. The area shown in grey represents the combinations of sulphur and nitrogen deposition that are below the critical load (i.e. critical load is not exceeded).

Exceedances are calculated by comparing the values of CLmaxS, CLminN and CLmaxN to the values of S and N (oxidised + reduced) deposition. The actual calculation depends on where the deposition falls in relation to these critical load values; the Critical Load Function is divided into five different regions for this purpose (Figure 1.4). The exceedance is defined by the sum of S and N deposition as shown by the red arrows in Figure 1.4 (i.e. not the length of the diagonal line); this is referred to as the "shortest distance" exceedance. Further details of the calculations are given in Hall et al. (2015).

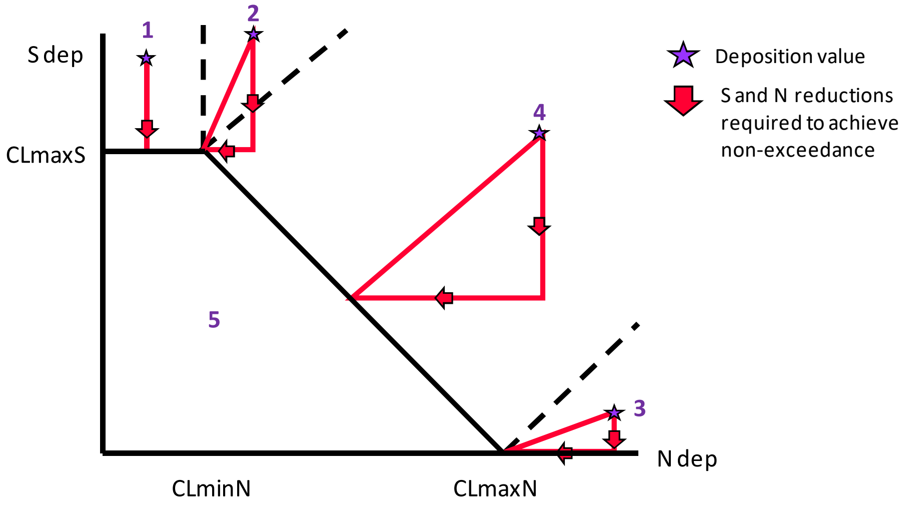


Figure 1.5: Example of S and N deposition reductions required depending on the region of the CLF. Deposition that falls in region 5 is below the critical load (i.e. critical loads not exceeded).

1.3.1 Exceedance and damage

The critical loads data on which exceedance calculations are based are derived from empirical or steady-state mass balance methods, which are used to define critical loads for the long term. Exceedance of critical loads is an indication that an ecosystem is at risk from potential harmful effects in the long-term. Therefore, exceedance is not a quantitative estimate of damage to the environment; it does not necessarily mean that harmful or adverse effects have already occurred or may be observed, but that there is a risk of damage in the long-term. Reducing deposition to below the critical load does not mean that ecosystems immediately recover. There are time lags before chemical recovery takes place, and further delays before biological recovery. Timescales for both chemical and biological recovery could be very long, particularly for the most sensitive ecosystems.

1.3.2 Critical load exceedance metrics

Critical load exceedances are calculated for each 1km square of the distributions of each terrestrial habitat, and for each catchment for freshwaters. The results are then summarised by habitat and country using the following exceedance metrics:

(i) Area of habitat exceeded

For terrestrial habitats, the area values are based on habitat maps mainly derived from LCM2019 data; if the critical load for any individual habitat is exceeded, the exceeded area is set to the habitat area within the 1km square for that particular habitat. For freshwater habitats, if the FAB acidity critical load is exceeded, the whole catchment is assumed to be exceeded and the exceeded area set to the catchment area. The total exceeded areas for individual habitats are summarised by country. Freshwater catchment areas are not included when calculating total area exceeded for acidity per country, to avoid double-counting of the areas of sensitive habitat within these catchments.

(ii) Percentage area of habitat exceeded

This is calculated from the exceeded areas derived in (i) and the total area of each habitat mapped in each country (Section 1.1). While this is a useful metric for expressing how much habitat is at risk, it does not clearly reflect decreases in the amount of exceedance. For example, when comparing exceedance results from one year to another (or one deposition scenario to another), there may be only small changes in the percentage area of habitat exceeded, particularly in regions with high deposition. This is because the magnitude of the exceedance may have reduced, but the area exceeding the critical load remains the same; the area exceeded will only reduce when the critical load is no longer exceeded. Even when the critical load is still exceeded, decreases in the amount of exceedance are likely to have some benefits (Rowe et al., 2017).

(iii) Accumulated Exceedance (AE)

AE takes account of both the magnitude of exceedance and the habitat area exceeded:

AE (keq year^{-1}) = exceedance (keq ha^{-1} year^{-1}) × exceeded area (ha)

AE is calculated for each 1km square for each habitat and then summarised by habitat and country. AE is set to zero where critical loads are not exceeded. This metric can be useful for comparing results for different years or scenarios, but because the results are expressed in as totals for the country (in keq year^{-1}) they are large numbers and not intuitive to understand. It should also be noted that the same AE can arise from a large exceedance and small exceeded area, or a small exceedance and a large area.

(iv) Average Accumulated Exceedance (AAE)

AAE averages the AE across the entire sensitive habitat area:

AAE (keq ha^{-1} year^{-1}) = AE (keq year^{-1}) / total sensitive habitat area (ha)

In this report we use the terms "Excess Nitrogen" as a synonym for the AAE of nutrient-N critical loads and "Excess Acidity" as a synonym for the AAE of acidity critical loads. This metric provides an exceedance value averaged across the whole habitat area. In the summary statistics presented (Section 2) it is based on the AE for the habitat (by country) divided by the total sensitive habitat area (by country). AAE is set to zero where critical loads are not exceeded. This metric provides a more intuitive value for comparing the exceedance results for different years or scenarios, and gives an indication of the reduction in the magnitude of exceedance even if there is no change in the percentage area of habitat exceeded.

1.3.3 Overall maps of critical load exceedance

Critical load exceedances are calculated by habitat, which can make it hard to interpret maps of exceedance. The AAE (Excess Nitrogen or Excess Acidity) is an area-weighted measure of exceedances across habitats (Figure 1.5). The AAE for each 1km square is calculated as:

$$\text{AAE} = \frac{\sum \text{AE for all habitats}}{\sum \text{Area for all habitats}}$$

Where AE is the area exceeded. AE and AAE are set to zero where the critical loads are not exceeded.

The latest Excess Nitrogen and Excess Acidity maps (Figure 1.5) show lower exceedances in Scotland. The greatest Excess Acidity values are seen in upland areas of central and NW England, and smaller areas in E and SW England, parts of Wales, southern Scotland, and Northern Ireland. Exceedances of nutrient N critical loads are seen across most of England, Wales and Northern Ireland, with many areas having exceedances above 14 kg N ha^{-1} $year^{-1}$ (1 keq ha^{-1} $year^{-1}$).

1.4 Calculation of N deposition onto protected sensitive habitats in England

The Defra Clean Air Strategy (Defra, 2019) includes an indicator for England, "total deposition of reactive N onto nutrient-N sensitive, protected, priority habitats" (N_{sens}). This metric is calculated as the area-weighted mean deposition (sum of oxidised and reduced N) in kg N ha^{-1} yr^{-1} (Equation 1).

$$N_{sens} = \frac{\sum_{i=1}^{n} A_i D_i}{\sum_{i=1}^{n} A_i} \qquad \text{(Equation 1)}$$

Where *n* is the number of habitats included in the calculation, *A* is the total area of each habitat, and *D* is the total N deposition onto each habitat.

The priority habitats included in this calculation are a subset of the habitats listed in Table 1.1, as indicated in that table. Deciduous woodland and mixed woodland were included, but not managed coniferous woodland (see Section 1.1).

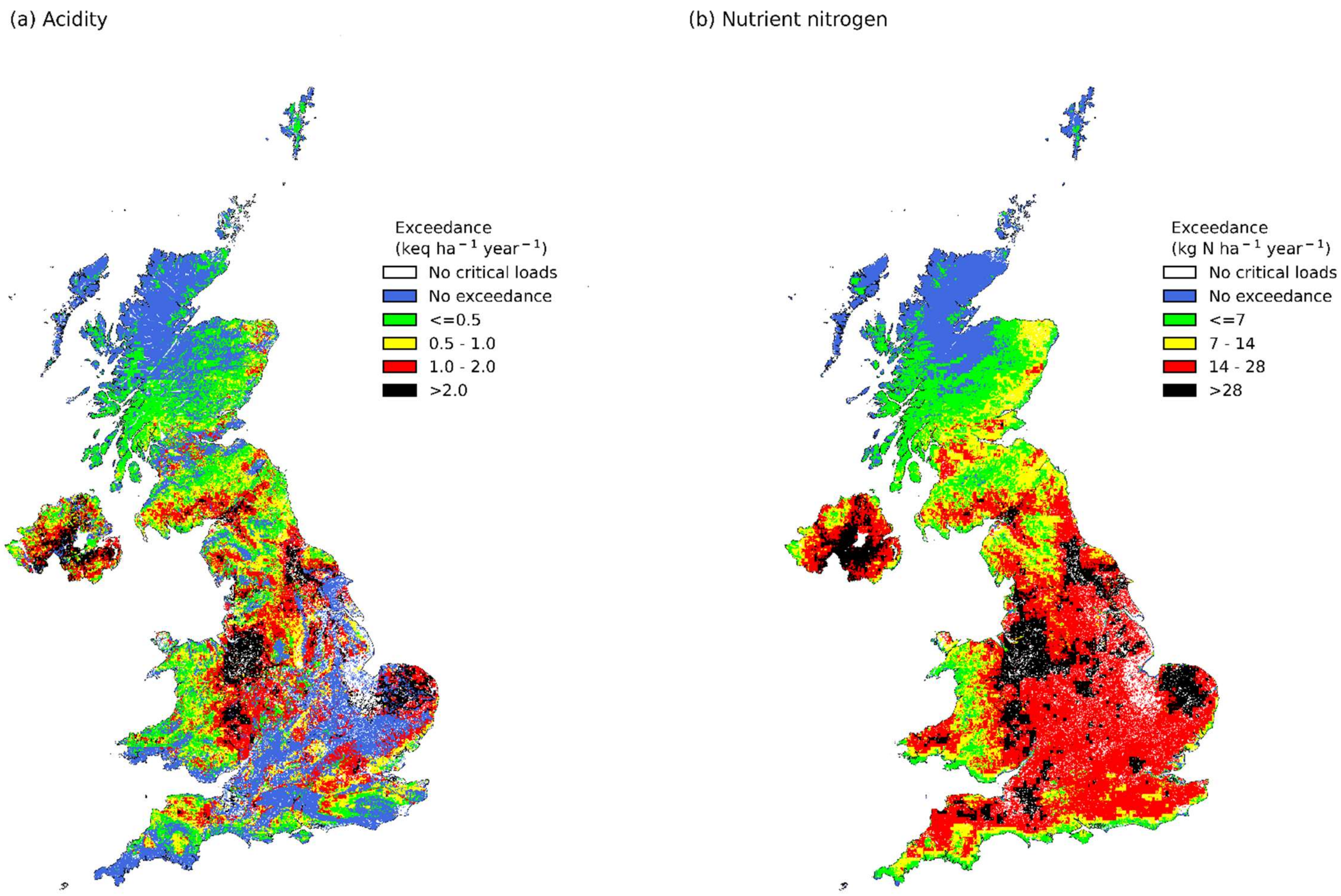

(a) Acidity
Exceedance
(keq ha⁻¹ year⁻¹)
No critical loads
No exceedance
<=0.5
0.5 - 1.0
1.0 - 2.0
>2.0
(b) Nutrient nitrogen
Exceedance
(kg N ha⁻¹ year⁻¹)
No critical loads
No exceedance
<=7
7 - 14
14 - 28
>28

Figure 1.6: a) Excess Acidity (Average Accumulated Exceedance of acidity critical load) and b) Excess Nitrogen (Average Accumulated Exceedance of nutrient-nitrogen critical load) in 2018-20. Although the legends for the two maps are given in different units, the class intervals are the same (e.g. 7 kg N ha^{-1} $year^{-1}$ is equal to 0.5 keq ha^{-1} $year^{-1}$).

Section 2: Trends in critical loads exceedance by habitat and country

The data used for the trends analysis are described in Section 1. Acidity and nutrient N exceedances by habitat and country are updated annually using the latest three-year rolling mean deposition data. The summary statistics as described in Section 1.3.1 are made available to Defra and the Devolved Administrations and JNCC. Trends in the percentage area of habitats exceeded are also included in the annual summary of UK Biodiversity Indicators (https://jncc.gov.uk/our-work/ukbi-b5a-air-pollution).

The trends results are shown as both tables and simple plots. It is worth noting that the percentage area exceeded for some habitats changes only gradually from one year to another, whereas AAE values (Excess Nitrogen and Excess Acidity) are more responsive to changes in deposition.

2.1 Trends by country

Table 2.1 shows the total land area by country and the area of habitats sensitive to acidification and eutrophication to which critical loads have been applied; 36% of the UK land area has habitats mapped for acidity critical loads, and 38% for nutrient N. Freshwater habitats are also mapped for acidity, but statistics are reported separately.

Table 2.1: Total land area and terrestrial habitat areas mapped for critical loads by country.

Country	Land area (km^2)#	Terrestrial habitat areas mapped for acidity (km^2)	Area mapped for acidity, as % of country	Terrestrial habitat areas mapped for nutrient nitrogen (km^2)	Area mapped for nutrient nitrogen, as % of country
England	132,938	23,429	18	26,038	20
Wales	21,225	9,075	43	9,412	44
Scotland	80,239	54,512	68	54,333	68
NI	14,130	3,527	25	3,990	28
UK	248,532	90,543	36	93,774	38

The UK and its countries: facts and figures. Office for National Statistics:

http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/administrative/the-countries-of-the-uk/index.html

2.1.1 Acidity results

The results for acidity (Table 2.2, Figure 2.1) show that the total percentage area of terrestrial habitats exceeding critical loads in the UK declined by 10.5%, from 63.4% in 2010 to 52.9% in 2019. However, the area exceeded varies between countries (Table 2.2, Figure 2.2), due to: a) geographic location of different sensitive habitats across the country (see Section 2.2); b) variability in critical load values across the country – lower critical loads associated with habitats on more acid soils; and c) higher deposition found in central and south-west England, parts of Wales and Northern Ireland and south-west Scotland (Figure 1.1). The percentage area of habitats exceeded is lowest in Scotland in all years; however as shown in Table 2.1, 68% of Scotland has habitats mapped for acidity critical loads, and that means the actual areas exceeded are larger than in the other countries (e.g. 20,810 km^2 exceeded by 2019 deposition). Although only 18% of England has habitats mapped for acidity critical loads, 72.9% of their area is exceeded for 2019, equivalent to 17,082 km^2. The magnitude of exceedance across the UK, expressed as AAE (Table 2.3, Figure 2.1), has fallen from 0.60 keq ha^{-1} $year^{-1}$ in 2010 to 0.44 keq ha^{-1} $year^{-1}$ in 2019.

Table 2.2: Acid-sensitive terrestrial habitat area and percentage area of habitats where acidity critical loads are exceeded, by country and deposition dataset year. Areas include freshwater catchments, which are likely to include overlaps with terrestrial acid-sensitive habitats.

	England	Wales	Scotland	NI	UK
	Total area (km^2) acid-sensitive habitats				
	23429	*9075*	*54512*	*3527*	*90543*
	Percentage acid-sensitive habitat area exceeded by country				
2009-2011	75.9	82.0	53.5	85.9	63.4
2010-2012	75.6	81.7	51.4	85.1	62.0
2011-2013	75.5	82.5	53.5	84.5	63.3
2012-2014	74.4	80.3	52.5	83.5	62.1
2013-2015	74.2	80.9	55.6	82.7	64.0
2014-2016	73.4	81.2	53.0	81.9	62.2
2015-2017	72.1	79.2	46.3	80.6	57.6
2016-2018	72.1	78.1	39.0	82.5	53.2
2017-2019	72.7	77.8	38.4	84.6	53.0
2018-2020	72.9	77.7	38.2	84.2	52.9
Reduction in % area exceeded, 2010-2019	2.9	4.2	15.3	1.7	10.5

Table 2.3: Excess Acidity (Average Accumulated Exceedance in keq ha^{-1} year^{-1}) by country and deposition dataset year.

	England	Wales	Scotland	NI	UK
	AAE (keq ha^{-1} year^{-1}) by country				
2009-2011	1.05	0.75	0.34	1.19	0.60
2010-2012	1.02	0.76	0.33	1.12	0.58
2011-2013	1.01	0.80	0.34	1.10	0.59
2012-2014	0.93	0.75	0.32	1.00	0.55
2013-2015	0.92	0.79	0.36	0.96	0.57
2014-2016	0.89	0.80	0.32	0.91	0.54
2015-2017	0.81	0.70	0.25	0.88	0.46
2016-2018	0.81	0.64	0.20	0.97	0.43
2017-2019	0.84	0.60	0.20	1.08	0.44
2018-2020	0.84	0.61	0.19	1.07	0.44
Reduction in AAE, 2010-2019	0.21	0.14	0.15	0.12	0.16

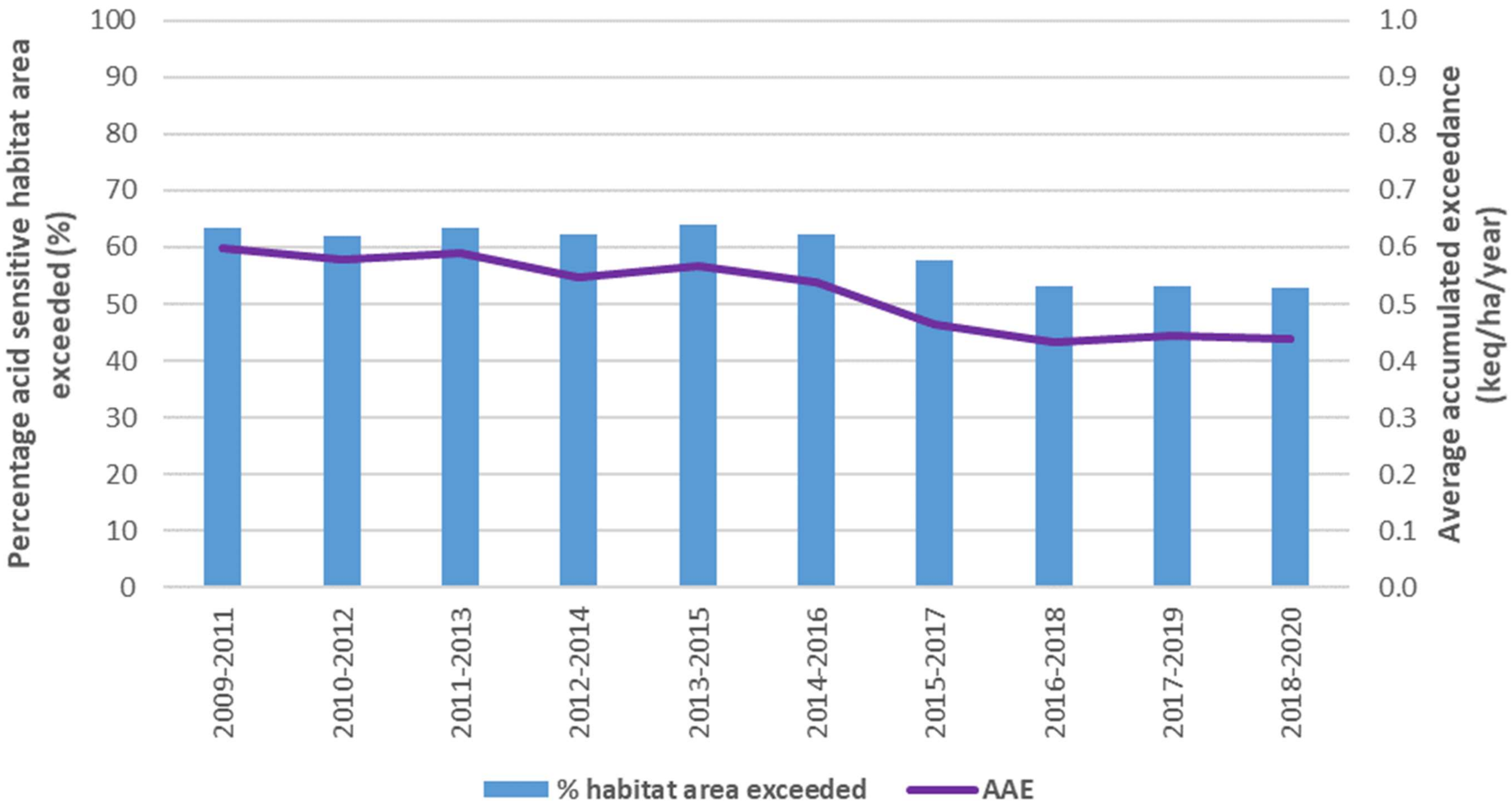


Figure 2.1: Acidity: Percentage area of acid-sensitive habitats with exceedance of acidity critical loads in the UK by year, and Average Accumulated Exceedance in keq ha^{-1} year^{-1}.

