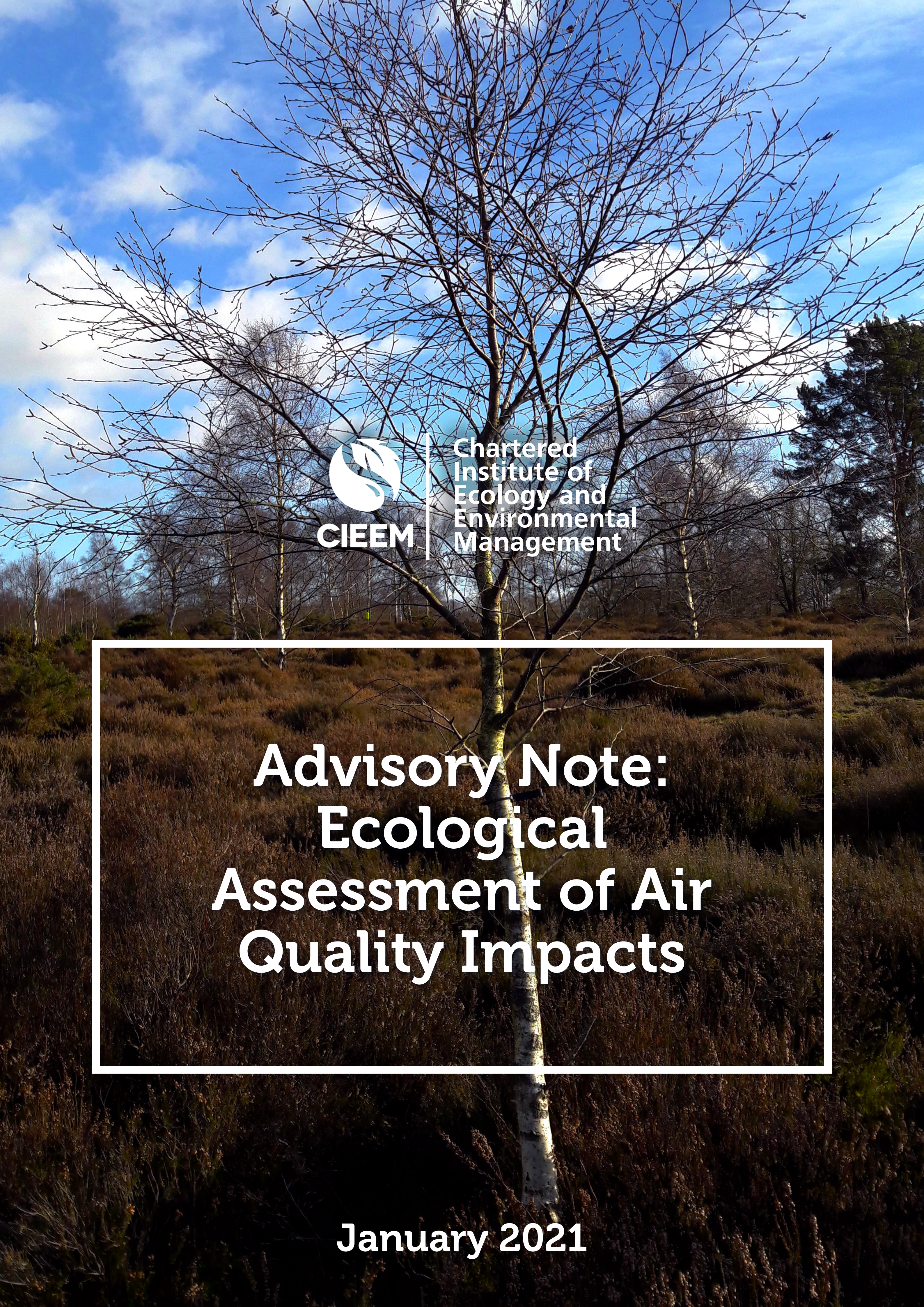

CIEEM
Chartered Institute of Ecology and Environmental Management

# Advisory Note: Ecological Assessment of Air Quality Impacts

January 2021

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*Front cover: Diffusion tube monitoring location within Wealden Heaths Phase II SPA (Broxhead and Kingsley Commons SSSI). Photo credit: Megan Le Mare, Atkins Ltd.*

# PREFACE

This advisory document is intended to take ecologists (and air quality specialists) through the issues that they should consider in order to make an informed judgement as to the ecological effects of changes in pollution concentrations and deposition rates. When air quality issues in relation to ecology cannot be dismissed purely on modelled outputs, ecological decisions need to be taken on a case-by-case basis using sound evidence. This advice aims to provide the reader with a consistent approach to understanding such effects, without prescribing the conclusion that should be drawn in any given situation. It does not set out definitive steps to be followed but is written to aid ecologists in making a balanced and informed judgement as to 'risk'.

The need for additional information and assistance for practitioners regarding air quality impact assessment for ecological sites was first identified at a joint Institute of Air Quality Management (IAQM)/Chartered Institute of Ecology and Environmental Management (CIEEM) workshop held in July 2015. The guidance gap between the numerical output of air quality assessments and conclusions on ecological significance is broad and complex. Ecologists need to assess the impacts and the ecological effects of the predicted changes in air quality at the site concerned. The diversity of habitats and species that may be affected by air pollution preclude standardised methodological approaches, which goes some way to explaining the notable lack of any detailed guidance on the issue to date.

This advice assumes a degree of understanding of the concepts of critical level and critical load. Therefore, it is essential that it is treated as a companion piece to the Institute of Air Quality Management (IAQM) document Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites (May 2020)[1], which discusses relevant air pollutants, collaboration between air quality scientists and ecologists to set the scope of an assessment, and modelling methodologies and assessment thresholds. It is strongly recommended that the IAQM document is read alongside this document.

The ecological interpretation of air quality modelling is a rapidly shifting and developing field with many important principles still being debated in the legal, air quality science and ecological communities. This advice represents best available information, at the time of writing, and must be read and interpreted accordingly. It does not seek to supersede or replace any existing guidance produced by other bodies. Readers are reminded that it rests with the Courts to provide definitive interpretation of how air pollution assessment should be approached, under any given piece of legislation. This advice will therefore need to evolve in line with any future Court decisions, which should always be regarded as a higher authority.

**CIEEM Air Quality Impact Assessment Working Group**

**January 2021**

1 Available at: https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf



# 1. UNDERSTANDING THE ECOLOGICAL EFFECTS OF POLLUTION

## INTRODUCTION

1. The effects of poor air quality on ecosystems and their function have been comprehensively documented in the scientific, peer reviewed literature[2]. Consequently, air quality is increasingly recognised as an impact pathway that requires assessment[3] by ecologists and air quality specialists. The most important natural areas of the UK are protected by national and international legislation, or as a matter of planning policy. They are generally referred to as 'designated nature conservation sites' (also broken down into statutory sites, designated as a matter of law, and non-statutory sites, referring to those designated as a matter of policy). They may include features such as woodland, heathland, grassland, bog, sand dune habitat, or other habitats sensitive to air pollution. The Air Pollution Information System (APIS) (www.apis.ac.uk) is a very useful online resource regarding the sensitivity of habitats, species and statutory designated nature conservation sites to air pollution.

*The New Forest National Park with the New Forest SAC, SPA, SSSI. Heathland habitat adjacent to the A31 (in background). The roadside habitats in this area are managed by grazing, burning and, occasionally, mowing. Photo credit: Andrew Cross, EPR Ltd.*

2. There is a need to consider the impact of development proposals on designated nature conservation sites through the implementation of the various sets of legislation[4]. This includes the air quality effects of those proposals that have the potential to be emitters of pollutants, for instance industrial processes, agricultural activities and vehicle exhaust emissions. It is now common for Habitats Regulations Assessments/Appraisals (HRAs) that accompany local authority Local Plans to evaluate the effect of

2 Dise, N.B., Ashmore, M., Belyazid, S., Bleeker, A., Bobbink, R., De Vries, W., Erisman, J.W., Spranger, T., Stevens, C.J. and van den Berg, L. (2011). Nitrogen as a threat to European terrestrial biodiversity. In: M. Sutton, C. Howard, J. Erisman, G. Billen, A. Bleeker, P. Grennfelt, H. van Grinsven and B. Grizzetti (eds), The European Nitrogen Assessment: Sources, Effects and Policy Perspectives, pp. 463-494. Cambridge University Press, Cambridge.

3 Habitats Regulations Assessments (HRA), Ecological Impact Assessments (EcIA), permit applications and planning applications

4 e.g. Environmental Impact Assessment Regulations and the Environmental Permitting Regulations, and on internationally important wildlife sites via the provisions of the Conservation of Habitats & Species Regulations 2017 (as amended) in England and Wales, the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) in Scotland and the Conservation (Natural Habitats &c.) Regulations (Northern Ireland) 1995 in Northern Ireland.

future traffic flows on internationally important wildlife sites. Equally, it is common for Ecological Impact Assessments (EcIAs) of major industrial facilities (such as energy from waste plants) and agricultural development to consider the potential effects of atmospheric pollution on designated nature conservation sites.

3. In particular, where the change in concentration/deposition is predicted to be 1%[5] of the critical level/load or more, either alone or 'in combination', an informed and knowledgeable ecologist can help to interpret the potential effects. This includes whether the forecast change might result in a negative effect on the designated site in question when combined with the effects from other proposals and, if so, to express the effect in ecological terms with a view to informing mitigation.

4. Note that this document focuses on the chemical effects of air pollutants such as oxides of nitrogen, sulphur dioxide and ammonia. The physical effects of particulate matter (i.e. dust deposition) are not covered by this document. However, the IAQM has produced guidance on dust assessment that does cover designated nature conservation sites[6].

5. Appendix of this advisory note presents an introduction to some aspects of air quality modelling, intended to inform the ecologist regarding parameters used and outputs they may be expected to interpret. The ecologist's role is to use the output from models created by air quality consultants to identify potential ecological effects on site; hence it is important that they have some understanding of what can influence such models. A Glossary of terms is also provided.

## HABITAT RESPONSES TO POLLUTION AND THE USE OF CRITICAL LOADS AND CRITICAL LEVELS

6. The IAQM guidance on this subject provides a detailed discussion regarding the pollutants of relevance to ecological receptors, and that detail is not repeated in this document. This document focuses on the two primary emitted pollutants that are most often of relevance to EcIA. These are oxides of nitrogen (known as NOx) produced by combustion, and ammonia ($NH_3$), which is largely produced by agriculture (from both livestock and fertiliser) but also comes from other sources, such as some traffic, combustion of organic matter (biomass burning) and industry.

7. Sulphur dioxide ($SO_2$) is produced from the burning of fossil fuels and although concentrations have fallen dramatically in recent years, it may be an additional pollutant to assess for certain development projects, such as those related to industry. Sulphur dioxide is toxic to vegetation, with lower plants (mosses, liverworts and lichens) being more sensitive than higher plants. It can also be deposited to ground, contributing to acid deposition and acidification, and can have synergistic effects when combined with NOx. Industrial processes may emit other pollutants, such as hydrogen fluoride, hydrogen chloride and heavy metals, but the need to consider such pollutants in any assessment should be discussed with the relevant country regulator.

8. In most parts of the UK average NOx concentrations are reducing due to improved abatement of point source emissions, such as power stations, and improved vehicle emissions technology. These trends can be checked using the 'Site Relevant Critical Loads Search Tool' on APIS (www.apis.ac.uk). On the other hand, ammonia concentrations in numerous areas are either static or increasing.

9. Both ammonia and NOx can be toxic to vegetation (e.g. causing leaf yellowing and dieback) and 'critical levels' (defined as '*concentrations of pollutants in the atmosphere above which direct adverse effects on receptors may occur according to present knowledge*')[7] have been set for vegetation for both pollutants[8]. However, both pollutants also contribute to deposition of nitrogen and (along with other pollutants such as sulphur dioxide) to deposition of acidifying compounds.

10. To capture this, 'critical loads' (defined as '*a quantitative estimate of 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*')[7] have been developed for both nitrogen deposition and acid deposition. These critical loads are specific to the sensitivity of each habitat and their constituent plant assemblage. Critical loads are subject to regular review. The most up-to-date list is available from APIS at http://www.apis.ac.uk/srcl.

*Site visit to Ballynahone Bog in Northern Ireland showing the impacts of nitrogen deposition on Cladonia. Photo credit: Dr Caroline Chapman FCIEEM.*

11. Deposition of nitrogen and acid can cause a variety of negative responses in habitats. Habitat responses to air pollution (particularly nitrogen deposition) are complex and cascade through to trophic levels, and this document is not intended to present a comprehensive guide to these effects. The literature on this issue is significant in volume and breadth, although an extensive discussion of potential effects is provided on the APIS website. The following section therefore provides only an overview of habitat responses to nitrogen deposition.

5 The 1% of critical level/load threshold is part of current UK assessment processes and is subject to review. In some countries a 4% of critical level/load threshold has been used for intensive farming. Screening thresholds are a tool to indicate when further assessment is required and should be informed by all available information (e.g. not used blindly).

6 Holman, C. et al. (2014). IAQM Guidance on the assessment of dust from demolition and construction. Institute of Air Quality Management, London. http://www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf.
IAQM (2016). Guidance on the Assessment of Mineral Dust Impacts for Planning. Institute of Air Quality Management, London. Available at https://iaqm.co.uk/text/guidance/mineralsguidance.

7 Source: Air Pollution Information System, http://www.apis.ac.uk/critical-loads-and-critical-levels-guide-data-provided-apis#_Toc279788051

8 These levels are: an annual average ammonia concentration of 1 µgm-3 (for lower plants) or 3 µgm-3 (for other vegetation) and an annual average NOx concentration of 30 µgm-3 (for all vegetation). NOx also has a short-term (daily average) critical level of 75 µgm- http://www.apis.ac.uk/srcl. In practice, different plants have different sensitivities but the values above were chosen to provide the best protection to the greatest number of species.

12. Bogs are particularly sensitive to atmospheric pollution. Due to their ombrotrophic nature they are typical of a low nutrient habitat. Moninea Bog Special Area of Conservation (SAC), located to the immediate east of an intensive poultry farm in Northern Ireland, provided a case study for monitoring pollution impacts on a lowland raised bog. Assessment of impacts took the form of visual assessments, analysis of plant nitrogen accumulation, monitoring of atmospheric ammonia, and modelling the dispersion from the poultry house[9]. Visual impacts were evident directly beside the poultry house where a 'thick algal slime' had accumulated on nearby birch trees. It was estimated that within 200 m of the farm, 90% of *Cladonia* and *Sphagnum* spp. were negatively affected. Nitrogen content within plants reached 4% near the poultry house, compared to between 0.5-1% on an unaffected site. Monitored concentrations of atmospheric ammonia were consistent with modelling, where concentrations closest to the farm ranged between 14–34 μg/m³, reducing to 1–4 μg/m³ at c. 670 m from the farm.

