Defra project AQ0834 - Identification of Potential "Remedies" for Air Pollution (nitrogen) Impacts on Designated Sites (R.A.P.I.D.S.)

Appendix 7 - Critical loads and Critical Levels

Jane Hall[1] & Ron Smith[2]

CEH Bangor, Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW

CEH Edinburgh, Bush Estate, Penicuik, Midlothian, EH26 0QB

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Key Messages

- Critical loads and critical levels are nationally (and internationally) agreed effects-based approaches for assessing the potential impacts of atmospheric pollutants on sensitive habitats or ecosystems.
- Using CBED 5km nitrogen deposition for 2010-12, critical loads of nutrient nitrogen (eutrophication) are exceeded across 65% of the area of sensitive habitats in the UK, with an average accumulated exceedance (AAE) of 7.4 kg N ha^{-1} $year^{-1}$. It should be noted that nitrogen deposition (NO_x and NH_x) can also contribute to acidification, not discussed in this Appendix.
- The minimum Site Relevant critical loads (SRCL) of nutrient nitrogen are exceeded for at least one designated feature for ~90% of UK SACs and SSSIs, based on CBED deposition for 2009-11. The SRCL database and exceedance calculations will be updated during 2014.
- Digital information on the area and location of designated features is not available and therefore the SRCL exceedance analysis assumes that all features can occur everywhere across the site; when summarising the results to the UK-level, the potential maximum exceeded area of any feature is used.
- Ammonia concentrations (based on 5km data for 2010-12) exceed the critical level of 1µg m^{-3} across 66.5% of the land area of the UK, and exceed the critical level of 3µg m^{-3} across 9% of the land area of the UK.

1. Introduction

Critical loads are defined as the amount of pollutant deposition below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge (Nilsson & Grennfelt, 1988). Where a critical load refers to deposition of pollutants, critical levels refer to pollutant concentrations in the atmosphere. When the pollutant deposition (or concentration) exceeds the critical load (or critical level) there is a potential for harmful effects to the receptor (i.e., soil, water, vegetation). The excess deposition or concentration is referred to as the "exceedance". This Appendix provides a brief overview of the application of nitrogen critical loads and ammonia critical levels in the UK, as well as the latest exceedance results; further details on the data and methods used can be found in Hall et al (2011, 2014a, 2014b).

2. Critical loads of nutrient nitrogen for UK habitats

Critical loads for nutrient nitrogen (eutrophication) are calculated and mapped nationally for 13 habitats sensitive to eutrophication in the UK (Hall et al, 2014a). There are two main methods for deriving critical loads:

(i) empirical approaches where the critical loads are based on relatively short-term (1-5 years) experiments or field evidence for the ecosystem response to nitrogen deposition (Bobbink & Hettelingh, 2011; Hall et al, 2011);

(ii) mass balance models or equations, which balance the long-term chemical inputs to and outputs from a system, and represent steady-state conditions.

In the UK the mass balance approach is applied to managed (productive) woodland habitats, and the empirical approach is applied to unmanaged woodlands and other sensitive habitats (Hall et al, 2014a). Using correspondence tables (footnote) the UK habitats sensitive to eutrophication have been related to the European EUNIS habitat classes (Davies & Moss, 2002), used by Hettelingh & Bobbink (2011) for assigning empirical nitrogen critical loads to different ecosystems. The empirical critical loads are expressed as a range; exceedances are calculated using the agreed UK "mapping value" (Table 1) from within the range and based on UK evidence of nitrogen impacts (Hall et al, 2011; 2014a).

Critical loads for terrestrial habitats are mapped at 1km resolution and national deposition data are currently available on a 5km grid. Exceedances are calculated separately for each habitat type using habitat-specific deposition values: mean deposition to moorland (i.e., low-growing vegetation) is applied to the coastal, grassland, heathland and montane habitats; mean deposition to forests is applied to all woodland habitats. Exceedances are calculated at 1km resolution by assuming that deposition values remain constant across each 5km grid square. Once these exceedance values have been derived, additional exceedance metrics are calculated to provide summary statistics by habitat and country (e.g., Table 2). These include:

- Area of habitat exceeded; this is derived from the habitat distribution maps generated specifically for UK critical loads research (Hall et al, 2014).
- Percentage area of habitat exceeded.
- Accumulated Exceedance (AE) which takes account of both the area exceeded and the magnitude of exceedance:

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

- Average Accumulated Exceedance (AAE) which averages the exceedance across the entire habitat area; this metric gives an indication of a change in the magnitude of exceedance even if there is no change in the percentage area of habitat exceeded.

The summary statistics (Table 2) show the average exceedance (AAE) for all habitats to be 7.4 kg N ha^{-1} year^{-1}, based on nitrogen deposition data for 2010-12, with AAE values ranging from 0.05 kg N ha^{-1} year^{-1} for saltmarsh, to 21.5 kg N ha^{-1} year^{-1} for unmanaged woodland. The results for all habitats can also be summarised and combined into a single map of AAE (Figure 1); this shows the north and west of Scotland as the only areas with deposition below nitrogen critical loads. Exceedance is widespread across the rest of the country, with exceedances > 14 kg N ha^{-1} year^{-1} for many areas. The summary exceedance statistics and maps are updated annually with the latest 3-year mean deposition (Hall et al, 2014b).

