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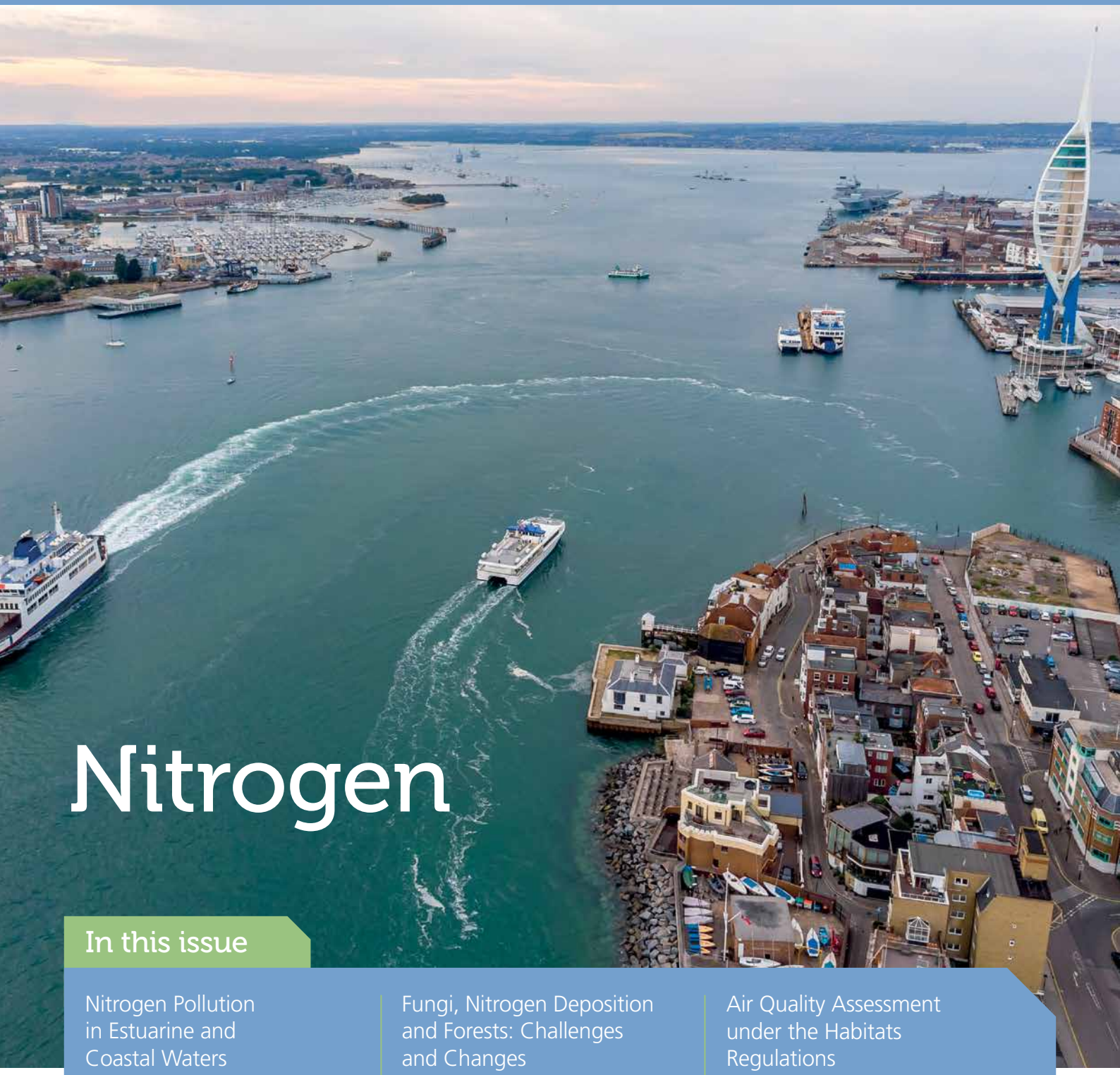

