

Biosecurity Good Practice

Marine INNS in the UK:  
the Scale of the Problem

Threat of Invasive  
Common Green Iguanas  
to Caribbean Fauna

'Phase 1 for Bugs': Rapid  
Assessments of Potential  
Value of Invertebrate Habitats



## Biosecurity and Invasive Species



# Forthcoming conferences to add to your CPD calendar



## Greening our Grey: improving the biodiversity in urban landscapes

5th & 7th  
October  
2021

In this time of opportunity to address the challenges of re-imagining and re-integrating strategic planning with the key agendas of the natural environment, sustainability, transport and wellbeing, this conference will explore how ecologists, environmental managers, planners, and policy makers can work together to develop and influence innovative approaches.



## Management, Mitigation & Monitoring CIEEM Autumn Conference

16th & 17th  
November  
2021

There is increased public and political awareness of the climate emergency and biodiversity crisis, creating demand for multi-functional and multi-disciplinary solutions for sustainable management of ecological resources. Through sharing good practice and innovation, delegates can join us in championing smarter, more effective ways of working.

## Call for papers for both events now open!

Visit the website for more details



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## Editorial



### Welcome

Signal crayfish, giant hogweed, killer shrimp, ash dieback and SARS-Cov-2 are all invasive non-native organisms that, as ecologists and environmental managers, we are well aware of, albeit to a greater or lesser extent - except for the virus. All of us have had a close-up and in many instances personal experience of COVID-19, so what has it taught us about how to deal with invasive non-native organisms?

Let's start with the essential need of working together to achieve a concerted approach in all aspects of the response: recording spread, understanding pathways, prescribing and raising awareness of how to prevent spread including public engagement, treatment and securing the necessary funding.

Such an integrated approach requires the input of not just a volunteer workforce, such as local action groups and rivers trusts, but the complementary role and input of ecologists and environmental managers. These specialists need to be trained, not just in drawing attention to these plants and animals on a site but being able to deliver a management programme through control to monitoring that is, importantly, accountable to the client and society more widely. Now is a moment to demonstrate to our governments that relying on volunteers to save ecosystems such our rivers,

heathlands and woodlands from alien invaders is dangerously naïve, and that a responsible approach requires professional input and appropriate funding to deal with a national and in many instances global issue.

Two important starting points for all of us are the ability to recognise these species and, critically, respond when we find one, even if only to pass the record on to, for example, a Local Environmental Records Centre (LERC) or county recorder. Secondly, we need not just appreciate the importance of prevention, but implement measures to stop us spreading these species, in both our professional work and our lives more broadly.

A good example of the synergy that we need to continue to grow between the volunteer and professional is horizon scanning. Recorders in the field cover their patches and feed records of 'new' species into their LERCs. These records are used to identify alerts, triggering a rapid response for that first species' record in the UK or Scotland or Ross-shire or the Isle of Lewis. The successes regarding Asian hornet illustrate this well, as do those for various aquatic invertebrates where there's a much more mature integration of volunteer and professional than there is for many terrestrial groups.

I've been careful to avoid the 'eradication' word. We've recognised that despite the huge efforts that have been made, COVID-19 is with us for

a little while yet and could well just become part of human epidemiology. Likewise, dealing with invasive plant and animal species can lead to control at a given site but despite considerable effort at, say, the county scale, eradication is unlikely, and even less so at the country scale. The equivalents of distancing, masks, personal hygiene, treatments, vaccinations and data recording, coupled with learning from our experiences and developing new solutions, all apply to those invasive plants and animals already here and those queuing up to benefit from umpteen pathways into the UK and Ireland and fuelled by such factors as climate change and globalisation.

Use this issue of *In Practice* to make sure that you are fit to do your part in stemming the damage that invasive non-native species are doing not just to ecosystems in the UK and Ireland, but globally. Some US\$1.4 trillion is spent every year in managing and controlling invasive species<sup>1</sup>. Did you make sure you'd cleaned your trainers before packing for your last holiday? OK, it was a while ago!

**Max Wade CEcol CEnv FCIEEM**

President

### Note

1. Amstutz, L.J. (2018). *Invasive Species*. Minneapolis, MN: Abdo Publishing, pp. 8–10.



Signal crayfish



# EcoWorks

## Scheme Now Open

A six month trial of a new EcoWorks scheme was launched in February 2021 for members of the Ecological Restoration and Habitat Creation Special Interest Group. This scheme provides free, rapid telephone/virtual advice from a panel of experienced volunteers on nature-based solutions for mitigation for, and adaptation to, global heating and the changing climate, as well as biodiversity net gain and actions to deal with the biodiversity crisis.

EcoWorks was piloted in 2019 to provide support on habitat creation, restoration and translocation projects in rural, urban fringe and urban locations. Full details of the scheme and how you can take part are available on the EcoWorks webpage:

[http://events.cieem.net/Portal/VolunteeringwithCIEEM/ERHC\\_EcoWorks.aspx](http://events.cieem.net/Portal/VolunteeringwithCIEEM/ERHC_EcoWorks.aspx) (Member login required).

*"The response I received was exemplary! Way beyond expectations, I was just hoping for some pointers."*

*"I would definitely recommend EcoWorks: I would say it was an essential service for freelance ecologists."*



**CIEEM**

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Front cover: Common green iguana (*Iguana iguana*). Photo: Mark Yokoyama.

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## New CIEEM Patron

We are delighted to announce that Roger Crofts is now a CIEEM Patron. In his role Roger will act as an ambassador for CIEEM and the profession, especially with regard to Scotland.

Roger said: *"I am delighted to be appointed a CIEEM Patron. The Institute continues to grow in stature and influence, and our members demonstrate a thoroughly professional approach in their everyday work. There has never been a more important time to stand up for nature, learn from it in instituting new policies and increased incentives, and improving practice on the ground. And it is vital that we continue the battle against outmoded approaches and bad practice which works against nature and undermines the future for short-term gain."*

Find out more: <https://cieem.net/roger-crofts-announced-as-newest-cieem-patron/>

## CIEEM briefing paper: Environmental Net Gain

This briefing paper aims to provide a practical definition of the term and provide the legislative, policy and strategic context within which ENG can be delivered. It also aims to highlight how CIEEM members can apply these concepts, during development (which includes retrofitting and redevelopment), in land management and when formulating strategies. By taking a holistic approach, significant gains in environmental benefits can be achieved.

<https://cieem.net/cieem-publish-briefing-paper-on-environmental-net-gain/>

## Member Assistance Programme (MAP)

Members are reminded that CIEEM continues to offer this service and can access an extensive package of support including telephone advice lines, counselling services and a website full of information and practical advice on topics as wide ranging as debt management, stress management and mental health. Their services

are available 24/7 and are delivered confidentially. More information is available via the 'My CIEEM' area of the website under 'Member benefits'.

## Staff changes

From 1 April 2021, we welcomed Mandy Marsh as the new Wales Project Officer. Mandy is settling into her new role and with the team.

## CIEEM is moving

We have moved out of our offices on Southgate Street in Winchester, and will take up new offices a short distance away in Ampfield, Hampshire from 1 July 2021. Don't worry if you've posted something to us at Southgate Street, we are getting mail redirected. Our phone numbers will remain unchanged. Look out for the full details from 1 July.

## Offsetting our emissions

As part of our Action 2030 project work we offset our carbon emissions with a donation to a nature restoration project that will capture carbon and enhance

biodiversity. For our emissions during 2020 we donated to Project Seagrass ([www.projectseagrass.org/](http://www.projectseagrass.org/)). Read more about our Action 2030 ambitions at: [www.cieem.net/action-2030](http://www.cieem.net/action-2030)

## Recent blog posts

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

- How to Get More Wildlife into Your Garden and Absorb More Carbon – by Penny Anderson
- Biodiversity Net Gain and Land Management – by Kevin Jay
- Tristan da Cunha: one of the world's biggest wildlife sanctuaries

If you would like to contribute your own blog, please contact [JasonReeves@cieem.net](mailto:JasonReeves@cieem.net).

## 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](mailto:enquiries@cieem.net).

## CIEEM Conferences

| Date                 | Title  | Location |
|----------------------|--|----------|
| 5 and 7 October 2021 | Scotland Conference 2021 – Greening the Grey: Improving the Biodiversity in Urban Landscapes | Online   |
| 16-17 November 2021  | Autumn Conference 2021 – Management, Mitigation and Monitoring                               | Bristol  |

Find out more: <https://cieem.net/events>

## In Practice Themes and Deadlines

| Edition        | Theme   | Article submission deadline |
|----------------|---|-----------------------------|
| September 2021 | 30th Anniversary Edition: The Next 30 Years   | n/a                         |
| December 2021  | Urban and Cultural Ecology                    | 20 August 2021              |
| March 2022     | Working on Site                               | 19 November 2021            |
| June 2022      | Nature-Based Solutions                        | 18 February 2022            |
| September 2022 | Bryophytes and Lichens                        | TBC                         |
| December 2022  | Non-themed (submissions welcome on any topic) | TBC                         |

If you would like to contribute to one of these issues, please contact the Editor at [nikprowse@cieem.net](mailto:nikprowse@cieem.net). Contributions are welcomed from both members and non-members. Further information and guidance for authors can also be found at: <https://cieem.net/in-practice/>

### Interim Office for Environmental Protection to be launched

Environment Minister, Rebecca Pow, has announced the Office for Environmental Protection, will be launched on an interim basis in July ahead of its formal establishment as part of the Environment Bill.

<https://cieem.net/interim-office-for-environmental-protection-to-be-launched/>

### New biodiversity indicator developed covering marine and terrestrial habitats

Research commissioned by Scottish Government to develop a high-level indicator to measure and report trends in both terrestrial and marine biodiversity in Scotland has been published. This will enable trends in biodiversity to be considered in the National Performance Framework. Scottish Government has recognised concerns regarding a single measure of combined data and has confirmed three indicators will soon make up the measure.

<https://www.gov.scot/publications/development-combined-marine-terrestrial-biodiversity-indicator-scotland/>

### Scotland's third Land Use Strategy published

The Scottish Government has published its third land use strategy, *Land use – getting the best from our land: strategy 2021 to 2026*. It sets out the Government's vision, objectives and policies to achieve sustainable land use.

<https://cieem.net/scotlands-third-land-use-strategy-published/>

### Minister Malcolm Noonan has secured Government approval for Ireland's second Prioritised Action Framework

The second Prioritised Action Framework sets out Ireland's priorities for habitat and species protection and restoration in Special Areas of Conservation and Special Protection Areas, and associated green infrastructure, in the period 2021-2027.

[www.npws.ie/news/minister-malcolm-noonan-has-secured-government-approval-ireland%E2%80%99s-second-%E2%80%9Cprioritised-action](http://www.npws.ie/news/minister-malcolm-noonan-has-secured-government-approval-ireland%E2%80%99s-second-%E2%80%9Cprioritised-action)

### All-Ireland Pollinator Plan for 2021-25 published

The *All-Ireland Pollinator Plan for 2021–2025* is a new 5-year road map that aims to help bees, other pollinating insects and wider biodiversity. The new Plan is even more ambitious than the first (2015–2020) – with 186 actions spread across six objectives.

<https://pollinators.ie/aipp-2021–2025/>

### Welsh Government appoints Environmental Protection Assessor | Llywodraeth Cymru'n penodi asesydd diogelu'r amgylchedd

The Welsh Government has appointed Dr Nerys Llewelyn Jones as the new interim environmental protection assessor for Wales. Dr Llewelyn Jones will consider issues raised by the public on the functioning of environmental law in Wales, and provide the Minister with advice and recommendations.

English: <https://gov.wales/welsh-government-appoints-new-environmental-protection-assessor>  
Cymraeg: <https://llyw.cymru/llywodraeth-cymrun-penodi-asesydd-diogelur-amgylchedd>

### CBD COP15 postponed to October 2021

The 15th meeting of the Conference of the Parties (COP) to the United Nations Convention on Biological Diversity (CBD) has been postponed again, this time until 11-24 October 2021. The events – which will see the world's nations agree a new Global Biodiversity Framework (GBF) – were originally scheduled for 15-28 October 2020.

<https://cieem.net/cbd-cop15-postponed-to-october-2021/>

### IUCN produce first global catalogue of ecosystems

The International Union for Conservation of Nature (IUCN) has published the first comprehensive system for classifying and mapping all ecosystems on Earth based on both their functions and composition. The system defines the key biophysical features of 108 major ecosystem types.

<https://cieem.net/iucn-produce-first-global-catalogue-of-ecosystems/>

### Insect decline research projects

Recently, evidence of a wholesale decline in insect abundance and diversity has begun to accumulate. The Natural Environment Research Council has agreed to fund two projects to address the issue: GLiTRS (GLobal Insect Threat-Response Synthesis) will examine global insect declines, whereas DRUID (Drivers and Repercussions of UK Insect Declines) will focus specifically on the UK. The projects will compile evidence to assess how widespread insect declines are, and will look for evidence of their causes and consequences.

# Biosecurity Good Practice for Ecologists and Environmental Managers



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Keywords: biosecurity, cleaning, drying, heating, invasive non-native species

This article summarises essential biosecurity measures for field ecologists and environmental managers, highlights the relevant legislation and provides examples of how these are underpinned by science.

## Introduction

The impact and threat to biodiversity and ecosystem functioning from invasive non-native species is well-understood (Vitousek 1994, Schröter *et al.* 2005), and recognised by our governments in England, Wales, Scotland, Northern Ireland and the Republic of Ireland. Non-native species are those plants or animals that survive outside of their historical or natural range as a result of human activity. They are also referred to as alien, exotic or non-indigenous species. A non-native species which, if uncontrolled, would be likely to have, or is already having, a significant adverse impact on biodiversity and other environmental, social or economic interests is termed

‘invasive’. Biosecurity is the range of measures that are put in place to prevent the introduction and/or spread of harmful organisms and is an important part of any ecological fieldwork.

## Our responsibilities and the law

Ecologists and environmental managers, be they consultants, trainers, students or working for statutory agencies, are potentially prime culprits for spreading invasive species. This high potential for ecologists to transport invasive propagules is due to such factors as direct contact with a wide range of habitats and sites, often visited in series on the same day or over a few days, along with scope to carry propagules on equipment, clothing, footwear and vehicles. Whether it's taking personal responsibility to ensure appropriate biosecurity protocols are followed, or informing a site manager, landowner or client of immediate measures that should be taken, we have a responsibility to take action.

All this comes under the heading of good biosecurity, as described in the *Great Britain Non-native Species*

*Strategy*, comprising prevention, rapid response and long-term control (Anon 2015). Although this article is concerned with biosecurity in so far as it relates to invasive non-native species, in practice our biosecurity behaviour must encompass all aspects. That includes disease transmission, which is integrated in the example of a decision-making process in Figure 1.

The need for biosecurity to protect our environment is backed by legislation which, although derived from slightly different instruments, revolves around the principle that to cause an invasive non-native species to grow or spread into the wild is an offence. The lists of species covered by legislation in England, Wales, Northern Ireland, the Republic of Ireland and the EU are very similar, with minor variations making it important to check for the region in which you are working. In Scotland, where the Wildlife and Natural Environment Act 2011 applies, there is a legal presumption against releasing any animals or plants into the wild outside their native range. The UK is also a signatory to the Convention on Biological Diversity,



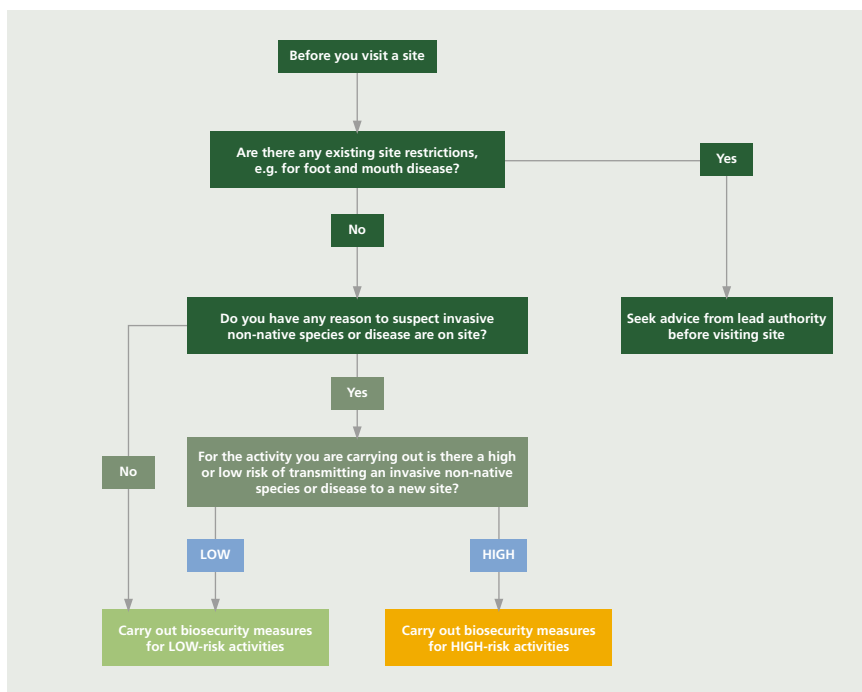


Figure 1. Example biosecurity decision trees. Source: Forestry Commission (2012). Crown Copyright, courtesy Forestry Commission (2012), licensed under the Open Government Licence.

Article 8 of which requires that ‘each Contracting Party shall, as far as possible and as appropriate prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species’. Although it is not necessarily contravening the legislation to have any of the scheduled plants or animals on your land, causing their spread or failure to act to prevent their spread beyond your land may be an offence (Defra 2010). Defining the area in which you are working is important because most legislation, policy and guidance refers to ‘the site’, which defines the boundaries of responsibilities. In comparison, the wild is less well defined, having been described as ‘the diverse range of natural and semi-natural habitats and their associated wild native flora and fauna in the rural and urban environments in general. This can also be broadly described as the general open environment’ (Defra 2010). Whether an introduction (release or escape) is into the wild may be dependent on the ecology of the species in question, the habitat management in place and the potentially affected environment: what constitutes the wild must be judged on a case-by-case basis.

Additionally, in England and Wales, those providing training in invasive

non-native species identification need to apply for a licence to transport certain species from the field into the classroom (Invasive Alien Species (Enforcement and Permitting) Order 2019). The law states: ‘it shall be a defence to a charge of committing an offence ... to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence’. This highlights the importance of having a biosecurity plan in place that is fit for purpose, understood by new staff, volunteers and students and demonstrates compliance through diligent record keeping. Don’t forget: legislation, policy, best practice, British Standards and guidelines change regularly. It is your

responsibility to keep up to date. For the UK regularly check the GB Non-Native Species Secretariat ([www.nonnativespecies.org/home/index.cfm](http://www.nonnativespecies.org/home/index.cfm)) and for the Republic of Ireland check Invasive Species Ireland (<http://invasivespeciesireland.com>).

### Information is power: the basics

Invasive non-native species cover a diversity of plants and animals from giant hogweed (*Heracleum mantegazzianum*) to water fern (*Azolla filiculoides*) and from killer shrimp (*Dikerogammarus villosus*) to muntjac deer (*Muntiacus reevesi*) (Booy *et al.* 2015). As well as being able to recognise these alien invaders, it is essential to identify the pathways along which, and vectors through which, propagules are spread, including phenology and life cycles (Table 1): all are critical to understanding how to avoid high-risk periods and life stages when engaging with these species.

### Good practice biosecurity for ecologists and environmental managers

Biosecurity guidance for invasive non-native species has been derived from advice for the aquatic environment (freshwater and marine), Defra’s ‘Check, Clean, Dry’ biosecurity campaign ([www.nonnativespecies.org/checkcleandry/](http://www.nonnativespecies.org/checkcleandry/)) and, for the forestry environment (applicable to a range of terrestrial habitats), in the Forestry Commission’s fold-up ‘Biosecurity: good working practice for those involved in forestry’ (Figure 2). Developing a decision tree, similar to that in Figure 1,



Figure 2. Guidance fold-ups produced by Forestry Commission (left) and Cheshire Wildlife Trust, Defra and the GB NNSS (right).

but tailored to best suit your work, is a good start in addressing your biosecurity responsibilities.

A key stage in prevention is field work planning, including:

- visit highest-risk sites/areas last
- if a high percentage of work is planned for a site or sites with invasive species, dedicate certain equipment and footwear to be used only at that site or sites
- purchase equipment and footwear with the fewest places for organisms and debris to become attached, such as one-piece waders with full rubber material and open cleat soles
- know your biosecurity protocol and what is expected of you
- start clean: footwear, clothing, tools, equipment
- take only what equipment is needed onto site
- ensure you have the necessary cleaning equipment (Box 1).

Arriving on site, park on hard standing wherever possible and avoid off-road driving. While on site:

- tread carefully, be aware of your surroundings, avoid areas known to contain invasive non-native species and if necessary take the long way round
- regularly inspect and clean equipment, footwear and clothing for live organisms particularly in areas that are damp and hard to inspect
- prior to leaving a site or waterbody, remove any mud and plant matter accumulated while on site from footwear and equipment, and bag footwear
- if you become aware of the presence of a disease, the work must stop immediately, and all footwear must be bagged to be disinfected back at your base
- at your base, wash any survey clothing and footwear and leave to dry
- keep a log of when items are used to ensure the minimum drying period has been met
- if you noticed specific invasive species risks, notify anyone else who might visit the site.