13. Whim Bog in the Scottish borders is a study site for impacts of atmospheric ammonia and nitrogen deposition onto bog habitats. Here ammonia emissions are simulated across the bog and effects are recorded along a concentration and deposition gradient. Studies on this site have been instrumental in identifying relevant critical levels for atmospheric ammonia, in addition to identifying specific effects of ammonia exposure and nitrogen deposition on bogs. Effects observed include loss of *Calluna vulgaris*, *Sphagnum capillifolium* and *Cladonia portentosa*, though abundance of *Eriophorum vaginatum* increased significantly[10].

14. In heathland, nitrogen deposition can result in a transition from heather to grass dominance, decline in lichens (such as Cladonia spp.), changes in plant biochemistry and increased sensitivity to stress . The physical, measurable and observable manifestations of these responses are generally in terms of reduction in species richness[11], reduction in vegetation cover of positive indicator species (or increase in grass cover) and resulting changes in broad habitat structure and function. These responses are not independent: for example, reduction in species richness[12] can cause, and in turn be exacerbated by, changes in habitat structure[13]. Habitats such as heathland, woodland, sand dunes and bogs are among the most sensitive habitats to nitrogen deposition. Bogs and the most sensitive sand dunes have minimum critical loads of 5-8 kg N/ha/yr, while heathlands and many woodland types have a minimum critical load of 10 kg N/ha/yr. Calcareous grassland has lower sensitivity[14] with a minimum critical load of 15 kg N/ha/yr, while saltmarshes and neutral[15] grasslands are naturally relatively nitrogen-rich habitats and thus have lower sensitivity still, with a minimum critical load of 20 kg N/ha/yr.

15. With regards to woodlands, elevated nitrogen deposition in general has driven strong biogeochemical responses, with many authors documenting reductions in soil carbon-nitrogen ratio, acidification and increased nitrate leaching[16]. Understorey plants can also be negatively affected by nitrogen inputs. However, the impact of nitrogen deposition on vegetation composition of woodlands is poorly understood, partly due to the strong confounding influence that tree canopy structure places on ground flora species richness, cover and other parameters that might otherwise enable one to discern the effects of nitrogen deposition. The canopy does this through interception of light, rainfall and pollution. The effect of woodland management on tree canopy structure also has a big influence on ground flora. However, direct toxicity from ammonia emissions can also occur in certain woodland types; an example of an extreme case was observed in Germany in the 1980s where 2000 ha was deforested due to ammonia emitted from large pig farms (c. 200,000 animals)[17].

16. At annual mean concentrations well above the critical level, there is evidence of direct NOx toxicity to vegetation. Toxicity effects have also been observed at levels above but closer to the critical level, primarily when concentrations of sulphur dioxide and/or low-level ozone are also elevated. Calculating nitrogen deposition rates, rather than relying purely on scrutiny of NOx concentrations, has the advantage of being habitat-specific. For some habitats a defined change in nitrogen deposition is directly relatable to measurable effects on the ground through scrutiny of published dose-response relationships. However, where critical levels are exceeded, consideration should also be given to the potential for direct effects from NOx, especially where concentrations of sulphur dioxide and/or low-level ozone are also elevated.

17. Concentrations of ammonia in the atmosphere can also have a significant effect on designated nature conservation sites. The ammonia critical level of 1 μg/m³ set for highly sensitive plant species (i.e. lower plants such as bryophytes and lichen) is based on field observations and losses in species richness combined with a statistical technique to establish a no-effects level. With more limited field observation for higher plants, a higher threshold to be protective in the long term was set at 3 μg/m³ ammonia[18].

18. There has been particularly detailed investigation of the effects of ammonia on Moninea Bog in Northern Ireland, as already referred to above. Notwithstanding some confounding factors (such as management), ammonia was considered the greatest threat to the site. The stumps of former Cladonia plants, plus currently dying Cladonia clumps, indicated that the site was deteriorating due to the current ammonia levels. This was attributed primarily to a nearby poultry farm[19].

9 Sutton, M., Leith, I., Bealey, W., Van Dijk, N. and Tang, Y. (2011). Moninea Bog - Case study of atmospheric ammonia impacts on a Special Area of Conservation. In: Hicks, W.K., Whitfield, C.P., Bealey, W.J. and Sutton, M.A. (eds). Nitrogen deposition and Natura 2000, COST Office - European Cooperation in Science and Technology, pp. 59-71.

10 Levy, P., van Dijk, N., Gray, A., Sutton, M., Jones, M., Leeson, S., Dise, N., Leith, I. and Sheppard, L. (2019). Response of a peat bog vegetation community to long-term experimental addition of nitrogen. Journal of Ecology, 107(3): 1167-1186.

11 Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, L., Phoenix, G., Power, S., Sheppard, L. and Stevens, C. (2016). *Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance.* Natural England Commissioned Reports, Number 210. Table 1, page 2.

12 This is a widely applicable indicator of the effect of nitrogen deposition on vegetation as it arises at low background deposition rates, is easily detectable and occurs across different habitats. However, there are exceptions. For example, calcareous grassland has no correlation between nitrogen deposition and species richness; for that habitat, rather than there being a reduction in the average number of species per quadrat, the reduced frequency of less competitive species appears to be offset by the increased frequency of more competitive species. For bogs, there is limited change in species richness over the range of nitrogen deposition investigated due to the small number of species in bogs and its sensitivity to air pollution at low levels of deposition.

13 Note that 'reduction in species richness' only means that fewer species are recorded in a randomly placed 2 x 2-m quadrat. Therefore, it does not mean species are 'lost' from the affected area; it simply means that at least one species occurs at a reduced frequency. It is therefore a relatively subtle metric.

14 For calcareous grassland, Caporn et al. (2016) note that '*Calcareous habitats are less affected by nitrogen deposition than less well pH buffered systems*'.
Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, L., Phoenix, G., Power, S., Sheppard, L. and Stevens, C. (2016). *Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance.* Natural England Commissioned Reports, Number 210. Page 45.

15 Vegetation typical of soils that are neither acid nor alkaline

16 Ibid. Section 7.3, page 65

17 Hofmann, G. and Heinsdorf, D., (1990). Zur landschaftsokologischen Wirkung von Stickstoff-Emissionen aus Tierprodukitionanlagen, insbesondere auf Waldbestande. Tierzucht, **44**: 500–504.

18 Cape, J.N., van der Eerden, L., Fangmeier, A., Ayres, J., Bareham, S., Bobbink, R., Branquinho, C., Crittenden, P., Cruz, C., Dias, T., Leith, I., Martins-Loução, M.A., Pitcairn, C.E.R., Sheppard, L., Spranger, T., Sutton, M., van Dijk, N. and Wolseley, P. (2009). Critical Levels for Ammonia. In: M.A. Sutton, S. Reis and S.M.H. Baker (eds), *Atmospheric Ammonia: Detecting emission changes and environmental impacts. Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution*, pp. 375-382. Springer Science & Business Media, Berlin.

19 https://www.pik-potsdam.de/news/public-events/archiv/alter-net/former-ss/2007/07-09.2007/sutton/literature/moninea_bog_site_report_10may07.pdf
http://ec.europa.eu/environment/nature/natura2000/platform/documents/sutton_integrated_approach_to_tackling_n_deposition_theme2_eng.pdf
https://www.cieem.net/data/files/Resource_Library/Conferences/2017_Irish_Conference/5_Gary_Dodds_NIEA.pdf

## BOX 1. THE DIFFERENCE IN APPROACH TO NITROGEN CRITICAL LOAD EXCEEDANCE IN THE UK AND THE NETHERLANDS.

The concept of critical loads and levels is long established and these thresholds are based on the best available scientific knowledge. Critical loads are defined as '*a quantitative estimate of an 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*'. The corollary of the definition of critical loads is that if they are exceeded harmful effects may occur. The Dutch have taken the view that in the case of a Habitats Regulations Assessment (HRA), where one has to prove a negative (i.e. demonstrate the absence of effects which are adverse to site integrity), the integrity test would be failed whenever critical loads are exceeded. The strict scientific approach to the consequence of critical loads/level exceedance was reflected in the legal opinion in cases C-293/17 and C-294/17 at the Court of Justice of the European Union (CJEU) when Advocate General Kokott at paragraph 62 said *'… it seems difficult, if not impossible, to accept values that are higher than the critical loads.'*[1] The Dutch Nitrogen Case, as they became known, resulted in the Dutch Government ceasing to grant permits for new livestock projects. In addition, as an interim measure to attempt to decrease nitrogen pollution, the national speed limit was reduced from 130 to 100 kph.

In the UK, the approach to assessing impacts is different. Assessment approaches, particularly at the screening stage of HRA, concentrate on the change in levels arising from a proposed plan or project (either alone or in combination) irrespective of whether critical loads or levels are currently being exceeded at a site. For example, Natural England guidance[2] states that a project that will result in an increase of no more than 1% of critical loads or levels (either alone or in combination) can be regarded as insignificant from an air quality point of view. It is argued that such an approach can be supported by Advocate General Sharpston's Opinion in Case C-258/11 where at paragraph 48 she stated '*the requirement for an effect to be 'significant' exists in order to lay down a de minimis threshold. Plans and projects that have no appreciable effect on the site can therefore be excluded. If all plans and projects capable of having any effect whatsoever on the site were to be caught by Article 6(3), activities on or near the site would risk being impossible by reason of legislative overkill.*'[3]

There is clearly a distinction between approaches adopted in The Netherlands, where critical loads and levels are regarded as an environmental limit that cannot be exceeded, and the screening approach adopted in the UK, which regards small increments in pollution as *de minimis* even where critical loads and levels are exceeded. There may be further clarification on these differing approaches as case law comes forward and the findings are reflected in updated policy and guidance.

1 See http://www.landmarkchambers.co.uk/wp-content/uploads/2018/11/C-293.17-and-294.17-Judgment.pdf paragraph 62

2 Natural England (2018). *Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations.* NE Internal Guidance, V1.4 Final, June 2018.

3 See http://curia.europa.eu/juris/liste.jsf?language=en&num=C-258/11 paragraph 48



**19.** An impact assessment must involve more than simply identifying whether the site currently exceeds the relevant critical load/level. Paragraph 5.26 of Natural England's relevant internal guidance[20] makes it clear that '*an exceedance alone is insufficient to determine the acceptability (or otherwise) of a project*', while paragraph 5.13 states that '*Other factors are relevant which may mean that a plan or project that exceeds the 1% screening threshold [in combination with other plans and projects] can still demonstrate no adverse effect on site integrity through an appropriate assessment*'. Readers should note, however, that the approach in the UK to the interpretation of exceedance of critical loads and levels differs from that which has been applied in some EU member states (see Box 1).

**20.** Depending on circumstances, determining whether significant negative effects will arise, or whether the achievement of a 'restore' objective will be undermined, may include consideration of factors such as: the action needed to achieve the conservation objectives for a given site; the expected future trend in pollutants of concern (and the scientific reasonableness of any trend); the magnitude of any future 'in combination' dose and how it may change the trend; and the physical extent of the affected area as a proportion of that interest feature within the European site. If a site is currently exceeding its critical loads and not achieving its relevant biodiversity objectives, then damage to the site is already likely to be occurring or has already happened. In such circumstances, scope for further declines in air quality will necessarily be limited.

**21.** The remainder of this document discusses these matters, although it should be noted that the document is intended to apply to ecological assessment of air quality data in all circumstances, not just for Habitats Regulations Assessments.

## STEPWISE PROCESS TO EXPLORING EFFECTS

**22.** This section sets out six steps which should greatly assist ecologists in making an objective, transparent and rigorous assessment of the likelihood of a negative effect. These steps cannot provide a definitive 'answer' as to whether air pollution is of concern in a given situation, as too many variable factors must be accounted for to allow a generic, simple 'tick box' assessment. However, they are intended to assist ecologists in making an informed judgement regarding matters such as the level of risk, the sensitivity of particular sites and habitats, and the magnitude of ecological effect. Taken together, consideration of these issues can enable an informed conclusion to be made.

**23.** Note that these steps are designed to apply to all instances in which air quality impact assessment of ecological receptors are required. For certain tiers of designation (notably internationally important sites) some of these steps must also be governed by the legal context and the appropriate use of the precautionary principle.

**24.** The six steps are:

Step 1. Identifying the Baseline Ecological Features and Air Quality
Step 2. Assessing Confounding Factors, Background Pollution Trends and the Sensitivity of the Receptor
Step 3. Is the Critical Load or Level Exceeded?
Step 4. Apply Critical Loads and Critical Levels with Expert Judgement
Step 5. Project Duration and Seasonal Effects
Step 6. Relative Importance of Pollutant Concentration vs Deposition

20 Natural England (2018). Natural England's approach to advising competent authorities on road traffic emissions under the Habitat Regulations. NE Internal Guidance, V1.4 Final, June 2018. Available at http://publications.naturalengland.org.uk/publication/4720542048845824.

## STEP 1 – IDENTIFYING THE BASELINE ECOLOGICAL FEATURES AND AIR QUALITY

**25.** Before doing anything else it is essential to confirm that the receptor feature (habitat, notified feature for species, plant or animal species of interest) for which the screening threshold is exceeded is actually present within the area to be affected, or should be present in order for the site to achieve its conservation objectives[21]. The sensitivity of notified features for nationally and internationally important designated nature conservation sites in the UK that are sensitive to air pollution can be found through the APIS 'Site Relevant Critical Loads Tool' (see paragraph 10, above). For a comprehensive list of features for nationally and internationally designated nature conservation sites, search on the relevant statutory nature conservation body (SNCB) website. Features of local sites can often be obtained through the local authority website.

**26.** An air quality specialist will make initial calculations for the site. For the sake of simplicity and as a worst-case scenario, they may choose the most sensitive habitat type for which that site is designated and model the closest point of the designated site to the source of emission. This is entirely appropriate when undertaking an initial assessment, such as for Habitats Regulations Assessment screening for significant effects. However, qualifying interest(s) of a designated site may not actually be present at that modelled location, and at the more detailed assessment stage this may be a relevant consideration.

**27.** A number of designated nature conservation sites include areas known as 'site-fabric'[22]. These are areas that do not support designated features of the site or their function and are never expected to do so. Areas of site-fabric are often included for reasons of administrative convenience to avoid odd or excessively fragmented, designated site boundaries. If the affected area is adjacent to a road, roadside habitats within the designated site may have already been recognised as site-fabric and it may not be reasonable to apply the relevant biodiversity objectives to these areas. This may render the air quality impacts of less significance in these areas. Again, site survey information may help to provide evidence as to whether or not this is likely to be the case. The presence of site-fabric within the affected part of a European site should always be discussed with the relevant SNCB on a case-by-case basis.