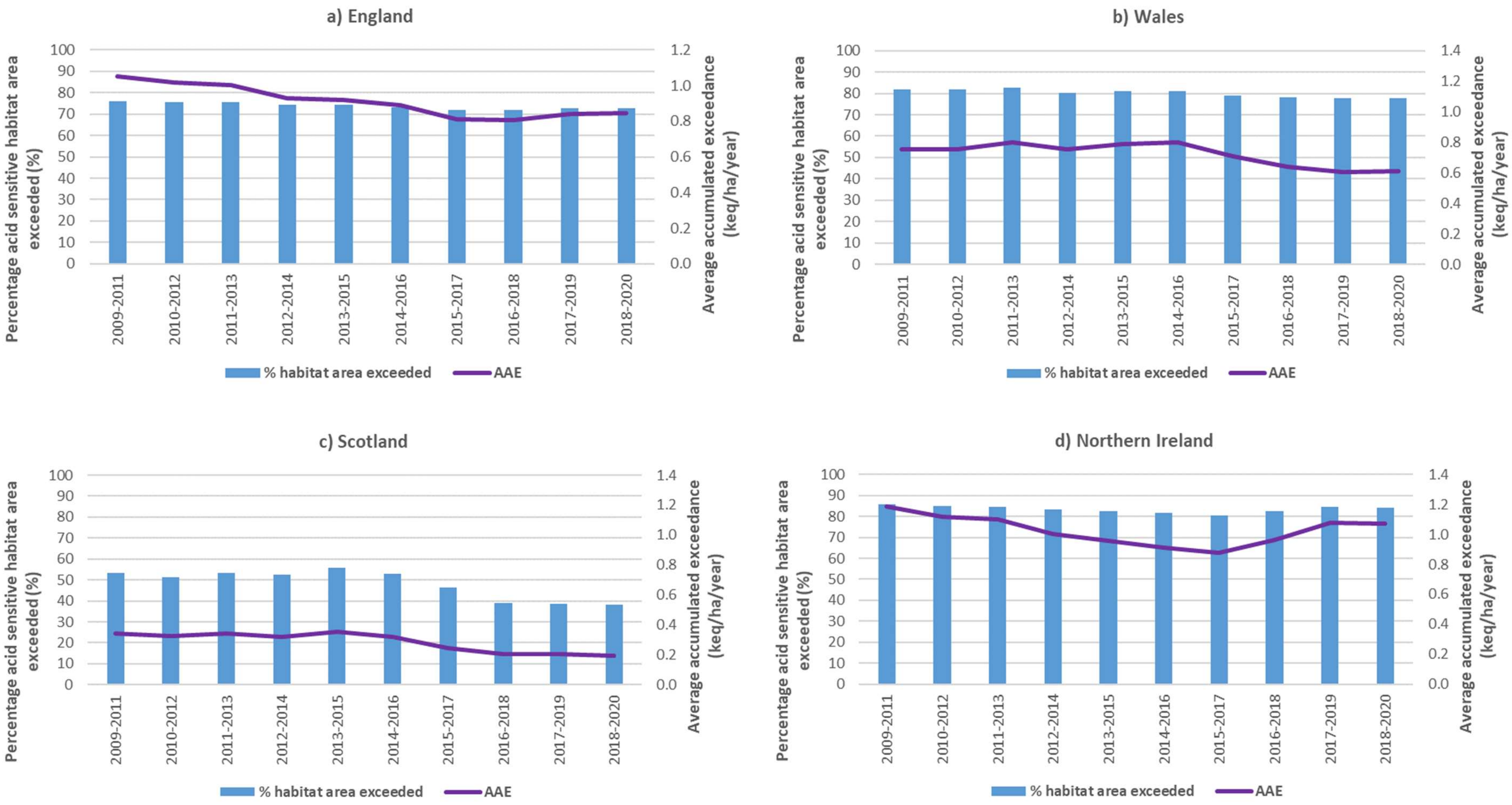


Figure 2.2: Acidity: Percentage area of acid-sensitive habitats with exceedance of acidity critical loads, by country and year, and Excess Acidity (Average Accumulated Exceedance in keq ha^{-1} year^{-1}).

2.1.2 Nutrient nitrogen results

The results for nutrient N (Table 2.4 and Figure 2.3) show a decline in the percentage area of habitats exceeded in the UK, from 74.4% in 2010 to 67.7% in 2019. The results for England, Wales and Northern Ireland remain above 90% exceeded over the same time period (Table 2.4, Figure 2.4). Scotland shows the smallest percentage habitat area exceeded of all countries, but the area exceeded (25,525 km^2 in 2019) is similar to the area exceeded in England (25,250 km^2 in 2019).

Table 2.4: Nitrogen-sensitive habitat area and percentage area of habitats where nutrient nitrogen critical loads are exceeded, by country and deposition dataset year.

	England	Wales	Scotland	NI	UK
	Total area (km^2) nitrogen-sensitive habitats				
	26,038	*9,412*	*54,333*	*3,990*	*93,774*
	Percentage habitat area where CLnutN is exceeded				
2009-2011	97.3	96.6	57.8	99.1	74.4
2010-2012	97.3	96.6	54.6	98.9	72.5
2011-2013	97.2	97.1	57.9	99.1	74.5
2012-2014	97.0	96.5	55.9	99.0	73.2
2013-2015	97.1	96.9	60.0	98.7	75.6
2014-2016	97.0	97.3	58.1	98.6	74.5
2015-2017	96.7	96.9	53.2	98.3	71.6
2016-2018	96.8	96.0	47.8	98.6	68.4
2017-2019	96.9	94.5	47.6	98.6	68.1
2018-2020	97.0	93.1	47.0	98.6	67.7
Reduction in % area exceeded, 2010-2019	0.4	3.5	10.8	0.5	6.7

The magnitude of the nutrient-nitrogen exceedance (expressed as Excess Nitrogen or AAE) across the UK has decreased , from 10.1 kg N ha^{-1} year^{-1} in 2010 to 8.8 kg N ha^{-1} year^{-1} in 2019 (Table 2.5, Figure 2.3). Excess Nitrogen varied among regions, with lowest values in Scotland and highest in Northern Ireland (Table 2.5, Figure 2.4).

Table 2.5: Nutrient nitrogen: Excess Nitrogen (Average Accumulated Exceedance in kg N ha^{-1} year^{-1}), by country and deposition dataset year.

	England	Wales	Scotland	NI	UK
	AAE (kg N ha^{-1} year^{-1}) by country				
2009-2011	19.5	12.6	4.5	19.7	10.1
2010-2012	18.6	12.3	4.3	18.4	9.6
2011-2013	18.2	12.8	4.5	18.2	9.7
2012-2014	17.0	12.0	4.2	16.7	9.1
2013-2015	17.3	12.9	4.8	16.3	9.6

2014-2016	17.2	13.4	4.5	15.6	9.4
2015-2017	16.6	12.4	3.7	15.5	8.7
2016-2018	16.9	11.4	3.2	17.0	8.4
2017-2019	17.8	11.2	3.4	19.0	8.8
2018-2020	17.8	11.5	3.2	18.8	8.8
Reduction (kg N ha^{-1} yr^{-1}) in AAE 2010-2019	1.7	1.1	1.3	0.9	1.4

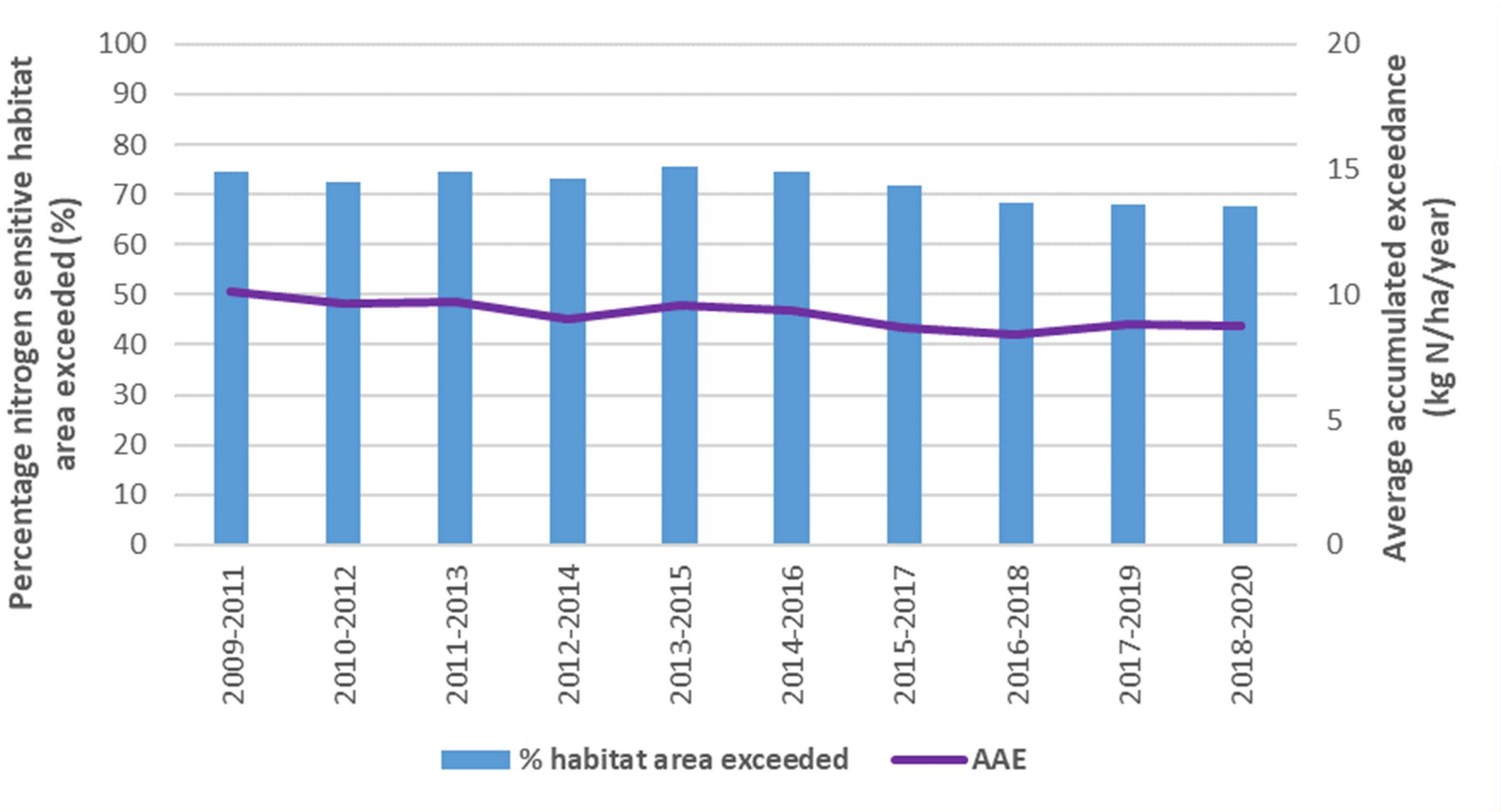


Figure 2.3: Nutrient nitrogen: Percentage area of nitrogen-sensitive habitats with exceedance of nitrogen critical loads in the UK by year, and Excess Nitrogen (Average Accumulated Exceedance in kg N ha^{-1} year^{-1}).

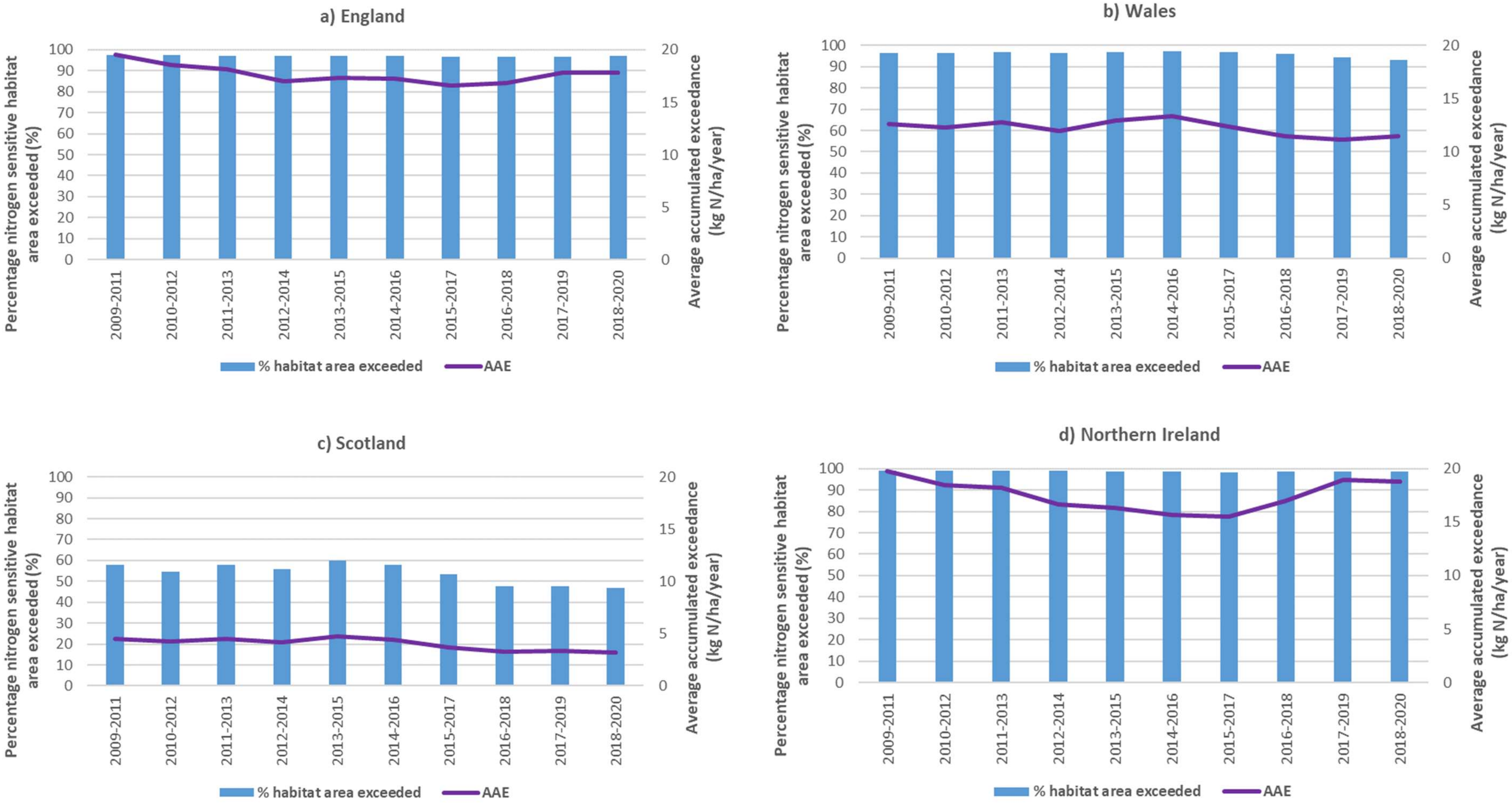


Figure 2.4: Nutrient nitrogen: Percentage area of nitrogen-sensitive habitats with exceedance of nitrogen critical loads, by country and year, and Excess Nitrogen (Average Accumulated Exceedance in kg N ha^{-1} year^{-1}).

2.2 Trends by habitat

This section focuses on the results by habitat for the UK. Habitat results for individual countries are also calculated and tabulated in the Annexe to this report.

2.2.1 Acidity results

The habitats with the highest percentage area where acidity critical load was exceeded are acid grassland and mixed woodlands (Table 2.6, Figure 2.5); these habitats also have some of the highest AAE values (Table 2.7, Figure 2.5). Acidity critical load was exceeded over relatively small areas of calcareous grassland, declining from 14.1% in 2010 to 9.5% in 2019 (Table 2.6), with correspondingly small AAE values (Table 2.7). Montane habitat shows the largest decrease in the area exceeded, from 86.3% (4,242 km^2) in 2010 to 56.2% (2,764 km^2) in 2019. The largest reductions in AAE over the same timescale are for acid grassland and montane habitats (Table 2.7).

2.2.2 Nutrient nitrogen results

There are seven habitats with more than 80% of their area exceeded for nutrient N in all years from 2010 to 2019 (Table 2.8, Figure 2.6): Calcareous grasslands, and several woodland habitats (beech, oak, broadleaved and mixed woodland). Beech woodland is >99% exceeded in all years. The largest reduction in the percentage area exceeded is for scots pine woodland from 57.0% in 2010 to 35.9% in 2019. AAE is generally highest for the woodland habitats (Table 2.9, Figure 2.6), with the exception of scots pine woodland, which is only found natively in Scotland where the magnitude of exceedance is generally lower due to the lower deposition in this region.

Table 2.6: Acid-sensitive habitat areas in the UK and percentage area of habitats where acidity critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland (unmanaged)	Fresh-waters	All habitats
Habitat area (km^2)	*20,365*	*1,012*	*21,846*	*9,118*	*4,915*	*15,935*	*17,354*	*7856*	*90,543*
	Percentage habitat area where acidity critical load is exceeded								
2009-2011	83.2	14.1	30.6	55.8	86.3	82.7	64.0	24.7	63.4
2010-2012	81.3	14.1	29.7	55.2	83.0	81.5	62.6	24.7	62.0
2011-2013	84.1	14.0	29.9	53.3	89.3	83.3	63.6	25.2	63.3
2012-2014	83.0	13.6	29.6	53.3	87.8	81.6	61.1	24.6	62.1
2013-2015	85.4	13.5	31.5	55.5	93.5	82.8	61.7	25.5	64.0
2014-2016	84.2	13.3	29.9	52.1	91.6	80.6	60.3	25.0	62.2
2015-2017	80.4	9.9	24.0	47.2	83.4	75.8	57.5	23.2	57.6
2016-2018	74.8	9.7	22.1	45.4	61.4	70.7	55.1	19.1	53.2
2017-2019	74.0	10.1	22.1	45.4	56.9	71.4	56.1	18.4	53.0
2018-2020	74.7	9.5	21.6	43.9	56.2	71.6	56.0	17.8	52.9
Reduction in % area exceeded, 2010-2019	8.5	4.6	9.1	11.9	30.1	11.1	7.9	6.9	10.5

Table 2.7: Excess Acidity (Average Accumulated Exceedance in keq ha^{-1} $year^{-1}$) by habitat for the UK by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland (unmanaged)	Fresh-waters	All habitats
	AAE (keq ha^{-1} $year^{-1}$) by habitat								
2009-2011	0.71	0.09	0.20	0.49	0.58	0.95	0.74	0.25	0.60
2010-2012	0.71	0.08	0.19	0.48	0.54	0.91	0.70	0.25	0.58
2011-2013	0.75	0.08	0.19	0.50	0.58	0.94	0.68	0.26	0.59
2012-2014	0.71	0.08	0.17	0.46	0.56	0.86	0.61	0.25	0.55
2013-2015	0.76	0.08	0.17	0.47	0.67	0.88	0.60	0.25	0.57
2014-2016	0.73	0.07	0.16	0.44	0.61	0.82	0.58	0.25	0.54
2015-2017	0.61	0.05	0.13	0.37	0.44	0.73	0.54	0.21	0.46
2016-2018	0.53	0.04	0.13	0.35	0.29	0.70	0.57	0.18	0.43
2017-2019	0.50	0.05	0.13	0.36	0.26	0.73	0.62	0.17	0.44
2018-2020	0.50	0.04	0.13	0.35	0.24	0.73	0.61	0.16	0.44
Reduction in AAE, 2010-2019	0.21	0.05	0.07	0.14	0.34	0.22	0.13	0.09	0.16

