England Biodiversity Indicators technical background document

Advice on the trends in acidity and nutrient nitrogen critical load exceedances

Updated: November 2023

Contents

Background information

This is the technical background document for:

- Indicator 19a - Trends in pressures on biodiversity: pollution

For further information on the England Biodiversity Indicators and the Trends in pressures on biodiversity: pollution indicator (19a) visit the England Biodiversity indicators page on GOV.UK.

Introduction

Critical loads are defined as thresholds below which significant harmful effects on sensitive habitats do not occur, according to present knowledge. When pollutant loads (atmospheric deposition) exceed the critical load, it is considered that there is a risk of harmful effects to sensitive habitats. Approximately 23,000 km^2 of terrestrial habitat areas in England are sensitive to acidification and about 26,000 km^2 are sensitive to nutrient nitrogen deposition (eutrophication). Many areas (almost 14,000 km^2) are sensitive to both. The excess deposition above the critical load is referred to as the ‘exceedance’.

Decreasing pollutant deposition to below the critical load reduces the risk of damage even when critical load has previously been exceeded. Where exceedance remains, reductions in the magnitude of exceedance may also benefit sensitive habitats and could allow some species to return, especially those for which conditions are only just unsuitable.

Methodology

There are 3 main steps in the assessment of the area of sensitive habitat that exceeds critical loads:

1. calculation of critical loads for each of the sensitive habitats
2. mapping of the habitats
3. identification of the area of habitat where deposition exceeds the critical load

While these 3 main steps remain valid, there have been two changes to the underlying methodology for the 2023 update of this indicator.

First, the critical loads of nutrient nitrogen (see below) were reviewed and revised in 2022, and the new values have been applied to the 2023 update of this indicator.

Second, a new calibration step has been added to the atmospheric chemistry and transport model used to estimate ammonia concentration. Outputs from the European Monitoring and Evaluation Programme (EMEP4UK) model are calibrated to measured concentrations from the UKEAP National Ammonia Monitoring Network (Stephens et al., 2021), using a proportional relationship to scale the modelled concentrations according to the measurements. This ensures that modelled outputs broadly reflect measured concentrations across the UK (see section 4.2 of the Air Pollution Trends Report 2023 for further details).

Table 1: The 14 habitats considered sensitive to acidification and/or eutrophication for which critical loads are calculated

Habitat	Critical loads calculated for acidification	Critical loads calculated for eutrophication
Acid grassland	Yes	Yes
Calcareous grassland	Yes	Yes
Dwarf shrub heath	Yes	Yes
Bog	Yes	Yes
Montane	Yes	Yes
Coniferous woodland	Yes	Yes
Beech woodland	No	Yes
Oak woodland on acid soil	No	Yes
Scots pine	No	Yes
Dune grassland	No	Yes
Saltmarsh	No	Yes
Mixed woodland	No	Yes
Freshwaters	Yes	No
Broadleaved and mixed woodland	Yes	No

Several methods are used to calculate critical loads for terrestrial habitats in England, based on either empirical (observational or experimental) evidence or mass-balance (input and output) data. Both types of method can be used to calculate critical loads for acidity and eutrophication, the choice of which method to use is determined by the habitat type.

Critical loads are reviewed and updated periodically as new research data becomes available. Critical loads for nutrient nitrogen were established in 2003 and revised in 2011. For all years, exceedance is calculated using the 2011 values for nutrient nitrogen critical loads. Details of the revision can be found in the 2011 UK Status Report and the 2015 Methods Report, available on the Critical Loads and Dynamic Modelling website. The latest revision of nutrient nitrogen critical loads was published in October 2022 and has been included in the 2023 update of this indicator. Most of the critical loads have been reduced (become stricter) and in most cases, the reliability of these values has increased. Details can be found in the Review and revision of empirical critical loads of nitrogen for Europe. The method for calculating acidity critical loads remain unchanged from those published earlier (see Air Pollution Trends Report 2023).

The trends in critical loads exceedances are calculated using deposition maps based on the Concentration Based Estimated Deposition (CBED) methodology. To identify the area exceeding critical loads, deposition maps based on a 5km x 5km grid covering the UK are produced based on the sum of wet deposition, dry deposition and cloud deposition (see UK Pollutant Deposition page on UKCEH website for further details). These deposition data are overlain on maps of critical loads for each habitat to calculate critical load exceedances and the areas of habitat exceeded. Critical loads data for freshwaters (not reported here; see Air Pollution Trends Report 2023) are available for 1,752 sites selected across the UK where water samples have been collected and analysed – these data do not provide complete UK coverage. The critical loads data for all the other habitats listed in are based on national-scale habitat distribution maps. In all years, a three-year rolling average deposition figure is used to smooth substantial year-to-year variability caused by the influence of weather on atmospheric chemistry and time periods are referred to using the middle year of the three; for example, “2010” means the period 2009 to 2011.

Further information on how critical loads are calculated and detailed critical load exceedance maps are available on the Critical Loads and Dynamic Modelling website.

Critical loads for acidification and nutrient nitrogen have also been applied to interest features of protected sites (Special Areas of Conservation, Special Protection Areas and Areas and Sites of Special Scientific Interest). Further information on critical load exceedance on protected sites is available on the Air Pollution Information System (APIS) website.

Average Accumulated Exceedance

NB: The example calculations below have used data from a previous version of this indicator. The calculation will be updated in the next publication of this indicator.

The percentage area of habitat with exceedance of critical loads is a useful metric but it can be insensitive to changes between years, since the area exceeded can remain the same even if there is a change in the magnitude of the exceedance. The ‘Average Accumulated Exceedance’ (AAE) averages the exceedance across the entire habitat area and so gives an indication of change in the magnitude of exceedance.

AAE is calculated as:

(exceedance × exceeded habitat area) ÷ (total sensitive habitat area)

The trend results show that the area of sensitive habitats in England exceeding acidity critical loads decreased from 75.9% in 2010 to 72.9% in 2019; over this timescale the magnitude of exceedance (AAE) has fallen by 25%, from 1.05 keq ha^{-1} year^{-1} in 2010 to 0.84 keq ha^{-1} year^{-1} in 2019. During the same period, the area of sensitive habitats where eutrophying pollutants (nutrient nitrogen) exceed critical loads fell slightly from 97.3% to 97.0% and the AAE in England decreased by almost 10%, from 19.5 kg ha^{-1} year^{-}1 to 17.8 kg N ha^{-1} year^{-1}.

Note that the results include some changes reported as percentages, for example, ‘The short-term trend between 2015 and 2020 showed a 6% decrease in the area affected by acidity’. These percentages do not refer to absolute change, in which going from 50% of land area exceeded to 25% exceeded would be considered a 25% decrease. They refer to relative change, for example, going from 50% of land area exceeded to 25% exceeded is considered a 50% decrease.