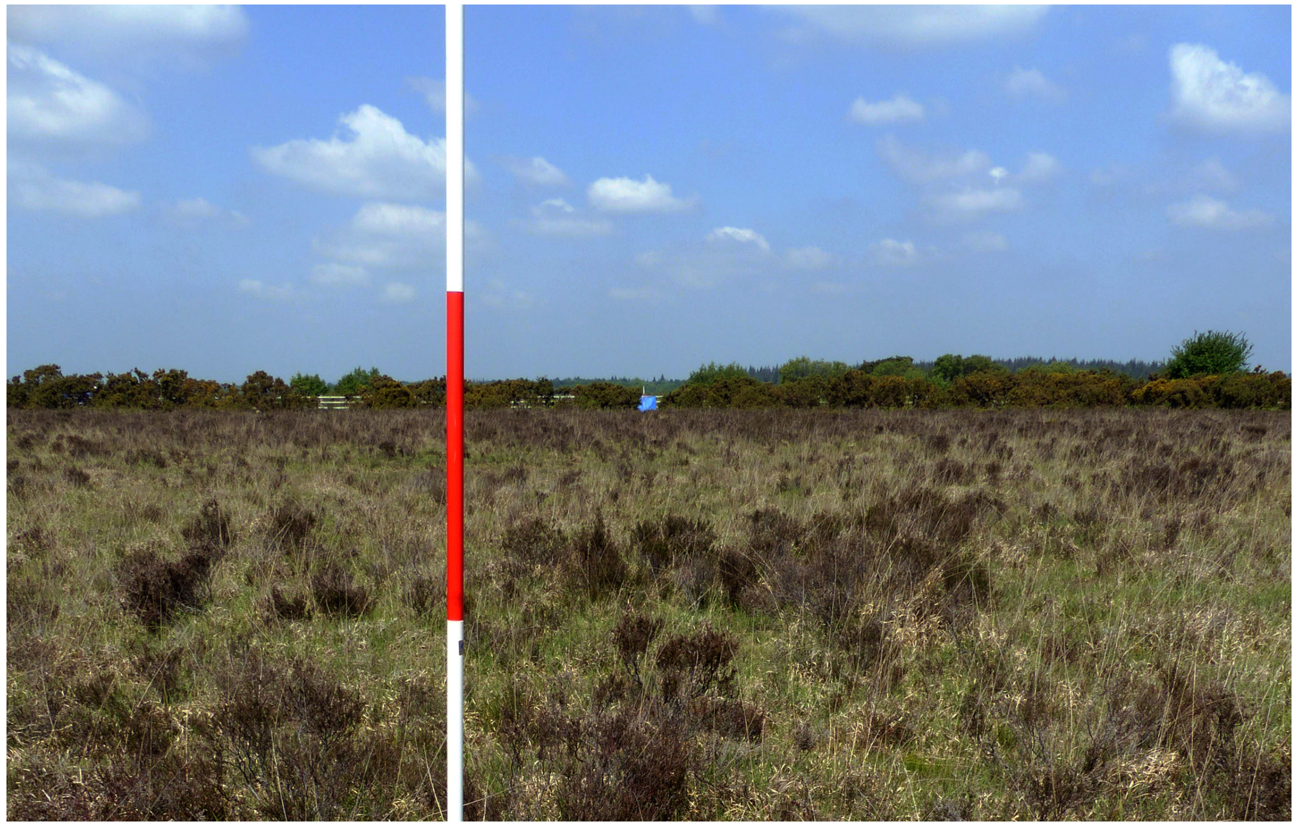
**28.** It may also be prudent to review any information on designated nature conservation sites, to confirm that the interest features are still present or expected to be so. Note, however, that the absence of a habitat or species does not mean that there is no requirement for protection of the habitat, as in the future the species may return, given appropriate management. This issue was addressed by the Planning Inspector in the case of land south of Wallisdown Road, Poole, Dorset, (Talbot Village Trust) APP/Q1255/V/10/2138124 (27 February 2012). In refusing an appeal, the Inspector stated that an appropriate assessment should '*take account of the potential for the restoration of the site to favourable conservation status, as opposed to taking the view that the proposed scheme would not have an effect because, as a result of the poor condition of the site, the interest features are not present*'.

21 In this context, the phrase 'conservation objectives' is being used in its broadest terms to include both favourable condition and favourable conservation status, depending on the site

22 'Site-fabric' is a general term used by Natural England to describe land and/or permanent structures present within a designated site boundary which are not, and never have been, part of the special interest of a site, nor do they contribute towards supporting a special interest feature of a site in any way, but which have been unavoidably included within a boundary for convenience or practical reasons. Areas of site-fabric will be deliberately excluded from condition assessment and will not be expected to make a contribution to the achievement of conservation objectives. Natural England (2018). *Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations.* NE Internal Guidance, V1.4 Final, June 2018.



**29.** It is important to note that condition monitoring is carried out for Sites of Special Scientific Interest (SSSI) and Areas of Special Scientific Interest (ASSI), some of which form part of an internationally important site (e.g. Special Protection Area (SPA), SAC or Ramsar site). The condition monitoring relates to the site interest features and may not be up-to-date as funding for this sort of work may be limited. It is also important that people using this information are aware of its limitations, as it uses the Common Standards Monitoring approach that is focused on identifying the presence or abundance of particular indicator species, for example, which are not necessarily good indicators of the effects of poor air quality. In England, supplementary advice for all SACs and SPAs is now available from Natural England's Access to Evidence website[23] on the features of the site and how to apply and achieve the conservation objectives of the site.



*Vegetation survey of heathland habitat within a 200m wide zone adjacent to the A31 in the New Forest. The survey data was used by Ecological Planning & Research Ltd (EPR) to create an air quality mitigation plan on behalf of New Forest District Council and the New Forest National Park Authority. Photo credit: Andrew Cross, EPR Ltd.*

**30.** The air quality specialist may have produced isopleth drawings, which are contour maps showing the variation in pollutant concentration or deposition due to the proposal(s)[24] for each pollutant across the designated site. Comparison of these isopleths with habitat maps for the site (either gained from field surveys, from online resources such as MAGIC[25] and analysis of high resolution aerial photography, or via consultation with the SNCBs) may show that the habitats present within the area predicted to be affected are less sensitive, or are not habitats for which the site was designated.

**31.** Similarly, where the site is designated for its animal interest, it may be useful to obtain maps showing the distribution of that species (and/or supporting habitat for the species) within the designated site. If such information is not available, then habitat information may be useful, in order to assess the suitability of the affected parts of the site for the animal species in question. If taking this approach, the

23 See http://publications.naturalengland.org.uk/ and search for <<the designated site name>> supplementary conservation advice

24 Often referred to as the Process Contribution

25 https://magic.defra.gov.uk/

conservation objectives for the site should be checked to ensure they do not include targets to improve currently unsuitable areas to support the species in question. However, if there are factors that mean the affected area could never be restored to the desired suitability, this may still be a valid conclusion.

**32.** Consider the physical setting of the affected area. Ecologists should be aware that air quality calculations may only take limited account of the setting or topography. Consider whether there are physical barriers that might inhibit or influence pollutant dispersal, such as thick tree shelterbelts[26], layers of buildings, or topography. For example, if the road from which pollutants are emitted is in a valley, whereas the designated site is at the top of the slope, the air quality calculations may overestimate pollutant concentrations and deposition within the designated site. Typically, these factors are not modelled in highways or agricultural air quality calculations (although they are more likely to be modelled for assessments of industrial installations) but they can be considered qualitatively within an ecologist's interpretation if the air quality specialist confirms they are relevant and appropriate, particularly if the predicted exceedance due to the plan or project is minor.

## Review of Current Levels of Pollution at the Site

**33.** The APIS website allows the user to search for a location using OS grid references, in order to obtain pollutant concentration and deposition rates at a particular location (http://www.apis.ac.uk/search-location). The current dataset is 3-year mean data from 2016-2018 at a one or five km resolution. It is also possible to select the type of habitats which are relevant to the site and examine the current levels against the critical loads and levels for the site. From these data it can be rapidly assessed as to whether there is already an exceedance of critical loads/level for the location. It should be borne in mind that location data are based on either a 1- or 5-km grid depending on pollutant and therefore actual levels may vary. For example, levels of ammonia are based on a 5-km resolution so the actual contribution to a site located close to an intensive poultry farm receiving high levels of ammonia may not be reflected in the APIS figures. If there is uncertainty regarding the baseline concentration, it may be appropriate to request detailed dispersion modelling from multiple existing hotspot sources or, alternatively, to request further monitoring.

## STEP 2 – ASSESSING THE CONFOUNDING FACTORS, BACKGROUND TRENDS AND SENSITIVITY OF THE RECEPTOR OTHER INFLUENCES ON THE SITE

**34.** Consider whether there are any confounding circumstances that may influence the effect on ecological features of increased pollutant levels or deposition rates. Air quality effects should never be considered in isolation but within the context of other factors that may have a greater effect on the ability of the site to support its interest features.

**35.** For example, it has been estimated that 0.3 kg of nitrogen is lost due to leaching or surface run-off, for every kilogram of nitrogen fertiliser or manure applied to a field[27]. Even in Nitrate Vulnerable Zones (where nitrogen application rates are restricted), nitrogen fertiliser is often applied at rates of up to

26 Bealy, W.J., Dore, A.J., Dragosits, U., Reis, S., Reay, D.S. and Sutton, M.A. (2016). The potential for tree planting strategies to reduce local and regional ecosystem impacts of agricultural ammonia emissions. *Journal of Environmental Management*, **165**: 106-116.

27 Duxbury, J.M., Harper, L.A. and A.R. Mosier, A.R. (1993). Contributions of agroecosystems to global climate change. In: L.A. Harper, A.R. Mosier, J.M. Duxbury, and D.E. Rolston (eds), *Agroecosystem Effects on Radiatively Important Trace Gases and Global Climate Change*, pp. 1-18. Special Publication no. 55. ASA. Madison, WI.



50-250 kg per hectare depending on crop and season[28]. Therefore, 45-75 kg of nitrogen can be lost to leaching or surface run-off from each hectare of arable land for every application and could thus affect adjacent designated nature conservation sites where there is hydrological connectivity. Moreover, these numbers do not include the ammonia released to air from the fertiliser or from livestock.

**36.** By comparison, inputs from non-agricultural atmospheric sources are often very modest (typically being at least an order of magnitude less than those from agricultural run-off). However, whilst relatively modest when compared with agricultural emissions, consideration should be given to the magnitude of emission and distance from sensitive receptors for emissions, regardless of sector. A material effect can occur from both a large distant emission source (e.g. a power station) or from a small, very local source (e.g. a road or agricultural activity), and advice should be sought from an air quality specialist. This advice should be borne in mind when determining the extent to which a given source might undermine the achievement of a biodiversity objective in view of the relative contribution from other sources, and the extent to which actions to be taken to deliver any necessary reductions have been secured.

## Considering Background Trends

**37.** In practice, where a site is already exceeding a relevant critical load or level there should generally be a conservation aim to improve air quality. Where European sites are concerned, this will usually be reflected in a conservation objective to restore (rather than maintain) 'favourable conservation status' (FCS) and, in England, will be mentioned explicitly in the Supplementary Advice for such sites. Many sites have specific objectives to improve air quality to or below critical loads/levels.

**38.** The extent to which small increments from new proposals would undermine a conservation objective to 'restore' (or improve) will involve consideration of whether there is credible evidence that the emissions represent a real risk that the ability of other national or local initiatives to otherwise reduce background levels will be compromised in a meaningful manner. This is reflected in recently released internal Natural England guidance[29]. This is a judgement that should be made (and justified) by the air quality specialist, but is informed by:

- the extent to which any credibly demonstrated, or forecast, improving national trends in air pollution, or strategic work to tackle emissions affecting the site, might otherwise lead to improvements and the rate at which such improvements are anticipated to come forwards; and
- source attribution data[30] and an understanding of the main sources of pollution that are responsible for the current exceedance.

**39.** Trends in pollutants for SSSIs (in England, Wales and Scotland), ASSIs (in Northern Ireland) and internationally important sites can be gleaned from the Site Relevant Critical Load function pages for the relevant sites on APIS. Examples are provided below for NOx concentrations and oxidised nitrogen deposition rates[31] at the Thames Basin Heaths SPA. Such improving trends may not exist for all pollutants, or for these pollutants on all sites. For example, APIS indicates that ammonia concentrations

28 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/432141/pb14050-nvz-guidance.pdf

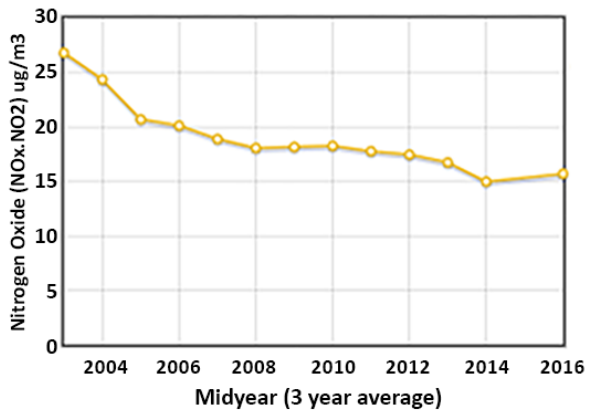
29 Natural England (2018). Natural England's approach to advising competent authorities on road traffic emissions under the Habitat Regulations. NE Internal Guidance, V1.4 Final, June 2018. Available at. http://publications.naturalengland.org.uk/file/5431868963160064

30 Available on APIS Site Relevant Critical Load pages as Source Attribution Tab for nationally and internationally significant designated nature conservation sites. See paragraph 43.

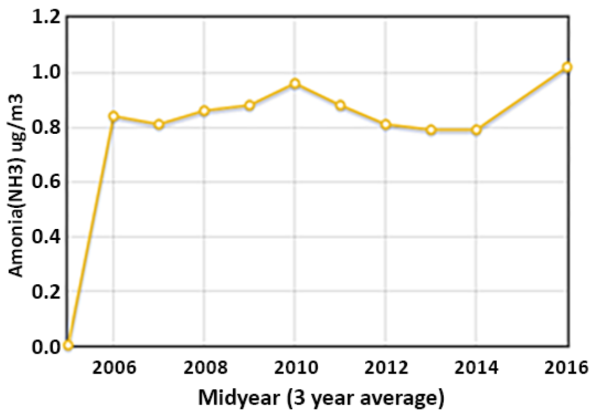
31 Nitrogen deposition has two components: oxidised nitrogen derives from combustion, such as vehicle exhausts, while reduced nitrogen results from ammonia primarily from agriculture. Total nitrogen deposition is both oxidised and reduced nitrogen combined.

(driven primarily by agriculture but also from increasing emission from traffic) are static or increasing (i.e. deteriorating) at many designated nature conservation sites, as can be seen from the graphs below, which are screen captures from APIS[32].