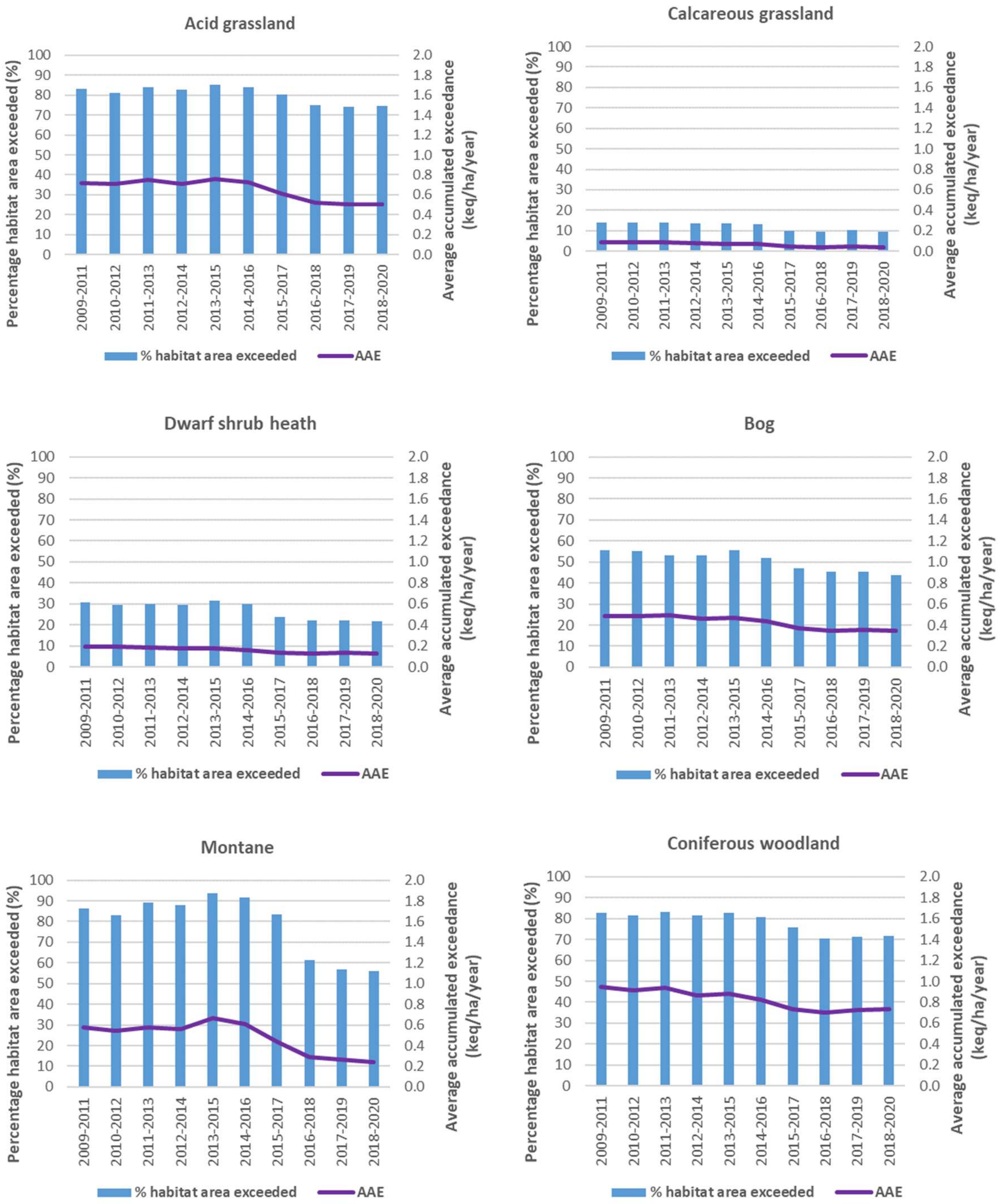
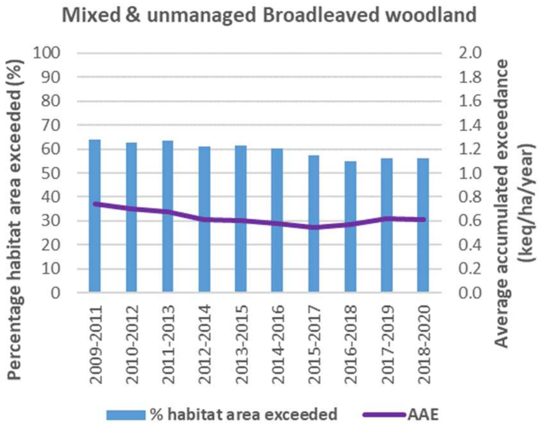


Figure 2.5: Acidity: Percentage area of habitats where acidity critical loads are exceeded, and Excess Acidity (AAE in keq ha^{-1} year^{-1}) for the UK by deposition dataset year.



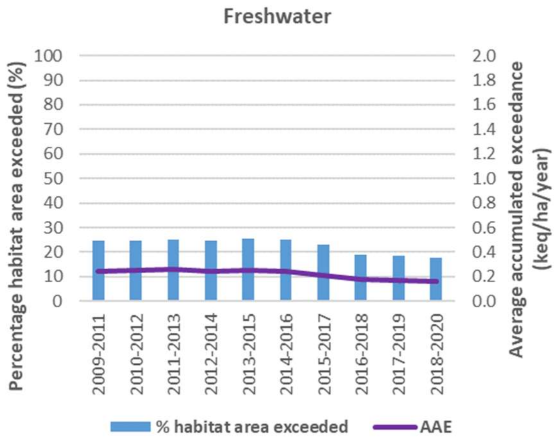


Figure 2.5 (continued): Acidity: Percentage area of habitats where acidity critical loads are exceeded, and Excess Acidity (AAE in keq ha^{-1} year^{-1}) for the UK by deposition dataset year.

Table 2.8: Nutrient-sensitive habitat area in the UK and percentage area of habitats where nutrient-nitrogen critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland (managed)	Other broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh
Habitat area (km²)	*20,365*	*1,012*	*21,846*	*9,118*	*4,915*	*14,450*	*8,706*	*2,059*	*6,958*	*1,485*	*1,422*	*632*	*808*
	Percentage habitat area where nutrient-nitrogen critical load is exceeded												
2009-2011	78.2	89.8	47.7	49.9	98.6	92.0	96.9	100.0	97.2	57.0	96.1	46.7	7.9
2010-2012	76.6	89.8	44.2	47.9	97.0	90.6	96.6	100.0	96.1	51.5	95.3	45.5	7.7
2011-2013	78.6	89.3	46.8	49.4	99.3	92.7	97.0	100.0	97.7	63.3	96.8	40.9	6.7
2012-2014	77.4	89.1	45.9	48.3	98.4	90.6	96.7	100.0	96.3	54.2	95.8	36.8	3.4
2013-2015	81.1	89.4	50.0	49.0	99.7	92.2	97.0	100.0	97.4	64.9	96.9	36.9	5.1
2014-2016	80.5	89.4	49.4	46.5	99.6	90.2	96.6	100.0	96.3	56.5	96.1	35.7	3.4
2015-2017	76.0	89.4	44.1	44.8	98.7	88.8	96.3	99.7	95.3	44.8	95.3	34.6	3.8
2016-2018	72.1	89.4	40.0	44.5	87.2	86.4	95.9	99.6	93.3	35.0	93.7	35.3	4.6
2017-2019	71.1	89.7	40.0	44.5	80.7	87.3	96.1	99.5	93.8	36.6	93.9	39.6	7.0
2018-2020	69.4	87.2	40.5	42.2	81.4	87.5	96.1	99.5	94.0	35.9	93.9	38.0	6.6
Reduction in % area exceeded, 2010-2019	8.8	2.6	7.3	7.7	17.1	4.5	0.9	0.5	3.2	21.1	2.3	8.6	1.3

Table 2.9: Nutrient nitrogen: Excess Nitrogen (AAE in kg N ha^{-1} $year^{-1}$) by habitat for the UK by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland (managed)	Other broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh
	AAE (kg N ha^{-1} $year^{-1}$)												
2009-2011	6.6	9.3	4.0	6.1	8.0	16.1	21.6	18.6	18.7	4.0	20.9	2.1	0.4
2010-2012	6.4	8.7	3.8	5.9	7.4	15.3	20.4	17.3	17.6	3.6	19.7	2.0	0.3
2011-2013	6.7	8.5	3.8	6.1	8.0	15.6	19.5	16.8	17.6	4.1	19.2	1.8	0.2
2012-2014	6.3	8.0	3.6	5.7	7.7	14.5	18.2	15.6	16.3	3.8	17.7	1.5	0.1
2013-2015	7.1	8.2	3.9	5.9	9.4	15.1	18.1	15.6	16.8	4.5	17.9	1.5	0.1
2014-2016	7.0	8.3	3.8	5.7	9.0	14.6	18.1	15.7	16.7	4.0	17.6	1.5	0.1
2015-2017	6.0	7.9	3.3	5.2	7.2	13.7	18.0	15.4	16.1	3.2	17.3	1.5	0.1
2016-2018	5.2	8.1	3.2	5.0	5.2	13.4	19.0	16.3	16.1	2.6	18.1	1.7	0.2
2017-2019	5.2	9.0	3.4	5.2	4.8	14.0	20.7	17.4	16.8	2.7	19.7	2.0	0.3
2018-2020	5.2	8.5	3.3	5.1	4.4	14.0	20.5	17.2	16.7	2.4	19.6	2.1	0.3
Reduction in AAE, 2010-2019	1.3	0.8	0.7	1.0	3.6	2.0	1.1	1.4	2.0	1.6	1.3	0.1	0.1

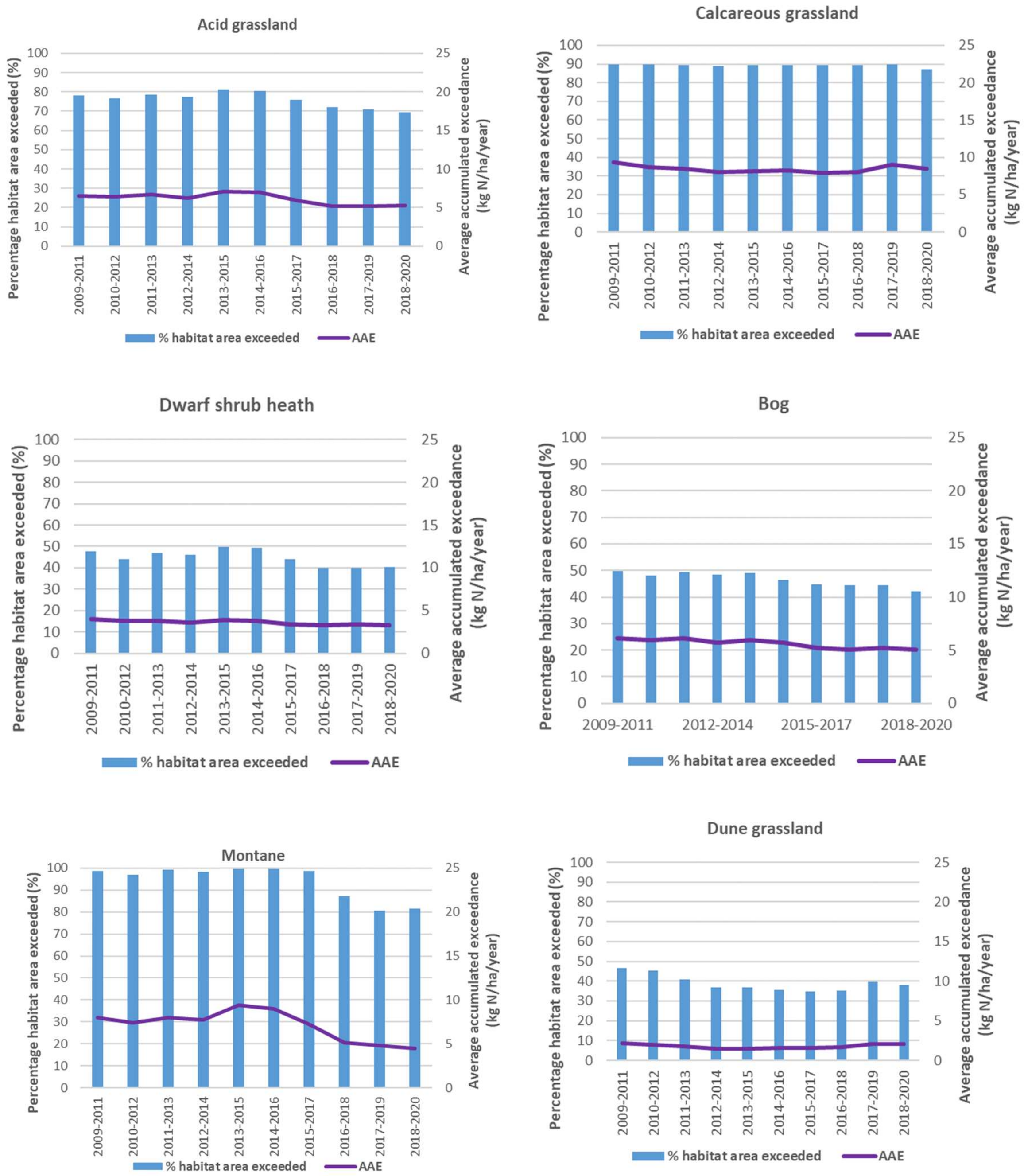


Figure 2.6: Nutrient nitrogen: Percentage area of habitats where nutrient nitrogen critical loads is exceeded, and Excess Nitrogen (AAE in kg N ha^{-1} $year^{-1}$) in the UK by deposition dataset year.

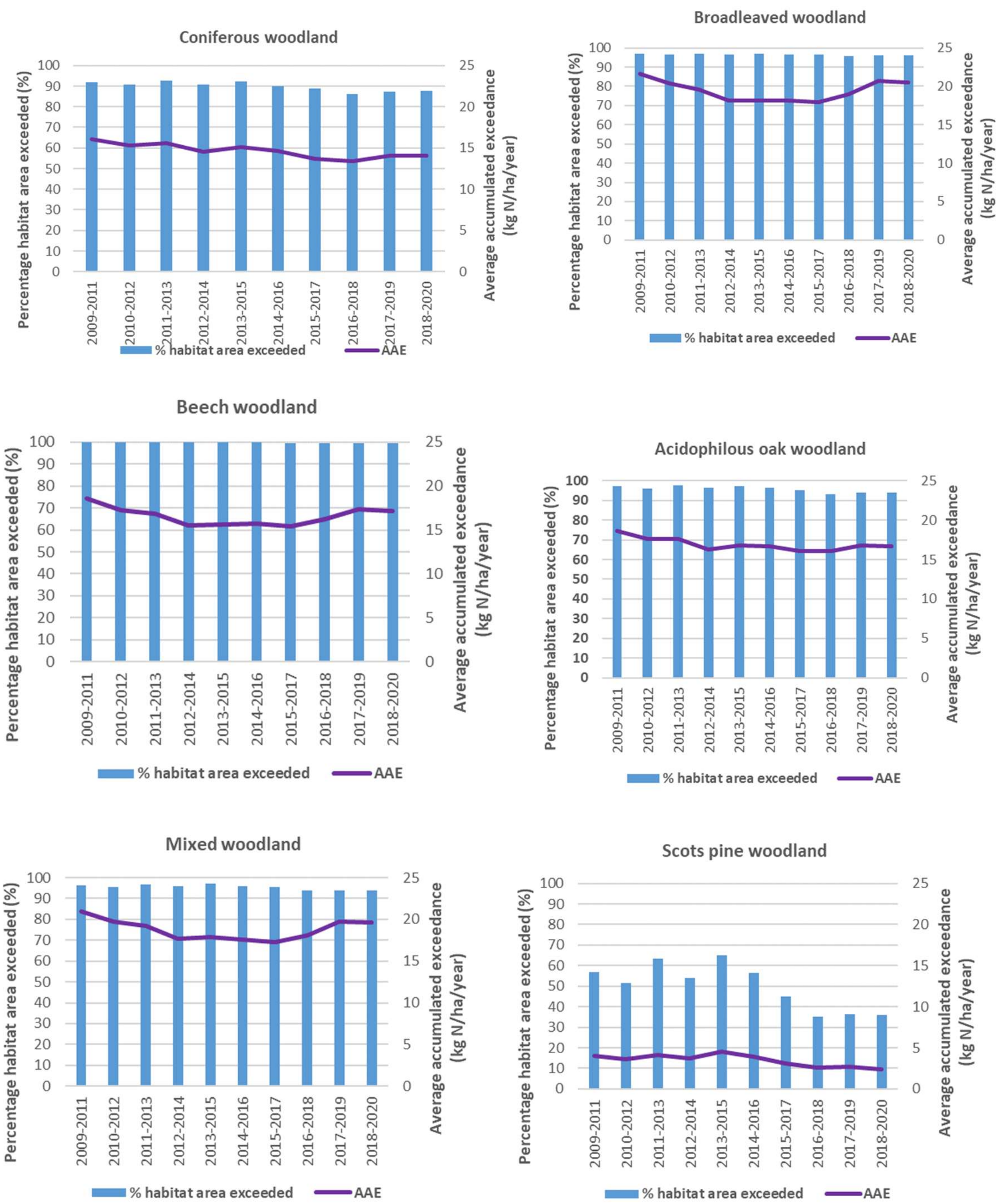


Figure 2.6 (continued): Nutrient nitrogen: Percentage area of habitats where nutrient nitrogen critical load is exceeded, and Excess Nitrogen (Average Accumulated Exceedance in kg N ha^{-1} year^{-1}) in the UK by deposition dataset year.

Section 3: Site-relevant critical loads and their exceedances

This section of the report focuses on the application of critical loads to sites designated for their nature conservation importance, hereafter referred to as site-relevant critical loads (SRCL), and their exceedances. The critical loads are based on the same methods applied to UK acid- and N-sensitive habitats described in Section 1 of this report, and are applied to acid- and N-sensitive features within the designated sites. Exceedances of critical loads are also calculated in the same way as the habitats (Section 1) and also based on UK 5x5 km CBED deposition, however, some different metrics are used to describe the exceedance results for SRCL and are explained below.

3.1 Overview of site-relevant critical loads

Site relevant critical loads (SRCL) have been applied to three types of statutory protected sites:

1. Special Areas of Conservation (SACs) are protected sites designated using the criteria set out in Annex III of the EC Habitats Directive. Annexes I and II of the Directive identify the habitats and species (excluding birds) to be protected; 78 Annex I habitat types and 41 species are believed to occur in, or be native to the UK.
2. Special Protected Areas (SPAs) are sites classified using the criteria set out in Article 4 of the EC Birds Directive to protect rare and vulnerable birds (as listed in an Annex to the Directive) and regularly occurring migratory species.
3. Sites of Special Scientific Interest (SSSIs in England, Wales and Scotland) and Areas of Special Scientific Interest (ASSIs in Northern Ireland) provide statutory protection to the UK's flora and fauna. There are additional SSSIs designated for geological or physiographic features but these are not included in the SRCL assessments.

Digital boundaries for all sites in the UK have been collated by each of the country conservation agencies, together with tables identifying the designated feature habitats and species associated with each site, but no digital information is currently available on the spatial area of each feature within each site. Therefore it is assumed that all features recorded for a site occur across the entire site area. To avoid double counting the area exceeding critical loads for sites with more than one designated feature, the maximum area exceeded for any feature is used when summarising results to the site and country levels (Section 3.2).

To assign SRCLs, the first step is to consider whether the interest feature is potentially sensitive to acidification and/or eutrophication. Specialists within Natural England, Scottish Natural Heritage and CEH used expert judgement to determine this (SNIFFER, 2007). For SPAs where the features are bird species, the broad habitats that the birds depend upon for feeding, breeding and roosting are considered.

To assign critical loads to the habitat features of designated sites, it is necessary to cross-match the different habitat classifications used. Acidity critical loads are mapped by broad habitat, and empirical critical loads for nutrient-nitrogen are assigned based on the European Nature Information System

(EUNIS) habitat classification. Look-up tables developed by (Moss and Davies, 2002) and available from the JNCC website (http://jncc.defra.gov.uk/page-1425) enable linkages to be made between:

- Annex I habitats and EUNIS classes
- Annex I habitats and broad habitats
- EUNIS habitats and broad habitats

Using the look-up tables the most appropriate EUNIS class and broad habitat class were assigned to each interest feature. However, some sites contain features that may be sensitive to acidification and/or eutrophication, but for which no appropriate critical loads are available.

The critical loads assigned to protected sites are based on designated features. However, the national critical load maps are based on national-scale datasets, which may not include small areas of sensitive habitats or some coastal habitats. Some sites are designated for habitat areas that are not included in the national-scale habitat mapping for critical loads. To overcome this, for SRCLs a separate database of national critical loads for terrestrial habitats was created, that provides critical loads for every 1 x 1 km square in the UK, whether the habitat is known to exist there or not. The appropriate SRCL can then be extracted for terrestrial habitat features of each designated site. The SRCLs assigned do not take into account acidity critical loads for freshwater habitats. For further information refer to the "Methods Report" (Hall et al., 2015).