**Table 1. Pathways and propagules of a range of invasive non-native species.**

| Species   | Pathway   | Propagule                                       | Propagule size (minimum)                       | Phenology/ life stages   |
|---|---|---|--|--|
| <b>Plants</b>   |   |   |  |  |
| Japanese knotweed ( <i>Reynoutria japonica</i> )          | Movement of soils in bulk or on tyres, tracks and footwear; water             | Rhizome fragments                               | 0.5 mm long, 0.5 g                             | Perennial; no viable seeds produced                                  |
| Giant hogweed ( <i>Heracleum mantegazzianum</i> )         | Movement of soils in bulk or on tyres, tracks and footwear; water; wind       | Seeds (Figure 3)                                | 10 mm long, 0.01 g                             | Biennial, dying after flowering and setting seed                     |
| New Zealand pigmyweed ( <i>Crassula helmsii</i> )         | Water; water-based recreation including angling; dogs; footwear and equipment | Stem fragments; may produce seeds               | 2 mm fragment (Figure 4), minute seed: <500 µm | Capable of growing as an emergent, sub-surface and terrestrial plant |
| Rhododendron ( <i>Rhododendron ponticum</i> )             | Movement of soils in bulk or on tyres, tracks and footwear; water; wind       | Seeds   | 0.8–1.4 mm long, 0.06 mg                       | A 2 m plant can produce >1 million seeds per annum                   |
| <b>Animals</b>  |   |   |  |  |
| Zebra mussel ( <i>Dreissena polymorpha</i> )              | Water; water-based recreation including angling; dogs; footwear and equipment | Sperm cells, eggs and veliger                   | Veliger <300 µm long                           | Females start producing eggs within 6 weeks of settling on riverbed  |
| Asian longhorn beetle ( <i>Anoplophora glabripennis</i> ) | Untreated timber, particularly that originating within beetle's range         | Infected wood containing eggs, larvae and pupae | 50 mm long, 5.4 mm wide                        | Species spends 2–4 years as a larva                                  |

**Box 1. Personal biosecurity kit.**

|  |  |
|--|--|
| Plastic storage box                            | Powder-free disposable vinyl gloves                                  |
| Supply of clean water (approximately 5 litres) | Eye protection   |
| Boot tray or flexitub                          | Brush, sponge or portable sprayer                                    |
| Hard brush and boot tread scraper              | Paper towels or wipes  |
| Disinfectant                                   | Re-sealable bags for samples   |
| Vapour-proof container for disinfectant        | Plastic bags and ties for clothing and personal protective equipment |

Source: Forestry Commission (2012).



## Best practice to protect your equipment

### Cleaning

Determine the cleaning requirements for the different biosecurity levels, then implement necessary cleaning and washing of equipment and footwear. This could range from using a boot tread scraper to remove dry soil from boot ridges to full disinfection (see below). Where water/disinfectant is used, this should be carried out on a permeable surface away from a water source where re-contamination could occur. Cleaning should be sufficient to remove dirt and kill or remove any animals or propagules present and to ensure that moisture is not retained. Larvae of mussels and crustaceans have a limited lifespan out of water but will persist for longer if damp conditions are maintained.

Where footwear or equipment cannot be adequately cleaned in the field, such items should be bagged and cleaned later, ideally using hot water (see below). A small pump-action sprayer can be useful in the field to remove invasive species.

### Drying and heating

Drying equipment that has had contact with potentially contaminated water can help break potential pathways of spread or transmission. Single stems of spiked water-milfoil (*Myriophyllum spicatum*) were found to be viable for up to 24 hours of drying and coiled strands were viable for up to 72 hours (Bruckerhoff *et al.* 2013), whereas for curled pondweed (*Potamogeton crispus*) single stems were viable for 18 hours and turions after 28 days of drying.

Heating can also be used in cleaning of equipment, footwear and clothing to kill invasive species, where access to hot water is possible. Ideally, both wet and dry heating can be employed and should be used in concert with drying to ensure that all invasive species are removed or killed. During wet heating, it is recommended that water is applied at a temperature of 60°C over a period of 10–20 seconds, for example a hot wash (over 60°C) of clothing exposed to contaminated water over a period of a minute is sufficient to kill the larvae of mussels and crustaceans (Wong *et al.* 2014). Dry heating should attempt to meet the same temperatures and can

be used to dry equipment, clothing and footwear.

Exposure of zebra mussels, killer shrimp, bloody-red mysid (*Hemimysis anomala*), floating pennywort (*Hydrocotyle ranunculoides*), curly waterweed (-thyme) (*Lagarosiphon major*), New Zealand pigmyweed (Figure 4) and parrot's feather (*Myriophyllum aquaticum*) to hot water (45°C, 15 minutes) was tested as a method by which equipment can be 'cleaned', comparing this to drying and a control (no heat treatment) (Anderson *et al.* 2015). Hot water caused 99% mortality across all species 1 hour after treatment and was more effective than drying at all time points. In contrast, six out of seven species survived for 16 days without any treatment, and drying caused significantly higher mortality than the control (no action) from day 4 onwards, demonstrating that short-term drying cannot be relied upon to kill propagules.

Additionally, hot water treatment of 45–50°C reduced seed viability of Himalayan balsam (*Impatiens glandulifera*) by up to 93% (Oliver *et al.* 2020) and after 8 days' incubation at 42°C none of the 1199 giant hogweed seeds that were incubated at this temperature were viable (Tanke *et al.* 2019).

### Chemical treatment

A range of disinfectants are used to kill invasive non-native species, although they are mostly targeted at diseases. Generally, chemicals are relatively ineffective in killing plant propagules for which washing, drying and heating are more effective. Chemicals are more effective against animals and particularly early life stages, for example veligers and other larval forms. For example, Barbour *et al.* (2013) found that Virkon® was 93.3% effective when used at 2% for 5 minutes in treating varying sizes of Asian clam (*Corbicula fluminea*). The use of any disinfectant requires risk assessment, including COSHH guidelines, to ensure proper use and suitability to the site in question.

### Ongoing research and gaps

The challenges presented by invasive non-native species are significant and



Figure 3. A single giant hogweed plant produces about 20,000 seeds. Photo: Max Wade.



Figure 4. New Zealand pigmyweed fragments on the hull of an inflatable boat. Photo: Mark Fennell.

predicted to increase (Stebbens *et al.* 2017). Research is needed to develop preventative, rapid response and control measures, and needs additional commitment from governments and other agencies. Moving research findings into practice requires closer cooperation between researchers and practitioners. New technologies offer interesting opportunities; for example, eLearning was highly successful at raising awareness of invasive non-native species and encouraging behaviour change among both field workers and researchers to try to reduce the risk of accidental introduction and spread (Shannon *et al.* 2020).

There is currently little work done on how individual invasive species are likely to respond to climate change, although indications are that increased invasions are likely (Waryszak *et al.* 2018). In addition to facilitating spread, conditions will be created in which new invasive species will thrive. Horizon scanning, and ensuring robust biosecurity is in place to minimise current and future impacts, have never been more important. Scientific developments will improve the management and control of invasive non-native species; however, to really gain traction on controlling them, countries and regions will need to improve biosecurity cooperation (Faulkner *et al.* 2020).

All this emphasises how important it is that biosecurity must be a matter of course as part of our fieldwork, just as is health and safety.

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# The True Cost of Biosecurity: Who is Paying?

Figure 1. Aquatic ecologists at work; their considerable equipment list must be checked, cleaned and dried. Photo: Five Rivers.



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Keywords: biosecurity risk, INNS, invasive non-native species, pathogens, wastewater

The cost of effective biosecurity procedures is a more complex issue than one would expect. Without appropriate biosecurity measures it is evident that our ecosystems pay the price. Fortunately, this risk can be reduced by investment in procedures, resources, facilities and education. In a world where the financial

bottom line too often dictates the selection of suppliers, consultants and contractors, the authors aim to raise awareness around the practical complexities of biosecurity and the true cost of robust biosecurity practices, while asking the question: how is the cost being shared?

### Paying the price

As ecologists, we have a passion for species and habitats and are well versed in the detrimental effect that the introduction of non-native species and

pathogens have on them. Professionally, we promote and adhere to best practice in line with the Defra 'Check, Clean, Dry' campaign and are acutely aware that our own activities pose a biosecurity risk. For context, in 2020 Tom and his team personally encountered 19 species of non-native and invasive species (see Table 1) in surveys of aquatic and riparian habitats. This list includes only the organisms we can see with the naked eye and does not take into account microorganisms such as crayfish plague or fish parasites. To deliver on best-practice biosecurity procedures, considerations need to be made to guarantee that adequate time, resources and budget are set aside to undertake measures to the desired standard.

### Biosecurity: it's about time

The most effective control measure to reduce the biosecurity risk from our activities as professionals can be summed up in one word: time. What is the cost of following industry standards and recommended procedures to a standard that one can be confident in? On paper, the task sounds simple: check

your equipment for plant fragments, invertebrates or any other organic matter that may hide hidden hazards; clean the equipment; and dry it. Simple. However, the practicalities and wider considerations are more intricate than one might first perceive: in aquatic ecology everything gets wet (see Figure 1), the equipment list is long and the list of organisms attempting to piggyback a lift to your next destination is even longer.

Your organisation may have the most dazzling of procedures, biosecurity policies and operational instruction, or (if you are a client procuring services) a

supplier evaluation model that scores biosecurity management. However, failure to allocate adequate time to every activity increases biosecurity threat, and the stakes are raised for species and habitats.

Time must be factored not only for the physical task of biosecurity, but for strategic planning. The first step is the scrutiny of policies, accreditation and method statements to select a supplier or contractors. Then, desk-based assessments are undertaken to identify sites that either pose a high risk or are inhabited by vulnerable populations of

conservation concern such as white-clawed crayfish (*Austropotamobius pallipes*). Next, we have a team of people on the ground: has enough time been allocated for the schedule ahead to allow for robust biosecurity between sites, or at the end of the day at a depot? This time is spread across the project lifespan and is often quantifiable, with no excuse for its absence in the project plan. Although the physical act of biosecurity activities ('Check, Clean, Dry') is undertaken by people with their boots firmly on the ground, is it their responsibility to ensure there is adequate time, facilities and resources for biosecurity planning and procedures? We suggest this is a shared responsibility with all parties involved, including consultants, designers, contractors and the client.

### Facilities and resources: where and how?

From a best-practice standpoint, effective biosecurity processes should be undertaken at the site itself (where practical), but how does this transfer to the real world? On large sites regulated under the Construction (Design and Management) regulations (2015) with compounds, hired-in drying rooms and vehicle wheel wash stations, things are much simpler. How what about the ecologist collecting baseline data in the middle of nowhere? Is it always practical to clean on site? Do they have adequate facilities at their office/depot or temporary accommodation for cleaning, disinfecting and drying? Let's take a closer look at some of the practical complexities that many face, as well as the solutions and costs (financial and environmental).

#### Check

This is the simplest of the three steps in biosecurity. The only resources required are a keen eye, attention to detail and – ideally – knowledge of the topic itself. First, time must be safeguarded in order to secure confidence in this critical first step. Secondly, training is needed to build knowledge of the types of micro- and macro-organisms that may hitch a ride with us along the way, and the consequences if they do.

#### Clean

Cleaning throws up far more challenges than one would expect, and the

**Table 1. List of non-native and invasive species found by Five Rivers Aquatic Ecology Team in 2020.**

| Common name              | Scientific name                   | Type of species    | Habitat           |
|--------------------------|-----------------------------------|--------------------|-------------------|
| Top-mouthed gudgeon      | <i>Pseudorasbora parva</i>        | Fish               | Wetland           |
| Zander                   | <i>Sander lucioperca</i>          | Fish               | Wetland           |
| Asiatic clam             | <i>Corbicula fluminea</i>         | Macro-invertebrate | Wetland           |
| Chinese mitten crab      | <i>Eriocheir sinensis</i>         | Macro-invertebrate | River             |
| <i>Crangonyx</i> spp.    | <i>Crangonyx</i> spp.             | Macro-invertebrate | River             |
| Demon shrimp             | <i>Dikerogammarus haemobaphes</i> | Macro-invertebrate | Wetland           |
| Narrow clawed crayfish   | <i>Astacus leptodactylus</i>      | Macro-invertebrate | Wetland           |
| Signal crayfish          | <i>Pacifastacus leniusculus</i>   | Macro-invertebrate | River             |
| Virile crayfish          | <i>Faxonius virilis</i>           | Macro-invertebrate | River             |
| Zebra mussel             | <i>Dreissena polymorpha</i>       | Macro-invertebrate | Wetland           |
| American mink            | <i>Neovison vison</i>             | Mammal             | River             |
| Canadian waterweed       | <i>Elodea canadensis</i>          | Plant              | River             |
| Floating pennywort       | <i>Hydrocotyle ranunculoides</i>  | Plant              | River             |
| Giant hogweed            | <i>Heracleum mantegazzianum</i>   | Plant              | Riparian corridor |
| Himalayan basalm         | <i>Impatiens glandulifera</i>     | Plant              | River             |
| Japanese knotweed        | <i>Fallopia japonica</i>          | Plant              | Riparian corridor |
| Large-flowered waterweed | <i>Elodia densa</i>               | Plant              | River             |
| New Zealand pigmyweed    | <i>Crassula helmsii</i>           | Plant              | Wetland           |
| Water fern               | <i>Azolla filiculoides</i>        | Plant              | Wetland           |



solution(s) are unfortunately not a 'one size fits all' scenario. Although the task itself is simple, the practicalities, wider environmental implications, equipment and facilities require considerable thought and, often, financial expenditure.

To every coin there is a flip side: stringent biosecurity uses considerable volumes of water, a dwindling resource due to abstraction for drinking water. Here it would appear that the cost of biosecurity is more than a financial one; rather, there is an environmental cost that must not be ignored. As a Tier One supplier to the water industry, we are aware of the investment being made by water companies to develop Water Resources Management Plans (WRMPs), to identify Strategic Resource Options (SROs) and to allocate capital expenditure to reduce the UK's reliance on water abstraction. Long-term planning is great news (especially for globally rare chalk stream habitats which are under threat), but in the short term there are actions that can be taken to reduce water usage while not jeopardising biosecurity.

Challenges faced following our move to a new head office with our current employer highlight the choices and investment required. We wanted to install rainwater storage but quickly discovered there was no connection to the mains foul sewer: sewage is treated on site, with no option for discharge of commercial wastewater. Thankfully, we had a plan B: a self-contained wash station manufactured by Filtabund (see Figure 2). The wastewater flows into a multi-stage settlement tank, automatically dosed with hydrogen peroxide and coagulant to bind sediment in solution, then filtered using mechanical, biological and ultraviolet filtration to supply clean water. The settlement tank is emptied annually with water and sediment responsibly disposed of using a licensed waste carrier. While far from a cheap solution (approximately £30,000), it was a small price for the confidence that equipment can be cleaned and risk-contained.

## Dry

In the UK we cannot rely on dry weather for the final biosecurity step. Heated and ventilated drying rooms are an essential resource – especially for those with busy schedules – to guarantee that equipment

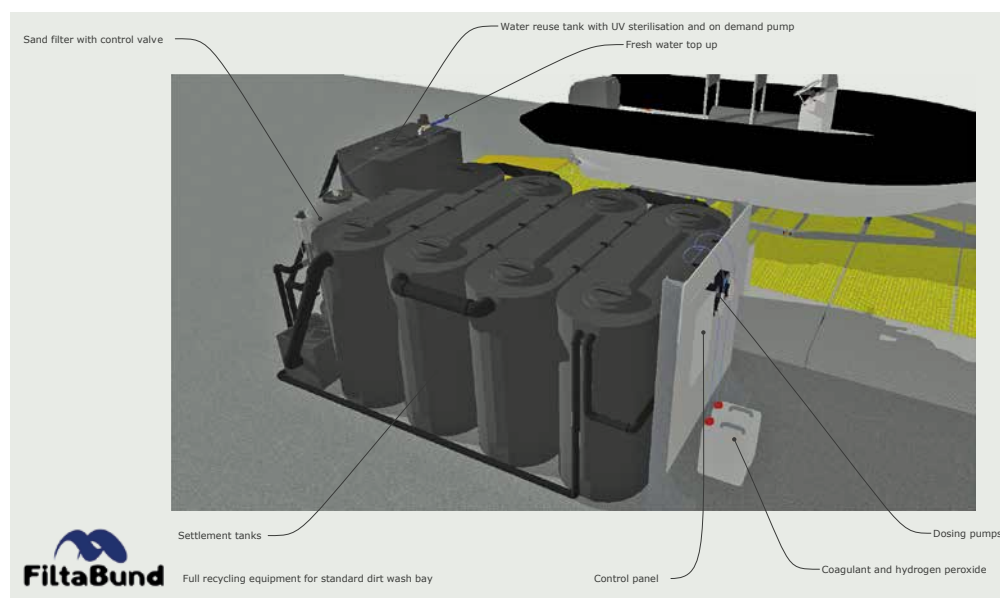


Figure 2. Filtabund system for collection and processing of wastewater generated during cleaning. Reproduced with permission of Filtabund.

is bone dry, killing organisms which may have evaded the checking and cleaning, or those so small that they are in the water itself. On a construction project, drying rooms can be hired in and built into the cost billed to the client, but what about back at the depot? Personal protective equipment (PPE) can be managed by drying at individuals' homes, potentially at their own cost if the central heating isn't already on. The permanent investment in assets such as drying rooms is an obvious choice and cost can be in the low to medium range, dependent on current space and infrastructure.

## Home and away

Another challenge faced by many is the reality of working away from home and their operational depot, staying in temporary accommodation. This requires its own considerations about the type of accommodation and may incur additional costs. When working remotely (not within the confines of a red line boundary), hotels don't cut the mustard: they offer inadequate space for daily cleaning, drying and, where required, the disinfection of boats, vehicles, equipment and PPE. Considerable time is required to find the right facilities within a specified budget to give confidence in our procedures.

## Where does the time go?

Now comes the critical consideration: if insufficient time is programmed, or inadequate resources are available, what happens next? Add to this scenario

the challenges of the real world such as land access issues arranged by a third party ("*Change of plan: we need you to visit site B instead today due to land access constraints.*"), a closing survey window looming on the horizon requiring last-minute programme change or an unexpected invasive species being encountered. In step our dutiful ecologists, machine operators, site operatives and conservationists, committed to their role in protecting and enhancing our environment, to thinking about and following through on biosecurity. The risk has been controlled, but who is paying for their commitment?

Is the project budget realistic and sufficient for operational teams to undertake the activities to industry-leading standards? Has enough planning and logistical time been allowed in the project programme, preventing the last-minute change of plans due to typical constraints such as land access? Is there a contractual mechanism for managing change and sharing the cost of unexpected invasive organisms, especially species that are time-consuming to check and clean from equipment, such as New Zealand pigmyweed (*Crassula helmsii*)? If the answer is no, then the stakes have just been raised, and the overheads of an organisation have increased, corners have been cut to save time to protect the financial bottom line or, in a commercial setting with time codes and tight budgets, dutiful employees may have just worked additional hours for free.

**Table 2. Annual cost of invasive and non-native species on each sector in the UK (Williams *et al.* 2010).**

| Sector                                       | UK cost        |
|--|----------------|
| Agriculture                                  | £1,070,000,000 |
| Construction, development and infrastructure | £212,000,000   |
| Forestry                                     | £109,000,000   |
| Tourism and recreation                       | £98,000,000    |
| Transport                                    | £81,000,000    |
| Human health                                 | £48,000,000    |
| Biodiversity and conservation                | £41,000,000    |
| Quarantine and surveillance                  | £18,000,000    |
| Research                                     | £17,000,000    |
| Utilities                                    | £10,000,000    |
| Aquaculture                                  | £7,000,000     |

### Sharing the risk and cost transparency

It's clear that the appropriate allocation of time and resources is essential in the facilitation of industry-leading biosecurity, and for this there is an associated cost. According to Williams *et al.* (2010) the estimated financial impact to the UK of invasive and non-native species was approximately £1.7 billion a year in 2010 (Table 2). While the report is now over 10 years old, the situation is unlikely to have changed and the cost is likely to have increased with the arrival of new species and further dispersal of those present in 2010. Good biosecurity may seem expensive in the short term, but the indirect financial implications ripple throughout our economy with long-term costs for communities and environmental sectors.

So, what can be done to reduce the risk of biosecurity breaches and their negative consequences, both for our environment and our wallets? After all, we are all consumers of essential products such as clean drinking water and food, whose prices are indirectly linked to biosecurity. How can we, as environmental professionals, influence industry to promote a culture of shared and transparent responsibility to guarantee the biosecurity bar is continually raised across our sectors and those that we are entwined with?

From a commercial standpoint, when evaluating tender submissions, should the client expect to see a minimum percentage of the contract value

allocated to the task of biosecurity, extended beyond the activity of 'Check, Clean, Dry' to include robust planning? This is certainly the case for project management, where it is widely accepted that the client expects to see a minimum percentage of the contract value to ensure project success.

Alternatively, is there a more evidence-based approach that can be adopted by the client in the procurement of contractors that provides quantifiable proof of biosecurity procedures and facilities? Evidence could include details of responsible management of wastewater produced during cleaning; submission of drainage plans and discharge consents; square metrage of drying facilities on site or at depots; the number of staff this space will service and the heater wattage; a commitment if awarded to supply details for those working remotely, providing detailed method statements for their accommodation of choice; or potentially more hands-on auditing of suppliers to observe procedures in action. Currently, this assurance may be provided by environmental certification (ISO 14001), which is a fantastic baseline, but is this evidence alone enough?

'You win some, you lose some,' goes the adage, but in the world of fixed price quotes and purchase orders, this is certainly the case. When it comes to the presence of invasive species not identified prior to pricing, then the time allocated to checking and cleaning equipment is likely to be considerably underestimated. A perfect example is New Zealand pigmyweed:

if, at the time of pricing, it is assumed to be absent but found on arrival to site, conversations must be had around reduced survey effort to allow for increased checking and cleaning, application of lower-risk methodologies or, worse yet, implementation of insufficient biosecurity procedures increasing the risk of spread. The use of professional services contracts that are designed to share risk, manage change and create an honest and open dialogue between consultant and client are surely the only option for ensuring the risk to our environment is minimised.

### Conclusion

With Invasive Species Week having just passed in May, it seems pertinent that we all make time to stop and think about our responsibilities in preventing the spread of biological organisms that threaten our ecosystems. The responsibility for biosecurity is a shared one, with all parties involved in projects required to play their part. Raising the standard to the highest of levels across our sectors and beyond will require more than investing time and resources for improved checking, cleaning and drying. If at every turn we promote, educate and deliver best practice, if we take time to influence key stakeholders through effective communication and if all sides work together in transparent partnership to share the risk, then the biosecurity threat will diminish.

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# Tackling INNS and Implementing Biosecurity in Local Authorities: A Yorkshire Case Study



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Keywords: amenity, development, modelling, pathways of spread

We present a case study in the Yorkshire Region aiming to implement biosecurity in local authorities (LAs) to slow the introduction and spread of invasive non-native species (INNS). We combined workshops and interviews with LAs and other land managers, and statistical modelling to develop recommendations for targeted biosecurity. Modelling revealed key pathways of spread (and hence targets for biosecurity) to be land use, including development sites, amenity sites and access routes. LAs

tend to be reactive rather than precautionary. Further, there is a lack of funds to tackle INNS and it is hard to know where to target biosecurity due to the multiple pathways of spread of INNS and uses of LA land. Key recommendations are the need for detailed cost assessments, coordinated biosecurity and responses within catchments, and embedding of biosecurity in key activities and current ways of working.