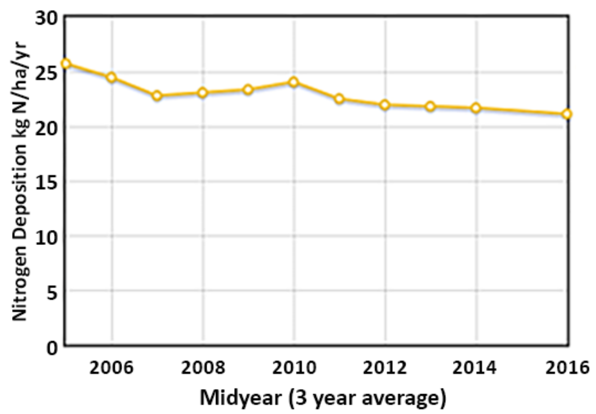
Trend in background NOx concentrations at the Thames Basin Heaths SPA




Trend in background ammonia at the Thames Basin Heaths SPA




Trend in background total nitrogen deposition at the Thames Basin Heaths SPA




32 Note that ammonia only starts at zero on the graph because monitoring data are not available prior to 2006. Also note that the axes of the graphs represent different measures: micrograms per cubic metre for nitrogen dioxide and ammonia, and kilograms per hectare per year for nitrogen.



**40.** In 2018 the Court of Justice of the European Union (CJEU) ruled in cases C-293/17 and C-294/17 (The Dutch Nitrogen Case, see Box 1). One aspect of that ruling concerned the extent to which 'autonomous measures' (i.e. improvements in baseline nitrogen deposition that are not attributable to the plan or project being assessed) can be taken into account in Appropriate Assessment. Since the implications of the ruling are still being debated in the legal, air quality and ecological communities and, at the time of writing, are being tested in the UK courts, it is not appropriate in this document to provide guidance on the ruling's implications. A discussion of the approach The Netherlands is taking to nitrogen critical load exceedances in the light of the Dutch Nitrogen Case is outlined in Box 1.

**41.** In Habitats Regulations Assessments, if an allowance is to be made for improvements in baseline pollutant concentrations or deposition rates, a clear understanding must exist regarding the scientific reasonableness and likelihood of any forecast at the site concerned, the level of uncertainty surrounding the forecast and any adjustments that are (or have been) made by the air quality team to minimise that uncertainty.

**42.** It is important to understand whether the background trend at the designated site is an improving, static or deteriorating one. Even if it is improving, it will still be necessary to consider the effect of a given plan or project (in combination with others as appropriate) in retarding or slowing any forecast improvement, and whether any slowing would be acceptable.

## The Relative Importance of Each Sector

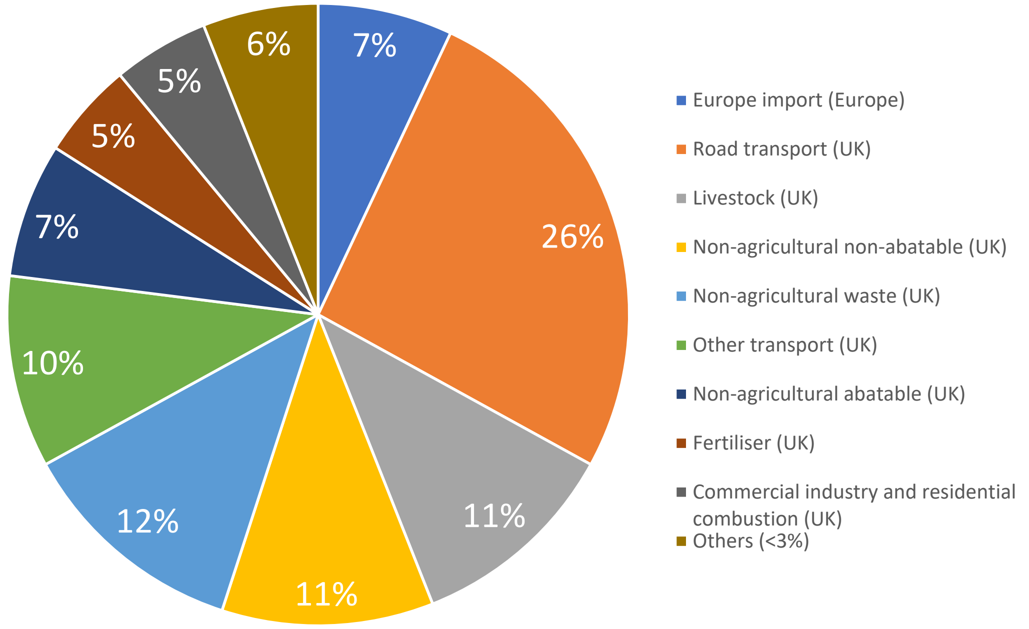
**43.** APIS provides source attribution data for nitrogen deposition, sulphur deposition and acid deposition. The information is presented as a pie chart and provides a helpful visual indication of the relative contribution that each source sector makes to current pollution levels. Given the dominant role of nitrogen-based pollution for ecological receptors, it is the nitrogen deposition information which will be most relevant. The source attribution data is provided in various formats but the 'local contributions to nitrogen deposition from sources (UK)' is most relevant to site-based decisions concerning a new local source of pollution. When considering the ecological question of how an individual proposal might undermine the achievement of site-based biodiversity objectives, it is appropriate to recognise:

a) the relative importance of the source sector (that the proposal is part of) to any current pollution levels;
b) the risk of proliferation of new sources within that sector (i.e. the likelihood of effects arising in combination with other plans and projects);
c) the presence of any site-based strategic approach to address nitrogen pollution.

**44.** Two examples are provided on the following page to illustrate how source attribution data might inform ecological decisions regarding the achievements of site-based biodiversity objectives. Figure 1 is from a SAC within an area of high development pressure where roads-based emissions make a significant contribution to current critical load exceedance.

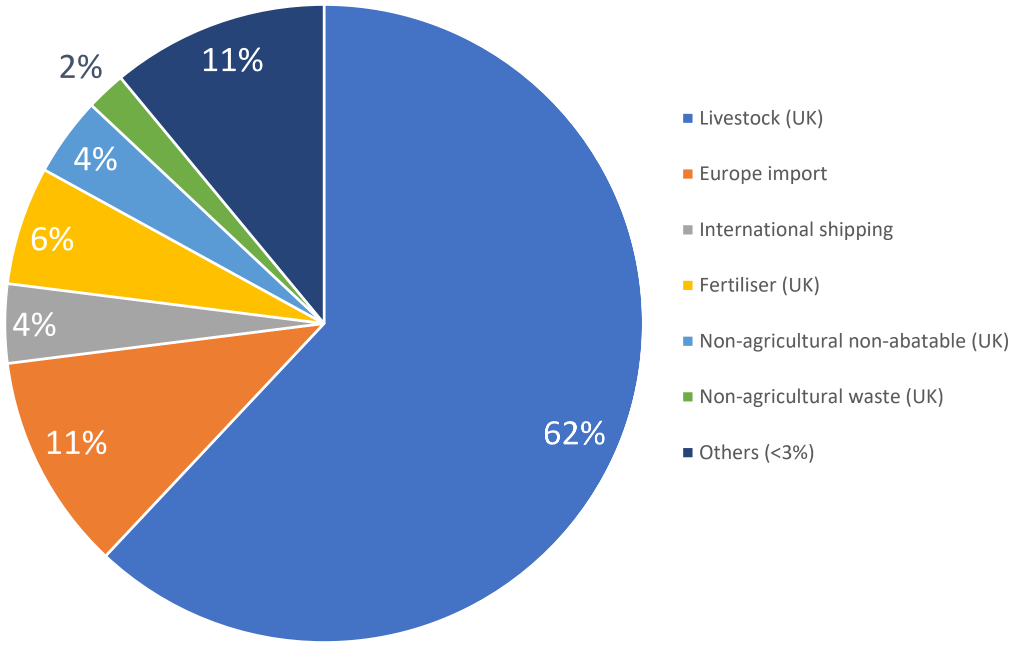
**45.** In this example, road transport is a significant source (26%) of nitrogen-based pollution. National initiatives to encourage uptake of clean technology and predicted future trends that are anticipated as cleaner cars become more affordable should lead to an improving trend in the background levels over time. The contribution from road transport, and the proliferation of proposals leading to increase traffic flows, is such that reliance on national initiatives alone are unlikely to be sufficient to regard a new proposal as acceptable. A site-based strategic approach to actively reduce pollution from existing road transport sources (and other sources) is likely to be necessary to achieve the biodiversity objectives for the site.

*Figure 1. Source attribution data from APIS for an example SAC with high development pressure where road sources make a significant local contribution to nitrogen deposition. Figures are proportions of the total attributed to different sources of nitrogen deposition.*




**46.** By way of comparison, consider the source attribution data for a different site in Figure 2 below. In this case, the SAC lies within an agricultural 'hotspot' and agricultural sources are the most significant local source of nitrogen-based pollution (68% in total when livestock and fertiliser contributions are combined). The relative contribution from local roads is less than 3%, such that it is grouped with 'others' in the pie chart. A site-based strategic approach to actively reduce pollution from existing agricultural sources will be necessary to achieve the biodiversity objectives for the site. Even a relatively minor additional agricultural contribution would undermine a biodiversity objective to restore (or improve) background levels. On the other hand, road transport makes only a small contribution to the critical load exceedance, therefore initiatives to encourage cleaner car technology may be sufficient to regard a new proposal which leads to a small increase in traffic on local roads as acceptable.

*Figure 2. Source attribution data from APIS for an example SAC within an agricultural 'hotspot' area: In this case, agricultural sources make the most significant local contribution to nitrogen deposition. Figures are proportions of the total attributed to different sources of nitrogen deposition.*






**47.** Any decision which takes account of sector contributions must be made on a case-by-case basis and will be specific to the site in question. The presence of a local strategic approach to deliver reductions from local sources will exert a significant influence over how contributions from different sectors are to be treated. Where a local strategic approach is in place which can be relied upon to deliver reductions from the key sectors, minor contributions from other sectors can more easily be regarded as acceptable.

## The Sensitivity of the Habitat or Species in Question

**48.** Check the information relating to the sensitivity of the habitat or species in question to the pollutant; there may be other influences that actually mean that nitrogen deposition or acid deposition (for example) aren't as important in a given situation as simple consideration of the critical load may imply. Where possible, APIS provides clarifying text that indicates site-specific considerations for when particular pollutants may be more of a concern than others.

**49.** For sites in England and Wales, refer to the Natural England Site Improvement Plans (England) or Priority Improvement Plans (Wales) as these can provide information as to whether air quality is considered a concern, although for many sites that will be based on whether the site exceeds the critical load for the designated habitats. In England, the supplementary advice documents produced for SACs and SPAs are also of relevance.

*The South Pennine Moors SAC, with a grip dam in the foreground. Habitats subject to other stresses, such as modified hydrology, may be more sensitive to the effects of air pollution. Photo credit: Philip Peterson*

**50.** Some illustrations of situations where this may apply are provided below:

- Freshwater systems are generally (although not always [33]) phosphorus-limited. This means that, in an unpolluted waterbody, phosphorus is the scarcest of the primary macronutrients[34]. It is therefore availability of phosphorus which dictates the growth response of freshwater vegetation and thus eutrophication. While the presence of nitrogen is not irrelevant, in most freshwater systems it is more

33 For example, the River Clun SAC in Herefordshire and Shropshire has conservation objectives relating to nitrogen inputs.

34 Nitrogen, phosphorus and potassium.

important to control phosphorus inputs than nitrogen inputs, in order to preserve or restore habitat health and diversity[35]. This is why phosphate discharge limits are often introduced on wastewater treatment works in order to protect freshwater habitats, but why nitrogen limits are rarely introduced to achieve the same objective. Phosphorus does not typically deposit from the atmosphere but does come from wastewater treatment work discharges and agricultural run-off[36].

- Similarly, while empirical studies have identified that nitrogen deposition rates above the critical load for fenland can result in negative effects on this habitat through excessive growth of coarse, competitive species, this does not mean that deposition above the critical load will result in negative effects in every given situation. Other factors must be considered, including the relevant limiting nutrient. 'Poor fens' (i.e. acidic fens) are strongly nitrogen-limited. In contrast, other types of fen with a relatively alkaline pH (called 'rich fens') are phosphorus-limited. In a phosphorus-limited system, high nitrogen availability will not result in a deleterious effect on vegetation provided that phosphorus availability is controlled[37]. That is not to say that nitrogen inputs would therefore be irrelevant, but it does mean that when nitrogen is already in excess (and phosphorus inputs can be controlled), a proportionate response should be made to the risk posed by small additional nitrogen inputs. This is reflected in the different critical load ranges for 'poor fens' compared to 'rich fens'.
- Marine systems are generally nitrogen-limited[38]. As such, nitrogen inputs are more likely to affect marine systems than freshwater systems. However, consideration should also be given to the relative scale of nitrogen inputs from air into marine habitats compared to those from other sources. In most cases, nitrogen inputs from the atmosphere are likely to be miniscule compared to inputs from marine and riverine sources. Therefore, even if it were possible to completely remove nitrogen inputs from the atmosphere (at least from local sources), it may have a negligible effect on nitrogen inputs into marine systems relative to the inputs from other sources. For saltmarsh (as an example) this is reflected on APIS, which states that '*Overall, N deposition* [from the atmosphere] *is likely to be of low importance for these systems as the inputs are probably significantly below the large nutrient loadings from river and tidal inputs*'[39].
- In addition, marine and inter-tidal systems will be subject to tidal flushing. Depending on the extent and frequency of inundation, this is likely both to have a much greater influence on botanical composition than atmospheric nitrogen inputs and to remove a large proportion of any nitrogen that does deposit from atmosphere, thus preventing it from accumulating to the same extent as in terrestrial habitats. This could reduce the effect of an exceedance of nitrogen deposition rate in a manner that cannot be taken into account via the critical load system and standard approaches to air quality modelling. In freshwater systems, very high levels of rainfall may have a similar flushing effect since nitrogen is easily washed out of soils. For example, water table level and precipitation have been identified as modifying factors for some habitats; bogs and heathland habitats are considered to be less sensitive to nitrogen in wetter areas than drier areas[40].

**51.** Box 2 discusses recent research that has been undertaken into dose-response relationships.

## BOX 2. A NOTE ON RESEARCH INTO NITROGEN DOSE-RESPONSE RELATIONSHIPS

1. Studies comparing deposition rates with reduction in species richness indicate that the response of some habitats to long-term nitrogen deposition is curvilinear for most parameters, with some of the sharpest losses in diversity occurring at or below the critical loads.
2. These dose-response curves illustrate how plant communities respond to increased nitrogen. They can be used to inform site-based assessments, taking account of the site-specific circumstances which apply in each case. For example, sites that are currently approaching their critical load can be particularly sensitive to even modest increases in nitrogen. Dose-response data should not, however, be used to generate 'significance' thresholds to be applied as a 'rule of thumb' in order to draw conclusions concerning the ecological implications of a given increase in nitrogen. This is because:
   - It is not possible to know where on the dose-response curve a site is positioned at any one time. A site may already be experiencing a reduction in species richness due to nitrogen deposition and therefore even a small addition of nitrogen may be damaging.
   - In reality, it is often very difficult to observe a dose-response in the field at a specific site, not least because many sites have been exceeding critical loads of nitrogen for some time such that species diversity may have already been reduced. Aggregating a large volume of data may be needed to observe trends.
   - Particular caution is required where there is a biodiversity objective to reduce nitrogen deposition. In such circumstances, the achievement of the biodiversity objective could be undermined by compromising the delivery of necessary reductions even in the absence of a further reduction in species richness.