For nutrient N, the empirical critical loads approach is applied to designated feature habitats sensitive to N. The critical load values applied to each habitat are the "Recommended" values agreed by habitat specialists for Article 17 reporting. For more information refer to http://www.apis.ac.uk/indicative-critical-load-values, and to Hall et al. (2015).

3.2 Overview of SRCL exceedance metrics

Exceedances are calculated separately for SACs, SPAs and SSSIs, for all site features that critical loads and deposition data can be assigned to (Hall et al., 2015). Metrics are calculated by:

a) <u>Feature</u> (within each site)

- Exceedance
- Exceeded area[#]
- Accumulated Exceedance (AE) (i.e. exceedance * exceeded area)
- Average Accumulated Exceedance (AAE)(i.e. AE / total site area)

b) <u>Site</u>

- Total number of features with SRCL
- Number and percentage of features with exceedance of SRCL.
- Maximum area exceeded[##] for any feature within a site
- Maximum AE for any feature within a site
- Maximum AAE for any feature within a site

c) Country

- Total number of sites
- Total number and percentage of sites with SRCL for one or more features
- Total number of features with SRCL
- Total number and percentage of sites with exceedance of SRCL for one or more features
- Total number and percentage of features with exceedance of SRCL
- Total area of all sites
- Total area of all sites with SRCL
- Maximum exceeded area###
- Maximum AE calculated as the sum of the maximum AE for all sites
- Maximum AAE; calculated from the country maximum AE and total area of all sites (with SRCL) within a country.

Feature exceeded area: if the critical load is exceeded and the deposition values are constant across the whole site, the exceeded area equals the site area; if the deposition values vary across the site (e.g. as a result of the site crossing the boundaries between grid squares with different deposition values), then the exceeded area will be the sum of the 1 x 1 km portions of the site where the deposition exceeds the critical load.

Site maximum exceeded area: set to the maximum exceeded area for any feature within a site.

Country maximum exceeded area: calculated as the sum of the site maximum exceeded areas for all sites within a country.

The sections below summarise the key results by country, based on the CBED deposition (Section 1.2) for 1996 to 2017. Summary statistics and maps present the worst case, since they are based on exceedance of at least one feature. Other features within a site may have a smaller exceedance, or not be exceeded. The results for AAE are based on the maximum exceedance of any feature within a site.

3.2.1 Exceedance of acidity critical load

The trends in acidity critical load exceedances are summarised in Tables 3.1-3.3 and present the percentage of sites (with SRCL) by country, where the SRCL was exceeded for one or more features, together with the maximum AAE.

Between 2010 and 2019, there was a 1.1% decrease in the percentage of SACs with critical load exceedance in England and a 6.6 % decrease in Scotland, but no change in Wales or Northern Ireland. Excess Acidity (acidity AAE) for SACs fell by between 9.3% (NI) to 63.8% (Scotland). These decreases are small relative to the large decreases in acidity pollution seen between the 1980s and early 2000s due to flue gas desulphurisation, but there has been an ongoing improvement in most statistics. For SPAs, there were reductions in the percentage of exceeded sites in Scotland (9.4%) and England (3.6%) but no change in Wales or NI, accompanied by a 15 - 57% reduction in their maximum AAE values. For SSSIs (ASSIs in NI), all countries showed reductions in the percentage of exceeded sites (Scotland 19.4%; England 5.4%, Wales 3.2% and NI 1.4%), with an 11 - 51% reduction in maximum AAE values.

At the UK level, the trends results show:

- for SACs, the percentage of sites with acidity exceedance decreased from 79.1% in 2010 to 76.2% in 2019, and the maximum AAE fell by 30% from 0.85 keq ha^{-1} $year^{-1}$ to 0.59 keq ha^{-1} $year^{-1}$ over the same time period;
- for SPAs, the percentage of exceeded sites fell from 73.7% in 1996 to 69.7% in 2019, and the maximum AAE decreased by 27% from 0.68 keq ha^{-1} $year^{-1}$ in 2010 to 0.50 keq ha^{-1} $year^{-1}$ in 2019.
- for SSSIs, the percentage of exceeded sites decreased from 62.7% in 2010 to 57.9% in 2019, and the maximum AAE fell by 27% from 0.67 keq ha^{-1} $year^{-1}$ in 1996 to 0.49 keq ha^{-1} $year^{-1}$ in 2019.

Maps of the maximum AAE per site (Figure 3.1) based on the latest CBED deposition (2019) show the highest exceedances of acidity critical load mainly in northern England, parts of Wales and south-west England and southern Scotland. Some sites in the far north of Scotland have no exceedance for any site feature due to low levels of acid deposition. Some SACs and SPAs and many small SSSIs in southern and eastern England are also not exceeded, because more calcareous soils in this region mean that site features are less sensitive to acidity pollution.

Table 3.1: Trends in acidity exceedances for SACs: a) % of sites with SRCL with exceedance of SRCL for at least one feature; b) Excess acidity [maximum AAE keq ha^{-1} year^{-1}]. NR = Not recorded.

	England	Wales	Scotland	NI	Eng/Wales*	Eng/Scot*	UK
Number of sites	231	85	236	54	7	3	616
Number of sites with SRCL for at least one feature	180	71	182	47	6	1	487
2009-2011	74.4 [1.44]	91.5 [0.93]	73.1 [0.26]	97.9 [1.21]	100.0 [NR]	100.0 [NR]	79.1 [0.85]
2010-2012	73.9 [1.42]	91.5 [0.93]	71.4 [0.25]	97.9 [1.16]	100.0 [NR]	100.0 [NR]	78.2 [0.83]
2011-2013	73.9 [1.44]	93.0 [0.99]	72.5 [0.26]	97.9 [1.14]	100.0 [NR]	100.0 [NR]	78.9 [0.85]
2012-2014	73.3 [1.34]	91.5 [0.95]	72.5 [0.25]	97.9 [1.07]	100.0 [NR]	100.0 [NR]	78.4 [0.80]
2013-2015	73.3 [1.34]	91.5 [0.99]	73.6 [0.29]	97.9 [0.98]	100.0 [NR]	100.0 [NR]	78.9 [0.82]
2014-2016	73.3 [1.27]	91.5 [1.01]	72.5 [0.25]	95.7 [0.92]	100.0 [NR]	100.0 [NR]	78.2 [0.77]
2015-2017	73.3 [1.14]	91.5 [0.90]	68.1 [0.18]	95.7 [0.89]	100.0 [NR]	100.0 [NR]	76.6 [0.67]
2016-2018	73.3 [1.19]	91.5 [0.80]	64.3 [0.11]	97.9 [1.00]	100.0 [NR]	100.0 [NR]	75.4 [0.61]
2017-2019	71.6 [1.12]	81.2 [0.73]	55.3 [0.10]	92.2 [1.10]	95.8 [NR]	100.0 [NR]	76.2 [0.62]
2018-2020	73.3 [1.08]	91.5 [0.69]	66.5 [0.10]	97.9 [1.10]	100.0 [NR]	100.0 [NR]	76.2 [0.59]
Reduction in % of sites exceeded, 2010-2019 [Reduction in AAE in same period]	1.1 [0.36]	0.0 [0.24]	6.6 [0.16]	0.0 [0.11]	0.0 [NR]	0.0 [NR]	2.9 [0.25]

* Some sites cross the England/Wales or England/Scotland border and were assigned to these border areas. For AAE calculations, each 1 x 1 km square (or part thereof) within each site was assigned to a single country, so results are calculated for individual countries only.

Table 3.2: Trends in acidity exceedances for SPAs: a) percentage of sites with SRCL with exceedance of SRCL for at least one feature; b) Excess Acidity [maximum AAE keq ha^{-1} $year^{-1}$]. NR = Not recorded.

	England	Wales	Scotland	NI	Eng/Wales*	UK
Number of sites	78	17	145	14	3	257
Number of sites with SRCL for at least one feature	63	13	86	10	3	175
2009-2011	88.9 [1.22]	69.2 [0.76]	61.6 [0.18]	80.0 [0.85]	100.0 [NR]	73.7 [0.68]
2010-2012	88.9 [1.21]	76.9 [0.75]	59.3 [0.17]	80.0 [0.80]	100.0 [NR]	73.1 [0.67]
2011-2013	88.9 [1.19]	76.9 [0.81]	58.1 [0.17]	80.0 [0.77]	100.0 [NR]	72.6 [0.67]
2012-2014	87.3 [1.13]	61.5 [0.76]	58.1 [0.16]	80.0 [0.69]	100.0 [NR]	70.9 [0.63]
2013-2015	84.1 [1.11]	61.5 [0.82]	55.8 [0.18]	80.0 [0.62]	100.0 [NR]	68.6 [0.63]
2014-2016	84.1 [1.07]	69.2 [0.82]	53.5 [0.16]	80.0 [0.58]	100.0 [NR]	68.0 [0.61]
2015-2017	84.1 [0.97]	69.2 [0.70]	50.0 [0.11]	80.0 [0.56]	100.0 [NR]	66.3 [0.53]
2016-2018	85.7 [0.96]	69.2 [0.62]	50.0 [0.08]	80.0 [0.66]	100.0 [NR]	66.9 [0.51]
2017-2019	86.0 [0.99]	67.9 [0.57]	51.7 [0.08]	78.9 [0.76]	100.0 [NR]	68.0 [0.52]
2018-2020	85.7 [0.95]	69.2 [0.55]	55.8 [0.08]	80.0 [0.72]	100.0 [NR]	69.7 [0.50]
Reduction in % of sites exceeded, 2010-2019 [Reduction in AAE in same period]	3.6 [0.27]	0.0 [0.21]	9.4 [0.10]	0.0 [0.13]	0.0 [NR]	4.0 [0.18]

* Some sites that cross the England/Wales have been assigned to this border area. No SPAs cross the England/Scotland border. For AAE calculations, each 1 x 1 km square (or part thereof) within each site was assigned to a single country, so results are calculated for individual countries only.

Table 3.3: Trends in acidity exceedances for SSSIs (ASSIs in Northern Ireland); percentage of sites (with SRCL) with exceedance of SRCL for at least one feature, and maximum AAE of all sites/features: a) % of sites with SRCL with exceedance of SRCL for at least one feature, b) Excess Acidity [maximum AAE keq ha^{-1} year^{-1}]. No SSSIs cross the England/Wales or England/Scotland borders, so all SSSIs were assigned to a single country.

	England	Wales	Scotland	NI	UK
Number of sites	4115	1018	1452	291	6876
Number of sites with SRCL for at least one feature	2924	676	905	178	4683
2009-2011	58.9 [1.02]	72.9 [0.82]	63.3 [0.27]	82.6 [1.07]	62.7 [0.67]
2010-2012	58.4 [1.00]	73.1 [0.83]	62.4 [0.26]	82.0 [1.02]	62.2 [0.66]
2011-2013	57.4 [1.00]	73.1 [0.89]	62.2 [0.27]	80.3 [1.01]	61.4 [0.67]
2012-2014	56.3 [0.94]	71.3 [0.86]	60.0 [0.26]	78.1 [0.94]	60.0 [0.63]
2013-2015	55.0 [0.93]	71.4 [0.89]	59.9 [0.29]	77.0 [0.86]	59.2 [0.65]
2014-2016	54.8 [0.89]	71.3 [0.91]	57.1 [0.26]	76.4 [0.81]	58.4 [0.62]
2015-2017	53.9 [0.80]	69.7 [0.81]	51.7 [0.19]	76.4 [0.78]	56.6 [0.54]
2016-2018	55.1 [0.77]	69.5 [0.72]	48.7 [0.15]	79.8 [0.87]	56.9 [0.50]
2017-2019	56.3 [0.79]	69.7 [0.66]	50.8 [0.14]	80.2 [0.97]	58.1 [0.50]
2018-2020	55.7 [0.78]	70.6 [0.66]	51.0 [0.13]	81.5 [0.96]	57.9 [0.49]
Reduction in % of sites exceeded, 2010-2019 [Reduction in AAE in same period]	5.4 [0.24]	3.2 [0.17]	19.4 [0.14]	1.4 [0.11]	4.8 [0.18]

(a) SAC (b) SPA (a) SSSI

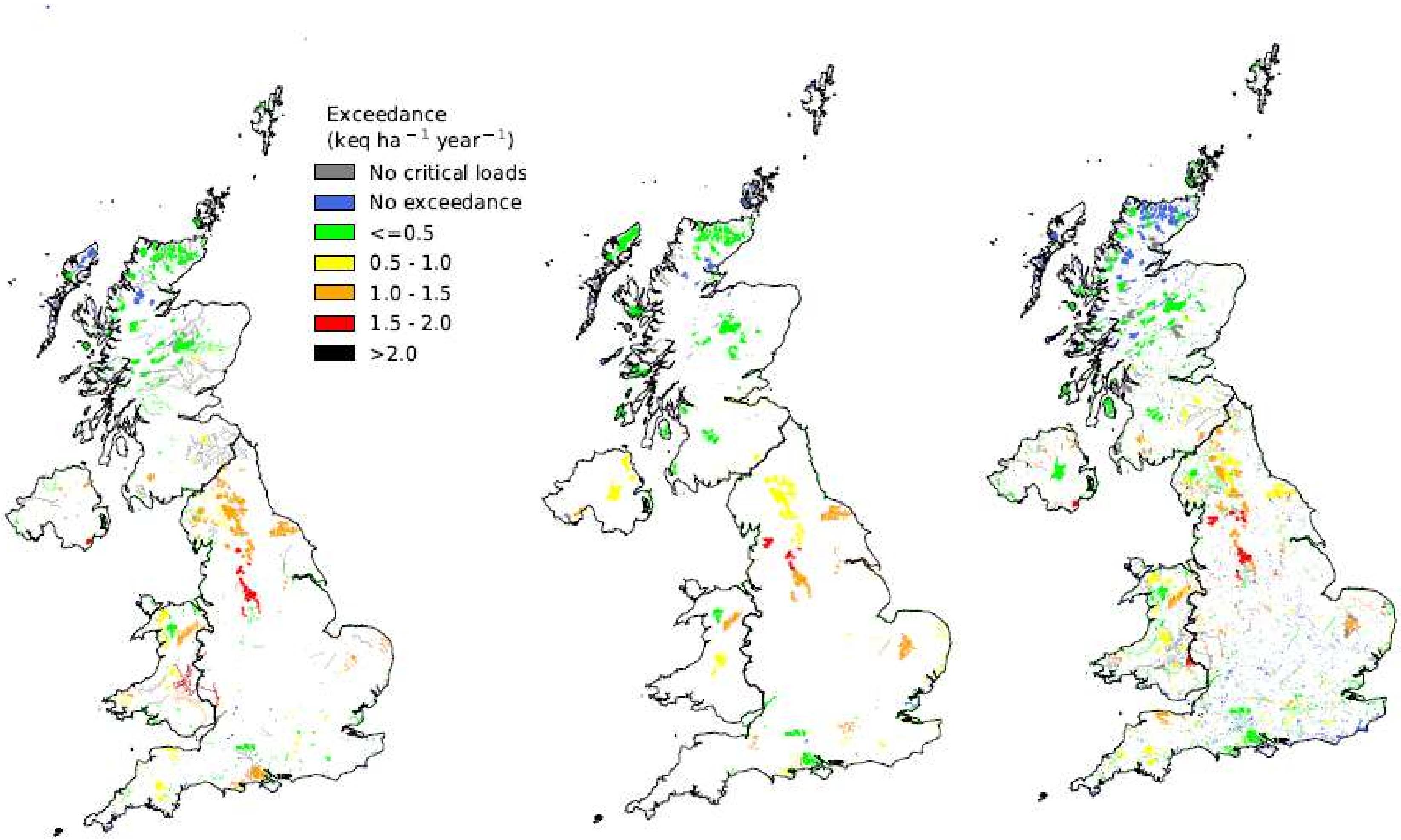


Figure 3.1: Excess Acidity. Average Accumulated Exceedance (AAE) of acidity critical loads by CBED deposition for 2018-20; maps show the maximum AAE for any feature within each site (other features may have lower or no exceedance).

3.2.2 Nutrient-nitrogen results

The trends in nutrient-N critical load exceedances from 2010 to 2019 are summarised in Tables 3.4-3.6. The decreases in the percentage of sites with exceedance of nutrient-N critical loads for one or more features, and decreases in AAE, were smaller than the decreases seen for acidity, reflecting the smaller decline in N deposition than in acidity deposition. Reductions varied by country for the different site types. In Northern Ireland, there was no decrease in the percentage of SACs, SPAs or SSSIs with critical load exceedance and in AAE. The largest decreases in the percentage of sites with exceedance were in Scotland for SACs (3% reduction), SPAs (8.7% reduction) and SSSIs (6% reduction). The percentage of sites exceeding nutrient-N critical load increased in some cases, e.g. the percentage of SPAs in exceedance increased by 7.2% in Wales, and the percentage of SSSIs in exceedance increased by 0.2% in England.

At the UK level:

- for SACs, the percentage of sites with nutrient-N exceedance decreased from 89.9% in 2010 to 87.9% in 2019, and the maximum AAE decreased a little from 12.2 kg N ha^{-1} $year^{-1}$ to 10.5 kg N ha^{-1} $year^{-1}$ over the same time period.
- for SPAs, the percentage of exceeded sites decreased from 76.9% in 2010 to 72.4% in 2019, and the maximum AAE decreased from 13.4 kg N ha^{-1} $year^{-1}$ in 2010 to 11.9 kg N ha^{-1} $year^{-1}$ in 2019.
- for SSSIs, the percentage of exceeded sites decreased from 90.9% in 2010 to 89.7% in 2019, and the maximum AAE decreased from 13.7 kg N ha^{-1} $year^{-1}$ in 2010 to 11.9 kg N ha^{-1} $year^{-1}$ in 2019.

Maps of the maximum AAE per site (Figure 3.2) based on the latest CBED deposition (2018-2020) show few sites with no exceedance for any feature. Exceedances are widespread across all countries, although lower proportions of protected sites are exceeded in Scotland. The maximum AAE is above 7 kg N ha^{-1} $year^{-1}$ for the majority of sites, with many sites having maximum AAE up to 28 kg N ha^{-1} $year^{-1}$, and a few sites in central England with maximum AAE above this value.

Table 3.4: Trends in nutrient nitrogen exceedances for SACs; percentage of sites (with SRCL) with exceedance of SRCL for at least one feature, and maximum AAE of all sites/features: a) % of sites with SRCL with exceedance of SRCL for at least one feature; b) [maximum AAE kg N ha^{-1} $year^{-1}$]. NR = Not recorded.

	England	Wales	Scotland	NI	Eng/Wales*	Eng/Scot*	UK
Number of sites	231	85	236	54	7	3	616
Number of sites with a critical load for at least one feature	197	79	201	50	7	2	536
2009-2011	92.9 [18.6]	92.4 [10.0]	83.6 [6.1]	98.0 [16.5]	100 [NR]	50.0 [NR]	89.9 [12.2]
2010-2012	93.4 [18.0]	93.7 [9.8]	82.6 [5.7]	98.0 [15.6]	100 [NR]	50.0 [NR]	89.9 [11.8]
2011-2013	92.9 [18.0]	93.7 [10.1]	83.6 [6.1]	98.0 [15.5]	100 [NR]	50.0 [NR]	89.9 [12.0]
2012-2014	93.0 [16.9]	92.4 [9.5]	83.1 [5.8]	96.0 [14.7]	100 [NR]	50.0 [NR]	89.4 [11.3]
2013-2015	92.4 [17.3]	92.4 [10.1]	83.1 [6.4]	96.0 [13.9]	100 [NR]	50.0 [NR]	89.2 [11.8]
2014-2016	91.9 [17.0]	93.7 [10.2]	82.6 [6.0]	96.0 [13.4]	100 [NR]	50.0 [NR]	89.0 [11.4]
2015-2017	90.9 [16.2]	92.4 [9.6]	79.6 [5.1]	96.0 [13.5]	100 [NR]	50.0 [NR]	87.3 [10.7]
2016-2018	92.4 [16.0]	92.4 [9.1]	79.6 [4.3]	98.0 [14.9]	100 [NR]	50.0 [NR]	88.1 [10.3]
2017-2019	92.9 [16.8]	92.4 [8.8]	80.6 [4.4]	98.0 [16.4]	100 [NR]	50.0 [NR]	88.6 [10.6]
2018-2020	90.9 [16.4]	92.4 [8.9]	80.6 [4.3]	98.0 [16.6]	100 [NR]	50.0 [NR]	87.9 [10.5]
Reduction in % of sites exceeded, 2010-2019 [Reduction in AAE in same period]	2.0 [2.2]	0.0 [1.1]	3.0 [1.8]	0.0 [-0.1]	0.0 [NR]	0.0 [NR]	2.1 [1.8]

* Some sites cross the England/Wales or England/Scotland border and have been assigned to these border areas. However, in calculating AAE each 1 x 1 km square (or part thereof) within each site has been assigned to a single country, so AAE results are calculated for individual countries only.

