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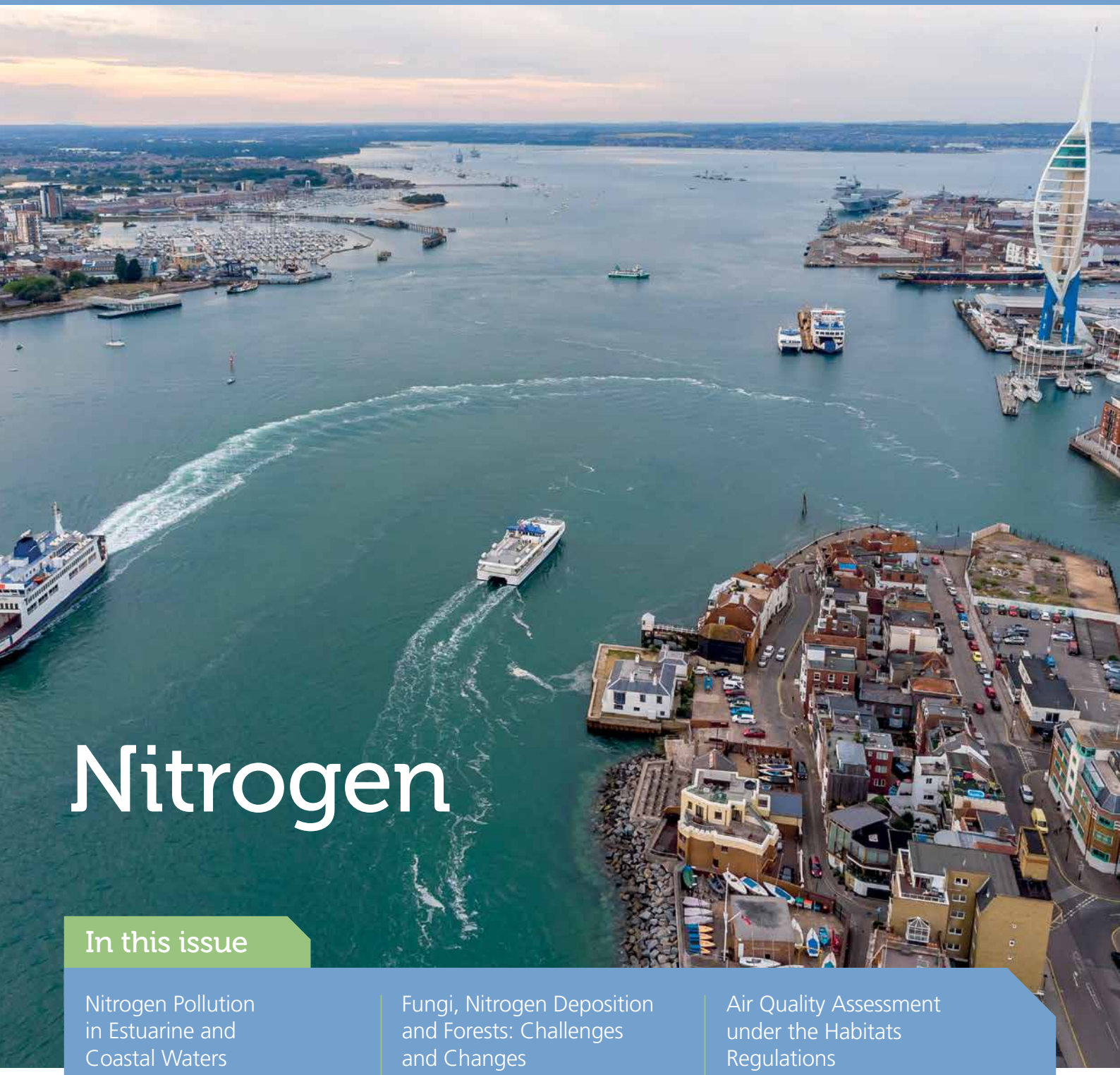

Nitrogen

In this issue

Welcome

The time has come to bid you all a fond farewell. When I joined the CIEEM team as Editor of *In Practice* back in 2013 my enthusiasm for the new role was tempered with some trepidation. I came from a background in academic publishing, albeit applied ecology, and knew I would need to make adjustments for a different audience. My concerns were reinforced as I began to handle articles – what was this preoccupation with GCN? And what did it stand for anyway? Seven years on and I can't imagine a world without great crested newts, although I still react against the over-use of TLAs! Along the way, I've learnt a huge amount about the challenges faced by you as members. I hope this has made me a better Editor, allowing me to bring out the best in articles while retaining the core message and respecting the objectives. Most importantly, I have come to understand just how crucial you all are in managing, protecting and conserving the natural world; your ecology skills underpinning the practical actions you take every day to find solutions to challenges from development and policy change.

Many of the feature articles we publish in *In Practice* demonstrate a level of dedication well beyond what is required of the job. You embark on research projects to find the best ways to manage habitats, protect vulnerable species, assess impacts or conduct surveys; you carry out ecological studies to learn more about species and ecosystems; you're involved in public engagement to promote understanding, advocacy to raise standards, and debate about policy changes that frame the wider picture. Much of the incentive to publish in *In Practice* is about sharing this knowledge and experience with fellow members: a desire to improve the state of the environment through practical action grounded on hard-won experience in real-life situations. We publish case studies that showcase best practice; descriptions of new or novel methods; reviews that challenge the status quo or question new approaches; success stories; factual analyses and more.

There have been many highlights over my tenure as Editor and far too many good articles to pick out a favourite. Some themes I've viewed with apprehension only to be happily surprised at the unexpected gems that have arrived; others have needed more work even though we thought the topic would be popular. Without exception, I was always pleased with the final selection of articles – a reflection of the breadth of knowledge and ability amongst authors.

We aim to select themes that are topical and articles that will provide a resource with long-term value. Some of our most successful have highlighted new developments, such as Genetic Techniques and Technologies (March 2018), focusing on eDNA – surely the most revolutionary change to the sector – or the bigger picture, such as climate change (Sept 2014 & Sept 2020). Quite rightly, the 100th edition stands out as a milestone and many of the 'Big Issues' we highlighted in June 2018 are just as relevant today.

The first Editorial I wrote recognised the value members place on *In Practice*, whilst considering the opportunities ahead. This year, COVID-19 precipitated a change to digital-only as the printing presses ground to a halt. We were freed from page constraints and experimented with changes to format and layout. Although we're back to printing on paper again, a new design from March 2021 will see further changes and new features. Building on the development work we've done over the last year, the look and feel of *In Practice* will be bigger and better!

Of course, I'm sorry I won't be around for the launch of the new design but it's a good time for the fresh ideas and different perspectives that will come with a new Editor. All that remains for me is to say a big thank you to the *In Practice* Editorial Board, both past and present, who generously give their time, professional skill and expertise, and have made the Editor's job so rewarding. Many thanks also to Jason Reeves, my brilliant colleague on *In Practice*, who is a pleasure to work with, and to Sally Hayns and the CIEEM Governing Board who have trusted me enough to leave me to get on with things. It's been an honour and a privilege to be Editor of *In Practice* for the last seven years.

Gill Kerby

In Practice Editor 2014-2020

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Information

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Front cover:
A number of the articles in this edition focus on the Solent. Shown here at Portsmouth.

Contents

Feature Articles

Professional Updates

Changing of the Guard

The time has come for change. After seven years as Editor of *In Practice*, Dr Gill Kerby is standing down. Gill has taken *In Practice* from strength to strength, raising our editorial standards through her professionalism and improved processes. We thank Gill for all she has done for the publication. Read more about Gill's time as Editor in her own words in this edition's Editorial.

From the next edition onwards, we welcome Dr Nik Prowse as the new Editor. Nik comes to the publication with a wealth of experience. You'll be able to read more about Nik in the next edition.

Gill (left) with CIEEM President Max Wade at the CIEEM Awards 2018.

CIEEM Conferences

2 February 2021	Wales Conference 2021 – Sustainable Management of Freshwater Resources: Bringing our Rivers back to Life. **Book your place now!**	Online
16 March 2021	Spring Conference 2021 – Long-term Ecological Research Projects: Using Evidence to Inform Practice (In partnership with the Ecological Continuity Trust) **Call for papers now open!**	Online
20-21 April 2021	Ireland Conference 2021 – Nature-Based Solutions **Call for papers opening mid-December!**	Online

Find out more: www.cieem.net/events

In Practice Themes and Deadlines

Edition	Theme	Article submission deadline
March 2021	Ethics and Standards	n/a
June 2021	Biosecurity and Invasive Species	26 February 2021
September 2021	30th Anniversary Edition: The Next 30 Years	21 May 2021
December 2021	Urban and Cultural Ecology	20 August 2021

If you would like to contribute to one of these issues, please contact the Editor at NikProwse@cieem.net. Contributions are welcomed from both members and non-members. Further information and guidance for authors can also be found at: www.cieem.net/in-practice/

In Practice Digital Editions

If you would like to reduce your and CIEEM's carbon footprint and receive only digital editions in the future, please let us know by contacting enquiries@cieem.net.

Recent Blog Posts

Recent blog posts on the CIEEM website (https://cieem.net/news/) include:

- From St. Lucia to the UK: What's Next? – by Bianca Gittens
- Our Green Recovery Needs You! – by Sally Hayns
- Land Use in Scotland: Changes, Challenges and Solutions – by Roger Crofts
- What Use is Bioacoustics in Consultancy? – by Paul Howden-Leach
- (Neuro)Divergent Working – by Naomi Davis
- The Government's proposed planning reforms: 'Build Back Better' or just 'Build Build Build'? – by Dominic Woodfield
- What makes us Ecologists? – by Nick Coppin
- Systems Thinking: A Best Practice Response to the Biodiversity Crisis – by Victoria Price
- Beyond the Visible – by Andrea Liggins
- Finding Work After Graduating – By Liam Barker
- The Fascination of Bats (or can we as ecologists suffer from our own nature disconnectedness?) – By Steph West
- Being a Policy Volunteer at CIEEM – By Craig Llewellyn
- Diverse Species and Ecosystems across the UK's Overseas Territories – by OT-SIG
- Birding Under Lockdown – by Drew Lyness

UK biodiversity indicators show ongoing decline

The latest report on UK progress towards meeting the 2010 Aichi biodiversity goals and targets shows an ongoing decline in nature. Alarmingly, it is not just habitats and species that are declining but *"[i]ntegration of biodiversity considerations into business activity"* is also listed as deteriorating.

https://jncc.gov.uk/our-work/uk-biodiversity-indicators-2020/

UK Prime Minister commits to protect 30% of land for biodiversity

UK Prime Minister Boris Johnson has signed the Leaders Pledge for Nature, committing to protect an additional 400,000 hectares of land for nature recovery. The additional protected areas will bring the total percentage of land designated under National Parks, AONBs and other protected areas to 30% in England.

https://cieem.net/uk-prime-minister-commits-to-protect-30-of-land-for-biodiversity/

None of England's rivers meet Water Framework Directive standards

Official assessments of 4,600 surface water and groundwater bodies across England, undertaken by the Environment Agency in 2019, have found that none met legal water quality standards for overall health.

https://cieem.net/none-of-englands-rivers-meet-water-framework-directive-standards/

Scottish Environment Minister announces new Marine Protected Area

Scotland's Natural Environment Minister Mairi Gougeon has announced the designation of a new Marine Protected Area off the West of Scotland covering an area of over 100,000 square kilometres.

https://cieem.net/scottish-environment-minister-announces-new-marine-protected-area/

Natural Resources Wales (NRW) data access

NRW has provided an update to members on how best to determine what data NRW hold on specific habitats, sites and species. You can download and return a Data Request Form from the Access to Information webpage (https://naturalresources.wales/evidence-and-data/accessing-our-data/request-environmental-data/) and there are Evidence Reports Online and Library Searches available. Operational teams, including species specialists and planning can be engaged by the Discretionary Advice Service via the 'Our Service to Developers' webpage **(https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/advice-for-developers/our-service-to-developers/).**

Scottish Government lead international declaration on biodiversity action

Scottish Government has led the agreement of an international statement of intent, known as the Edinburgh Declaration, calling for bold action on biodiversity loss. Those signed up to the agreement have committed to mainstreaming biodiversity across public, private and business sectors, and increasing resources for investment in biodiversity and Nature-Based Solutions.

https://cieem.net/scottish-government-lead-international-declaration-on-biodiversity-action/

More than £100 million of new investment in Wales' rural economy announced

Welsh Government has announced a new investment of £106 million which will support projects boosting the rural economy, enhancing biodiversity and improving food sector resilience throughout Wales.

https://gov.wales/more-ps100million-new-investment-wales-rural-economy-announced
https://llyw.cymru/cyhoeddi-buddsoddiad-newydd-o-fwy-na-ps100miliwn-yn-economi-wledig-cymru

UN's Fifth Global Biodiversity Outlook highlights failure in meeting Aichi targets

The United Nations Secretariat of the Convention on Biological Diversity has published its Fifth Global Biodiversity Outlook report showing that none of the targets have been achieved in full and just six of the 20 goals have been "partially achieved".

https://cieem.net/uns-fifth-global-biodiversity-outlook-highlights-failure-in-meeting-aichi-targets/

NI Environment Minister announces £645,000 investment for environmental projects

Environment Minister Edwin Poots has announced the allocation of an additional £645,000 of funding to environmental projects across Northern Ireland. This will focus on environmental protection, improvement and monitoring of habitats and species; and promotion of health, well-being, understanding, appreciation and action.

https://www.daera-ni.gov.uk/news/poots-announces-ps645000-investment-environmental-projects

WWF Living Planet Report 2020: 68% fall in wildlife populations since 1970

The World Wildlife Fund has published the 2020 Living Planet Report which warns of an average 68% decline in the population sizes of mammals, birds, amphibians, reptiles and fish between 1970 and 2016.

https://cieem.net/wwf-living-planet-report-2020-68-fall-in-wildlife-populations-since-1970/

Forestry Bill introduced to reform appeals process

The Forestry (Miscellaneous Provisions) Bill was signed into law on 2 October to reform the way appeals lodged against forestry licences are handled and speed up decisions. The Bill has seen objections from environmental groups who say it compromises the ability to appeal decisions.

https://www.oireachtas.ie/en/bills/bill/2020/32/?tab=bill-text

Nutrient Neutrality: The Next Frontier?

Dominic Coath CEcol MCIEEM
In Practice Editorial Board & Environment Agency

Keywords: Nature-Based Solutions, nitrogen, nutrient neutrality

We live in a hyper-nutrified landscape. Few ecologists or environmentalists would deny this. Conversely few people in our society would even be aware of it is an issue. Consider as an example, species-rich floodplain meadows. Naturally productive due to good water availability and the annual deposition of fertile river silts, they would have been the grade 1 agricultural land of their day with a land value to match. Nowadays they would be considered by many farmers as low-value, unproductive land in need of significant 'improvement'. Their existing botanical interest (where it still remains) is threatened by a continuous assault of nitrogen-rich inputs leaking out from surrounding air, land and water. In many, perhaps most parts of the countryside, the levels of available nitrogen and phosphate for plant growth far exceed anything that would have naturally occurred throughout much of evolutionary history, making this issue a serious threat to our biodiversity. Some of these impacts are all too apparent, for example loss of plant diversity in grasslands, woodlands and heathlands. The effects on other less visible organisms, such as mycorrhizal fungi, are only just starting to be understood but the potential impacts on ecosystems could be even more profound

The concept of and need for nutrient neutrality is becoming an increasingly hot issue in ecology. At the risk of sounding like a famous character from a well-known sci-fi franchise, it is clear many of our protected sites *"cannae take much more!"*. A frontline is starting to emerge around our protected estuaries in the South of England where continuing inputs of nitrates can create thick algal mats risking sediment anoxia and loss of food for the internationally important waterbirds they support. Natural England has advised that any further nutrient inputs into these sites would constitute an adverse effect on their integrity. This effectively places a block on any further development unless and until it can demonstrate that it will not lead to an increase in these nutrients. This is similar in principle to the situation that emerged around the Thames Basin Heaths in the previous decade. Perhaps nutrient neutrality is set to become the new recreation and disturbance…?

Planners, developers and ecologists will need to come together to agree mutually acceptable and beneficial solutions that will address this emerging issue. Although some of these solutions will be technical in nature such as improved wastewater treatment, reduction in fertiliser use or improving/eliminating vehicle emissions, this will not be enough.

We need to think much bigger and start developing strategies for actively taking anthropogenic plant nutrients out of our environment, at scale. Perhaps we need to start talking explicitly about the need for nitrogen sequestration (demobilisation? neutralisation?) to sit alongside carbon sequestration and biodiversity net gain as a stated policy aim. Realising this will rely increasingly on the use of Nature-Based Solutions, for example creating wetlands and other habitat buffers that can intercept emissions or treat nutrients coming off agricultural land. If they are designed and sited in the right way these new habitats could also improve overall habitat connectivity and integrity, and have other benefits such as flood storage, carbon sequestration and improved access to nature. They could provide much needed green infrastructure for some of the new developments that are currently being stalled, creating a virtuous circle

However the debate on nutrient neutrality evolves in the future, I would encourage us all to see this as another opportunity to demonstrate that nature, rather than being the problem, is in fact the solution.

About the Author

Dominic Coath has worked as an ecologist for over 20 years, mainly in the public sector but also as a consultant and for a number of wildlife NGOs. He worked for several years in London and the South-east advising on planning and green infrastructure for Natural England. He currently works for the national biodiversity team at the Environment Agency, developing policy that will better embed biodiversity outcomes into its ways of working. Occasionally he gets let out of the office to see if any of this is doing any good.

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

Susan Zappala CEnv, Alexandra Cunha and **Bev Nichols MCIEEM**
Joint Nature Conservation Committee
Ulli Dragosits
UK Centre for Ecology & Hydrology, Edinburgh

Keywords: air pollution, ecosystem recovery, nitrogen deposition, risk assessment, uncertainty, weight of evidence

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

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Nitrogen Pollution in Estuarine and Coastal Waters

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Keywords: ammonium, catchment, estuary, eutrophication, farming, nitrate

Nitrogen pollution is responsible for causing a range of negative impacts to estuarine and coastal waters, including to Marine Protected Areas and other designated sites. This article outlines the sources and extent of nitrogen pollution in the UK and Ireland, the problems caused and the potential remedial measures. Poole Harbour is used as a case study, where a multi-faceted approach has been adopted to combat nitrogen pollution.

Sources of nitrogen pollution

Significant anthropogenic sources of nitrogen entering estuarine and coastal waters include land run-off (both agricultural and urban) and discharges from sewage works and storm drains (Thornton *et al.* 2020). These may enter such waters directly or via rivers and groundwater.

The total amount of biologically available nitrogen arising from human activities has increased significantly, with most of this associated with increased use of fertilisers (Millennium Ecosystem Assessment 2005). Increased fertiliser use has led to increased nitrogen concentrations in rivers, lakes, groundwaters, transitional waters (estuaries and lagoons), coastal waters and wetlands (Environment Agency 2019). Agriculture is the main source of nitrogen emissions to water across all regions of Ireland (Mockler *et al.* 2017). Nitrogen from agricultural sources also dominates in estuaries classified as eutrophic in England (Environment Agency 2019) (Figure 1).

When fertilisers containing nitrogen are applied to agricultural land they add to the nitrogen budget and the forms of nitrogen they contain may be converted by the nitrogen cycle. When excessive amounts are used this can result in nitrogen migrating to surface waters and groundwaters in forms such as nitrate and ammonium, which may cause water quality and ecological problems. Gaseous ammonia may also be released from certain fertilisers through volatilisation and then be deposited in rainfall, thus also providing a route to the aquatic environment.

Figure 1. Nitrogen from agricultural sources can cause eutrophication in estuaries.

Other sources of nitrogen exist, such as fish farm feed and waste (Priestley *et al.* 2017). Atmospheric deposition of ammonia and nitrate may also add nitrogen to salt marshes, estuarine habitats and other littoral systems, however in most coastal systems the atmospheric pathway is not the major source of nitrogen inputs (APIS 2020).

Extent of nitrogen pollution

Annual loads of nitrogen in estuaries in the UK demonstrate distinct regional variations. The Severn estuary, the Mersey, the Clyde, the Humber, the Thames and the estuaries around the Solent have the highest nitrogen loads as they drain catchments with generally high nitrate soils, often in Nitrate Vulnerable Zones (NVZs) (Nedwell *et al.* 2002). The west Wales estuaries and the north Scottish estuaries have particularly low nitrogen loads as they drain relatively infertile catchments, with low population densities (Nedwell *et al.* 2002).

About 58% of land in England is designated as an NVZ due to nitrogen pollution of the water environment, and of this total NVZ area, 6% is designated due to eutrophication in estuaries and

lakes or reservoirs (House of Commons Environmental Audit Committee 2018). Sixteen shallow tidal harbours or estuaries in England and Wales are designated as eutrophic under the Urban Waste Water Treatment and Nitrates Directives (Environment Agency 2019). Ninety three per cent of monitored estuarine water bodies and 47% of monitored coastal water bodies in England exceed the Water Framework Directive nitrogen standards for good ecological status (Environment Agency 2019).

In Ireland, only 38% of transitional waters are in good or better ecological status as defined under the Water Framework Directive, with nitrogen inputs to the marine environment increasing by 16% since 2014 (Environmental Protection Agency 2019). In contrast, 80% of Irish coastal waters are in good or high ecological status, reflecting their more open, exposed nature and greater capacity to absorb nutrients (Environmental Protection Agency 2019).

In general terms, high ecological status under the Water Framework Directive means that the biological community reflects what would be anticipated in conditions of no or minimal anthropogenic impact, and good ecological status represents only a slight variation from this condition.

Problems caused by nitrogen pollution

Eutrophication in estuarine and coastal waters occurs when the environment becomes enriched with nutrients, increasing the amount of plant and algal growth, potentially leading to harmful algal blooms, oxygen depletion, dead zones and fish kills (National Ocean and Atmospheric Administration 2017, Environment Agency 2019). Increased nitrogen availability does not always lead to excessive biological growth, as other factors such as phosphorus and silicate availability, light and temperature can also be prime limiting factors, and these can vary during the year.

Nitrogen is generally the main nutrient involved in eutrophication of estuaries and coastal waters, while phosphorus is largely responsible in rivers (House of Commons Environmental Audit Committee 2018, Environment Agency 2019). Nitrogen enrichment can have the following consequences for estuaries and coastal waters (Ni Longphuirt *et al.* 2016):

- phytoplankton and algal blooms
- reduced water quality (e.g. high levels of ammonia that can be toxic to fish)
- loss of macrobenthos communities
- changes to food web structure
- creation of hypoxic conditions.

The Environment Agency has identified the main issue caused by nitrogen pollution in transitional waters and coastal waters as excessive growth of macroalgae on the inter-tidal areas of shallow 'harbours' (Environment Agency 2019). In estuaries, eutrophication causes the growth of macroalgal mats that can affect invertebrates, smother saltmarsh vegetation and interfere with the ability of waders and waterfowl to feed (House of Commons Environmental Audit Committee 2018) and these mats can cover extensive areas of intertidal habitats (Thornton *et al.* 2020).

A study of the estuaries in mainland Britain demonstrated a significant correlation between the log total annual loads of Total Oxidized Nitrogen (nitrate plus nitrite), ammonium and phosphate (but not silicate) for each estuary, and the degree of biological response in coastal waters, as represented by spring maximum chlorophyll a concentrations (Nedwell *et al.* 2002). There therefore appeared to be a direct link between the loads of both nitrogen and phosphorus in estuaries and the phytoplankton biomass in adjacent coastal waters.

Nitrogen pollution is a significant issue for some Natura 2000 sites in estuaries and coastal waters, as it can lead to problems in achieving statutory compliance under the Habitats and Water Framework Directives.

Table 1. Measures identified by the Environment Agency as being most effective in reducing nitrogen pollution from agriculture.

Measure	Comment
Have a nutrient plan and know the nitrogen content of fertilisers	The nitrogen content of manures, composts and slurries can be variable and testing is advisable.
Grow cover crops	These can reduce the amount of nitrogen leached from fields and can be a low-cost option.
Calibrate fertiliser spreaders	An 8% reduction in leaching is predicted.
Land-use change	For example, change intensively farmed arable land to less intensively managed grassland or woodland. This can be expensive.
Reduce stocking density	This is the most effective measure to reduce nitrogen loading from livestock, but it is costly.

Action to reduce nitrogen pollution

The first step to address nitrogen pollution in estuaries and coastal waters is to determine the sources entering each system. Some will be point sources, such as discharges from sewage works and storm drains, and others will be diffuse sources, such as run-off from agricultural land. As rivers are a major route for nitrogen to reach the marine environment, action to improve the quality of rivers is also likely to benefit estuarine and coastal habitats. For example, to reduce agricultural pollution of rivers, the Environment Agency (2019) identifies the measures shown in Table 1 as being the most effective in terms of cost and nitrate leaching reduction.

Pollution pathways and processes also need to be considered. For example, in catchments where the groundwater has been polluted by nitrogen from historical farming activities, and feeds in to rivers, there is likely to be a significant lag before changes to farming practices result in reduced nitrogen levels in the rivers. In Ireland, the impact of measures to reduce nitrogen loadings and reduce eutrophication was observed to be largely dependent not only on load source, but also on nitrogen cycling processes between sediments and the water column, and on modulating factors such as light and residence time, which also affect primary production (Ni Longphuirt *et al.* 2016).

Given the diversity of nitrogen pollution sources and processes, it is often necessary

to take an 'integrated catchment management' approach, which aims to achieve fully integrated management of the land, water and human activities in a catchment (Lerner and Zheng 2011). Such action is co-ordinated as part of River Basin Management Plans drawn up by the environmental agencies in the UK and Ireland (Scottish Environmental Protection Agency 2020). These are required under the Water Framework Directive to identify measures to bring all water bodies up to 'good' status, and they cover:

- the state of the water environment
- pressures affecting the quality of the water environment where it is in less than good condition
- actions to protect and improve the water environment
- a summary of outcomes following implementation.

'Catchment partnerships' have been used as an effective tool to co-ordinate the activities of various stakeholders, such as farmers, water & sewerage companies and landowners. For example, in 2018, Thames Water, Yorkshire Water and Anglian Water signed a water catchment declaration aiming to reach and exceed water quality objectives by working with farmers to make more efficient use of fertiliser and by improving soil quality (House of Commons Environmental Audit Committee 2018).

'Nutrient management plans' are used as a tool when Natura 2000 sites are threatened by nutrient (including nitrogen) pollution, by identifying sources of nutrients that are entering rivers and the steps that can be taken to manage them (Environment Agency and Natural England 2014). They provide a mechanism for tackling water pollution where excessive nutrient loading requires a combined approach that addresses point and diffuse sources. Nutrient management plans have been produced, for example, to protect the Special Areas of Conservation associated with the rivers Avon, Wye and Clun and, in some cases, have led to restrictions on development, including house building (Mustow 2019).

In addition to upstream catchment management actions, direct measures can also be taken to reduce nitrogen levels in estuarine and coastal waters. These may include, for example, increasing nitrogen removal at sewage treatment works discharging directly into such waters and placing controls on fish farms. Aquaculture of bivalve molluscs can also remove excess nitrogen and make water clearer (Natural Capital Committee 2019).

Natural England issued an advice note in June 2019 to the Solent planning authorities advising that planning permission should not be granted for new development unless Nutrient Neutrality could be demonstrated (Natural England 2019). This was due to increased nutrient levels in the Solent resulting in dense mats of green algae. These are impacting on the Solent's habitats and bird species, protected under the Habitats Regulations and other legislation (Potts *et al*., this issue). The advice note provides a methodology for determining whether there will be a net increase in nitrogen emissions as a result of a development and if so whether mitigation is required. Mitigation can be in the form of nitrogen removal from wastewater treatment plants, the creation of wetlands and reedbeds, and land use changes within the development site and wider catchment (West, this issue). Although there is clearly an important environmental problem to be addressed, concern has been raised about the impact on housing delivery due to this significant new restriction (Beavan and Stala 2020).

Case study – Poole Harbour

Poole Harbour is a Site of Special Scientific Interest as well as a Special Protection Area (SPA) under the Habitats Directive, due to the extensive mudflats that support a large overwintering bird population. It has also been designated as a Ramsar site and certain areas of the harbour have been designated as local and national nature reserves. Because of its SPA status it is also designated as a European Marine Site, which is a type of Marine Protected Area, and as a Protected Area under the Water Framework Directive.

Natural England has determined that the SPA is in unfavourable condition due to eutrophication. Negative effects have included growth of dense mats of seaweed, loss of seagrass, change in the functioning of the saltmarsh (e.g. elevated nitrogen levels may have diminished root biomass) and phytoplankton blooms (Bowles 2020, Thornton *et al.* 2020, Potts *et al*., this issue).