Table 1: Empirical critical loads of nutrient nitrogen for habitats currently mapped nationally in the UK. Reliability scores assigned at Noordwijkerhout workshop in 2010 (Bobbink & Hettelingh, 2011):

reliable: when a number of published papers of various studies showed comparable results.
quite reliable: when the results of some studies were comparable.
(#) expert judgement: when no empirical data were available for the ecosystem; critical load based upon expert judgement and knowledge of ecosystems which were likely to be comparable with this ecosystem.

UK Habitat mapped for critical loads	**EUNIS class(es)**	**Critical load range (kg N ha^{-1} year^{-1})**	**UK Mapping Value (kg N ha^{-1} year^{-1})**
Acid grassland (wet & dry)	E1.7[c] E3.52	10-15[##] 10-20[#]	10 15
Calcareous grassland	E1.26	15-25[##]	15
Dwarf shrub heath (wet & dry)	F4.11[b,d] F4.2[b,d]	10-20[#] 10-20[##]	10 10
Bog	D1[b]	5-10[##]	8, 9, 10 depending on rainfall[(1)]
Montane	E4.2	5-10[#]	7
Coniferous woodland (managed)	G3	Mass balance equation used	
Broadleaved woodland (managed)	G1	Mass balance equation used	
Beech woodland (unmanaged)	G1.6	10-20[(#)]	15
Acidophilous oak woodland (unmanaged)	G1.8	10-15[(#)]	10
Scots pine woodland (unmanaged)	G3.4	5-15[#]	12
Unmanaged woodland (coniferous and/or broadleaved)	G4	Conifer 5-15[##] Broadleaf 10-20[##]	12
Dune grassland	B1.4[a]	8-15[#]	9 acid dunes 12 non-acid dunes
Saltmarsh	A2.5	20-30[(#)]	25

[(1)]As defined in Hall et al (2011; 2014b).

[a] For acidic dunes, the 8-10 kg N ha^{-1} year^{-1} range should be applied; for calcareous dunes the 10-15 kg N ha^{-1} year^{-1} range should be applied.

[b] Apply the high end of the range to areas with high levels of precipitation and the low end of the range to areas with low levels of precipitation; apply the low end of the range to systems with a low water table, and the high end of the range to systems with a high water table. Note: water tables can be modified by management.

[c] Apply the lower end of the range to habitats with low base availability, and the higher end of the range to those with high base availability.

[d] Apply the high end of the range to areas where sod cutting has been practiced; apply the lower end of the range to areas with low-intensity management.

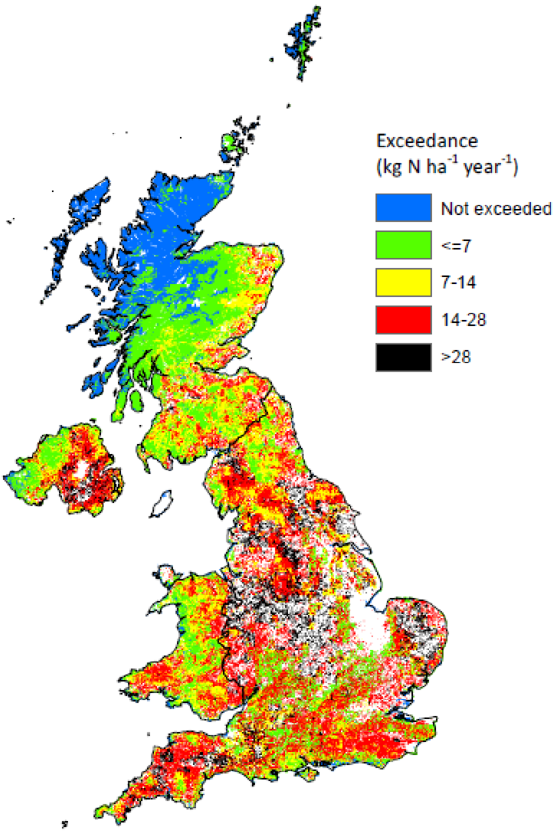

Figure 1: Average Accumulated Exceedance (AAE) of nitrogen critical loads (all habitats combined) by CBED deposition for 2010-12.

Limitations of national nitrogen critical loads and exceedance data

- Nitrogen critical loads for managed (productive) woodlands are based on the dominant soil type in each 1km grid square; other soil types may result in different critical loads.
- Habitat areas are based on the habitat distribution maps developed for UK critical loads research (Hall et al, 2014a) and therefore may differ from other national habitat distribution maps.
- The percentage habitat area exceeded, while a useful metric, may remain the same when comparing results for different deposition scenarios or for different years, because although the magnitude of the exceedance may have altered (reduced or increased), the area exceeded will only change once the critical load (for a given habitat in a given 1km square) is no longer exceeded.
- AE is a useful metric for comparing the results of different deposition scenarios, but because of the units (keq year^{-1}) it results in very large values that are not intuitive to understand. In addition, the same AE can result from a large exceedance and small exceeded area, or a small exceedance and a large exceeded area.