## Introduction

Once established, invasive non-native species (INNS) can rarely be eradicated and costs can spiral with year-on-year treatment. The total cost of INNS to the

British economy is approximately £1.8 billion per year (Environmental Audit Committee 2019). Many of these costs relate to treatment, and it is therefore very important to prevent the spread of INNS.

Although INNS can spread naturally, the main pathway of spread is human activity, including agriculture, tourism, trade, recreation, environmental management and development. INNS can be spread by contamination of clothing, vehicles and equipment or in soil, and just a few fragments of plant, a few seeds or a few animals can form a new infestation (Environmental Audit Committee 2019). Many of the key pathways in the UK involve work in/or around the water environment – agriculture, recreation or water/environmental management – or recreational water use (e.g. by anglers, boaters and hikers). Understanding the links between INNS spread and human activities around water is important because aquatic INNS present an additional challenge due to these multiple pathways. Furthermore, aquatic INNS establish and spread both in the river channel and on the banks, presenting a great technical challenge and greater costs due to their rapid spread.

Figure 1 shows the spread of Japanese knotweed (*Fallopia japonica*), an INNS plant native to East Asia, in the Upper Aire Catchment, Yorkshire. The data, downloaded from INNS Mapper (<https://ywt-data.org/inns-mapper/home>), show the spread between 2014 and 2016. In 2014, Japanese knotweed was predominantly in the lower river reaches of the Upper Aire, whereas in 2015 it was found further upstream. The upstream spread over such a large area does not relate to natural

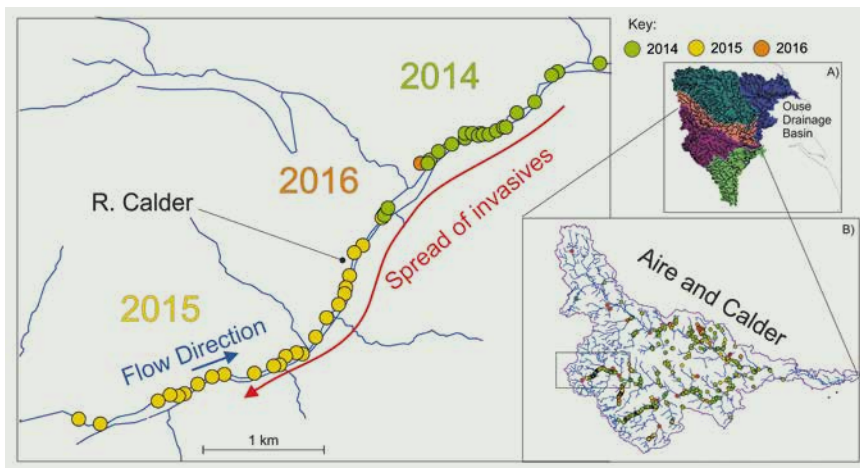


Figure 1. Upstream spread of Japanese knotweed in the Upper River Calder, detailing the first recorded occurrence of the INNS. Insets: (A) wider Ouse Drainage Basin and (B) location of the Aire and Calder river catchments. Data taken from INNS Mapper.

pathways of spread. The most likely pathway of this spread is human activity (e.g. development, navigation, recreation). This highlights the need for biosecurity as the first line of defence in preventing INNS introduction and spread. It involves simple measures to reduce the risk of INNS spread via activities out in the environment, and is promoted through campaigns such as Defra's 'Check, Clean, Dry' ([www.nonnativespecies.org/checkcleandry/](http://www.nonnativespecies.org/checkcleandry/)) and 'Be Plant Wise' ([www.nonnativespecies.org/beplantwise/](http://www.nonnativespecies.org/beplantwise/)).

Previous research with stakeholders in Yorkshire identified that critical barriers to biosecurity include cost (especially time) and lack of clear guidance (Sutcliffe *et al.* 2017). Leeds University researchers tested and developed different biosecurity protocols (e.g. cleaning of clothing and equipment using hot water soaking, high-pressure hot water sprays and drying) appropriate to a range of environmental activities (Anderson *et al.* 2015, Shannon *et al.* 2018, Bradbeer *et al.* 2021). They developed evidence-based biosecurity protocols while minimising associated costs and ensuring staff safety and environmental compliance. This research offers vital practical knowledge for embedding biosecurity in organisations. To ensure cost-effective use of biosecurity, especially in the context of limited budgets, it is important to identify high-risk activities that may lead to INNS spread.

The Integrated Catchment Solution Programme (iCASP; <https://icasp.org>).

uk/), Environment Agency, Yorkshire Water, Yorkshire Wildlife Trust, Dales to Vales network, Yorkshire Invasive Species Forum and two local authorities (LA) are using existing research evidence and expertise on biosecurity, modelling, stakeholder engagement, policy development and behavioural change to inform LA strategies related to INNS. An initial workshop hosted by iCASP highlighted that LAs tend to be reactive (focusing resources on year-on-year management of established INNS) rather than precautionary (preventing the introduction and/or further spread of INNS). Further, there is a lack of funds to tackle INNS and it is hard to know where to target biosecurity due to the multiple pathways of spread of INNS and uses of LA land. To help facilitate the uptake of biosecurity by LAs, the project aims to address these issues. This article presents a case study of the work in two Yorkshire LA areas, part of the Aire and Calder catchments (Figure 1). These catchments have a wide range of land uses and include large areas of both rural and urban land. Many of the rivers in these catchments drain upland areas, then pass through major towns and cities before joining the River Ouse and draining into the Humber Estuary.

### Tackling INNS in Yorkshire

Interviews were undertaken by the iCASP team to understand how INNS are currently being addressed across Yorkshire. A range of organisations were interviewed including LAs, water companies, statutory agencies

and charities. The interviews showed varying approaches to tackling INNS. INNS are a cross-departmental problem and it is often the case that no one team has a budget or remit to address INNS. There is reliance on integrating efforts across departments with other work priorities and budgets. Due to the lack of designated funding within organisations, INNS work tends to be reactive (treatment) rather than precautionary (biosecurity). In many cases it falls to individual officers within an organisation to promote awareness and champion the treatment/prevention of INNS, and to influence senior management to allocate resources. Individual officers identified the importance of biosecurity to guard against rising annual management costs of INNS; however, cost data are needed to support this approach. There is also a lack of data on the costs of INNS for specific organisations: often organisations record the cost of hiring contractors for work, but little consideration is given to the knock-on costs (e.g. access to recreational sites, delays to building works or the costs from loss of biodiversity). Further, the commonly used metric of 'linear metres along a watercourse' does not take into account the volume of INNS treated, limiting the ability to make accurate cost evaluations and comparisons between sites. Standardised data across organisations/departments are important to quantify the costs of INNS and provide evidence for the cost-effectiveness of moving from a reactive to a proactive, precautionary approach.

### Pathways of spread of INNS

Identifying the main pathways of INNS spread is important to reduce this spread and to target a biosecurity effort, particularly when resources are limited. We used data on the spatial distribution of INNS and their spread over time alongside data on key activities and land use to identify pathways of spread. This will allow authorities to target high-risk activities and uses of their land, ensuring a cost-effective approach to biosecurity.

This project used data from INNS Mapper on the presence of three key INNS plant species in the Yorkshire region: Japanese knotweed, Himalayan balsam (*Impatiens glandulifera*; native to the Himalayas) and giant hogweed



(*Heracleum mantegazzianum*; native in SW Asia) (Figure 2). These species were identified by the LA as the most prevalent and problematic in the LA areas of interest. In collaboration with LA partners, data were compiled on land use (including development data), access points such as pathways and roads, location of the water network and the location of amenities including green space and angling sites, primarily using Ordnance Survey data. These physical and anthropogenic factors represent different pathways of spread. Statistical analysis was undertaken to ascertain which pathways contribute to the presence and spread of INNS. The potential pathways of spread were categorised as follows: amenity (e.g. green space, angling sites), access (paths, roads) and land use (e.g. urban, development, farming) (Figure 3). Our analysis asked two related questions: which types of location are more likely to be colonised by INNS? (a spatial model) and which areas suffer the most rapid spread of INNS? (a temporal model). The rationale for two analyses was that the initial factors leading to infestation may differ to those that cause subsequent spread over time. Between 2011 and 2013 there were 413 sightings of Japanese knotweed, Himalayan balsam and giant hogweed; in 2014–2016 there were 3356, an increase of 700%. These data show that INNS are becoming more common in the region and highlight the need for biosecurity in Yorkshire to reduce/prevent

further spread as well as the need to understand what is causing the spread. Our spatial modelling indicates a significant relationship between INNS and land use, amenities and access (e.g. footpaths). There was also a higher incidence of INNS in areas where development/construction had occurred. With regards to land use, giant hogweed was found more often near water and Japanese knotweed was more likely to occur in non-natural (e.g. urban) areas. Spread (temporal modelling) of INNS over time was similarly related to these factors. The full statistical output will be available on the iCASP website shortly and a peer-reviewed article is in progress. Development (i.e. construction, including existing buildings with works, such as extensions requiring work permits) was a key factor predicting the presence and spread of INNS. Incorporating development data for the larger LA area, Himalayan balsam and giant hogweed were found significantly more often on development sites, with a similar trend in the smaller LA. Spread of giant hogweed over time was also related to the locations of developments in the larger LA. These results highlight the importance of development activities in the accidental spread of INNS to new sites. Overall, this work shows that there is a strong link between INNS presence and land use. There are stronger links between INNS and development in the larger LA, perhaps due to more



Figure 2. (A) Giant hogweed, (B) Himalayan balsam and (C) Japanese knotweed. Photos: (A, B), Steph Bradbeer; (C) Tube Lines Ltd - GB Non-native species secretariat, Crown Copyright.

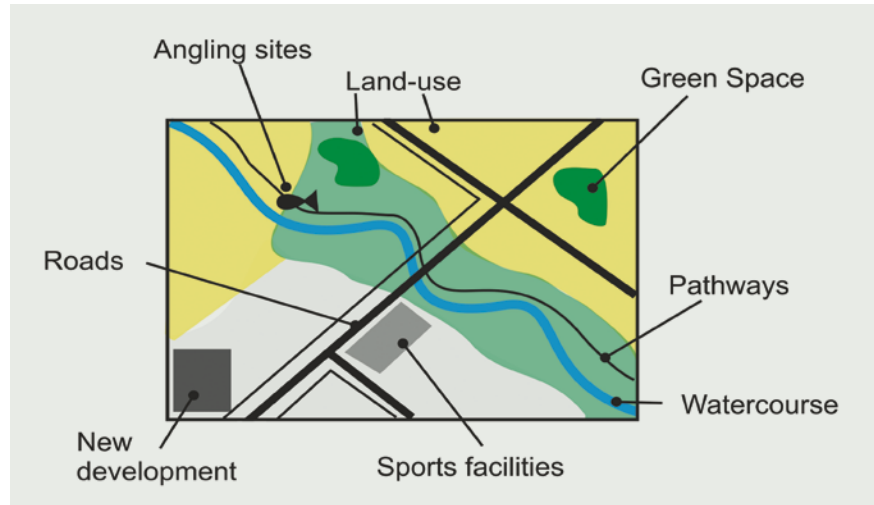


Figure 3. Schematic diagram showing the factors that affect the spread of INNS, including land use and development sites, amenities including angling and green space, and access routes such as pathways and roads.

development occurring. The spread of the three INNS over time reflects movement, whether of people (in the case of amenities and footpaths) or of machinery and building material (in relation to development and roads). These data can be used to target biosecurity effort. The link between areas of amenity and INNS spread highlight the importance of awareness-raising among the public (e.g. anglers, walkers), focusing also on access points (e.g. car parks). The links between INNS spread and development highlight the importance of targeted biosecurity for industry and contractors undertaking work on LA land.

## Recommendations

### Recommendation 1: The need for more data

INNS Mapper is a key resource to enable land and catchment managers to coordinate INNS management. It is important for LAs and other land managers to record INNS on INNS Mapper. We have also demonstrated its use in identifying drivers of INNS spread. This project focused primarily on open access data. However, through interviews with stakeholders it is clear that more information needs to be collected. Linear measurements such as 'metres of riverbank infected' do not show the areal coverage of the INNS. This information is vital to ensure that organisations budget correctly for tackling INNS.

An understanding of the full costs of INNS (e.g. impacts on recreation and human health, delays to development) is important. Speaking in terms of these socio-economic impacts is key and highlights the importance of biosecurity to guard against spiralling future costs.

### Recommendation 2: The need to embed biosecurity within organisations

In Yorkshire, INNS are becoming more common. Biosecurity to prevent the arrival of INNS in new sites is more cost-effective than treating established INNS, and increased investment and focus on biosecurity is vital to stop this spread and escalating treatment costs. To be effective, it is recommended that biosecurity protocols are embedded in current ways of working, for example by including biosecurity in the tendering process for contractors.

INNS control relies on a combination of treatment and preventative measures. However, effective biosecurity practices allow for a shift towards a proactive precautionary approach to INNS to prevent the spread of INNS and the associated increasingly costly reactive treatment. Embedding biosecurity in LAs will ensure a focus on many of these pathways, since LAs work across a wide area and have different departments and contractors that interact with these pathways. For effective uptake of biosecurity, training and guidance is required. In relation to LAs, evidence-based training and guidance should be tailored to the types of user and

contractor that LAs work with who are at risk of spreading INNS.

### Recommendation 3: The need for coordinated responses to INNS

Within a river catchment there are multiple organisations at work. Platforms such as the Yorkshire Invasive Species Forum are crucial to coordinating a regional response by sharing ideas, best practice and lessons learned, as well as facilitating the coordination of data collection and on-the-ground efforts to promote efficiency and biosecurity procedures.

## Conclusions

Biosecurity represents a vital action to prevent the spread of INNS. To be implemented, a clear budget is required. It is important that LAs embed biosecurity in their existing ways of working, for example during tendering, to guard against INNS introduction and spread and associated year-on-year treatment costs. This project has shown that in Yorkshire biosecurity efforts should focus on the following key areas: waterways, grasslands and non-natural and urban areas including sites of development, areas of amenity (green space and angling sites) and access routes. They should also focus on the key activities of recreation and development.

Biosecurity training and guidance should be evidence-based and tailored to each specific audience to ensure effective uptake; it should not represent an additional barrier but should work within the current practices of organisations. This work is the first time the spread of INNS has been statistically assessed in Yorkshire. However, lessons learned can be applied across catchments in the UK. Defra estimates that between 36 and 48 new INNS will become established in the next 20 years in Great Britain (Environmental Audit Committee 2019), and therefore slowing the rate of arrival is a first priority to prevent their establishment. The pathways investigated in this study are ubiquitous across the UK and should be the focus of biosecurity efforts related to aquatic INNS.

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## Note

The full statistical output of the work presented here will be available on the iCASP website shortly.

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# Marine Invasive Non-native Species in the UK: Scale of the Problem and Progress of the Response

Figure 1. Marine tubeworm (*Ficopomatus enigmaticus*), Liverpool Docks, November 2013. Photo: Steve Mustow.



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**Keywords:** alien species, biosecurity, ballast, brackish, Marine Protected Areas

This article provides an overview of marine, including brackish water, invasive non-native species (INNS) in the UK, and considers how they are introduced and spread, the legal and policy background, the measures taken to prevent introduction and, when that fails, how they can be managed or potentially eradicated once

established. Issues associated with climate change and Marine Protected Areas are also considered, and a case study is provided.

### Introduction

Marine INNS cause environmental, social and economic problems, and are one of the greatest threats to global marine biodiversity (Foster *et al.* 2016). Although most non-native species (NNS) do not produce impacts, a minority

have the potential to become invasive (Shannon *et al.* 2020a). Marine INNS threaten ecosystem services such as food and energy and can result in restriction of navigation, clogging of propellers and smothering and disease of aquaculture stock (Payne *et al.* 2015, Shannon *et al.* 2020b). Marine INNS present a major threat to biodiversity by changing habitat and ecosystem functioning, introducing diseases and parasites, and causing genetic impacts (Cook *et al.* 2016). The direct cost of INNS to aquaculture and shipping in Great Britain was estimated in 2010 at £40 million per year (Williams *et al.* 2010) and is now likely to be greater. In Great Britain the problem appears to be growing. The Joint Nature Conservation Committee biodiversity indicators showed an increase in the number of marine INNS established across 10% or more of coastline from 2010 to 2017, compared to 2000 to 2009 (Environment Agency 2019).





Figure 2. Leathery sea squirt (*Styela clava*), Liverpool Docks, May 2014. Photo: Steve Mustow.

Table 1. Brackish water and marine INNS designated by UKTAG as high impact.

| Species   | Group  | Habitat             | Distribution*           | GB risk assessment† |
|---|--------|---------------------|-------------------------|---------------------|
| Chinese mitten crab ( <i>Eriocheir sinensis</i> )                             | Animal | Freshwater/brackish | E, S, W                 | Yes                 |
| Gulf wedge clam ( <i>Rangia cuneata</i> )                                     | Animal | Freshwater/brackish | E (Lincolnshire only)   | Yes                 |
| Marine tubeworm ( <i>Ficopomatus enigmaticus</i> ; Figure 1)                  | Animal | Brackish            | E, W, NI                | No                  |
| Slipper limpet ( <i>Crepidula fornicata</i> )                                 | Animal | Marine              | E, S, W, NI             | Yes                 |
| Colonial tunicate ( <i>Didemnum</i> spp. non-native)                          | Animal | Marine              | E, W, NI                | Yes                 |
| Asian shore crab ( <i>Hemigrapsus sanguineus</i> )                            | Animal | Marine              | E, W                    | Yes                 |
| Asian shore crab ( <i>Hemigrapsus takanoi</i> )                               | Animal | Marine              | E (Thames estuary only) | Yes                 |
| American lobster ( <i>Homarus americanus</i> )                                | Animal | Marine              | E, S                    | Yes                 |
| Leathery sea squirt ( <i>Styela clava</i> ; Figure 2)                         | Animal | Marine              | E, S, W, NI             | No                  |
| American oyster drill ( <i>Urosalpinx cinerea</i> )                           | Animal | Marine              | E                       | Pending             |
| Common cord-grass, Townsend's grass or rice grass ( <i>Spartina anglica</i> ) | Plant  | Marine              | E, S, W, NI             | Pending             |
| Japanese kelp ( <i>Undaria pinnatifida</i> )                                  | Plant  | Marine              | E, S, W, NI             | Pending             |

Climate change is likely to exacerbate this situation by enabling the poleward movement of some alien species (Minchin *et al.* 2013).

### Marine INNS in the UK

At least ninety NNS have been identified from British marine and brackish waters, of which 58 are established (Minchin *et al.* 2013). Twelve high-impact marine and brackish water INNS have been identified in Great Britain by the UK Technical Advisory Group (UKTAG) on the Water Framework Directive (Environment Agency 2019), as shown in Table 1.

The ongoing challenge of preventing the arrival of new marine INNS is illustrated by a recent study that screened 363 marine NNS currently absent from or with a limited distribution in EU marine waters. The study identified 26 species as posing a particular risk of invasion (Tsiamis *et al.* 2020).

### Biodiversity impacts

Biodiversity impacts can occur through several mechanisms (examples below as referenced in Cook *et al.* 2016), as follows.

- Habitat modification: for example, in two regions of the Netherlands species diversity decreased significantly following introduction of the carpet sea squirt (*Didemnum vexillum*), which ended up locally covering 95% of the hard bottom.
- Changes to ecosystem functioning: for example, the introduction of a *Spartina* hybrid into a US estuary changed the system from being algal to detritus-based.
- Parasites and diseases: for example, the trial cultivation in Europe of Japanese eel (*Anguilla japonica*), led to a parasitic nematode being released, causing significant damage to other eel species.

\*From NBN Atlas (<https://species.nbnatlas.org/>), accessed 5 April 2021. E, England; W, Wales; S, Scotland; NI, Northern Ireland.

†As reported by Environment Agency (2019). Risk assessments, together with other information on marine INNS, are available from the Non-native Species Secretariat ([www.nonnativespecies.org/home/index.cfm](http://www.nonnativespecies.org/home/index.cfm)).



- Genetic impacts: for example, in Australia genes from imported stocks of the Mediterranean mussel (*Mytilus galloprovincialis*) were found to have introgressed into the native Australian population.

### Introductory pathways

Marine NNS are introduced through a range of pathways, key ones including:

- Commercial shipping: 90% of world trade is transported by ship and this is a key pathway for the spread of INNS, which can be carried with ballast materials and biofouling on hulls (House of Commons Environmental Audit Committee 2019).
- Aquaculture: this involves both the intended introduction of aquaculture species to new locations, which may sometimes prove to be invasive, and the unintended introduction of species that have contaminated aquaculture consignments (Tidbury *et al.* 2016).
- Recreational boating: a particularly important vector at more local scales, with species carried on the hull or in the bilge, allowing the secondary spread of INNS away from sites of initial introduction (Foster *et al.* 2016, Tidbury *et al.* 2016).

Marine INNS can also be transported to new areas on plastic and other litter, and even on larger structures such as pontoons and jetties that are broken by storms and other events (Environment Agency 2019).

Introductions of marine NNS are ongoing, particularly in areas identified as 'invasion hot spots' due to the presence of key vectors including shipping activity, recreational boating and live animal aquaculture import (Sambrook *et al.* 2014, Tidbury *et al.* 2016). London and Immingham (north east Lincolnshire) are hot spots due to high shipping (Tidbury *et al.* 2016).

The majority of NNS in Britain were initially recorded from the English Channel, with many then moving northwards (Minchin *et al.* 2013). The majority of NNS in Britain originate from the North Pacific (35 species), followed by the north-west Atlantic (22 species), both at a similar latitude to the UK (Minchin *et al.* 2013, Payne *et al.* 2015).

### Climate change

Increases in temperature and extreme weather events due to climate change may result in alterations to the distribution of INNS around the British coast (Minchin *et al.* 2013). Habitat suitability will generally increase further north for the species with the highest potential to become established or problematic (Townhill *et al.* 2017). This has happened already: the Pacific oyster (*Magallana gigas*) has been farmed in the UK since the 1960s and it was originally believed that low sea temperatures would stop it reproducing in the wild (Mieszkowska *et al.* 2020). However, as temperatures have increased, wild populations have established outside farms, with dense beds significantly modifying existing habitat (Mieszkowska *et al.* 2020).

Other species of particular concern in the UK in relation to climate change include Asian shore crab, leathery sea squirt (*Styela clava*; Figure 2), wireweed (*Sargassum muticum*) and cord-grass (*Spartina anglica*; Townhill *et al.* 2017). The Asian shore crab, for example, is expected to spread north around the British Isles, where it has the potential to outcompete the native green shore crab (*Carcinus maenas*; Townhill *et al.* 2017).