Nutrient stripping incorporated at Poole sewage treatment works in 2009 reduced the nitrogen entering the harbour from the works (Environment Agency 2019). However, to achieve the full reduction needed to achieve Marine Protected Area compliance, a reduced leaching rate per hectare was also required from the farming industry (Bowles 2020). A river catchment partnership was formed, consisting of farming representatives, Wessex Water, the Environment Agency, Natural England, local councils, the Southern Inshore Fisheries Conservation Authority, the Royal Society for the Protection of Birds and other stakeholders, to plan and deliver targets in a nitrogen management plan (Bowles 2020). A range of measures are being implemented, including an innovative nitrogen offsetting scheme using an online platform called ENTrade developed by Wessex Water (https://www.entrade.co.uk/). ENTrade allows farmers to sell environmental services to water companies, government agencies and businesses. The services include sowing winter cover crops and this is reported to have reduced the amount of nitrogen entering Poole Harbour (Hackett 2019).

Although the initiatives to reduce nitrogen levels in Poole Harbour are showing good progress, ongoing monitoring is needed to check that the required water quality and ecological improvements are delivered. Even with appropriate measures in place there will be a lag of approximately 30 years in achieving desired nitrogen levels in the harbour, due to the historical nitrogen load in the aquifer, which will need to work its way through the system (Bowles 2020).

Conclusions

The challenge posed by nitrogen pollution in estuaries and coastal waters is complex. Freshwater, estuarine and coastal processes are all involved, a wide range of sources and pathways exist, and stakeholders are diverse, from farmers and fishermen to regulators and water companies. Other nutrients, including phosphorus, have to be considered and many of the impacts are indirect, for example eutrophication leading to low oxygen conditions.

Where Marine Protected Areas are affected, in particular Natura 2000 sites, significant action is required to reduce nutrient levels, such as constraints on development, upgrades to sewage treatment facilities and altered farming and land-use practices. These have potential implications for society and the economy. Innovative measures have been employed, such as nitrogen offsetting through the ENTrade platform. Post-Brexit these are likely to gain impetus with the proposed introduction in 2024 of DEFRA's Environmental Land Management scheme in England and Wales, which will pay farmers and land managers to undertake environmental work on their land, potentially including nitrogen reduction measures.

Despite the work undertaken to date, there is still a long way to go to address the challenge, given the large number of estuarine and coastal waters that continue to exceed nitrogen standards.

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Solent Nutrients: An Opportunity to Build Back Better?

Keywords: counterbalance, Dutch Nitrogen, Nature-Based Solutions, neutrality, nitrogen, mitigation

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Nutrients from agricultural and residential sources are damaging coastal sites, designated for habitats and bird species in the Solent between the Isle of Wight and Hampshire on England's south coast. The elevated level of nutrients accelerates the growth of algae, smothering habitats and altering species composition, with potential for detrimental impacts on the internationally important bird assemblages.

Whilst the majority of excess nutrients entering the Solent are from agricultural sources, with the sites in unfavourable condition, and over 60,000 houses planned in the catchments, Natural England advised the 15 affected Local Planning Authorities that residential development is likely to have a significant effect on the European protected sites. These include the Solent Maritime Special Area of Conservation (SAC), Solent and Southampton Water Special Protection Area (SPA) and Ramsar site, Portsmouth Harbour SPA and Ramsar site, and Chichester and Langstone Harbours SPA and Ramsar site (referred to as 'European sites' hereafter, Figure 1).

To support the LPAs dealing with this issue, Natural England created a methodology to calculate nitrogen budgets for development, enabling the identification of counterbalancing mitigation measures to achieve neutrality. The focus for the Solent is on reducing nitrogen, as the nutrient primarily limiting plant growth, however evidence suggests for the Medina catchment, on the Isle of Wight, both nitrogen and phosphorus play a role, so both nutrients are targeted there. The

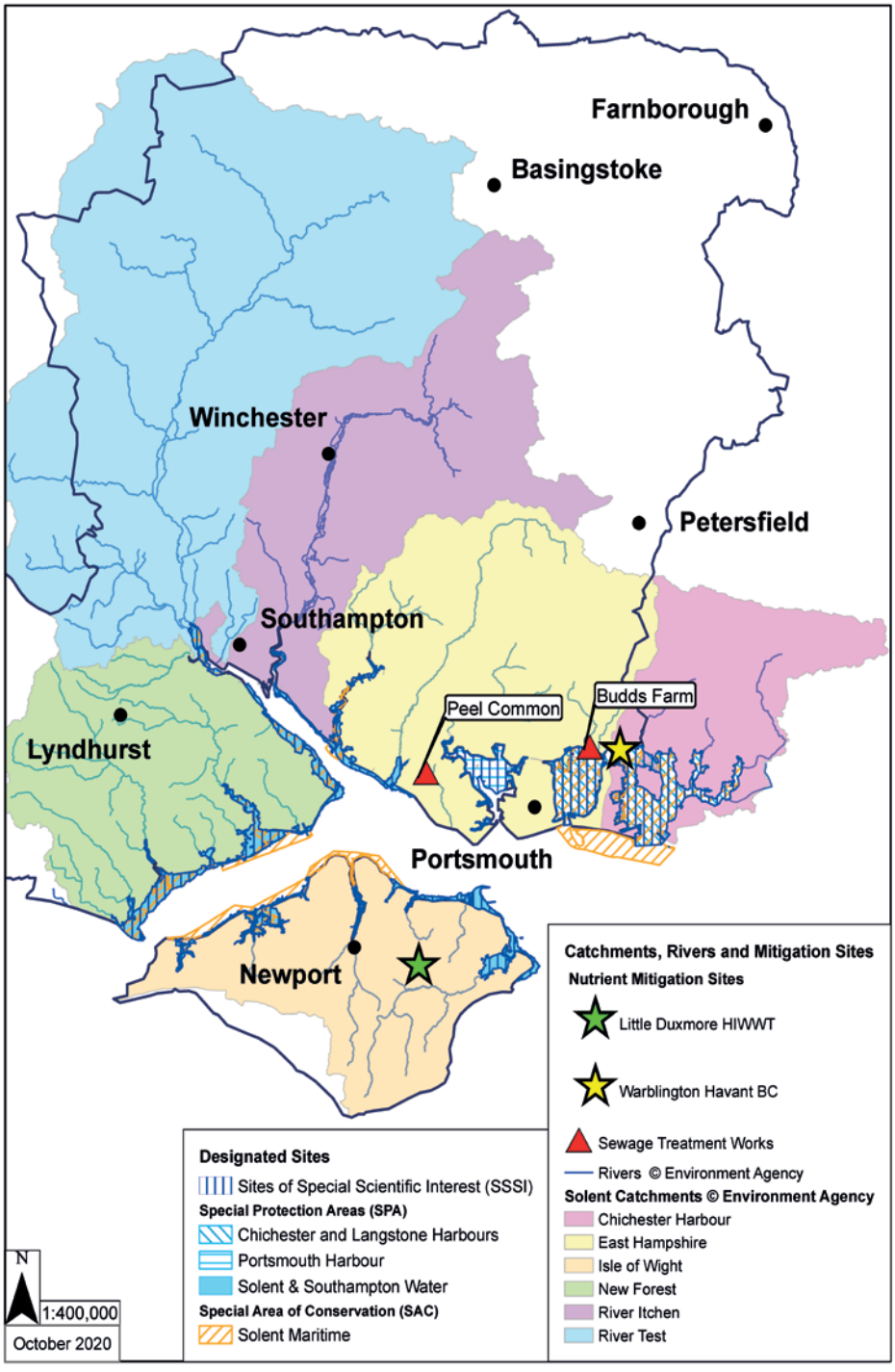

Figure 1. Map showing the Solent catchments, relevant designated sites, location of case study mitigation sites and key wastewater treatment works. © Natural England.

Figure 2. Algal mats at Beaulieu, on the Solent coast in southern England. Photo credit Natural England.

application of this methodology is enabling housing delivery without increasing the nutrient burden on the Solent from residential development.

Introduction

The Solent coastline is internationally designated (see Figure 1) for its overwintering and breeding birds, coastal and wetland habitats and important assemblages of plants and invertebrates. Considerable areas are in unfavourable condition (Natural England 2020a), with water quality, namely nutrients and largely nitrogen, a major contributing factor. This is despite some good work by the agricultural sector (such as the Defra-sponsored Catchment Sensitive Farming programme to improve land management practices and fund new infrastructure) (Mustow, this issue) and water companies (who have invested millions improving coastal wastewater treatment works to remove more nitrogen); however, the amount of nitrogen entering the Solent remains too high. The catchments draining into the Solent are large (328,986 hectares) and 62% agricultural (Morton *et al*. 2019), whilst the coastal conurbations house more than 1.3 million people.

Nitrogen is naturally present in the water environment and is an important nutrient fuelling plant growth. Eutrophication, an excessive richness of nutrients, can cause disproportionate growth of algae. Nitrogen is the primary focus in the Solent area because it is the main limiting factor controlling the growth of the coastal algal mats. In some locations (such as the Medina Estuary on the Isle of Wight) phosphate levels are also contributing to the problem. Algal mats cover the mudflats in many areas (Figure 2), limiting the oxygen available to animals in the sediment, creating a physical barrier for feeding birds and threatening rare habitats. There are also impacts on seagrass and on saltmarsh habitats, such as physical smothering by algae (Newton and Thornber 2013), and/or high nutrient levels having a destabilising effect on saltmarsh root systems (Wigand *et al*. 2014). The bulk of the nitrogen in the Solent originates from agricultural sources: fertiliser, slurry and livestock inputs, which escape into the water environment. Work to reduce nitrogen inputs from the agricultural sector has been ongoing for some time, but it has been very difficult to secure sustained reductions. Wastewater from homes also contains nitrogen, with treatment plants stripping some of it out in accordance with their permitted discharge levels (which vary) (Mustow, this issue).

The entirety of the coastal habitat features assessed for the Solent Maritime SAC are in unfavourable condition (either no change or declining), with water quality, namely excessive nutrients, contributing to the failures (Natural England 2020a). Not enough is known about coastal ecology and recovery from high nutrient levels to make good predictions about tipping points or timescales for recovery when nutrients decrease. However, diffuse pollution in areas with chalk geology (which occurs high up in Solent catchments) may take decades to reach the coastal designated sites, meaning that the impacts of historic agricultural practice will be felt for some time to come (Wang *et al*. 2016).

Dutch Nitrogen

In November 2018, the European Court of Justice (CJEU) ruled on a case now known as Dutch Nitrogen (European Court of Justice 2018). This judgement has implications for European protected sites in unfavourable condition or where environmental benchmarks are exceeded or close to exceedance. The judgement concludes that, where a European protected site is in unfavourable conservation status (or 'unfavourable condition'), the ability to permit activities which would give rise to additional pollution is 'necessarily limited' and would need careful justification to ensure that it is compatible with the Habitats Directive. It suggests that there would be 'limited' circumstances in which such plans or projects could be permitted. It also concludes that an Appropriate Assessment should not take into account measures that are not 'certain' at the time of the assessment. Whilst the case, and therefore the ruling, focusses on air quality and nitrogen, it clearly has broader application to other areas of Habitats Regulations Assessment (HRA), most notably water quality (including other pollutants, such as phosphorus), where there are close similarities with exceeded environmental benchmarks and development pressures.

Having considered this ruling, and the unfavourable conservation status of the European sites, in February 2019 Natural England advised affected Local Planning Authorities (LPAs) in the Solent catchments that there is uncertainty about the impact of additional nutrients on the affected European sites (Figure 1) (Natural England 2020b). The advice recommended that this issue was considered in Habitat Regulations Assessments (HRA) for residential development and that it is currently uncertain whether the additional nutrients (largely nitrogen) from new development would give rise to an adverse effect on the integrity of the European sites. Natural England also pointed out that, if development came forward with mitigation that counterbalanced its nutrient contribution, then the LPAs, in their role as competent authorities, could be certain that no adverse effect would occur and could grant planning permission (Natural England 2020b).

Nutrient Neutrality and the Solent

To make it possible to calculate and deliver Nutrient Neutrality, Natural England developed, published and refined a methodology to ensure that the European sites are not harmed by new housing development (Natural England 2020b). It is called Nutrient Neutrality, rather than Nitrogen Neutrality, in recognition of the specific locations (e.g. Medina estuary, Isle of Wight) where phosphates are also an issue requiring bespoke mitigation. The methodology uses the average residential occupancy rate, water use and 90% of the permitted nitrogen discharge concentration of the relevant wastewater treatment works (or a concentration of 27mg/l for those works without a nitrogen permit) to calculate the increased nitrogen generated by each application for new housing. By considering the land use change associated with the proposal and subtracting an allowance (in recognition that water will always contain some level of nitrogen), the methodology estimates the nitrogen load of the new development. A 20% buffer is applied as a further precautionary element to rule out the risk of under-mitigation (e.g. if some households change plumbing fittings over time to use more water than the standard factored into the methodology). Finally, the methodology uses information on the location and type of land use change which could provide mitigation to counterbalance the impact of the development proposal. Mitigation can also be provided by retrofitting more water-efficient bathroom fittings to council-controlled housing stock where they are linked to a wastewater treatment works with a nitrogen permit.

It has taken time for the methodology to be understood, accepted and worked through by stakeholders including LPAs, developers and mitigation providers. It is not easy to find and secure mitigation sites, particularly as they need to benefit the same designated site which will receive the wastewater from the new development. However, LPAs have identified novel mechanisms to ensure mitigation is legally secured, monitored and enforced for the lifetime of the developments effects (80-125 years).

Given that Nutrient Neutrality is still a novel approach, it is unsurprising that there have been delays to development proceeding. Over 6,000 houses have been on hold across the Solent catchments. The social and economic impact of these delays, especially given their overlap with COVID-19, should not be underestimated and have generated considerable political interest. The issue was raised in Prime Ministers Questions (Hansard 2020), with Boris Johnson saying "*It is important that we deal simultaneously with nitrate neutrality and satisfy our environmental*

Case Study 1 – Warblington Farm mitigation scheme

A Nutrient Neutrality mitigation scheme launched in summer 2020 at Warblington Castle Farm (Figure 1). This resulted from alterations to an existing agricultural tenancy on land owned by Havant Borough Council, significantly reducing the level of nitrogen. The project is spearheaded by the Council, in collaboration with Natural England and part-funded by the Solent Local Enterprise Partnership (LEP). The farm (Figure 3) is on the shoreline and was previously a working 60-ha dairy farm. The Warblington Farm project will take place in phases, ensuring a smooth transition and continued low nutrient management. The phased cessation of intensive agriculture on the farm removes nitrogen from the catchment and offers an immediate nutrient benefit for the SPA, whilst enabling nearby development schemes to become nutrient neutral: a conclusion backed by an evidence-based study. While each potential mitigation scheme needs individual assessment, this solution is perfectly replicable along the Solent and across the country.

This mitigation scheme addresses the immediate issue, but Havant Borough Council are committed to achieving more as the site is transformed into a nature reserve:

- The site offers an ideal opportunity to provide a refuge for overwintering SPA bird species, contributing significantly to a managed network of permanent, supporting habitat sites. By making this site permanently available to the birds, it will end the lottery of which crops are farmed on which fields across the Solent area.
- The site includes former watercress beds and watercourses that can be developed into wetlands to remove additional nutrients before they enter the harbour, showcasing two ways of achieving nitrogen reduction on the same site.
- Net biodiversity gain projects and strengthened ecological links between Chichester Harbour and the South Downs National Park can be incorporated.
- A footpath, which will soon form part of the England Coast Path, will give better access to open spaces with opportunities for education and interpretation.

Figure 3. Warblington Castle Farm near Chichester, Hampshire. Photo credit Havant Borough Council.

The scheme is funded through contributions coming from new developments: it is cost neutral to the taxpayer. Due to pressures on local government funding, it would not be possible to undertake these kinds of projects if it were not for funding from development.

needs while ensuring that her [Caroline Nokes, MP for Romsey and Southampton North] *community gets the housing that it needs*". LPAs, developers, mitigation providers and Natural England have been working together to apply the methodology and, at the time of writing (September 2020), schemes are securing permissions on a nutrient-neutral basis in some areas. There has been a positive dialogue with the relevant government departments, and significant funding is being sought to pump-prime mitigation solutions and understand the impact pathways and the best locations to ensure mitigation secures additional benefits.

The emerging mitigation proposals are encouraging, encompassing all affected catchments around the Solent (Figure 1) and a range of Nature-Based Solutions, including wetlands and woodland which can also deliver biodiversity gains, natural flood management, carbon offsets and public access. The proposals are coming from landowners, developers, private companies, NGOs and the LPAs themselves (West 2020, this issue). If all these schemes proceed, planned development could be mitigated until 2034. In future, it is hoped that a more strategic approach to the location of mitigation can be taken, making sure that affected local communities benefit from the land use change, costs are minimised, and development is unlocked across the affected area.

The longer term future for the Solent

Whilst Nutrient Neutrality is key to enabling development to proceed without harm to the European sites, in general it will do nothing to recover them to favourable condition. Traditionally, we have relied on mechanisms like Diffuse Water Pollution Plans (DWPP), programmes such as Catchment Sen sitive Farming and upgrades to wastewater treatment works to secure improvements in the

Case Study 2 – Wildlife Trust mitigation through rewilding

In February 2020, Hampshire & Isle of Wight Wildlife Trust came forward with a Nature-Based Solution to mitigate development impacts on the European sites, firmly rooted in their Wilder Strategy (Hampshire & Isle of Wight Wildlife Trust 2019). The scheme will not only counterbalance, but also reduce, the overall nitrogen burden in the Solent, as well as create new habitats for wildlife, permanently. The Trust aims to acquire mitigation sites in each catchment area, if possible, transforming intensive farmland into new nature reserves through rewilding – returning these sites to natural habitats such as scrubland, woodland, meadow and wetland.

To demonstrate proof of concept, the Trust purchased Little Duxmore Farm (Figures 1 and 4) in north east Isle of Wight, in April 2020. The 42-ha site, a former arable and poultry farm, discharges into nearby Wootton Creek.

Using five years of agricultural cropping records, and precise mapping of each field (excluding hedgerows or woodland), Natural England's methodology determined that the Trust's plans for rewilding Little Duxmore Farm will remove 848 kg of nitrogen per year from the Solent ecosystem. The Trust will therefore be able to offer this number of nitrogen credits (1 credit being equal to 1 kg N/year) to developers, allowing them to balance the additional nitrogen and demonstrate Nutrient Neutrality for new housing schemes in the eastern Solent catchment.

A long-term management fund for Little Duxmore Farm will be created from the sale of nitrogen credits, held by the Trust in a designated fund for this purpose, overseen by the charity's Trustees. Mitigation sites acquired by the Wildlife Trust will be managed in line with charitable objectives (for wildlife, education and science) and held as heritage assets, meaning they will be effectively safeguarded for ever.

Figure 4. Little Duxmore Farm on the Isle of Wight, six months after the last arable crop: rewilding in progress. Photo credit Debbie Tann.

Keen to achieve more than just neutrality, the Trust aims to deliver a net reduction in pollution. For Little Duxmore Farm, the Trust will sell only 806 nitrogen credits, holding back 5% towards improving the Solent ecosystem. The Trust will also use its mitigation scheme to push the bar higher for developments wherever possible, giving preference to those agreeing to incorporate wildlife gains into their plans. And by rewilding previously intensive farmland, huge benefits for wildlife will follow, with the Trust letting nature take the lead rather than pre-determining what natural habitats will be created. A full programme of ecological monitoring will establish and communicate the wildlife gains as the site becomes wilder over the years.

The Trust has attracted some criticism from Hampshire residents for stepping forward with a mitigation scheme rather than trying to stop development. The Trust acknowledges that there are failings in the planning system, and will continue to campaign for policies that will lead to better environmental outcomes (such as Biodiversity Net Gain and the Nature Recovery Network (Department for Environment, Food and Rural Affairs 2020)). By offering a better mitigation option and by positioning Nature-Based Solutions as a positive answer, it is hoped that those driving economic growth can start to appreciate the vital role of investing in nature to support society and a sustainable economy.

water environment. Whilst modelling work to better understand the situation in the Solent continues, it is possible that voluntary actions (which feature prominently in most DWPPs) will not deliver the scale of improvement needed. The potential for Environmental Land Management Schemes (ELMS) to create a step-change in delivery is very welcome, as is recognition of the need for challenging interim reduction goals to drive short-term action. However, additional agricultural regulation may prove necessary to restore the European sites. Work is underway to identify options and agree the most practicable route to restore favourable condition. Natural England will continue to work with government departments and agencies to explore the significance of agricultural diffuse pollution as a constraint on housing development and to consider whether policy change is needed.

Ultimately, new housing is inevitable: our communities need new homes. To ignore this fact would itself threaten the natural environment; at best it will lead to poor solutions, at worst it could precipitate a dilution of environmental legislation. It is vital that we communicate the issues clearly, so that developers and communities understand why Nutrient Neutrality is important. Havant Borough Council is leading the way, with the production of accessible summary information and an animation (Havant Borough Council 2020). Natural England believes the best way to approach environmental constraints is to work collaboratively across LPAs, government departments and agencies, and with the third sector and communities, to meet the challenge head on. The authors believe that the Nutrient Neutrality approach delivers sustainable development in the truest sense of the term.

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Nitrogen Neutrality Within the Solent Region – An Ecologist's View

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Keywords: collaborative working, development, habitat creation, Habitats Regulations Assessment, nitrogen, sustainable drainage

Within the Solent region on the South coast of England, residential development must achieve nitrogen neutrality (no net increase in nitrogen output). This article discusses the effect this has had on project planning from a consultant's perspective, as well as potential mitigation options and next steps.

Similar issues with nitrogen are beginning to be identified elsewhere such as Stodmarsh Special Area of Conservation in Kent, and there are requirements for phosphate neutrality in some areas such as Somerset and Herefordshire. It is therefore likely that other parts of the UK will be required to achieve nitrogen neutrality in future, and there are important lessons to be learnt from the example of the Solent region.

Introduction

As an ecological consultant working in the Solent region of Southern England (Figure 1), the introduction of the Nutrient Neutrality requirement has been one of the biggest challenges over the past two years. Nutrient Neutrality means that developments resulting in a net increase in overnight accommodation (typically residential development but including student accommodation, hotels, etc.) must not result in a net increase in nutrient (primarily nitrogen) outputs post-development. This requirement has been driven by Natural England to avoid additional damage from pollution to European protected sites in the Solent (Potts *et al*., this issue). Nutrient Neutrality

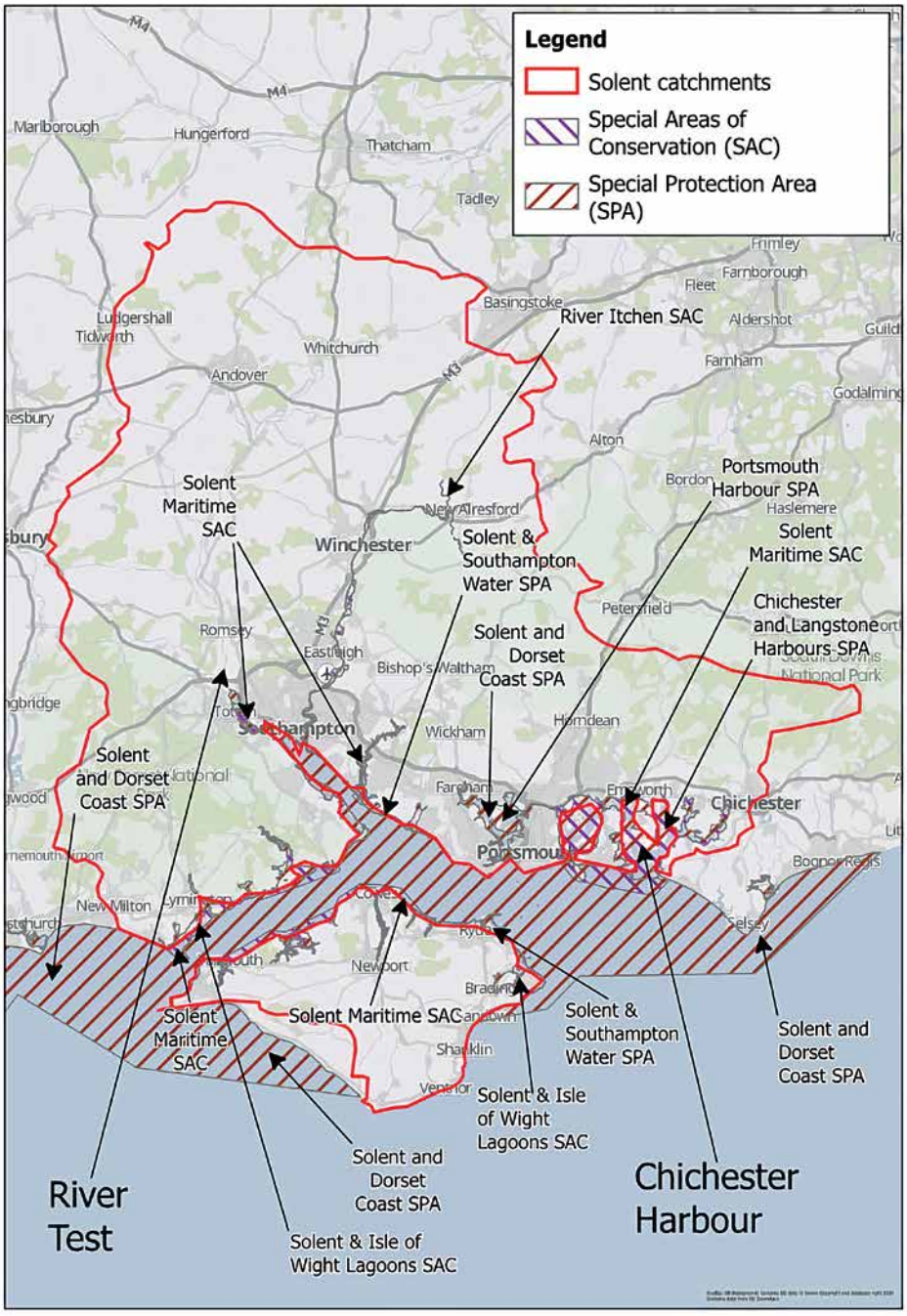

Figure 1. Area affected by Nutrient Neutrality and Solent European protected sites.

is now a key consideration in Appropriate Assessment of plans and projects within the region (a requirement under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 [as amended]). It has led to significant delays in delivering housing, including projects which previously had outline planning permission. Although all developers have been affected by these delays, the greatest impact has been on smaller businesses which are reliant on the quick turnover of smaller sites. As of August 2020, several mitigation schemes have been established to allow developments to achieve Nutrient Neutrality; these offer a greater level of certainty going forwards. However, there are still some affected areas where no mitigation is available and there is a need for more schemes to be developed to allow development to proceed.

The need for Nutrient Neutrality

In March 2018, the Partnership for South Hampshire (PfSH – a group of twelve local authorities, formerly known as PUSH) published an Integrated Water Management Study to assess the potential impacts of planned housing growth in the region on the water environment (PUSH 2018). This study found that there was uncertainty as to whether new housing could be accommodated by the existing wastewater treatment infrastructure without having detrimental effects on the network of European protected sites within the Solent (Box 1). Condition assessments of the qualifying features (most recently undertaken by Natural England in 2018 and 2019) revealed that for the Solent Maritime SAC, several qualifying habitats are in unfavourable condition, partially due to elevated nitrogen levels (e.g. causing eutrophication and algal mats). Although the full extent has not been assessed, 81% of the surveyed area of the SAC is in unfavourable condition.

Nitrogen is a major source of pollution within these coastal sites, particularly from diffuse freshwater sources polluted by agriculture; however, wastewater treatment works also discharge polluted water. Some wastewater treatment works in the region are monitored and have discharge permits for Total Nitrogen (TN), such as those which discharge near Chichester Harbour (Box 2). Permits range from 9 to 15 mg/l TN; however, most do not have TN limits, with those located along the Rivers Test and Itchen focussed on minimising phosphate outputs.

Box 1. The Solent European Sites

The Solent European protected sites include the following Special Protection Areas (SPA), Special Areas of Conservation (SAC) and Ramsar sites (several of which overlap) shown in Figure 1.

- Solent Maritime SAC
- Solent and Southampton Water SPA / Ramsar
- Portsmouth Harbour SPA / Ramsar
- Chichester and Langstone Harbours SPA / Ramsar
- Solent and Isle of Wight Lagoons SAC
- Solent and Dorset Coast SPA

Box 2. Nitrate or Nitrogen?

One area of confusion amongst consultants, developers and local authorities has been which nutrients are being considered in assessments of nitrogen neutrality. Many strategies still refer to nitrates, such as the recent Winchester City Council Cabinet Paper (Winchester City Council 2020). The key determinand is Total Nitrogen (TN). TN is the sum of ammonia-nitrogen and organic nitrogen (known as Total Kjeldahl Nitrogen or TKN) plus nitrate-nitrogen and nitrite-nitrogen. It is TN to which this article refers when discussing nitrogen.