Table 2: Summary nutrient nitrogen exceedance statistics for the UK based on deposition data for 2010-12

Habitat	EUNIS class(es)[#]	Habitat area (km^2)[##]	Exceeded area (km^2)	Percentage area exceeded	Accumulated Exceedance (keq $year^{-1}$)	Average Accumulated Exceedance[###] (keq ha^{-1} $year^{-1}$)	Average Accumulated Exceedance[###] (kg N ha^{-1} $year^{-1}$)
Acid grassland	E1.7 & E3.52	15235	9553	62.7	441917	0.29	4.06
Calcareous grassland	E1.26	3578	3335	93.2	160950	0.45	6.30
Dwarf shrub heath	F4.11 & F4.2	24826	11002	44.3	545748	0.22	3.08
Bog	D1	5526	2540	46.0	158605	0.29	4.02
Montane	E4.2	3129	2554	81.6	75545	0.24	3.38
Managed coniferous woodland	G3	8383	7536	89.9	786464	0.94	13.13
Managed broadleaved woodland	G1	7482	7280	97.3	1142725	1.53	21.38
Beech woodland (unmanaged)	G1.6	719	719	100.0	92356	1.28	17.98
Acidophilous oak woodland (unmanaged)	G1.8	1434	1343	93.7	165197	1.15	16.13
Scots pine (unmanaged)	G3.4	204	81	39.6	3140	0.15	2.16
Other unmanaged woodland	G4	1761	1679	95.3	270563	1.54	21.52
Dune grassland	B1.4	323	138	42.7	2692	0.08	1.17
Saltmarsh	A2.5	427	4	0.9	157	0.003	0.05
All habitats		73027	47764	65.4	3846059	0.53	7.37

[#]EUNIS classes are the European habitat classes to which empirical nitrogen critical loads have been assigned (Bobbink & Hettelingh, 2011); UK habitats have been assigned relevant EUNIS class(es) to enable the most appropriate critical loads to be assigned (Hall et al, 2011; 2014a).

[##] Habitat areas are based on the distribution maps developed for critical loads research in the UK (Hall et al, 2014a). Note these maps only include areas where there are also data available to map the critical loads, and therefore they may differ from other national habitat distribution maps.

[###] Results for AAE are given in both keq ha^{-1} $year^{-1}$ and in kg N ha^{-1} $year^{-1}$ as this unit is more commonly recognised for nitrogen.

3. Site Relevant Critical Loads (SRCL) for nitrogen

SRCL are the nitrogen critical loads assigned to the habitats of the designated features (habitats or species) of SACs and A/SSSIs. Using correspondence tables (footnote) the designated features have been related to the European EUNIS habitat classes (Davies & Moss, 2002) used by Hettelingh & Bobbink (2011) for assigning empirical nitrogen critical loads to different ecosystems. These critical loads are expressed as a range, and the exceedance calculations for SRCL are carried out using (a) the minimum value of the range; (b) the maximum value of the range; (c) the agreed UK "mapping value" from within the range and based on UK evidence of nitrogen impacts (Hall et al, 2011; 2014a). The empirical values in (c) are used in the mapping of critical loads and calculation of exceedances for the habitats in Section 2 above, with the exception of the managed woodlands where the mass balance approach is applied. If no "mapping value" is available for a designated feature, then the mid-range value has been applied.

The deposition data used for calculating exceedances are on a 5km grid for the UK. These are the same deposition data as used for the national habitat critical load exceedance calculations. The deposition values for moorland are applied to grassland, heathland and other low-growing vegetation habitat types, deposition values for woodland are applied to the woodland feature habitats, and grid-average deposition values are applied to aquatic feature habitats. Because some designated sites cross the boundaries between 5km grid squares, the calculated deposition rate may vary across the site. This means that critical loads could be exceeded for part of a site, but not all of it (eg, Figure 2a-d). Therefore, exceedance calculations are carried out at a sub-site scale by overlaying a 1km grid onto the sites and splitting each site into 1km squares (or parts thereof), and assuming that the 5km deposition is constant across each grid square. This approach is consistent with the method used for acidity SRCL exceedances, where the acidity critical loads data are on a 1km grid, and with the method for national habitat exceedances (Section 2), where the acidity and nitrogen critical loads are mapped on a 1km grid.

The key steps in calculating exceedances of nitrogen SRCL are:

- Calculate exceedance for each feature, for each 1km square (or part thereof), within each site (e.g., Figure 2a-d shows exceedance maps for four features within a single site). Total (oxidised plus reduced) nitrogen deposition data are used in the calculations.
- Calculate the exceeded area for each feature, for each 1km square (or part thereof), within each site.
- Calculate Accumulated Exceedance (AE; see Section 2) for each feature, for each 1km square (or part thereof), within each site.
- For each feature in each site, calculate the total area exceeded, the sum of all the AE values for each 1km square (or part thereof), and calculate the Average Accumulated Exceedance (AAE; see Section 2). Table 3 gives an example of these results for the data shown in Figure 2a-d.
- For each site, calculate the number of features with any area exceeded, and the maximum exceeded area, the maximum AE and the maximum AAE for any feature within a site (e.g., Table 4). This is done so the results can be summarised by country, without double counting the areas exceeded, and provides a single exceedance value per site that can be mapped (e.g., 2e, Figure 3b).
- Summarise the results by country (e.g., Tables 5-6) and generate summary maps for the UK (e.g., Figures 3-4).