### Marine Protected Areas

The potential for INNS to negatively impact Marine Protected Areas (MPAs) is of particular concern, given the importance of the ecosystems they encompass and the statutory requirements to protect them. Natural England (Macleod *et al.* 2016) assessed the potential impacts of eight INNS on MPAs in England and Wales. All eight target INNS were found in one or more of the 317 MPAs in England and Wales, although changes in MPA features were only reported for three of the target INNS. These were Japanese kelp, wireweed and orange-tipped sea squirt (*Corella eumyota*), whose introduction had led to changes in community composition.

A risk assessment was then undertaken of MPAs, based on features that were susceptible to or had already been colonised by INNS, and the number of target INNS that were likely to become established. Five MPAs were of particular concern due to being

susceptible to colonisation by four or more of the eight target INNS (Macleod *et al.* 2016).

### Legislation and policy

Key international conventions relevant to the control of marine INNS include the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1982, the Convention on Biological Diversity 1992 and the International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) Convention 2017. The UK has not yet ratified the BWM Convention despite the Environmental Audit Committee recommending ratification in 2014 and subsequent frustration that this had still not been done in 2019 (House of Commons Environmental Audit Committee 2019).

In England and Wales specific legislation covering INNS includes the Alien and Locally Absent Species in Aquaculture (England and Wales) Regulations 2011 and the Invasive Alien Species (Enforcement and Permitting) Order 2019. At a broader level, legislation such as the Conservation of Offshore Marine Habitats and Species Regulations 2017 is also relevant.

The Great Britain INNS Strategy was updated by Defra, the Scottish Government and Welsh Assembly Government in 2015 (Defra *et al.* 2015). It covers the terrestrial, freshwater and marine environments, and has the overarching aim of minimising the risk posed by INNS, and reducing their negative impacts.

### Control measures for marine INNS

Preventing the introduction of INNS is the most efficient and cost-effective way of avoiding economic, ecological and economic impacts. This is particularly true in the marine environment where it is extremely difficult, and often impossible, to control or eliminate INNS once established (Tidbury *et al.* 2016, Shannon *et al.* 2020a).

Biosecurity is a key component of preventing the introduction of marine INNS and includes measures to prevent their introduction and secondary

spread (Shannon *et al.* 2020b). Ideally the approach is tailored to different stakeholders and can include policy interventions, including laws or voluntary agreements, and social incentives for good behaviour (Shannon *et al.* 2020b).

Best practice guidance has been produced by Scottish Natural Heritage, Natural England and Natural Resources Wales for developing biosecurity plans for marine INNS (Payne *et al.* 2015). Examples of control measures included in this and other guidance are provided in Box 1.

### Box 1. Examples of control measures for marine INNS.

#### Prevention

- Directing visiting vessels to berths closest to the freshwater inflow, if available (reduced salinity will kill many marine INNS).
- Instructing boat/ship owners not to dispose of any water contained on the vessel into the water.
- Carrying out rapid visual checks of shellfish and finfish stock prior to release at site for any 'hitchhikers'.

#### Detection and rapid response

- Training relevant staff in INNS identification.
- eDNA surveys.
- Establishing a clear reporting and response system.

#### Control and containment

- Physically removing the species.
- Encouraging the targeted removal and commercial and /or recreational utilisation of dead specimens.
- Promoting native consumers (predators or grazers) that feed on the invasive species.

Sources: Payne *et al.* (2015), Giakoumi *et al.* (2019).



Figure 3. Seasearch dive in Liverpool Docks. Photo: Steve Mustow.

When preventative measures fail to stop the introduction of marine INNS it is important that they are detected early and that the response is rapid, as eradication measures are likely to be more successful before the species have become established (Tidbury *et al.* 2016).

New eDNA metabarcoding survey techniques can assist with both early detection and temporal/spatial monitoring of marine INNS, as demonstrated by Holman *et al.* (2019), who detected many NNS, including several newly introduced species, at four marinas across the UK.

A range of actions can be taken to manage marine INNS once they have become established (see Box 1), but none are ideal (Giakoumi *et al.* 2019). A recent study based on expert opinion suggested that raising public awareness and encouraging the commercial use of invasive species may be the most effective management techniques, whereas biological control

actions may be the least effective (Giakoumi *et al.* 2019).

Established marine INNS with potential for commercial exploitation for food include shellfish such as the American razor clam (*Ensis directus*), the American lobster, the Pacific oyster and the Manila clam (*Ruditapes philippinarum*) (there are already fisheries for the latter two species in the UK) and seaweed such as Japanese kelp (Townhill *et al.* 2017).

#### Case study: carpet sea squirt

The introduction to the UK of the carpet sea squirt, which is native to Japan, provides a good example of the risks posed by marine INNS and the challenge of eradicating them once established. The carpet sea squirt can lead to changes in habitat complexity and ecosystem function (Cottier-Cook *et al.* 2019) and attempts to eradicate it once established have been largely unsuccessful. This is illustrated by measures undertaken in Holyhead



Marina in Wales which was the first location in Britain where *D. vexillum* was detected, in September 2008. Treatment measures included wrapping infected artificial structures in polythene to prevent oxygenated water reaching the colonies, with occasional chemical applications to accelerate the process, and drying and cleaning the hulls of infected boats (Sambrook *et al.* 2014). Although the treatment had some success it failed to completely eradicate *D. vexillum* and by 2013 over £800,000 had been spent (Sambrook *et al.* 2014). *D. vexillum* was subsequently detected elsewhere in the UK, including at an oyster farm in Loch Creran marine Special Area of Conservation in Scotland, where it threatens the most expansive reefs of the serpulid, *Serpula vermicularis*, in the world (Cottier-Cook *et al.* 2019).

## Conclusions

Marine INNS are a significant problem in British waters and this is likely to get worse as more species are introduced and as climate change facilitates their spread. Preventing further marine INNS arriving and establishing is key to containing the problem. Although there is still much to be done, progress has been made, for example as a result of marine biosecurity plans developed for various regions and sectors, as well as for individual facilities and projects. Also, a consultation process is now in place on legislation to finally implement the BWM Convention into UK law by the end of 2021 (Maritime and Coastguard Agency 2021), and CIEEM will be responding to this.

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# Floating Pennywort on the Bedford Ouse:

## Lessons from Large-scale Management



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Environment Agency

**Keywords:** lessons learned, manual and herbicide treatments, mechanical, strategic management plan

In 2015 a solitary raft of the invasive non-native species floating pennywort (*Hydrocotyle ranunculoides*) was identified around a mooring on the River Great Ouse in Bedfordshire. The Environment Agency operations team treated it with herbicide and apparently removed the problem. Five years on we are still working to control the infestation, which has spread 60 km downstream and threatens to overwhelm the Ouse Washes internationally designated wetland, which also acts as a major flood storage reservoir. Despite great success during the control programme, there have been setbacks. This article outlines our catchment management plan, our field-

based approach and what we have learned about undertaking a large-scale invasive species control project.

### Introduction

Floating pennywort was originally introduced to the UK as an ornamental plant for ponds and fish tanks. It has the ability to grow up to 20 cm a day and re-grow from tiny fragments, and was soon released into the wild. In the slow-flowing rivers of East Anglia it is able to grow un-checked, quickly choking a watercourse and impacting on the native flora and fauna.

The River Great Ouse downstream of Bedford is a wide, slow-flowing lowland river, which runs 60 km to its tidal limit

through a largely agricultural landscape with many winding back channels. It is of great recreational benefit, enjoyed by boaters, anglers, canoeists, naturalists and the local populations of the market towns and villages it passes through.

From the initial 2015 infestation, in 2016 over 100 tonnes of floating pennywort were removed and composted from 1.5 km of river (Figure 1). The extent of the problem had increased significantly, with small rafts recorded over 6 km downstream.

While floating pennywort control is not generally the responsibility of the Environment Agency, due to the threat it represented to the internationally designated Ouse Washes, which is maintained as a flood reservoir, a multi-team working group was established



Figure 1. Composting 100 tonnes of floating pennywort in a low-ecological-value area. Photo: Environment Agency.



in 2016 to develop a management plan. This included representatives from fisheries, navigation, flood risk management, hydrometry and ecology, and catchment officers, inputting their technical knowledge and ensure all risks were considered in the management plan.

### Management plan

The aim of the 5 year management plan was to control the floating pennywort infestation to the point where simple repeat surveys would keep it in check. Our plan split the river into three zones: an intensive control zone, an extensive control zone and a quarantine zone (see Figure 2), characterised as follows:

- Intensive zone: mechanical removal of the large rafts starting at the upstream extent, followed by repeated passes of the length, hand-picking and spot treating with herbicide for inaccessible areas.
- Extensive control: mechanical removal of large rafts from the main river once a year in autumn to try to prevent winter floods spreading it downstream.
- Quarantine zone: 14 km immediately upstream of the Ouse Washes, regular surveillance followed up by swift removal of any plants to prevent establishment. This meant that there would be no sources of fragments close to the sensitive site.

An initial intensive zone of 4 km was set, based on the volume of floating pennywort present and the resources available to treat it. The plan stipulated that as floating pennywort was brought under control in the initial Intensive zone this length of concentrated management would be extended downstream incrementally each year, with the aim of eventually linking to the quarantine zone, thus having the whole river managed. The plan also acknowledged the need for on-going follow-up surveys beyond 5 years to identify and treat any re-growth and for very strict biosecurity measures during control. We raised awareness with other water users by contacting angling clubs and marinas, putting up alert posters at locks, producing articles for navigation magazines and speaking directly with catchment groups.

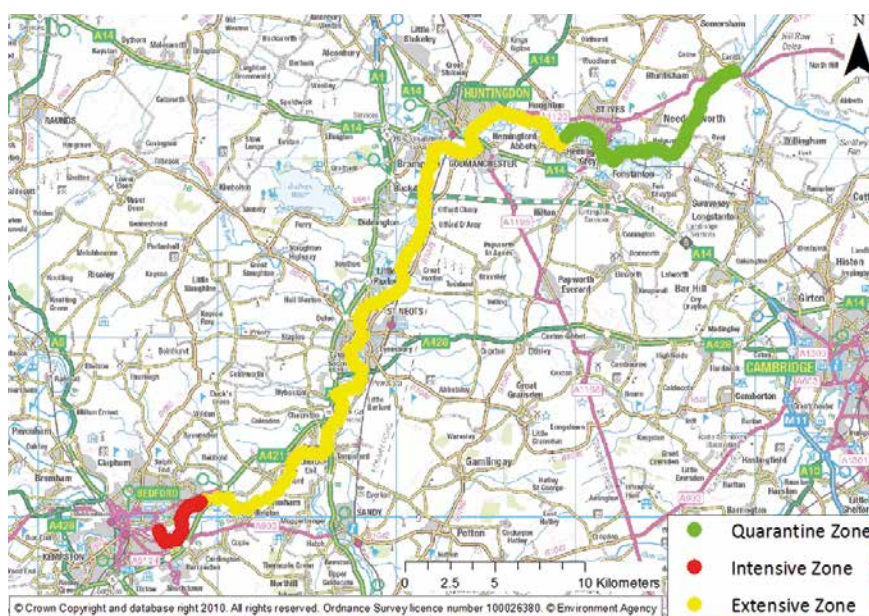


Figure 2. Map showing the extent of the different control zones in year 1.

### Translating the management plan to actions in the field

In year 1 we conducted intensive removal on the river including all side channels over 4 km, using mechanical control with weed boats feeding material into the weed harvester (a boat with a conveyor belt which pulls material from the water surface into the hull) to remove the large rafts. Pennywort was placed at intervals on the bank to compost. Floating booms were placed at key locations across the channel to collect fragments. After mechanical removal very regular repeat boat surveys were undertaken with hand removal of re-growth. Where we found that we could not reach areas safely, particularly behind navigation booms around sluices, we used herbicide for control. A glyphosate-based herbicide (suitable for aquatic use) with the adjuvant Topfilm (which helps the product 'stick' to the waxy leaves) was applied using a knapsack sprayer between April and October, when the floating pennywort was actively growing.

One of the key issues we identified was that using booms for fragment control on the main river was partially ineffective due to the lack of flow and the need to maintain navigation access. As a result we switched to having a fragment control boat, working in tandem with the weed boats, with operatives collecting fragments in hand nets. This was a much more successful option and, although more resource-

intensive, was a significant improvement for biosecurity and preventing further downstream colonisation.

As the work progressed it became apparent that tree-lined reaches were exceptionally difficult to manage (Figure 3). Pennywort tangled in the overhanging branches and was inaccessible from the boats, meaning rapid re-growth occurred. Therefore a programme of tree trimming was initiated the following winter in the intensive zone, raising the branches far enough out of the water to allow access while retaining as much biodiversity benefit as possible.

In conjunction with this work, regular surveys were carried out both to identify potential sources of re-introduction (such as connected tributaries) to include them in the control, and to monitor the extent of pennywort on the main channel.



Figure 3. Overhanging willow trees preventing control of floating pennywort. Photo: Environment Agency.

The co-operation of local partners and groups was key in the delivery of this work. Proactive water users coordinating their own working parties and local organisations undertaking engagement work vastly improved awareness and control, which complemented the management plan. Recently RiverCare (part of Keep Britain Tidy) launched a 'Pennywort Alert' campaign urging regular river users to report their sightings of floating pennywort via the iRecord website, which is monitored by the Environment Agency.

### Lessons learned and challenges

First and foremost, controlling a large-scale floating pennywort infestation is very costly, requires a lot of time and concentrated effort and is difficult to gain funding for. Therefore if you find a new infestation on a river or other waterbody that hasn't spread too far, control it immediately and visit every 2 weeks until all of the pennywort has been removed. Make sure that follow-up visits are conducted in subsequent years as the floating pennywort can return several years after apparently successful removal. Investing resources in rapid control and longer-term monitoring will save thousands of pounds and other resources.

When undertaking control, consider whether a weed boat can be used in preference to a weed harvester to lift out the rafts, as this generates fewer fragments. Remember, fragment control will be required for any form of mechanical control. Also ensure that the deposited material is on a dry area, as damp conditions will allow the plant to grow back down the bank into the water. Mechanical removal of large rafts should ideally be undertaken in autumn or winter, ready to start intensive hand-picking in spring when re-growth commences.

Herbicide treatment (with a glyphosate-based product and suitable adjuvant) only kills the leaves that it touches. On large rafts the top layer of leaves die off and others re-grow from beneath. Only use repeat herbicide spot treatments as a last resort, where it is impossible to remove the pennywort because it is deep rooted or entangled into marginal plants. Public perception of herbicides can raise challenges to its use.

Ultimately, the key to successful control is the quality of work. Employing experienced specialist contractors who are dedicated to removing every fragment, willing to adapt management techniques and provide continual feedback will result in a successful management plan.

One major challenge was a lack of clarity over who was responsible for controlling and funding the removal of floating pennywort. A removal programme is costly in terms of both time and money. Much time was also spent raising awareness across all water user groups to highlight the problems caused by floating pennywort and the biosecurity measures required to prevent its spread. Despite these efforts, and the fact that the sale of this species is now banned, a recent post on social media alerted us to multiple plants for sale in Bedfordshire. Re-release of this species could undo all of the management work.

The floating pennywort management plan will always require an adaptive approach. Naturally occurring events such as floods which uproot and move the species downstream, mild winters which allow the pennywort to grow continually with no die-back and hot summers that accelerate the growth of the species all require flexibility in the approach. Despite a reactive approach, early high water levels precluded us from fully maintaining the quarantine zone in 2019 and one raft of floating pennywort was able to establish in the designated site (which was swiftly removed once conditions allowed).

### Conclusions

Implementing an adaptive management plan, starting at the upstream extent of the infestation, with concentrated, repeated effort it is possible to control floating pennywort over long sections of the river, returning to isolated stubborn areas frequently.

We were in a good position despite work being impacted by COVID-19, before the major floods in December 2020. We had over 37 km of river under tight management and the final section of intensive control had undergone mechanical removal, ready for hand-picking. We believe that within 2 years we will be able to manage

floating pennywort on the Bedford Great Ouse with vigilant surveys and quick treatment of any re-infestations.

Research at the Centre for Agriculture and Bioscience (CABI) has led to the prioritisation of trials for a biological control agent for floating pennywort. Currently awaiting Government approval for release into the environment, the weevil *Listronotus elongatus* will hopefully contribute significantly to the sustainable management of floating pennywort and provide future cost savings.

### Acknowledgements

Thank you to all colleagues, individuals, local groups and organisations who have contributed to controlling floating pennywort: it really does need a collaborative approach.

### Resources

CABI: [www.cabi.org/projects/controlling-floating-pennywort-in-a-safe-and-sustainable-way/](http://www.cabi.org/projects/controlling-floating-pennywort-in-a-safe-and-sustainable-way/)  
 GB Non-Native Species Secretariat: [www.nonnativespecies.org](http://www.nonnativespecies.org)  
 iRecord: [www.brc.ac.uk/irecord](http://www.brc.ac.uk/irecord)  
 RiverCare website: [www.rivercare.org.uk](http://www.rivercare.org.uk)

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# Studying New Zealand Pigmyweed (*Crassula helmsii*) to Develop Innovative Assessment and Management Techniques



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Keywords: innovation, invasive species, management

The invasive New Zealand pigmyweed (*Crassula helmsii*) was first recorded in the Eastern District of the Caledonian Canal, Inverness (hereafter referred to as the canal), in 2016, with Scottish Canals reporting an increasing occurrence of the plant since then in both terrestrial and aquatic habitats of the canal. This led to the development of a long-term staged study. The aim of the study is to develop innovative assessment and management techniques to control the growth and spread of *C. helmsii*. Ecus have been involved in this ongoing study since its inception in 2018. This article discusses the project and the findings that Ecus have made to date.

## Introduction

The Caledonian Canal is a Scheduled Monument and an operational canal, important for the local tourism industry and amenity use. The colonisation by *C. helmsii* of the canal and its subsequent spread has led Scottish Canals to raise concerns of potential significant negative environmental, recreational and economic impacts on the canal.

*C. helmsii* (Figure 1) is listed as an invasive non-native species (INNS) under Schedule 9 of the Wildlife and Countryside Act 1981 (as amended by the Wildlife and Natural Environment (Scotland) Act 2011); it is an offence to 'plant, or otherwise cause to grow, a plant in the wild at a location outside its native range'.

Scotland's 2018–2032 *Climate Change Plan* (Scottish Government 2018) and the associated update (Scottish Government 2020) sets out the Scottish Government's pathway to targets set by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 (Scottish Government 2019). The documents consider the impacts of climate change on native species and the need for these species to adapt

to climate change. Native species are likely to face an increased threat as environmental conditions in the UK become more suitable for INNS. This is likely to become a significant threat to biodiversity in the UK.

## *C. helmsii*: origins and biology

*C. helmsii* is native to Australia and New Zealand; DNA analysis indicates Australia to the origin of the plants found in the UK (Brunet 2002). It was likely introduced before 1914 (Dawson and Warman 1987) but was only commercially available after 1927 and was probably sold as an 'oxygenating plant' for ornamental ponds. The first naturalised population in the UK was recorded in Essex in 1956. Currently, *C. helmsii* occurs widely throughout England and Wales, with a patchy but expanding distribution in Scotland.



Figure 1. The invasive New Zealand pigmyweed (*Crassula helmsii*). Photo: Ecus.

The species has terrestrial and aquatic forms and may develop dense monospecific stands in damp conditions up to 0.7 m above high water levels and more open stands down to 3 m depth in the water column (Dawson and Warman 1987).

The species has a high capacity for regeneration, readily breaking into small fragments, with the primary dispersal mechanism through hydrochory (the dispersal of seeds, spores or fruit by water). New shoots can develop from a single node (Dawson 1994, Hussner 2009). Furthermore, there is little winter die-back and *C. helmsii* can utilise crassulacean acid metabolism (a photosynthetic adaptation that allows gas exchange to occur at night), which may provide an advantage (Klavsén *et al.* 2011).

### Potential impacts of *C. helmsii*

Published information as to the impacts of *C. helmsii* is conflicting. The Centre for Agriculture and Bioscience International (CABI) states that *C. helmsii* has the ability to form dense stands of 100% cover, which cause many negative environmental, aesthetic and economic impacts (CABI 2018a).

It is considered that the impact of *C. helmsii* is proportional to its abundance: it is likely that there is a threshold between the presence and abundance of *C. helmsii* where there is no impact upon native species. Once that threshold is exceeded, *C. helmsii* could out-compete native plants.

### Structure of study

The long-term staged study, led by Scottish Canals working in collaboration with the CAN-DO Innovation Challenge Fund, a partnership between Scottish Enterprise, Highlands and Islands Enterprise, Scottish Government and the Scottish Funding Council, is currently being undertaken through the following series of phases:

- Initial mapping study: completed by Ecus in November 2018 (Ecus 2019)
- Phase 1: design and initial testing of innovative treatment methods (July 2019–March 2020)
- Phase 2: upscaling of preferred treatment methods (currently in very early stages of planning).

The aim of the study is that each phase builds upon the knowledge gained from the previous phase(s) to develop a scalable and viable long-term treatment solution for *C. helmsii*.

### Initial mapping study

The initial mapping study surveyed the full 9.5 km stretch of the Eastern District of the Caledonian Canal. The survey revisited the findings of a Scottish Canals 2016 survey to determine if *C. helmsii* had spread during the intervening period.

The study comprised accurate mapping of the distribution and abundance of *C. helmsii* in terrestrial and aquatic habitats along the survey area of the canal. The findings of the exercise (literature review and survey data) were used to provide an assessment of areas as high, moderate and low risk of further infestation by *C. helmsii*.

### Findings of initial mapping exercise

The mapping study found the presence of terrestrial and aquatic forms of *C. helmsii*, with a strong correlation between the distribution of the aquatic form and the three marinas (Seaport, Caley and Dochgarroch moorings) present on that stretch of the canal. The marinas provide suitable conditions and a potential advantage for colonisation through disturbance and the introduction of propagules, transferred for example by boats, footwear or clothing. It was also observed that recreational users of the canal (boat users, anglers and dog walkers, with dogs swimming in the canal) are likely to contribute to the spread of the plant.