Natural England believes that increased TN outputs from wastewater treatment works as a result of new residential development is likely to have a significant adverse effect on the Solent European sites (Box 1) (Potts *et al.*, this issue). In accordance with Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended), all residential development which connects to wastewater treatment works discharging to any of these European sites (directly or indirectly) requires Appropriate Assessment, with a need to demonstrate beyond reasonable scientific doubt that there will be no adverse effect. Given the poor condition of the European sites, which appears to at least in part be due to elevated nitrogen levels, it is unlikely that any increase in TN output can be proven to be unharmful. This was the position taken by the Court of Justice of the European Union (CJEU) in November 2018 in cases C-293/17 and C-294/17 (colloquially the Dutch Nitrogen Cases; Chapman, this issue). Therefore, Natural England (2020) has proposed that developments could achieve nitrogen neutrality by counterbalancing increases in outputs from wastewater treatment works with reductions in nitrogen from other sources (such as agriculture) (Potts *et al.*, this issue).

This advice began to be applied consistently by local authorities in April 2019 but some developments have yet to be progressed. According to PfSH, in January 2020 some 10,000 homes had been delayed (BBC 2020a).

Nitrogen budgeting in the early days

My first engagement with nitrogen neutrality was in June 2018 for a proposed development at Harbour Place in Bedhampton (Figure 2), just north of Chichester and Langstone Harbours SPA, when the issue was raised in a consultation response from Natural England (even though at the time we believed that all constraints to new development had been addressed). Shortly afterwards, in August 2018, Natural England issued draft guidance which set out a protocol for calculating nitrogen budgets for developments.

The protocol uses factors such as population size, water usage and the permitted TN discharge concentration at the receiving wastewater treatment works to calculate a nitrogen budget for a proposed development (Natural England 2020). Any reduction in nitrogen output arising from changes to land use as a result of development is also taken into account. If the nitrogen budget is negative (i.e. a net reduction in TN output) then the development is deemed to be nitrogen-neutral, with no adverse effect on the European protected sites. However, if the nitrogen budget shows a net increase in TN output, then further measures are required

Figure 2. Harbour Place, Bedhampton. This development of 320 houses and a care home will result in an increase of 292 kg TN/yr from wastewater but a decrease of 407 kg TN/yr from the land, primarily because 12.8 ha of the 22.9 ha agricultural area formerly in arable cultivation will become open space. This results in a net decrease of 115 kg TN/yr.

to counterbalance the additional nitrogen before any new development can proceed.

Initially, it was unclear who was responsible for achieving Nutrient Neutrality. Obviously, a collaborative approach was needed with inputs from engineers, landscape professionals and ecologists but I have found that, following a great deal of background research, an ecologist is ideally placed to lead this aspect of a project. It is important not to lose sight of the key output of Nutrient Neutrality, which is to enable an Appropriate Assessment to be concluded, which is typically the responsibility of the ecologist.

Land use change

Since April 2019, the primary method of achieving Nutrient Neutrality has been land use change. This removes areas of land from agricultural use, thereby reducing direct nitrogen inputs to the land from farming. A nitrogen budget can be calculated for farmland in the same way as a housing development. Typically, to maximise the TN reduction, post-development land use involves habitat creation such as new woodland. According to research by Natural England, the mean TN output (through leaching through the soil into water) from non-agricultural land is 5 kg TN/ha/yr (Natural England 2020). Therefore, the conversion of one hectare of arable land previously under cereal crops (which has a leachate value of 31.2 kg TN/ha/yr) to woodland, results in a reduction of 26.2 kg TN/yr.

Although calculating nitrogen budgets is simple in principle, our understanding is evolving and has led to constantly changing requirements for planning applications in terms of evidence and design. A key consideration is the location of a proposed development. Although nitrogen affects European sites across the Solent region, at the project-level it is important to identify the catchment of the receiving water body to make sure land use change affects the

Case study

The proposed development site at Harbour Place, Bedhampton, Hampshire, was previously used for arable farming (Figure 2). Unusually, a high proportion of undeveloped land was included within the scheme, partly due to the need to provide habitat for overwintering birds. By calculating the amount of nitrogen leaching from the land whilst farmed, and comparing with the calculated outputs from wastewater and post-development land uses, we were able to demonstrate that the development project was nitrogen-neutral. However, careful consideration of long-term management of the site was important to ensure that vital grassland creation for wintering birds could be achieved without future nitrogen inputs. Long-term management will be delivered by The Land Trust.

same site as the impacts from any increase in the output from wastewater treatment works. Recently, Natural England has stated that, in addition, the location within the catchment must be considered. Sites located a long distance from watercourses, or on chalk bedrock, are likely to take longer to achieve a reduction in TN and will require hydrological studies to assess the likely lag time.

As land use change constitutes mitigation for impacts on European protected sites, it must be secured in perpetuity, with an appropriate mechanism in place. If land is to remain in private ownership, Natural England advises that a legal agreement alone is not sufficient and that sites should be planted as woodland. This is because woodland benefits from a number of additional layers of security, such as the need for a felling licence for removal and the potential use of tree preservation orders.

Challenges of land use change

A key challenge with land use change is cost, with potentially large areas of land required to achieve Nutrient Neutrality. The best farmland for this purpose is that in more intensive use, such as cereal crops, which is likely to be more expensive than less productive land such as lowland grazing. In some areas, for example the South Downs, the conversion of agricultural land to woodland may conflict with landscape objectives and careful liaison with local authorities is needed. With the forthcoming departure of the UK from the EU, food security and the development of a long-term sustainable food strategy is a key objective for the government (Finlay and Ward 2020) and the removal of large areas of land from agricultural use may conflict with this.

As an ecologist, the greatest difficulty I have faced has been establishing accurately how the development land was used prior to development in order to calculate nitrogen budgets. Natural England recommends that land use over the past 10 years is considered but this information is not always available. Even where the land use seems obvious, local authorities are not consistent in the level of evidence they require, or even what that evidence should be. In these cases, specialist advice from an agronomist can be invaluable.

Wetlands, an alternative approach to achieving Nutrient Neutrality

At Whitewool Farm in West Meon, Hampshire, working closely with Natural England, we have completed a series of hydrological and ecological assessments to design an alternative approach to Nutrient Neutrality using a treatment wetland. The proposed wetland will comprise a shallow basin with dense emergent vegetation to reduce nitrogen within the Whitewool Stream, which flows through a dairy farm where it is heavily polluted (Figure 3). Based on a detailed study of 5853 wetlands which concluded that wetlands had a mean nitrogen removal efficiency of 37% (Land *et al*. 2016), it is predicted the new wetland will prevent 4000 kg of nitrogen from reaching the Solent annually.

We are also developing similar projects to reduce nitrogen in surface water run-off. These require careful design where they are also expected to act as Sustainable Drainage Systems (SuDS). SuDS are typically designed to provide treatment for sediment and the like before discharging at greenfield run-off rates, with an appropriate level of storage capacity for storm events (often in otherwise dry basins). A wetland incorporated into a SuDS scheme needs to be shallow (up to 300 mm) to support emergent vegetation, with a near constant water supply to maintain the vegetation and a slow flow to allow time for nitrogen removal to occur.

The key benefit of wetlands is their efficiency compared to land use change. Land *et al.* (2016) found a mean removal rate for wetlands of 181 TN g/m^2/yr.

Figure 3. Channelised reach of Whitewool Stream, West Meon, where a wetland is proposed.

Assuming the flow to the wetland has a high enough TN concentration, this equates to a removal of up to 1810 kg TN/ha/yr. To achieve an equivalent scale of removal, 69 ha of cereal crop land would have to be converted to woodland.

Despite the efficiency and performance of wetlands, there are challenges which prevent them from being a one-size-fits-all solution to nitrogen neutrality. Suitable locations for treatment wetlands (as opposed to SuDS) are more difficult to find because they require a reliable input flow and an output to a suitable watercourse within the correct catchment. Typically, this means constructing a wetland connected to an existing stream or other watercourse. This adds further complications such as the need for additional permits (e.g. abstraction licences, discharge permits or land drainage consent) and the need to make sure that the wetland (either during construction or operation) does not cause adverse effects downstream. A high level of input is also required at the design stage compared to land use change. If data are not available, monitoring of existing TN concentration and flow will be required to estimate the potential capacity for nitrogen removal. This can involve detailed hydrological modelling and assessment.

Benefits of Nutrient Neutrality

Nutrient Neutrality offers benefits beyond a reduction in nitrogen reaching the Solent. Taking land out of agricultural production can provide valuable habitat in its own right, as well as opportunities for additional habitat creation such as floodplain meadow or wet woodland, restoration of engineered reaches of watercourses and contributions to ecosystem services such as flood risk management.

Dealing with Nutrient Neutrality promotes collaboration between consultants and other professionals. For myself, I have never consistently worked as closely with such a diverse group of consultants (including hydrologists, agronomists and engineers) and consultees (including Natural England and local authority officers) as I have over the past two years. This, along with the research I have undertaken to gain a better understanding of the issue, has afforded me interesting avenues for professional development and improved my approach to other projects and topics.

The early onus on consultant- and developer-led mitigation has also resulted in a high degree of collaboration between developers. Since early 2019, I have been advising the South Coast Developers Consortium on Nutrient Neutrality, helping them to explore opportunities for strategic mitigation, and lobbying the Government for support. This led to a land rewilding scheme on the Isle of Wight, which is being delivered by Hampshire and Isle of Wight Wildlife Trust, with initial funding provided by Persimmon Homes. Recently, the Government has announced a grant of £2.3m to PfSH to fund land use change schemes (BBC 2020b, Potts *et al.*, this issue).

Conclusions

Unless there is a significant shift in the interpretation of case law (specifically the Dutch Nitrogen cases) or the protection afforded to European sites, the need for Nutrient Neutrality is not going to go away. Indeed, even if permits for wastewater treatment works are tightened further in future, this will only set a new baseline against which effects will be measured. Furthermore, similar issues are arising beyond the Solent region, for example nitrogen outputs to Stodmarsh SAC in Kent are a significant concern, as are phosphate outputs to the River Lugg in Herefordshire.

Mitigation options are now being offered by some local authorities, most recently in Havant (Havant Borough Council 2020), whereby developers can pay for mitigation credits. However, these are unlikely to meet demand. For example, the £2.3m Government grant to PfSH is predicted to mitigate only 1522 houses. Given the scale of planned future growth in Southern England (and the rest of the UK), land use change and wetland schemes are needed to make sure that the UK is able to meet its national housing need without compromising the recovery of European protected sites, such as those in the Solent.

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About the Author

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Fungi, Nitrogen Deposition and Forests: Challenges and Changes

Martin I. Bidartondo
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Keywords: environmental change, forests, monitoring, mycorrhizas, nitrogen, soil carbon

Nutrient uptake in Europe's trees is dominated by fungi. Atmospheric nitrogen deposition and carbon dioxide have risen dramatically due to human activities and can result in enhanced tree growth.However, when soil nutrients are insufficient to meet the demands of faster growing trees, their nutritional status deteriorates. Mycorrhizal fungi are the interface between trees and soil, and they play a key role in tree nutrition, but their study has so far been largely neglected in favour of more obvious factors.

Recently, we have linked belowground mycorrhizas of dominant trees across Europe with environmental conditions, and we identified sharp thresholds for change in species composition of fungal communities with increasing nitrogen deposition. These findings call for the readjustment of nitrogen critical loads as ecosystem assessment tools in forests and can inform environmental policy. We now have the first robust belowground baseline to test whether and how mycorrhizal fungi and environmental changes over time are linked with forest condition changes at large scales.

Figure 1. Some of the 137 intensively monitored forests plots across Europe where mycorrhizas have been sampled. Photo credit Sietse van der Linde.

Introduction

Though unseen within the soil, it is fungi that do the hard work of mining for the mineral nutrients that allow plants to grow. Nearly all the nitrogen and phosphorus in plant tissues is directly transferred from fungal cells into plant cells. This nutritional partnership is so ancient and widespread that it allowed plants to green terrestrial land masses and decarbonise the atmosphere after life emerged from water to land some 500 million years ago (Field *et al.* 2015). Plants supply or 'pay' fungi with carbon that they fix from air and the more they do this, the more fungi can explore the soil and provide plants with the soil minerals they need, thus fuelling further plant growth aboveground and fungal growth belowground. As part of this interdependency, more carbon from the air is pumped into soil. This is what we owe to 'mycorrhizas', the rather cumbersome name for the most common, but out of sight, partnerships on land (Box 1).

The massive plant-fungal transfer of carbon from air into soil is balanced out by the activity of other soil fungi, the recyclers of dead plant and fungal material, the decomposers. They are uniquely able to break down carbon stored in soil; in doing so they respire carbon back into the air and release nutrients back into the soil that can be used for plants and other organisms again. Interestingly, it turns out that the growth and respiration of decomposers are themselves limited by the nitrogen

mining activities of mycorrhizal fungi, which is known as the 'Gadgil effect' (Box 1) (Fernandez and Kennedy 2016). Fuelled by their direct access to plant energy, mycorrhizal fungi can outcompete decomposers when mining for nitrogen in the soil, slowing down decomposition and therefore locking up more carbon in soil. Thus, carbon can be both pumped into and stored in soil for long periods of time, and eventually some of it can even fossilise. Currently, there is vastly more carbon in soil than in the air, unlike the situation when life first moved onto land.

Since the Industrial Revolution (1760-1840), human activity has been bringing fossil carbon back into the air, disrupting more and more a global balance of photosynthesis, carbon storage and respiration that took millions of years to develop. We have also been adding mineral nutrients to soils at different rates across the world, some intentionally to accelerate crop growth, some unintentionally through water and air pollution. These changes impact plant and fungal relationships in ways we are only just learning about. We are presenting these organisms with new ecological and evolutionary challenges. They may cope or they may not. We may manage or mismanage their responses.

Nitrogen, forests and mycorrhizas

Here we focus on nitrogen, forests and mycorrhizas, and some major, recent advances in understanding plant-fungal change. Forests are of particular interest as they are currently considered the only viable and popular means for managing large-scale carbon capture in Britain and worldwide (Waring *et al.* 2020). The fine roots of dominant trees in Europe (pine, spruce, beech, birch, oak) are fully sheathed by mycorrhizal fungi forming ectomycorrhizas ('outer-fungus-roots'). These act as the interface between the trees and the soil environment and therefore they are directly exposed to changes in both. Long-term, intensive monitoring is a key component of scientific advances regarding environmental change: if we do not know what changes and how it does so, we cannot learn, we can only speculate. High quality data from above- and belowground forest monitoring (ICP Forests, International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests, www.icp-forests.net) has been central to the quest to fill knowledge gaps because it can be directly combined with high quality belowground fungal data obtained in the same forests, backed up by international reference data (van der Linde *et al*.

Figure 2. Examining roots at Kew's Jodrell laboratory. Photo credit Sietse van der Linde.

2018). Unfortunately, long-term intensive monitoring of forests has been severely scaled down in recent years, particularly in the UK where it has declined from 20 plots in the 1990s to only five plots now.

What have we learned so far?

Mycorrhizal fungi control many ecosystem processes, from soil formation to seedling survival, plant diversity, productivity and nutrient uptake (van der Heijden *et al.* 2015, Tedersooo and Bahram 2019). Over the last decade, forest ecologists have collected data showing that the nutritional status of the leaves of Europe's main forest trees is becoming alarmingly imbalanced, risking the health, growth and ecosystem services of our forests. Could this be linked to changes in the fungi that nourish trees?

Looking belowground, we analysed nearly 40,000 mycorrhizas of pine, spruce, beech and oak from over 13,000 soil cores in 137 forest monitoring sites across 20 European countries (Figures 1&2). The data were combined with information on soil, tree, atmospheric deposition and climate factors from intensive, long-term monitoring. Sampling for mycorrhizas took place throughout the year, regardless of whether mushrooms or leaves were present, and each mycorrhiza was visually examined and then identified using DNA sequencing. In total, 1,406 species of fungi were found across the four tree species. Of the mycorrhizas sampled, 60% were formed by fungi that can also be identified by their aboveground fruitbodies

Box 1. Glossary

Mycorrhiza: ancient symbiosis between soil dwelling fungi and the roots of up to 90% of the plant species on Earth. In this 'fungus-root' mutualism, fungi trade soil nutrients and water for photosynthetically fixed carbon from the plant. Mycorrhizas directly control plant nutrition and growth.

Ectomycorrhiza: 'outer-fungus-root'. In this symbiosis, the fungal filaments fully cover fine roots and get inbetween root cells without penetrating them. Nearly every fine root of most trees in temperate and boreal forests (e.g. oak, beech, pine, spruce, birch, lime, willow, eucalyptus) is an ectomycorrhiza.

Critical load: threshold of a factor at which harmful effects are observed.

Gadgil effect: competition for soil nitrogen between mycorrhizal fungi and decomposers that leads to slower decomposition rates of soil organic matter and therefore higher carbon sequestration in soil.

Throughfall deposition: elements in wet atmospheric deposition that go through the forest canopy into the soil.

Threshold indicator species (taxa) analysis: statistical analysis that allows identification and interpretation of ecological community thresholds along an environmental gradient based on multiple individual species abundances.

Sum(z+), sum(z-): cumulating points of change of increasing and decreasing taxa, respectively, in threshold indicator species analysis.

Table 1. The 38 environmental and tree host variables from intensive, long-term forest monitoring that were combined with mycorrhizal data in van der Linde *et al.* (2018).

Environmental variables		Tree host variables
* Latitude	* Deposition throughfall Mg	Defoliation
* Longitude	* Deposition throughfall Na	* Foliar N
* Deposition throughfall pH	* Deposition throughfall NH_4	* Foliar K
** Mean annual temperature	* Deposition throughfall Cl	* Growth season length
* Minimum annual air temperature	* Deposition throughfall NO_3	Foliar P
* Maximum annual air temperature	* Deposition throughfall SO_4	** Foliar N:P ratio
* Soil pH $CaCl_2$	** Deposition throughfall N total	* Foliar Ca
** Forest floor pH $CaCl_2$	Mean annual precipitation	* Foliar Mg
Forest floor total organic C	Soil total organic C	* Foliar S
* Forest floor total organic N	* Soil total organic N	* Mean tree age
* Elevation	* Forest floor dry mass	* Tree species
* Deposition throughfall conductivity	* Soil type	* variables influencing ectomycorrhizal communities significantly ($p<0.05$) in the non-metric multi-dimensional scaling ordination analysis; ** identified key variables.
** Deposition throughfall K	* Climatic region	
* Deposition throughfall Ca		

(mushrooms), but the rest only produce inconspicuous crusts, subterranean fruitbodies (truffles), sclerotia (resistant propagules), or do not produce fruitbodies at all. Over half of the ectomycorrhizal fungi were associated with broadleaf or conifer trees only, and 7% specialised on only one tree species; the rest were generalist fungi that can associate with any of the trees. We also observed that some fungi were able to produce more, or fewer, fungal filaments in soil ('phenotypic plasticity') depending on the environmental conditions; this reflects how these fungi adapt to change until they get replaced by more competitive and/or tolerant species. These data allow us to open up the soil 'black box', find out which fungi live there, how abundantly, if they are thriving or declining, and link them to forest change and management. This type of data has long been available for more easily visible organisms, like animals and plants, but for soil fungi it is new. Finally, we no longer have to ignore the organisms that drive key processes in ecosystems.

Nitrogen and mycorrhizas

Among the 38 different factors tested, the most important for mycorrhizas was nitrogen throughfall deposition (Box 1) followed by soil pH, air temperature, potassium throughfall deposition and the ratio of nitrogen to phosphorus in leaves (Table 1). In Europe, nitrogen air pollution – ammonium and nitrate ions arising from human activities and carried by wind and precipitation – shows a historical geographic gradient with lower values in parts of Scandinavia and some Alpine regions (below 5 kg N/ha/yr) and higher levels in industrialized areas, with maximum values in The Netherlands, Belgium and parts of Germany (above 25 kg N ha/yr). British nitrogen deposition spans the middle range of the gradient with lowest values in Scotland (www.apis.ac.uk).

The most sensitive fungi to nitrogen atmospheric deposition include the darkening brittlegill *Russula vinosa*, the red hot milk cap *Lactarius rufus* and the gypsy mushroom *Cortinarius caperatus* (see www.nbnatlas.org for fruitbody images for these and other fungi). Most of the sensitive fungi are conifer-associates and specialise on mining complex nitrogen compounds across long distances through their abundant production of filaments ('hyphae'). This form of fungal mining demands the highest carbon payment by trees and results in more carbon being pumped into soil (Figure 3). However, human impacts are detrimental to these hard-working fungi and they have declined markedly or even disappeared in more polluted areas. Further analysis of the data revealed a much lower level at which nitrogen deposition negatively starts to affect forest mycorrhizas than previously estimated, 5.8 kilograms of nitrogen per hectare per year. To put this into context, we typically apply more than 100 kilograms of nitrogen (N) fertiliser per hectare to major crops like wheat and maize, whose soils release abundant carbon into air.

It is important to note that for correct statistical analysis, one must include a full range of samples across the nitrogen deposition gradient. Samples from low-atmospheric deposition monitoring plots that can only be found in a few regions, such as northern Scandinavia, must be included alongside samples from the most polluted areas, e.g. The Netherlands. A UK-only analysis would produce misleading results because it would miss very low or very high nitrogen deposition levels. Below the critical load that we identified in our threshold species indicator analyses (5.8 kg N/ha/yr), additional nitrogen essentially acts as a fertiliser, and even sensitive fungi benefit. But above the critical load, sensitive species respond with sharp declines or may disappear altogether, being replaced by nitrogen-tolerant fungi that may be less effective nutritional partners of trees. More nitrogen-tolerant fungi include the common earthball *Scleroderma citrinum*,

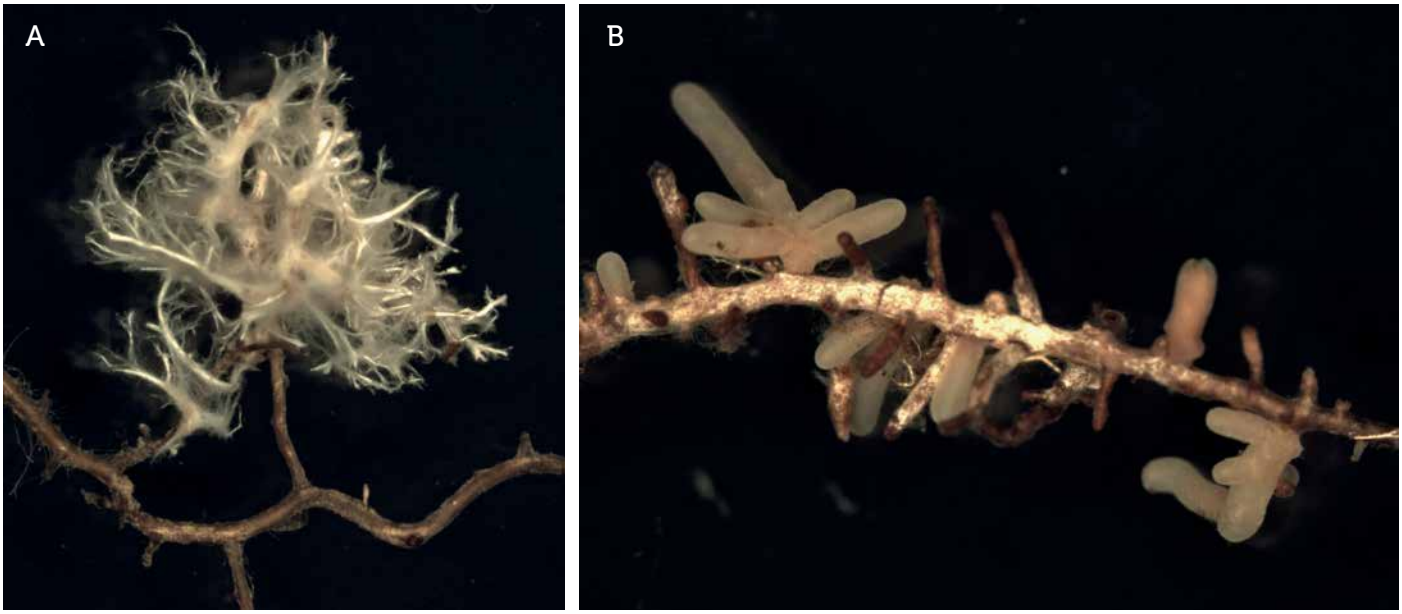

Figure 3. Ectomycorrhizas showing different soil exploration types:
(A) *Cortinarius* sp. (webcap), a medium-distance explorer, and (B) *Russula* sp. (brittlegill), a contact explorer. Photo credit Laura M. Suz.

(Figure 4) the blusher *Amanita rubescens* and the ochre brittlegill *Russula ochroleuca* whose functions under these eutrophic conditions in forests, and their long-term tolerance to even higher nitrogen levels, are still unknown. Nearly all of Britain and much of Europe exceeds the critical load, which may well be a tipping point – easy to cross in one direction, but difficult to cross back.

What do we need to know next?

Since the 18th Century, air pollution has been rising dramatically due to industrialisation and other human activities. Continuously high nitrogen pollution combined with increasing carbon dioxide in the air can result in enhanced tree growth and greater soil carbon sequestration. However, when soil nutrients are insufficient to meet the demands of faster growing trees, their nutritional status deteriorates. Across Europe, many dominant forest trees are now showing serious nutrient imbalances. Are forests reaching tipping points, and can they recover?

Given the potential of trees to sequester carbon to mitigate climate change, we urgently need to understand how they act as an interface between the atmosphere and soil. Mycorrhizas are the link between trees and soil, but they have largely been neglected in favour of more easily-studied factors. Ectomycorrhizal fungi have been shown to drive global soil carbon sequestration and to mitigate carbon dioxide additions (Averill *et al.* 2014, Terrer *et al.* 2016). Whether this remains the case under high atmospheric nitrogen deposition when trees become deficient in phosphorus, has not been examined to date. However, we do know that mycorrhizal species composition, relative abundance, and the proportions of fungi with different enzymatic capabilities change strongly across Europe – reaching tipping points – with increasing nitrogen air pollution, and that trees showing leaf nutritional deficiencies harbour different mycorrhizal fungi. Different fungi have different carbon storage capabilities, and vary in their ability to take up and translocate mineral nutrients. This capability changes as nitrogen pollution increases, with important consequences for trees and forest ecosystems. Forest growth can be impacted, along with tree health and essential ecosystem functions at large scales, including carbon sequestration and nutrient cycling. It is known that it is much easier to recover some easily observable ecosystems, such as lakes, before they cross tipping points than after they do, and that phenotypic plasticity in organisms can affect tipping points and how ecosystems recover from change (Dakos *et al.* 2019). Whether and how this applies to forests belowground needs to be understood as soon as possible.

Figure 4. Earthball *Scleroderma* sp. fruiting body. Photo credit Laura M. Suz.

Table 2. Environmental thresholds of changes in ectomycorrhizal fungal communities based on threshold indicator species analysis for five key environmental and tree host variables.

	Point of change in the environmental gradient	
Variable	Decreasing taxa Sum(z-)	Increasing taxa Sum(z+)
Nitrogen throughfall deposition	5.8 kg N/ha/yr	15.5 kg N/ha/yr
Foliar N:P ratio	10.2	13.3
Potassium throughfall deposition	6.9 kg K/ha/yr	21.7 K/ha/yr
Mean annual temperature	7.4 °C	9.1°C
Forest floor pH	3.8	3.8

Conclusion

Understanding belowground changes in our forests can inform science, forest management, environmental policy and conservation efforts (Suz *et al.* 2015). We have recently linked belowground ectomycorrhizal diversity of dominant trees in forests across Europe with environmental conditions, and we identified clear thresholds for community composition change of ectomycorrhizas (Table 2).

Now that the first robust belowground baseline is available, we can test whether and how mycorrhizal fungi and environmental factors change over time, and how these changes are linked with tree and forest condition changes at large scales. Thus, it is urgent to:

1. carry out a large-scale test for biological change over time in forest soils across Europe, and
2. combine it with a targeted field experiment designed to disentangle the key fungal players in tree nutrition, their functional traits in these forests, and how these fungi and their trees respond to and recover from environmental change.

We can then include the data in a forest model to predict how natural versus managed changes in mycorrhizal communities and their traits will influence forest functioning, tree growth and soil carbon capture, and how these are influenced by environmental change. Despite increasingly severe constrains to fundamental natural environment research investment and to long-term intensive forest monitoring in the UK, we very much hope to be able to continue our studies, so that soil stops being treated as a 'black box' in our rapidly changing world.

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A Novel Approach to Quantify and Mitigate for Biodiversity Loss Caused by Nitrogen Deposition:

A Worked Example and Case Study

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Keywords: air quality, Defra metric, habitat creation, offsetting, transport emissions

Figure 1. Cannock Chase, the focus of the case study.

This article describes a first attempt at using a novel methodology to calculate how much habitat has to be created or enhanced to offset the effects of nitrogen pollution. It is based on the Defra metric for biodiversity net gain and directly equates transport-related nitrogen deposition to biodiversity loss, which is then translated into a proportionate area of habitat to be mitigated. The approach is illustrated using a case study focused on Cannock Chase (Figure 1) and, in theory, could be applied to any plan or project where increases in nitrogen deposition need to be quantified and offset.