## STEP 3 – IS THE CRITICAL LOAD OR LEVEL EXCEEDED?

**52.** Examine whether the Predicted Environmental Concentration (PEC, i.e. the contribution of the plan or project combined with the baseline deposition rate and other plans and projects) actually exceeds the critical level or critical load. If it does not, then it may be possible to conclude that there would not be a negative effect, notwithstanding the fact that the contribution of the proposed plan or project cannot be dismissed as trivial on purely mathematical criteria. However, this will depend on the extent to which known relevant other projects are factored into the PEC[41], whether or not a net improvement

35 '*When considering nutrient nitrogen (N) deposition for wet habitats, other sources of nutrient inputs, such as diffuse pollution, should be considered which may be more dominant. In these cases the relative contribution from atmospheric and land based sources may need to be considered further to inform any judgements*'.
Source: Environment Agency Operational Instruction 67_12 (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.* Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010039/EN010039-000589-Environment%20Agency%20-%20Document%202.pdf.

36 Although nitrogen is not the primary contributor to eutrophication in the freshwater environment, it is also a contributor to acidification and this process may be relevant to a freshwater site if acidity critical loads are available.

37 '*In a nutrient limited system, excess of the non-limiting nutrient may not result in any signs of enrichment in the vegetation as the plants are unable to make use of one nutrient without sufficient amounts of the other*'.
Source: McBride, A., Diack, I., Droy, N., Hamill, B., Jones, P., Schutten, J., Skinner, A. and Street, M. (eds) (2011). *The Fen Management Handbook. Chapter 4. Understanding Fen Nutrients.* Scottish Natural Heritage, Perth. Available at https://www.nature.scot/sites/default/files/Publication%202011%20-%20Fen%20Management%20Handbook.pdf.

38 Howarth, R.W. and Marino, R. (2006). Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: Evolving views over three decades. Limnology and Oceanography, **51**: 364-376.

39 UK Air Pollution Information System website. Nitrogen deposition: coastal saltmarsh. Available at http://www.apis.ac.uk/node/968.

40 Source: Environment Agency Operational Instruction 67_12 (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.* Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010039/EN010039-000589-Environment%20Agency%20-%20Document%202.pdf.

41 For example, Environment Agency guidance states that if '*the process contribution plus background concentration (i.e. PEC)* ▶

is expected even allowing for the proposed plan or project due to an improving baseline, and on the scale of any predicted effect. It is recommended that the ecologist discusses this with the air quality specialist.

**53.** Within this context, it should be noted that whilst the published critical loads reported on APIS are the most authoritative source of information, critical loads are periodically revised as new research emerges. Several recent literature reviews suggest that, with regards to nitrogen deposition, there is some evidence, for some habitats, that the critical loads currently adopted may need to be lowered in the future. For example, there is published research[42],[43] which suggests that rates of nitrogen deposition below the published critical loads for acid grassland[44] may still significantly affect the species composition of this habitat type. This is also reflected in a recent Natural England research report[45].

**54.** Nonetheless, the critical loads provided on APIS should be used for the purposes of assessment, subject to interpretation. Since widely accepted critical loads are required for the purposes of assessment, it would be a retrograde step for individual ecologists to decide to use alternative critical loads on their own account. However, it must be borne in mind that these critical loads may alter in the future to reflect emerging research regarding vegetation sensitivity.

## STEP 4 – APPLY CRITICAL LOADS WITH JUDGEMENT

**55.** The empirical evidence supporting the setting of critical loads is variable[46]. This is reflected in the commentaries available on APIS and it is therefore necessary to apply the critical loads or levels assigned to each designated site on APIS with judgement, particularly for a site designated for its fauna, where the effect of air pollution is often indirect. For example, habitat structure may be more important than botanical diversity for sites designated for their bird or insect interest. In these cases, the critical load for the habitat may be less applicable to the preservation of the interest features of the site where it can be demonstrated that no link exists between the effects of deposition on the habitat and its ability to support the particular species.

**56.** For stag beetle, for example, a plentiful supply of dead wood with adequate moisture in the area of rot is the key requirement to preserve the population, such that the critical load for the habitat present is not particularly relevant. APIS provides a Site Relevant Critical Load for nitrogen associated with Richmond Park SAC, which is internationally designated for its stag beetle population. Stag beetle is associated with woodland and therefore the critical load range presented on APIS is that required to protect the botanical diversity of woodland. However, the ability of a site to support stag beetle is unrelated to its botanical diversity and strongly related to the presence of partially buried dead wood, a resource which will not be affected by changes in nitrogen deposition. Therefore, in reality, the ability of the SAC to meet its conservation objectives for stag beetle is unrelated to nitrogen deposition rates, notwithstanding the species association with a habitat that is itself sensitive. This is reflected on the APIS website, which clarifies that no negative effect on stag beetle is expected despite the sensitivity of its broad habitat. This example is specific to stag beetle and may not be applicable to other saproxylic invertebrates, but it illustrates how a conclusion is presented on APIS[47] but the presentation of the information has to be understood for it to be correctly interpreted. It must be noted that SACs and SPAs are also SSSIs, and that the list of designated features for the SSSI may be much more extensive than for the SAC or SPA. This is the case for Richmond Park SSSI. Therefore, it is essential to ensure that any assessment considers all of the interest features for which the relevant nature conservation site is designated.

**57.** Consider whether the habitat in question is heavily manipulated. For example, because nightjar and woodlark nest in rotationally managed commercial plantations in addition to heathland habitat, APIS provides a critical load for 'coniferous woodland' on its Site Relevant Critical Load pages for sites supporting those species. However, there is typically a belt of permanent woodland preserved next to roads as standard forestry practice that may buffer nesting areas, although consideration would still be needed of its potential value as foraging habitat. In addition, research into rotationally managed commercial plantation in Breckland Forest[48] has identified that the amount of plantation in each growth stage and (for woodlark) the planting and restock period management regime (such as whether the area was de-stumped or ploughed, and factors such as brash cover and weed control) explain the vast majority of the recorded spatial and temporal variation in nightjar and woodlark abundance. Provided these aspects of management are appropriate, other factors are therefore less likely to influence the achievement of biodiversity objectives for these species in rotational forestry than they do in more natural habitats. Note, however, that long-term plans to restore plantation to other habitats such as heathland, and the way nitrogen deposition may affect those future habitats, should also be taken into account as such restoration proposals may be key to achieving the long-term biodiversity objectives for the species.

**58.** Some nitrogen critical loads, such as for saltmarsh, are not as reliable as others and this is often indicated on APIS with a judgement of reliable/quite reliable/expert judgement. For example, APIS provides a minimum critical load of 20 kg/ha/yr N for saltmarsh, and nitrogen inputs have been experimentally demonstrated to have an effect on overall species composition of saltmarsh. However, APIS note that the experimental studies which underlie conclusions regarding the sensitivity of saltmarsh to nitrogen deposition have *'… neither used very realistic N doses nor input methods, i.e. they have relied on a single large application more representative of agricultural discharge'*[49], which is far in excess of anything that would be deposited from the atmosphere. As a result of research by

*is less than 100% of the appropriate environmental criterion it can be assumed there will be no adverse effect'*. Source: Environment Agency Operational Instruction 67_12 (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.* Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010039/EN010039-000589-Environment%20Agency%20-%20Document%202.pdf.

42 Payne, R.J., Dise, N.B., Stevens, C.J., Gowing, D.J. and BEGIN Partners (2013). Impact of nitrogen deposition at the species level. *Proceedings of The National Academy of Sciences*, **110**(3): 984–987.

43 Stevens, C.J., Dise, N.B., Gowing, D.J.G. and Mountford, O.J. (2006). Loss of forb diversity in relation to nitrogen deposition in the UK: regional trends and potential controls. *Global Change Biology*, **12**(10): 1823-1833.

44 UK Air Pollution Information System website. Nitrogen deposition: acid grassland. Available at http://www.apis.ac.uk/node/963.

45 Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, L., Phoenix, G., Power, S., Sheppard, L. and Stevens, C. (2016). Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance. *Natural England Commissioned Reports*, Number **210**. Available at http://publications.naturalengland.org.uk/publication/5354697970941952.

46 Skeffington, R.A., Hall, J.R., Heywood, E., Wadsworth, R.A., Whitehead, P., Reynolds, B., Abbott, J. and Vincent, K. (2007). *Uncertainty in critical load assessment models.* Science Report: SC030172/SR. Technical Report. Environment Agency, Bristol. Skeffington, R.A. (2006). Quantifying Uncertainty in Critical Loads: (A) Literature Review. *Water, Air, and Soil Pollution,* **169**: 3-24. Available at https://doi.org/10.1007/s11270-006-0382-6.

47 The Air Pollution Information System concludes that whilst the woodland habitats which stag beetle inhabit are vulnerable to nitrogen deposition, stag beetles themselves are not vulnerable to nitrogen deposition. The main reason cited is that '*nitrogen deposition is not believed to have a direct, major effect on tree growth in the UK*' and thus the cycle of tree growth and death should continue, as should a continued supply of dead wood. Most of the effects of nitrogen deposition on woodlands are on features other than tree growth, such as ground flora diversity/structure, fungi and lichen populations.

48 Dolman, P. and Morrison, C. (2012). *Temporal change in territory density and habitat quality for Breckland Forest SSSI woodlark and nightjar populations.* Report to Forestry Commission and Natural England, number ENV103/11/19.

49 UK Air Pollution Information System website. Nitrogen deposition: coastal saltmarsh. Available at http://www.apis.ac.uk/node/968.

Boorman and Hazelden (2012)[50], advice is provided on APIS[51] to apply the higher end of the saltmarsh critical load, 30 kg/ha/yr N, except for densely vegetated upper saltmarsh.

59. It should be noted that any deviation from the critical loads/levels set out on APIS would need to be justified by empirical data and in the case of Habitats Regulations Assessment be demonstrated beyond reasonable scientific doubt.

*Coniferous woodland adjacent to the A3 at Ockham and Wisley Commons SSSI, part of the Thames Basin Heaths SPA. Photo credit: Rebecca Brookbank, EPR Ltd.*

60. Critical loads for acidity are based on the dominant soil type within a 1-km grid square. In reality, soil type changes on a much finer scale than 1-km squares suggest. Therefore, if an exceedance of the critical load for acid deposition is anticipated it may be necessary to consider whether the location that will experience an exceedance lies on an atypical patch of underlying soil typology. If so, then it may be more or less sensitive than the critical load assigned indicates. For example, Molinia meadows can be found on a number of different soil types ranging from calcareous to acidic and is therefore represented by a number of different acidity classes. The critical load values will therefore not always reflect the correct underlying soil type[52]. If site-specific information is available to refine usage of the

50 Boorman, L.A. and Hazelden J. (2012). *Impacts of additional aerial inputs of nitrogen to salt marsh and transitional habitats.* Countryside Council for Wales Science Report No. **995**. Countryside Council for Wales, Bangor.

51 APIS indicative critical load values: Recommended values within nutrient nitrogen critical load ranges for use in air pollution impact assessment. Available at http://www.apis.ac.uk/sites/default/files/downloads/APIS%20critical_load_range_document.pdf.

52 Source: Environment Agency Operational Instruction 67_12 (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.* Available at https://infrastructure.planninginspectorate.



critical loads, then this should supplement the risk assessment. Where this information is not available, a precautionary approach should be taken.

61. Since the effect of acid deposition is on the properties of the soil rather than the vegetation, it can be difficult to relate a change in the vegetation community to acidification, rather than to other factors that may have a more marked effect on vegetation in particular circumstances (e.g. changes in hydrology or management). Moreover, responses to acidification may be relatively slow and so an effect may be difficult to determine initially. However, there is no doubt that reduced acid deposition rates decrease the risk of a negative effect.

## STEP 5 – PROJECT DURATION AND SEASONAL EFFECTS

62. Consider whether the project air quality impacts are likely to be long-term or short-term. Critical loads and most critical levels are based on an annual average quantity. There are short-term (24-hour mean) critical levels available for some pollutants based on acute effects of pollutant concentrations but there is currently no equivalent for critical loads and deposition. Moreover, the critical loads for nitrogen deposition are also based on an assumption of exposure to those nitrogen loadings for periods of 20-30 years[53,54]. If the scheme is to operate for only a few months, then there is a reduced likelihood of a negative effect unless the change in deposition rate is very large, because it is less likely to result in a material change in the annual average value and, by definition, will not contribute to long-term exposure.

63. It is also possible to factor in seasonal changes. For example, an area such as the New Forest is likely to experience a seasonal increase in traffic related to tourism.

## STEP 6 – RELATIVE IMPORTANCE OF POLLUTANT CONCENTRATION VS DEPOSITION

64. Due to its alkaline nature, ammonia has toxic effects on vegetation (particularly lower plants) at low concentrations, separately from its role in nitrogen deposition. Therefore, exceedance of '1% of the critical level'[55] for ammonia could well mean cumulative negative effects on vegetation even if the '1% of the critical load' threshold for nitrogen deposition is not exceeded. In contrast, the predominant role of NOx regarding vegetation is as a source of nitrogen[56] (which can in turn result in growth stimulation, growth inhibition and changes to chlorophyll), although it is possible that at high concentrations it may also affect lipid biosynthesis and cell acidity.

65. For example, a study undertaken for Countryside Council for Wales (now part of Natural Resources Wales) reviewed the effects of atmospheric nitrogen deposition on saltmarsh, including the relative importance of NOx concentrations as distinct from nitrogen deposition rates. The review concluded that

gov.uk/wp-content/ipc/uploads/projects/EN010039/EN010039-000589-Environment%20Agency%20-%20Document%202.pdf.

53 Sutton, M.A., Reis, S. and Baker, S.M.H. (eds) (2009). *Atmospheric Ammonia: Detecting emission changes and environmental impacts. Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution.* Springer Science & Business Media, Berlin.

54 Hornung, M., Sutton, M.A. and Wilson, R.B. (1995). Mapping and modelling of critical loads for nitrogen workshop report. Report of a workshop held at Grange-over-Sands, Cumbria, UK, 24—26 October 1994. Institute of Terrestrial Ecology, Penicuik.