This process is carried out using the three critical load values mentioned above (minimum, maximum and UK mapping value). A suite of Python scripts is used to perform the exceedance calculations and summarise the results.

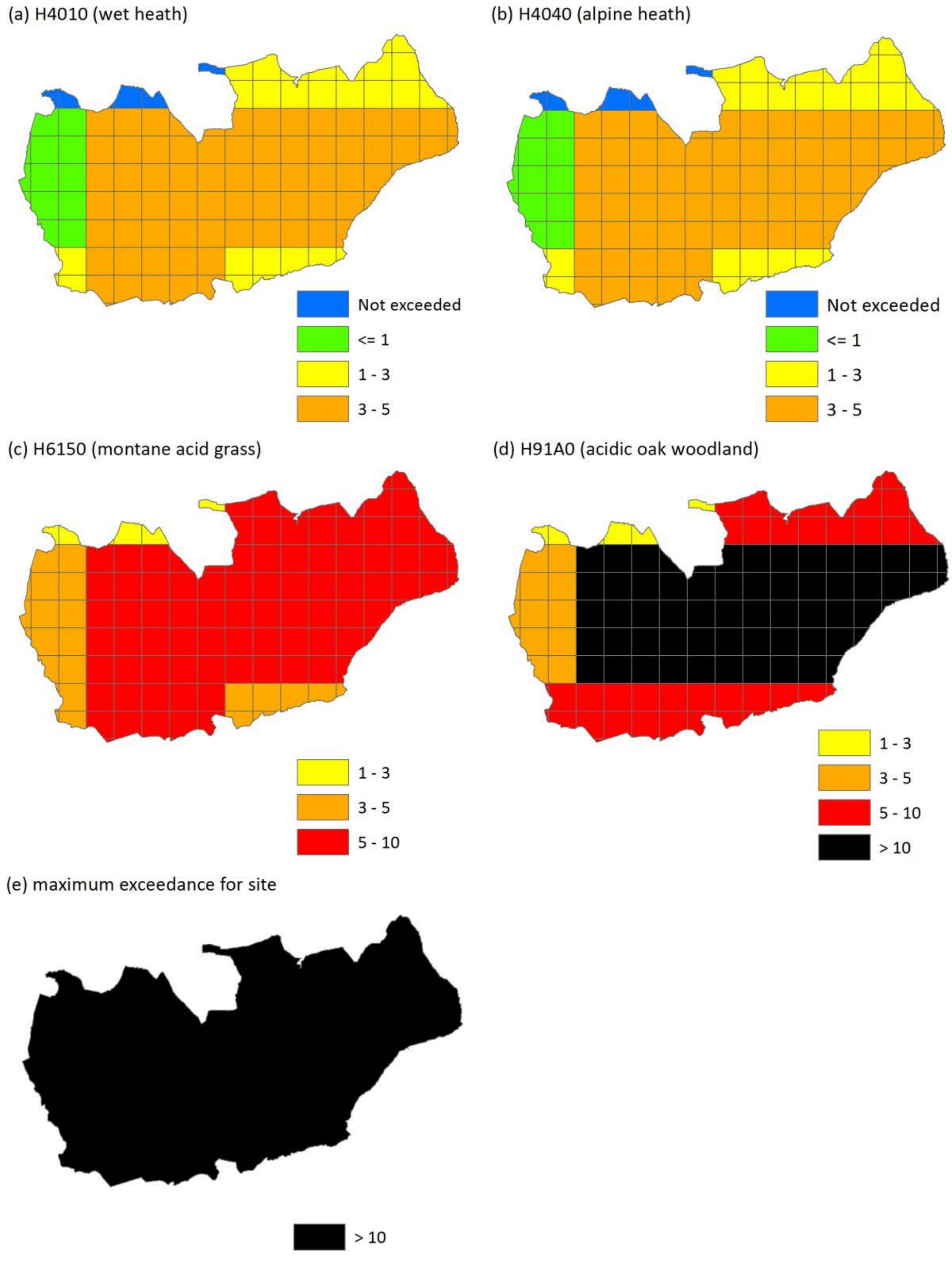

Figure 2: Example showing nutrient nitrogen exceedance maps for each 1km square (or part thereof) of an SAC for four different features; maps assume all features occur everywhere across the site. Legends on maps are in kg N ha^{-1} $year^{-1}$. NB. Although the boundary is for an actual SAC, only a selected number of features are shown in this example. Maps (a)-(d) show the exceedances for individual features, and Map (e) shows the maximum exceedance for the site.