Background

As an ecologist working on large multidisciplinary projects, there is very often a need to develop an understanding of interrelated disciplines to fully consider the

impacts of a proposed development project on sites, habitats, or species. Air quality, specifically nitrogen, is a case in point. It is technically complex and impact assessments are challenging.

This article sets out an approach to mitigate the effects of transport-related nitrogen deposition on Cannock Chase Special Area of Conservation (SAC) arising from new development. The method was collectively worked through and agreed with Natural England, Cannock Chase SAC Partnership, Lichfield District Council and Cannock Chase District Council on an iterative basis. Ultimately, each party felt the method arrived at a reasonable representation of the level of harm and therefore proportional mitigation.

The method is project-specific and whilst it could readily be applied to other plans and projects, the exact detail would require discussion and agreement with stakeholders. For example, the median value was selected for the critical load of nitrogen (as opposed to the lower or upper limits) by mutual consensus. Likewise, measures included as mitigation within the proposed development to discourage private car use and reduce the overall level of likely harm were attributed an additional reduction in nitrogen. This, again, was agreed with statutory consultees.

The methodology relies on published information, such as Caporn *et al.* (2016), to quantify biodiversity loss. No field surveys were carried out and relevant data are taken from existing studies. It assumes that the effects of nitrogen would be felt across the whole of the SAC due to the maximum critical load for nitrogen already being in exceedance in the local area. This was also due to the SAC being primarily designated for one dominant habitat type.

The selection of buffer habitat to offset the effects of nitrogen represents mitigation as opposed to compensation, this being the next best alternative to avoidance, following the mitigation hierarchy. Buffer habitat was agreed by consultees to be mitigation as opposed to compensation due to the timing of the buffering habitat creation / restoration commencing before the nitrogen impacts would occur.

Introduction to the case study

An Environmental Statement was produced for a large, mixed-use development proposed on a former industrial site in the Midlands. The site fell within the Zone of Influence of Cannock Chase Special Area of Conservation (SAC), lying approximately 4 km south of the site at its closest point. Cannock Chase SAC is primarily designated under Article 4.1 for its European lowland dry heath, which covers approximately 933 ha of the 1237 ha site. Northern Atlantic wet heaths with *Erica tetralix* (cross-leaved heath) are a qualifying feature and cover 17 ha. The Natural England (NE) guidance note '*Approach to Advising Competent Authorities on Road Traffic Emissions and HRAs*' advises that impacts may arise where roads fall within 200 m of a SAC if the sites' features are sensitive to air pollution (Natural England 2018).

The potential impacts of the project on Cannock Chase SAC were assessed and provided to the Competent Authority to inform a Habitats Regulations Assessment (HRA).

Transport-related nitrogen emissions

The main source of nitrogen pollution from the proposed development would be in vehicle emissions (Figure 2). Therefore, the first step was to determine the extent to which the predicted increase in car use could result in increased nitrogen emissions. At this stage, transport experts were employed to model changes in traffic, and air quality experts to model predicted nitrogen deposition.

Pollution benchmarks were taken from the UK's Air Pollution Information System (APIS, www.apis.ac.uk) to understand the sensitivity of the SAC features to air pollution. The sensitivity is quantified by the term 'critical load', expressed in kilogrammes of pollutant per hectare per year (kg/ha/yr). The critical load for both SAC features – European dry heath and Northern Atlantic wet heath – is 10-20 kg N/ha/yr.

The following screening thresholds, taken from Natural England's guidance note (Natural England 2018), were applied to the results:

- Does the project generate an additional 1,000 Annual Averaged Daily Traffic (AADT) movements of private cars?
- Will the construction period result in 200 or more Heavy Goods Vehicle (HGV) movements in 24 hours?
- Does the project cause a ≥1 % increase in the critical load of the SAC's features, i.e. 10–20 kg N/ha/yr?

The AADT screening threshold was exceeded for the two roads within 200 m of Cannock Chase SAC but the critical load only exceeded the 1% threshold for one road (A513 north), which is arguably a more accurate prediction than AADT alone (Table 1). The critical load exceedance on the A460 (0.86 %) also requires consideration as an in-combination effect. Clearly, there is likely to be a significant

Table 1. Changes in traffic movements measured as Annual Averaged Daily Traffic (AADT), and associated changes in air quality impacting the qualifying features at the Cannock Chase SAC, arising from the project alone.

Roads within 200 m of Cannock Chase SAC	Additional AADT movements *(threshold = 1000)*	Changes in daily number of HGVs *(threshold = 200)*	% change in critical load *(threshold = 1%)*	Critical load change expressed in kg for lower and upper limits of pollutant load
A513 north	1907	N/A. Routing plan avoided these roads. Even in absence of routing plan, HGVs were below 200.	2.59%	0.26 kg (based on lower critical load limit of 10 kg N/ha/yr) 0.52 kg (based on upper critical load limit of 20 kg N/ha/yr)
A460 south	3705	As above	0.86%	0.09 kg (based on lower limit of 10) 0.17 kg (based on upper limit of 20)

Figure 2. Nitrogen pollution from vehicle emissions can have a detrimental impact on biodiversity.

effect on the SAC from one road considered alone (A513) and also a detrimental effect from the other road (A460) when its traffic impact is considered in combination with other impacts from the proposed development. The approach taken in this method was to sum the nitrogen deposition for both roads (2.59 + 0.86 = 3.45%) to ensure residual effects were accounted for.

The percentage exceedance varies depending on whether it is measured as a proportion of the lower critical load value (10 kg N/ha/yr) or the upper critical load value (20 kg N/ha/yr) for the range of values of pollutant load, where the latter effectively doubles the value (column 5, Table 1).

Nitrogen deposition and biodiversity loss

It is known that nitrogen can affect a range of habitat types including lowland heathland, which is the focus of this study, as well as upland heathland, bog, grasslands and sand dunes (Caporn *et al.* 2016, Natural England 2014, 2020).

In lowland heathlands, certain grass and sedge species benefit from nitrogen deposition, increasing the area of cover but at the expense of other species. Species that benefit include wavy hair-grass *Deschampsia flexuosa* and hare's-tail cotton grass *Eriophorum vaginatum* on dry heathland and purple moor grass *Molinia caerulea* on wet heath and mire.

The balance between grass and shrub cover is important in maintaining the intrinsic diversity of heathland habitats. Nitrogen deposition can negatively affect heather by slowing growth, shortening its lifecycle and increasing its susceptibility to frost and drought. Lichens and bryophytes are also negatively affected by nitrogen and respond quickly to increases due to their lack of root structure. These changes, coupled with increasing grass cover, may be detrimental to site integrity.

Background pollution

Where background pollution levels currently exceed the critical load and have done so for some time, the resultant loss in biodiversity is proportionally lower. In the early stages of pollution exceedance, more sensitive plants die off, leaving fewer species and reduced biodiversity. At the upper end of the critical load range, a substantial loss has already occurred. Small amounts of additional nitrogen deposition on a site which is already polluted have less severe impacts on the already degraded habitats and impacted species.

At Cannock Chase SAC, the APIS website shows background pollution levels to be in exceedance of the critical load of 10 – 20 kg N/ha/yr, averaging 21.2 kg N/ha/yr (range 19.5 – 27.6 kg N/ha/yr). Therefore, the baseline for the impact assessment was nitrogen levels that were already too high for both lowland dry heath and wet heath. Whilst the air quality model predicted a decrease in the background pollution levels in the future due to greener technologies, the assessment was necessarily based on the current data as the best available information.

Table 2. Effects of nitrogen increase above the critical load range for Cannock Chase SAC due to the proposed development. Values are taken from Caporn *et al.* (2016) and air quality calculations carried out for the proposed development.

Background nitrogen deposition (kg)	Applicable range from Caporn *et al.* (2016) (kg)	% species loss per 1 kg increase in nitrogen above critical load	Predicted increase in nitrogen above critical load of 10 (lower) due to the proposed development	Predicted increase in nitrogen above critical load of 20 (upper) due to the proposed development	Range of resultant biodiversity loss (%) at Cannock Chase SAC
21.2 kg (average)	20 kg	-1.6%	0.26 kg (A513 north)	0.52 kg (A513 north)	**-0.42% (lower)** **-0.62% (median)** **-0.83% (upper)**
21.2 kg (average)	20 kg	-1.6%	0.09 kg (A460 south)	0.17 kg (A460 south)	**-0.14% (lower)** **-0.21% (median)** **-0.28% (upper)**

Quantifying biodiversity loss caused by nitrogen deposition

The effects of incremental increases in nitrogen on the biodiversity of lowland heathland were quantified using calculations in Caporn *et al*. (2016) that give a percentage change in biodiversity for each extra 1 kg N/ha/yr where it is already above the critical load. According to these calculations, for every additional 1 kg of nitrogen around Cannock Chase SAC, there will be a further species loss of -1.6% (Table 2).

The increase in nitrogen deposition predicted to be caused by the development project resulted in a predicted loss of biodiversity in Cannock Chase SAC. Summing the median value in Table 2 (according to the methodology agreed with consultees; 0.62% + 0.21%), the effect of both roads was a reduction in biodiversity of -0.83%.

Mitigating for the biodiversity loss caused by nitrogen deposition

As the additional nitrogen deposition arising from the proposed development is expected to result in biodiversity loss in Cannock Chase SAC, mitigation was required. Various options were explored but none were found to be wholly viable. These included direct habitat management measures within the SAC, but as the SAC is under existing management as part of Higher Level Stewardship (HLS) these measures would not be additional. The installation of roadside catalytic screens is recognised as a means to absorb nitrogen. However, as large stretches of roadside habitats surrounding the SAC are owned by third parties, this could not be relied upon as mitigation, would be time consuming to organise and may not be in place before the increased traffic flows occurred. Tree planting along roads to absorb nitrogen was also not likely to be viable due to tree planting restrictions within the Cannock Chase Area of Outstanding Natural Beauty (AONB). Instead, it was agreed that a fund be set up by the Applicant and administered by Lichfield District Council for the creation or restoration of buffer habitat in the area around Cannock Chase SAC.

Creation of buffer habitat

The buffer habitat will comprise suitable areas that can be restored and managed to support habitats such as heathland to supplement the lowland heath already present within Cannock Chase SAC. Appropriate habitat areas will be identified through use of the Heathland Recovery Network as identified by the Lichfield Nature Recovery Network Mapping. These area(s) will be at least 200 m from the edge of a road affected by the project to reduce exposure to traffic-related nitrogen

The buffer will increase the functional connectivity of Cannock Chase SAC to create a more resilient complex of habitats away from direct impacts of traffic emissions. This will be especially important while background nitrogen levels remain high, until the adoption of greener technologies leads to reductions.

Calculation of buffer habitat area

The area of buffer habitat required was calculated using the following values:

- Predicted loss in biodiversity = – 0.83% (median)
- Total SAC area = 1236.93 ha.

The biodiversity loss was translated into a hectare value as a proportion of the total SAC area: (1236.93 / 100) x 0.83 = 10.27 ha. In selecting the total SAC area, the method assumes that the effects of nitrogen arising from the proposed development would be equal across the SAC. Insufficient evidence was available to reliably apportion effects to areas by a greater or lesser extent. Furthermore, as the critical load is in exceedance in the local area, it is more likely to reflect the current reality. By assuming the worst-case scenario of the entire SAC being affected evenly by nitrogen from additional traffic emissions, the risk of the buffer area being inadequate is minimised.

Therefore, using this method, the impact on biodiversity due to nitrogen emissions as a result of the proposed development equates to a 10.27 ha area of the SAC, but note the assumptions as part of the method outlined above.

Transport avoidance measures

Additional traffic avoidance measures were identified. These were not included in the traffic modelling which informed the nitrogen pollution values, but were committed to as part of the proposed development. They were intended to

discourage private petrol or diesel car use by, for example, providing high-speed internet to encourage home working, electric vehicle charging points, cycleways, a bus route and a Framework Travel Plan (FTP) to offer subsidised travel for a period of time. Based on evidence of uptake from other similar schemes, it was agreed with consultees that, cumulatively, these additional measures contributed to a reduction of 21% of the nitrogen deposition.

Using the Defra metric to calculate the biodiversity unit value

The 10.27 ha buffer area was translated into Biodiversity Units (BU) using the Defra Biodiversity Metric Beta Version 2.0 (Natural England 2019). The figure of 10.27 ha was input as lowland heathland (the primary feature of the SAC, covering 75% of the area) in good condition with medium ecological connectivity and high strategic significance, giving a value of 234 BU. The transport avoidance reduction of 21% was then applied, resulting in a final value of 185 BU.

The effects of the project's nitrogen emissions on the biodiversity of Cannock Chase SAC therefore equated to 185 BU using this method.

Habitat management contribution

A suitable parcel of land to be created or enhanced as lowland heathland will be identified within the Lichfield Habitat Recovery Network. A Habitat Management Plan will be developed to create/restore heathland and complementary habitats within this area, which will be managed and maintained by Lichfield District Council for a 25-year period. The habitat creation or restoration measures will be in place prior to the occupation of the first dwelling in the first phase of the proposed development. In this way, there will be no lag time between the establishment of the buffer habitat and increases in nitrogen resulting from the occupation of dwellings.

Conclusions

Nitrogen deposition arising from transport emissions due to a proposed development are expected to result in biodiversity loss in the Cannock Chase SAC heathland. By translating this loss into a biodiversity unit value using the DEFRA metric, it is proposed that the negative impacts can be mitigated by creating or enhancing new habitat to yield the appropriate number of biodiversity units (185 BU) within a buffer area in the immediate vicinity of the SAC. Whilst there are a number of limitations to the method, it has the merit of being a practical, systematic approach to assessing the effects of nitrogen on biodiversity, which could be readily applied to other projects or plans across a range of habitat types.

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Nitrogen Deposition Near Roads – The Importance of Trends and Local Factors in Air Quality Assessment

Keywords: ammonia, critical loads, nitrogen deposition, oxides of nitrogen, trends, uncertainties

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This article considers the assessment of nitrogen deposition at designated ecological sites near to roads, the key pollutants, and some of the uncertainties that should be considered. It provides a brief summary of nitrogen deposition; historic and predicted future trends UK-wide and the need to consider local trends; the importance of the location of the ecological site in proximity to a source and of the location of its qualifying features; uncertainties in assessment; and the importance of collaboration between the air quality and ecology practitioners.

Nitrogen deposition and critical loads

Nitrogen deposition (N dep) is described as 'the input of reactive nitrogen from the atmosphere to the biosphere both as gases, dry deposition, and in precipitation as wet deposition.' (APIS 2020) . Nitrogen deposition is primarily caused by emissions of reduced nitrogen, or ammonia, from farming practices, and by emissions of oxidised nitrogen from road transport and combustion sources. The excess nitrogen is deposited onto soils and plants, and

whilst the subsequent processes are very complex, the consequence can be that some nitrogen-tolerant plants thrive whilst those that are sensitive to too much nitrogen do less well (Defra 2019).

The term critical load is used to define the rates of nitrogen deposition below which significant harmful effects are not expected to occur in sensitive habitats. Different habitats have different critical loads depending on their sensitivity to nitrogen, with some habitats such as inland surface waters having a lower critical load of 3 kg N/ha/yr, while saltmarsh habitats have a higher range of values from 20 to 30 kg N/ha/yr (APIS 2020).

The assessment of nitrogen deposition is a key element of air quality assessment where there are designated ecological sites near to sources of emissions such as roads or industrial facilities. Air quality specialists model pollutant concentrations in the atmosphere and calculate nitrogen deposition rates, which are then passed to ecologists for interpretation and comparison with critical loads for the habitat in question.

Trends in nitrogen deposition

Historic trends

The area of nitrogen-sensitive habitats in the UK which exceeded the critical loads for nitrogen deposition decreased from 75% in 1996 to 57.6% in 2017 (Rowe *et al*. 2020). This decrease has largely been driven by reductions in emissions of nitrogen oxides (NO_x) from industrial combustion plant, such as coal and gas-fired power stations, and in response to the increasingly stringent European vehicle emission standards introduced over the last 40 years. Emissions of ammonia (NH_3) have also reduced as a result of policy measures to improve farming practices.

In 2017, over 80% of the area of six types of nitrogen-sensitive habitat in the UK exceeded nitrogen deposition critical loads: calcareous grasslands (84.4%), unmanaged beech woodland (99.8%), unmanaged oak woodland (82.8%), other unmanaged woodland (93.4%), managed coniferous woodland (81.9%), and managed broadleaved woodland (95.6%) (Rowe *et al*. 2020). By contrast, virtually no saltmarsh habitat exceeded critical loads (0.9%), partly due to the higher critical loads for this type of habitat but also as a function of its location further away from pollution sources such as busy roads and industry. Some habitats have seen substantial improvements in the area exceeding nitrogen critical loads between 1996 and 2017. These include dune grassland habitat (reduction of 51.5%), unmanaged Scots pine woodland (reduction of 42.3%), montane (reduction of 37.8%) and dwarf shrub heathland (reduction of 22.7%) (Rowe *et al*. 2020).

Trends at individual sites

Trends for individual designated sites are provided on the Air Pollution Information System (APIS) website using data from the period 2004 to 2017 (APIS 2020).

Although these trends are based on modelled data, they are still useful when interpreting the findings of air quality assessments and considering future background nitrogen deposition rates (Natural England 2018). For example, at the Thames Basin Heaths Special Protection Area (SPA) total nitrogen deposition rate to forests decreased from 26 kg N/ha/yr in 2005 to 21 kg N/ha/yr in 2017. The decrease is not linear but is nonetheless a significant downward trend, equating to 0.42 kg N/ha/yr (approximately 1.6% per year) over a 12-year period (Figure 1; note that the year shown on the x axis is the mid-point of the three-year average provided on APIS).

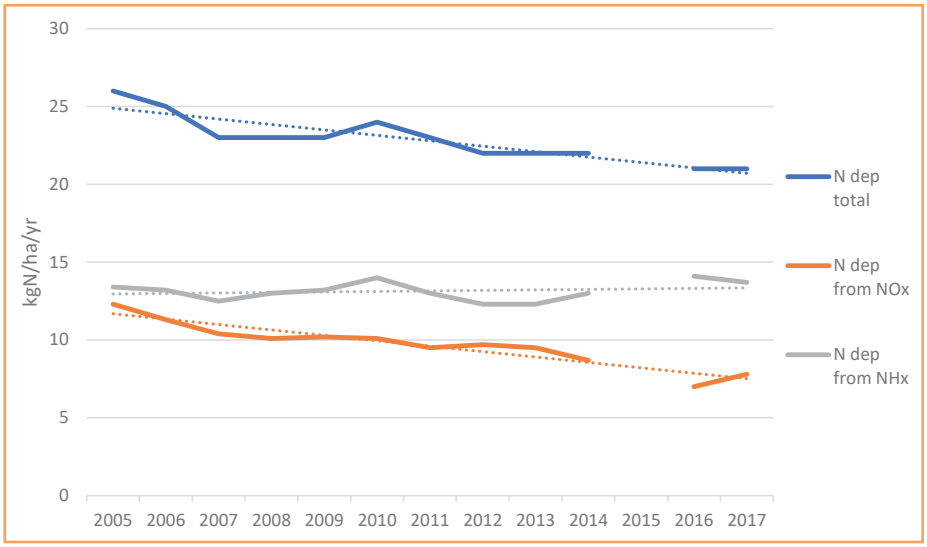

Figure 1. Trends in nitrogen deposition (N dep) to forest in the Thames Basin Heaths SPA.

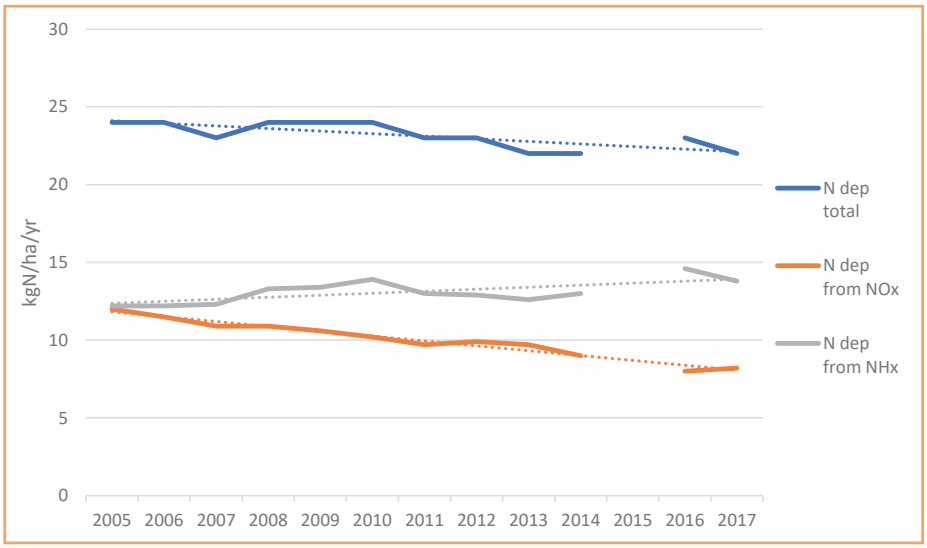

Figure 2. Trends in nitrogen deposition (N dep) to forest in Ashdown Forest SAC.

The trend in nitrogen deposition can be further subdivided into oxidised (NO_X) and reduced nitrogen (ammonia gas, NH_X) deposition rates. The oxidised nitrogen decreased from 12.3 kg N/ha/yr in 2005 to 8.4 kg N/ha/yr in 2017, while the ammonia gas increased slightly from 13.4 to 13.7 kg N/ha/yr over thåe same period (Figure 1).

The historic trends differ between sites, for example the Ashdown Forest Special Area of Conservation (SAC) shows a smaller decline in total nitrogen deposition, from 24 kg N/ha/yr in 2005 to 22 kg N/ha/yr in 2017, driven by the increase over time in ammonia emissions, which are predominantly from agriculture (Figure 2).

It is important to consider the trends in the specific geographic area where an assessment of nitrogen deposition is being made, together with any other factors described in Local Plans. This can help to justify assumptions about future background deposition rates (Natural England 2018), which will ultimately be based on professional judgement.

Uncertainties in air quality assessments near roads

Nitrogen oxides and ammonia

Over the past 20 years, nitrogen oxides (NO_X) have been the focus of air quality assessments for road schemes and land developments because nitrogen dioxide (NO_2) can affect human health. Many areas in the UK, particularly urban and congested roadside locations, still exceed both the EU Air Quality Directive limit and UK national air quality objective for NO_2, and the health effects have driven much of the national and local policy in recent years.

The contribution of NO_X emissions to nitrogen deposition at ecological receptors must be considered when assessing road schemes in the UK. However, Highways England's Design Manual for Roads and Bridges (DMRB) (Highways England 2019) does not provide a method for calculating the contribution of ammonia to nitrogen deposition, nor is it included in Natural England's guidance NEA001 (Natural England 2018). As NO_X emissions have fallen over time, it may be useful to consider including the contribution of ammonia emissions, particularly at ecological sites close to busy roads, but guidance is needed.

Although the majority of ammonia emissions derive from farming practices (84% in 2018) (National Atmospheric Emissions Inventory n.d.), ammonia is also a by-product of the emission control technology used to reduce NO_X emissions from vehicles. The quantity of ammonia emitted from a vehicle exhaust per kilometre driven is low compared to that of NO_X but ammonia has a higher deposition velocity and will contribute around half the total nitrogen deposition at the roadside (Holman *et al*. 2020). Further away from the source, concentrations decrease rapidly with distance due to dispersion in the atmosphere (Air Quality Consultants 2020a).

Emission factors for ammonia

Defra's Emissions Factors Toolkit (EFT) (Defra 2020a) is the main source of input data used by air quality practitioners when undertaking assessments of road schemes and developments. To date, there are no standard emission factors included in the EFT for ammonia comparable to those for NO_X. This is because the EFT is focussed on the assessment of pollutants specified in local air quality regulations for human health concerns. There are also challenges in monitoring ammonia and uncertainty about the best method for assessment of this reactive gas.

Emissions factors for ammonia are provided in the National Atmospheric Emissions Inventory (NAEI) (NAEI n.d.) but in less detail than for other pollutants assessed for human health. For instance, there is no consideration of how emissions of this pollutant vary with vehicle speed, which is a fundamental element of any study of road traffic emissions (NO_X emissions are much higher in congested, stop-start conditions than in free flow). There has been recent acknowledgement that the NAEI estimates may be too low (Emissions Analytics 2020, Ricardo 2020). However, monitoring networks for ammonia are not as well established in roadside environments, and there is a greater level of uncertainty associated with measured results (Centre for Ecology & Hydrology 2020 and Ms Tang *pers. comm.*, 12 June 2020).

Emission trends

Uncertainty in emissions data is not a new concept in air quality assessment (Institute of Air Quality Management 2018) and it is commonplace to undertake sensitivity tests or to adopt conservative assumptions based on historic data.

Measured roadside NO_X and NO_2 concentrations have been decreasing recently across the UK (Air Quality Consultants 2020a,b; Defra 2020b,c), particularly as new vehicles have had to meet the most stringent current emissions standards (Euro 6) since 2015. Whilst this national trend is likely to continue, local trends are also important as they may differ from national trends.

Historic information about vehicle emissions of ammonia is less detailed. Emissions from diesel vehicles are generally lower than those from petrol vehicles and, as people switch to petrol or hybrid vehicles, it is possible that ammonia emissions will increase in the short term. In the longer term, ammonia emissions from road traffic should fall as electric vehicles become more common. Furthermore, the UK has committed to reducing emissions of ammonia to meet the EU National Emissions Ceilings Directive (Defra 2019),

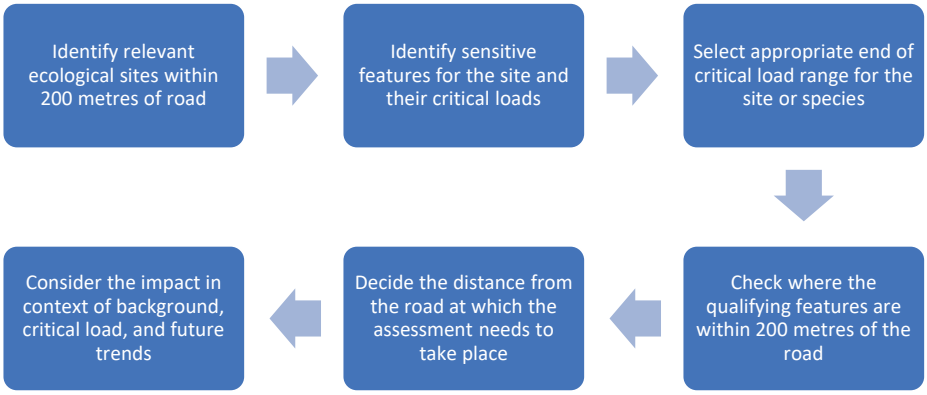

Figure 3. Steps involved in assessing impacts of air quality on ecological sites.

therefore future emissions from all sectors should fall in line with this target.

The effect of the global pandemic

The economic downturn that has arisen as a consequence of COVID-19 may well slow the rate of vehicle replacement. However, this may be counterbalanced by the recent focus on the human health impacts of air quality and the pollution from traffic. A switch to cleaner vehicles might happen more quickly in cities compared to more rural areas resulting in a more rapid improvement in air quality in denser populated areas, but with an improvement in background levels elsewhere.

Meteorological conditions

Weather conditions significantly influence nitrogen deposition rates, particularly wind direction, speed and rainfall. In the Netherlands, modelling is used to estimate nitrogen deposition rates up to 2030 and the estimates are compared with measured data on an annual basis. Contrary to predictions, the measured data show an increase in rates of nitrogen deposition since 2016, despite the reductions in emissions that were expected. One of the key reasons has been the unpredictability of weather conditions which have overridden best efforts to provide a robust assessment (Bal 2020).

Location, location, location

An assessment of nitrogen deposition at a designated ecological site should consider the precise location of the sensitive species and the habitats that they are dependent upon. It is relatively straightforward to search the APIS website, look up the critical loads for the sensitive features, select the lowest value in the range against which to make an assessment, and make reasonable assumptions about emissions and the likely future trend in nitrogen deposition rates. However, establishing whether that feature is present within 200 metres of a road, and whether it should therefore be considered in the assessment is more challenging (Figure 3) and should be undertaken by an ecologist.

The importance of the location of specific features is noted in Natural England's (2018) guidance (NEA001) at step 2 and 3 of the screening process, and again as a consideration within the appropriate assessment when undertaking Habitat Regulations Assessments (Natural England 2018). It is also documented in guidance from the Institute of Air Quality Management (IAQM) (Holman *et al*. 2020). It is particularly important to consider the location of the supporting habitats for Special Protection Areas (SPAs) which are designated for birds, rather than necessarily the entire designated area, and the potential sensitivity of those habitats to nitrogen deposition.