Table 3.5: Trends in nutrient nitrogen exceedances for SPAs; percentage of sites (with SRCL) with exceedance of SRCL for at least one feature, and maximum AAE of all sites/features: a) % of sites with SRCL with exceedance of SRCL for at least one feature, b) [maximum AAE kg N ha^{-1} $year^{-1}$]. NR = Not recorded.

	England	Wales	Scotland	NI	Eng/Wales*	UK
Number of sites	78	17	145	14	3	257
Number of sites with a critical load for at least one feature	72	14	124	12	3	225
2009-2011	91.7 [19.8]	71.4 [14.1]	67.7 [5.7]	83.3 [19.0]	100 [NR]	76.9 [13.3]
2010-2012	90.3 [19.1]	78.6 [13.8]	67.7 [5.4]	83.3 [17.8]	100 [NR]	76.9 [12.8]
2011-2013	90.3 [18.7]	78.6 [14.2]	67.7 [5.5]	83.3 [17.1]	100 [NR]	76.9 [12.6]
2012-2014	87.5 [17.8]	71.4 [13.6]	65.3 [5.2]	83.3 [15.8]	100 [NR]	74.2 [12.0]
2013-2015	87.5 [17.9]	71.4 [14.6]	66.1 [5.7]	83.3 [15.5]	100 [NR]	74.7 [12.3]
2014-2016	87.5 [18.0]	71.4 [14.9]	62.1 [5.3]	83.3 [15.2]	100 [NR]	72.4 [12.2]
2015-2017	87.5 [17.4]	71.4 [13.9]	58.9 [4.6]	83.3 [15.5]	100 [NR]	70.7 [11.6]
2016-2018	90.3 [17.7]	71.4 [13.1]	60.5 [4.3]	83.3 [17.1]	100 [NR]	72.4 [11.6]
2017-2019	91.7 [18.5]	71.4 [12.8]	60.5 [4.6]	83.3 [19.3]	100 [NR]	72.9 [12.2]
2018-2020	91.7 [18.0]	78.6 [12.8]	58.9 [4.6]	83.3 [19.0]	100 [NR]	72.4 [12.0]
Reduction in % of sites exceeded, 2010-2019 [Reduction in AAE in same period]	0.0 [1.8]	-7.2 [1.3]	8.7 [1.1]	0.0 [0.0]	0.0 [NR]	4.4 [1.3]

* Some sites that cross the England/Wales have been assigned to this border area. No SPAs cross the England/Scotland border. However, in calculating AAE each 1 x 1 km square (or part thereof) within each site was assigned to a single country, so AAE results are calculated for individual countries only.

Table 3.6: Trends in nutrient-nitrogen exceedances for SSSIs (ASSIs in Northern Ireland); percentage of sites (with SRCL) with exceedance of SRCL for at least one feature, and maximum AAE of all sites/features: a) % of sites with SRCL with exceedance of SRCL for at least one feature; b) [maximum AAE kg N ha^{-1} $year^{-1}$]. No SSSIs cross the England/Wales or England/Scotland borders, so all SSSIs have been assigned to a single country.

	England	Wales	Scotland	NI	UK
Number of sites	4115	1018	1452	291	6876
Number of sites with SRCL for at least one feature	2954	686	938	188	4766
2009-2011	90.9 [19.6]	97.1 [16.1]	85.4 [6.0]	96.3 [22.3]	90.9 [13.7]
2010-2012	89.3 [18.9]	97.4 [15.8]	84.5 [5.7]	96.3 [20.9]	89.8 [13.2]
2011-2013	88.0 [18.7]	97.5 [16.3]	85.0 [6.1]	95.7 [20.4]	89.1 [13.3]
2012-2014	87.5 [17.7]	96.6 [15.6]	84.0 [5.7]	95.2 [19.0]	88.4 [12.5]
2013-2015	86.8 [18.0]	96.9 [16.5]	84.3 [6.5]	93.1 [18.6]	88.0 [13.1]
2014-2016	87.1 [17.9]	97.4 [16.7]	83.6 [6.0]	93.1 [18.2]	88.1 [12.8]
2015-2017	86.6 [17.1]	97.4 [15.7]	81.1 [5.3]	93.6 [18.4]	87.3 [12.1]
2016-2018	88.4 [17.1]	96.5 [14.8]	78.4 [4.5]	96.3 [19.9]	87.9 [11.7]
2017-2019	91.8 [17.9]	96.1 [14.4]	80.7 [4.5]	96.3 [22.2]	90.4 [12.1]
2018-2020	91.1 [17.6]	96.4 [14.7]	79.4 [4.4]	95.7 [22.0]	89.7 [11.9]
Reduction in % of sites exceeded from 2010 to 2019 [Reduction in AAE in same period]	-0.2 [2.0]	0.7 [1.4]	6.0 [1.6]	0.6 [0.3]	1.2 [1.7]

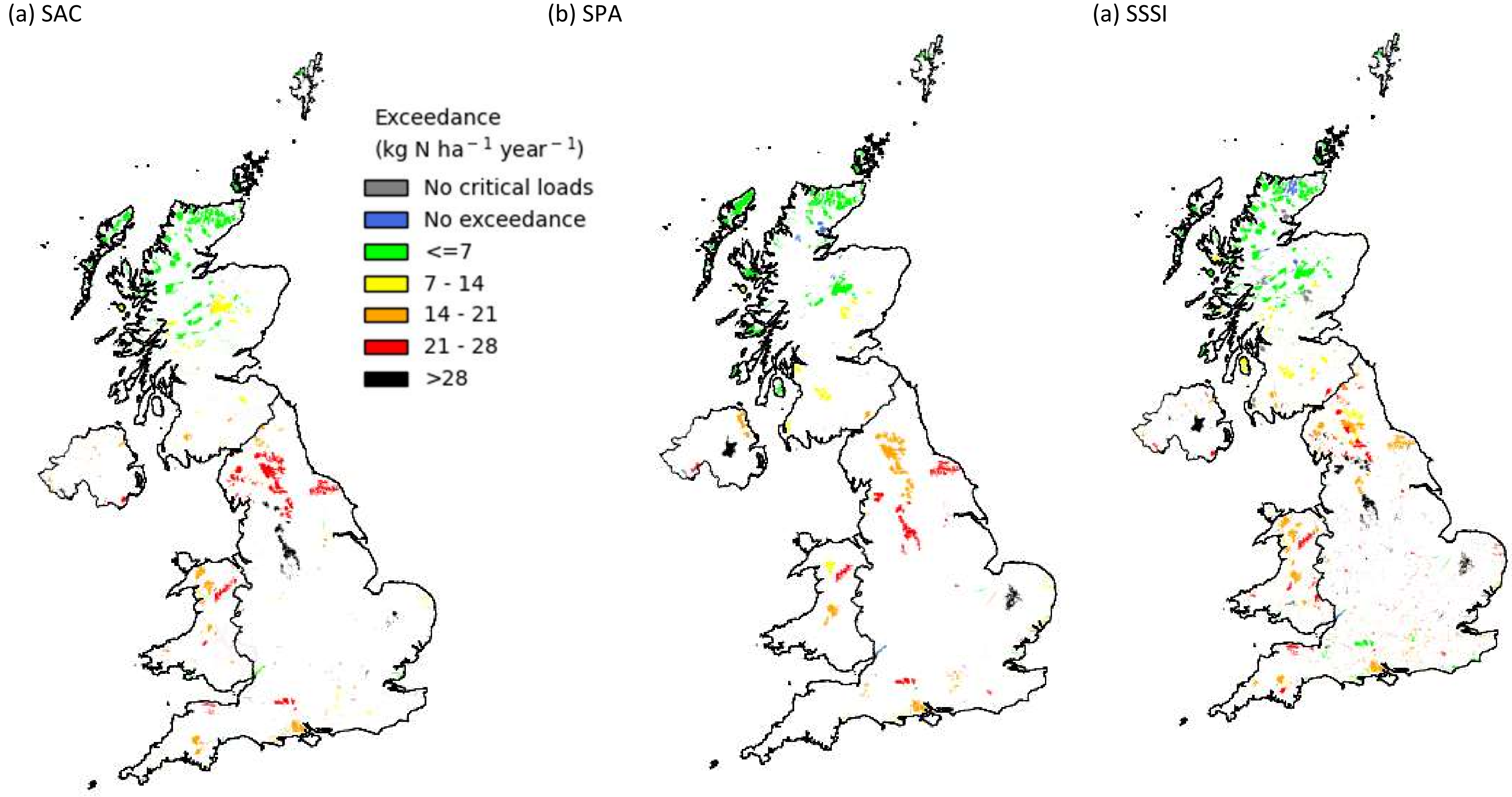


Figure 3.2: Excess Nitrogen: Average Accumulated Exceedance (AAE) of nutrient nitrogen critical loads by CBED deposition for 2018-20. Maps show the maximum AAE for any feature within each site. Other features may have lower or no exceedance.

Section 4: Critical levels and their exceedances

This section of the report focuses on the trends in exceedance of critical levels for ammonia, that are set to protect: a) lichens and bryophytes; or b) higher (i.e. vascular) plants. The trends are based on rolling 3-year mean ammonia gaseous concentrations, and only cover the period from 2009-11 to 2017-19. Ammonia concentration estimates are not currently available for earlier periods. For brevity, the three-year means are mainly referred to in this report using the middle year, for example "2010 to 2015" equates to "2009-11 to 2014-16". The 1x1 km ammonia concentration data are routinely a year behind the deposition data, due to the timing of availability of the required input data, so the most recent concentration data used for this report are for the period 2017-19.

4.1 Critical levels of ammonia

The critical levels considered here are annual mean concentrations of ammonia above which direct adverse effects on sensitive vegetation may occur according to present knowledge (CLRTAP, 2017). Critical levels have also been defined for other pollutants: sulphur dioxide, some N oxides, and ozone. Critical levels based on mean concentrations over shorter time periods have also been defined. These other pollutants and timescales are not considered here; further information can be found in (CLRTAP, 2017).

The critical levels for ammonia were reviewed and updated at an international workshop held in 2006 (UNECE, 2007) and approved by the Task Forces of the International Cooperative Programmes (ICPs) of the CLRTAP. Critical levels are only defined for two taxonomic groups (Table 4.1), in contrast to the range of habitats for which critical loads have been defined. This means that critical levels of ammonia have not here been applied to individual habitats or to habitat features of designated sites in the UK. Critical level exceedance metrics used are described in Section 4.3.

Table 4.1: Critical levels of ammonia (CLRTAP, 2014)

Vegetation type	Critical level NH_3 [µg m^{-3}]	Time period
Lichens and bryophytes (including ecosystems where lichens and bryophytes are a key part of the ecosystem integrity)	1	Annual mean concentration
Higher plants (including heathland, semi-natural grassland and forest ground flora)	3*	Annual mean concentration

*An explicit uncertainty range of 2-4 µg m^{-3} was set for higher plants; this was intended to be used when applying the critical level in different assessment contexts.

4.2 Concentrations of ammonia

For previous Trends Reports, the distribution of ammonia concentrations was calculated using the FRAME model (Dore et al., 2007; Fournier et al., 2004; Singles et al., 1998; Vieno et al., 2010) at 1 x 1 km resolution for the UK. For the current report, the spatial distribution of gaseous ammonia was calculated using the European Monitoring and Evaluation Programme (EMEP) model. The EMEP model is considered to provide more accurate estimates of ammonia concentration than FRAME. The EMEP model has the potential to be run at 1 x 1 km resolution, but is currently run at a 3 x 3 km resolution, to reduce computation time, and because the availability of fine-scale meteorological and emissions data is limited (Hallsworth et al., 2010). Modelled ammonia concentrations are calibrated relative to annually averaged measurements from the UKEAP National Ammonia Monitoring Network (Stephens et al., 2021), using the median bias to adjust the concentrations. Data from all monitoring stations that have a temporal coverage of measurements data for at least 50% of the year were used for calibration, with the exception of one station very close to a point source that was not representative of the surrounding area, and one site in central London. EMEP4UK requires annual total emissions for NO_x, NH_3 and SO_x, which are provided as both diffuse area emissions (on a 1 x 1 km grid) and as point source emissions. Emissions are updated annually using data from the National Atmospheric Emissions Inventory (NAEI, 2020). Other required inputs include wind-rose data (frequency and speed), land cover, precipitation, and UK-boundary conditions.

4.3 Calculation of critical levels exceedance

The critical level exceedance metrics calculated for this Trends Report are:

- The percentage land area in England, Wales, Scotland, Northern Ireland and UK where ammonia concentrations exceed the critical levels.
- The percentage area of N-sensitive habitats in England, Wales, Scotland, Northern Ireland and UK where ammonia concentrations exceed the critical levels. The habitat areas are based on the habitat distribution maps used for mapping nutrient N critical loads (Section 1.1).
- The percentage of designated sites (SAC, SPA, SSSI) in England, Wales, Scotland, Northern Ireland and the UK, where ammonia concentrations exceed the critical levels anywhere across a site. Ammonia-sensitivity has not yet been determined for the current set of designated sites, so critical level exceedance was calculated for all sites.

4.4 Trends in ammonia critical levels exceedance

4.4.1 UK land area with exceedance of ammonia critical levels

Ammonia concentrations exceeded the critical level of 1 µg m^{-3} (set to protect sensitive bryophytes and lichens) across 69.2% of the UK land area in 2018, compared to 63.5% in 2010 (Figure 4.1a; Table 4.2). Exceedance varies spatially, with minimum 22.5% of Scotland, but more than 90% of England and Northern Ireland having ammonia concentrations above 1 µg m^{-3}.

The ammonia critical level of 3 µg m^{-3}, set to protect sensitive vascular plants, was exceeded in 2018 in very few areas for Scotland (< 1%) and relatively small areas of the rest of the UK: < 2.0 % for Wales, 7.6 % for England, and 36.0% for NI. (Figure 4.1b; Table 4.2).

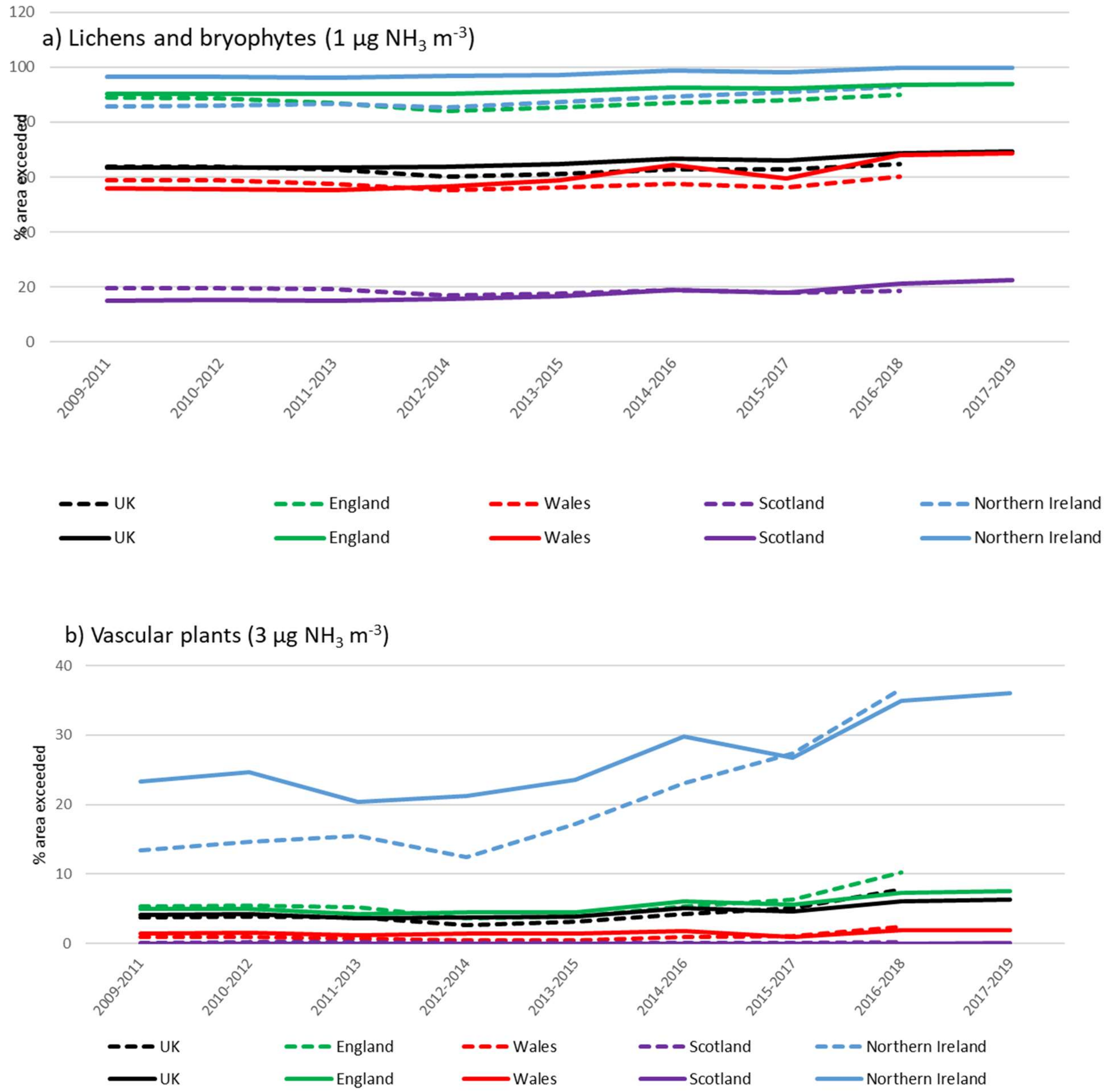


Figure 4.1: Percentages of the UK land area where ammonia concentrations, as calculated using FRAME (dashed lines) or EMEP (solid lines), exceeded critical levels: for a) lichens and bryophytes; b) vascular plants.

Table 4.2: Percentages of the UK land area where ammonia concentrations exceed critical levels.