Table 3: Summary of exceedance results for four features in an example site (Figure 2), with exceedances based on the UK mapping value critical load and 5km deposition data for 2009-11. Note, although based on data for an actual SAC, the results shown are only for a selected number of the features within the site.

Interest Code	Site area (ha)#	Exceeded area (ha)#	AE (keq year^{-1})	AAE (keq ha^{-1} year^{-1})	AAE (kg N ha^{-1} year^{-1})
H4010	9317	9118	2182	0.2	3.3
H4060		9118	2182	0.2	3.3
H6150		9317	3839	0.4	5.8
H91A0		9317	7449	0.8	11.2

#As spatial data are not available on the location and area of each designated feature[1], the feature area is set to the area of the site (i.e., the interest feature is assumed to occur across the entire site).

##The exceeded area is calculated at the area within each site where the critical load is exceeded (e.g., see Figure 2).

Table 4: "Maximum" exceedance results for an example site (Figure 2); this provides a set of results at the site level (derived from the values for the four features in Table 2), without double counting the areas exceeded.

Site Code	Site area (ha)	Maximum Exceeded area (ha)	Maximum AE (keq year^{-1})	Maximum AAE (keq ha^{-1} year^{-1})	Maximum AAE (kg N ha^{-1} year^{-1})
UK example	9317	9317	7449	0.8	11.2

Table 5: Summary by site type and country of the percentage of designated sites with nitrogen critical loads exceeded for one or more features. Results are based on deposition data for 2009-11. The percentage of sites with at least one feature exceeded is calculated from the total number of sites that have critical loads for at least one feature.

Site type	Country	% of sites with critical load for at least one feature#	% of sites with at least one feature exceeded based on:		
			Minimum critical load	Maximum critical load	UK mapping value critical load
SACs	England	85	97	80	94
	Wales	93	95	84	94
	Scotland	85	84	53	72
	NI	93	98	90	94
	UK	87	92	72	85
A/SSSIs	England	72	93	70	85
	Wales	67	99	83	97
	Scotland	65	88	55	82
	NI	65	93	81	88
	UK	69	93	69	85

#Some sites will contain designated features either not sensitive to eutrophication, or features for which no appropriate critical load can be set.

[1] Neither JNCC nor any other organisation holds a UK-wide digital database providing the **spatial** location and area of each designated feature habitat – both of these are needed to improve the analysis.

Table 6: Summary by site type and country of the percentage area of designated sites with nitrogen critical loads exceeded for one or more features. Results are based on deposition data for 2009-11. The percentage area of sites with at least one feature exceeded is calculated from the total number of sites that have critical loads for at least one feature.

Site type	**Country**	**% area of sites with critical load for at least one feature**[#]	**% area of sites with at least one feature exceeded based on:**		
			Minimum critical load	**Maximum critical load**	**UK mapping value critical load**
SACs	England	92	87	76	82
	Wales	48	64	45	56
	Scotland	81	80	36	54
	NI	90	95	91	91
	UK	71	81	56	67
A/SSSIs	England	87	95	80	91
	Wales	89	94	82	90
	Scotland	85	91	35	56
	NI	79	94	87	90
	UK	86	93	62	77

This percentage can be low (e.g., for SACs in Wales) where sites include large areas of coast/sea with features either not sensitive to eutrophication, or features for which no appropriate critical load can be set. In addition, the 5km deposition data are only mapped for the UK land area so exceedances cannot be quantified for site areas extending beyond the coastline.

The results (Table 5, Figures 3a, 4a) show it has been possible to assign critical loads to the majority of features within sites, and that for most sites the critical load for at least one feature is exceeded. The percentage areas of sites with critical load exceedance (Table 6) is very high, but these values may overestimate the true area at risk because of the assumptions that have to be made about the areas occupied by designated features. The maps of maximum AAE per site (Figures 3b, 4b) show the highest exceedances in central and southern England, some areas of south-eastern England, and across many sites in Wales. Smaller exceedances are found in parts of Scotland where deposition tends to be lower, and also around the coast where some of the feature habitats are less sensitive to eutrophication and have higher critical loads.