Nitrogen

In this issue

Use It or Lose It: Making Our Evidence About Air Pollution Work for Beneficial Ecosystem Change

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What evidence do practitioners need to restore ecosystems affected by air pollution? This article explores recent projects implemented by the Joint Nature Conservation Committee (JNCC) to help tackle air pollution effects on ecosystems through risk assessment, enhanced decision-making and targeted effort. CIEEM practitioners can help to test these initiatives and decide how the evidence can be presented and used to maximise benefits for ecosystems, their function and the species which rely on them.

Figure 1. Inset shows the last surviving thallus of the very rare *Squamarina lentigera* on Thetford Heath National Nature Reserve, Suffolk. A few thalli still persist on a nearby site. Background photograph shows an area of Thetford Heath NNR, stripped of turf in 1946, and the last refuge of *Squamarina lentigera* on the site. It was stripped again in 2005 to try to recover the species and a wider lichen assemblage. Photo credit B. Nichols, 1996.

Air pollution is linked to biodiversity loss

The weight of evidence demonstrating widespread effects of air pollution on UK ecosystems is substantial. Payne *et al.* (2017) estimated that UK species richness for some habitats is approximately one-third less than it would have been without excess nitrogen deposition. Carvalheiro *et al.* (2019) demonstrate more insidious effects, highlighting the time lag for impacts on higher trophic levels through loss of habitat quality, changes in plant nutrition and subsequent effects on pollinator assemblages.

The implementation of significant controls on emissions has resulted in substantial progress in addressing acute issues such as acid rain and human health effects of nitrogen oxides. In recent decades, attention has turned to tackling nitrogen effects on ecosystems and exploring options for mitigation. Ammonia, in particular, provides a challenge because levels are increasing for some UK countries rather than decreasing (Richmond *et al.* 2020). Globally a similar picture is painted in proceedings from the Royal Society Science Plus discussion on Air Quality, which provides a valuable review of global air quality trends affecting people and their health as well as ecosystems and their function (Fowler *et al.* 2020).

Over 80% of UK Areas/Sites of Special Scientific Interest (A/SSSI) sensitive to air pollution have nitrogen deposition rates above levels at which harm is expected (Rowe *et al*. 2020). Over 60% of the UK land area has ammonia concentrations which are potentially damaging to lichens and bryophytes. This is despite an overall reduction in the maximum amount of excess nitrogen at A/SSSIs which dropped by 56.4% between 1996 and 2017 from 14.9 kg N/ha/year to 8.4 kg N/ha/year. There are country-specific variations in addition to those recognised at local level to be aware of when interpreting these results. Ecological change is also happening in systems experiencing nitrogen deposition below current critical loads defined for each habitat (Payne *et al.* 2020). The values for habitat specific critical loads can be found on the Air Pollution Information System website (www.apis.ac.uk).

Public money for public goods – improving our evidence

The CIEEM 2020 Spring Conference highlighted several challenges faced by practitioners when using data and evidence related to air pollution effects on ecosystems. These included variation in UK risk assessment processes, difficulty accounting for local conditions and emerging case law. JNCC, the UK conservation agencies and regulators have joined together to develop evidence partnership projects to address these concerns.

Now is a time of great innovation in modelling, computer processing, habitat mapping and monitoring through earth observation and citizen science. Government agencies, non-governmental organisations, consultancies and researchers are continually generating new information. How can we not only improve data access but also ensure that the information is usable and valued through that use?

Act locally, nationally and globally

International air quality targets, UK policy and national strategies are contributing to improvements in air quality generally. However, more is needed to restore and enhance our ecosystems at risk of damage from poor air quality, excess nitrogen and acid deposition. The evidence base now available can help us to implement emission reductions in the right places.