The terrestrial form was recorded only at the far north eastern extent of the survey stretch. For the aquatic form, of the conditions required by *C. helmsii* (Preston and Croft 1995, Brunet 2002, Ewald 2014, Dean 2015, Dawson and Warman 1987), observations made during the mapping study indicated that depth and the presence of a silt substrate were the most important. It was considered that nutrient levels are a minor factor in the success of the species, once it has colonised an area. Although light levels play an important role in the presence of *C. helmsii*, there were extensive stretches of the canal subject to undisturbed light levels where

the plant was not recorded, most likely due to a lack of silt on the canal bed or low nutrient levels. Plant growth appeared to be absent in water depths greater than 1.5 m.

High, moderate, low and negligible risk rankings were developed to indicate the likely presence and/or likelihood of infestation of the aquatic form of *C. helmsii* based on the findings of the survey as follows. The canal was assessed against the risk.

- High risk: within 10 m of active marinas under the following conditions: less than 0.5 m water depth on a flat, silted bed with no overhanging vegetation.
- Moderate risk: between 10 and 50 m upstream and downstream of active marinas, under the following conditions: less than 1.5 m water depth on a flat, silted bed with no overhanging vegetation.
- Low risk: over 50 m upstream or downstream of active marinas, under the following conditions: less than 1.5 m water depth on a flat, silted bed and/or in marginal areas covered by overhanging vegetation.
- Negligible risk: over 1.5 m water depth and/or 50 m upstream or downstream of active marinas and/or in marginal areas covered by overhanging vegetation.

### Phase 1: design and initial testing of innovative treatment methods

Ecus was one of four contractors selected to undertake Phase 1. Each contractor was tasked with developing and testing their own innovative solution to treat *C. helmsii* in allocated controlled areas where *C. helmsii* was identified as present during the initial mapping study (Ecus 2019). The control areas were identified and allocated by Scottish Canals and comprised areas of terrestrial, semi-aquatic and aquatic habitat (the Phase 1 Study Areas) within the northern extent of the canal.

### Review of previous work

As part of the mapping study a literature review of potential eradication/management techniques was undertaken. To date a successful technique for long-term eradication of the plant has not been found. Based



on work completed by Van der Loop *et al.* (2018), a review of 59 studies investigating the successful eradication of *C. helmsii*, only 10% resulted in a potentially effective eradication of the plant species. Of these studies, 37 implemented a single control measure and the remaining 22 implemented a combination of two or more measures. CABI (2011, 2018b) are currently undertaking trials on the use of the *Crassula* mite (*Aculus crassulae*) in England and Wales. However, as with the introduction of any form of biological control, this is undergoing rigorous testing and is not currently available for commercial purposes.

### Ecus' approach

Ecus were focused on developing an effective, environmentally friendly treatment that was both scalable and economical to implement, and which utilised the lessons learned from previous studies to formulate an innovative approach.

The initial concept at the planning stage was to combine two or three treatment methods, each approach tailored to the Phase 1 Study Areas. The approach implemented consisted of a combined method using hand-weeding/aquatic vacuuming plus shading using Yuzet geotextile matting. Within each Phase 1 Study Area, Ecus deployed five quadrats: four treatment quadrats and a single randomly allocated control quadrat (with no treatment). The quadrats were fixed to the bed of the canal to reduce the risk of contamination.

Phase 1 commenced in July 2019 with the establishment of the Study Areas and initial treatment, which comprised the following:

- Terrestrial: hand-weeding combined with 100% shading. However, it was swiftly concluded that removal of the turves containing *C. helmsii* (3 cm deep in the Study Area) combined with 100% shading was a preferable and likely to be a more efficient approach.
- Semi-aquatic (canal banks where profile stones are laid into the bank): targeted hand-weeding of *C. helmsii* between the profile stones, combined with 100% shading (Figure 2). All native species were retained using this method.



Figure 2. Setting out a quadrat in a semi-aquatic survey area. Photo: Ecus.

- Aquatic: targeted hand-weeding of *C. helmsii* combined with the use of a pond vacuum OASE PondoVac 5 to remove growing substrate and 100% shading (Figure 3). All native species were retained using this method.

Monthly visits were undertaken throughout the study period. In December 2019, treatment ceased in two quadrats within each Study Area to allow monitoring of re-growth to determine the efficacy of treatments.

Due to the outbreak of COVID-19 and associated travel restrictions, the final site visit was delayed from March 2020 until December 2020. This provided the opportunity to better understand the efficacy of the treatment post cessation, as *C. helmsii* had undergone a full growing season.

### Assessment of growth

Selected growth parameters were monitored for each quadrat over the course of the study: number of plants of *C. helmsii*, length of those plants, percentage cover and other vascular plants/algae/bryophytes present. Once treatment ceased (December 2019) only a single monthly value of 'percentage cover' for each quadrat was recorded.



Figure 3. Use of a pond vacuum in an aquatic survey area. Photo: Ecus.

The potential for contamination was considered when reviewing the level of growth and the source of any new growth within the quadrat was considered accordingly.

### Biosecurity and disposal

Biosecurity was of key importance throughout the study. After each trip all clothing, footwear, waders and equipment were inspected and cleaned thoroughly, then disinfected with VIRKON S.

All *C. helmsii* plants and *C. helmsii*-contaminated sediment resulting from hand-weeding and aquatic vacuuming was stored in heavy-duty, zip-locked bags placed in sealed bins which were then stored in a secure location on site prior to disposal.

Following discussions with the Scottish Environment Protection Agency (SEPA) and Scottish Canals, it was recommended that based on Anderson *et al.* (2015) all collected *C. helmsii* material be heated to a temperature of at least 50°C, considered sufficient to kill the plant. The final approach comprised composting for 18 months, placement in a saline solution and then heating to a minimum temperature of 60°C prior to disposal.

### Phase 1 findings

See Table 1 overleaf.

### Conclusion

The staged approach of the CAN-DO Innovation Challenge Study means that each phase builds upon the knowledge gained from the previous phase(s) to develop a scalable and viable long-term treatment solution for *C. helmsii*.

Table 1. Findings of the Phase 1 study.

| Study Area   | Treatment  | Benefits   | Constraints   | Conclusion  |
|--------------|--|--|---|---|
| Terrestrial  | Full turf removal  | 100% effective   | Removes all native species<br>Potentially prohibitive over large areas due to treatment costs (a SEPA-accredited waste disposal units must be used) | Highly effective (root system removed) but treatment cost must be considered                                      |
| Semi-aquatic | Targeted hand-weeding, followed by shading               | 100% successful as long as shading was maintained                              | When shading was removed, <i>C. helmsii</i> returned  | Effective if maintained; success is dependent upon the removal of the root system                                 |
| Aquatic      | Targeted hand-weeding, removal of substrate, and shading | Over 95% successful across a full growing season following treatment cessation | Labour-intensive over large areas<br>Maximum working depth of 0.5 m   | Effective as substrate removal permits the removal of root system<br>Risk of re-colonisation from untreated areas |

To date, Ecus has successfully mapped the extent and abundance of the plant within the Eastern District of the Caledonian Canal. The identification of risk zones for the colonisation of the plant is key to the long-term management of the species and for planning management strategies for watercourses/waterbodies that contain *C. helmsii*.

The innovative methods used in Phase 1 show very positive results in treating both the terrestrial and aquatic strains of *C. helmsii*. Regardless of the approach, a major finding of the study is that the removal of the full root system is key to the success of long-term management of the plant.

The study is key to the understanding of *C. helmsii* and the development of management and eradication techniques of the species. The long-term management of INNS will become a key focus as part of the climate change agenda and the maintaining and management of biodiversity and the protection of native species.

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# Invasive Signal Crayfish in the UK: Survey Methods to Inform Evidence-based Management



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Keywords: crayfish survey, limitations, methodological advancement, *Pacifastacus leniusculus*, population demographics, triple drawdown

With invasive crayfish becoming increasingly widespread, evidence-based management is crucial to protect freshwater ecosystems. Knowledge of the structure and function of invasive crayfish populations allows for an effective evaluation of management efforts. Recent methodological developments have enabled the first truly quantitative studies of UK invasive crayfish populations

in the field. This was achieved by the triple drawdown (TDD) survey approach. In this article, we explore current survey approaches and their limitations, and we introduce the TDD method with its implications for crayfish survey, policy development and management.

### Introduction

Crayfish are among the most widespread and damaging freshwater invaders (Twardochleb *et al.* 2013).

Seven species of non-native invasive crayfish are already present in the UK (Ellis 2014), of which three (signal crayfish *Pacifastacus leniusculus*, red swamp crayfish *Procambarus clarkii* and spiny-cheek crayfish *Orconectes limosus*) are currently listed under Schedule 2, Part 1 of the Invasive Alien Species (Enforcement and Permitting) Order 2019. This highlights the significant concern of UK policymakers and environmental practitioners regarding the threat posed to freshwater ecosystems by invasive crayfish. The most widespread invasive crayfish, the signal crayfish, is now present across most of the UK, with the current, notable exception of Northern Ireland.



Figure 1. Large male signal crayfish retrieved from a modified (5 mm mesh) baited funnel trap. Photo: Eleri Pritchard.

## Signal crayfish in the UK

Introduced in the 1970s in an attempt to establish a new aquaculture industry, the signal crayfish has spread rapidly across the UK by both accidental and intentional means. Its capacity to persist in diverse environmental conditions, a generalist diet and high fecundity make the signal crayfish an extremely effective freshwater invader. It outcompetes the UK's only native crayfish, the white-clawed crayfish (*Austropotamobius pallipes*) and acts as a vector of crayfish plague (*Aphanomyces astaci*), which is fatal to the former (Dunn *et al.* 2009). Signal crayfish invasions have been linked to negative impacts on fish and macroinvertebrate communities (Mathers *et al.* 2016, Galib *et al.* 2021). Burrowing activity further impacts freshwater ecosystems through bank erosion and fine sediment mobilisation (Sanders *et al.* 2021). Despite these negative impacts, their widespread distribution and decades of research, delivery of effective management has remained challenging. We believe that strong limitations and biases of current survey techniques are contributing factors in this respect.

## Crayfish survey and management

Different crayfish survey techniques are available to practitioners. Perhaps the

most commonly employed methods in the UK are baited funnel traps (Figure 1) and manual searches, which together form the UK Common Standards Monitoring (CSM) methodology for native crayfish survey (Bradley *et al.* 2015). Artificial refuge traps (ARTs), formed by a series of tubes that mimic natural refugia, are also increasingly used for surveys despite taking longer to deploy (Green *et al.* 2018). These sampling techniques can confirm presence and provide semi-quantitative estimates of relative abundance through catch-per-unit effort (CPUE). Environmental DNA (eDNA) is a recently developed technique capable of detecting the presence of both invasive and native crayfish (Chucholl *et al.* 2021). However, additional testing of eDNA is ongoing to determine detection limits and the technique's ability to quantify relative crayfish abundances.

Alongside practical considerations such as water body depth, bedform and access limitations, the information required on a crayfish population determines the most appropriate survey method. When confirming presence only, the main limitation of a method is its probability of failing to detect a crayfish population. Detection probability is largely controlled by the capture efficiency of a method, its appropriate application and the target population's demographics. For example, undertaking manual searches in turbid conditions severely limits the possibility of crayfish detection, an issue exacerbated when surveying low-density populations. Similarly, because trapping tends to select for large adults, it may fail to detect populations dominated by smaller size classes. ARTs capture a wider range of size classes and may therefore prove more suitable in these situations (Green *et al.* 2018). When precise spatial data are required, manual searches or ARTs may be more appropriate than eDNA given the remaining uncertainty over DNA degradation, dilution and dispersal (Coward *et al.* 2018, Troth *et al.* 2021). In turn, eDNA is likely better suited to rapid catchment-scale surveys than other techniques. While not a limitation of the data itself, biosecurity and impacts on non-target species are also key considerations for method selection. The risks associated with bycatch and

transferring invasive species and pathogens increase directly with the number of interactions between watercourses, surveyors and equipment. In this context, methods employing single-use consumables such as eDNA greatly reduce risk compared to traditional survey techniques.

The limitations associated with current survey techniques become increasingly apparent when more detailed demographic data are required. Questions of biomass, density, size class distribution and recruitment cannot be adequately addressed through the aforementioned survey methods. This information is nonetheless crucial for the effective management of invasive crayfish. Juvenile and adult crayfish have distinct dietary and habitat preferences, and accurately recording the density and relative proportions of size classes is therefore key to understanding and predicting ecological impacts.

Management of invasive crayfish is arguably the most data-dependent process, with detailed knowledge of the response of a target population to intervention representing the key to delivering impactful and cost-effective outcomes. There are currently no fully effective methods for the eradication or control of invasive crayfish. Perhaps the most widely tested is intensive trapping, which has been trialled with limited success in both lotic and lentic systems (e.g. Stebbing *et al.* 2014, Krieg *et al.* 2020). Many additional methods have been trialled, including the use of chemicals, habitat destruction and release of sterilised males (Manfrin *et al.* 2019, Peay *et al.* 2019). However, issues with cost, sustainability, species specificity and efficacy can render these options undesirable or impractical. A combination of techniques has been recommended to increase the efficiency of control (Hein *et al.* 2006), for example trapping and netting (García-de-Lomas *et al.* 2020). The limitations of the data generated from survey methods, as discussed, can in some instances also prevent meaningful assessments of the outcomes of management. With these considerations in mind, we developed the novel triple drawdown and tested it against CSM approaches with the aim of generating quantitative data on crayfish populations in the field (Box 1).



### Box 1. The triple drawdown method

The triple drawdown (TDD) method was designed to sample crayfish of all sizes in their natural habitat. A waterbody section is completely isolated and drained, typically by use of nets, temporary dams and petrol-driven pumps. All potential refugia such as cobbles and woody debris are then removed (Figure 2). Crayfish are left exposed, allowing them to be easily collected by hand or with small nets. When no more crayfish are found, the site is allowed to re-wet, enticing any remaining animals out of refuges. The site is drained once again, and newly exposed animals are collected. This process continues for at least three ‘sweeps’ and until a decreasing return of crayfish is observed. Calculations can be made using the exact maximum likelihood method based on sweep depletion values to estimate the total number of crayfish present (e.g. Carle and Strub fisheries approach). In turn, this can be used to generate crayfish density values (total number of crayfish/site area) and to evaluate the efficiency of the method (captured crayfish/TDD estimated crayfish). The TDD method was first tested at three sites ( $\approx 20$  m in length) along a rocky headwater stream in North Yorkshire (full details in the open access publication Chadwick *et al.* 2021). Here, signal crayfish had established a thriving population following illegal introduction in the 1990s.



Figure 2. Operatives removing refuges during the first sweep of a triple drawdown in a small rocky headwater stream, North Yorkshire. Photo: Eleri Pritchard.

The TDD proved effective in sampling over 90% of the estimated total signal crayfish population as determined by depletion analyses. Densities of up to 110 crayfish per square metre were recorded, far exceeding all previous estimates for the UK. These hyper-dense populations were dominated by juvenile cohorts, with fewer than 2.5% of individuals large enough to be caught in standard traps. Furthermore, small females (<25 mm carapace length) were found carrying eggs during the TDDs, affirming that crayfish can become sexually mature before reaching ‘trappable’ size. When compared to trapping and manual search surveys, which were also undertaken prior to the TDDs, the TDD was found to be the only approach to provide consistent and reliable demographic data capturing all size classes (Chadwick *et al.* 2021).

### Survey potential and limitations of TDD

The TDD captured crayfish across the full range of size classes and provided accurate density estimates, likely the first fully quantitative crayfish survey generated in the UK. In theory, the TDD could be adapted to operate in various freshwater systems. Dewatering requires a team of skilled operatives and pumping equipment. Therefore, available resources, site specifications (e.g. landowner permission, accessibility and size of water body) and environmental parameters (e.g. water flow or volume and substrate type) are key considerations when assessing

feasibility. TDDs should ordinarily be completed during the in-river working window following appropriate permissions from regulatory bodies. Consideration should also be given to the welfare of non-target organisms, as dewatering could potentially have negative impacts on various local flora and fauna. Precautions such as localised fish rescues should be taken to minimise impact, and prolonged dewatering should be avoided by increasing the number of operatives and/or sweeps. At the end of a TDD, all substrate should be carefully returned to the waterbody with the aim of returning a site to how it was. Once complete, biosecurity (at a

minimum compliant with Defra’s Check, Clean, Dry) should be undertaken, due to the risk of invasive species and disease transfer via survey equipment.

The TDD performed particularly well in the headwater study system, with relatively small sites (15–30 m<sup>2</sup>), low summer flows and no fish mortalities observed at sites where present. The TDD is therefore highly suited to small rocky streams with lots of natural in-channel refuges. Testing the TDD in other sites, including small stillwaters and larger rivers, is important to help define the limitations of the method, such as the cost and effort required and non-target selectivity. Until then, we would recommend that the TDD is used to provide, where required, detailed demographic data, to further evaluate current survey approaches or to ‘ground-truth’ the development of new approaches.

### Implications for management

The ability of the TDD to generate comprehensive data on crayfish population demographics provides opportunities to inform management approaches. For example, given the dominance of smaller animals at our study sites (Figure 3), including sexually mature females too small to be caught in traps, it is clear that undertaking trapping



Figure 3. Demographics of invasive signal crayfish populations from a triple drawdown in an upland rocky headwater stream in North Yorkshire, showing the dominance of smaller (<25 mm carapace length) crayfish individuals within the population. Photo: Eleri Pritchard.

for management at our site would fail. It stands to reason that trapping for crayfish control purposes would therefore be ineffective at all other sites where population size structure, density and biomass are dominated by 'non-trappable' individuals.

The TDD can be used to evaluate the success of management interventions, by undertaking TDDs using a before/after control/impact approach. Such an approach allows for the quantification of reductions in crayfish density and biomass, and would identify how interventions impact different size classes. In the past, a decline in trappable CPUE has been used to evaluate management success (e.g. Hein *et al.* 2006). However, increased awareness of the limitations of trapping suggests that a decline in such a metric may not represent a meaningful population-level response. The ability to reliably evaluate management efforts will lead to better-informed policy and management decision-making.

As quantitative survey methods such as the TDD are developed, and evidence builds for techniques such as ARTs and eDNA, practitioners can have greater confidence in the outcomes of future surveys and management. However, prevention remains the most important element to control the spread of invasive crayfish. Best practice and thorough biosecurity are vital when working directly with invasive species and more generally in catchments where invasion is possible, and it should be promoted between all users of the UK's freshwaters.

## Conclusions

Effective surveys of UK crayfish populations are crucial for practitioners managing invaded sites. While existing techniques often provide expedient means for confirming presence, approaches need to be developed and tested that enable greater insight into crayfish ecology in our waterbodies. Only then can targeted management be evaluated and refined, with evidence-based research leading effective decision-making. While reliable quantitative methods such as the TDD will not replace contemporary approaches to survey and control, they facilitate the development of applied knowledge due to the high quality of data produced. With invasive crayfish continuing to spread and their

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impacts on freshwaters becoming better understood, there has never been a more important time to develop evidence-based crayfish policy development and management in the UK.

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## Note

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## About the Authors

This work was led by a team of researchers from University College London (UCL), King's College London (KCL) and PBA Applied Ecology: Dan Chadwick, ACIEEM, Senior Project Ecologist, PBA Applied Ecology, Dr Lawrence Eagle, ACIEEM, Senior Project Ecologist, PBA Applied Ecology, Eleri Pritchard, PhD Researcher, UCL, Paul Bradley, MCIEEM, Director, PBA Applied Ecology, Dr Michael Chadwick, Senior Lecturer, KCL, Professor Carl Sayer, Professor, UCL and Dr Jan Axmacher, Associate Professor, UCL. They are interested in biological invasions and the development of evidence-based conservation and management of freshwater ecosystems. The development of the triple drawdown method was part of Dan's PhD research on crayfish in the UK, funded by the London NERC DTP and in partnership with PBA Applied Ecology.

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# The Threat of Invasive Common Green Iguanas to Native Caribbean Fauna



Figure 1a and 1b (below). The invasive common green iguana (*Iguana iguana*) can be found in many colours and forms. Photos: Mark Yokoyama.



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Keywords: conservation, hybridisation, invasive iguana, translocation

The common green iguana, *Iguana iguana*, has spread rapidly throughout the Caribbean's Lesser Antilles, posing a threat to the native Lesser Antillean iguana, *Iguana delicatissima*. The two species are able to hybridise to produce fertile offspring. Invasion of *I. iguana* on other islands has been reported to lead to the extirpation of

the native iguana within a few decades. As eradication or control of the invasive iguana is often logistically and financially challenging, recent conservation efforts on a number of Caribbean islands have focused on establishing populations of the native iguana species on offshore islands free from *I. iguana*.



Figure 1b.

The decline in species diversity has been disproportionately rapid on islands in relation to their global land area and species, with 61% of all extinct species and 37% of all critically endangered species confined to islands (Tershey *et al.* 2015). The majority of the world's archipelagos have been invaded by non-native species, and invasive species have been identified as a major driver of these extinctions (Holmes *et al.* 2019). Invasive mammalian predators, including rats, mice and mongoose, are the most widespread and are known to have detrimental effects on native fauna and flora (Spatz *et al.* 2017). However, the effects of non-predatory invasive species can be just as damaging.

The common green iguana *Iguana iguana* (Figure 1) is native to Latin America, including parts of Mexico, as well as the mainland and island regions of Central and South America (Vuillaume *et al.* 2015). In recent years, the common green iguana has been expanding its range throughout the Lesser Antilles and northern Caribbean (van den Burg *et al.* 2018) (Figure 2) into the range of the native Lesser Antillean iguana *Iguana*

*delicatissima*, with invasions of the common green iguana being assisted by tropical storms (Censky *et al.* 1998), ship traffic between islands (which have inadequate biosecurity measures) and the pet trade (van den Burg *et al.* 2018). The native Critically Endangered *I. delicatissima* (van den Burg *et al.* 2018) is threatened across its range by several factors including habitat loss and fragmentation, particularly in recent years by coastal development for tourism (Debrot *et al.* 2013). Predation by introduced invasive species (rats, cats and mongooses) is also a major threat. For example, on islands where Asian mongoose (*Herpestes auropunctatus*) have been introduced, *I. delicatissima* is either extinct or highly threatened (Breuil 2002). However, the most widely reported threat facing *I. delicatissima* is competition and hybridisation with *I. iguana* (Vuillaume *et al.* 2015).