Benefits of surveys

By undertaking early survey work, and collating surveys of the site from relevant organisations such as Natural England or local wildlife trusts, ecologists can help to identify where features sensitive to nitrogen are present. This can focus and scope the air quality assessment so that it is relevant and proportionate. For example, if the features sensitive to nitrogen are only identified at a location beyond 100 metres from a road, then the air quality assessment would only need to focus on the area within 100 to 200 metres from the road (beyond that distance, impacts can be deemed insignificant) (Figure 3). Site visits and survey work can add to the body of evidence used to justify decision-making at this stage.

The location of the nitrogen-sensitive features within a designated site should also be given attention when interpreting an air quality assessment. The ecologist may wish to place more focus on those sites closest to the source of emissions, given that there can be much uncertainty in undertaking assessments further away, where a small, modelled incremental change from a scheme can be difficult to distinguish from uncertainty in measurements or background fluctuations.

Summary

When considering the potential impacts of nitrogen pollution on ecological sites, it is important to look at the bigger picture. Nitrogen deposition to UK habitats peaked in the 1980s following an increase in emissions from industry and a rapid rise in the number of road vehicles from the 1950s onwards. Deposition rates have been falling since then, which is good news, but they are still higher than they were in the 1950s (Dragosits *et al.* 2016). Furthermore, there are different trends in different habitats. In some cases, habitats are in a stable or good condition, and are improving in quality through careful management, but the situation varies by location.

Clearly, the effects of nitrogen deposition on vegetation are far more complex than even detailed air dispersion modelling exercises can demonstrate. There will be other, more site-specific aspects that affect the viability of nitrogen-sensitive species, such as the exposure to pollution historically, or the way in which the land has been managed in the past. There are many other unknowns, including the effect of global warming on species survival rates.

We need to work closely together, as air quality specialists and ecologists, to obtain as much information as possible about the specific site or sites we are assessing. We then need to use this as evidence of potential impacts when undertaking and interpreting the assessment of vehicle emissions. Our aim should be to reduce uncertainties and make any assessment as focussed and site-specific as possible.

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Air Quality Assessment under the Habitats Regulations

– Why We Need to Agree a Robust Approach to the Concept of De Minimis and the Setting of Thresholds and Screening Criteria

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DTA Ecology Ltd.

Keywords: air pollution, critical load, Habitats Regulations, significance, thresholds

Figure 1. The impacts of nitrogen deposition on *Calluna* at Ballynahone Bog in Northern Ireland. Photo credit Caroline Chapman.

This article seeks to explore the implications for practitioners and decision makers of recent court cases concerning the use of thresholds in air quality assessments.

Introduction

In 2017 the High Court ruled in the case of Wealden District Council v Secretary of State[1] that the application of a threshold (refer Box 1) to avoid the need for further assessment effort in respect of traffic emissions associated with housing development had brought about a clear breach of the Habitats Directive. Of particular concern to the Court, from my reading of the decision at least, was that the use of the threshold which had been applied could not be supported on logical and empirical grounds (paragraph 101 in the Court judgment). In the words of the Court, it *'cried out for further explanation'*. The logic applied by the Court in this judgment is irrefutable and it is clear from a common sense approach that the threshold applied

was not appropriate given the specific circumstances of the case in question.

This decision has prompted extensive discussion amongst practitioners and is currently a reliable way to generate some lively debate in any Habitats Regulations Assessment training session... The threshold subject to scrutiny by the Courts in the *Wealden* case concerned the predicted increase in annual average daily traffic (AADT) along an affected road. At the time, if the change was less than 1000 AADT the effects from traffic emissions associated with development had escaped the need for further assessment under the Habitats Regulations, either alone or in combination. The implication of the *Wealden* decision is that this threshold can no longer be relied upon. Another threshold which had also been widely used to avoid the need for further assessment in the context of an individual point source emission was 1% of the critical load or level and the *Wealden* decision has, by extension, also undermined the application of that threshold.

The knock-on effects for decision making are profound and, as a direct consequence, there has been a significant increases in requests for detailed (and often expensive) modelling to inform an in-combination assessment. The most common interim approach is to apply the earlier threshold (whether 1000 AADT or 1% of the critical load/level) such that a plan or project only escapes further assessment if the combined contribution with other plans and projects is below the threshold. I refer to this approach as *interim* as, in my professional opinion, it cannot reasonably become the new standard. Whilst it has some merit in the short term (in demonstrating compliance with the judgment of the High Court in *Wealden*), it has had the effect of removing any concept of a threshold below which individual proposals can properly be ignored. The in-combination assessment now must take account of the combined effect of *all* plans and projects irrespective of the magnitude of their individual contribution. The purpose of this article is to explain my reasoning for this view with the intention of promoting discussion amongst practitioners. It is recognised that some readers may not agree with the views expressed herein, which is inevitable given the nature of the issues; healthy debate is to be encouraged and welcomed.

Box 1. Some useful definitions.

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.

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.

De minimis, thresholds and screening criteria:

Reuters states that De Minimis is '*a legal term meaning too small to be meaningful or taken into consideration; immaterial. As a matter of policy, the law does not encourage parties to bring legal actions for technical breaches of rules or agreements where the impact of the breach is negligible. The term de minimis is taken from a longer Latin phrase which translates into "the law does not concern itself with trifles*".' For the purpose of this article when I refer to 'de minimis' I do so in a legal sense, in the context of decision making, and have in mind a situation where a predicted impact does not require further consideration as it is negligible in its effect. A de minimis effect is one which can properly be ignored.

The phrase 'de minimis' has been used interchangeably with 'screening criteria' or 'screening thresholds'. Sometimes they are combined to refer to a 'de minimis screening threshold'. This is unhelpful – the concept of de minimis is fundamentally different to the question as to a 'likely significant effect' with which screening is concerned.

Having defined de minimis in this context, thresholds and screening criteria are different. **Thresholds seek to identify a maximum contribution from an individual emission source that can safely be ignored for the purpose of decision making as it will not make a meaningful contribution to a significant effect.** Screening criteria can be synonymous to thresholds but can also be informed by emission type, distance from source, background trends, source attribution and the characteristics and specific environmental conditions at a site. Screening criteria can therefore take account of the local circumstances which apply at a given site.

Key principles arising from case law

Some key principles can be derived from case law decisions which have shaped and informed a correct approach to the in-combination requirements. In the case of *Newry*[2] (2015), when considering the claim that an assessment had failed to properly apply the in-combination provision, the Courts relied upon the reasoning in the case of *Boggis*[3] that any party alleging that there was a risk which should have been taken into account must produce '*credible evidence that there was a real, rather than a hypothetical, risk*'. The Court in *Newry* applied this reasoning to the asserted requirement to undertake an in-combination assessment, even when a decision maker is of the opinion that the effects 'alone' will not contribute to any in-combination effects with other development in a meaningful manner. The Court in *Newry* concluded:

'at no stage… did the applicant put forward credible evidence that there was a real, rather than a hypothetical risk which should have been taken into account'.

This is a perfectly sensible and pragmatic decision. Hypothetically, the assessment of every plan or project, with even the slightest effect, should include an assessment in combination with other plans and projects. To do so however would create an overly burdensome and excessive approach which was cautioned against by Advocate General Sharpston in her Opinion in the case of *Sweetman*[4]. This case concerned the de minimis argument and the Advocate General explains how the requirement for an effect to be 'significant' lays down a de minimis

threshold. Paragraph 48 of her Opinion recognises the inherent dangers which arise from an excessive interpretation of the in-combination provisions:

'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'.

The *Wealden* judgment is significant, but it needs to be read and interpreted in light of other, well established principles. Looking back over decisions which have shaped our understanding of in-combination effects, these can reasonably be summarised below:

- In-combination provisions must be interpreted and applied in a proportionate manner. An in-combination assessment must be practically feasible (refer European Commission parliamentary question[5])
- There must be a degree of flexibility in an in-combination assessment and the competent authority is entitled to exercise judgment over which other plans and projects to take into account (refer *Walton*[6] 2011)
- In-combination effects can, in principle, be eliminated on the basis of a lack of credibility, having regard to advice from the statutory nature conservation body (refer *Newry*[2])
- If all plans and projects having any effect whatsoever are subject to assessment in-combination, activities on or near the site risk being impossible by reason of legislative overkill (refer *Sweetman*[4]).

Can we define a new approach for air pollution?

Caution is needed here over terminology and, with reference back to Box 1, there are risks with the term de minimis being applied and interpreted too broadly. De minimis relates to an overall magnitude of change that can properly be ignored. It is therefore problematic within the context of an in-combination assessment to attempt to describe individual emission sources as de minimis. There is a need for a threshold based approach in decision making which facilitates the identification of individual proposals which can properly be ignored but that is a separate and distinct issue to de minimis. Looking across decision-making approaches the setting of criteria which avoid the need to have to consider the potential for in-combination effects tend to fit within one of two models.

1. Firstly the **'zone of influence' based approach.** Here the zone sets the 'threshold' and anything within the zone, however small, is regarded as having the potential to act in combination with other plans and projects. The strategic approaches to recreational pressure are all zone of influence based.
2. Secondly, we have the **threshold based approach**, whereby every plan and project (irrespective of proximity to a site) whose individual contribution is below that threshold is regarded as acceptable.

In some cases a combined approach may be appropriate whereby a zoned approach is taken to the application of a threshold. Both these approaches can be sound. Nothing in the *Wealden* decision suggested that a threshold approach was unacceptable in principle; indeed, the Court explicitly recognised that '*if it is known that specific impacts are very low indeed, or are likely to be such, these can properly be ignored*' (emphasis added). What is not acceptable, in view of the Advocate General's Opinion in the *Sweetman* case, and the need to avoid legislative overkill, is to fail to recognise any threshold at all.

Figure 2. Air Quality monitoring at Ballynahone Bog SAC in Northern Ireland. Photo credit Caroline Chapman.

It is therefore reasonable to argue that, for air pollution, a threshold can be derived to identify proposals that can properly be ignored. The counter cry to such an assertion goes as follows… "Ah, but you are forgetting about the in-combination test. Even the smallest contribution can become significant if there are enough individual sources; you cannot define a threshold which can withstand scrutiny beneath the lens of the in-combination test" (sound familiar?) … I accept the legal principles behind such an assertion but, at this stage, we are firmly within the *hypothetical* risk territory. Hypothetically, setting a threshold is not possible as, hypothetically there might be an infinite number of individual sources such that the combined effects could, eventually, become significant. At this point I must lean back on my old friend Mr Boggis and the esteemed reasoning of Advocate General Eleanor Sharpston and a response might go as follows… "Yes, but there must be credible evidence that the risk you refer to is real; activities on or near the site would risk being impossible if all plans and projects capable of having any effect whatsoever are subject to further assessment effort." This is where it gets interesting…

When we accept that an approach to a threshold will not be held to scrutiny against *any* hypothetical scenario we immediately feel less exposed. We need to engage with credible evidence of a real risk that an individual proposal might contribute to an in-combination assessment in a meaningful manner; legislative overkill is to be avoided. Within this context, common sense and professional judgment are allowed to exert an influence and the setting of some form of decision-making threshold becomes possible. Furthermore, we can look at actual sites and undertake some modelling scenarios against which a proposed threshold value might helpfully be tested. The hypothetical risk of numerous proposals which contribute a small pollution load acting in combination presupposes that all these sources have overlapping impact footprints. In reality, it is quite unlikely that this would happen in the case of individual point sources. Linear road sources *are* different but there is a point at which the credible evidence of a real risk boundary is crossed. Modelling work could helpfully be undertaken to explore this in more detail and the Joint Nature Conservation Committee have recently let a contract to undertake such modelling (Zappala *et al.*, this issue), so… watch this space.

It's all about the conservation objectives…

If we anticipate that an accepted de minimis value might emerge, from which a decision-making threshold might be derived, what does this mean for screening criteria? At this point it is necessary to understand that, in the context of an assessment under the Habitats Regulations, an 'effect' is never unqualified. The regulations are not concerned with *any* effect, only those that might undermine the conservation objectives. Screening criteria can therefore be derived to ensure that the combined effect of plans and projects excluded by them will not be significant for the site concerned. The combined effects are still permitted to exert an effect upon the site, as long as that effect does not undermine the conservation objectives.

But how might that work in practice? In the case of air pollution, for most sites it can fairly safely be anticipated that the conservation objective will be to restore the site such that the critical load/level is not exceeded. In defining screening criteria for such a scenario we first need to understand what action is required to achieve that objective. Only once we have addressed this question can we then consider the extent to which a given new

proposal might undermine the ability to deliver such action.

For the sake of argument, if we assume that a threshold value has been agreed, we can anticipate that we are only now concerned with proposals that exert a meaningful influence on a site (i.e. those that cannot properly be ignored). If we know what actions are required to achieve the conservation objectives, we can address the extent to which a small additional contribution from a particular proposal might undermine the delivery of that action, or otherwise compromise the extent to which such steps might be actively pursued. This will likely depend on the circumstances which apply.

Example scenario

By way of example, consider a site which exceeds the critical load: 65% of the nitrogen deposition comes from agricultural sources and only 5% come from local roads. It is a rural site where residential development pressure is low, but it is an agricultural 'hotspot'. Two proposals are on the table: firstly, a small residential development which will lead to a few additional vehicle movements on one local road which lies within 100 m of the boundary of a Special Area of Conservation; secondly, a small agricultural proposal for a new dairy housing unit and associated increase in slurry storage capacity. The question here is whether both proposals represent the same risk of undermining the achievement of the conservation objectives.

Steps to avoid critical load exceedance for this site will require action to reduce emissions from existing agricultural sources. Given the location of the site it can also be assumed that applications concerning agricultural activities arise frequently. If such sources continue to be permitted on the basis that their individual contribution is 'small' then two consequences can be anticipated. Firstly, there will be a creeping cumulative impact from the combined effects of all the small applications leading to an overall increase in pollution which will clearly undermine the delivery of an objective to reduce the nitrogen loading. Secondly, the ongoing permitting of these proposals essentially removes the political driver for the necessary action to be taken to reduce emissions from existing agricultural activities, again undermining the achievement of the conservation objectives.

If we turn to the small residential development, a few additional vehicles on the road will not undermine the delivery of necessary action to reduce emissions from agricultural sources. The rural setting means that there is no credible evidence of a real risk of many applications leading to a creeping cumulative impact which might undermine the delivery of an objective to reduce the nitrogen loading in a meaningful manner.

The risk from each proposal, when viewed through the lens of the action which is required to deliver the conservation objectives, is different. That is not to say that the same logic would apply to all sites. In some cases, the action required to achieve the conservation objectives might require active measures to reduce emissions from traffic. For many sites the credible evidence of a real risk of the conservation objectives being undermined by housing development is undisputed.

Conclusion

So, by way of summary, a new threshold based approach is urgently required to avoid legislative overkill and excessive modelling work for air quality assessment efforts. A threshold might reasonably be derived from modelling scenarios and credible evidence of a real risk. The setting of screening criteria is a subsequent step which is, in my opinion, all about the conservation objectives. The achievement of the conservation objectives is specific to the site concerned and screening criteria could reasonably be agreed on a site- and/or sector-specific basis.

Reference

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Notes

1. Wealden DC v SoS and Lewes DC [2017] EWHC 351 (Admin). https://www.bailii.org/ew/cases/EWHC/Admin/2017/351.html

2. Application for Judicial Review by Newry Chamber of Commerce [2015] NIQB 65. https://www.bailii.org/nie/cases/NIHC/QB/2015/65.html

3. Peter Boggis v Natural England [2009] EWCA Civ 1061. https://www.bailii.org/ew/cases/EWCA/Civ/2009/1061.html

4. Case C-258/11 Sweetman v An Bord Pleanála, April 2013. http://curia.europa.eu/juris/liste.jsf?num=C-258/11&language=EN

5. Written question by Satu Hassi to the European Commission, 3rd March 2005.

6. Walton and Fraser v Scottish Ministers [2011] CSOH 131. https://www.bailii.org/scot/cases/ScotCS/2011/2011CSOH131.html

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What Happened to "More, Bigger, Better and Joined"?

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Keywords: Government policy, habitat restoration, Nature Recovery Network, rewilding, wildlife conservation

It is 10 years since *Making Space for Nature* was published. In that time, its 'executive summary' of "*more, bigger, better and joined*" has become the guiding principle for statutory and voluntary conservation organisations in the UK, and in the formulation of Government policy. Here I report on an open letter to the Prime Minister from all the panel members who wrote the original report urging three essential actions, by adopting the "Lawton principles" at sufficient scale to reverse the apparently inexorable collapse of UK wildlife. I also review some of the main, large-scale conservation actions that have been taken over the last decade, those that are ongoing and some that are being planned, and briefly consider why the legacy of this report appears to be so long-lasting.

Introduction

In September 2010 a panel I chaired produced a report for Defra entitled *Making Space for Nature: A review of England's wildlife sites and ecological network* (Lawton *et al.* 2010). The work was commissioned in 2009 by the then Secretary of State Hilary Benn. It was to focus on terrestrial and freshwater (but not marine) habitats in England. Hilary Benn was a Labour Party Minister, and after Labour lost the General Election in May 2010, a new Conservative Secretary of State (Caroline Spelman) was appointed. To her credit Caroline Spelman agreed that my panel should carry on its work, which we did.

Making Space for Nature (now widely cited as "*the Lawton report*") argued that in order to halt and then reverse the depressing and on-going declines of UK wildlife we needed a step-change in England's approach to wildlife conservation, moving on from trying to hang on to what we have left (important as that still is) to one of large-scale habitat restoration and re-creation, underpinned by the re-establishment of ecological processes and ecosystem services, for the benefits of both people and wildlife. We needed an 'executive summary' to help policy-makers get their heads round our recommendations, and Tom Tew (one of the panel members) came up with the brilliant mantra: "*More, Bigger, Better and Joined*". We need more, bigger and better managed protected sites, all in a joined-up network. The mantra worked. And to my astonishment a decade later it has become the guiding principle underpinning wildlife conservation in both the voluntary and statutory sectors across the UK, and increasingly in continental Europe.

A letter to the Prime Minister

On 16 September 2020, exactly a decade after my report was published, with the help of the original Secretary to the panel, Dr Pete Brotherton in Natural England, I wrote to Prime Minister Boris Johnson. The letter was also signed by all the original panel members. (Sadly one of them, Professor Dame Georgina Mace, died about a week after she had signed it.) The letter points out that since its publication, despite the fact that the report has helped shape significant Government policies – including the Natural Environment White Paper, the Biodiversity 2020 strategy, the National Planning Policy Framework and the 25-Year Environment Plan – UK wildlife continues its seemingly inexorable decline. The policies are not working, but this isn't because the policies are wrong, it's because their implementation has been insufficient.

The letter then spelled out what we considered to be three essential and overarching actions:

1. Better protect and manage our remaining wildlife habitats. The past decade has seen no noticeable improvement in the condition of our Sites of Special Scientific Interest (SSSIs), and wildlife habitats outside SSSIs. As a result, many species are declining in the very sites established to protect them. This needs to be urgently addressed, to re-establish healthy populations in core areas.
2. Deliver ecological restoration at scale. Our review clearly demonstrated that the amount of wildlife habitat that remains is not sufficient to halt wildlife declines: there is an extinction debt still to be paid if we do not create more space for nature. The 25-Year Environment Plan commits to establishing 25 large Nature Recovery Areas (NRAs) as part of a Nature Recovery Network. The 25 NRAs should be established urgently, building on the recent experience of delivering large-scale projects, such as in the 12 pilot Nature Improvement Areas that were an outcome of the original report. The NRAs need to deliver large blocks of contiguous habitat (>5000 ha) to establish thriving populations of species that can spread across the rest of the network. These large areas will also be ideally suited to delivering Nature-Based Solutions to climate change and other societal challenges and they will enable the introduction of cost-effective and new management approaches, such as rewilding.
3. Bring nature to people. We need a focused programme of ecological restoration within and surrounding our towns and cities. Over the last decade, compelling evidence has emerged of the benefits to people of regular access to nature, in terms of physical and mental health and well-being, with particular benefits experienced by children. Ecological restoration close to homes also provides a range of proven Nature-Based Solutions including reducing air pollution, water management and cooling effects.

To deliver, we urged the Government to commit an additional £1 billion as a one-off capital investment in this 'Green Infrastructure'. This is a great deal of public money, but it is relatively modest compared with, for example HS2 (£100 billion and rising), Cross Rail (£20 billion), or this August's 'Eat Out to Help Out' scheme (>£0.5 billion). We pointed out that a significant investment in nature's restoration has the potential to create thousands of green jobs. In the USA, ecological restoration activities employ more people than timber, coal and steel industries combined (https://envmarketsandfinancesummit.com/wp-content/uploads/2019/11/EMF-Summit-Report.pdf).

Amongst other things, the letter also pointed out that during the COVID-19 pandemic young people have paid a heavy price to keep more vulnerable people safe. For several years, this same generation has been telling us with growing insistence that what they want most from Government is a step-change in action to address the joint crises of biodiversity loss and climate change. It's time we listened.

And finally, we pointed out the time for international leadership is now. We are entering the UN's Decade of Ecosystem Restoration. With the UK's presidency of the G7 and of the Climate Change COP26 next year, the world will be watching what we do, so there is no better time to demonstrate global leadership through decisive, ambitious action.

A policy framework is emerging

In 2018, the Westminster Government published *A Green Future. Our 25 Year Plan to Improve the Environment*, in which it explicitly aspired to create a "*nature recovery network*" based on the "*Lawton principles*", including the creation and restoration of 5,000 km^2 of wildlife-rich habitats outside the existing protected area network, and an increase in woodland cover in England to 12% by 2060 (planting up 180,000 ha by 2042; this looks set to be superseded by more ambitious tree-planting targets to contribute to the UK's net zero commitments, including planting 30,000 ha of woodland by 2025). The 25-Year Plan is great on aspirations, and depressingly vague on details – the how, where, when and who pays – of practical conservation. But looked at optimistically, it's a step in the right direction.

There are also encouraging implementation mechanisms under development, notably the new Environmental Land Management scheme with a strong focus on rewarding farmers for providing public benefits (explicit in Recommendation 17 of *Making Space for Nature*) and the requirement for net biodiversity gain from development, but the devil will be in the detail, and there are already signs of Government 'rowing back'. The new Nature for Climate fund also has the potential to make a significant contribution towards the UK's net zero ambitions as well as for wildlife (including by ramping up the tree-planting ambition outlined above). In *Making Space for Nature* we highlighted the importance of tackling the challenges of climate change and biodiversity loss together.

A great deal has already and is happening

Outside Government, a great deal has happened over the past decade, and much more is in the pipeline. Space precludes a comprehensive review, but some of the major developments include the following.

In *Making Space for Nature* we said that "*delivering a more effective ecological network may require refinements to the [agri-environment] schemes, such as rewarding farmers who act cooperatively*." It took time, but these ideas led eventually to Farmer Cluster Initiatives (e.g. www.farmerclusters.com/) funded by Natural

England's Facilitation Fund and modelled on the Marlborough Downs NIA (which was entirely farmer-led), to deliver "*more, bigger, better and joined*" across groups of farms.

The National Trust's Priority Habitats Initiative (www.nationaltrust.org.ok/news/our-plan-to-restore-nature-at-our-places) is another. In 2017, explicitly acknowledging *Making Space for Nature,* the UK's biggest private landowner set itself two targets: that by 2025 it will have created 25,000 ha of new habitats (for example, restored chalk-downland) and by that same date, 50% of its entire farmland will be "*nature friendly*".

The Heritage Lottery Fund (as it was then called) was grant-aiding large-scale habitat creation and restoration well before 2010 through its Landscapes Partnerships Programme (www.hlf.org.uk/looking-funding/landscapes-parks-nature/landscapes). But after the publication of *Making Space for Nature* the HLF Board asked me to give them a presentation around "*more, bigger, better and joined*", and revised and extended the programme accordingly. The Landscapes Partnership Programme closed in 2017, and over its lifetime awarded £225 million to 125 landscape-scale programmes. HLF (now National Lottery Heritage Fund) is still supporting landscape-level conservation projects, but not through a dedicated programme.

Other habitat restoration and recreation projects that pre-date *Making Space for Nature,* but have since taken on the mantle of "*more, bigger, better and joined*" include the RSPB's Futurescapes and The Wildlife Trusts' Living Landscapes, both of which have already, and continue to, restore habitats at scale across the whole of the UK.

Making Space for Nature cannot claim credit for two other highly significant conservation initiatives in England, both of which pre-date the report and both involve a degree of rewilding, moving away from land sharing to the restoration of large-scale tracts of semi-natural habitat. They are Wild Ennerdale in the English Lake District (www.rewildingbritain.org.uk/rewilding/rewilding-projects/wild-ennerdale) and the wilding of the Knepp Estate in West Sussex (Tree 2018). Both show what can be achieved when nature is given the space. And both have now been joined by an ever growing list of other initiatives in rewilding.

One of the most recent is the Endangered Landscapes Programme (2019), which I have the privilege of Chairing. Established in 2018, the programme is administered by the Cambridge Conservation Initiative supported by a $30 million grant from Arcadia, the charitable fund of Lisbet Rausing and Peter Baldwin. This programme is not confined to the UK but is Europe-wide, with the aim of restoring biodiversity and ecosystem processes at vary large scales: "*more, bigger, better and joined on steroids*" as one of my colleagues put it. One is in the UK – Cairngorms Connect – and is the biggest habitat restoration partnership in Britain, weighing in at 600 km^2 in the Scottish Highlands. The other six sites range from Portugal in the west to Georgia in the east. The largest is a staggering 12,000 km^2 spanning four countries (Poland, Belarus, Ukraine and Romania) around the Polesia region.

Lessons for the conservation-policy interface

An obvious question (which I am probably not the best person to answer) is why "*more, bigger, better and joined*" has had an impact way beyond anything I could have dreamed of in 2010. After all, there was little new science in it; the underpinning ecological principles had been known for 10 or 20 years (they are

basically island biogeography), and some of the same arguments had been put by others to less effect. Indeed, the realisation that there was no new science in *Making Space for Nature* has been a basis for criticising the report as a waste of time and money (Carter 2017; though in fact it took less than a year and cost the salary of one full time member of staff). But *Making Space for Nature* wasn't just re-hashing established science. We assembled new datasets (including the first England-wide spatial dataset of Local Wildlife Sites) and carried out novel analyses to assess the strengths and weaknesses of the various sites that make up England's ecological network. The report was commissioned at a time when influential people were beginning to suggest that protected sites had had their day and we just had to think about landscapes – after all, we'd tried protected areas for 60 years and yet biodiversity had still declined. What *Making Space for Nature* did was to turn this argument on its head: demonstrating that landscape-scale approaches to nature conservation needed thriving wildlife sites at their heart. The ranking that we provided (in terms of what to do first, second and so on) of our over-arching mantra on wildlife sites in England (better > bigger > more > joined) has stood up to subsequent scientific scrutiny (e.g. Crick *et al*. 2020), and is being used to design future nature networks, including in England. In total the report has been cited over 400 times in the academic literature alone.

But science isn't enough. In my Presidential Address to the British Ecological Society (Lawton 2007) I gave 11 reasons why politicians and policy-makers often ignore sound scientific advice (these were not original either, and for a much more comprehensive analysis see Owens 2015). But sometimes, just sometimes, the stars align, ideas catch peoples' imagination and policies change. Why? Is it just luck, or a combination of luck and 'something else'? In a thoughtful and careful analysis, Rose *et al.* (2018) conclude that it was a combination of luck (government was ready to receive the message), and quite a lot of hard work to get the message across clearly with minimal jargon. The panel were also very careful to frame our arguments honestly, using rigorous science to make our case around topics that would find traction with government: climate change; the restoration of ecosystem services for the benefits of people and wildlife; the importance of local decision-making through consortia of the willing; and success stories – we know how to do this stuff.

Epilogue

Of course, most of what has happened to deliver the vision in *Making Space for Nature* since 2010 are 'output measures' – restoring habitats, creating corridors and so on – the muddy-welly and big digger end of conservation. Are we actually now creating more space for nature by these efforts than 'human progress' destroys and inevitably seems to carry on its coat-tails? We don't know. It's rather like trying to restore your bank balance having got into debt, without knowing how much money you have or expect to earn in the future. We don't run our economy like that, and we should not try to manage the environment lacking crucial data on how we are doing. Individual organisations such as RSPB know (to the last hectare, see Ausden *et al.* 2019), but there appears to be no central inventory of all the habitat re-creation being carried out across all the Wildlife Trusts for example, so that in aggregate we have no idea what is going on. It is astonishing! There is a hard but important research question for somebody here. Just what has been and currently is the scale of habitat re-creation and restoration across the UK since *Making Space for Nature* was published?

By 2019 when the third *State of Nature* report was published, it appeared the *outcome* of all this activity had little to show for it. But I wouldn't expect it to be evident nationwide after only a decade at best. The crucial question is, as habitats are restored and recreated, how much will we have to do to really turn around wildlife conservation in the UK and beyond? Only time will tell. But I am cautiously optimistic that the tide is turning, and that as a society we can, and will, eventually make more space for nature, for the benefits of people and wildlife.