	England	Wales	Scotland	NI	UK
	% land area where ammonia concentrations exceeds 1 µg m^{-3}				
2009-2011	90.2	56.0	15.1	96.4	63.5
2010-2012	90.2	55.6	15.4	96.5	63.6
2011-2013	90.1	55.3	15.0	96.2	63.3
2012-2014	90.2	56.4	15.6	96.7	63.7
2013-2015	91.2	59.0	16.8	97.3	64.9
2014-2016	92.4	64.3	18.9	98.8	66.8
2015-2017	92.5	62.5	18.9	98.7	66.6
2016-2018	93.6	68.1	21.4	99.7	68.6
2017-2019	94.0	68.8	22.5	99.7	69.2
Change in % area exceeding 1 µg m^{-3} from 2010 to 2018	+3.4	+12.1	+6.3	+3.3	+5.1
	% land area where ammonia concentrations exceeds 3 µg m^{-3}				
2009-2011	5.0	1.4	0.0	23.3	4.1
2010-2012	5.0	1.5	0.0	24.6	4.2
2011-2013	4.3	1.2	0.0	20.3	3.6
2012-2014	4.5	1.4	0.0	21.2	3.7
2013-2015	4.5	1.4	0.0	23.5	3.9
2014-2016	6.1	1.9	0.0	29.8	5.1
2015-2017	5.8	1.6	0.0	29.1	5.0
2016-2018	7.3	2.0	0.0	34.9	6.1
2017-2019	7.6	1.9	0.0	36.0	6.3
Change in % area exceeding 3 µg m^{-3} from 2010 to 2018	+2.3	+0.5	0.0	+11.6	+2.0

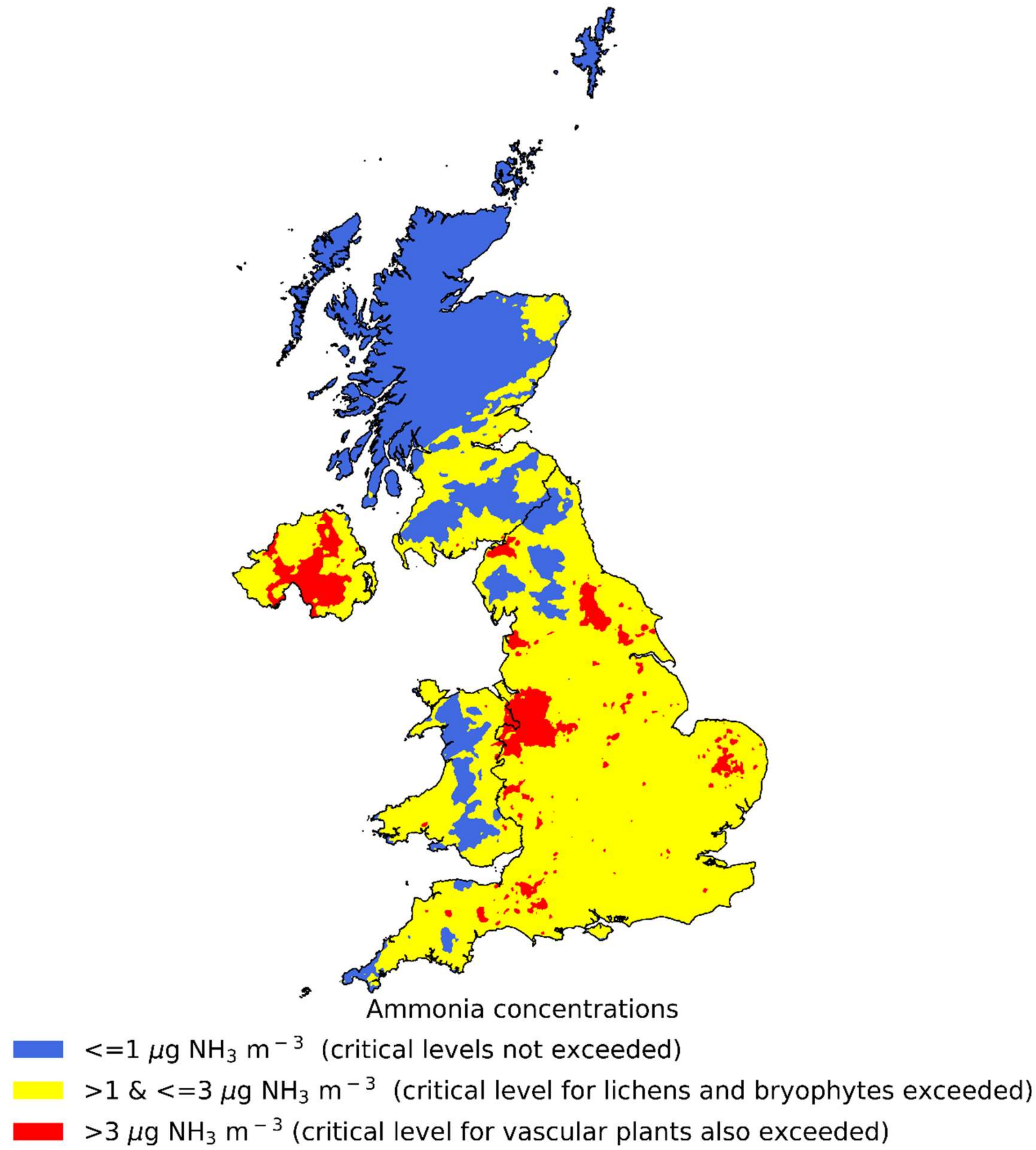


Figure 4.1: EMEP 1 x 1 km mean ammonia concentrations for 2017-19.

4.4.2 Nitrogen-sensitive habitats with exceedance of ammonia critical levels

Around a quarter of the mapped area of N-sensitive habitats in the UK receives ammonia concentrations above the critical level of 1 µg m^{-3} (Table 4.3). The results vary spatially across the UK depending on the variability in ammonia concentrations (see Figure 4.1), and the distributions of the different N-sensitive habitats. Although 58% of the total UK area of N-sensitive habitats is found in Scotland, because the ammonia concentrations are generally low in this part of the country (Figure 4.1) only 10.9% of the Scottish habitat area coincides with ammonia concentrations above 1 µg m^{-3} and there were very few areas in Scotland with concentrations above 3 µg m^{-3} in 2018 (Table 4.3). The highest exceedances are seen in England and Northern Ireland, with ammonia concentrations above 1 µg m^{-3} for 81.2-95.9% of their N-sensitive habitat areas and above 3 µg m^{-3} for 4.1 - 23.5%. The percentage area of N-sensitive habitats in the UK with exceedance of the critical level of 1 µg m^{-3} increased from 32.5% in 2010 to 39.0% in 2018.

Table 4.3: Percentages of the area of nitrogen sensitive habitats in the UK where ammonia concentrations exceed critical levels of 1 µg m^{-3} and 3 µg m^{-3}, by country.

		England	Wales	Scotland	NI	UK
N-sensitive habitat area (km^2)		26,038	9,412	54,333	3,990	93,779
1 µg m^{-3}	2009-2011	72.3	46.9	6.6	88.6	32.5
	2010-2012	72.1	46.2	6.8	88.2	32.4
	2011-2013	71.7	45.7	6.6	87.5	32.1
	2012-2014	71.6	46.7	6.9	88.2	32.4
	2013-2015	74.0	49.7	7.5	90.1	33.8
	2014-2016	77.2	55.1	8.7	94.1	36.1
	2015-2017	76.5	48.6	8.0	94.8	34.8
	2016-2018	80.0	59.0	10.1	96.0	38.1
	2017-2019	81.2	59.8	10.9	95.9	39.0
Change in % area exceeded from 2010 to 2018		+8.9	+12.8	+4.2	+7.3	+6.5
3 µg m^{-3}	2009-2011	2.5	1.9	0.0	15.9	1.6
	2010-2012	2.5	2.1	0.0	16.8	1.6
	2011-2013	2.2	1.7	0.0	14.4	1.4
	2012-2014	2.3	1.9	0.0	15.0	1.5
	2013-2015	2.4	1.9	0.0	16.3	1.5
	2014-2016	3.2	2.4	0.0	19.8	2.0
	2015-2017	2.9	1.2	0.0	16.9	1.6
	2016-2018	3.9	2.5	0.0	22.6	2.3
	2017-2019	4.1	2.6	0.0	23.5	2.4
Change in % area exceeded from 2010 to 2018		+1.6	+0.7	0.0	+7.6	+0.9

The N-sensitive habitats (Table 4.4) with the highest percentage area of exceedance of the ammonia critical level of 1 µg m^{-3} in 2018 were beech woodland (95.2%), calcareous grassland (89.6%), broadleaved woodland (86.4%), and mixed woodland (81.6%). Other habitats had smaller percentage areas where ammonia concentrations were above 1 µg m^{-3}. However, although only 19.1% of Dwarf shrub heath is exceeded, this habitat occupies a large area across the UK so this equates to 4,095 km^2, similar to the area of Acidophilous oak woodland that is exceeded (4,589 km^2).

Differences between years were small, and reflect fluctuations in ammonia concentrations due to inter-annual variability in meteorology. However, there was no evidence of decreases in the area where critical levels are exceeded.

Table 4.4: Percentages of the area of nitrogen-sensitive habitats where ammonia critical levels of 1 µg m^{-3} and 3 µg m^{-3} were exceeded in the UK, by habitat.

		Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak	Scots Pine	Mixed woodland	Dune grassland	Saltmarsh
Habitat area (km^2)		*20,365*	*1,012*	*21,846*	*9,119*	*4,915*	*14,452*	*8,706*	*2,059*	*6,958*	*1,485*	*1,423*	*631*	*808*
1 µg m^{-3}	2009-2011	24.1	83.8	15.0	19.1	0.6	33.0	80.5	91.7	59.0	3.3	74.6	43.9	71.2
	2010-2012	24.0	83.3	14.9	19.0	0.6	33.0	80.6	91.5	58.9	3.5	74.7	44.0	71.1
	2011-2013	23.4	83.3	14.7	18.8	0.5	32.6	80.3	91.7	58.6	3.3	74.2	44.0	71.3
	2012-2014	23.9	83.3	14.7	19.1	0.5	33.0	80.6	91.6	58.9	3.4	74.6	44.1	71.4
	2013-2015	26.1	84.8	15.8	20.3	0.7	34.5	81.9	92.9	60.7	4.0	76.1	44.8	73.0
	2014-2016	29.6	86.4	17.4	22.4	1.0	37.2	83.9	94.1	63.4	4.6	78.7	46.3	75.5
	2015-2017	26.6	85.7	16.9	21.0	0.6	35.8	83.9	94.0	62.5	3.8	78.6	47.4	75.6
	2016-2018	32.8	88.2	18.6	24.0	1.2	39.9	85.8	95.1	66.0	5.4	80.9	47.8	77.5
	2017-2019	34.2	89.6	19.1	24.7	1.3	41.1	86.4	95.2	67.0	6.3	81.6	47.9	77.8
Change in % area, 2010 - 2018		+10.1	+5.9	+4.2	+5.6	+0.7	+8.2	+5.9	+3.5	+8.0	+2.9	+6.9	+4.1	+6.5
3 µg m^{-3}	2009-2011	0.6	0.4	0.5	2.1	0.0	1.6	4.9	1.4	2.1	0.0	8.6	2.6	8.1
	2010-2012	0.7	0.4	0.5	2.2	0.0	1.6	5.0	1.4	2.3	0.0	8.9	2.8	9.1
	2011-2013	0.6	0.3	0.4	1.9	0.0	1.5	4.2	1.2	1.9	0.0	7.7	2.7	8.0
	2012-2014	0.6	0.4	0.5	2.0	0.0	1.6	4.4	1.4	2.1	0.0	8.0	2.7	7.6
	2013-2015	0.6	0.4	0.5	2.2	0.0	1.7	4.7	1.4	2.1	0.0	8.5	2.7	6.7
	2014-2016	0.8	0.6	0.7	2.6	0.0	2.1	6.2	2.0	2.8	0.0	10.3	2.9	8.1
	2015-2017	0.5	0.4	0.5	2.2	0.0	1.8	5.7	1.8	2.1	0.0	8.8	2.2	7.9
	2016-2018	0.9	0.7	0.8	3.0	0.0	2.5	7.7	2.4	3.1	0.0	11.8	3.1	9.6
	2017-2019	1.0	0.7	0.9	3.1	0.0	2.5	8.0	2.6	3.2	0.0	12.2	3.5	9.6
Change in % area, 2010 - 2018		+0.3	+0.3	+0.4	+1.1	0.0	+0.9	+3.1	+1.2	+1.1	0.0	+3.6	+0.9	+1.6

4.4.3 Designated sites with exceedance of ammonia critical levels

These results show the percentage of sites (SACs, SPAs, SSSIs) where ammonia critical levels are exceeded; a site is counted as exceeded if the ammonia concentration exceeds the respective critical level anywhere across a site. SACs may contain one or more SSSIs, and some SACs and SPAs may overlap one another (Figure 4.2), however in this analysis the sites are all assessed independently.

SACs

65.9% of SACs occur in areas of the UK where ammonia concentrations exceed 1 µg m^{-3} (Table 4.5); the lowest number of sites with exceedance is in Scotland, where ammonia concentrations are < 1 µg m^{-3} at 22.5% of sites. The percentage of UK SACs with exceedance of the 1 µg m^{-3} critical level increased by 6.3% between 2010 and 2018, but this varies spatially across the UK with more increase seen in Wales and Scotland, than in England over this time period.

The percentage of SACs with ammonia concentrations above 3 µg m^{-3} is smaller, mostly <15% in 2018 (Table 4.5). However, in Northern Ireland there has been a steady increase in the number of SACs where this higher critical level is exceeded, with ~28% of sites now exceeded.

Table 4.5: Percentage of SACs where ammonia concentrations exceed critical levels of 1 µg m^{-3} and 3 µg m^{-3} anywhere across a site.

		England	Wales	Scotland	NI	UK
Number of sites		231	84	236	54	615*
1 µg m^{-3}	2009-2011	90.0	69.0	15.3	100.0	59.5
	2010-2012	90.0	69.0	15.3	100.0	59.5
	2011-2013	89.6	67.9	15.3	100.0	59.2
	2012-2014	90.0	69.0	15.7	100.0	59.7
	2013-2015	92.2	73.8	17.8	100.0	62.0
	2014-2016	93.1	77.4	18.6	100.0	63.1
	2015-2017	92.6	72.6	17.8	100.0	62.0
	2016-2018	94.4	83.3	20.8	100.0	65.2
	2017-2019	94.4	83.3	22.5	100.0	65.9
Change in % of sites exceeded, from 2010 to 2018		+4.3	+14.3	+7.2	0.0	+6.3
3 µg m^{-3}	2009-2011	6.1	1.2	0.0	16.7	4.2
	2010-2012	6.1	1.2	0.0	18.5	4.6
	2011-2013	6.1	1.2	0.0	14.8	4.2
	2012-2014	6.5	1.2	0.0	14.8	4.4
	2013-2015	6.5	1.2	0.0	18.5	4.7
	2014-2016	7.8	3.6	0.0	20.4	5.7
	2015-2017	7.8	1.2	0.0	16.7	5.2
	2016-2018	9.5	3.6	0.0	25.9	7.0
	2017-2019	10.0	3.6	0.0	27.8	7.5
Change in % of sites exceeded, from 2010 to 2018		+3.9	+2.4	0.0	+11.1	+3.3

*includes 7 sites on the England/Wales border and 3 on the England/Scotland border.

SPAs

The results show an over 20% increase from 2010 to 2018 in the number of sites in Wales exceeding the critical level of 1 µg m^{-3} though it should be noted there are only 15 SPAs in Wales. There was a small increase in the percentage of exceeded sites in England (2.6%) and no change in Northern Ireland (Table 4.6). Over 97% of the SPAs in England and nearly all 14 sites in Northern Ireland are exposed to ammonia concentrations above 1 µg m^{-3}.

The critical level of 3 µg m^{-3} is not exceeded for any SPAs in Wales and Scotland; this is consistent with the fact that <1% of the land area has ammonia concentrations above 3 µg m^{-3} (Table 4.6). Overall, the percentage of sites with ammonia concentrations above 3 µg m^{-3} is considerably smaller than the number exceeding the critical level of 1 µg m^{-3}. In Northern Ireland, three SPAs showed exceedance of the ammonia critical level of 3 µg m^{-3}, representing roughly a 7% increase since 2010 of the percentage of sites exceeded, to 21.4%.

Table 4.6: Percentage of SPAs with ammonia concentrations exceeding critical levels of 1 µg m^{-3} and 3 µg m^{-3} anywhere across a site.

		England	Wales	Scotland	NI	UK
[number of sites]		*[77]*	*[15]*	*[139]*	*[14]*	*[248*]*
1 µg m^{-3}	2009-2011	94.8	46.7	12.9	100.0	46.4
	2010-2012	94.8	40.0	14.4	100.0	46.8
	2011-2013	94.8	46.7	14.4	100.0	47.2
	2012-2014	94.8	53.3	14.4	100.0	47.6
	2013-2015	96.1	53.3	17.3	100.0	49.6
	2014-2016	97.4	60.0	17.3	100.0	50.4
	2015-2017	97.4	60.0	18.7	100.0	51.2
	2016-2018	97.4	66.7	20.9	100.0	52.8
	2017-2019	97.4	66.7	22.3	100.0	53.6
Change in % of sites exceeded, from 2010 to 2018		+2.6	+20.0	+9.4	0.0	+7.3
3 µg m^{-3}	2009-2011	9.1	0.0	0.0	14.3	3.6
	2010-2012	9.1	0.0	0.0	14.3	4.0
	2011-2013	9.1	0.0	0.0	14.3	4.0
	2012-2014	10.4	0.0	0.0	14.3	4.4
	2013-2015	10.4	0.0	0.0	14.3	4.4
	2014-2016	11.7	0.0	0.0	14.3	4.8
	2015-2017	11.7	0.0	0.0	14.3	5.2
	2016-2018	13.0	0.0	0.0	21.4	6.0
	2017-2019	13.0	0.0	0.0	21.4	6.0
Change in % of sites exceeded, from 2010 to 2018		+3.9	0.0	0.0	+7.1	+2.4

*includes 3 sites on the England/Wales border.

SSSIs

The percentage of SSSIs/ASSIs in the UK in areas where ammonia concentrations exceed the critical level of 1 µg m^{-3} increased by 7.1% between 2010 and 2018, to 78% (Table 4.7). Over 90% of the sites in England and Northern Ireland are in locations where this critical level is currently exceeded, as well as 74.2% of sites in Wales and 31.6% of sites in Scotland.

There was a small increase in the number of UK SSSIs/ASSIs showing exceedance of the 3 µg m^{-3} Critical Load for ammonia, with the number of sites exceeded increasing in every country. In particular, it is worth noting that between 2010 and 2018 there has been an 8.7% increase in the percentage of ASSIs in Northern Ireland that received ammonia concentrations above the critical level of 3 µg m^{-3}. England and Wales showed small increases <5%, and Scotland showed a very slight increase (0.1%).

Table 4.7: Percentage of SSSIs (ASSIs in Northern Ireland) with ammonia concentrations exceeding critical levels of 1 µg m^{-3} and 3 µg m^{-3} anywhere across a site.

		England	Wales	Scotland	NI	UK
Number of sites		4,191	1,006	1,422	289	6,808
1 µg m^{-3}	2009-2011	89.3	60.6	19.7	97.6	70.9
	2010-2012	89.3	60.5	20.5	97.6	71.0
	2011-2013	89.2	60.2	20.0	97.6	70.8
	2012-2014	89.4	61.6	20.7	97.7	71.3
	2013-2015	90.5	64.0	22.5	98.3	72.7
	2014-2016	91.8	70.0	25.9	99.7	75.1
	2015-2017	91.3	64.5	24.6	97.9	73.7
	2016-2018	93.1	73.6	30.1	99.7	77.3
	2017-2019	93.5	74.2	31.6	99.7	78.0
Change in % of sites exceeded, from 2010 to 2018		+4.2	+13.5	+11.9	+2.1	+7.1
3 µg m^{-3}	2009-2011	3.8	1.7	0.0	15.9	3.2
	2010-2012	3.9	1.8	0.1	17.6	3.3
	2011-2013	3.3	1.7	0.1	14.5	2.9
	2012-2014	3.7	1.7	0.1	14.9	3.1
	2013-2015	3.5	1.7	0.1	16.3	3.1
	2014-2016	5.0	2.4	0.1	19.7	4.2
	2015-2017	5.0	1.6	0.1	17.0	4.0
	2016-2018	6.6	2.5	0.1	24.2	5.4
	2017-2019	6.8	2.4	0.1	24.6	5.5
Change in % of sites exceeded, from 2010 to 2018		+3.0	+0.7	+0.1	+8.7	+2.3

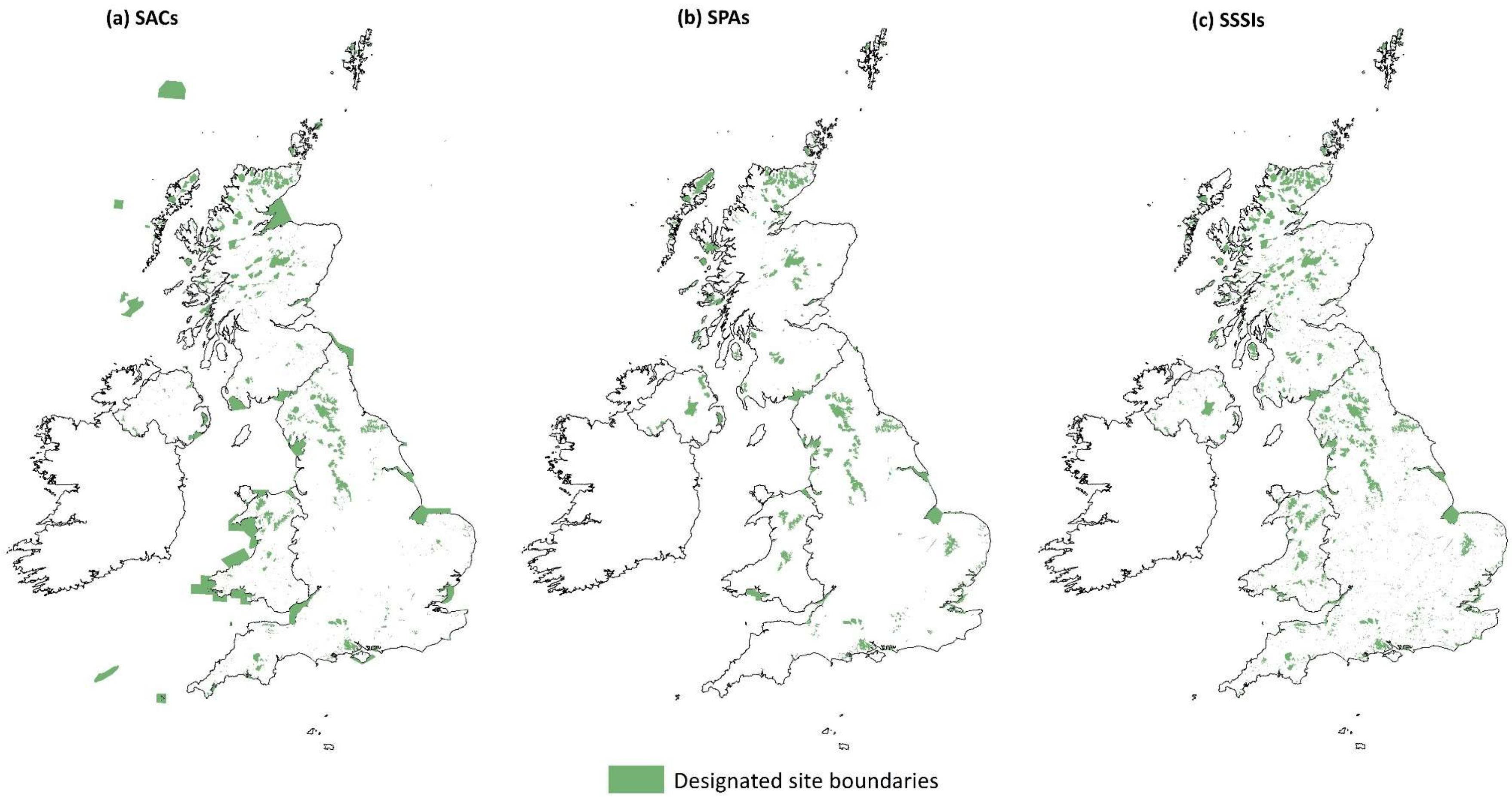


Figure 4.2: Distribution of SACs, SPAs and SSSIs / ASSIs in the UK.