Hybridisation between *I. delicatissima* and *I. iguana*, resulting in fertile offspring, has been confirmed through both molecular and morphometric analyses from Guadeloupe and all other main islands across their range (Vuillaume *et al.* 2015, van den Burg *et al.* 2018). Post-invasion displacement of *I. delicatissima* is rapid and population extirpations due primarily to the presence of *I. iguana* have been recorded from several islands in the French West Indies (van den Burg *et al.* 2018). Experiences from Guadeloupe, Martinique and other nations show that when *I. iguana* are present, *I. delicatissima* typically disappear within a few decades.

The UK Overseas Territory of Anguilla provides critical habitat for the *I. delicatissima*, but in 1995 the presence of *I. iguana* was first reported, with individuals recorded arriving on pieces of driftwood following storms. *I. iguana* have also been reported as stowaways on boats arriving from the neighbouring island of Sint Maarten, and being smuggled into the island to be kept as pets. Over the last 25 years, the invasive iguana has spread widely across mainland Anguilla and evidence of hybridisation with the local population of *I. delicatissima* has been recorded (Pounder *et al.* 2020). The successful and rapid colonisation

by *I. iguana* is in part due to its higher fecundity compared to native iguana species, with the common iguana laying approximately 30 eggs in one clutch compared to the Lesser Antillean iguana that lays on average 12 eggs (Knapp *et al.* 2014).

While adults of the two species can be distinguished visually by their morphological characteristics, experiences from other Caribbean islands have highlighted that eradicating or controlling introduced and established *I. iguana* populations is both practically and financially challenging (Rivera-Milán and Haakonsson 2020). In addition, hybrids can be harder to identify, particularly if they are not first-generation offspring; thus, genetic analysis is required to fully classify a pure *I. delicatissima* individual (Pounder *et al.* 2020). As eradication of *I. iguana* is often not feasible, recent conservation efforts in the region have focused on protecting populations at sites that have not yet been colonised by *I. iguana*, and include translocation from mainland sites to more easily protected offshore cays (islands) with no human or *I. iguana* populations. As a conservation strategy translocation has so far proved successful in Anguilla where, between 2015 and 2020, 23 *I. delicatissima* captured on mainland Anguilla were translocated to the *I. iguana*-free Prickly Pear East (Figure 3). This management action appears to be working, with the juveniles born on the island recorded for the first time in 2019. However, given the risk of *I. iguana* reaching Prickly Pear East, a long-term commitment to biosecurity monitoring and checks are essential to prevent the invasion of *I. iguana*. Biosecurity activities include regular (every 6 weeks) visual checks of the island, liaison with and training of restaurant owners to request that they are vigilant and report any sightings of *I. iguana* immediately, and frequent contact with the charter boats from Sint Maarten that visit the island to ensure that they observe strict biosecurity measures when travelling between the islands and are vigilant for stowaways. While there now appears to be hope for Anguilla's population of *I. delicatissima*, there still remains the problem of a growing population of *I. iguana* on mainland Anguilla which

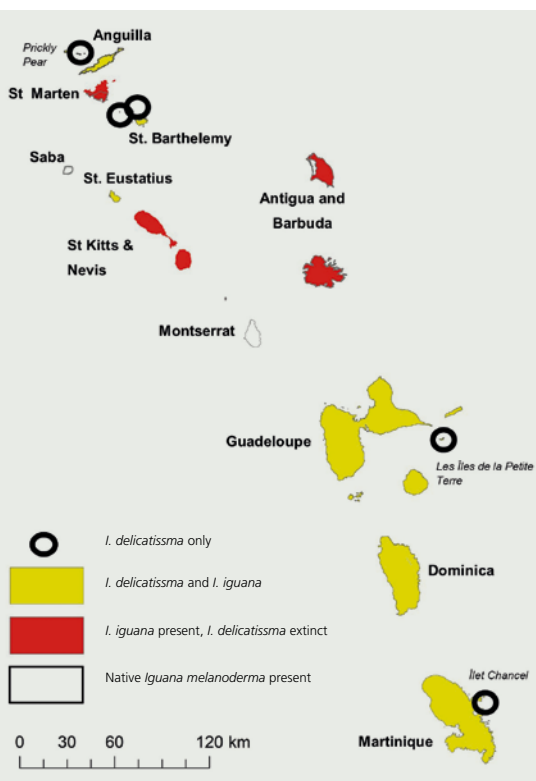


Figure 2. The range of the invasive *Iguana iguana*, and the native *Iguana delicatissima* and *Iguana melanoderma*. Both native species are threatened with extinction primarily caused by hybridisation with the invasive *I. iguana*.





Figure 3. A native Lesser Antillean iguana (*Iguana delicatissima*) being released onto *I. iguana*-free Prickly Pear East, Anguilla. Photo: Farah Mukhida.

has increased to such levels that crop destruction by *I. iguana* is now being reported in the agriculture sector. Elsewhere in the region this species has also been reported to cause severe detrimental impacts on the economy through damage to buildings and other infrastructure in urban areas (Krysko *et al.* 2007, Falcón *et al.* 2012). It has also created health and safety risks, for example by posing an airstrike risk at airfields (Engeman *et al.* 2005). *I. iguana* was recently reported to be interbreeding with endangered *Cyclura* rock iguanas in the Cayman islands, thus now posing an even greater risk to iguana species in the region (Moss *et al.* 2017).

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# How Eradication of Invasive Rats can Restore the Chagos Archipelago



Figure 1. Red-footed Booby resting on heliotrope bush, Middle Brother Island, Great Chagos Bank. Photo: John Slayer.



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Keywords: coconut, coral, monoculture, restoration, seabirds

The Chagos Archipelago, a UK Overseas Territory in the Indian Ocean, is one of the most diverse tropical coral reef ecosystems in the world and is a ‘no-take’ marine protected area. Uninhabited and remote, the archipelago should be an example of a pristine

environment but invasive species, predominantly black rats (*Rattus rattus*), have degraded 50% of the islands (94% of the landmass), which in turn is likely to have a detrimental effect on coral reef recovery from climate change-induced bleaching. Researchers, conservationists

and government, led by the Chagos Conservation Trust, are now working together to achieve the largest rat eradication operation ever to be attempted on tropical islands, which will result in boosting biodiversity and strengthening a future for the Chagos Archipelago.



## Introduction

The Chagos Archipelago is located in the Indian Ocean, to the east of the Seychelles, and forms the British Indian Ocean Territory (BIOT). It is one of 14 UK Overseas Territories and administered from London by the BIOT Administration and was declared a 640,000 km<sup>2</sup> 'no-take' marine protected area in 2010.

It is an archipelago made up of some 55 islands with a land area of 60 km<sup>2</sup> and 698 km of coastline. Three hundred species of coral and approximately 800 species of fish are found in the archipelago's waters. The islands are internationally important breeding sites for green turtles (*Chelonia mydas*) and the critically endangered hawksbill turtle (*Eretmochelys imbricate*). There are 18 species of seabird breeding with an estimated 282,000 breeding pairs per annum (Carr *et al.* 2020).

When French and then British explorers first settled the Chagos Archipelago in the late 1700s they introduced several non-native and invasive species, including rats. Concurrently, to create farmlands and settlements, native forest and other habitats were cleared (Wenban-Smith and Carter 2016).

Invasive species have had a catastrophic impact on island fauna and flora, resulting in 75% of terrestrial vertebrate extinctions on islands (McCreless *et al.* 2016), and are the principal threat to seabird populations globally along with habitat destruction (Dias *et al.* 2019). Of these, rats are one of the world's most damaging invasive species and are responsible for some 40–60% of all bird and reptile extinctions (Howald *et al.* 2007).

Across the archipelago, the main driver of habitat destruction was the creation of coconut plantations. So successful were the plantations at producing copra, the dried kernel from which oil is extracted, that the archipelago was known at the Oil Islands in their heyday (Scott 1961). Combined, rats and habitat destruction decimated the archipelago's seabird populations; for example, Bourne (1886) recorded 'tens of thousands' of sooty tern (*Onychoprion fuscatus*) in the 1880s breeding on Diego Garcia: none now breed on this atoll.

The plantations closed in the late 1960s and early 1970s and the archipelago renamed the British Indian Ocean Territory. Apart from a military support facility on one island, Diego Garcia, which holds a transient human population, the islands are now uninhabited (Wenban-Smith and Carter 2016).

Yet, despite the lack of direct human disturbance throughout most of the archipelago for over 40 years, seabirds are not recolonising atolls where they are locally extinct. This is because every island that was farmed for coconuts and had its native vegetation cleared still has rats. Rats suppress breeding seabirds and recent research has demonstrated that seabirds very strongly favour native habitats when recolonising islands, and actively avoid abandoned coconut plantations (Carr *et al.* 2021).

In 2018, Chagos Conservation Trust (CCT) and the BIOT Administration formed a partnership and convened a meeting with experts to determine a shared vision to achieve rat eradication across the archipelago and to map a way forward to achieve this goal. CCT recognised that rat eradication as a single intervention will not be enough for seabirds to recolonise. For the seabird islands to be restored, the invasive rats must first be eradicated and then the abandoned coconut plantations must be converted to habitat conducive to breeding seabirds.

## The Chagos Archipelago

The archipelago is in the geographical centre of the tropical Indian Ocean, stretching approximately 240 km north to south and 140 km east to west. It lies at the southern end of the Maldives–Lakshadweep–Chagos ridge that was formed as the Indian subcontinent moved northwards from Early Cretaceous time (c. 130 mya), passing over a volcanic hotspot. The oldest rocks thought to be formed in this movement are the Deccan Traps in western India (Eisenhauer *et al.* 1999).

Four species of seabird breed on the archipelago in internationally significant numbers that trigger Important Bird and Biodiversity Area status for four locations (Carr *et al.* 2020). Three species, the sooty tern, lesser noddy (*Anous tenuirostris*) and red-footed booby (*Sula sula*; Figure 1), make up

96% of the 282,000 breeding pairs found annually in the archipelago (Carr *et al.* 2020).

The 2010 declaration of all 640,000 km<sup>2</sup> of the archipelago (except the island of Diego Garcia) and its surrounding seas to be a no-take marine protected area means that all commercial fishing and extractive activities are prohibited (BIOTA 2016). The declaration doubled the previous global no-take area, as well as providing protection to approximately 1.5% of the total global area of near-surface coral reefs (BIOTA 2016).

Today the archipelago remains one of the largest marine protected areas in the world and is a benchmark against which we can compare the impacts of human activities on tropical marine ecosystems around the world.

## A natural system broken down

Seabird islands and coral reefs of the Chagos Archipelago are inextricably linked. Seabirds provide nutrients, collected as food from the open ocean to the reefs primarily through *guano* that leaches into the seas surrounding the islands.

This sea-to-land-to-sea process has recently been proven to enhance surrounding ecosystems, one of the benefits being boosting coral resilience to stressors such as climate change (Graham *et al.* 2018). The presence of invasive black rats (*Rattus rattus*; Figure 2) on 30 of the 55 islands, 94% of the terrestrial



Figure 2. The invasive black rat, *Rattus rattus*. Photo: Grant Harper.

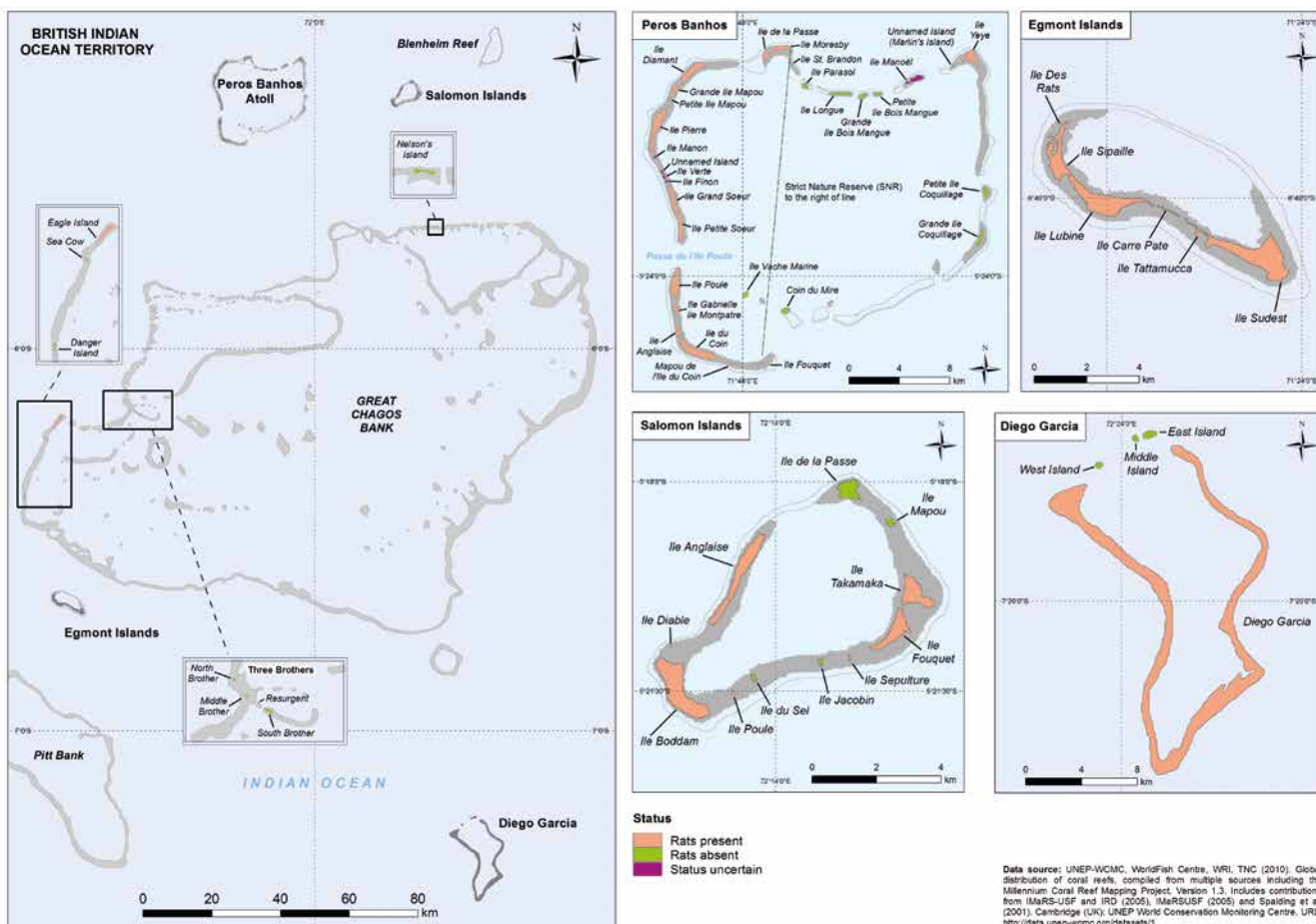


Figure 3. The distribution of black rats in the Chagos Archipelago. Source: courtesy of Peter Carr.

landmass, of the Chagos Archipelago has perturbed this link (Figure 3).

The world has seen two recent significant ocean warming events, in 1998 and 2015–2016, that were attributed to climate change, and the 1998 event affected the Indian Ocean more than any other ocean (Sheppard *et al.* 2008). The Chagos Archipelago was badly affected in 1998 and saw very heavy to total coral mortality (Sheppard *et al.* 2017). Coral cover on seaward slopes before the 1998 warming event was between 50 and 95% but afterwards dropped to only 12%, and in shallower areas 0% (Sheppard *et al.* 2017).

This was a surprise to many, given the archipelago has no direct human impacts and is extremely remote. Other coral reefs around the world also suffered devastating coral bleaching from the 1998 warming event but the difference with the Chagos Archipelago’s corals was the speed of recovery in comparison.

The 2015 heatwave killed 60% of the hard corals at depths of up to 10 m

across the archipelago, with some species more affected than others. Some 86% of *Acropora* corals, for example, previously the most abundant after recovering well from the 1998 event, perished (Head *et al.* 2019).

Before corals were given a chance to recover, another heatwave struck just 1 year later, which was far more intense than the previous events. Data collected from the Peros Banhos Atoll showed that 68% of the remaining hard corals were bleached and 29% died, suggesting that approximately 70% of hard corals were lost between 2015 and 2017 overall (Head *et al.* 2019) (Figure 4).



Figure 4. Bleached coral in the Chagos Archipelago, April 2016. Photo: Dan Bayley.

In 2018, researchers from the Bertarelli Programme in Marine Science (BPMS) found that seabird densities and nitrogen deposition rates are 760 and 251 times higher, respectively, on islands where humans have not introduced rats. Therefore, coral surrounding islands with rats, and a lack of seabirds, could find it harder to recover from devastating bleaching events due to the reduction of nutrients from the seabirds (Graham *et al.* 2018).

They concluded that rat eradication on oceanic islands should be a high conservation priority as it is likely to benefit terrestrial ecosystems and enhance coral reef productivity and functioning by restoring seabird-derived nutrient subsidies from large areas of ocean.

### Restoring the balance

January 2021 saw CCT launch the Healthy Islands, Healthy Reefs programme, a collaborative project to ecologically restore the Chagos Archipelago by eradicating rats



“Rat eradication on oceanic islands should be a high conservation priority as it is likely to benefit terrestrial ecosystems and enhance coral reef productivity and functioning.”

and manage abandoned coconut plantations to facilitate the recolonisation of seabirds. This project is hugely ambitious and an extreme logistical challenge but the potential benefits match the scale.

To date, CCT has commissioned a peer-reviewed feasibility study into the eradication of rats as well as an Environmental Impact Assessment. A peer-reviewed operational plan has also been commissioned and this remains a work in progress. The programme is currently in its research and development stage to fill knowledge gaps in the operational plan and secure funding to enable the £5 million ecological restoration programme to be implemented. To complete the operational plan, CCT is collaborating with scientists from the BPMS.

If funded, BPMS scientists and eradication practitioners will be conducting experiments that will provide key information to the eradication operational and vegetation management plans. The BPMS team intends to eradicate rats from four islands with emerging drone technology to deliver poison bait and use these islands to test techniques to convert plantations to seabird breeding habitat. Using four rat-free islands as controls, the scientists intend to monitor the impact of the interventions over time; the data gathered will be shared with the CCT to fill knowledge gaps in the operational plan.

Healthy Islands, Healthy Reefs is based on sound science highlighting the significant linkages between the health of the islands of the Chagos Archipelago and their surrounding coral reefs (Box 1). The benefits of restoring the islands and creating a richer island ecosystem so that natural biodiversity is re-established and the linkages between land and sea continue to function cannot be denied.

CCT and partners are dedicated to ensuring the future of the Chagos Archipelago is secured and can continue to be a valuable benchmark against which we can compare the impacts of human activities on tropical marine ecosystems around the world.

### Box 1. Case study: Ile Vache Marine Restoration Project

Ile Vache Marine is a small island within the eastern Peros Banhos Strict Nature Reserve. It lies amidst six islands that are classified IUCN Important Bird and Biodiversity Areas, designated for their breeding seabird populations. Unlike its neighbouring islands, Ile Vache Marine was rat-infested and had very few breeding seabirds. In 2014, CCT conducted an invasive rat eradication operation as part of the Darwin Plus-funded Ile Vache Marine Restoration Project. The island was declared rat-free in 2017 and monitoring of the flora and fauna is ongoing. This was the first successful rat eradication operation on an island in the archipelago, providing proof of concept and forming the basis of CCT's Healthy Islands, Healthy Reefs programme.

### About the Authors

Helen Pitman BSc is a conservation biologist and has been Director of the Chagos Conservation Trust since 2015. She is responsible for commissioning the feasibility study for rat eradication in the Chagos Archipelago and building partnerships to ensure the full implementation of Healthy Islands, Healthy Reefs.

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# Rapid Assessments of the Potential Value of Invertebrate Habitats: Applications for Planning and Nature Conservation (‘Phase 1 for Bugs’)

“ Invertebrates are the most  
biodiverse macro-organisms  
but receive proportionately little  
legal protection or conservation. ”





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Keywords: conservation management, green infrastructure, Invertebrate Habitat Potential (IHP), Preliminary Ecological Appraisal (PEA), survey

This article introduces a tested protocol which enables experienced non-entomologists to undertake preliminary assessment of the potential of sites to support important invertebrate assemblages. The survey can be conducted as a standalone walkover survey (e.g. to assess nature conservation sites) or as part of wider assessment such as Preliminary Ecological Appraisal.

## Introduction

Invertebrates are by far the most biodiverse macro-organisms in our ecosystems but receive proportionately little legal protection or conservation priority when compared to the more widely studied vertebrate groups. Available literature is not always helpful in guiding non-entomologists in determining a robust, defensible but proportionate approach to invertebrate survey and habitat assessment. In the case of development sites, guidance from Natural England (English Nature 2005) and Buglife (2015) encourages ecologists to seek the advice and guidance of an entomologist at every stage of project evolution, including during initial site scoping surveys, rather than to attempt to make even a preliminary assessment of a site's potential to support important invertebrate assemblages. This approach would be impractical and costly if adopted for every site, and an initial filter would be beneficial, to highlight at an early stage the areas of habitat likely to be of most importance for invertebrates. Furthermore, the numerous more detailed documents on the subject (e.g. Drake *et al.* 2007,

Lush *et al.* 2013, Natural England 2014, Webb *et al.* 2018), which could be reviewed to determine a site-specific approach, are most easily interpreted by specialists. In the case of nature conservation sites, invertebrate habitats are not often prioritised and usually depend on input from local expertise, which may or may not be acted upon. Therefore, due to the lack of accessibility of some guidance documents to non-

specialists, deriving a proportionate approach to invertebrate survey and assessment can be complex, and heavily reliant on receiving good advice from a suitably experienced ecologist or entomologist. These considerations have been helpfully introduced by Jukes (2021) for brownfield sites. It is intended therefore that Invertebrate Habitat Potential (IHP) assessment (Box 1) will address the key initial

### Box 1. Identifying the need: the roots of Invertebrate Habitat Potential assessment

The IHP assessment protocol was developed in response to dissatisfaction experienced by John Dobson who was conducting a large number of extended Phase 1 habitat surveys, one aim of which was to recommend sites for Site of Importance for Nature Conservation (SINC) designation by local authorities. As an experienced entomologist, the surveyor was able to highlight habitat features thought likely to be of importance for invertebrates. This approach could not, however, properly address the issue for a number of reasons including:

- Habitat features (for invertebrates), which were not specifically included on the recording form, could not be entered as searchable properties in the resultant database, and there was no specific value placed on these features in the protocol, in contrast with botanical habitats.
- There were site-to-site inconsistencies in recording invertebrate habitat features.
- Then (as now) only a small percentage of habitat surveyors are experienced entomologists.