The UK Government has recently joined the Leaders Pledge for Nature, with the Prime Minister committing to halt biodiversity loss through ambitious goals and binding targets. The UK devolved administrations and Defra have strategies for clean air that consider biodiversity and acknowledge the transboundary nature of air pollution. Significant effort is now focussed on mitigation options, emission reductions and determining where these efforts will provide the greatest benefit for ecosystems. For example, Natural England has implemented a £3m, 3-year pilot for Catchment Sensitive Farming, and Natural Resources Wales and Welsh Government are prioritising sustainable farming under the Clean Air Plan for Wales. The consultation on Northern Ireland's Ammonia Strategy will be launched soon, and the revision of the Cleaner Air for Scotland strategy is underway.

However, those assessing risk to ecosystems as well as managers of these precious areas requiring restorative management are not always confident they have enough information to understand air pollution impacts or implement mitigation (see Box 1).

A good time for tools and evidence

The following evidence partnership projects, and their scope, aim to fill evidence gaps identified by the Inter-agency Air Pollution Group and their stakeholders. This ensures that the projects deliver what is needed most. This is an initial list to open discussion about how UK projects might address some of the issues raised at the CIEEM 2020 Spring Conference. JNCC welcomes discussion about related projects and potential synergies to ensure these projects are accessible and valuable through their effective application.

Box 1. Case study of Breckland, east England.

Breckland, straddling the border of Norfolk and Suffolk, is an area of around 1000 km^2 which, unlike surrounding areas, is characterised by light, sandy calcareous and acidic soils. Though much changed by modern farming, forestry and urban development, it still retains some of its historic character as an open landscape, and has amongst the highest concentrations of rare, scarce and locally distinct species and semi-natural habitats in England.

Much of the biodiversity value of Breckland lies in the species of early successional habitats and disturbed and bare ground (Dolman *et al*. 2010) found on heaths, forest rides and arable margins. The decline and loss of many of these species (such as the rare *Squamarina lentigera* lichen) can be attributed to the gradual disappearance of the kind of ecological processes (including human activity) which create the dynamism of bare ground creation and subsequent regeneration (Figure 1). The closing over of bare areas, loss of lichen-rich habitats, and increase in dominant species such as wavy hair-grass *Deschampsia flexuosa* are all symptomatic of this disappearance. Unfortunately, these are also symptomatic of the effects of Breckland's high nitrogen pollution (average 17 kg N/ha/y), so disentangling cause and effect and devising appropriate mitigation responses can be problematical, whether operating at site or regional levels.

Nature recovery strategies rely on sound evidence, and the tools currently under development by JNCC help to inform the necessary decisions to make them a reality.

Conceptually, remedying the tangible neglect of a site can be relatively straightforward, but understanding how air pollution impacts a site is more complex with edge effects and changes to soil chemistry all playing a part (Vanguelova and Pitman 2019). Is the cause the artificial fertilising of adjacent fields, the pig unit next door, or the major road 500 m away? With 22% of nitrogen deposition in the UK coming from long-range European sources, what contribution is that making to the overall loading on the site? Addressing each of these requires different responses, both to restore existing sites, and to target the creation of new areas and ecological networks.

Table 1. Four JNCC evidence projects and how they could contribute to issues raised at the CIEEM 2020 Spring Conference. 'Yes' indicates the project was designed to address the need, 'No' indicates it will be unlikely to meet the need and 'Maybe' means we should explore further how the need might be met.