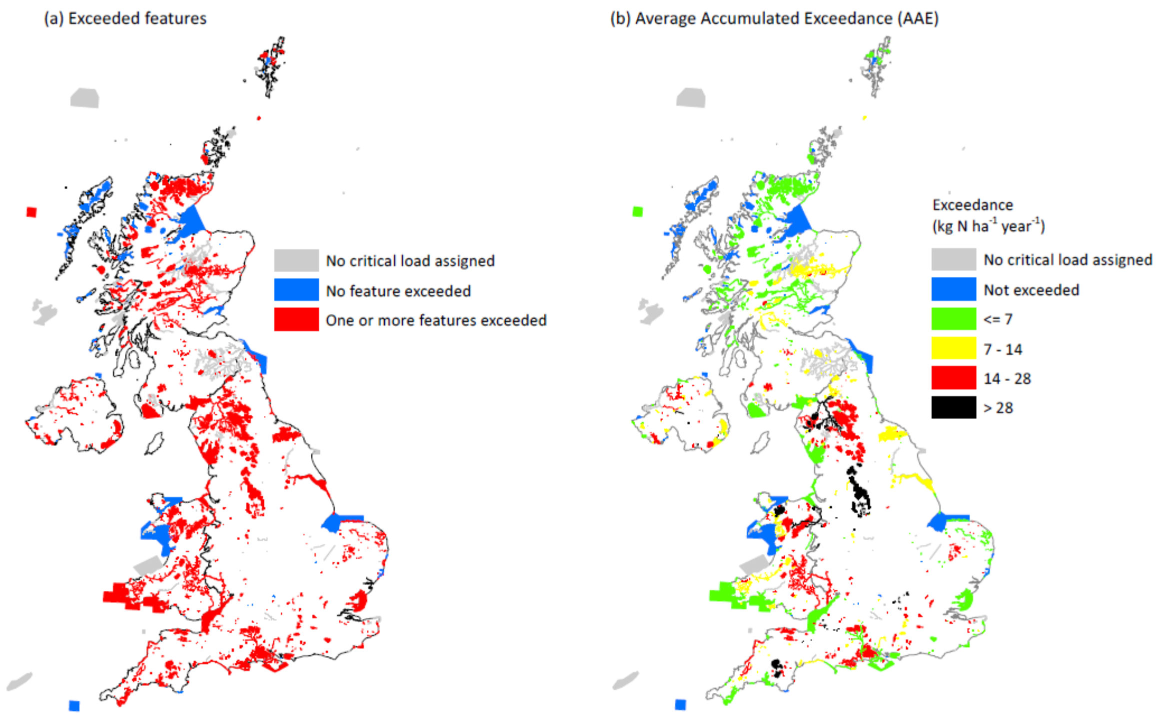

Figure 3: Exceedances of nitrogen SRCL for SACs in the UK, based the UK mapping value critical loads and deposition data for 2009-11. Map (b) shows the maximum AAE of any feature within each site.

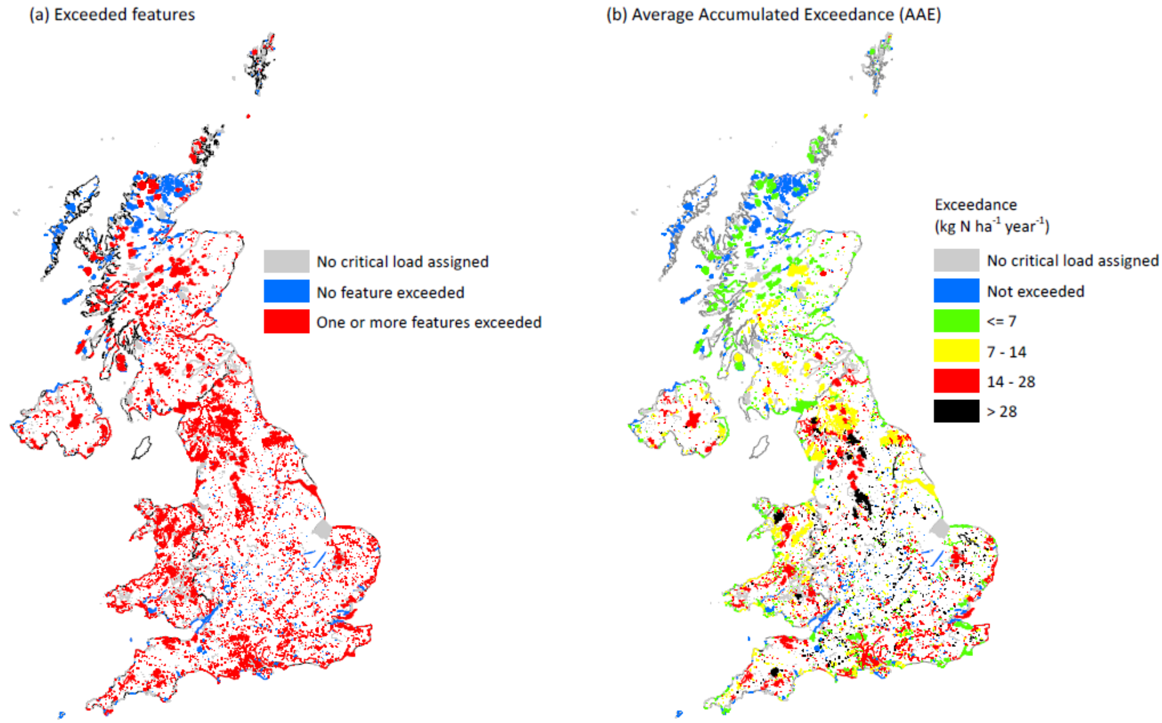

Figure 4: Exceedance of nitrogen SRCL for SSSIs in the UK, based on the UK mapping value critical loads and deposition data for 2009-11. Map (b) shows the maximum AAE of any feature within each site.