In this light the surveyor saw a need for guidance to help ecologists and

practitioners (including experienced volunteer conservationists) without specialist entomological expertise to identify key habitats and features likely to support important invertebrate assemblages, and to consistently record those data. This would also allow priority habitats and features important for invertebrates (examples include veteran trees, open mosaic habitat on previously developed land, riverine shingle deposits and ponds) to be recognised at an early stage (e.g. Preliminary Ecological Appraisal). The results of the preliminary assessment would then determine the need for more targeted 'appropriate' surveys to be completed by an entomologist.

The author (John Dobson) circulated a draft version of the protocol to Invertebrate Link, and subsequent to their encouraging feedback presented it at a IEEM/Royal Entomological Society conference (Dobson 2011) where there was significant uptake by practitioners. He was later joined by Jim Fairclough who brought experience from working on development sites, including large projects informed by Environmental Impact Assessment.

**Table 1. Summary of the 11 habitat elements assessed by IHP survey.**

| Habitat element       | No.  | Comments  |
|-----------------------|------|---|
| Decaying Wood         | HE1  | In all its forms; from decaying wood on/in large trees to woodland floor debris   |
| Rotational Management | HE2  | Planned or serendipitous; and whether for nature conservation or other purposes   |
| Nectar Resources      | HE3  | As a proxy for nectar- and pollen resources, as assessment of pollen resources is impracticable on a walk-through survey  |
| Wet Substrates        | HE4  | Including marginal, marshy, muddy and seasonally inundated habitats, as well as flushes   |
| Open Water Habitats   | HE5  | The open water element of rivers, lakes, ponds, streams, ditches, etc.  |
| Structural Patchwork  | HE6  | Habitat mosaics, including, but by no means restricted to open mosaic habitats on previously developed land   |
| Still Air (S)         | HE7  | Suntraps and still-air microclimates in open situations; the term 'still air' is used in preference to 'wind breaks' as many rigid wind breaks are likely to produce turbulent air in their lee |
| Still Air (H)         | HE8  | Humid still-air microclimates in sheltered and shaded situations  |
| Connectivity          | HE9  | Landscape-scale connectivity between the site and external habitats   |
| Ecoclines             | HE10 | A graded transition between two or more broad habitats  |
| Bare Earth            | HE11 | Unshaded bare or sparsely vegetated well-drained substrate, regardless of soil type   |

stages in this process. Additionally, Chris Cathrine, Richard Wilson (both consultant entomologists) and Craig Macadam (Buglife) are in the early stages of preparing a comprehensive guide to planning, undertaking and interpretation of invertebrate surveys which will undoubtedly be invaluable to all parties.

### IHP assessment protocol

The IHP assessment protocol may be carried out by those inexperienced in invertebrate survey, but with a good ecological grounding and able, with practice and experience, to follow the manual and record habitat elements, and to grade them in the field. This may be during the course of other surveys (e.g. Phase 1 habitat survey, UK habitat classification or ecological walkover surveys) or during a dedicated survey to assess a site for its IHP. A first step on proposal sites is to undertake a desk study to identify parcels of habitat at the site that may form the focus of the assessment. Parcelling allows a site to be subdivided, potentially offering the opportunity to scope out areas of uniform poor-quality habitat (e.g. amenity land, intensively managed agricultural or silvicultural land). A walkover of a site (which may comprise one- or multiple parcels) then enables the findings of the desk study to be verified or amended, as appropriate.

Eleven habitat elements are recognised by IHP (Table 1) based on the field

**Table 2. Grading system applied to habitat elements.**

| Grade                 | Description  |
|-----------------------|--|
| Negligible/Absent (E) | Habitat element is absent or of insignificant (barely perceptible) quantity.   |
| Minor (D)             | Habitat element is present but is insufficient quality to qualify as Moderate or above. For example, it may be of extremely limited extent, or very sparsely dispersed. Likely to support common and widespread, generalist species.   |
| Moderate (C)          | A clear example of the habitat element is present, but which does not qualify as Major. Likely to be of sufficient quality to support a characteristic invertebrate fauna.   |
| Major (B)             | Good quality examples of each habitat element which do not meet the criteria for Exceptional. Likely to be a predominant factor in supporting characteristic and specialised invertebrate assemblages. Considerations might include the extent, maturity and historic and current connectivity of the element. |
| Exceptional (A)       | Very high-quality examples of the habitat element, including but not restricted to those of potential regional significance. This may be for reasons of intrinsic quality, rarity, vulnerability or the perceived importance of its position in the wider landscape.   |



“ Eleven habitat elements are recognised, comprising the habitats, resources and influencing factors that contribute to providing potential value for invertebrate assemblages. ”

experience of the authors and consideration of relevant literature. These comprise the main habitats/ meso-habitats, and resources and influencing factors that contribute to providing potential value for invertebrate assemblages. Therefore, sites or parcels (within sites) with a greater variety of habitat elements have the capacity to support a more diverse invertebrate fauna. It is, however, not appropriate to add value to a site or parcel that has multiple habitat elements where they are of poor quality. A grading system is therefore applied (Table 2) to enable an assessment of the quality of the habitat element, from Negligible (Grade E) to Major (Grade B) and, in a few cases, Exceptional (Grade A). Habitat elements with better grades are considered likely to be able to support more specialised, unique and often rare invertebrate assemblages. For example, a veteran tree in an intensively managed field parcel which qualifies as Grade A (Decaying Wood) may have a higher potential than an adjoining parcel where all 11 habitat elements are present but are graded C or D. The protocol includes detailed guidance to assist the surveyor in identifying and grading these habitat elements; some examples of which are shown in Figures 1 and 2.

Outcomes of IHP

Each parcel is characterised by a string of 11 letters corresponding to the habitat elements. Thresholds for ‘further action’ are given based on the representation of the upper grades, namely: Axxxxxxxxx, BBxxxxxxxx or BCCxxxxxxxx. For example, a parcel with nine habitat elements with a Grade E or D and one habitat element with Grade C and one with Grade B would not



Figure 1. An example of previously developed land showing a number of IHP habitat elements including Structural Patchwork, Nectar Resources (not visible from photo), Bare Earth and Still Air habitat. Note: grading is applied per survey parcel based on the habitat elements present, so cannot be critically applied from photographs. Photo: Jim Fairclough.

meet the threshold for ‘further action’. The choice of further actions typically depends on the original reasons for the IHP assessment, for example whether conducted for a development site, or for nature conservation purposes, where a wider range of nuanced responses is potentially available.

Sites subject to development proposal/scheme

There are two potential pathways that may be followed when further action is recommended by an IHP assessment:

- 1. An entomologist should be consulted who will be able to review the IHP assessment and develop a scope



Figure 2. A maturing area of created habitat in urban surroundings showing six IHP habitat elements: Structural Patchwork, Open Water, Wet Substrate (marshland), Bare Earth, Still Air and Nectar Resources (upper left). Photo: John Dobson.



of appropriate survey that targets relevant invertebrate assemblages or taxa with reference to industry guidance (see References).

2. The outcomes of IHP assessment can be utilised to help avoid or sustainably mitigate the impact of a development on key habitat elements, and therefore scope out the requirement for dedicated invertebrate survey in those instances.

### Nature conservation sites

In this context, nature conservation sites include sites formally designated at any level for their wildlife value, and undesignated sites where biodiversity is a significant consideration of the site manager or owner. The outcomes of IHP can provide detailed preliminary guidance for decision making, such as justifying appropriate invertebrate surveys, prioritisation for management, revision/cessation of inappropriate management and highlighting features in outreach and education. On nature conservation sites there is additional discretion for these actions to be applied to areas of identified invertebrate habitat not meeting the thresholds for action given for proposal sites.

### Green infrastructure, wildlife installations and IHP

Between them, the authors have observed good and poor examples of all the habitat elements occurring in created urban naturalised environments. Uniformly managed amenity land with ornamental tree plantings, or a *Sedum* roof would generally be expected to receive a low overall IHP grade due to a lack of antiquity of features, low species diversity and limited structural complexity and corresponding microclimatic heterogeneity (limiting still air formation, for example).

Conversely, some green infrastructures (e.g. sympathetically planned landscapes), including but not exclusively those which combine existing features of antiquity (such as hedgerow trees, old meadows and ponds), with modern installations (e.g. created open mosaic habitat, brown roofs, wetlands and sustainable urban drainage systems, etc.) can include good quality invertebrate habitat elements.

IHP survey is therefore applicable to created urban environments. While these may include good-quality IHP elements, their presence may often be fortuitous rather than due to consideration of invertebrate conservation. The possibility therefore arises of utilising the assessed habitat elements detailed in the IHP protocol as templates and guidance to inform the design, management and enhancement of green infrastructures and wildlife installations, benefiting invertebrates.

### Next stages

IHP assessment cannot be used as a substitute for invertebrate species surveys, particularly where the latter are sufficiently comprehensive to enable assessment of the relative contributions of multiple invertebrate habitats and resources to a site's value using Pantheon analysis (Webb *et al.* 2018). However, IHP assessment provides a much needed first step in introducing the world of invertebrates to the non-specialist and, in doing so, provides a standardised and proportionate approach to the recognition of invertebrates at the early stages of a project. The aim is therefore to promote the consistent identification and recording of sites (and features) with potential value to invertebrates. In doing so it can help to guide not just ecologists and nature conservation organisations, but also policy- and decision-makers in the importance of recognising invertebrates, either at a strategic level (e.g. Nature Improvement Areas, Nature Recovery Networks and Local Nature Recovery Strategies and Buglife B-lines) or in a local and project-specific context (e.g. a development or nature conservation project which may affect habitats of potential importance to invertebrates).

It is intended that the IHP assessment protocol will be a live document, capable of being updated and improved as its usage increases. Subject to stakeholder feedback, the IHP protocol will become available as a file downloadable from the Buglife website later this year (Dobson and Fairclough in preparation).

### Acknowledgements

Many individuals, entomologists and non-entomologists, have kindly field-tested the survey on both development and nature conservation sites. The published protocol will acknowledge their vital roles in more detail, but we would like for the present to thank Invertebrate Link and Buglife for their support and encouragement during the long gestation of this project.

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# Working Towards a Plant Quadrat Data Repository for Britain and Ireland



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Keywords: vegetation, plant communities, quadrats, plots, database

Although a lot of plant quadrat data are collected by ecologists in Britain and Ireland, the community lacks an online repository in which to permanently store data. Such a tool would increase data sharing, improve our knowledge of vegetation and how it might be changing,

and allow for future updates to national vegetation classifications.

Plant ecologists in Britain and Ireland have a long history of surveying vegetation using quadrats of one type or another (Sheail 1987), yet, compared to more general biological recording, there have been few attempts to provide the ecological community with a general solution to the online collection and databasing of such data. Plot-based data are a key source of information about spatial and temporal

trends in habitats and vegetation, from the scale of countries to that of individual sites, and are used routinely by ecological consultants and others to sample vegetation, understand its value and investigate its responses to the physical environment and conservation management. While in Britain the National Vegetation Classification (NVC) project was at the vanguard of the large-scale collection and analysis of phytosociological data (Rodwell 2006), the vast majority of plot data collected over the decades since the NVC surveys are not openly available; indeed, there is no doubt that much

is completely lost to science. As an organisation that values environmental data and promotes data sharing in its code of conduct for members (CIEEM 2019), this is a situation which CIEEM should be concerned about. We also note that much has changed since the NVC was first published, in terms of both analytical approaches and the environment itself. The Republic of Ireland has responded to this situation with a modern vegetation classification of its own, the Irish Vegetation Classification, with an associated online analytical platform, ERICA (National Biodiversity Data Centre, n.d.), whereas we are not aware of similar initiatives for Britain. Increasing the sharing of new vegetation data, which are already being collected for other purposes, would make updates to the British NVC a more realistic prospect.

“ The tool is aimed at all collectors of vegetation data, and we hope that researchers and land managers will use the site to make historic quadrat data more widely available. ”

The UK Centre for Ecology & Hydrology has been working to develop a general, freely available, web-based tool to rectify this situation. This website will allow for existing quadrat data to be uploaded via a spreadsheet importer, as well as allowing for the interactive creation of plot locations and associated samples. The site will be based on the Indicia toolkit ([www.indicia.org.uk](http://www.indicia.org.uk)), which underlies popular general recording sites such as iRecord ([www.brc.ac.uk/irecord](http://www.brc.ac.uk/irecord)), meaning that much existing functionality can be reused, including options to publish sample data to the National Biodiversity Network ([nbnatlas.org](http://nbnatlas.org)) and Global Biodiversity Information Facility ([www.gbif.org](http://www.gbif.org)), and we will have the ability to cover associated issues such as the choice of appropriate Creative Commons licenses (<https://creativecommons.org/licenses/>) for users' data. The tool is ultimately aimed at all collectors of vegetation data, not just ecological consultants, and we are hoping that researchers and land managers will use the site to make historic quadrat data more widely available. While we appreciate that it is perhaps only a minority of ecological professionals collecting vegetation data using quadrats or other types of plots, we hope that it will nonetheless prove a useful tool to those working in this area.

“ The ecological community lacks a online repository in which to permanently store quadrat data. ”

A beta version of this site was launched in May 2021, and potential CIEEM users interested in using such a tool to easily store and share quadrat data are welcome to get in touch with the first author of this article to engage with the project as beta testers. Although phase one of the project focuses on web-based collection, storage and open publishing of data, we also aim to acquire funding for a linked field app, and analytical options, in the future. We will aim to publish information in future issues of *In Practice* as the project develops.

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# Good Practice Guidance: Where's the Evidence?

Greater horseshoe bat.



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Keywords: good practice guidance, principles, professional practice, standards

CIEEM recently updated a list of good practice guidance documents on its website. This is aimed at encouraging its members to use guidance, and to use the right guidance.

It is our view that guidance should be based on good scientific evidence, not so we can repeat the politician's mantra that we're just 'following the science', but so that we can be confident that we're delivering better outcomes for biodiversity.

Our experience of reviewing guidance documents tells us that not all of it is up to date, based on published evidence or clear in communicating its advice and recommendations to the intended user. We summarise the findings of a study on the use of evidence

in guidance undertaken by 13 organisations involved in the production of guidance, led by Conservation Evidence. We draw attention to important principles about the production of guidance and seek to raise awareness about how it is produced, its accessibility and the evidence it is based upon. CIEEM has set up a survey to invite comment from members on this issue. The Professional Standards Committee is keen to hear members' views and will review the survey responses and comment in a future edition of *In Practice*.

## Introduction

As professional ecologists we are all reliant on good practice guidance documents. We should be familiar with relevant published guidance, produced by recognised experts, for any area of work we're involved with. This is a clear requirement of CIEEM's Code of Professional Conduct (CIEEM 2019) and of the British Standard BS42020 (BSI 2013).

Guidance is an authoritative source of information and recommendations, with the objective of informing the decisions and actions of practitioners. It can come in a wide range of formats, including detailed technical handbooks, advice for landowners, brief advice notes, or leaflets and webpages. Ecological guidance covers diverse topics from surveying methods to implementation of conservation or mitigation actions, and covers a range of taxa and habitats.

Good practice guidance is vital. It informs conservation practitioners and ecological consultants of both what to do and how to do it; ideally, it will also tell them why they need to do something in a particular way. It enables recognised experts to disseminate their experience and knowledge to others. Good practice guidance also ensures a consistent approach and allows for comparison in assessing the

effectiveness of mitigation; this is of particular importance when it comes to post-development monitoring, which may be carried out by ecologists other than those who carried out the original assessment. It also facilitates professional ecologists being 'held to account' over their assessments, recommendations and actions, as others can more clearly understand whether the right approach has been taken in a specific circumstance.

Given the reliance we place on guidance, it needs to be good. But what does good guidance look like and what should practitioners look for when assessing the quality of the guidance they are following?

In 2016 CIEEM's Professional Standards Committee (PSC) wrestled with this very question. And its answer was a set of fundamental principles published in, ironically, a guidance document. These principles were then used to inform the numerous guidance documents that CIEEM itself produced, as well as informing CIEEM's review of guidance documents produced by others when asked for its endorsement. The PSC recently approved an update of the principles, and these are published in a revised document available on the CIEEM website (CIEEM 2021).

## The Conservation Evidence study

Principle v of CIEEM's Preparing Good Guidance is that 'Good guidance is based on good evidence.' But how many of our widely used guidance documents are based on good evidence?

Conservation Evidence is a free resource that has been designed to provide documented evidence to help conservationists and consultants in their decision-making. As well as collating this evidence, Conservation Evidence also aims to improve ways of getting evidence used more widely in practice, such as in guidance documents. Conservation Evidence recently searched 370 UK guidance documents, published between 1992 and 2020, that related to undertaking mitigation or management actions. These were selected by searching major UK conservation organisation websites (e.g. RSPB, The Woodland Trust) and the NHBS website ([www.nhbs.com](http://www.nhbs.com)) and

by consulting conservation practitioners. The evidence used in the published guidance was subsequently analysed. The study (Downey *et al.* under review) found that only 29% of guidance documents contained references to evidence in the form of in-text citations, bibliographies or reading lists. Many of the documents did not give specific references for actions but referred to other general documentation or referred to the natural history and ecology of the species. Documents also tended not to include discussion of areas of uncertainty, and the strength of the evidence was unclear. The study also found conflicting guidance on some topics.

Conservation Evidence subsequently analysed a subset of CIEEM's list of good practice guidance (see Box 1) and found a similar picture. The study initially selected 105 documents that related to mitigation or management actions, excluding guidance documents listed by CIEEM that relate to survey or monitoring techniques and primary research papers. Conservation Evidence restricted its analysis to 71 free-to-access documents where it could be expected that a recommended intervention could be supported by evidence. Only 41 (58%) of the reviewed subset contained references and only eight (11%) contained appropriate references (i.e. a reference that tested the recommended mitigation or management action).

This is a worrying finding. It suggests that much of the guidance we rely on as professional ecologists is either not based on evidence or, if it is, then it hasn't clearly identified what that evidence is. Of course, much of the guidance we use is based on the knowledge and expertise of the author(s), but there may be a lack of published evidence sources to underpin their recommendations. In such cases, the lack of published evidence should be made clear, and the requirement to collect appropriate data to allow refinement of the guidance encouraged, identifying areas where additional research is needed. A lack of published evidence doesn't mean that we should necessarily dismiss the guidance, but that we also shouldn't blindly accept that guidance without question.



### Box 1. CIEEM's list of good practice guidance.

In order to assist members in their selection of relevant guidance, CIEEM's PSC compiled a list of what it considered to be the relevant guidance documents that professional ecologists should be using. It did this by asking recognised experts to review the available guidance documents for different areas of professional practice, and list those that they considered to be relevant to the work of professional ecologists. Experts were asked to add notes on the scope of guidance, as well as explaining where any elements had been superseded in some areas or need updating, for example.

This list has been recently reviewed and updated by PSC and the group of recognised experts, and is available at <https://cieem.net/revised-good-practice-guidance>. We would encourage all CIEEM members to familiarise themselves with it, and to familiarise themselves with the documents listed for any habitat or species that they are working with.

Interestingly, there was no discernible trend of increasing use of evidence in more recent publications. This is despite the increase in the availability of evidence and organisations, such as Conservation Evidence, that specifically aim to collate relevant research for ecological practitioners.

It is also noteworthy that approximately one third of the CIEEM listed guidance documents related to mitigation or management actions are not free to access. This review raises some fundamental issues around improving access to guidance and ensuring appropriate funding to prepare high-quality and evidence-based guidance.

### How do we improve?

In the last decade, wildlife and land management scientific evidence has become increasingly accessible through open access journals, improved search engines and collations of research,

such as Conservation Evidence ([www.conservationevidence.com](http://www.conservationevidence.com)), Environmental Evidence ([www.environmentalevidence.org](http://www.environmentalevidence.org)), the Nature-based Solutions Initiative ([www.naturebasedsolutionsinitiative.org](http://www.naturebasedsolutionsinitiative.org)) and the Invasive Species Compendium from CABI ([www.cabi.org/isc](http://www.cabi.org/isc)). These resources provide critically appraised and synthesised scientific evidence and should make the production of evidence-based guidance more attainable for organisations.

A good recent example of scientific research informing guidance relates to the use of artificial lighting of bat commuting routes. Various papers have been published in recent years assessing the impacts of lighting on bats, including those listed by Conservation Evidence ([www.conservationevidence.com/actions/2017](http://www.conservationevidence.com/actions/2017)). Conservation Evidence concludes that there is good evidence that avoiding lighting of bat commuting routes is 'Likely to be beneficial' and this conclusion (which is widely held by bat ecologists) has led to the publication of

updated guidance on bats and artificial lighting in the UK (ILP/BCT 2018).

Conservation Evidence, together with a number of nature conservation organisations, including CIEEM, has drafted a set of specific principles for ensuring that guidance is evidence-based. These principles are intended to complement CIEEM's overarching principles of producing good guidance, but encourage greater use of evidence and transparency in relation to the evidence used to make recommendations (see Box 2).

### How do you know if a particular guidance document is 'good guidance'?

Some guidance documents are endorsed by CIEEM. This means that CIEEM has been involved in its production, or has reviewed and commented on a draft, or ideally both. CIEEM reviews new guidance against its principles of good guidance to confirm that it is in accord with them.

If a document appears on CIEEM's list then it is reasonable to assume that it

### Box 2. Principles for ensuring that guidance is evidence-based.

#### Collating evidence

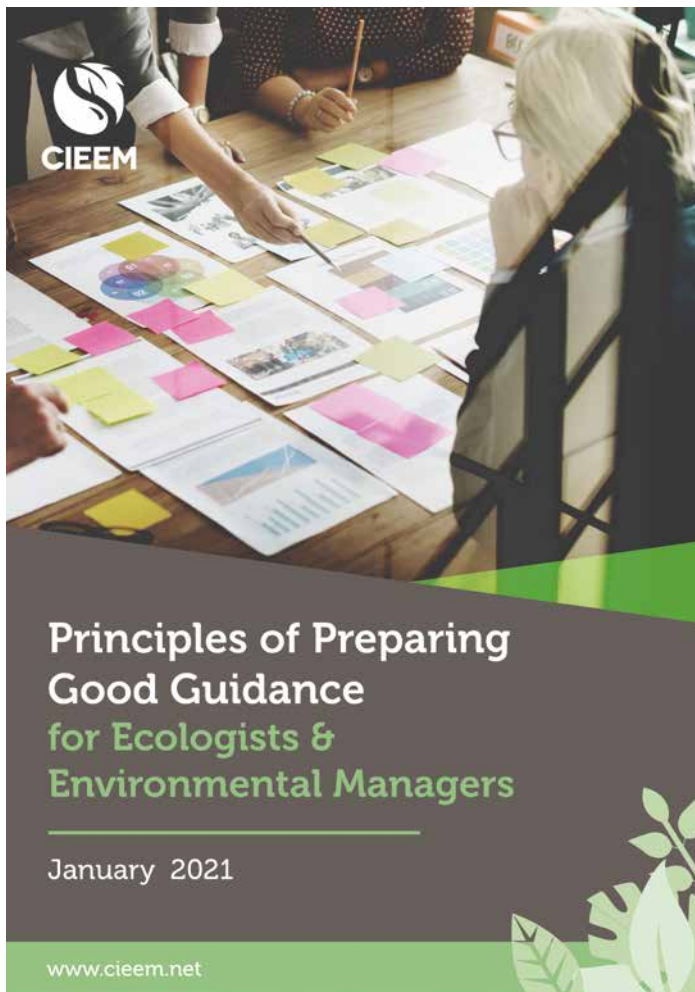
1. The scientific evidence should be searched, and used in formulating recommendations where available.
2. The presentation and interpretation of evidence should be neutral.
3. State the date and search terms of literature searches for evidence.
4. Where possible, assess the financial cost, cost-effectiveness and 'side effects' of potential interventions.