Section 5: Nitrogen deposition onto protected sensitive habitats

An indicator of air pollution pressure, "total deposition of reactive N onto nutrient-N sensitive, protected, priority habitat" (abbreviated as N_{sens}) is included (Table 5.1) to illustrate progress towards the target for England in the UK Government's Clean Air Strategy (Defra, 2019). See sections 1.1 and 1.4. This indicator has only been calculated for the most recent 4-year periods for which deposition data are available, i.e. periods centred on 2016, 2017, 2018 and 2019. Progress towards the target is assessed relative to a baseline year of 2016. As noted in Section 1.4, revisions of the underlying habitat maps are unlikely to affect the reported trend. Currently, this indicator is showing a 3.5 % increase in England during the period 2016 to 2019. There are several potential explanations for the increased deposition, and these are being investigated. Ammonia emissions are lower than they were in the 1990s, but there was an increase in emissions between 2012 and 2016. Emissions have showed a slight decrease in the most recent data (Churchill et al., 2021). Measured NHx concentrations have shown marked decreases at the most polluted sites, but have increased at many less-polluted sites, resulting in an overall increase. This is likely to be due to a combination of factors: changes in the spatial pattern of ammonia emissions; chemical interaction with atmospheric SO_2 and NOx; and increasing temperatures causing greater ammonia emissions than the inventory predicts.

The CAS target applies only to England, but N_{sens} was also calculated for the Devolved Administrations, for comparison. The Devolved Administrations are considering atmospheric nitrogen pollution indicators and targets for their own countries, and these will be presented in future Trends Reports.

Table 5.1: Total deposition of reactive N onto nutrient-N sensitive priority habitat (N_{sens} in kg ha^{-1} year^{-1}, mean for 3-year periods centred on the year shown) by country.

Year	N_{sens} (kg N ha^{-1} year^{-1})				
	England (target)	Wales (comparison)	Scotland (comparison)	NI (comparison)	UK (comparison)
2016	27.9	22.9	11.7	25.9	18.0
2017	28.1	22.0	10.9	27.3	17.6
2018	29.0	21.7	11.0	29.3	18.0
2019	28.9	22.1	10.8	29.1	17.9
Percent change, 2016-2019	+3.5	-3.4	-7.5	+12.7	-0.9

References

Bobbink, R., Hettelingh, J., (2011) Review and revision of empirical critical loads and dose-response relationships: Proceedings of an expert workshop, Noordwijkerhout, 23-25 June 2010. Rijksinstituut voor Volksgezondheid en Milieu RIVM.

Braban, C.F., Stephens, A.M., Tang, Y.S., Twigg, M.M., Leeson, S.R., Jones, M.R., Simmons, I., Harvey, D., Kentisbeer, J., van Dijk, N., Nemitz, E., Roberts, E., Leaver, D., Andres, C., Smith, R., Banin, L., Sleep, D., Poskitt, J., Carter, H.T., Thacker, S., Patel, M., Tanna, B., Keenan, P.O., Pereira, G., Lawlor, A.J., Warwick, A., Farrand, P., Sutton, M.A. (2021) UK Eutrophying and Acidifying Atmospheric Pollutant project's National Ammonia Monitoring Network (NAMN). https://ukair.defra.gov.uk/networks/network-info?view=nh3.

Calver, L., (2003) A suggested improved method for the quantification of critical loads of acidity for peat soils. University of York.

Calver, L.J., Cresser, M.S., Smart, R.P. (2004) Tolerance of Calluna vulgaris and peatland plant communities to sulphuric acid deposition. Chemistry and Ecology 20, 309-320.

Carnell, E., Hina, N., Sawicka, K., Rowe, E., (2022) Updating habitat maps for critical load exceedance calculations. UK Centre for Ecology & Hydrology.

CLRTAP, (2017) Mapping Manual.

Conolly, C., Vincent, K., Sanocka, A., Richie, S., Knight, D., Halser, S., Donovan, B., Osbourne, E., Sampford, A., Braban, C.F., Stephens, A.M., Tang, Y.S., Twigg, M.M., Leeson, S.R., Jones, M.R., Simmons, I., Harvey, D., Kentisbeer, J., van Dijk, N., Nemitz, E., Roberts, E., Leaver, D., Andres, C., Smith, R., Banin, L., Sleep, D., Poskitt, J., Carter, H.T., Thacker, S., Patel, M., Tanna, B., Keenan, P.O., Pereira, G., Lawlor, A.L., Warwick, A., Farrand, P., Sutton, M.A. (2018) UKEAP 2018 Annual report. Prepared for the Environment Agency & Defra and the devolved administration by NERC Centre for Ecology & Hydrology & Ricardo Environment and Energy. 64 pp. https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2109211306_UKEAP_annual_report_2018.pdf.

Defra, (2019) Clean Air Strategy 2019. https://www.gov.uk/government/publications/clean-airstrategy-2019.

Dore, A.J., Vieno, M., Tang, Y.S., Dragosits, U., Dosio, A., Weston, K.J., Sutton, M.A. (2007) Modelling the atmospheric transport and deposition of sulphur and nitrogen over the United Kingdom and assessment of the influence of SO2 emissions from international shipping. Atmospheric Environment 41, 2355-2367.

Evans, C., Artz, R., Moxley, J., Smyth, M.-A., Taylor, E., Archer, N., Burden, A., Williamson, J., Donnelly, D., Thomson, A., Buys, G., Malcolm, H., Wilson, D., Renou-Wilson, F., (2017) Implementation of an emission inventory for UK peatlands. . Report to the Department for Business, Energy and Industrial Strategy, Centre for Ecology and Hydrology, Bangor., p. 88.

Fournier, N., Dore, A.J., Vieno, M., Weston, K.J., Dragosits, U., Sutton, M.A. (2004) Modelling the deposition of atmospheric oxidised nitrogen and sulphur to the United Kingdom using a multi-layer long-range transport model. Atmospheric Environment 38, 683-694.

Fowler, D., Cape, J.N., Leith, I.D., Choularton, T.W., Gay, M.J., Jones, A. (1988) The influence of altitude on rainfall composition at great dun fell. Atmospheric Environment (1967) 22, 1355-1362.

Fuller, R.M., Smith, G.M., Sanderson, J.M., Hill, R.A., Thomson, A.G., Cox, R., Brown, N.J., Clarke, R.T., Rothery, P., Gerard, F.F., (2002) Land Cover Map 2000 (1km dominant target class, GB). NERC Environmental Information Data Centre.

Gammack, S.M., Smith, C.M.S., Cresser, M.S., (1995) The approach used for mapping critical loads for ombrotrophic peats in Great Britain., in: Battarbee, R.W. (Ed.), Proceedings of a Conference on Acid Rain and its Impact: The Critical Loads Debate. Ensis Publishing, London., pp. 180-183.

Hall, J., Curtis, C., Dore, T., Smith, R., (2015) Methods for the calculation of critical loads and their exceedances in the UK. Report to Defra under contract AQ0826. Centre for Ecology and Hydrology.

Hallsworth, S., Dore, A.J., Bealey, W.J., Dragosits, U., Vieno, M., Hellsten, S., Tang, Y.S., Sutton, M.A. (2010) The role of indicator choice in quantifying the threat of atmospheric ammonia to the 'Natura 2000' network. Environmental Science & Policy 13, 671-687.

Henriksen, A., Posch, M. (2001) Steady-state models for calculating critical loads of acidity for surface waters. Water, Air and Soil Pollution: Focus 1, 375-398.

Hettelingh, J.-P., Posch, M., De Smet, P.A.M., Downing, R.J. (1995) The use of critical loads in emission reduction agreements in Europe. Water, Air, and Soil Pollution 85, 2381-2388.

Hornung, M., Bull, K., Cresser, M., Hall, J., Langan, S., Loveland, P., Smith, C. (1995) An empirical map of critical loads for soils in Great Britain. Environmental Pollution 90, 301-310.

Moss, D., Davies, C.E., (2002) Cross-references between the EUNIS habitat classification and the nomenclature of CORINE Land Cover. NERC/Centre for Ecology & Hydrology, p. 44.

Nilsson, J., Grennfelt, P., (1988) Critical loads for sulphur and nitrogen. Report 188:15. UNECE/Nordic Council of Ministers, Copenhagen, Denmark.

Posch, M., de Smet, P.A.M., Hettelingh, J.-P., (1999) Critical loads and their exceedances in Europe: an overview, in: M., P., P.A.M., d.S., J.-P., H., R.J., D. (Eds.), Calculation and Mapping of Critical Thresholds in Europe: Status Report 1999. Coordination Centre for Effects, RIVM, Bilthoven, Netherlands, pp. 3-11.

Posch, M., de Vries, W., Hettelingh, J.-P., (1995) Critical loads of sulphur and nitrogen, in: M., P., P.A.M., d.S., J.-P., H., R.J., D. (Eds.), Calculation and Mapping of Critical Thresholds in Europe: Status Report 1995. Coordination Centre for Effects, RIVM, Bilthoven, Netherlands, pp. 31-41.

Posch, M., Hettelingh, J.-P., (1997) Remarks on critical load calculations, in: M., P., P.A.M., d.S., J.-P., H., R.J., D. (Eds.), Calculation and Mapping of Critical Thresholds in Europe: Status Report 1997. Coordination Centre for Effects, RIVM, Bilthoven, Netherlands, pp. 25-28.

RoTAP, (2012) Review of Transboundary Air Pollution: Acidifcation, Eutrophication, Ground Level Ozone and Heavy Metals in the UK. Contract Report to the Department for Environment, Food and Rural Affairs. Centre for Ecology and Hydrology.

Rowe, E., Sawicka, K., Tomlinson, S., Levy, P., Banin, L.F., Martín Hernandez, C., Fitch, A., Jones, L., (2021) Trends Report 2021: Trends in critical load and critical level exceedances in the UK. Report to Defra under Contract AQ0849. CEH Project: 07617., p. 67.

Rowe, E.C., Jones, L., Dise, N.B., Evans, C.D., Mills, G., Hall, J., Stevens, C.J., Mitchell, R.J., Field, C., Caporn, S.J., Helliwell, R.C., Britton, A.J., Sutton, M., Payne, R.J., Vieno, M., Dore, A.J., Emmett, B.A. (2017) Metrics for evaluating the ecological benefits of decreased nitrogen deposition. Biological Conservation 212, 454-463.

Singles, R., Sutton, M.A., Weston, K.J. (1998) A multi-layer model to describe the atmospheric transport and deposition of ammonia in Great Britain. Atmospheric Environment 32, 393-399.

Skiba, U., Cresser, M. (1989) Prediction of long-term effects of rainwater acidity on peat and associated drainage water chemistry in upland areas. Water Research 23, 1477-1482.

Smith, C.M.S., Cresser, M.S., Mitchell, R.D.J. (1992) Sensitivity to acid deposition of dystrophic peat in Great Britain. Ambio 22, 22-26.

Smith, R.I., Fowler, D., Sutton, M.A., Flechard, C., Coyle, M. (2000) Regional estimation of pollutant gas dry deposition in the UK: model description, sensitivity analyses and outputs. Atmospheric Environment 34, 3757-3777.

SNIFFER, (2007) Source attribution and critical loads assessment for Special Areas of Conservation and Special Protection Areas in the UK. Final Report to SNIFFER for Project AQ02. Centre for Ecology and Hydrology, Edinburgh, p. 47.

Stephens, A., Tang, Y., Braban, C., Dos Santos Pereira, G., Tanna, B., Hunt, A., Keenan, P., Guyatt, H., Thacker, S., Salisbury, E., Smith, H., Shield, J., Leaver, D., Lobo-Guerrero Villegas, J.P., (2021) UKEAP (UK Eutrophying and Acidifying Atmospheric Pollutants) 2020 dataset: Acid Gas and Aerosol Network (AGANet). April 2021. https://uk-air.defra.gov.uk/data/.

Sverdrup, H., De Vries, W. (1994) Calculating critical loads for acidity with the simple mass balance method. Water, Air, and Soil Pollution 72, 143-162.

Sverdrup, H., De Vries, W., Henriksen, A. (1990) Mapping critical loads: a guidance to the criteria, calculations, data collection and mapping of critical loads. Nordic Council of Ministers [etc.].

Tang, Y.S., Braban, C.F., Dragosits, U., Dore, A.J., Simmons, I., van Dijk, N., Poskitt, J., Pereira, G.D., Keenan, P.O., Conolly, C., Vincent, K., Smith, R.I., Heal, M.R., Sutton, M.A. (2018a) Drivers for spatial, temporal and long-term trends in atmospheric ammonia and ammonium in the UK. Atmospheric Chemistry and Physics 18, 705-733.

Tang, Y.S., Braban, C.F., Dragosits, U., Simmons, I., Leaver, D., van Dijk, N., Poskitt, J., Thacker, S., Patel, M., Carter, H., Pereira, M.G., Keenan, P.O., Lawlor, A., Conolly, C., Vincent, K., Heal, M.R., Sutton, M.A. (2018b) Acid gases and aerosol measurements in the UK (1999-2015): regional distributions and trends. Atmospheric Chemistry and Physics 18, 16293-16324.

UNECE, (2007) Report on the Workshop on Atmospheric Ammonia: Detecting Emission Changes and Environmental Impacts. United Nations Economic and Social Council (UNECE), Executive body for the Convention of Long-Range Transboundary Air pollution: Working Group on Strategies and Review, Geneva.

Vieno, M., Dore, A.J., Bealey, W.J., Stevenson, D.S., Sutton, M.A. (2010) The importance of source configuration in quantifying footprints of regional atmospheric sulphur deposition. Science of the Total Environment 408, 985-995.

Annex: Critical load exceedances by habitat and country

This Annex contains summary critical load exceedance statistics for acidity and for nutrient nitrogen by habitat, with separate tables for each UK country.

Acidity results: Tables A1-A8

Nutrient nitrogen results: Tables N1-N8

Table A1: Acid-sensitive habitat area in England and percentage area of habitats where the acidity critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
Habitat area (km^2)	4,545	1,000	2,608	1,782	366	3,540	9,588	1,109	23,429
	Percentage of habitat area where acidity critical load is exceeded								
2009-2011	90.0	13.9	86.7	97.7	100.0	83.4	64.9	49.8	75.9
2010-2012	90.1	14.0	87.3	97.7	100.0	83.1	64.1	50.1	75.6
2011-2013	90.7	13.9	86.6	97.9	100.0	83.1	63.9	49.5	75.5
2012-2014	90.3	13.5	85.6	97.7	100.0	81.5	62.2	49.5	74.4
2013-2015	90.5	13.5	85.0	97.9	100.0	81.6	61.8	49.0	74.2
2014-2016	89.7	13.2	83.3	97.5	100.0	80.6	61.1	49.0	73.4
2015-2017	89.0	9.9	80.4	97.3	100.0	79.5	60.0	48.9	72.1
2016-2018	88.0	9.6	79.9	97.2	100.0	79.5	60.6	47.6	72.1
2017-2019	88.1	10.0	80.6	97.3	100.0	80.1	61.4	47.6	72.7
2018-2020	88.2	9.3	82.0	97.2	100.0	81.1	61.3	47.2	72.9
Reduction in % area exceeded, 2010 - 2019	1.8	4.6	4.7	0.5	0.0	2.3	3.6	2.6	2.9

Table A2: Excess Acidity in England: Average Accumulated Exceedance for acidity (in keq ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
	AAE (keq ha^{-1} $year^{-1}$)								
2009-2011	1.18	0.09	0.88	1.49	1.85	1.42	0.89	0.76	1.05
2010-2012	1.17	0.08	0.87	1.51	1.80	1.37	0.83	0.78	1.02
2011-2013	1.22	0.08	0.85	1.54	1.94	1.33	0.79	0.77	1.01
2012-2014	1.14	0.08	0.79	1.46	1.84	1.23	0.72	0.75	0.93
2013-2015	1.17	0.07	0.77	1.48	1.97	1.21	0.68	0.70	0.92
2014-2016	1.11	0.07	0.74	1.39	1.82	1.18	0.67	0.69	0.89
2015-2017	0.97	0.05	0.66	1.19	1.50	1.13	0.65	0.63	0.81
2016-2018	0.87	0.04	0.64	1.08	1.22	1.16	0.70	0.62	0.81
2017-2019	0.85	0.05	0.66	1.09	1.16	1.22	0.77	0.62	0.84
2018-2020	0.88	0.04	0.65	1.06	1.16	1.28	0.75	0.56	0.84
Reduction in AAE, 2010 - 2019	0.30	0.05	0.23	0.43	0.69	0.15	0.14	0.19	0.21

Table A3: Acid-sensitive habitat area in Wales and percentage area of habitats where the acidity critical load is exceeded, by deposition dataset year

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
Habitat area (km^2)	4,444	1	677	193	17	1,590	2,152	1,225	9,075
	Percentage of habitat area where acidity critical load is exceeded								
2009-2011	93.0	40.7	84.6	99.1	100.0	77.1	60.3	47.0	82.0
2010-2012	93.1	40.7	85.6	99.1	100.0	77.0	58.8	47.4	81.7
2011-2013	93.1	40.2	86.0	99.1	100.0	78.5	60.8	50.4	82.5
2012-2014	93.1	40.7	85.6	99.1	100.0	75.7	54.0	47.2	80.3
2013-2015	93.1	40.7	85.1	99.2	100.0	77.0	55.7	49.4	80.9
2014-2016	93.2	40.7	85.3	99.2	100.0	77.4	55.9	49.4	81.2
2015-2017	92.9	39.6	84.1	99.1	100.0	73.7	51.6	46.5	79.2
2016-2018	92.8	39.6	82.2	99.1	100.0	70.7	50.0	34.2	78.1
2017-2019	92.7	45.6	79.1	98.9	100.0	69.5	50.8	30.1	77.8
2018-2020	92.4	49.5	77.8	98.7	100.0	69.5	51.6	28.5	77.7
Reduction in % area exceeded, 2010 - 2019	0.6	-8.8	6.8	0.4	0.0	7.6	8.8	18.5	4.2

Table A4: Excess Acidity in Wales: Average Accumulated Exceedance for acidity (in keq ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
	AAE (keq ha^{-1} $year^{-1}$)								
2009-2011	0.82	0.12	0.54	0.73	1.49	0.95	0.53	0.38	0.75
2010-2012	0.84	0.11	0.56	0.77	1.52	0.93	0.50	0.41	0.76
2011-2013	0.90	0.12	0.62	0.83	1.64	0.98	0.51	0.45	0.80
2012-2014	0.87	0.13	0.61	0.79	1.61	0.90	0.44	0.40	0.75
2013-2015	0.91	0.12	0.65	0.85	1.67	0.93	0.45	0.45	0.79
2014-2016	0.93	0.12	0.66	0.87	1.69	0.94	0.45	0.48	0.80
2015-2017	0.82	0.07	0.55	0.76	1.50	0.84	0.41	0.40	0.70
2016-2018	0.73	0.09	0.48	0.60	1.24	0.77	0.40	0.29	0.64
2017-2019	0.67	0.15	0.44	0.51	1.04	0.74	0.41	0.22	0.60
2018-2020	0.69	0.26	0.44	0.48	1.03	0.73	0.43	0.19	0.61
Reduction in AAE, 2010 - 2019	0.14	-0.14	0.11	0.26	0.46	0.21	0.09	0.19	0.14