Issue raised at CIEEM Conference	Nitrogen Futures	De Minimis	Emission Source Attribution	Integrating Tools for Air Pollution Assessment (AERIUS UK)
Identifying relevant projects (Scoping in EIA /Screening in Habitats Regulation Assessment)	Maybe	Yes	Maybe	Yes; AERIUS performs detailed modelling and could provide an initial outcome
'In-combination' effects from several emission sources	No	Maybe	Maybe	Yes, through register of emission sources
Predicted future background pollution	Yes, if policy measures remain relevant	Maybe	Maybe	Yes
Predicted effects of national measures at a specific designated site	Yes	No	Maybe	Maybe
Determining **likelihood to undermine conservation objectives**	Maybe	Yes	Maybe	Yes, if defined in tool
Designing strategic approaches to emission reductions	Yes	Maybe	Yes	Maybe
Monitoring strategic approaches to emission reductions	No	No	Maybe	Yes

Table 1 provides an overview of the four projects and the project-specific sections below share more detail about the project aims and specific areas of potential interest.

Evidence partnership project descriptions

Nitrogen Futures. Nitrogen Futures compares current and possible future emission reduction policies to help maximise the benefits to ecosystems and the people that live near them. It quantifies the benefits from a range of potential emission mitigation scenarios for ammonia and nitrogen oxides. These scenarios explore the location for mitigation measures to maximise benefits to ecosystems and protected areas (Dragosits *et al*. 2020).

More certainty is needed about how national emission reduction measures would affect a specific site and, subject to legal advice, Nitrogen Futures helps support some of this evidence need. Less formally, the evidence could be helpful when designing strategic air pollution mitigation (e.g. for local plans) or when looking to restore protected areas under pressure from air pollution. The report can be found on the JNCC Resource Hub Nitrogen Futures page (see Web Resources, below).

De Minimis and Air Pollution Thresholds. The project improves the evidence base for the risk assessment step that identifies proposals that require further assessment (e.g. screening or EIA scoping). A modelling approach will be used to determine when a proposal and the emissions it gives rise to are considered 'inconsequential' for overlapping effects on a protected area. Habitats regulations assessment refers to this as screening for 'in-combination assessment'. This will outline when a proposal has a minimal enough effect that decision makers can be confident an effect is unlikely at the protected site both for the project alone and when combined with other similarly small sources. Follow project progress on the De Minimis webpage.

Update of the emission source attribution dataset on the Air Pollution Information System (APIS). This dataset is publicly available for understanding which types of emission sources affect a specific protected area. The current dataset is based on 2012 emission sources. An update is planned for release in 2021 (based on 2018 emission sources). Source attribution data could assist with understanding which types of emission sources may need to be mitigated to achieve site conservation objectives.

Integrating Tools for Air Pollution Assessment (ITAPA). The ITAPA project aims to develop a freely available online tool for the UK that simplifies ecological risk assessment for air pollution. The proposed UK solution is based on the AERIUS tools that support the Integrated Approach to Nitrogen (PAS) in the Netherlands. AERIUS, and any resulting UK tool, uses detailed modelling to combine air quality changes across all source types such as transport, industrial processes and agriculture. When compared to current approaches, this makes the assessment process easier and clearer whilst reducing cost in time and effort to support decision-making.

Your two pence

For these projects to be successful, we need your advice. Please get in touch to share ideas about how the evidence can be used and displayed to maximise benefit for UK ecosystems, their function and the wildlife that relies on them. Express your interest through the JNCC Air Pollution Projects stakeholder list or email susan.zappala@jncc.gov.uk.

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Web resources

AERIUS, calculation tool for the living environment. National Institute for Public Health and the Environment. https://www.aerius.nl/en/products

AERIUS Register. https://www.aerius.nl/en/about-aerius/products/aerius-register

Air Pollution Information System (APIS). Source attribution dataset. http://www.apis.ac.uk/srcl/source-attribution

De Minimis and air pollution thresholds. https://jncc.gov.uk/our-work/deminimis-project/

Integrating Tools for Air Pollution Assessment (ITAPA). https://jncc.gov.uk/our-work/itapa/

JNCC Air Pollution Project Stakeholder List. https://jncc.us1.list-manage.com/subscribe?u=205a2a3660eb825f6170957cf&id=d52255137a

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Nitrogen Futures. https://jncc.gov.uk/our-work/nitrogen-futures/

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