Limitations of nitrogen SRCL and exceedance data

- It is not at present possible to assign critical loads to all designated features sensitive to eutrophication, since current knowledge on nitrogen impacts does not include all habitat types (Bobbink & Hettelingh, 2011). For some sensitive habitats there is not a direct correspondence between the feature habitat and a EUNIS class, and a critical load for the nearest EUNIS class may be used.
- No national information is available in digital format on the location and area of designated features within sites[2]; therefore the SRCL exceedance analysis assumes all features occur across the entire site. When summarising the results to site and country levels, the potential maximum exceeded area of any feature is used, but this is also based on the assumption that the feature occurs across the entire site.
- The areas of SACs and A/SSSIs overlap with one another, and with the habitat area maps; this should be borne in mind when considering the areas with critical load exceedance.
- The SRCL database will be updated during 2014 to include an additional set of critical load values based on the values used for Article 17 Reporting for the Habitats Directive.
- The summary exceedance statistics and maps presented here will be updated with the new SRCL and with more recent deposition data (e.g., 2010-12).
- Deposition data used for calculating exceedances are mapped on a 5km grid; this resolution of data may not highlight "hot spots" of deposition from smaller point sources (e.g., pig or poultry farms). For site-specific assessments (rather than the UK/country wide assessments presented here), local knowledge of a site, its management, and local pollution sources (and modelling of their dispersion) should be considered.

4. Critical levels of ammonia

Critical levels for ammonia (NH_3) are based on annual mean concentrations as the long-term effects of NH_3 are considered to be more significant than short-term effects (CLRTAP, 2014). Critical levels have been defined for only two 'vegetation types' only by CLRTAP (2014, see Table 7), with lichens and bryophytes generally more sensitive to NH_3 than higher plants. The aim of the NH_3 critical levels is to protect the functioning of plants and plant communities.

Table 7: Critical levels of NH_3 (CLRTAP, 2014)

Vegetation type	**Critical level NH_3 ($\mu g\ m^{-3}$) as annual mean concentrations**
Lichens and bryophytes (including ecosystems where lichens and bryophytes are a key part of the ecosystem integrity)	1
Higher plants (including heathland, grassland, and forest ground flora)	3*

*An explicit uncertainty range of 2-4 $\mu g\ m^{-3}$ was set for higher plants (including heathland, semi-natural grassland and forest ground flora). The uncertainty range is intended to be useful when applying the critical level in different assessment contexts (e.g., precautionary approach).

[2] Neither JNCC nor any other organisation holds a UK-wide digital database providing the **spatial** location and area of each designated feature habitat – both of these are needed to improve the analysis.

Preliminary calculations of the exceedance of critical levels of NH_3 have been carried out under Defra Contract AQ0826; these calculations determine:

- The land area of the UK where the critical levels are exceeded.
- The area of habitats sensitive to nitrogen deposition where the critical levels are exceeded.
- The area of designated sites where the critical levels are exceeded.

In all of these analyses specific critical levels are not assigned to individual habitats or features. The results, based on 5km annual mean concentration data for 2010-12 (Figure 5) are summarised below.

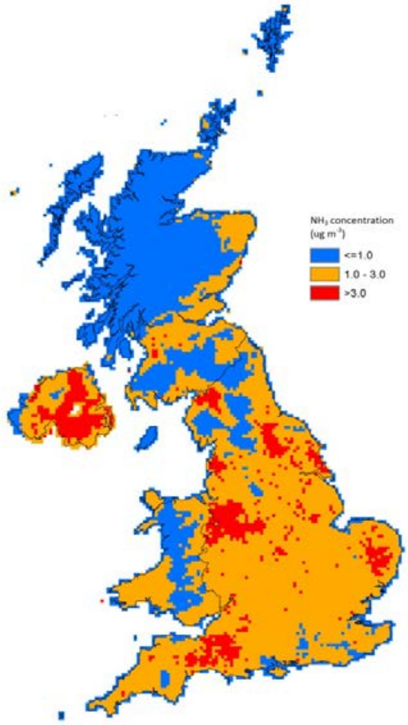

Figure 5: 5km NH_3 concentrations for 2010-12.

Land area exceeding NH_3 critical levels

Figure 5 and Table 8 show that most of England and Northern Ireland, and large areas of Wales exceed the critical level of 1µg m^{-3}, and 9% of the country exceed the critical level of 3µg m^{-3} (43.6% in Northern Ireland). The areas with the lowest concentrations of NH_3 (ie, <1µg m^{-3}) tend to be in the upland areas of the country.

Table 8: Percentage of total land area of the UK (by country) where annual mean concentration data for 2010-12 exceeds the NH_3 critical levels of 1 and 3 µg m^{-3}.

Country	**Land area (km^2)**	**Percentage land area exceeding NH_3 critical level of:**	
		1 µg m^{-3}	**3 µg m^{-3}**
England	131,152	90.0	12.0
Wales	20,761	60.9	0.9
Scotland	78,744	24.2	0.4
NI	14,177	92.1	43.6
UK	244,834	66.5	9.1

Habitat areas and exceedance of NH_3 critical levels

These calculations are based on the habitat distribution maps generated for nutrient nitrogen critical loads work (Hall et al, 2014a). The results (Table 9) reflect the spatial distributions of both the habitats and the NH_3 concentration data. Overall, the critical level of 1 µg m^{-3} is exceeded across 30% of the total area of these habitats, while the critical level of 3 µg m^{-3} is only exceeded across 2.2% of the habitat area. The critical levels are not exceeded in montane habitats which may be too high or too far from sources. There are only very small areas (4 km^2) where concentrations are above 1 µg m^{-3} for Scots Pine. The habitats with the largest areas with concentrations above the critical levels are calcareous grassland, managed broadleaf woodland, beech woodland and other unmanaged woodlands (highly dependent on the spatial distribution of habitats relative to the areas of elevated NH_3 concentrations); all habitats that may be closer to NH_3 sources (e.g., agricultural land or pig and poultry farms).