Table A5: Acid-sensitive habitat area in Scotland and percentage area of habitats where the acidity critical load is exceeded, by deposition dataset year

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
Habitat area (km^2)	10,928	0	17,604	6,295	4,526	10,314	4,847	5,337	54,512
	Percentage of habitat area where acidity critical load is exceeded								
2009-2011	75.9	0.0	17.8	37.6	85.2	82.7	60.9	14.0	53.5
2010-2012	72.3	0.0	16.6	36.8	81.6	81.1	58.6	13.9	51.4
2011-2013	77.2	0.0	17.1	34.0	88.3	83.6	61.4	14.0	53.5
2012-2014	75.3	0.0	16.9	34.2	86.8	81.9	59.0	14.0	52.5
2013-2015	79.8	0.0	19.5	37.4	93.0	83.7	61.2	14.9	55.6
2014-2016	77.8	0.0	17.8	32.7	90.9	80.5	57.6	14.4	53.0
2015-2017	71.4	0.0	11.2	25.8	82.0	73.9	51.7	12.5	46.3
2016-2018	61.3	0.0	8.8	22.9	58.1	66.5	42.6	9.2	39.0
2017-2019	59.8	0.0	8.5	22.8	53.2	67.6	43.8	9.2	38.4
2018-2020	61.2	0.0	7.8	20.6	52.5	67.6	43.6	8.7	38.2
Reduction in % area exceeded, 2010 - 2019	14.8	0.0	10.1	16.9	32.7	15.1	17.3	5.3	15.3

Table A6: Excess Acidity in Scotland: Average Accumulated Exceedance for acidity (in keq ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
	AAE (keq ha^{-1} $year^{-1}$)								
2009-2011	0.46	0.00	0.06	0.13	0.47	0.74	0.40	0.11	0.34
2010-2012	0.45	0.00	0.06	0.12	0.44	0.71	0.37	0.10	0.33
2011-2013	0.48	0.00	0.05	0.13	0.46	0.75	0.40	0.11	0.34
2012-2014	0.45	0.00	0.05	0.12	0.45	0.69	0.35	0.11	0.32
2013-2015	0.53	0.00	0.06	0.12	0.56	0.73	0.39	0.11	0.36
2014-2016	0.48	0.00	0.05	0.10	0.51	0.65	0.34	0.10	0.32
2015-2017	0.37	0.00	0.03	0.08	0.34	0.54	0.27	0.08	0.25
2016-2018	0.29	0.00	0.02	0.07	0.21	0.49	0.24	0.07	0.20
2017-2019	0.27	0.00	0.02	0.08	0.18	0.51	0.25	0.07	0.20
2018-2020	0.26	0.00	0.02	0.07	0.16	0.49	0.24	0.06	0.19
Reduction in AAE, 2010-2019	0.21	0.00	0.04	0.06	0.31	0.25	0.16	0.05	0.15

Table A7: Acid-sensitive habitat area in Northern Ireland and percentage area of habitats where the acidity critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
Habitat area (km^2)	448	10	957	848	6	490	768	186	3,527
	Percentage of habitat area where acidity critical load is exceeded								
2009-2011	94.6	22.1	75.2	93.0	93.3	94.5	81.6	36.2	85.9
2010-2012	94.3	19.9	73.2	92.6	93.3	94.5	80.9	36.2	85.1
2011-2013	94.1	16.4	71.7	92.6	93.3	94.4	80.6	36.2	84.5
2012-2014	93.4	15.0	70.2	91.7	93.3	93.9	79.6	32.6	83.5
2013-2015	92.8	14.7	68.5	91.2	93.3	93.8	79.1	32.1	82.7
2014-2016	92.4	13.7	66.5	90.5	93.3	93.6	79.0	25.1	81.9
2015-2017	91.6	13.3	62.9	89.4	93.3	93.6	79.2	23.5	80.6
2016-2018	93.1	14.7	66.9	90.8	93.3	94.0	80.0	32.4	82.5
2017-2019	94.1	19.2	71.9	91.9	93.3	94.5	81.4	32.4	84.6
2018-2020	93.8	19.2	70.6	91.9	93.3	94.5	81.4	32.4	84.2
Reduction in % area exceeded, 2010-2019	0.8	2.9	4.6	1.1	0.0	0.1	0.2	3.8	1.7

Table A8: Excess Acidity in Northern Ireland: Average Accumulated Exceedance for acidity (in keq ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved and mixed woodland	Freshwaters	All habitats
	AAE (keq ha^{-1} $year^{-1}$)								
2009-2011	1.06	0.13	0.60	1.02	1.42	1.93	1.71	0.34	1.19
2010-2012	0.99	0.10	0.55	0.96	1.36	1.83	1.62	0.31	1.12
2011-2013	0.99	0.10	0.53	0.96	1.29	1.84	1.57	0.30	1.10
2012-2014	0.91	0.08	0.47	0.88	1.25	1.69	1.43	0.26	1.00
2013-2015	0.85	0.07	0.41	0.84	1.06	1.65	1.41	0.23	0.96
2014-2016	0.79	0.07	0.38	0.79	0.99	1.57	1.36	0.20	0.91
2015-2017	0.73	0.07	0.37	0.74	1.00	1.51	1.36	0.20	0.88
2016-2018	0.83	0.08	0.45	0.81	1.16	1.61	1.46	0.23	0.97
2017-2019	0.93	0.10	0.54	0.89	1.32	1.77	1.62	0.29	1.08
2018-2020	0.92	0.10	0.53	0.88	1.37	1.76	1.62	0.29	1.07
Reduction in AAE, 2010-2019	0.13	0.02	0.07	0.14	0.05	0.18	0.09	0.05	0.12

Table N1: Nutrient-sensitive habitat area in England and percentage area of habitats where the nutrient nitrogen critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
Habitat area (km^2)	4,545	1,000	2,608	1,782	366	3,540	5,950	1,753	3,222	0	538	199	535	26,038
	Percentage of habitat area where nutrient-N critical load is exceeded													
2009-2011	99.4	89.7	98.9	100	100	99.7	100.0	100.0	100	NA	100.0	73.7	11.6	97.3
2010-2012	99.3	89.7	99.1	100	100	99.7	100.0	100.0	100	NA	100.0	71.6	11.3	97.3
2011-2013	99.3	89.2	99.2	100	100	99.7	100.0	100.0	100	NA	100.0	68.2	9.7	97.2
2012-2014	98.8	88.9	99.0	100	100	99.7	100.0	100.0	100	NA	100.0	63.7	5.0	97.0
2013-2015	99.4	89.3	98.7	100	100	99.7	100.0	100.0	100	NA	100.0	64.2	7.4	97.1
2014-2016	99.0	89.3	98.6	100	100	99.7	99.9	100.0	100	NA	100.0	61.3	4.9	97.0
2015-2017	97.5	89.3	98.6	100	100	99.7	99.9	99.8	100	NA	99.9	62.3	5.6	96.7
2016-2018	98.1	89.4	98.6	100	100	99.7	99.9	99.8	100	NA	99.9	61.4	6.8	96.8
2017-2019	98.0	89.7	98.5	100	100	99.7	99.8	99.8	100	NA	99.9	62.4	9.8	96.9
2018-2020	99.2	87.1	98.5	100	100	99.7	99.9	99.8	100	NA	99.9	64.2	8.2	97.0
Reduction in % area exceeded, 2010-2019	0.1	2.6	0.4	0.0	0.0	0.0	0.1	0.2	0.0	NA	0.0	9.5	3.4	0.4

Table N2: Excess Nitrogen in England: Average Accumulated Exceedance for nutrient-Nitrogen (in kg N ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
	AAE (kg N ha^{-1} $year^{-1}$)													
2009-2011	12.5	9.3	14.8	17.9	25.5	25.1	24.6	19.1	24.7	NA	24.0	4.0	0.5	19.5
2010-2012	12.0	8.6	14.3	17.7	24.7	23.9	23.1	17.8	23.4	NA	22.6	3.9	0.5	18.6
2011-2013	12.5	8.5	14.0	18.1	26.1	23.2	22.1	17.2	22.8	NA	21.7	3.6	0.3	18.2
2012-2014	11.5	8.0	13.4	17.2	24.8	21.7	20.7	16.0	21.3	NA	20.3	2.9	0.1	17.0
2013-2015	12.5	8.2	13.7	18.1	26.9	22.0	20.4	15.9	21.4	NA	20.3	3.0	0.1	17.3
2014-2016	12.1	8.3	13.7	17.5	25.7	21.9	20.7	16.0	21.4	NA	20.5	3.1	0.2	17.2
2015-2017	10.8	7.9	12.9	15.7	22.6	21.5	20.6	15.8	21.1	NA	20.3	3.1	0.2	16.6
2016-2018	9.6	8.1	12.9	14.7	19.6	22.1	21.9	16.8	21.8	NA	21.4	3.3	0.2	16.9
2017-2019	9.6	9.0	13.4	15.0	19.3	23.3	23.7	18.0	23.0	NA	23.0	3.7	0.4	17.8
2018-2020	10.0	8.5	13.2	14.6	19.2	23.9	23.5	17.7	22.7	NA	22.8	3.8	0.4	17.8
Reduction in AAE, 2010-2019	2.4	0.8	1.6	3.3	6.3	1.2	1.1	1.4	2.0	NA	1.1	0.2	0.2	1.7

Table N3: Nutrient-sensitive habitat area in Wales and percentage area of habitats where the nutrient nitrogen critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
Habitat area (km^2)	4,444	1	677	193	17	1,590	281	279	1,567	0	125	106	131	9,412
	Percentage of habitat area where nutrient-N critical load is exceeded													
2009-2011	98.3	98.9	95.9	100.0	100.0	99.7	100.0	100.0	100.0	NA	100.0	24.1	0.4	96.6
2010-2012	98.3	98.9	96.0	100.0	100.0	99.7	100.0	100.0	100.0	NA	100.0	23.7	0.4	96.6
2011-2013	99.1	98.9	96.8	100.0	100.0	99.7	100.0	100.0	100.0	NA	100.0	25.2	0.4	97.1
2012-2014	98.1	98.9	95.7	100.0	100.0	99.7	100.0	100.0	100.0	NA	100.0	22.8	0.4	96.5
2013-2015	98.9	98.9	95.9	100.0	100.0	99.7	100.0	100.0	100.0	NA	100.0	23.2	0.4	96.9
2014-2016	99.6	98.9	96.6	100.0	100.0	99.7	100.0	99.8	100.0	NA	100.0	25.0	0.4	97.3
2015-2017	99.0	98.9	95.9	100.0	100.0	99.7	100.0	98.5	100.0	NA	100.0	23.0	0.4	96.9
2016-2018	97.4	98.9	94.9	100.0	100.0	99.7	100.0	98.2	100.0	NA	100.0	16.8	0.4	96.0
2017-2019	94.3	98.9	94.8	100.0	100.0	99.7	100.0	97.7	100.0	NA	100.0	16.1	2.3	94.5
2018-2020	91.2	100.0	94.2	100.0	100.0	99.7	100.0	97.7	100.0	NA	100.0	14.8	6.6	93.1
Reduction in % area exceeded, 2010-2019	7.1	-1.1	1.6	0.0	0.0	0.0	0.0	2.3	0.0	NA	0.0	9.3	-6.2	3.5

Table N4: Excess nitrogen in Wales: Average Accumulated Exceedance for nutrient-Nitrogen (in kg N ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
	AAE (kg N ha^{-1} $year^{-1}$)													
2009-2011	7.8	6.2	11.0	10.4	19.0	20.7	15.0	16.0	19.5	NA	17.3	0.9	0.0	12.6
2010-2012	7.7	5.8	11.0	10.6	19.1	20.1	14.3	14.9	18.6	NA	16.5	0.8	0.0	12.3
2011-2013	8.2	5.7	11.6	11.1	20.3	20.7	14.4	15.0	18.9	NA	16.7	0.8	0.0	12.8
2012-2014	7.9	5.7	11.4	10.6	19.9	19.3	13.2	13.7	17.4	NA	15.4	0.7	0.0	12.0
2013-2015	8.9	5.9	12.4	11.9	21.5	20.5	13.7	14.4	18.3	NA	16.2	0.7	0.0	12.9
2014-2016	9.4	6.2	12.8	12.5	22.1	20.9	14.0	14.7	18.6	NA	16.5	0.8	0.0	13.4
2015-2017	8.4	5.3	11.8	11.5	20.3	19.7	13.2	13.8	17.7	NA	15.6	0.8	0.0	12.4
2016-2018	7.3	5.7	10.9	9.8	17.2	18.5	13.3	13.7	17.1	NA	15.3	0.8	0.0	11.4
2017-2019	6.9	7.4	10.5	8.9	15.3	17.9	13.9	14.3	17.2	NA	15.5	0.9	0.0	11.2
2018-2020	7.4	10.2	10.6	8.7	15.3	17.9	14.6	14.7	17.5	NA	16.0	1.0	0.1	11.5
Reduction in AAE, 2010-2019	0.4	-4.0	0.4	1.8	3.7	2.8	0.4	1.3	2.0	NA	1.3	-0.1	-0.1	1.1

Table N5: Nutrient-sensitive habitat area in Scotland and percentage area of habitats where the nutrient nitrogen critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
Habitat area (km²)	*10,928*	*0*	*17,604*	*6,295*	*4,526*	*8,829*	*1,867*	*28*	*2,038*	*1,485*	*336*	*258*	*141*	*54333*
	Percentage of habitat area where nutrient-N critical load is exceeded													
2009-2011	60.3	NA	35.4	27.5	98.4	87.3	85.7	100.0	90.6	57.0	83.6	24.0	1.0	57.8
2010-2012	57.5	NA	31.0	24.7	96.7	85.0	84.4	100.0	86.6	51.5	80.2	23.1	1.0	54.6
2011-2013	60.9	NA	34.2	26.9	99.2	88.4	86.2	100.0	92.3	63.3	86.6	13.9	1.0	57.9
2012-2014	59.3	NA	33.2	25.2	98.3	85.0	84.7	100.0	87.3	54.2	82.3	8.7	0.1	55.9
2013-2015	65.5	NA	38.2	26.3	99.7	87.6	86.1	100.0	91.2	64.9	87.1	9.9	0.8	60.0
2014-2016	64.5	NA	37.5	22.6	99.6	84.2	84.4	100.0	87.2	56.5	83.5	8.6	0.4	58.1
2015-2017	57.0	NA	31.0	20.2	98.6	82.0	83.2	100.0	84.0	44.8	80.3	8.0	0.4	53.2
2016-2018	50.0	NA	26.0	19.7	86.1	78.0	81.2	100.0	77.2	35.0	73.5	8.8	0.1	47.8
2017-2019	49.4	NA	26.1	19.7	79.0	79.6	82.2	100.0	78.8	36.6	74.2	17.0	0.9	47.6
2018-2020	47.0	NA	26.6	16.4	79.9	79.9	82.2	100.0	79.6	35.9	74.1	11.6	0.5	47.0
Reduction in % area exceeded, 2010-2019	13.4	NA	8.8	11.1	18.6	7.4	3.6	0.0	11.0	21.1	9.6	12.4	0.5	10.8

Table N6: Excess nitrogen in Scotland: Average Accumulated Exceedance for nutrient-Nitrogen (in kg N ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
	AAE (kg N ha^{-1} $year^{-1}$)													
2009-2011	3.4	0.0	1.6	1.4	6.5	11.0	10.7	9.3	8.0	4.0	9.2	0.6	0.0	4.5
2010-2012	3.3	0.0	1.4	1.3	5.9	10.5	10.3	9.0	7.3	3.6	8.8	0.5	0.0	4.3
2011-2013	3.5	0.0	1.4	1.4	6.4	11.1	9.9	9.4	7.9	4.1	8.7	0.4	0.0	4.5
2012-2014	3.3	0.0	1.4	1.3	6.3	10.3	8.9	8.2	7.2	3.8	7.8	0.3	0.0	4.2
2013-2015	4.1	0.0	1.7	1.4	8.0	11.0	9.4	8.5	8.1	4.5	8.4	0.3	0.0	4.8
2014-2016	3.8	0.0	1.6	1.3	7.6	10.1	8.9	8.2	7.4	4.0	7.8	0.3	0.0	4.5
2015-2017	2.9	0.0	1.2	1.1	5.9	9.0	8.2	7.4	6.4	3.2	7.1	0.3	0.0	3.7
2016-2018	2.4	0.0	1.0	1.1	3.9	8.5	8.1	6.9	5.8	2.6	6.8	0.3	0.0	3.2
2017-2019	2.4	0.0	1.1	1.1	3.5	9.0	9.1	7.5	6.3	2.7	7.7	0.4	0.0	3.4
2018-2020	2.2	0.0	1.0	1.1	3.2	8.8	9.0	7.5	6.1	2.4	7.5	0.4	0.0	3.2
Reduction in AAE, 2010-2019	1.2	0.0	0.6	0.3	3.4	2.2	1.7	1.8	1.9	1.6	1.7	0.2	0.0	1.3

Table N7: Nutrient-sensitive habitat areas in Northern Ireland and percentage area of habitats where the nutrient nitrogen critical load is exceeded, by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
Habitat area (km²)	*448*	*10*	*957*	*848*	*6*	*490*	*608*	*0*	*131*	*0*	*424*	*68*	*0*	*3,990*
	Percentage of habitat area where nutrient-N critical load is exceeded													
2009-2011	99.0	99.0	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	88.7	0.00	99.1
2010-2012	97.5	99.0	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	87.8	0.00	98.9
2011-2013	99.1	99.0	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	87.5	0.00	99.1
2012-2014	98.3	99.0	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	86.6	0.00	99.0
2013-2015	97.0	98.9	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	81.0	0.00	98.7
2014-2016	95.8	98.4	100.0	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	80.3	0.00	98.6
2015-2017	95.2	93.7	99.8	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	72.7	0.00	98.3
2016-2018	95.9	94.3	99.5	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	87.9	0.00	98.6
2017-2019	97.1	94.9	98.5	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	94.9	0.00	98.6
2018-2020	96.8	94.8	98.5	98.8	100.0	97.3	100.0	NA	100.0	NA	100.0	97.7	0.00	98.6
Reduction in % area exceeded, 2010-2019	2.2	4.2	1.5	0.0	0.0	0.0	0.0	NA	0.0	NA	0.0	-9.0	0.0	0.5

Table N8: Excess nitrogen in Northern Ireland: Average Accumulated Exceedance for nutrient-Nitrogen (in kg N ha^{-1} $year^{-1}$) by habitat by deposition dataset year.

	Acid grassland	Calcareous grassland	Dwarf shrub heath	Bog	Montane	Coniferous woodland	Broadleaved woodland	Beech woodland	Acidophilous oak woodland	Scots Pine woodland	Mixed woodland	Dune grassland	Saltmarsh	All habitats
	AAE (kg N ha^{-1} $year^{-1}$)													
2009-2011	11.5	10.8	14.6	15.5	21.7	26.5	29.6	NA	26.1	NA	27.3	4.4	0.00	19.7
2010-2012	10.4	9.3	13.6	14.4	20.8	24.9	27.7	NA	24.6	NA	25.6	3.8	0.00	18.4
2011-2013	10.5	9.4	13.4	14.5	20.2	25.1	26.6	NA	24.2	NA	25.2	3.6	0.00	18.2
2012-2014	9.5	8.2	12.5	13.3	19.7	23.0	24.2	NA	22.2	NA	23.0	3.2	0.00	16.7
2013-2015	8.9	8.2	11.8	13.0	17.8	22.7	24.2	NA	22.0	NA	22.8	2.8	0.00	16.3
2014-2016	8.2	7.4	11.3	12.3	17.0	21.6	23.8	NA	21.3	NA	22.0	2.6	0.00	15.6
2015-2017	7.8	7.3	11.2	11.8	17.4	21.2	24.2	NA	21.2	NA	21.9	2.7	0.00	15.5
2016-2018	9.3	8.3	12.7	13.0	19.5	22.8	26.1	NA	22.6	NA	23.6	3.7	0.00	17.0
2017-2019	10.7	9.6	14.3	14.2	21.9	25.2	29.4	NA	25.1	NA	26.4	4.9	0.00	19.0
2018-2020	10.5	9.4	14.1	14.0	22.3	24.9	29.3	NA	25.0	NA	26.3	4.9	0.00	18.8
Reduction in AAE, 2010-2019	1.0	1.3	0.5	1.5	-0.6	1.6	0.3	NA	1.1	NA	1.0	-0.5	0.0	0.9