55 In this section the 1% threshold is used as a widely agreed basis to define an imperceptible degree of change that lies well within the limits of natural variation. It carries with it no assumption as to what, or how many, plans/projects are taken into account in the comparison

56 APIS: *'It is likely that the strongest effect of emissions of nitrogen oxides across the UK is through their contribution to total nitrogen deposition'*

'*... the robustness of the salt marsh nutrient system might suggest that the application of the critical load limits* [as opposed to critical level] *may afford sufficient protection ... it seems likely that the cumulative effects of these short term impacts* [of elevated NOx] *would, in general, be adequately covered by the application of the critical load approach*'[57]. In other words, for this habitat it is likely that a focus on nitrogen deposition will adequately address the effect of elevated NOx, without a need to separately consider other effects of the gas unrelated to its role in increasing available nitrogen.

66. It may also be useful to consider whether the NOx exceedance is for the annual mean critical level or the short-term critical level. The former is generally likely to be more important in determining the ultimate effect on plant communities due to the ability of many plants to recover from relatively short-term exposures even at high concentrations. According to work by the Centre for Ecology and Hydrology, the '*UN/ECE Working Group on Effects strongly recommended the use of the annual mean value, as the long-term effects of NOx are thought to be more significant than the short-term effects*'[58]. Similarly, the long-term annual critical levels are recommended for atmospheric ammonia as they are the most precautionary[59].

*Part of the Broads SAC, in The Norfolk Broads. Freshwater systems are often phosphorus rather than nitrogen-limited, meaning the effects of additional nitrogen inputs may be limited by the availability of phosphorus Photo credit: Philip Peterson*

57 Boorman, L.A. and Hazelden J. (2012). *Impacts of additional aerial inputs of nitrogen to salt marsh and transitional habitats.* Countryside Council for Wales Science Report No. 995. Countryside Council for Wales, Bangor.

58 Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P., van Grinsven, H. and Grizzetti, B. (eds) (2011). The European Nitrogen Assessment: Sources, Effects and Policy Perspectives. Page 414. Cambridge University Press, Cambridge.
CLRTAP (2017). *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads & Levels and Air Pollution Effects, Risks and Trends. Chapter 3: Mapping Critical Levels for Vegetation.* Umwelbundesamt, Berlin. Available at https://www.umweltbundesamt.de/sites/default/files/medien/4292/dokumente/ch3-mapman-2017-10.pdf.

59 Sutton, M.A., Reis, S. and Baker, S.M.H. (eds) (2008). *Atmospheric Ammonia: Detecting emission changes and environmental impacts. Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution.* Springer Science & Business Media, Berlin.



# 2. MITIGATION AND MONITORING

## INTRODUCTION

67. This section provides advice on the application of measures to address impacts and the use of monitoring where the assessment predicts negative effects will occur or where negative effects cannot be ruled out. For the purposes of this advice, a sequential mitigation hierarchy[60] is recommended.

68. Preference should be given to **preventing or avoiding** exposure to the pollutant in the first place by eliminating or isolating potential sources, moving sources away from sensitive receptors or by replacing sources or activities with alternatives. This is usually best achieved through taking air quality considerations into account at the development proposal design stage.

69. **Mitigation** measures should next be considered to **reduce** the effects of exposure once all options for prevention/avoidance have been implemented so far as is reasonably practicable (both technically and economically). To achieve this, preference should be given first to:

- mitigation measures that act on the source; before
- mitigation measures that act on the pathway; which in turn should take preference over
- mitigation measures at or close to the point of exposure that address the impacts upon the receptor; but consider that
- in each case, measures that are designed or engineered to operate passively are preferred to active measures that require continual intervention, management or a change in people's behaviours.

70. Where mitigation is used to change the outcome of a risk assessment, certainty of the mitigation measure's success and influence on emissions can be a factor in meeting legal requirements of the specific designated nature conservation site being assessed. This certainty should be explained with reference to the peer reviewed literature and, where a measure's success is less certain, precautions should be taken (e.g. do not overestimate emission reduction, implement an area of habitat management as large as possible to meet the needs and check that certainty levels of techniques are adequate).

71. Having exhausted potential solutions for preventing/avoiding and then for reducing impacts, the air quality effects of a new development can be compensated by proportionately contributing to air quality improvements that benefit other locations/habitats within the same designated site (or designated sites elsewhere). Another form of compensation would be to complete actions (such as habitat creation or management) that address the harmful effects of an air quality impact. Where compensation is being considered in the context of predicted impacts on European Sites, careful consideration of the legal tests of the Conservation of Habitats and Species Regulations (2017) (as amended) is required (see Box 3).

72. Where the ecologist considers that a potential negative effect from air quality impacts may occur, it may be appropriate to undertake monitoring of the impact of the project to evaluate whether the mitigation measures are effective. There may also be a case for monitoring where no negative effects are predicted, but where there is a degree of uncertainty in this finding. There are a variety of means

60 CIEEM (2018) *Guidelines for Ecological Impact Assessment in the UK: Terrestrial, Freshwater, Coastal and Marine version 1.1.* Chartered Institute of Ecology and Environmental Management, Winchester

by which impacts could be monitored, e.g. measurement of atmospheric concentrations[61] or habitat assessments to determine species composition/growth rate. If monitoring indicated that impacts were occurring that were not predicted at the time of consenting, this could be used to trigger additional action to address those impacts (see section on Adaptive Management and Other Measures in Response to Monitoring, below).

## BOX 3. MITIGATION AND COMPENSATION: AN IMPORTANT POINT FOR HABITATS REGULATIONS ASSESSMENT

In some cases, air quality impacts will be considered in the context of potential effects on European Sites. Any such effects will need to be considered through the Habitats Regulations Assessment (HRA) process. This document is not intended to be a guide to HRA (see Part 1 for an introduction to the process and further relevant literature) but readers should be aware of the importance of distinguishing between mitigation and compensation during HRA due to the legal requirements of the HRA process.

Measures defined as mitigation must be confined to those measures which avoid or reduce an impact, or the effect of an impact, at the location at which it is predicted to occur. Such measures cannot be considered during screening for Likely Significant Effects (LSE) but must be considered during completion of an Appropriate Assessment.

Compensation measures must be clearly defined as those needed to offset effects on the network of European Sites in the UK if, following mitigation, there remain residual adverse effects on site integrity or such effects cannot be ruled out. For European Sites, compensation can only be considered if there are no alternative solutions (that would be less damaging to site integrity) and if there are imperative reasons of over-riding public interest (IROPI) as to why the plan or project should, nevertheless, go ahead.

Considering compensation measures during HRA screening and Appropriate Assessment of a project is therefore not appropriate and may pose a risk of legal challenge.

Readers should be mindful that legislation, case law and guidance changes regularly, and should check for the latest updates to these rather than relying on references in this document.

73. It should be noted that due to the strict legal tests relating to HRA under the Habitats Regulations, it may not be possible for consent for a project to be granted where the potential for adverse effects is uncertain unless the alternatives and public interest tests are also met (see Box 3).

74. In reality, monitoring the ecological effects of air quality is not easy, not least because air quality fluctuates according to changes in meteorological conditions, emissions from a range of sources, and/or emissions from the specific plan or project under consideration. There may be a lag effect on a habitat and the effect of pollution may not be observed for some time (potentially many decades) after onset. In addition, pollutant deposition rates are not routinely measured outside of the national UKEAP network [62]. Robustly identifying an impact due to a single plan or project with a low magnitude of emissions is often challenging, therefore, and where impacts are small it is likely to effectively be impossible.

61 Concentrations of pollutants such as oxides of nitrogen (NOx and/or NO2), ammonia (NH3), sulphur dioxide (SO2) and ozone (O3) can be monitored using a range of survey techniques.

62 United Kingdom Eutrophying & Acidifying Network (UKEAP), see: https://uk-air.defra.gov.uk/networks/network-info?view=ukeap.



75. To undertake such a study could require monitoring before and after a plan or project is implemented. The duration of monitoring will depend on its purpose and the scale of the risk of negative ecological effects.

76. Condition monitoring of the habitats and species associated with the designated site can also be carried out to assess the response of these to any increase in pollutant concentration and/or deposition rates. Monitoring should include consideration of the ‘trigger points’ for taking action and what those actions would be. This is explored further in subsequent sections of this document.

## POTENTIAL AVOIDANCE, MITIGATION AND COMPENSATION MEASURES

### Avoidance and Mitigation Measures – Source Management

77. For most project-level assessments, by the time the air quality effects are assessed in detail the basic project parameters will have been fixed. For example, for industrial facilities there may be limited sites available for such a development, or in the case of road projects the need to integrate with the existing highways network may limit where the project can be located.

78. For some projects, however, it is possible to avoid or reduce negative effects by changing the location and/or design of a project. Where projects cannot completely avoid an impact, the effects may still be minimised in order to increase the acceptability of the project. In most instances, such measures will need to be developed by the ecologist and/or air quality specialist in conjunction with other project team members. For example, route selection for a highways proposal will require input from the highways design team and numerous other technical specialists. Potential measures that an ecologist could consider include:

- Relocating the source of the emissions so as to reduce impacts on designated site(s)
- For industrial installations such as power stations, modifying how the installation will be operated to lessen effects on ecological receptors
- For strategic land use plans, identifying emission reduction measures to maintain or reduce overall emissions levels at designated sites and other ecological receptors
- Traffic management measures to limit the effects of vehicle emissions on ecological receptors. For example, it may be possible to include measures to discourage the use of roads near designated sites by targeting improvements elsewhere or even closing certain routes to motorised vehicles
- Measures to promote the use of more sustainable transport options to reduce vehicle emissions through ‘modal shift’
- Altering farming techniques and equipment to reduce emissions of agricultural ammonia.

### Mitigation – Pollutant Interception

79. It may be possible to intercept a proportion of pollutants from an emission source before they reach a designated site. Measures range from the use of strategically located barriers and vegetation (tree shelterbelts, green walls) through to technological solutions. There is uncertainty about how effective some of these measures are under ‘real world’ conditions, with the evidence for some interception techniques showing that these may deliver negligible or no benefits. It is imperative that ecologists and air quality specialists work together closely to identify if pollution interception techniques are viable for a plan or project and, if so, that solutions with demonstrable effectiveness are considered.

80. Pollutant interception can however be an effective means of reducing ammonia emissions from agricultural sources. The use of pollutant interceptors such as scrubbers have been shown to reduce emissions by 70 – 90%[63]. Similarly, inclusion of tree shelterbelts has been modelled to show a maximum of 27% ammonia capture from livestock housing[64]. This level of reduction presumed a 10-m canopy height, 50 m width and 50 m backstop. Altering the canopy length, leaf area index, leaf area density, and canopy height was shown to reduce pollutant removal to 7%. This work highlights the importance of such components when planning a tree shelterbelt as a means of reducing impacts from ammonia. The UK Centre for Ecology and Hydrology, in collaboration with Forest Research, have developed an online tool to calculate the efficacy of such shelterbelts for ammonia capture from agricultural installations[65].

*Ecological mitigation area adjacent to gas-fired power station. Photo credit: Philip Peterson.*

63 Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B. and Manville, C. (2018). *The impact of ammonia emissions from agriculture on biodiversity: An evidence synthesis.* The Royal Society, London. Available at https://www.rand.org/pubs/research_reports/RR2695.html.

64 Bealey, W.J., Loubet, B., Braban, C.F., Famulari, D., Theobald, M.R., Reis, S., Reay, D.S. and Sutton, M.A. (2014). Modelling agro-forestry scenarios for ammonia abatement in the landscape. *Environmental Research Letters*, **9**: 125001. Available at https://doi.org/10.1088/1748-9326/9/12/125001.

65 See https://www.farmtreestoair.ceh.ac.uk/



## Habitat Management

81. Habitat management may either maintain the target habitats in a favourable condition, despite additional nitrogen inputs, or mitigate the effects of air pollution through measures that maintain the favourable conservation status of target species or ecological communities. It can therefore offer opportunities to address negative effects on ecological receptors. Caution is advised regarding the use of habitat management in the context of Appropriate Assessment under the Habitats Regulations. Habitat management applied to address the effects of air pollution on European Sites may not pass the relevant legal tests to be deemed 'mitigation'. Habitat management in this context may need to be considered 'compensation', which cannot be used in HRA until after the Appropriate Assessment stage (see Box 3).

82. For grassland habitats, changes in the grazing/mowing regime may be an effective means of reducing the effects of additional nitrogen deposition on habitat composition. This includes increasing or decreasing stocking density, changing livestock type, or removing livestock from the designated site overnight (and thus removing some of the fertilising effect associated with their urine and manure production).

83. Grazing can remove small quantities of nitrogen through accumulation in livestock. It can also help to maintain habitats in a favourable condition through opening up the grassland sward and hence reducing the dominance of competitive species that thrive when nutrient levels are elevated. There is evidence that whilst poorly managed cattle grazing can be disruptive to grassland ecosystems, well-managed grazing can maintain the conservation status of habitats in the face of elevated nitrogen deposition and invasive species[66].

84. It is important to consider other sources of pollution on a designated site if introduction or alteration of habitat management to address air quality effects is being considered. Designated sites may already be subject to management agreements between landowners and the SNCB(s) and/or a more strategic Site Nitrogen Action Plan (SNAP)[67] may be in place or under development. Where such agreements/plans are in place, early consultation with the relevant SNCB is advised.

85. CCW (now NRW) published a report[68] that examined the relative effectiveness of habitat management to address atmospheric nitrogen deposition effects in a range of terrestrial habitats[69], which provides a useful review in this area.

## Compensation Measures

86. Where it is not thought possible to avoid or mitigate negative effects arising from air pollution, compensation may be considered as a last resort. Some of the techniques that can be considered are similar to those identified in the mitigation section above. It is important to be clear on whether measures being proposed are considered mitigation or compensation. In accordance with CIEEM

66 Weiss, B. (1999). Cars, Cows and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species. *Conservation Biology*, **13**(6): 1476-1486.

67 Natural England (2015). *Developing a strategic approach for England's Natura 2000 sites.* Available at http://publications.naturalengland.org.uk/file/5688662740172800. Accessed 5 August 2020.

68 Stevens, C., Jones, L., Rowe, E., Dale, S., Payne, R., Hall, J., Evans, C., Caporn, S., Sheppard, L., Menichino, N. and Emmett, B. (2013). *Review of the effectiveness of on-site habitat management to reduce atmospheric nitrogen deposition impacts on terrestrial habitats.* CCW Science Series Report No: 1037 (part A). CCW, Bangor. Available at https://core.ac.uk/download/pdf/33452245.pdf.

69 Including broadleaved, mixed and yew woodland; 'natural' coniferous woodland; neutral, calcareous and acid grasslands; dwarf shrub heath; fen marsh and swamp habitats; bogs; coastal dunes and slacks and other coastal habitats.

guidance[70], mitigation normally involves measures that reduce the effects arising from an impact. Compensation, on the other hand, involves measures that make up for the loss of, or permanent damage to, ecological features despite mitigation.

**87.** Compensation for air quality effects could therefore include one or more of the following:

- Providing new areas of habitat that support the qualifying interests of a designated site, either at or near to the designated site
- Enhancing management of existing habitats that support the qualifying interests of a designated site, either at or away from the designated site
- Where a qualifying interest is a species rather than a habitat, carrying out targeted interventions to improve the conservation status of the species[71].