That was the point of the letter to the Prime Minister. But a month after writing to him, he still hasn't replied.

Acknowledgements

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Extended Season Environmental DNA Surveys for Great Crested Newts

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Keywords: environmental DNA, extended season sampling, great crested newts

In the UK, environmental DNA (eDNA) is used routinely to survey for great crested newts *Triturus cristatus* (GCN). However, the survey window (15 April – 30 June) is relatively short and any negative eDNA samples collected at other times cannot be relied upon as evidence of likely absence of GCN. We discuss the efficacy of GCN eDNA surveys undertaken later in the year and call for further evidence to support an extension to the recommended eDNA survey window to allow more flexibility when utilising this survey method.

Background

Environmental DNA is nuclear or mitochondrial DNA that is released from an organism into the environment. Sources of eDNA include secreted faeces, mucous, gametes, shed skin, hair and carcasses. In aquatic environments, GCN DNA is diluted and distributed in the water where it persists for 7–21 days, depending on the conditions (Biggs *et al.* 2014). With developments in quantitative Polymerase Chain Reaction (qPCR) methods, it became financially feasible to utilise the persistence of eDNA in the aquatic environment to confirm presence or likely absence of a range of organisms on a commercial scale. Issue 99 of *In Practice*, published in March 2018, contains a wealth of articles exploring the use of eDNA (CIEEM 2018).

Environmental DNA sampling is now commonplace, although it should be noted that eDNA sampling can only record the presence/likely absence of GCN; this method cannot indicate population size. The eDNA survey period coincides with peak adult GCN aquatic activity during their breeding season.

Rees *et al*. (2017) found GCN DNA in water samples from at least one of two ponds in Cambridgeshire sampled every month between March 2014 and February 2015. In both study ponds, GCN DNA was detected each month from March to August. Buxton *et al*. (2017) studied eight, naturally-colonised pond systems and measured how seasonal changes in eDNA were influenced by the abundance of GCN adults and larvae. They found peaks in GCN DNA in early June when adult breeding was coming to an end and between mid-July and mid-August when larvae were most abundant. GCN DNA concentration fell rapidly between late August and early September as most larvae metamorphosed and left the ponds. All ponds used in both the Rees *et al*. and Buxton *et al*. studies had known GCN populations previously detected by 'traditional' (non-eDNA) survey methods. Neither study explicitly states that these were known breeding ponds prior to the studies but it is implied in both papers that this was the case.

These studies confirm that GCN DNA can be detected outside the standard eDNA survey window but the samples were small. Further evidence is needed to demonstrate that an extended survey window would reliably indicate likely absence as well as presence, and that the risk of false negatives is acceptable compared to the standard survey window. The extended season eDNA surveys described here build upon these earlier studies by surveying a larger number of ponds, with a wider geographical scope. We hope it will encourage others to report their own survey results to create a robust evidence base.

Case studies

Surveys for GCN eDNA were undertaken at 15 ponds at three sites during September 2019. At the first nine ponds (Leigh, Greater Manchester, 3 ponds; Sandiway, Cheshire, 6 ponds), population size class assessments (PSCAs) were carried out between April and June 2015 using a combination of bottle trapping and torchlight surveys in accordance with Natural England guidance (English Nature 2001). All ponds were found to support GCN. There was no PSCA at the third site (Melton Mowbray, Leicestershire, 6 ponds) but recent records indicated that GCN were present within a 1-km radius of the ponds.

The eDNA survey and subsequent analysis followed good practice guidance (Biggs *et al.* 2014) other than the timing of the survey, and all samples were analysed by an approved laboratory. Evidence of GCN eDNA was recorded in all 15 ponds.

Discussion

The surveys reported here were undertaken between 65-82 days later than the recommended eDNA survey window. All 15 ponds returned positive results for GCN presence; none of the surveys undertaken in September 2019 resulted in false negative results.

An extension in the eDNA survey season would have several benefits including:

- Earlier detection of GCN populations when the current accepted survey period has been missed due to late instruction or project start-up, thereby allowing more time for robust decision making and thorough planning of conservation or mitigation/compensation activities
- Reduced costs and delays to developers
- A longer and easier-to-manage eDNA survey season for surveyors and eDNA laboratories.

It is likely that GCN DNA persisted into September at the ponds reported here because:

- GCN DNA can persist in the aquatic environment for up to 21 days (Biggs *et al*. 2014) even when GCNs have been absent for up to three weeks.
- GCN won't necessarily leave the breeding pond once breeding activities cease and can utilise aquatic environments well beyond 30 June.
- GCN larvae live in the aquatic environment until they develop into air-breathing juveniles, at which stage they will begin to emerge, usually during August, although they are sometimes known to overwinter in aquatic habitats (Frazer 1983).
- As GCN and their larvae can overwinter in aquatic environments, they could be present in the water all year round in breeding ponds that don't freeze solid in the winter (Langton *et al*. 2001).

The presence or absence of larvae in a pond is likely to be a key factor in DNA detection rate for extended season sampling, particularly from mid-August onwards. Therefore, later sampling may miss waterbodies not used for breeding every year or non-breeding waterbodies where larvae are absent even though they are used by GCN. However, as breeding waterbodies are by far the most important aquatic resource for this species and form the core of most licencing considerations, it is considered that extension of the eDNA sampling season would not compromise the key data requirements for good conservation outcomes for GCN populations.

Clearly, more evidence is needed to support the validity of an extended survey season for GCN but the results reported here, and those of Rees *et al.* (2017) and Buxton *et al.* (2017), demonstrate that eDNA surveys are able to detect GCN DNA beyond the normal survey window. We invite other GCN surveyors to come forward with their own results and observations, both positive and negative, so that we can build a substantive evidence base to assess whether eDNA survey for GCN breeding ponds undertaken significantly later than 30 June is effective and can be relied upon to predict likely absence as well as indicate presence.

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Claire Wansbury is an Associate Director of Ecology within Atkins. She is a generalist ecologist with particular interest in practical application of innovations to deliver genuine benefits for nature conservation and society. Claire has been involved in enhancements in GCN mitigation since developing the first application of the approach that evolved into masterplan based licences.

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The Line We Tread: Assessing Complaints Against Members that Relate to Live Planning Matters

Ellie Strike CEnv MCIEEM
Environment Agency and Co-Chair of CIEEM's Professional Standards Committee

I remember some years ago, when newly embarking on my journey as a people manager, having a conversation about performance management – well, more specifically, the management of poor performance. The nugget of wisdom imparted to me was, whilst for a manager the process of handling poor performance, a grievance, or disciplinary may just be your job, for the staff member involved it is their life!

When I reflect on this, there is part that does not resonate. I have never been involved in a complex people management issue and not had my own emotional response to it, including some sleepless nights. And speaking to other managers over the years, I haven't met one who would be able to easily park these issues, and not take them home with them to some extent. To be a good people manager you need empathy. But with empathy comes emotional investment.

However, the main learning point remains pertinent, you never embark on any formal process lightly, because it will inevitably carry with it a big personal impact for the person at the centre. And so, if you choose that route, you have a duty of care to treat those involved with respect and compassion, and always give them a right of reply. So, perhaps you can already anticipate where I am heading with this.

I have now been Co-Chair of our Professional Standards Committee (PSC) for several years, and in that time I have overseen the assessment of a significant number of complaints against our members, and have seen the evolution of our Professional Conduct Inquiry processes. With every intake of new PSC committee members, without doubt, the bit that causes most trepidation is the knowledge that at some point they will have to be part of that process, and they will have to make decisions that affect people – real people, fellow members, people who share our profession. The responsibility looms large, and it should.

I can say with certainty that there is nobody involved in the Professional Conduct Inquiry process who relishes making decisions that may impact on another person's life or livelihood. But, as a professional body, a chartered institute, and for this committee in particular, there is a line that we must tread!

Whilst the vast majority of the work we are involved in, and proactively steer, is concerned with the improvement of professional standards through growth and encouragement, there is a flip-side. And the flip-side is that we also have a responsibility, both to our membership and to the public at large, to hold members to account if they fall short of the values and standards that we all sign up to when we become a CIEEM member (as set out in our *Code of Professional Conduct*). It gives our members reassurance that you are part of an institute that takes professional standards seriously, and ensures that your membership continues to be a quality mark that you can be proud to associate with. And for the public, much the same, they benefit from assurances that when they come into contact with a CIEEM member they can expect a level of professionalism and quality of work that is benchmarked and endorsed – and if this isn't their experience, then there is recourse and accountability.

I am very proud to say that we have an excellent Professional Conduct Inquiry process, which has proven time and again to work, and to be robust in the face of potential abuses. But we are never complacent. We undertake planned reviews of all elements of our process, and allow for more dynamic reviews and reforms based on learning from cases, new information or guidance and advice. We also ensure regular training for everyone involved.

However, every now and again we come up against an issue for which there is no easy answer. This happened at our last PSC meeting, and we felt it worth sharing with you.

We have always seen a disproportionate number of complaints that relate to live planning matters. It is perhaps not surprising, as the world of development is often emotive, and can be something of a melting pot of views, specialisms and perspectives. As a committee we have recently had further cause to reflect on our suspicion that our complaints process may be seen by some as just another route by which they can potentially frustrate the planning process by discrediting ecological work associated with proposed schemes.

To some, the fact that our area of work relies heavily on professional judgement, rather than clear cut, black and white answers, means that it can be seen as an easy target for spurious challenge. And this is another reason why we continue to

stress the importance of recognising where you are applying professional judgement, and ensuring that this is set out accordingly – for example, by describing how you have reached your position in reports, and fully identifying any limitations, and how you have accommodated them. A more full ranging discussion on professional judgement can be found in March 2016's *In Practice* (https://cieem.net/resource/in-practice-issue-91-animal-plant-diseases-march-2016/), which I would commend to the reader.

In our awareness of the potential impact that complaints can have on subjects, we tread a fine line between allowing for a fair, transparent and open channel for recourse, and weighing that against the value of scrutinising our members and laying them bare to the criticism of others.

We have found that, in the vast majority of cases where complaints are raised against members by others in the profession, there is validity. However, by contrast, where complaints are raised by members of the public against members, there is often less validity. And so as a committee we have considered whether there is a way in which we could reduce the number of spurious or disingenuous complaints from members of the public, with a view to preventing unnecessary stress and anxiety for our membership.

It would be easy to assume that many of the complaints raised by members of the public are done so for devious purposes. However, this is not always the case, and we cannot base decisions about complaints on assumptions. Essentially we must, to a degree, remain 'motivation blind' when we are assessing complaints. Maintaining objectivity is vital to any judicial process. The only bar that we in PSC can judge against, is whether there is sufficient evidence to warrant further investigation.

The planning process is often controversial, and for many members of the public it will be the first, or only time they meet our profession. Not being expert's means that they are not always in a position to critically evaluate our professional judgement, but they will still have opinions and sometimes feel compelled to challenge when they don't fully understand our position, think that we are wrong, or have acted inappropriately. So, sometimes the challenge may be misguided, or ill-informed, but it may not be disingenuous. And we should also recognise the value in having people out there who feel so passionately about defending local resources – which is often the root cause of a complaint.

Of course, it is true that some complaints may be disingenuous in their intent, but we are confident that, in cases where this is true, they will be weeded out by our process. However, it is also true to say that by the time a case reaches the stage of a Preliminary Investigation Panel (where such weeding takes place), a member could already have been subject to significant personal impacts.

Whilst many complaints relating to live planning matters raised by the public against our members are not upheld (and the evidence bears this out), we have not been able to identify any simple revision to our processes that would enable a proportionate mitigation of the risk of disingenuous complaints. We also feel strongly that we need to maintain a transparent complaints process that is open all. And, whilst they may not always be upheld, these complaints can allow us to better track common issues that result from the interface of our profession and the public at large, which has further value in helping us to direct other strategies to improve professional standards.

But, we do recognise the risks this may present for those involved, and we have a duty of care to our members, which we take very seriously. So, we want to reassure you, as fellow members that whilst our processes remain unchanged, here's what we are doing, and will continue to do:

- We are updating our public facing documents to further emphasise to potential complainants that we will not tolerate abuses of our complaints process, in particular where this is done for the purposes of frustrating the planning system.
- We will support any subject throughout the complaints process by keeping them informed, and by providing them with resources to support well-being management.
- We will continue to maintain the high standards of scrutiny and objectivity that we are proud of in the Professional Standards Committee, and will ensure that our Preliminary Investigation Panels continue to weed out spurious or disingenuous complaints.
- We will continue to monitor trends and use these to inform any future reviews of our processes.

How we are viewed by the public is a responsibility that we all share. Whilst our interactions will perhaps invariably result in some differences of opinion, they also present an invaluable opportunity to showcase the work of our profession. We all play a part in reducing the complaints that we receive, through the everyday actions we take – and through careful application and description of our professional judgement. But please know that, in the event that a complaint is raised, we never treat it lightly, we always respect those involved, and we always look for the learning points.

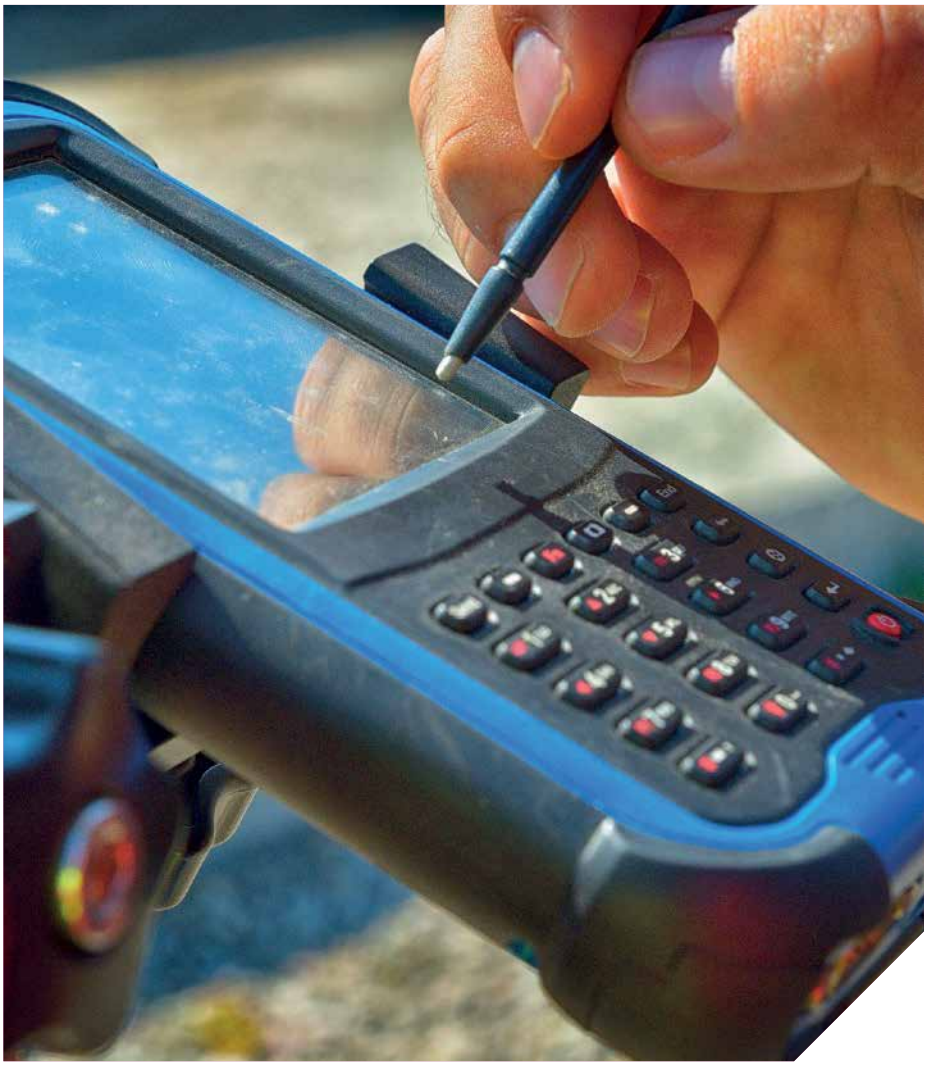
About the Author

Ellie Strike BSc MSc CEnv MCIEEM is Co-Chair of CIEEM's Professional Standards Committee. She works as a Senior Advisor in the Chief Executives Directorate of the Environment Agency. In this role she manages a number of work-streams supporting reputational risk management. This includes the handling of complex requests for information and complaints, the running of their Executive Correspondence Unit, handling of ombudsman cases, and managing the part of their incident response structure that scales up in major incidents to provide support to Executive Directors Team, Ministers and Government. Her team is also now leading on the Environment Agency's preparedness for the complaints and enforcement functions of the Office for Environmental Protection, when it comes into being.

Update on The UK Habitat Classification

Bob Edmonds CEnv MCIEEM
Director, UKHab Ltd and Technical Director, SLR Consulting Ltd

Action to reverse biodiversity declines through sustainable land management is more pressing than ever. Monitoring change in ecosystems and biodiversity is essential to evaluate national policies on Biodiversity Net Gain and climate change. Access to consistently classified, comprehensive habitat data is fundamental to underpin this, as well as support comparisons at other geographic scales. UKHab (www.ukhab.org) is a free-to-use, unified and comprehensive classification system for all terrestrial, freshwater and coastal habitats in the UK. Launched in 2018, it is now the foundation of many biodiversity conservation initiatives in the UK and is becoming widely applied by our community of ecologists and environmental practitioners.



UKHab integrates with all major habitat classifications. Its architecture – a primary habitat hierarchy with supporting secondary codes – makes it a particularly powerful tool for integrating satellite- and field-data into ecological impact assessment, biodiversity metrics, natural capital accounts and ecosystem service assessments. UKHab is proposed as the base classification for habitat units in Biodiversity Metric 2.0 (Treweek, Butcher and Temple, 2010; Defra, 2012; and Natural England, 2019). UKHab data will therefore become integral to the planning, design and implementation of projects seeking to achieve Biodiversity Net Gain, due to become mandatory in England through the Environment Bill, currently on passage through Parliament. UKHab also translates well into NatureScot's EUNIS-based classification for terrestrial habitats and, uniquely, provides a stand-alone Green Infrastructure Typology designed specifically for surveying urban areas.

UKHab v1.1

In September 2020, a new minor update to UKHab was launched with a small number of additions, including the remaining four rare Annex 1 habitats missing from version v1.0. Further changes were made to improve the classification of farmed landscapes to support natural capital assessments and agri-environment planning, for example through Defra's

Environmental Land Management (ELM) scheme and Glastir in Wales. Other codes were added in response to practitioner feedback. The Habitat Field Key (published alongside UKHab) was also updated following comments from users with more steps to common woodland types and changes to the layout.

In September 2020, UKHab migrated to a new website, www.ukhab.org. This new site makes available all the UKHab classification documents, alongside updated FAQs and details of training courses offered by UKHab Ltd. UKHab has updated and clarified its End User Licence Agreements. All users of UKHab are encouraged to visit the website and download the new version and to keep in touch about future updates.

UKHab Training

UKHab uses UKBAP Broad and Priority Habitats and Annex 1 habitats within the main classification, so many experienced ecologists will recognise individual elements. However, undertaking formal training will help people understand the power of the new system and is likely to reduce risks of mis-classification and inter-observer error. CIEEM and UKHab Ltd are running a series of Zoom-based remote training courses through 2021 and hope to move to classroom and field-based courses as soon as possible. More courses will be timetabled through 2021 if demand is high.

UKHab 2021 v2.0

A more significant update is planned for 2021 to address further user-feedback and ensure that UKHab is fully compatible with other systems. We are also exploring the development of a specialist edition to assist in classification of agricultural land. We would encourage users to contact UKHab during 2021 with any feedback on the system to ensure this update captures your experiences.

Feedback from UKHab training:

"Great training session… Brains fired-up and we're going to use this technique more and more." Richard Gowing CEnv MCIEEM, Associate Director, WSP

"Great course thanks!" Louise Mapstone CEcol CEnv MCIEEM, Ecologist and Biodiversity Net Gain Advisor, Warwickshire and Buckinghamshire County Council

Table 1. UKHab Training Courses through CIEEM and UKHab Ltd in 2021.

Dates	Course title	Provider
13-14 January 2021	UK Habitat Classification for Practitioners	UKHab Ltd
21-22 January 2021	UK Habitat Classification for Practitioners	CIEEM
28-29 January 2021	UKHab & BNG	UKHab Ltd
10-11 February 2021	An introduction to UKHab	UKHab Ltd
5-6 March 2021	UK Habitat Classification for Practitioners	UKHab Ltd
25-26 March 2021	Introduction to UKHab	CIEEM
29-30 April 2021	UK Habitat Classification for Practitioners	UKHab Ltd
18-19 May 2021	An introduction to UKHab	UKHab Ltd
10-11 June 2021	UK Habitat Classification for Practitioners	UKHab Ltd
8-9 July 2021	UK Habitat Classification for Practitioners	CIEEM

About the Authors

Bob Edmonds is a Director of UKHab Ltd and a Technical Director at SLR Consulting Ltd.

UKHab Ltd is an independent, not-for-profit organisation established to promote, maintain and update the UK Habitat Classification and provide support and training to users. The Directors of UKHab Ltd are Bill Butcher, Peter Carey, Bob Edmonds, Lisa Norton and Jo Treweek. UKHab can be contacted on info@ukhab.org.

Ethical Dilemmas

This is our series of problems and conundrums that can face members during their professional practice. The purpose of the feature is to encourage you to reflect on and explore scenarios that you may face during the course of your work and to consider the appropriate ways to respond to ensure compliance with the *Code of Professional Conduct*.

In the September 2020 issue of *In Practice* we described a dilemma in which you are an ecological consultant. In 2019 you were asked by a property developer to carry out a Preliminary Ecological Appraisal (PEA) of a small plot of land including a barn which would be demolished as part of the proposals. You completed the PEA which included an assessment of the exterior of the barn but no internal inspection (access was not available). Your PEA Report included, amongst other things, a recommendation for a bat survey of the barn, including an internal inspection followed up with dusk emergence and/or dawn re-entry surveys, if needed.

The client subsequently commissioned you to do an internal inspection of the barn to search for evidence of bats, during which you found bat droppings, including both fresh and old droppings. The droppings, their distribution within the barn, and the number of them recorded, were consistent with use of the building as a roost by a single brown long-eared bat (or small numbers of brown long-eared bat). However, during the internal inspection you also noted that there was a partitioned off area of roof void which could not be accessed to search it, but could nevertheless be accessed and used by bats for roosting. The status and level of use of the building could therefore not be confirmed without dusk and/or dawn surveys.

Before writing your report you phoned the client, as promised, to inform them of your findings and to confirm the need for dusk and/or dawn surveys. The client asked you not to produce a report or do any further surveys, as the project was going on hold. You accepted this instruction and simply filed away the field notes for when the project was re-started.

Approximately 12 months later the client contacts one of your colleagues and asks them to make a minor amendment to the PEA Report and re-issue it. You are suspicious about the client's motives for this, so you undertake a search for planning applications on the local authority website and find that an application has been submitted for the site, including demolition of the barn. Your PEA Report has been submitted with the application along with a bat survey report produced by another ecological consultancy. You read the bat survey report and find that no evidence of bats was recorded during an inspection, which took place only six weeks after yours, and that no dusk or dawn surveys were carried out. The bat survey report concludes that the barn is of negligible potential for bats, and that demolition can proceed without constraint in relation to bats.

You are concerned that planning permission will be granted without adequate assessment of the barn's status as a bat roost, and that a bat roost will be destroyed without any mitigation or licence. However, you are also concerned that you might breach client confidentiality if you report the findings of your 2019 survey.

What do you do?

Is there anything you could have done differently, which would have helped improve your position in this scenario?

The response to this situation needs to be multi-pronged.

First check your terms and conditions (you should have had a formal contract with the client) and check what the confidentiality agreement says. If you have an agreement that permits sharing of records, or does not refuse the sharing of records, then if you haven't already submitted them, do so immediately. As a member of CIEEM you are expected to share data unless restricted from doing so, so this provides justification for your action. You should have done this anyway under the terms of an European Protected Species (EPS) survey licence (including Natural England's Class Licence) although this may have been directly to the Statutory Nature Conservation Body rather than to a Local Environmental Records Centre (LERC). Data submission protocols can differ across the UK and Ireland.

You should also contact the client. Do not assume that their motives were to bury your bat survey report – they may not have been, it may have been an accident. Even if it wasn't an accident, if you approach the conversation with an open mind the end result is likely to be better. This also gives you the opportunity to (in a non-confrontational way) make them aware that they would still be committing an offence and that you are keeping an eye on things. You do not have to mention that you have seen the more recent report, you can be just 'following up' on a project. If you don't feel able to have this conversation in a non-confrontational way then it would perhaps be best avoided and move on to the next step.

The outcome of the conversation with the client will inform what you do next. It would probably now be appropriate to contact the consultant who did the bat survey. There may be reasons why they did not recommend further surveys. Perhaps the barn had been swept clean and the partitioned off area opened up or hidden. Again, do not assume they were simply negligent or acted unethically. If they have been misled then they should understand the consequences and act quickly to resolve this. You may feel after this conversation that you do not need to do anything else.

It might be worth an off-the-record call to the Local Planning Authority's (LPA) ecologist – if they have one – or someone else with suitable influence (e.g. the local Bat Group). This will obviously be helped

if you've submitted your records to the LERC as you are then just highlighting information that the LPA and other stakeholder groups have access to, rather than telling them something which they couldn't have got from anyone other than you. The LPA may ask you to make a formal response to the planning application consultation, but can agree to redact your details.

Hopefully the above options will result in the right outcome for the bats. If these don't end in successful resolution, you will need to consider whether you need to monitor the situation more closely. Should you have evidence that a wildlife crime has occurred/is likely to occur you have a professional duty to report it using the appropriate channels (e.g. National Wildlife Crime in the UK, NPWS in Ireland) and the LPA.

If you feel that the other consultant may have been negligent and/or acted unethically, and they are a CIEEM member, then you should consider making a complaint to CIEEM.

Finally, how could this be avoided in future? You could improve your position in such a scenario by ensuring that you have a formal understanding with your client, and that those terms and conditions include an agreement stating that you will be submitting any records to the LERC.

So, now for this issue's dilemma.

A very experienced senior ECoW has provided written advice to inform an innovative and non-standard method statement with the main contractor on a construction site. The method statement is intended to address an almost unique situation. In an email exchange, it has been agreed these works will be undertaken while the senior ECoW is away on holiday but supervised by one of her experienced ECoW colleagues. At the last minute, a less experienced ECoW, who has never previously visited the site, is sent to site to observe the works, because the intended ECoW who would have provided holiday cover has had to take time off due to illness.

When works commence on site, the less experienced ECoW is worried that the method statement is not consistent with published good practice and they advise the contractor's team on site to stop immediately. There is no written evidence that the senior ECoW actually approved the final method statement that is being used.

The contractor is insistent that works should recommence immediately, on the basis that they are working to an 'agreed' method statement, or they will ask for the less experienced ECoW to be taken off of the project on the grounds of incompetence. The less experienced ECoW is very concerned that the method statement is unsound and if implemented may result in a wildlife crime. He is unsure what to do and concerned about the implications for the biodiversity interest and their own position.

What would you do and what information would you require to inform your decision?

Complaints Update

Breaches of the *Code of Professional Conduct*

At a professional conduct hearing held on 12 August 2020, Mrs Sue Searle MCIEEM was found in breach of clauses 2, 3, 4, and 5 of the *Code of Professional Conduct* in respect of bat survey, assessment and reporting. Mrs Searle has been reprimanded.

Following review of the outcomes of a professional conduct hearing held on 15 October 2019, Mr Andrew Gardner of EnviroTech has been excluded from membership of the Institute and his entitlement to use the award of Chartered Environmentalist has been removed. Should he wish to do so, Mr Gardner can reapply to rejoin the Institute upon satisfactory proof of competence for the grade of membership applied for.

PROFESSIONAL & PERSONAL SUPPORT FOR MEMBERS

MENTORING

Looking to identify the next steps in your career?

Need support in upgrading your membership or applying for Chartership?

Register your development needs online to be matched with a volunteer mentor that can help.

Why not become a mentor and give something back to your profession? You may learn something too, and it counts as CPD!

MEMBER ASSISTANCE PROGRAMME

A library of online resources and guidance, and practical advice on topics such as debt, legal and tax issues, as well as family care and support, is freely available to CIEEM members and their dependants. In these challenging times, you can also use a free, confidential telephone adviceline to explore your worries and concerns with a trained counsellor who will guide you towards realistic positive solutions which work for you.

Access all this support through the members page of the website

www.cieem.net

CIEEM Chartered Institute of Ecology and Environmental Management

Policy Activities Update

Amber Connett GradCIEEM
Policy and Communications Officer, CIEEM

We continue to update and review our COVID-19 advice and information webpages (www.cieem.net/covid-19) as circumstances change and have expanded information on mental health well-being as we move into the winter months.