Designated areas and exceedance of NH_3 critical levels

More than half of UK SACs and A/SSSIs are located in areas where the annual mean concentrations (2010-12) of NH_3 exceed 1 µg m^{-3}, and 8-9% where concentrations exceed 3 µg m^{-3} Table 9). The areas exceeded are lowest in Scotland (Table 10) where the NH_3 concentrations are lower (Figure 5).

Limitations of NH3 critical levels and exceedances

- Critical levels are only available for two vegetation types only, and in this analysis no attempt has been made to assign specific critical levels to habitats or habitat features.
- Not all areas of the country, habitats and designated sites considered in this analysis will contain lichens, bryophytes or higher plants or ecosystems sensitive to NH_3 concentrations.
- The areas of SACs and A/SSSIs can overlap with one another, and with the habitat area maps; this should be borne in mind when considering the areas with critical level exceedance.
- Concentration data used for calculating exceedances are mapped on a 5km grid; this resolution of data may not highlight "hot spots" of concentrations from smaller point sources (e.g., pig or poultry farms). For site-specific assessments (rather than the UK/country wide assessments presented here), local knowledge of a site, its management, and local pollution sources (and modelling of their dispersion) should be considered.

Table 9: Summary of the area of UK habitats where NH_3 concentrations exceed the critical levels of 1 and 3 µg m^{-3}

Habitat	**EUNIS class(es)#**	**Habitat area (km^2)##**	**Area (km^2) exceeding 1µg NH_3 m^{-3}**	**% Area exceeding 1µg NH_3 m^{-3}**	**Area (km^2) exceeding 3µg NH_3 m^{-3}**	**% Area exceeding 3µg NH_3 m^{-3}**
Acid grassland	E1.7 & E3.52	15235	3722	24.4	338	2.2
Calcareous grassland	E1.26	3578	3272	91.5	224	6.3
Dwarf shrub heath	F4.11 & F4.2	24826	2626	10.6	218	0.9
Bog	D1	5526	727	13.2	75	1.4
Montane	E4.2	3129	0	0.0	0	0.0
Managed coniferous woodland	G3	8383	2311	27.6	124	1.5
Managed broadleaved woodland	G1	7482	6284	84.0	432	5.8
Beech woodland (unmanaged)	G1.6	719	583	81.1	12	1.7
Acidophilous oak woodland (unmanaged)	G1.8	1434	670	46.7	26	1.8
Scots pine (unmanaged)	G3.4	204	4	1.7	0	0.0
Other unmanaged woodland	G4	1761	1510	85.8	179	10.1
Dune grassland	B1.4	323	66	20.3	0	0.0
Saltmarsh	A2.5	427	154	36.2	7	1.6
All habitats		73027	21929	30.0	1635	2.2

[#] UK habitats have been assigned to relevant EUNIS class(es) for critical load purposes (Hall et al, 2011; 2014a).

[##] Habitat areas are based on the distribution maps developed for critical loads research in the UK (Hall et al, 2014a). Note these maps only include areas where there are also data available to map the critical loads, and therefore they may differ from other national habitat distribution maps.

Table 10: Summary of the number and area of designated sites (SACs, A/SSSIs) where NH_3 concentrations exceed the critical levels of 1 and 3 µg m^{-3}

Site type	Country	Site count	% number of sites where NH_3 concentrations exceed:		Site area (ha)[#]	% site area where NH_3 concentrations exceed:	
			1 µg m^{-3}	3 µg m^{-3}		1 µg m^{-3}	3 µg m^{-3}
SACs	England	231	93.5	14.7	792605	38.7	0.8
	Wales	85	75.3	1.2	302510	16.0	0.1
	Scotland	235	27.2	0.4	801663	4.7	<0.1
	NI	54	94.4	33.3	61049	81.7	4.5
	England/Wales[#]	7	100	42.9	-	-	-
	England/Scotland[#]	3	100	33.3	-	-	-
	UK	615	65.9	9.4	1957827	22.6	0.5
A/SSSIs	England	4115	89.1	10.5	1032877	52.0	2.1
	Wales	1017	67.6	1.0	255270	23.2	0.3
	Scotland	1447	33.7	0.7	1015019	5.7	<0.1
	NI	290	90.3	26.2	83496	85.1	12.1
	UK	6869	74.3	7.7	2386663	30.4	1.4

[#]Some SACs cross country borders and these are shown in the site count; however, when calculating the country area, this is based on the site area within each country, so there are no cross-border area values.

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