## Monitoring

**88.** Where negative effects are predicted or where there is uncertainty over predicted effects, monitoring may be appropriate. Monitoring may (and in many cases should) be linked to measures that would be taken if the monitoring revealed negative effects were occurring. Chemical or biological monitoring could be considered, or a combination of both. A summary of potential monitoring options is provided overleaf.

**89.** It should be noted that monitoring is not easy, not least because air quality fluctuates according to changes in meteorological conditions, emissions from a range of sources, and/or emissions from the specific plan or project under consideration. The effects of other environmental variables may mask the effects of air quality, negating the value of any monitoring proposed. The purpose, and the viability of any proposed monitoring measures to achieve that purpose, should always be carefully considered.

## Pollutant Concentration Monitoring

**90.** A range of analytical techniques are available to measure the concentration of pollutants in the atmosphere, including ambient NOx and NH3. These range from simple techniques such as diffusion tubes through to electronic monitoring systems. Monitoring techniques are also available for estimating rates of deposition of pollutants, e.g. nitrogen; these are typically much more complex and expensive to operate than concentration monitoring techniques.

**91.** Techniques for monitoring ambient concentrations of other pollutants are also available. Their applicability and use will vary on a project- and site-specific basis. The air quality specialist should lead on the development of any air quality monitoring proposals, seeking input from the ecologist as required. For example, when identifying air quality monitoring locations the air quality specialist may require information from the ecologist on the locations of habitats of interest.

**92.** Any monitoring proposals should be reviewed with the relevant SNCBs to agree the aims, objectives and techniques to be used. Agreement to any measures that will be employed if monitoring identifies negative effects, should also be sought (see Adaptive Management and Other Measures in Response to Monitoring, on following page).

70 CIEEM (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1.* Chartered Institute of Ecology and Environmental Management, Winchester.

71 For example, this could involve cultivating the food plant of a species that is a qualifying interest of a designated site, or a captive breeding programme.



## Habitat and Vegetation Monitoring

**93.** In addition to the chemical techniques described above, biological monitoring can be used to assess whether habitats are being changed by air quality impacts. An overview of techniques is provided below. Again, the purpose of the proposed monitoring and the ability of the proposed methods to meet that purpose should be carefully considered. It may be difficult to determine whether any observed negative effects are linked to the target plan or project under consideration. Monitoring programmes may be most effective in detecting change where:

- The change from the target plan or project is predicted to be relatively large and outside the range of natural variation
- Monitoring can be delivered over the long term, increasing the likelihood of detecting the potentially subtle effects of air quality impacts
- Previous research has established the likely responses of the target habitat types(s) to changes in air quality
- The effects of changes in air quality on the structure, condition and vegetation composition of the habitat(s) are understood and can be observed.

**94.** Bioindicator monitoring is the use of groups of organisms to assess environmental change. In the context of air quality changes, this usually involves surveying species groups that are sensitive to changes in air quality. Lower plants such as lichens, mosses and liverworts that do not grow in soil are well-suited to this as they obtain most of their water and nutrients directly from atmospheric deposition.

**95.** The Centre for Ecology and Hydrology (CEH) has produced a guide for monitoring air quality using epiphytic lichens[72]. The guide sets out how the presence of different types of lichen can be used to assess the broad levels of nitrogen pollution. This is because some types of lichen are more tolerant of increasing nitrogen levels and deposition rates than others. Once a survey has been completed using the guide, a 'Nitrogen Air Quality Index' (NAQI) can be calculated. The CEH has also developed a mobile phone application that can be used to support completion of these surveys[73].

**96.** Wider habitat and vegetation condition monitoring may also be considered. For example, where a negative effect is predicted for a habitat, National Vegetation Classification (NVC) surveys could be carried out before and after the plan or project is implemented. This monitoring could be used to support an assessment of whether air quality impacts are contributing to changes in the habitats present.

**97.** Other botanical monitoring may also be considered, for example monitoring the Ellenberg nitrogen values of plants within a potentially affected habitat. Ellenberg values cover a range of environmental parameters that plants are sensitive to, for example soil moisture content, salinity, light and fertility levels. If a programme of monitoring revealed an increase in the number and/or extent of plants with high Ellenberg fertility levels, this could indicate a corresponding increase in nitrogen levels in the habitat. Monitored changes in the cover and height of different plant species may also be used to infer changes in the nutrient status of the habitat.

**98.** As per direct monitoring of pollutant concentrations and deposition rates, any programme of biological monitoring should be carefully considered and agreed with the relevant SNCB. Monitoring should be

72 See http://www.apis.ac.uk/nitrogen-lichen-field-manual.

73 See http://www.apis.ac.uk/lichen-app/main.

proportionate to the level of impact predicted, with the purpose and objectives clearly established at the outset.

## Adaptive Management and Other Measures in Response to Monitoring

**99.** Under certain circumstances, it may be appropriate to consider the use of adaptive management strategies to tailor responses to the results of monitoring. Adaptive management is a decision process that promotes flexible decision-making in response to increasing knowledge of how habitats (or other ecological receptors) are responding to management actions and other events[74].

**100.** It will be most appropriate to consider adaptive management for air quality effects in a plan/project context when it can be integrated into existing management for a designated site. Many designated sites are already under management plans, either managed by the relevant SNCB; by landowners (sometimes through agreements such as Environmental Stewardship); or by other parties such as conservation charities. In some cases, strategic SNAPs might be in place or under development. Where existing measures are in place, a plan or project could provide additional support to sustain or modify these to respond to potential effects from air quality impacts.

**101.** Integrating into existing measures rather than trying to deliver adaptive management at the plan or project level has a number of advantages, and:

- Avoids conflicts with existing site management practices;
- Supports holistic management of the designated site(s) for nature conservation objectives;
- Streamlines the delivery of the adaptive management measures;
- It is easier to demonstrate delivery and enable compliance checks through the planning process, for example through the use of S106 agreements.

**102.** For statutory designated sites, the relevant SNCB will usually be able to provide advice on any existing agreements/plans, and should be consulted along with landowners/managers where adaptive management measures are being considered. For non-statutory designated sites, management may be administered through local authorities, nature conservation charities, or the landowner. Land managers should be engaged as early as possible in the project- or plan-making process, once the need for adaptive management measures in relation to air quality has been identified.

**103.** Adaptive management is typically carried out where there is uncertainty about the ecological effects arising from a planned activity. Given the high legal bar of certainty for Habitats Regulations Assessment (the removal of reasonable scientific doubt over potential for adverse effects before authorising a plan or project; see Box 1), careful consideration will be needed when proposing this during HRA of European Sites.

**104.** This is because by the time vegetation/habitats have changed enough for effects to be linked to a new air quality impact, this would usually indicate that an adverse effect on site integrity has occurred. A Competent Authority may only grant permission for a plan or project where there is no likelihood (i.e. without reasonable scientific doubt) that an adverse effect on integrity would occur. Under an adaptive management scenario, absence of reasonable scientific doubt would be difficult to demonstrate.

**105.** Under Article 6(4) of the Conservation of Habitats and Species Directive 2017 (as amended), it is possible for a Competent Authority to authorise a plan or project that may lead to adverse effects

74 CIEEM (2019). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1.* Chartered Institute of Ecology and Environmental Management, Winchester.



on the integrity of a European Site. Authorisation may only be given when there are no alternative solutions; where the plan or project is required for imperative reasons of over-riding public interest; and where compensatory measures to address the adverse effect are delivered.

**106.** Adaptive management could form part of compensatory measures under these circumstances, as an adverse effect on the integrity of a European Site has implicitly been accepted. This approach was taken during the authorisation of the Lübeck-Blankensee airport in Germany, where the European Commission accepted the use of habitat creation and management as compensation for adverse effects on European Sites. These adverse effects were predicted to arise due to increased emissions and subsequent nitrogen deposition from expansion of the airport[75].

*Air quality monitoring station at Ballynahone Bog SAC, Northern Ireland. Photo credit: Caroline Chapman*

75 Commission of The European Communities, May 2009. Case C(2009) 3218. Opinion of The Commission delivered upon request of Germany according to Art. 6 (4) Sub Par. 2 of Council Directive 92/43/EEC of 21 May 1992 on the conservation of the natural habitats as well as the wild animals and plants, concerning the approval of the extension of the Lübeck-Blankensee airport. Available at https://ec.europa.eu/environment/nature/natura2000/management/opinion_en.htm.

# APPENDIX

## INTRODUCTION TO AIR QUALITY MODELLING FOR ECOLOGISTS

The following information is primarily adapted from Environment Agency guidance[76] and what is required from air dispersion modellers to inform Environmental Permitting. Different pollution sources require different modelling approaches, whether they be from a point/stack (e.g. intensive agricultural unit), linear (e.g. traffic) or diffuse (e.g. slurry spreading) source. The inclusion of different parameters should be considered on a project-specific basis and their incorporation should be discussed with air pollution modellers. As an ecologist, when interpreting air pollution models for potential ecological effects, or working with air pollution modellers, it is important to be aware of the required assessment content and modelling parameters, below. This Appendix is intended to summarise considerations behind air quality assessments for ecologists and is not intended as guidance for air quality modelling itself, for which the Institute of Air Quality Management (IAQM) and relevant authority guidance should be given precedence. Where Habitats Regulations Assessment is concerned, this information is relevant to both screening stage and subsequent Appropriate Assessment stages.

| | |
|---|---|
| **Report Explanation** | This describes the purpose of the study and explains all modelled scenarios. Should make clear the type of assessment, for example is it a screening report or a full, detailed assessment. |
| **Location Map** | A site location map showing proposed site, surrounding land use and modelled area (for traffic-related modelling, this will usually be modelled 200-m transects from the relevant road). For point-source modelling (e.g. energy from waste facilities or intensive agriculture), this should identify other contributing sources. |
| **Emissions & Environmental Standards for Air** | Typically defined as either critical levels or critical loads for specified conservation features of designated nature conservation sites (see the UK Air Pollution Information System, APIS). |
| **Baseline Concentrations** | A rationale for the baseline concentration used should be provided. It should be noted that due to averaging over 1- and 5-km grids, national models may not be representative of all process contributions from existing hotspot sources. In relation to contributions to atmospheric ammonia, Shropshire County Council guidance[77] recommends identifying all process contributions to a nature conservation site and including them in modelling. Alternatively, it may be appropriate to recommend baseline monitoring (which should consider annual variation). This is an important consideration when carrying out assessment under the Habitats Regulations in combination with site air quality monitoring. |

76 Environment Agency and Department for Environment, Food & Rural Affairs (2019). *Environmental permitting: air dispersion modelling reports*. Available at https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports#include-input-files.

77 Shropshire Council (2018). Assessing the impact of ammonia and nitrogen on designated sites and Natural Assets from new and expanding livestock units (LSUs). Shropshire Council Interim Guidance Note GN2 (Version 1, April 2018). Available at https://shropshire.gov.uk/media/9752/interim-guidance-note-on-ammonia-emitting-developments-v1april2018-web-version.pdf.



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| **Model Explanation** | All model outputs will inherently exhibit some level of variation, therefore it is important that specific details of models used are provided, for example what software was used (e.g. ADMS, AERMOD, SCAIL-Combustion, SCAIL-Agriculture) and the type of model this software is based on (e.g. Gaussian, plume rise). Similarly, the parameters used to set up the model should also be described. |
| **Emission Parameters** | For point-source modelling, the stack location, stack height, pollutant emission factor, exit diameter, exit temperature, efflux velocity, volumetric flow rate (actual), and volumetric flow rate at reference conditions should be detailed in a table. Deposition velocities will normally be provided (where pollutant deposition is relevant); it should be noted that woodlands and short vegetation (i.e. grasslands and bogs) have different deposition velocities. An adjustment factor to allow for dispersion model bias is typically included in traffic assessments. The source of the information used should be explained, and their relevance to the proposed development stated. If modelling from an existing source of pollution, have existing emissions been modelled in addition to proposed additional sources? |
| **Modelled Domains & Receptors** | The resolution of the model receptor grid used needs to be justified. Additionally, details of potential receptors need to be provided, including location and height above ground where relevant. |
| **Weather Data & Surface Characteristics** | Meteorological variation will influence modelled dispersion extents, direction and concentration. The choice of weather data should be explained. Is it monitored or modelled data? How far from the site is the chosen Met Office weather station? Typically, 3-5 years should be modelled as individual years, and the worst-case scenario should be considered for potential impacts. The worst-case scenario can refer to either the greatest concentration or farthest dispersion extent, depending on site-specific information. Typically, the lower the dispersion extent, the higher the local concentrations. Surface characteristics are important for consideration of both deposition and plume depletion; woodlands, for example, have a higher deposition velocity compared to grasslands. |
| **Terrain & Building Treatments** | Terrain is an important consideration for all dispersion models, as it influences how air moves over an area. Building treatments (where relevant) need to be explained and justified. The location and dimensions of all buildings need to be provided, as these will influence the dispersion of air around them. |
| **Model Uncertainty** | All models have some level of uncertainty, which may be reduced by validation through monitoring. This uncertainty should at least be estimated, for example through reference to previously reported model validation assessments. If uncertainty might influence the predicted environmental effect then the model could be re-run in alternative software and the variability between both models could be considered. |
| **Sensitivity Analysis** | Typically, for point-sources, modelling should include an analysis of how the dispersion plume is affected by the various model inputs. |
| **Special Treatments** | If any specialised model treatments are applied (for example deposition, photochemistry, atmospheric chemistry, coastal models, etc.), input parameters and the rationale for their inclusion should be provided. |

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| **Impact Assessment** | Impact assessment refers to impacts on air quality, not subsequent ecological effects (as an ecologist, an ecological impact assessment is where your input is most beneficial). |
| **Breaches of Environmental Standards for Air** | The exceedances of critical levels and loads of relevant habitats need to be identified. Model uncertainty should be considered. |
| **Contour Plots/Isopleth Diagrams** | These are most often produced for point-source modelling, indicating the dispersion extent and concentrations of pollutant. These must include the name of the pollutant, predicted concentrations and modelling scenario, with averaging time provided. When used, these should clearly indicate areas of exceedance. |
| **Results** | Results should be presented in a table showing, as a minimum, the process contribution and the predicted environmental concentration presented as both concentrations and percentages of relevant critical levels and loads. Inclusion of baseline concentrations may depend on stage of assessment in the case of HRA and relevant regulatory authority guidelines. Results should identify the locations of maximum air quality impacts at sensitive receptor locations. A discussion of results should be provided before drawing conclusions regarding their significance. An ecologist should be involved to determine the significance of contributions to environmental effects on a site-specific basis. |
| **Input Files** | An input file can be generated from most modelling software, indicating all inputs into the dispersion model. This should be included as an appendix to all air quality reports to ensure that the models provided can be replicated and adequately validated. |