There has been a lot of recent focus on a Green Recovery and we have published a statement on what we want a Green Recovery to look like (https://cieem.net/building-back-better/). We also teamed up with our fellow Environmental Policy Forum members to issue a joint statement on what we think a Sustainable Recovery looks like (https://www.envpolicyforum.org.uk/our-work).

UK and England

At the time of writing, the All-Party Parliamentary Group for Nature is planning a virtual 'parliamentary roundtable' event on Nature-based solutions (NbS) to be jointly hosted with the RSPB. Speakers will present the latest research in NbS, followed by a wider discussion amongst parliamentarians about what is needed in the run up to COP26 in November 2021. The event is provisionally planned for 27 November 2020.

We have responded to several England-based consultations in recent months, including England's Tree Strategy (DEFRA) and on proposed planning reforms (MHCLG). We have also responded to the Environmental Audit Committee's inquiry on Biodiversity and Ecosystems which applied to the whole of the UK.

We have recently begun work on Environmental Net Gain by setting up a task group of members who are working on a briefing paper and principles for implementation.

Scotland

In September, we held a joint 'Pie and a Pint' event with the British Ecological Society's Scottish Policy Group on 'Opportunities for Implementing Biodiversity Net Gain in Scotland' – see page 68 for more details.

At the time of writing, the Scotland Policy Group are finalising a follow up briefing to the *Biodiversity Net Gain in Scotland* briefing paper (https://cieem.net/resource/biodiversity-net-gain-in-scotland-briefing/) on implementation for local authorities.

The Scottish policy group has responded to consultations including the ECCLR Committee's call for views on a Green Recovery and the ECCLR call for views on the UK Withdrawal from The European Union (Continuity) (Scotland) Bill in regards to environmental governance post-Brexit, and is working on the Scottish draft infrastructure investment plan consultation.

Wales

The Wales Policy Group and Welsh Section Committee have started working with Welsh Government to create a good practice guidance document on achieving net benefit within development planning.

Our Wales Policy Group has been working on several consultation responses, including on Barriers to the Successful Implementation of the Well-Being of Future Generations Act (CCERA) and Changes to Guidance for Assessing the Impact of Ammonia and Nitrogen from Agricultural Developments (NRW).

In addition, the group has been reviewing Area Statements with the view to providing feedback and facilitating future engagement with NRW, as well as pulling together some key issues we would like all political parties to consider within their manifestos in advance of Senedd elections in May 2021.

A recording of the Jane Davidson and Tony Juniper webinar on Jane's new book – *#FutureGen: Lessons from a small country* – and the implications for nature, is available online (https://cieem.net/resource/futuregen-and-nature-in-conversation-with-jane-davidson-and-tony-juniper/).

Ireland

Our Ireland Policy Group held a workshop on 'Critical Thinking for Pollinator Actions' on 17 November as part of our action for the All-Ireland Pollinator Plan. This involved discussions on the role of ecologists and landscape architects, issues and solutions in meadow creation, and experiences of wildflower creation on road projects. The group has also submitted a response to the public consultation on the Draft Prioritised Action Framework for Ireland 2021-2027 run by the National Parks and Wildlife Service.

Our Vice President (Ireland), Will Woodrow, recently wrote to newly appointed Ministers in the Republic of Ireland to introduce CIEEM and request a meeting to discuss the climate emergency and biodiversity crisis.

Future Priorities

Over the coming months, we will be focusing on our priority policy areas, including ensuring a green recovery, Biodiversity and Environmental Net Gains, agriculture arrangements following Brexit, and next year's COP15 and COP26 events. Brexit will be a particularly important area over the winter due to the risks of governance gaps caused by delays in the Environment Bill's parliamentary journey. Our Country Policy Groups will also be meeting in the new year to discuss priorities and actions for 2021.

Please note all of our briefings and consultation responses can be found at our Resource Hub (https://cieem.net/resources-hub/) under 'Policy Resources'.

Contact Amber at:
AmberConnett@cieem.net

CIEEM is grateful to the following organisations for investing in our policy engagement activities:

ARCADIS Design & Consultancy for natural and built assets
RSK biocensus EXPERTS IN ECOLOGY
EPR
Stantec

Obituary: Georgina Mace

Professor Jon Bridle and Professor Kate Jones
Centre for Biodiversity and Environment Research, University College London

Professor Dame Georgina Mace CBE (12 July 1953 – 19 September 2020) revolutionised how we measure ongoing rapid biodiversity loss, and how we predict and prevent its consequences for people and the planet. Her efforts helped transform conservation biology into a science that systematically compares patterns of biodiversity loss across species and ecosystems, beyond popular focus on the plight of a few well-known and well-loved species.

Georgina championed the idea that our well-being depends on protecting biodiversity, and that we cannot continue to accept its loss as somehow necessary for progress. Her enormous impact can be found in every corner of conservation biology, and in the connections between nature and social justice that she helped cement into policy. Her influence will continue to grow through the unfailingly generous support and time that Georgina gave to generations of scientists and colleagues throughout her distinguished career.

Born in London in 1953, Georgina studied zoology at the University of Liverpool before completing a PhD at the University of Sussex, researching the evolutionary ecology of mammals under the supervision of evolutionary biologist Paul Harvey. Following a number of postdoctoral positions, including with leading mammologist John Eisenberg at the Smithsonian Institution in Washington DC, Georgina joined the Zoological Society of London (ZSL) in 1986, working first for the Zoo Federation (the precursor of the British and Irish Association of Zoos and Aquariums) and then at the Institute of Zoology.

Predicting extinction risk

In the late 1980s, Georgina's research in understanding factors determining the viability of small populations caught the attention of the International Union for Conservation of Nature (IUCN). For the next few years, she worked with them to create scientific and defensible criteria for inclusion of species on IUCN's *Red List of Threatened Species*.

Georgina was one of the first scientists to show that a species' extinction risk can be predicted based on a few key ecological characteristics, its evolutionary history and the rate at which its populations can grow, even when its actual status in the wild is unknown. For the first time, her approach identified species that were dangerously overexploited, such as the Atlantic cod, whose rapid population declines signalled high extinction risk despite having none of the life history traits usually associated with endangered species.

Georgina also realised that many of the same factors that increase species' extinction risk also affect their rates of evolution by natural selection, and therefore how quickly populations can adapt to future environmental change. This insight threw dramatic light on the importance of biological diversity within populations, and across the habitats where species live. Conservation needs to protect common as well as rare species, and the interactions they have with each other that are fundamental to how ecological communities function. With this in mind, Georgina embraced the emergence of novel ecological and genomic technologies that allow exploration of more biological communities, especially in less well-studied ecosystems such as the soil and the open ocean.

Opportunities for action

The IUCN Red List, created using Georgina's new criteria, exposed perilously high levels of extinction risk for thousands

of species and their habitats, led the United Nation's Convention on Biological Diversity in 2002 to commit to significantly reduce the rate of biodiversity loss by 2010. In 2005, Georgina led the biodiversity component of the UN's Millennium Ecosystem Assessment (MEA) to quantify this rate of biodiversity loss, and to decide where conservation efforts should be best targeted, especially given the added threat of impending and rapid climate change.

Identifying the opportunity for action was key to how Georgina worked: she knew that change happens when people feel powerful rather than helpless in the face of huge challenges. Instead of grieving for the habitats and species already lost, she would continually emphasise the benefits to nature and to our own humanity if we work together to protect the biodiversity that remains.

In 2000, as ZSL's Director of Science and Head of the Institute of Zoology, Georgina influenced the design of many of the science-based indicators of species' global status and trends in ecosystems used to measure progress towards meeting international biodiversity targets. These included the Red List Index (RLI), which quantifies changes in the level of extinction risk from repeated Red List assessments, and the Living Planet Index (LPI; developed with WWF), which reports abundance trends across the populations of more than 4,000 vertebrate species.

Natural capital drives policy-making

By 2010, the signal from these global indicators was that biodiversity was in catastrophic decline, a trend that has continued largely unabated. For example, the latest WWF *Living Planet Report* (2020) reveals average declines in LPI of 68% in the past 50 years, and of more than 90% in some organisms and habitats, especially in the tropics. Such data made it clear that the CBD targets set in 2002 would not be met. Recognising the need for economies to properly value biodiversity as 'natural capital', Georgina began to move increasingly between disciplines and across science-policy boundaries, working to convince governments everywhere that biodiversity is the fundamental resource on which all economic activity, health and well-being depends.

After more than two decades at ZSL, where her leadership reshaped the role of science in determining conservation policy, Georgina moved to Imperial College London in 2006 as the Director of the Centre for Population Biology. There she continued to work on the scientific questions that interested her most. At the same time, she helped galvanise the UK's commitment to end ecosystem degradation through her work on its National Ecosystem Assessment.

She used her characteristic acuity to develop a natural capital framework that directly brought the environment into conventional economic decision-making. Her actions led to the UK government's explicit acknowledgement that addressing natural capital decline was first and foremost an economic problem. An Environment White Paper followed in 2011, committing to reverse the decline in the state of the environment. The world's first Natural Capital Committee (NCC) was then established in 2012, with Georgina as a founding member, aiming to place environmental policy at the heart of UK government.

On the NCC's recommendation, a national 25 Year Environment Plan was devised and published in 2018 and included many policy innovations. Its principles – themselves so central to Georgina's commitment to recognising the real economic value of biodiversity – underpin the Agriculture and Environment Bills currently passing through UK Parliament.

In 2012, Georgina moved from Imperial College to University College London (UCL) to become the founding director of a new institute – the Centre for Biodiversity and Environment Research (CBER). Georgina shaped and guided the Centre's research agenda, and nurtured a deeply collaborative and supportive working environment that remains central to life at CBER. Georgina's interests also resonated with research across UCL in the way it linked nature to global health, economy and society. Indeed, one of her last publications explored how post-COVID-19 recovery could provide a unique opportunity for the fundamental shift in how we think and organise our economies that is so urgently needed for planetary survival.

A friend, a mentor and a citizen

Georgina received countless international awards, honours and appointments. From the UK alone, these included Fellow of the Royal Society (2002) and Dame Commander of the British Empire (2016). She was awarded the CIEEM Medal in 2018. Beyond these honours however, the vast number of tributes to Georgina on social media are testament to her influence on the lives and careers of thousands of scientists, conservationists, policy-makers and citizens throughout the world.

She had a special ability to communicate across vast intellectual areas with immense scientific rigour, while nurturing and amplifying other voices. Her love of biodiversity seemed indivisible from her commitment to encouraging diverse views in discussions and in government, and her energy in bringing together those who could learn from each other.

Just as importantly, Georgina's candour and kindness meant one felt as comfortable sharing disappointments and uncertainties with her as successes and revelations. She always saved her words for important and constructive contributions, and inspired others to live up to the example she set as a scientist, a friend, a mentor and as a citizen.

Georgina's huge achievements helped to reveal the ecological emergency that we face, and that we have less than a decade to prevent. However, perhaps her most remarkable achievement was the way she could calmly convince an audience of this fact, while expressing an unwavering optimism that we still have time to forge a more creative interaction with the rest of nature, one that benefits more than a wealthy minority, and one that can last more than just a few more decades. We very much hope that her faith in our humanity was justified.

Georgina is survived by her husband Rod, her children Kate, Emma and Ben and granddaughter Harriet Georgina.

Our Work on Equality, Diversity and Inclusion

Diana Clark MCIEEM
Project Officer (Wales), CIEEM

Many of you will have already picked up on some of our Equality, Diversity and Inclusion (EDI) work via our blog post published in August (https://cieem.net/we-need-to-talk-about-diversity/). As discussed in that article, we are committed to doing the work in the long-term and working hard to creating change, no matter how challenging that may be. So, several months on, how have we continued that work?

Since August, our internal Diversity Working Group has actioned a number of tasks, the most significant of which is starting to engage with the Diversity and Inclusion Progression Framework (https://sciencecouncil.org/professional-bodies/diversity-equality-and-inclusion/diversity-framework/). This is an initiative set up by the Science Council and the Royal Academy of Engineering to help professional bodies assess and monitor their progress on diversity and inclusion. It *"centres on identifying diversity and inclusion practice in relation to eight functions common to professional bodies"* and *"gives professional bodies the opportunity to assess each of these functions against a four-level maturing mode"*. The aim of the progression framework is to support discussion, initiation, planning and assessment of diversity and inclusion work.

CIEEM is starting out at or close to the bottom of the four-level maturing model across most of the eight functions, and whilst this is not a surprise to us, it is important to openly acknowledge where we are right now. For example, in relation to meetings, conferences and events, we already consider venue accessibility (level 1 of the framework) as well as proactively communicating this to participants (level 2). However, in relation to membership and professional registration, we do not currently gather any data on the demographics of members – which doesn't even allow us to meet level 1 criteria.

As noted in the framework, *"getting into the habit of gathering and recording quantitative data is important for organisations wanting to make progress on diversity and inclusion"*. If we do not know the current situation and we are not recording future changes, there is no way of knowing if we have improved or not. The framework helps us to understand where we need to improve, what that – and outcomes – should look like, and to challenge and hold us to account. It will also help us to develop an action plan for making those changes.

Over the last few months we have been focusing on data collection. We are currently exploring ways to sensitively collect data on protected characteristics and other areas of diversity. To start, we will be asking members to complete a short survey regarding your experiences as ecologists and environmental managers in relation to EDI. We are currently developing this survey, so look out for it soon and please engage with it as much as you can. It will really help us to gain a better understanding of the diversity and experiences of our members, rather than our current perceptions which are currently ad hoc and anecdotal.

Longer-term, we also want to collect data on our members for ongoing monitoring purposes. This would of course be entirely voluntary, anonymous and confidential, with participation offered as standard to all existing and new members. We will communicate more on this in due course.

There has been a significant increase in interest in EDI issues over the past year, and we are aware that many environmental organisations are looking at how they can improve. One outcome of this is that it is a great opportunity for organisations to share their thoughts, concerns, issues, plans and actions with each other. Our CEO, Sally Hayns, has been engaging with other organisations working on change and also with those already using the progression framework. This is a challenging but incredibly important area of work for us, and we feel it is essential to both seek and provide support to others wherever we can. EDI issues are sector-wide and are likely to improve only when we all work together.

On collaborative working, we are also looking to expand our Diversity Working Group. The group currently only involves Sally Hayns, Siân Kear, Jason Reeves and myself, all members of the Secretariat, and (you may have noticed) not as diverse as we would like. We are still working out the details of extending this group, but in principle we would like to include people from the membership who have EDI experience, either first-hand or in supporting those who have. Do look out for an invitation in due course, and please do get in touch if you have any thoughts, comments or suggestions for us.

Contact Di at:
DianaClark@cieem.net

Your Career and Membership Journey

Sarah Cox
Membership Operations Manager, CIEEM

Whatever stage of your career you have reached when you first join CIEEM, there is always the option to progress through the membership grades. Whether you join as a Student member and work your way up through our grades, or as a Full member later on in your career, there are still ways to acknowledge and demonstrate your growing knowledge, skillset and expertise.

Why should you bother upgrading your membership?

We want members to consider their membership as a journey and we have a number of tools available to assist you with your ongoing professional development. Taking some time to sit back and reflect on your achievements can sometimes be hard to do, but it is important to ensure you celebrate the successes and gain recognition for what you have achieved. We encourage you to be at a grade of membership that best reflects your abilities and which will provide you with the increased recognition your experience deserves, both within the sector and amongst your peers. That is why upgrading your membership is so important. By doing so you will show others – whether it be colleagues, clients or stakeholders – that you have the skillset and competence required to undertake increasingly complex projects and activities. Moving up to the next level is what every member should be aspiring to so that their achievements and ability are recognised. At higher membership grades you have the chance to give something back to the sector, by influencing policy and standards, volunteering on one of our standing committees or acting as a mentor to those just starting out on their professional journey. You also have the opportunity to become Chartered or a Fellow of the Institute.

How can we help you with the upgrade process?

There are lots of tools available to support you along the way. The Competency Framework self-assessment tool, available on the CIEEM website, gives you the option to regularly review your competence in different skill areas, helping to inform a professional development plan. You can create and keep track of this plan within the online CPD tool and the extensive training programme (which is currently being delivered remotely where possible) can help you to gain the missing knowledge and expertise you have identified. There is also the mentoring platform that you can make use of to gain advice and coaching on different topics from others working in the sector who are ready and willing to support members wanting to progress their careers.

What do you need to do?

So, how do you actually go about upgrading? For members wanting to upgrade to Qualifying, Associate or Full grades, guidance information and application forms can be found within the online portal under 'Upgrade your membership' in the member only section of the website. We will be looking at delivering some dedicated upgrade webinars in the new year so please keep an eye out for more details about these. Those members wanting to apply for Chartered status can find more information on the Membership pages of the main website. We have been working hard over the last six months to align processes as much as possible across all membership grades, and we have now removed all deadlines associated with Chartership applications.

Finally, if you have by now made a significant contribution to the profession, you could consider applying for Fellowship. We now have two routes via which you can do so – self-nomination or peer-nomination – and more information about both processes is available on the Membership pages of the website.

More information

I would lastly like to finish with a few facts about the application process which you may not be aware of:

- All applications to Associate level or above are assessed by members. We have a dedicated and very hard-working pool of volunteer assessors who review all applications to Associate, Full, Chartered status and Fellow.
- Whatever grade you are applying for there is no need to wait for a submission deadline or the end of our subscription year, just submit your application to us as soon as you have it ready.
- The Membership team is here to support you at every step of your membership journey and we are very happy to answer questions or chat through options with you. Please do get in touch with us if we can help you on your membership journey with us.

Contact the CIEEM Membership Team at: membership@cieem.net

CIEEM Welcomes New Fellows

Fellows are role models and ambassadors for CIEEM, inspiring others and often having a strong track record of having given back to the profession. They are highly respected and have reached a demonstrable level of professional excellence within the disciplines of ecology and/or environmental management. CIEEM's Fellows help to shape and set the strategic direction of our Institute and more widely through their professional careers and varied roles. Fellowship matters, both to the individual and the Institute.

Six members have been awarded Fellowship of the Institute in the past six months and that that is worth celebrating. So here they are, in alphabetical order:

Dr Caroline Chapman FCIEEM

Caroline is a widely respected and influential practitioner in the application of the Habitats Regulations Assessment (HRA) process. Her career has included working for the Environment Agency (EA), Natural England (NE), David Tyldesley and Associates (DTA), and now as Director of DTA Ecology Ltd.

Whilst with NE, Caroline was responsible for relevant joint EA-NE HRA guidance which included overseeing the development of procedural, technical and policy guidance to staff, advising on assessments requirements at individual sites, resolving difficult casework in consultation with specialists and local staff, and providing support and management to Regional Officers. The role included supervision and steering of research programmes for developing standards and assessment criteria appropriate to HRA. Caroline was lead author of NE's guidance on the site integrity concept.

At DTA she continued to provide advice to the statutory agencies (SNCBs), local planning authorities and other competent authorities. She led work on ground-breaking HRA cases including a new airfield, port-related, and energy generation developments. She is the co-author (with David Tyldesley FCIEEM) of the *Habitats Regulations Assessment Handbook and the co-editor of the Habitats Regulations Assessment Journal.*

Along with work on HRA, she has continued to develop her expertise on the complex issue of air quality assessment in the HRA process and beyond.

Dr Stephen Gibson CEnv FCIEEM

Stephen has influenced policy and legislation development and execution in domestic and international theatres, through ecological, political, partnership and leadership expertise in a devolved political landscape. Between 2011 and 2019 he led the Joint Nature Conservation Committee (JNCC) as a Science Director and Executive Board member. He ensured that the JNCC Executive and the Non-Executive Board influenced and were effective in conservation across the UK, offshore, Europe and internationally. He was extensively engaged in JNCC's evidence work across marine and terrestrial environments, innovating and responding to challenges, ensuring the quality of JNCC's science, developing a specialist staff across several disciplines, and constantly building and renewing relationships.

In 10 years as a science-for-policy advisor working in the EU, Europe and internationally, he provided scientific advice and influence on policies developing in the Council of Europe through the Bern Convention, internationally in the Convention on Biological Diversity and the Convention on the Conservation of Migratory Species, and in the EU by advising the European Commission (EC). As a member of International Treaty delegations, he ensured high quality natural science advice was central to the UK's engagement with the treaties and other parties, on subjects such as invasive non-native species, Global Plant Strategy and removal of perverse incentives. He also established a SNCB office in Brussels and led engagement with the EC through that office, establishing a strong reputation for the four country conservation bodies as a trusted and respected advisor.

Stephen also has over 15 years' experience developing biodiversity monitoring and evidence in the terrestrial and marine environments. Highlights include being the responsible scientist for completing the Terrestrial Mammal Monitoring Programmes and for developing the Bat Monitoring Programme; both remain part of the UK's long-term monitoring portfolio.

Gordon Haycock CEcol CEnv FCIEEM

Gordon is a highly respected ecologist, well known by his peers throughout Yorkshire and Humberside. He is an authoritative botanist and bryologist at the forefront of developing upland vegetation communities mapping using remote-sensing techniques.

As Chair of the Yorkshire Dales Biodiversity Forum, Gordon has guided Biodiversity Action Plan development and advocated for landscape-scale conservation initiatives. His work has helped to develop biodiversity policy and practice for upland habitats. His feedback on assessment protocol and definition of priority habitats and identification of protocol flaws has led to improvements in the assessment of Priority Habitats in the Yorkshire Dales.

Gordon gives his time generously to others. He has frequently led workshops for planning officers, developers, agents and

consultant ecologists to enhance the quality of ecological information submitted with planning applications to the Yorkshire Dales National Park Authority. He has trained NE staff in field identification and leads specialist bryophyte recording events.

Gordon founded the Yorkshire and Humber CIEEM shadow-Section in 2007 and was Convenor until 2015, contributing to an active and inclusive Committee.

Dr Dorian Latham CEnv FCIEEM

Dorian has over 30 years' experience in environmental consultancy, with the EA, and in ecological research. He is currently Technical Director at JBA Consulting.

Dorian has been at the forefront of innovation and application of practical ecological principles and knowledge in mitigation development. For example, the Morpeth Flood Alleviation Scheme, based on the river Wansbeck, is one of the best white-clawed crayfish rivers in the country. The scheme proposed an upstream storage that required construction of a large dam structure. Dorian developed a research programme with Durham University to consider the impact of the structure, monitoring the movements of crayfish through the culverts using radio-tracking and comparing the movement through an artificial culvert (20 m) and an existing culvert (270 m), demonstrating that there was no significant difference between movement through the culvert structures and the open natural watercourses.

Other notable schemes include the Greatham Managed Realignment where he was the project manager and lead designer for the construction of a scheme to create over 30 ha of inter-tidal and 20 ha of freshwater habitat to replace coastal habitat lost as part of its flood risk and coastal management programme. The inter-tidal area has developed over the last five years to attract a range of typical saltmarsh plants, large numbers of over-wintering birds and waders.

Dorian regularly teaches Environmental Impact Assessment at BSc and MSc levels and has mentored numerous junior ecologists and environmental scientists.

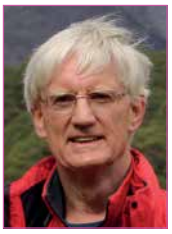
Paola Reason CEnv CEcol FCIEEM

Paola has been a practising ecologist for 30 years, beginning as a Research Assistant at Bristol University, and then co-founding an independent NGO working on Comoros fruit bats. In 1995 she joined Cresswell/Hyder/Arcadis (through successive acquisitions) as an ecological consultant, becoming a Technical Director in 2007. She recently joined RSK Biocensus as a Director.

She has since undertaken further bat research, most recently into the effects of noise, working with noise specialists to develop a methodology for assessing construction site noise impacts on bats using ultrasonic noise modelling.

Paola has provided training on bats for consultants and contributed, via a Technical Review Board, to all editions of the Bat Conservation Trust's *Bat Survey Guidelines*. She was on CIEEM's Bat Mitigation Research Project Advisory Group and is currently on the Steering Group for new guidance on bat mitigation (in development). She was appointed a member of NE's Bat Expert Panel in 2018.

Paola was the lead author of the Bats section of CIEEM's *Alternative Approaches to Ecological Assessment* guidance, produced to help CIEEM members adapt to COVID-19 restrictions. Paola is also actively involved in a major CIEEM project to develop new survey and mitigation standards.



Professor Chris Spray MBE FCIEEM

Chris is a Past-President of CIEEM, Emeritus Professor and part-time Senior Research Fellow at the University of Dundee. He is a highly respected ecologist with over 40 years of experience in water and wetland management, environmental regulation, the water industry, policy-making, academia and the NGO conservation sector, focusing on wetland ecosystems and natural resource management. His previous roles include Director of Science for the Scottish Environment Protection Agency, Director of Environment for Northumbrian Water Group, and Chair of Water Science & Policy at the UNESCO Centre for Water Law, Policy and Science, University of Dundee. Chris currently chairs the UK Government's Special Protection Area-Ramsar Scientific Working Group, which .

Chris is a recognised international expert on waterfowl (especially swans) ecology and conservation, and has played a pivotal role in the movement to remove lead from ammunition for wildfowling. He is a world leader in river restoration policy and good practice, having authored numerous international publications.

His research interests focus on wetland ecosystems, particularly how emerging research on wetland ecosystem services can be translated into policy, legislation and action. This includes bio-physical aspects such as flood risk management, water quality improvements, habitat restoration and conservation, as well as linked social systems. Much of the focus of his work is on the Tweed, a UNESCO HELP Basin on the Scottish-English border, working closely with the internationally acclaimed Tweed Forum.

Always willing to share his authoritative knowledge and expertise, particularly in relation to river restoration and integrated catchment management, he continues to make a significant contribution to the profession.

Student Hub:

Students and Early Careers

Coronavirus: Is this the Dawn of a New Age of Volunteering?

Whilst it may appear that the pandemic is closing doors to many volunteering opportunities (temporarily at least), others are now unlocked and are just waiting for you to find them!

Long breaks during student life are the ideal time to develop new skills, make like-minded friends, and create vital contacts in industry. There's no better way to do this than through volunteering! Opportunities to contribute to conservation and research projects abroad is extremely tempting, and many end up constructing idyllic plans for their 'best holiday ever', while protecting endangered species in the process. From tagging reef sharks in Fiji to surveying birdlife in the rainforests of Peru, it sounds incredible right? However, as wonderful as these experiences can be, can they set you apart from everyone else?

Coronavirus will have stunted many volunteering trips planned during student breaks in 2020. There is no doubt this is disappointing, however the reality is that trips like this are rarely enough to assist graduates onto the job ladder. Memories created will last a lifetime, but any skills developed and contacts gained will be niche! Additionally, these experiences can be short-lived (just few weeks), expensive and, understandably, very popular. This creates problems when it comes to job recruitment in the sector, as competition for roles is high and the quality of applicants can be very strong.

Successful job applications usually meet all 'essential' and most 'desirable' qualities needed to undertake a role. These often include (1) a good understanding of how the sector works in practice and (2) being able to showcase an impactful demonstration of the skills required. Both points are relatively simple to add to a job application once your foot is on the job ladder, but as a student or recent graduate, these requirements are tough! Volunteering is a great alternative to source these requirements, but it's important to donate your time constructively.

Be cautious to avoid roles which lead to a skewed perspective on the sector, as some volunteer opportunities focus on practical conservation in one particular geographical area or habitat. Consider whether you would be able to relate these skills to the job you are applying for within a regional context. It is advisable to refresh yourself with CIEEM's Competency Framework for the transferable and technical skills that apply most to our sector locally.

Finding your first job often comes down to who you know. Having a wide network of contacts in the sector is valuable at an early stage of any career, and whilst COVID-19 might limit travel, it has not stopped anyone from reaching out digitally. If you have always meant to sign up for LinkedIn or Twitter, now is the time! Follow people in an organisation or area of work you want to get into. Like, share and comment on their posts to get your name out there.

The pandemic has forced conservation organisations and special interest groups to adapt. A vast amount work in conservation is now done online, and for many volunteering roles currently on offer, there is no need to even leave home to become a productive player in the sector.

There are volunteering roles in publicity, communications, marketing, fundraising, administration, campaigning, education, research and data handling (to name just a few)!

All these skills will open doors, and often all you need is a computer and access to the online world. For many roles, geographical location is no longer relevant in volunteer recruitment. This allows you to pick and choose the most relevant roles. Additionally, meeting people (albeit virtually) that have the knowledge, expertise and experience you are looking to gain is simpler than ever. Remember that once you are a registered volunteer within an organisation, you can get to know the people within it. Never be afraid to request opportunities to grow your skills and knowledge.

While those exotic overseas volunteering trips may have to wait for now, with luck, there will be time to get involved in these in the future. In the short term, focus on volunteering opportunities that help you build transferable, demonstrable skills within a group or organisation that works for a cause that you believe in!

Join clubs, groups, and societies. Offer them your time and skills. Keep in mind that offering to take on ready-made role profiles often proves more successful. The world of volunteering is remains yours for the taking, all from the comfort of your own home.

British Ecological Society

The Benefits of Moving Conferences Online in 2020

BRITISH ECOLOGICAL SOCIETY

The BES is looking forward to welcoming delegates to a Festival of Ecology this December, as it moves its Annual Meeting online.