# GLOSSARY

| Term | Abbreviation | Description |
|---|---|---|
| Acid deposition | | Atmospheric input of pollutants which may acidify soils and freshwater. |
| Air Pollution Information System | APIS | An online resource that provides comprehensive information on air pollution and the effects on habitats and species (www.apis.ac.uk). |
| Air Quality Assessment | AQA | The process of assessing the impact of a plan or project on air quality. |
| Ammonia | $NH_3$ | A gas which may cause acidification of soils and physically damage vegetation. |
| Annual Average Daily Traffic | AADT | The number of vehicles using a road in a 24-hour period, averaged over a year. |
| Ancient Woodland | | Ancient woods are defined as areas of woodland that have existed continuously since 1600 in England, Wales or Northern Ireland, and since 1750 in Scotland. Ancient woodlands include Ancient Semi-Natural Woodland and Plantations on Ancient Woodland Sites. The vegetation present in ancient woodland requires special consideration in relation to the potential effects of air pollution. |
| Annual mean | | The average of values measured for one year (usually a calendar year). |
| Appropriate Assessment | AA | In the UK - an assessment required by the Habitats Directive and Regulations where a plan or project would be likely to have a significant effect on a European site, either alone or in combination with other plans or projects (part of the Habitats Regulations Assessment process). |
| Area of Outstanding Natural Beauty | AONB | A landscape designation protected under the Countryside and Rights of Way Act, 2000. |
| Area of Special Scientific Interest | ASSI | A geological or biological conservation designation denoting a nationally protected area in Northern Ireland. |
| Avoidance | | Prevention of impacts occurring, having regard to predictions about potentially negative environmental effects (e.g. project decisions about site location or design). |
| Background | | When used in the context of concentration or deposition rate of a pollutant, this refers to the average over a 1 km by 1 km or 5 km by 5 km grid provided by Defra or CEH, e.g. the Local Air Quality Management (LAQM) background maps. |

| Term | Abbreviation | Description |
|---|---|---|
| Baseline | | The conditions that would pertain in the absence of the proposed project at the time that the project would be constructed, operated or decommissioned. The definition of these baseline conditions should be informed by changes arising from other causes (e.g. other consented developments). |
| Chartered Institute of Ecology and Environmental Management | CIEEM | Professional body governing ecology/ecologists. Prior to granting of a Royal Charter in 2013, the body was known as IEEM. |
| Centre for Ecology and Hydrology | CEH | Natural Environment Research Council research organisation focusing on land and freshwater ecosystems and their interaction with the atmosphere. |
| Compensation | | Measures taken to make up for the loss of, or permanent damage to, ecological features despite mitigation. Any replacement area should be similar in terms of biological features and ecological functions to those that have been lost or damaged, or with appropriate management it should have the ability to reproduce the ecological functions and conditions of those biological features. |
| Conservation objective | | Objective for the conservation of biodiversity (e.g. specific objective for a designated site or broad objectives of policy). |
| Conservation status | | The state of a species or habitat including, for example, extent, abundance, distribution and their trends. |
| Critical level | | Concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as plants and ecosystems, may occur according to present knowledge. Usually measured in units of µg/m3. |
| Critical load | | A quantitative estimate of an 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. Usually measured in units of kilograms per hectare per year (kg/ha/yr) (nitrogen deposition) or keq/ha/yr (acid deposition). |
| Cumulative impact/effect | | Additional changes caused by a proposed development in conjunction with other developments or the combined effect of a set of developments taken together. |
| Department for Environment, Food and Rural Affairs | Defra | UK Government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities. |
| Deposition | | The main pathway for removing pollutants from the atmosphere, by settling on the earth's surface. |
| Deposition flux | | Deposition velocity x concentration. |



| Term | Abbreviation | Description |
|---|---|---|
| Designated Site | | Statutory designated sites that are legally protected for their wildlife interest. These include the following designations (but also refer to the definition for 'European sites' and 'local sites' below):<br>• Wetland of International Importance (Ramsar site)<br>• Special Area of Conservation (SAC)<br>• Special Protection Area (SPA)<br>• Site of Special Scientific Interest (SSSI)<br>• Area of Special Scientific Interest (ASSI)<br>• National Nature Reserves (NNR)<br>• Local Nature Reserves (LNR). |
| Do Minimum | | The future baseline, without the project (see 'Do Something'). |
| Do Something | | Refers to the impact of a proposed project in the future. This enables comparison to be made with the future, without the project (see 'Do Minimum'). |
| Ecological feature | | Habitat, species or ecosystem. |
| Ecological Impact Assessment | EcIA | A process of identifying, quantifying and evaluating potential effects of development-related or other proposed actions on habitats, species and ecosystems. |
| Ecosystem | | A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. |
| Effect (including 'negative' and 'adverse') | | The changes that occur to a habitat or species as a result of changes in concentrations or deposition of air pollution. Also see 'Impact'.<br>'Negative effect' is referred to in EcIA/EIA, but 'adverse effect' is referred to in HRA. In practice the term used for reporting will depend on the assessment framework being utilised. |
| Emission | | The release of a substance into air. May be discharged from a stack, vent, vehicle exhaust or from diffuse sources. |
| Enhancement | | Improved management of ecological features or provision of new ecological features, resulting in a net benefit to biodiversity, which is unrelated to a negative impact or is 'over and above' that required to mitigate/compensate for an impact. |
| Environment Agency | EA | The non-departmental government body responsible for permitting certain industrial process in England. |
| Environmental Impact Assessment | EIA | Assessment of projects carried out under the EIA Directive and Regulations. |
| Environmental Permit | EP | A permit required by industrial operators in accordance with the Environmental Permitting Regulations. |

| Term | Abbreviation | Description |
|---|---|---|
| Environmental Permitting Regulations | EPR | The various sets of national regulations that regulate pollution through a permitting system. |
| Environmental Statement | ES | A document describing the effects of a project on the environment prepared during EIA. Referred to as 'Environmental Statement' in the UK. |
| EUNIS | | The EUNIS habitat classification is a comprehensive pan-European system to facilitate the harmonised description and collection of data across Europe through the use of criteria for habitat identification. The classification is hierarchical and covers all types of habitats from natural to artificial, and from terrestrial to freshwater and marine. |
| European Sites | | A network of European designated nature conservation sites including Special Protection Areas (designated under Directive 2009/147/EC) and Special Areas of Conservation as listed in Annex I and II of the EU Directive 92/43/EEC ('Habitats Directive'). These were termed Natura 2000 sites but are now described as European Sites in the UK and will be reported post-EU Exit under the Bern Convention Emerald Network. European sites also include Ramsar sites as a matter of national planning policy in England. |
| Eutrophication | | The process by which an ecosystem is subject to excessive growth of a few species of competitive plants and/or microorganisms as a result of excessive nutrient supply, thus forcing out less competitive plants and (in aquatic ecosystems) resulting in oxygen depletion and a reduction in animal life. |
| Favourable Conservation Status | FCS | [78]The conservation status of a natural habitat will be taken as 'favourable' when:<br>• its natural range and areas it covers within that range are stable or increasing, and<br>• the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and<br>• the conservation status of its typical species is favourable |

78 Definitions taken from Article 1 of the Habitats Directive (COUNCIL DIRECTIVE 92 / 43 / EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora).



| Term | Abbreviation | Description |
|---|---|---|
| Favourable Conservation Status (cont.) | FCS | • population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and<br>• the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and<br>• there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis. |
| Habitat | | The place or type of site where an organism or population naturally occurs. Often used in the wider sense referring to major assemblages of plants and animals found together. |
| Habitats Regulations Assessment / Appraisal | HRA | An assessment, undertaken by the competent authority (i.e. the decision maker), of a plan or project potentially affecting European (Natura 2000) sites in the UK, required under the Habitats Directive (European Directive 92/43/EEC) and Regulations (Conservation of Habitats and Species Regulations, 2017 (as amended)). |
| Impact | | The change in concentrations or deposition of an air pollutant. This may or may not give rise to an effect on an ecological feature. See also 'Effect'. |
| Institute of Air Quality Management | IAQM | The professional body representing air quality professionals. |
| Joint Nature Conservation Committee | JNCC | The statutory nature conservation body that advises the UK government and devolved administrations on UK-wide and international nature conservation. |
| Kilogram per hectare per year | kg/ha/yr | Unit of measurement used to describe the amount of deposition. |
| Kilogram equivalent per hectare per year | keq/ha/yr | Unit of measurement used to describe the rate of acid deposition, in terms of hydrogen ion ($H^+$) equivalent. |
| Leaching | | The process whereby nutrients from agricultural fertilisers are washed out of soil through the percolation of rainfall. |
| Local Nature Reserve | LNR | Statutory designation for places with wildlife or geological features that are of special interest locally. |
| Local sites | | 'Non-statutory' sites of nature conservation value that have been identified locally (i.e. excluding SSSIs, ASSIs, SPAs, SACs and Ramsar sites). LNRs are included as they are a designation made by the Local Authority rather than by statutory country conservation agencies. These are often called Local Wildlife Sites, Local Nature Conservation Sites, Sites of Importance for Nature Conservation or other, similar names. |

| Term | Abbreviation | Description |
|---|---|---|
| Microgram per cubic metre | μg/m$^3$ | Unit of measurement of the concentration of an air pollutant. Often used for ambient concentrations. |
| Milligram per cubic metre | mg/m$^3$ | Unit of measurement of the concentration of an air pollutant. Often used to describe emissions and their limit values for industrial processes. |
| Mitigation | | Measures taken to avoid or reduce negative impacts and their effects. |
| Multi-Agency Geographic Information for the Countryside | MAGIC | A web-based mapping browser showing various geographical designations including designated nature conservation site boundaries. |
| National Nature Reserve | NNR | A statutory designation supporting wildlife or geological features that are significant at a national level. |
| Natural England | NE | A non-departmental government body that is the government's adviser for the natural environment in England. |
| Natural Resources Wales | NRW | Welsh Government Sponsored Body, created in 2013, which took over the work of Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. Responsible for ensuring that the natural resources of Wales are sustainably maintained, enhanced and used. |
| Nature Scot (known as Scottish Natural Heritage until May 2020) | SNH | Body funded by the Scottish Government to promote, care for, and improve natural heritage in Scotland. |
| Nitrate Vulnerable Zone | NVZ | A designated area where land drains into and contributes to nitrate found in nitrate-polluted waters. |
| Nitrogen | N | Nitrogen ($N_2$) is a relatively inert gas but certain molecules containing nitrogen are more reactive with other chemicals. |
| Nitric oxide | NO | Produced during combustion processes. |
| Nitrogen dioxide | $NO_2$ | Produced during combustion and formed by the oxidation of NO in the atmosphere. |
| Northern Ireland Department for Agriculture, Environment and Rural Affairs | DAERA | A government department in the devolved administration for Northern Ireland with responsibility for food, farming, environmental, fisheries, forestry and sustainability policy and the development of the rural sector. |
| Northern Ireland Environment Agency | NIEA | An executive agency within the DAERA responsible for the conservation of Northern Ireland's environment and natural heritage. |
| Oxides of nitrogen | NOx | A term describing a mixture composed of nitrogen oxides (NO and $NO_2$). |
| Pathway | | The route by which a pollutant moves from a source to a receptor. |



| Term | Abbreviation | Description |
|---|---|---|
| Precautionary Principle | | Where there are threats (reasonable grounds for concern) of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation[79].<br>*or alternatively*<br>The principle that the absence of complete information should not preclude precautionary action to mitigate the risk of significant harm to the environment[80]. |
| Predicted Environmental Concentration | PEC | An indication of the total concentration or amount of deposition of a pollutant in the environment following the onset of proposed project(s), taking account of the amount initially present including all sources. |
| Process Contribution | PC | The additional pollutant loading to a receptor as a result of the project subject to assessment (i.e. the difference between the 'do something' and 'do minimum' scenarios). |
| Project (also known as plan or permission) | | Term used for proposals to which this advice might be applied (e.g. development proposal, road scheme, industrial facility or other land use change). |
| Ramsar | | A wetland site designated of international importance under the international Convention on Wetlands, known as the Ramsar Convention. These sites are considered in the same way as European Sites as a matter of government policy. |
| Receptor | | An identified location where an effect may occur. |
| Restoration | | The re-establishment of a damaged or degraded system or habitat to a close approximation of its pre-degraded condition. |
| Scoping | | The determination of the extent of an assessment (for an EcIA, full EIA or AQA). |
| Screening | | A term used to describe different tests under EIA and HRA. For EIA, 'screening' determines whether or not an EIA is necessary. For HRA, 'screening' for likely significant effects is the first specific stage in the HRA process; case law dictates that where likely significant effects cannot be excluded ('screened out') on the basis of objective information, then an Appropriate Assessment must be carried out. In the context of Air Quality Assessments (AQA), it may be possible to 'screen out' emissions that are inconsequential using numerical criteria. |

79 Principle 15 of the Rio Declaration on Environment and Development. Available at https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf.

80 CIEEM (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1*. Chartered Institute of Ecology and Environmental Management, Winchester. Available at https://cieem.net/wp-content/uploads/2018/08/ECIA-Guidelines-2018-Terrestrial-Freshwater-Coastal-and-Marine-V1.1Update.pdf.

| Term | Abbreviation | Description |
|---|---|---|
| Scottish Environmental Protection Agency | SEPA | Scotland's principal environmental regulator responsible for permitting certain industrial processes. |
| Sensitive Receptor | | An ecological feature, usually a designated site, that could be affected by air quality impacts. |
| Significant effect | | An effect that either supports or undermines biodiversity conservation objectives for 'important ecological features'. |
| Site condition (e.g. favourable condition) | | Similar to conservation status (see above) for nationally significant sites. |
| Site of Nature Conservation Interest | SNCI | Non-statutory areas of local nature conservation importance (see Local sites for other names used). |
| Site of Special Scientific Interest | SSSI | A geological or biological conservation designation denoting a nationally protected area in England, Wales and Scotland. |
| Site Nitrogen Action Plan | SNAP | Plans applied to Natura 2000 sites to reduce atmospheric nitrogen deposition and implement habitat restoration. |
| Special Area of Conservation | SAC | Area of protected habitats and species defined in the European Union's Habitat Directive (92/43/EEC) as 'a site of Community importance designated by the Member States through a statutory, administrative and/ or contractual act where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated'. |
| Special Protection Area | SPA | A designated area for birds under the European Union Directive on the Conservation of Wild Birds (2009/147/ EC). |
| Statutory Nature Conservation Body | SNCB | Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resources Wales (NRW), Nature Scot and the Northern Ireland Environment Agency (NIEA). |
| Sulphur dioxide | $SO_2$ | Combustion product formed from sulphur contained in fuels. |

*Air quality impacts can significantly affect estuarine habitats. Photo credit: Philip Peterson.*

*Western Gorse-Bristle Bent grass heathland at Canford Heath SSSI, part of the Dorset Heaths SAC; a site where Nitrogen deposition has the potential to undermine restoration objectives. Photo credit: Andrew Cross, EPR Ltd.*

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