The BES Annual Meeting is our flagship event of the year. It's the largest and most welcoming ecology conference in Europe, when around 1,200 ecologists normally come together for four days in a conference centre to discover new ideas, find inspiration and form new connections.

This year will be a little different of course. It's clear that large conferences won't be back with us for a while yet. But in responding to the coronavirus pandemic, sometimes the new things we are doing bring new opportunities. And that is certainly true of the online Festival of Ecology we will be holding on 14-18 December 2020.

We are working hard to make sure the Festival has all the ingredients that make the BES Annual Meeting such a welcoming and inclusive conference every year. In addition, by holding it online, it will have the great advantage of being accessible to even more people in the UK and around the world.

The conference can be viewed from your phone or desktop wherever you are, and there are plenty of opportunities to participate and share your science. Because of this – as well as removing the need to travel and stay in a hotel for several days, with the carbon footprint that brings – it's easier to plan what you watch and when.

By moving online, we've been able to come up with an extended five-day programme of live and on-demand events. Delegates will be able to access videos of the content in their own time for a month after the conference has ended. This year, we won't have to race between conference rooms with the fear of missing out.

Tickets for the Festival of Ecology are a lower price, another way in which going online is more accessible for people. Moreover, the discount available for BES members means it's cheaper to become a member of the Society and register for the conference.

The conference programme is all that you would expect at our Annual Meeting. A line-up of world class researchers has been assembled to give plenary lectures through the week. There are themed sessions covering emerging topics across the field of ecology, including many in applied areas. Mike Morecroft of Natural England and the BES Policy team are hosting a session on the potential of Nature-Based Solutions to lessen the effects of climate change. Another thematic session looks at the future status of biodiversity and the implications for human well-being and prosperity, while the importance of peatlands is among the other sessions.

An unrivalled set of workshops offers everything from advice on research techniques to careers and personal development, including engaging with policy-makers and working in interdisciplinary teams. We'll also be putting on a variety of live social and networking events throughout the week, including the opportunity to find out more about our Special Interest Groups.

We don't know what future years will bring for large conferences and we are sure that meeting in person is still very important in sharing our science and stimulating ideas. But we are confident we have put the plans in place to make our Festival of Ecology in 2020 one to remember. We look forward to seeing many of you there.

Full details for our Festival of Ecology 2020 are available at:
www.britishecologicalsociety.org/festival-of-ecology

Member Network News

COVID-19 has made Member Networks (MNs) and Special Interest Groups (SIGs) more important than ever

In October 2020 elections were held to appoint new volunteers onto the committees of our Geographic Sections. Successful candidates will have been welcomed by the existing committees and will be learning the ropes of their new roles, with an induction session from the CIEEM secretariat. We hope that new volunteers understand what resources and support is available to them in their roles to enable them to make the most of the time they donate to the Institute.

We are excited to be working closely with the committees in 2021, especially because the services that MNs provide will be pivotal for many in our sector. COVID-19 has meant that networking and socialising has been challenging. MNs and SIGs will become a more active platform, facilitating engagement through technology. Post-conference feedback often includes that most learning took place at the bar! Having the opportunity to share experience and knowledge with others in similar situations is extremely valuable, both in a practical sense as well as for mental health and well-being.

With uncertainly around lockdowns, it is unclear where Britain and Ireland will be regarding group events (indoors or outdoors) in 2021. Therefore, MNs and SIGs will continue to have access to CIEEM's Zoom platform to host meetings, talks and socials. Whilst many members are desperate to attend events in-person again, we must continue to abide by official advice but will seek to host face-to-face events again once safe to do so.

Thank you to all the nominees who put themselves forward for MN committees in 2020. If you are contemplating getting involved with your MN committee or a SIG, please check the volunteer vacancies in the members' area of the website. You can apply by contacting Drew Lyness (CIEEM Volunteer Engagement Officer) at drewlyness@cieem.net. Our member groups can co-opt new volunteers at any time of the year.

Scotland Geographic Section

'Pie and a Pint' goes Virtual!

The joint 'Pie and a Pint' event with the British Ecological Society's Scottish Policy Group on 'Opportunities for Implementing Biodiversity Net Gain in Scotland' took place online on 8 September. Speakers included David Burslem (Aberdeen University), Vikki Patton (Ramboll), Paul Sizeland (NatureScot), Andy Tharme (Scottish Borders Council) and Francis Williams (Scottish and Southern Electricity Networks). Thank you to the speakers for their time and excellent talks.

This event was fully booked, and attendees were able to listen to the speakers from the comfort of their own home, hopefully with pints and pies in hand! We look forward to holding future events with the BES Scottish Policy Group. A blog and report are available on the website.

The Future of Biological Records in Scotland – Have Your Say!

The Scotland Section held a joint workshop on 29 September, partnered with the Scottish Biodiversity Information Forum (SBIF), on 'quick wins' to ensure consultants get maximum benefit from transforming the recording infrastructure. Thanks to all the consultants and other commercial data users who attended the workshop for your valuable insights. A full report is on the website.

Ireland Geographic Section

Launch of Lunchtime Chats

This year the Irish Section started a monthly event (on the last Wednesday each month) dubbed 'The Lunchtime Chats' series. The Irish Section has embraced the Zoom format and is delighted to offer this opportunity for members to chat to each other and specialists.

On 30 September we had a lunchtime chat with Dr Karen Bacon on investigating non-chemical controls for management of Japanese knotweed. This fully booked event can be watched on the CIEEM website.

On 28 October we were joined by Conor McCabe from the Marine Planning Unit in the Department of Housing, Local Government and Heritage. Conor shared information about new marine legislation and the Marine Planning Bill that will soon be implemented. You can watch his talk on the CIEEM website.

Where could ecology take you?

The Section was delighted to be part of the online ENVIRON conference – *Where Could Ecology Take You?* – organised by the Environmental Science Association of Ireland (ESAI) on 20 October.

Maeve Flynn, a senior ecologist for An Bord Pleanála, represented the Public sector; Niamh Roach who works part-time for Bat Conservation Ireland represented the environmental NGO sector; Dr David Kelleghan, a Fulbright TechImpact Scholar, spoke about academia; and Niamh Burke, formerly a principal ecologist for JBA and now starting her own consultancy, represented the private sector. There was great engagement with over 30 students attending our event. Thanks to ESAI, speakers and all the participants.

From the Project Officers

Elizabeth O'Reilly – Ireland

Greetings to the wider CIEEM! I am delighted to take this opportunity to introduce myself. If you are an Irish member hopefully you will be fully aware who I am. I have been in the role of Project Officer Ireland since 2017. Like my follow PO colleagues, I work from home for 15 hours a week. I consider myself very lucky to be able to work for such a great organisation, support amazing volunteers and all from my lovely home parish of Haggardstown!

Despite the challenges that 2020 has thrown at us I am only positive about the work that has been achieved in the Irish Section this year. Our Committee has been great and have met via Zoom almost monthly, we adapted quickly to move our conference online and have set up a Member Network series, where we get speakers in for 'Lunchtime chats' at the end of each month. These activities do make up a lot of my working hours but I am also working on supporting the activities of the Irish Policy Group (see page 68), meeting with other organisations to build relationships, and developing projects to further benefit our members here in Ireland. I look forward to delving into my daily routines more in this space and giving you all a continued insight and update of my activities here in Ireland. And for our Irish members, don't forget to check out our bi-monthly Irish Section newsletter for all the up to date news.

Contact me at:
elizabeth@cieem.net

Annie Robinson – Scotland

As the Scotland Project Officer, I help support the amazing volunteers in the Scottish Committee, the Scottish Policy Group and our Vice-President for Scotland Caroline McParland. I work from home (15 hours a week) in sunny Aberdeenshire, so was thankfully already well set-up for home-working. Although our species licensing event with NatureScot in February 2020 was the last in-person Member Network event, we have held several events online as well as virtual student and career events. Check out the member network news on page 68 for write-ups on joint events with the BES Scottish Policy group and SBIF. Going forward we would like to continue with a mix of in-person and virtual events to open them up to more members across Scotland.

We held a pre-conference event with Professor Roger Crofts on Upland Issues and Solutions prior to the annual CIEEM Scotland conference on *Land Use in Scotland: Changes, Challenges and Scotland*. With 118 people booked, the Scottish Conference was a great day of fantastic talks and virtual interactions. Thanks to all the speakers, chairs and everyone who attended.

We regularly interact with other organisations and in the last few months we have attended:

- a consultation meeting with the Scottish Land Commission to help inform the recommendations of the Vacant and Derelict Land Report;
- stakeholder engagement group meeting of the Scottish Biodiversity Programme; and
- launch event of Landscape and Place for Success with Scotland's Landscape Alliance.

To find out more about all the activities going on in the Scottish section check out the bi-monthly Scottish Section newsletter.

Contact me at: annierobinson@cieem.net

Diana Clark – Wales

Over the bridge in Wales we, like everyone else, have been caught up in the effects of the pandemic that is causing chaos across the world. As I type, we are in the middle of the so-called 'fire-break' period with no real idea of what restrictions will look like on the other side of it. The situation since March 2020 has made holding in-person Member Network events extremely challenging, however alongside our Wales-based volunteers I've still been busy with other aspects of Project Officer work.

In particular, we are delighted that our relationship with NRW has gone from strength to strength, not least with the scheduling of strategic 'critical friend' meetings twice a year. Our second meeting was held in late September and our next will be in March 2021. In future we hope to communicate the results of our discussions more widely, and we are currently exploring the best way to do this.

I've also been closely involved with the work of our internal CIEEM Student and Careers Working Group (SCWG), as well as our Diversity Working Group. You can read more about our diversity work on page 62, and find one of our SCWG outputs on page 66.

Finally, our Wales Policy Group has also been busy (details on page 59) and our postponed conference *Bringing Our Rivers Back to Life* is being re-scheduled for early in the new year, so do keep a look out for that.

Contact me at:
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New Members

The decision on admission is usually taken by the Membership Admissions Committee or Registration Authority under delegated authority from the Governing Board but may be taken by the Governing Board itself.

CIEEM is pleased to welcome the following individuals as new members:

ADMISSIONS

Chartered Ecologist (CEcol)
Laura Carter-Davis, Sean Crossland, Matthew Hanson, Dr Andrew Lucas, Donncha Madden, Gemma Mahoney, Emma Mundy, Amy Prendergast, David Stanton, Frances Tobin, Dr Barry Walls, Zoe Webb

Chartered Environmentalist (CEnv)
Calum Campbell, Emma Fambely, Lewis Pate, Kieran Shaw, Heather Simpson, Catherine Wiseman, Lottey Wren

Full Members (MCIEEM)
James Adler, Ellen Brand, Nickola Brown, Heidi Carruthers, John Findlay, Nicholas Flores Martin, Catriona Gall, Paul Holton, Mark Mulqueeney, Neil Rowntree, Dr Holly Smith, Chloe Tan

Upgrades to Full Membership (MCIEEM)
Felicity Andruszko, Celia Barlow, Dr Angela Brennan, Benjamin Christie, Alexandra Cole, Emily Costello, Joseph Dance, William Dommett, Lisa Durrant, Rebecca Harrington-Harding, Elizabeth Kimber, Dr Jessica Lea, Dean LeFeuvre, Mhairi Mackintosh, Ian Nixon, Mark Norriss, Rebecca Northey, Danny Oliver, Phillip Playford, Rowan Rumball, Henry Sturgess, Samantha Turner, Daniel Wales, Bradley Williams

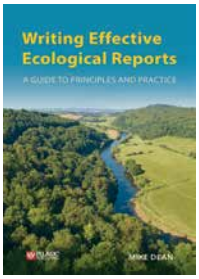
Associate Members (ACIEEM)
Holly Bennett, Sophie Bradfield, Jill Crighton, Robert Jones, Jennifer Lackie, Nathaniel Legall, Emily Major, Claire McCormack, Alexander Morley, Craig O'Brien, Graham Sparshott, Amy Stanley, Ian Stephens, Luke Wallace

Upgrades to Associate Membership (ACIEEM)
Hayley Barrett, Emily Bartlett, Georgina Baulcomb, Rebecca Brown, Cameron Chester, Katharine Coope, Charlene Davies, Thom Erritt, Caitriona Fenton, Alexandra Gow, Lee Haley, Matthew Hazleton, Charlotte Hewitt, Gary Hillier, Russell Hoyle, Rosie Jackson, David Kent, Matthew Kirby, Kathryn Lillistone, Louise Mandry, Lyndsey McBean, Frances Morris, Natalie Morrison, Amy Parsons, Gwilym Pask-Hale, Adam Penney, Gary Price, Ellen Quinton, Fiona Scott, Dr Catherine Seale-Duggan, Amy Sharples, Nicolle Stevens, Dr Melody Stokes, Darren Storey, Máté Vakarcs, Brooke Waites, Miles Watchman, Diana Webber, Ashley Welch, Matthew Whittle, George Wilkinson, Bethany Wilson, Natalie Woollacott

Qualifying Members
Lizzie Atkinson, Abbie Banwell, Nicholas Bayne, Huw Beckett, Callum Bedford, Christopher Breeze, Guy Brown, Joe Butler, Neil Campbell, Bhav Chavda, Thomas Clarke, Anya Coffey, Patrick Collins, Timothy Collins, Grace Cooper, Rachel Crapper, Molly Crookshank, Duncan Cullingford, Cerys Davenport, Thomas Doyle, Dr Wayne Edwards, Jamie Rhys Evans, Emily Fair, Hannah Fearon, Megan Fitzpatrick, Charlotte Gupwell, Petrina Harris, Francesca Hart, Charlotte Louise Henderson, Eleanor Mary Hide, Alexander William Hodges, Jack Holman, Emily Hopkin, Rhiannon Hoy, Amie Humphries, Benjamin James, Matthew Janes, Dr Paul Jarman, Faye Kelland, Andrew Kirkland, Jake Lacey, Ryan Lavery, Juan Lincango Vega, Sophie Linsley-Parrish, Joseph Longbone, Dr Jennifer Loyd-Pain, Lucy Mackinson, Nicole Mallett, Charlotte Mathews, Campbell McCallum, Carina Anne Louise Morris, George Parry, Katherine Richardson, Ericka Robson, Matthew Ruiz, Gregory Shaw, Joshua Smith, Siannon Steel, Bethany Stonier, Joseph Taylor, Laura Turner, Joseph Valentine, Samantha Watkins, Ben Whitley, Elizebeth Wilcox, Aimmie Woodman, Calum Wyatt, Jack Wykes-Anderson, Alexander Young, Harry Young

Upgrades to Qualifying Membership
Alison Affleck, Stephanie Bevan, Samuel Binks, Celia Brailsford, Emma Carney, Nicholas Chambers, Adam Chambers, Manuel Chopitea Kober, Emily Clarke, Daniel Connell, Fintan Damer, Ella Dangerfield, Rhodri Davies, Steven Duddell, Zoe Durran, Natalie Elms, Bethany Field, Caroline Folwell, Choon-Wha Fuller, Janine McMahon, Alexander Melson, Lucy Moorhouse, Liam Murtagh, Sylvia Myers, Findlay Rae, Emily Ramsden, Olivia Satur, Alexander Sinclair, Rhian Smith, Craig Smith, Alison Stuart, Lucy Sumner, Amy Tose, Ljiljana Vujakovic, Ellie Welch, Jack Wheeler, Jordan Whitcombe

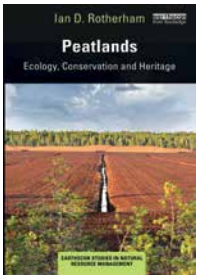
Student Members
Alisha Adams, Joseph Allsop, Madeleine Ambler, Madeleine Anderson, Alexandra Ash, Caroline Austen, Frida Backstrom, Neil Baldwyn, James Ball, Zoe Barrett, Samara Bebb-Bassett, Cathal Bergin, Andrew Beverley, Aidan Harry Bird, Murray Borthwick, Jamie Brewster, Catherine Bryant, Joanne Burgin, Stewart Burton, Sharron Burton, Jade Clayson, Nick Clayton, Holly Clements, Catherine Coe, Bryn Coffey, Rebecca Cousins, Joshua Daly, Rachael F Davies, Aurora De Castro Aguilar, Celia Donkin, Kevin Donovan, Katerina Eleftheriou, Katy Elliott, Kira Estes, Georgia Evans, Gillian Farmer, Daniel Faulkner, Dr James Fielding, Adam Ford, Charlie Fothergill, Holly Fowler, Bethany Fox, Matthew Freeman, Camilla Fulford-Roberts, David Galiana Wallace, Tabitha Gibbons, Holly Gillon, Polly Godfrey, Claire Graham, Davina Gray, Holly Green, Darcey Haldar, Paul Hammond, Finn Harrigan, Patrick Heaney, Eleanor Hey, Simon Hislam, Nikki Hulse, Robert Hutchinson, Kenneth Hutchison, Annie Ives, Sarah Jordan, David Judson, Hannah Karim, Isobel Kaul, Alex Kekewich, Sean Kerr, Emma King, Annabel Kirby O'Keeffe, Joao Louro, Madeleine Mangoni, Andrea Marchettini, Phillip Markey, Helen Mason, Nairne McBeath, Freja McCall-Stevenson, Calum McGonigal, Sarah McKiernan Brake, Molly Melling, Mary Moroney, Sarah Mullally, Siobhan Mullarkey, Gabrielle Needler, Sophie Nicholls, Maia Nicholson, Theo Nickols, Stuart Nicolson, Bethan Nowell, Neansaí O'Donovan, Emily Page, Joseph Parkes, Paola Perez, William Pilkington, Olivia Pool, Corrie Porter-Young, Mitchell Prescott, Daniel Pritchard, Bethan Pugh, Gemma Retallick, Sofia Riccomagno, Madeline Richards, Michael Robinson, Joshua Rose, Amy Ross, Caroline Rothschild, Lottie Rowedder, Jayne Ryan, Amy Shenton, Samantha Skinner, Abbie Smith, Imogen Frances Emily Smith, Angus Smith, Colleen Smith-Moore, Verity Sprigg, Jack Stanley, Stephanie Stone, Christina Sturt, Amanda Talbert, James Thompson, Bryce Thomson, Ellena Trelfa-Stewart, Fiona Turnbull, Iain Turner, Harry Vernon, Sara Ann Stevenson Wallace, Rebecca Walters, Thomas Weston, Charlotte Wiles, Alice Wilkins, Emily Williams, Ramesh Wilson, Darren Wilson, Bronwen Winter, Kirsty Witts, Ellis Wood, Chloe Wood, Jessica Wooden, Nicola Woods, Ailsa Wright



Writing Effective Ecological Reports: A Guide to Principles and Practice

Author: Mike Dean CEcol CEnv FCIEEM
ISBN: 9781784272418
Price: £34.99
Available from: www.pelagicpublishing.com

Mike Dean, co-author of the *CIEEM Guidelines on Ecological Report Writing*, provides an in-depth guide to writing high-quality and effective professional ecological reports based on over 20 years of experience as an ecological consultant. The book provides practical advice on structure, content and style of ecological reports, including writing effective summaries, report templates and proof-reading. This guide is useful for all levels of ecologists.



Peatlands: Ecology, Conservation and Heritage

Author: Ian D. Rotherham CEnv MCIEEM
ISBN: 9781138343214
Price: £34.99
Available from: www.routledge.com

This book combines a natural and social overview of peatlands, providing a concise overview for students and researchers. Chapters explain how peat is formed and detail the ecology, history, ecosystem services and wildlife of peatlands. It addresses the causes of peatland degradation and how this is contributing to climate change and biodiversity loss.

Nature-Based Solutions to 21st Century Challenges

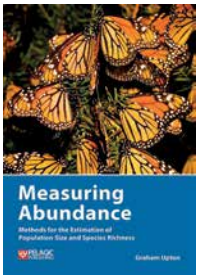
Author: Robert C. Brears
ISBN: 9780367266899
Price: £34.99
Available from: www.routledge.com

This book provides a systematic review of nature-based solutions and their potential to address current environmental challenges. Policy developments that encourage the implementation of nature-based solutions to address societal challenges while simultaneously providing human well-being and biodiversity benefits are assessed and best practice guidance is presented.

Invasive Birds: Global Trends and Impacts

Editors: Colleen T. Downs and Lorinda A. Hart
ISBN: 9781789242065
Price: £135.00
Available from: www.cabi.org

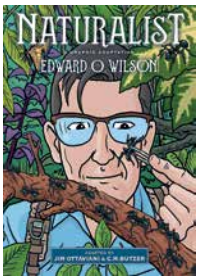
This book provides an account of 32 global avian invasive species (as listed by the Invasive Species Specialist Group, ISSG), assessing current invasive status for each bird species, including details of physical description, diet, introduction and invasion pathways, breeding behaviour and natural habitat. The environmental impact and control methods for each species are also detailed. Finally, the impact of invasive species on native communities, problems associated with invasive bird management and the use of citizen science are considered.



Measuring Abundance: Methods for the Estimation of Population Size and Species Richness

Author: Graham J.G. Upton
ISBN: 9781784272319
Price: £34.99
Available from: www.pelagicpublishing.com

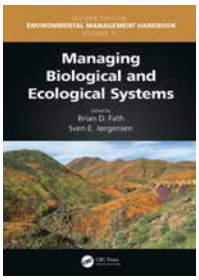
This book brings together the methods used to estimate the abundance of individuals in nature. The statistical basis of each method is detailed along with practical considerations for survey design and data collection. Case studies are provided, along with example R code where necessary. Methods for stationary and mobile species are covered.



Naturalist: A Graphic Adaptation

Authors: Edward Wilson, Jim Ottaviani and C.M. Butzer
ISBN: 9781610919586
Price: £20.99
Available from: www.islandpress.org

This vibrant graphic adaptation of E.O. Wilson's classic science memoir brings Wilson's childhood and celebrated career to life through full-color illustrations and Wilson's own lyrical writing. This is an inspiring and accessible account – of his career and the fields he helped to define – for all ages.



Managing Biological and Ecological Systems (Second Edition)

Authors: Brian D. Fath and Sven Erik Jorgensen
ISBN: 9781138342644
Price: £140.00
Available from: www.routledge.com

This second edition provides a resource for finding basic knowledge on the biosphere and ecological systems and includes important problems and solutions faced today. The book demonstrates the key processes, methods, and models used in studying environmental management. It provides a comprehensive overview of environmental problems, their sources, their assessment, and their solutions.

Free downloads that may be of interest to members:

- IUCN (2020). *IUCN Global Standard for Nature-based Solutions: First Edition*. Available at: https://portals.iucn.org/library/node/49070
- IUCN (2020). *Guidelines for Conserving Connectivity Through Ecological Networks and Corridors*. Available at: https://portals.iucn.org/library/node/49061
- UN FAOs (2020). *Better Data, Better Decisions – Towards Impactful Forest Monitoring*. Forestry Working Paper no.16. Available at: http://www.fao.org/3/cb0437en/CB0437EN.pdf

Evaluating the potential for bird-habitat models to support biodiversity-friendly urban planning

Plummer K.E. , Gillings S., Siriwardena G.M.

Journal of Applied Ecology 2020, 57(10): 1902-1914

DOI: 10.1111/1365-2664.13703

Biodiversity-friendly urban landscapes could deliver benefits for both wildlife and people, by incorporating conservation and ecosystem services objectives. This study combines national-scale bird abundance data with high resolution habitat data to characterize relationships between bird densities and urban landscape form in Britain to evaluate the potential for species-specific models to be used to predict bird densities in novel or modified urban areas. Subject to verification of predictive ability, practitioners can apply the models to compare, for example, land-sparing and sharing within developments.

Correspondence: kate.plummer@bto.org

Promoting self-facilitating feedback processes in coastal ecosystem engineers to increase restoration success: Testing engineering measures

Schotanus J., Walles B., Capelle J.J., van Belzen J., van de Koppel J., Bouma T.J.

Journal of Applied Ecology 2020, 57(10): 1958-1968

DOI: 10.1111/1365-2664.13709

Coastal ecosystem engineers often depend on self-facilitating feedbacks to ameliorate environmental stress creating difficulties in the restoration of such coastal ecosystem engineers. This study investigated the possibility of increasing transplantation success in intertidal blue mussels *(Mytilus edulis)* by stimulating the formation of an aggregated spatial configuration using fencing. The fences successfully reduced losses and induced the formation of a banded pattern with high local mussel densities, which locally reduced predation.

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Area-based conservation in the twenty-first century

Maxwell S.L., Cazalis V., Dudley N. *et al*.

Nature 2020, 586: 217–227 (Open Access)

DOI: 10.1038/s41586-020-2773-z

Area-based conservation efforts, which include both protected areas and other effective area-based conservation measures, are likely to extend and diversify. This review shows how the expansion of protected areas by national governments since 2010 has had limited success in increasing the coverage across different elements of biodiversity and ecosystem services. Authors urge the need for more effective area-based conservation and better collaboration with the Indigenous peoples, community groups and private initiatives.

https://www.nature.com/articles/s41586-020-2773-z#citeas

Bending the curve of terrestrial biodiversity needs an integrated strategy

Leclère D., Obersteiner M., Barrett M. *et al*.

Nature 2020, 585: 551-556

DOI: 10.1038/s41586-020-2705-y

This study uses an ensemble of land-use and biodiversity models to assess whether—and how—humanity can reverse the declines in terrestrial biodiversity caused by habitat conversion. Results show that immediate efforts of unprecedented ambition and coordination could enable the provision of food for the growing human population while reversing the global terrestrial biodiversity trends caused by habitat conversion.

Correspondence: https://www.nature.com/articles/s41586-020-2705-y#citeas

Landscape-wide changes in land use and land cover correlate with, but rarely explain local biodiversity change

Jung M., Scharlemann J.P.W., Rowhani P.

Landscape Ecology 2020, 35: 2255–2273

DOI: 10.1007/s10980-020-01109-2

Changes in land use and land cover (LULC) are suspected to impact local biodiversity. This study investigates whether landscape-wide changes in LULC, defined as either trends, or abrupt changes, in magnitude of photosynthetic activity, are driving bird diversity change in the USA. Results show changes in relative abundance was negatively, and assemblage composition positively, correlated with changes in photosynthetic activity within the wider landscape.

https://link.springer.com/article/10.1007/s10980-020-01109-2#citeas

Extending full protection inside existing marine protected areas, or reducing fishing effort outside, can reconcile conservation and fisheries goals

Belharet M. *et al*.

Journal of Applied Ecology 2020, 57(10): 1948-1957

DOI: 10.1111/1365-2664.13688

This study provides the first assessment of stock status for three coastal species in the north-western Mediterranean and evaluate the ecological and fisheries outcomes of different management strategies. Results show extending full protection inside existing multiple-use marine protected areas or reducing fishing effort outside can deliver both conservation and fisheries benefits.

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Forthcoming Events

For information on these events please see *www.cieem.net*.

Conferences		
Date	**Title**	**Location**
2 February 2021	Wales Conference 2021 – Sustainable Management of Freshwater Resources: Bringing our Rivers back to Life. **Book your place now!**	Online
16 March 2021	Spring Conference 2021 – Long-term Ecological Research Projects: Using Evidence to Inform Practice (In partnership with the Ecological Continuity Trust) **Call for papers now open!**	Online
20-21 April 2021	Ireland Conference 2021 – Nature-Based Solutions **Call for papers opening mid-December!**	Online

Other Events		
10 December 2020	Building Back Faster and Better amidst COVID-19: Is Green Recovery possible?	Online webinar
11 December 2020	Ireland Environmental Law Workshop	Online workshop

Online Training	
December 2020	
8 & 15	Biodiversity Net Gain Through Development
9 & 14	Calculating and Using Biodiversity Units with Metric 2.0
9-10	Winter Tree Identification
9 & 16	Introduction to Nature Conservation Legislation in the UK
10-11	Ecological Report Writing
14-17	Beginners QGIS for Ecologists and Conservation Practitioners
January 2021	
13-14	Preliminary Ecological Appraisal
13 & 20	Positive Planning for Biodiversity – First Principles
14 & 21	Introduction to Bats and Bat Survey
20 & 28	Developing Skills in Ecological Impact Assessment (EcIA)
20 & 27	Effective Workplace Mentoring
21-22	UK Habitat Classification for Practitioners
February 2021	
4 & 11	Bat Impacts and Mitigation
March 2021	
25-26	Introduction to UK Habitat Classification

CONFERENCES 2021

WALES CONFERENCE 2021
Sustainable Management of Freshwater Resources: Bringing our Rivers Back to Life
2 February 2021, Online
BOOK YOUR PLACE NOW!

SPRING CONFERENCE 2021
Long-term Ecological Research Projects: Using Evidence to Inform Practice
(in partnership with the Ecological Continuity Trust)
16 March 2021, Online
CALL FOR PAPERS NOW OPEN!

IRELAND CONFERENCE 2021
Nature-Based Solutions
20-21 April 2021, Online
CALL FOR PAPERS OPENING MID-DECEMBER!

For more information visit
www.cieem.net/training-events

CIEEM