#### Making recommendations

1. Specify the type and source of evidence used to make recommendations. Document the sources (e.g. scientific papers, grey literature, expert opinion, indigenous knowledge) and review process, for example with a website that explains how the evidence was identified and

extracted. This allows the details to be available to those that are interested to research further.

2. The strength of the evidence behind recommendations should be transparent. If there is uncertainty or conflicting evidence this should be apparent.
3. Make explicit where statements have been made in the absence of effectiveness information. Consensus recommendations can be made where there is no evidence, based on stakeholder experience and knowledge. Of course, to do this you need to check if there is evidence in the first place. Guidance gaps should drive research funding calls or the undertaking of experiments to generate relevant evidence.
4. Make explicit where recommendations have not been made due to consideration of evidence of effectiveness alone (e.g. costs, social acceptability).



is widely accepted, and is as good as it gets, even where it isn't perfect. Not all of the guidance documents on the list will have been reviewed by CIEEM in relation to the principles of good guidance prior to their publication. Many will pre-date those principles, and may be considered out of date by many, but the list does highlight where more recent publications have superseded parts of the guidance.

A key feature of good guidance is that you should be able to easily find out how it was put together and what information the recommendations were based upon. It should also be updated as needed, and highlight uncertainties in evidence, allowing users to apply their professional judgement.

## Conclusions

CIEEM's code of conduct states that professional ecologists are expected to maintain their knowledge and skills, to only undertake work where they are competent and to exercise sound judgement. It also states that CIEEM

members should have regard to the relevant published technical guidance and standards. It is therefore essential that CIEEM members are directed towards relevant guidance and that CIEEM encourages and facilitates the production of good guidance. The *Principles of Preparing Good Guidance* (CIEEM 2021) and the list of good practice guidance (<https://cieem.net/revised-good-practice-guidance>) are essential steps taken by CIEEM in this regard for the benefit of its members. Nevertheless, the analysis undertaken by Conservation Evidence raises concerns about the clarity of our guidance in terms of the evidence that underpins it. It also raises questions about how guidance is produced, some of which have been identified in this article.

We would be interested to hear the views of CIEEM members on this topic. CIEEM has set up an online survey to gather those views in a systematic manner and encourages all members to take part. The survey is available at [www.surveymonkey.co.uk/r/7QYVNGL](http://www.surveymonkey.co.uk/r/7QYVNGL).

## Acknowledgements

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# Assessing the Effect of Nitrogen Deposition on Cannock Chase SAC under the Habitats Regulations: A Different View



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**Graham Machin**

Keywords: air quality, compensation measures, mitigation measures, offsetting transport emissions, retained EU case law

In our opinion, the approach described in issue 110 of *In Practice* in the case study about Cannock Chase is not appropriate. It mistakenly applies proposed off-site habitat works as 'mitigation measures' to offset the harm that could occur to the Cannock Chase SAC as a result of nitrogen deposition from transport emissions generated by the development. The works would not prevent or reduce the perceived harm to the qualifying habitats of the SAC. We explain why, in line with retained EU case law and good practice guidance, the measures are 'compensatory' and should not be taken into account in the appropriate assessment of the effects of the relevant project on the SAC.

We refer to an article in issue 110 of *In Practice* (Hibbert 2020). It carefully explains an approach put forward in respect of transport emissions from a proposed, large, mixed-use development approximately 4 km south of Cannock Chase Special Area of Conservation (SAC). It is relevant to note that at the time of writing this viewpoint the planning applications made to the Cannock Chase and Lichfield District Councils had not yet been determined.

The article describes the approach as '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.' Although the approach described uses a case study focused on Cannock Chase, it is argued that, in theory, it could be applied to any plan or project where increases in nitrogen deposition need to be quantified and offset. Essentially, the

proposal concluded that there is likely to be a significant effect on the Cannock Chase SAC, but argued that this can be mitigated by creating or enhancing new habitat to yield the appropriate number of biodiversity units within a buffer area in the immediate vicinity of the SAC. The project proposal contained financial provision for the acquisition of as-yet-unidentified land, within the vicinity of Cannock Chase, on which habitat creation or improvement would be carried out.

If a statutorily designated site had not been involved, the approach would be commendable. However, statutory designations, particularly involving sites in the National Site Network of European sites (formerly Natura 2000), bring additional considerations and legal requirements to bear on the authorisation of plans or projects likely to have a significant effect on the qualifying features. Given that the case study focuses on Cannock Chase, which is a designated SAC, we believe that the approach adopted and described in the article is incorrect and we disagree with its application, were it to be used to justify the granting of planning

permissions for the development project in this case study.

Our point of difference is this: the ‘innovative proposals’ described in the article are not ‘mitigation measures’ intended to avoid, cancel or reduce the harm to the habitats in the Cannock Chase SAC. They are ‘compensatory measures’. As such they should not be taken into account in the ‘appropriate assessment’ of the effects of the project on the SAC under regulation 63 of the Habitats Regulations (2017). Compensatory measures should only be brought into the assessment process if the competent authority has not been able to ascertain that there would not be an adverse effect on site integrity, and wishes to nevertheless authorise the project, being satisfied that there are no alternative solutions and that there are imperative reasons of overriding public interest (regulations 63, 64 and 68).

The article concludes that there is likely to be a significant effect on the SAC, and that mitigation is required. That being so, no amount of habitat creation or improvement on land outside the SAC can prevent or reduce the perceived risk of harm as a result of nitrogen deposition on the qualifying habitats inside the SAC.

The principles relating to the use of habitat improvement and creation in and outside European sites, as a means of authorising plans and projects under the Habitats Directive (1992), are well established in law. A series of cases in the Court of Justice of the European Union (CJEU): *Briels* (CJEU 2014), *Orleans* (CJEU 2016) and *Grace and Sweetman* (CJEU 2018), have firmly established that the provision of new or improved habitat, even within the same European site, let alone outside it, cannot mitigate for the loss of or damage to qualifying habitat, or the habitat of qualifying species, elsewhere within the site.

The case of *Briels* is particularly pertinent because it related, among other things, to the effects of transport-generated nitrogen deposition on the habitats of a SAC as a result of the widening of the A2 road in the Netherlands. The project proposed improvements to the hydrology and on-site management in part of the SAC,

which would create a larger area of better quality of the qualifying feature (*Molinia* meadows). In its judgment, the CJEU found that the habitat creation and improvement measures were not aimed at either avoiding or reducing the significant adverse effects on the designated habitats that would be affected by the motorway project; rather, they would compensate after the fact for these effects.

*Orleans* related to an infrastructure project at the port of Antwerp where the development would result in the loss of 20 ha of intertidal habitats within a Natura 2000 site. The CJEU concluded that because the new habitats, proposed to be created to offset the loss of existing habitats, would take time to fulfil their ecological objectives, and with uncertain success, they were not mitigation measures. Like *Briels*, the case relied on future benefits offsetting the significant adverse effects on the site. *Grace and Sweetman* related to a wind farm in Ireland, which would result in the loss of significant areas of foraging habitat of the hen harrier (*Circus cyaneus*) within a Special Protection Area. The CJEU ruled that even where measures are proposed to ensure that sufficient habitat is always available to the species, such measures should not be taken into account in the appropriate assessment as mitigation because, despite them, some parts of the site would not be able to provide suitable habitat for the species. Notably, in that case, the habitat was not itself the qualifying feature. All three of these cases are retained EU case law.

The assessment of the harm must be at the time of the assessment under the Habitats Directive, and not at some future time when habitats have evolved. In other words, to be taken into account under the Habitats Regulations, mitigation measures must avoid, cancel or reduce the adverse effects on the relevant habitats as they actually exist at the time of the assessment, within the designated site. The habitat works in the buffer area at Cannock Chase cannot do this. Although the proposed works could potentially increase the ecological resilience of the SAC, by reconnecting parts of a fragmented site, we are of the opinion that the competent authorities, in conducting

an appropriate assessment under the regulations, cannot lawfully take into account the buffer area proposals as mitigation in deciding whether the relevant project may adversely affect the integrity of the Cannock Chase SAC.

It is beyond the scope of this article to consider what the outcome of a properly conducted appropriate assessment might be. It remains an open question whether the project, relying only on measures which can properly be characterised as mitigation, can be configured in such a way as to justify the conclusion that it can be ascertained not to threaten any significant adverse effect on the integrity of the SAC. If the local authorities could not so ascertain, they would only be able to authorise the project should they be satisfied that the stringent requirements of the derogatory provisions contained in regulation 64 are met. Only in that context would off-site measures, such as those proposed, become relevant, as available compensatory measures pursuant to regulation 68.

We note that the buffer habitat was agreed by consultees to be mitigation as opposed to compensation due to the timing, commencing as it did before the nitrogen impacts would occur. However, there is no such criterion, as is implied here. The fact that compensatory measures might be in place before adverse effects occur does not convert compensation into mitigation.

Our assessment is fully supported by the evidence presented in Tyldesley and Chapman (2013–2021), which provides a detailed analysis of the CJEU cases and also examines relevant European Commission guidance. We believe that the case is inconsistent with Natural England (2018) internal operational guidance. Nowhere does this guidance indicate that off-site habitat creation or improvement measures can comprise mitigation, which in turn could enable a competent authority to ascertain that nitrogen deposition on a European site, which is sensitive to air pollution generated by traffic, would not be an adverse effect on site integrity. The proposed approach would be contrary to a recently published CIEEM advisory note (CIEEM 2021; see para 71, Box 3 and paras 86–87).



### Box 1. Natural England comment: assessing the effects of nitrogen deposition on Cannock Chase SAC.

Natural England recognises how important is it for competent authorities when undertaking assessments of plans and projects under the Habitats Regulations 2017 (as amended) ('HRAs') to properly distinguish mitigation measures (that avoid, prevent or reduce the risk of adverse effects occurring in the first place) from compensatory measures (that offset or make up for any unavoidable adverse effects that cannot be ruled out).

In light of the clear case law on this subject, Natural England's view continues to be that the creation of new habitat that is initially proposed to 'mitigate' for a predicted adverse impact on designated habitats within a European Site should instead be treated as a compensatory measure. Such measures should only be taken into account following an appropriate assessment and where, despite a negative conclusion to that assessment, a competent authority has decided to consider a derogation for a plan or project and has already satisfied itself that there are no alternative solutions and imperative reasons of overriding public interest.

In this particular case, it was Natural England's advice that the proposed mitigation measures as put forward

by the applicants would substantially increase the ecological resilience of the SAC by creating a significant amount of new high quality habitat that would re-connect parts of this very fragmented site. This proposal was accepted as part of a package of mitigation measures to address the air quality impacts on the SAC habitat that were predicted to occur within 200 m of the affected road network.

On reviewing the advice given to date on this case, we recognise that this specific mitigation measure would not in itself prevent the predicted additional road traffic emissions from the project reaching a small area of the SAC. We accept that this measure, whilst well-intentioned, is better categorised as a compensatory, rather than mitigating, measure. However, we maintain our view that the creation of buffering habitat immediately adjacent to and functionally connected with the SAC habitats is a welcome positive measure that will further the site's conservation objectives in the longer term by increasing its ecological resilience to external impacts.

Natural England will continue to provide advice to the local planning authority on the case.

24 February 2021

Finally, Natural England have provided a comment (see Box 1), from which it can be seen that Natural England's position is aligned with our own. We are pleased to note that Natural England will continue to provide advice to the local planning authorities on the instant case.

### Conclusion

Taking account of buffer habitat during the appropriate assessment as if it mitigated the predicted effects of a project and could avoid an adverse effect

on site integrity is incompatible with retained EU case law and good practice guidance. It could have the effect of evading the need to use the derogatory procedures of the regulations. In our view, decisions taken on the basis described in Hibbert (2020) would be potentially vulnerable to a successful legal challenge through judicial review. We would urge anyone proposing to follow the approach described in the article to take legal advice and consult Natural England as appropriate.

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# Response to Comments made by Tyldesley and Machin to Hibbert (2020)



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I acknowledge the points raised by Tyldesley and Machin in relation to their interpretation of policy and retained EU case law, and appreciate their experience in this field. While it would not be productive to discuss the finer aspects of their argument, I would like to emphasise several points which demonstrate the importance of considering both policy and context holistically.

In the case law examples cited by Tyldesley and Machin (pp. 55–57, this issue), *Orleans* relates to the direct loss of tidal habitats within a Natura 2000 site. The relevance of this is questioned because any measures to address the effects could only conceivably be compensation due to the direct loss of internationally important habitats. The wind farm case in *Grace and Sweetman* is also less relevant as it is again a development within a Natura 2000 site, the effects of which would be felt immediately on the species in question, the hen harrier (*Circus cyaneus*). The road case in *Briels* also relates to nitrogen effects which would be felt immediately on a Natura 2000

site, whereas the effects of the project in question will be phased, with no perceptible effect in the short term.

The *In Practice* article (Hibbert 2020) was a condensed version of a 'Shadow' Habitats Regulations Assessment (SHRA) which followed a comprehensive, collaborative process that took place over a 12 month period between May 2019 and May 2020. An SHRA is termed as such because it is an appropriate assessment as part of an HRA undertaken on behalf of the developer, hence the 'Shadow' element. The competent authorities (CAs) are responsible for producing their own appropriate assessment, in this case the two local planning authorities (LPAs). Developers can produce their own assessments to guide the CAs, but it is the CAs themselves who have overall responsibility. In this case, the planning officer's report for the LPAs states 'the Councils have therefore completed Appropriate Assessment stages of the Habitats Regulations process and consulted Natural England.... On this basis it is concluded that the LPA have met its requirements as the competent authority.'

In order to reach their position, many meetings took place between the LPAs, Natural England, the Special Area of Conservation (SAC) partnership, the developer and their consultants. These were both face-to-face and later virtual (due to the coronavirus pandemic). Early in the process, a draft version of the SHRA was circulated to consultees for comment, based on the first stages of Natural England's internal guidance (Natural England 2018). In its early form, the SHRA acknowledged the potential for an adverse effect on Cannock Chase SAC arising from transport-related nitrogen emissions in the absence of

mitigation, and potential options for mitigation were proposed to be taken forward as part of the appropriate assessment, including but not limited to catalytic road screens and tree planting. Based on the consultees' local knowledge, it was advised that they were not wholly viable due to issues such as land ownership. The consultees then suggested that the creation or restoration of habitat via the Nature Recovery Network (heathland zone) would be an acceptable, novel approach to buffer Cannock Chase SAC and increase habitat connectivity. This suggested mitigation complements the measures outlined in Natural England's Cannock Chase SAC Supplementary Nature Conservation Objectives (Natural England 2017) (in order for the site to achieve favourable condition) for connecting the heathland network and, as such, is part of wider-scale actions being undertaken to manage the SAC to protect it from a range of pressures. This demonstrates that the selection of buffering habitat as a mitigation measure was agreed between consultees, following the appropriate process.

Subsequent consultation responses from statutory bodies including Natural England confirmed that they formally signed off the approach. As part of this, Natural England were in agreement that the approach was mitigation not compensation. This confirms consultees were satisfied that the SHRA was in accordance with accepted best practice *at the time*, and indeed it was specifically noted in the meetings that it followed Natural England's own current guidance. Therefore, it is important to recognise that, at the time of the assessment, full consultation took place and the approach was based on the best



available information. Natural England's subsequent response (see Box 1 in Tyldesley and Machin, this issue) reflects an amended position as well as referring to their original view. This only goes to reinforce the grey areas in between mitigation and compensation.

The suggestion that the approach is not mitigation because it will take place in the future will now be considered. In the case of a masterplan housing development, the phased construction will take place over a 30+ year period, with the effects on air quality peaking only at full occupation. The concurrent creation/restoration of heathland habitat when the first phase of the development commences (base year was 2021 in the SHRA, now likely to be 2023) will allow over 25 years of establishment before the development is fully occupied. Therefore, by the time there are likely to be tangible increases in nitrogen emissions the heathland will have become established. All ecological assessments necessarily project effects into the future, as they are based on a snapshot in time (the baseline). As the nitrogen effects can only be felt in the future, it follows that the measures developed to protect the SAC are also structured in this way.

The mixed-use development in question, and the developer's proactive approach with the LPAs and consultees, have been heralded as forward-thinking and exemplary. At all stages of the process, consultees were actively engaged to shape the emerging scheme. If no solution could be found for the impacts of nitrogen deposition on Cannock Chase SAC, this could have profound effects not only on the ability to maintain the SAC itself without adverse changes, but also on the ability to continue development within the region. Developments, regardless of how progressive, could not occur unless they could demonstrate they satisfy regulation 64 of Imperative Reasons of Over-riding Public Interest (IROPI). This is undoubtedly an undesirable scenario.

Some of the forward-thinking measures to reduce reliance on private (petrol or diesel) vehicles were accounted for in the SHRA as additional mitigation. However, one important and deliberate omission was the increasing composition of electric vehicles in the vehicle fleet because, at the time, there was no firm Government commitment to make electric vehicles mandatory. As targets were aspirational only, they could not be relied on. The Government's recent announcement that the sale of petrol and diesel engines will be banned from 2030 means that by the indicative future assessment date of 2029 in the SHRA, the proportion of electric vehicles in the fleet could be as high as 25% of private cars as opposed to the 15% that is the currently projected.

The appointment of Natural England's National Air Quality Team is welcomed, along with the increasing impetus for making real and tangible differences to reducing the background levels of NOx. I am also grateful to CIEEM for producing guidance on nitrogen assessments (CIEEM 2021). Neither of these key resources were available at the time of the assessment.

Through the author's professional experience, there are numerous other examples of buffer habitat being employed as mitigation for adverse effects on Natura 2000 sites. Here we presented a challenge which took a multi-agency approach to resolve and which would feed into a solution for a larger-scale issue. This is something much more powerful than a debate on mitigation and compensation alone.

In an environment where valuable habitats and species are increasingly fragmented and background levels of nitrogen deposition are often exceeded, a strategic, landscape-scale approach to create 'bigger, better, more joined-up' (Lawton 2010) may in fact be a well thought out comprehensive solution to increase resilience and aid species recovery in modern times.

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## About the Author

Catherine Hibbert BSc(Hons), MCIEM has been an ecological consultant for 13 years, working on a wide range of developments in the UK. Her passions lie in habitat management and botany, which tie in neatly with her increasing involvement in biodiversity net gain.

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# Edinburgh Biodiversity Declaration



**Des Thompson**  
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## Introduction

The outcome of the Convention on Biological Diversity's Aichi targets makes negative reading with none of the 20 targets set a decade ago having been fully met (CBD 2020). Comparing these outcomes with the new data emerging on biodiversity loss and climate change (IPBES 2019, IPCC 2018) we might become ever more despondent. Is it too late to act? Is the lack of political will in too many countries impossible to overcome? Are the promises of additional finance deliverable? And is the vision for 2050 of 'living in harmony with nature' too far into the future for meaningful action? These are all legitimate questions which need to be addressed now and for specific resource commitments and actions to be agreed in late 2021 at the latest at the Conferences of the Parties of both the Convention on Biological Diversity (CBD) in Kunming (Biodiversity COP15) and the Framework Convention on Climate Change (FCCC) in Glasgow (Climate COP26).

Every step along the long road to successful intervention to address and hopefully turn round the negative trends arising from a cumulation of problems of humanity's making is helpful. With the continuing failure of action to redress these negative trends, the time has come for more locally based initiatives and approaches.

## The Edinburgh Declaration

One glimmer of light was the signing of the Edinburgh Declaration in

August 2020 (Scottish Government 2020). Formally called *The Edinburgh Process for Subnational and Local Governments on the Post 2020 Global Biodiversity Framework*, it follows on from the process used to develop and agree the *Plan of Action on Subnational Governments, Cities, and Other Local Authorities for Biodiversity* (2011–2020) under CBD Decision X/22. More significantly, it stemmed from a deep concern about *"the significant implications that the loss of biodiversity and climate change has on our livelihood and communities"*. More broadly, the lead parties were concerned that *"action by CBD Parties alone is insufficient to put us on a path to the 2050 vision of 'living in harmony with nature' or to achieving the UN Sustainable Development Goals (SDGs); and that convergence across multilateral environment agreements (MEAs) is progressing at too slow a pace"*.

## The main elements

### What was the process?

The development of the CBD post-2020 biodiversity strategy was stimulated by a more open-ended and inclusive process engineered by the CBD Secretariat. With the limitations imposed to limit the spread of the COVID-19 pandemic, a virtual process was established for developing the Edinburgh Declaration using the global communication methods now available, and involving around 400 participants. Communication around the globe simultaneously is not easy given time differences, and

necessitated stretching out the working day for many participants. A spirit of cooperation readily developed, aided by involvement of the CBD Secretariat and the leadership of Scottish Government and NatureScot officials in Edinburgh, and the engagement of other leading players.

The Edinburgh Process is led by the Scottish Government in partnership with the European Committee of the Regions, ICLEI – Local Governments for Sustainability, Group of Leading Subnational Governments toward the Aichi Biodiversity Targets (GoLS), Regions 4 Sustainable Development, Government of Quebec, and the Welsh Government; and with the support of the UK Government, UN Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC), NatureScot and Royal Botanic Garden Edinburgh.

### What action is proposed?

The parties to the Edinburgh Declaration – subnational governments, cities and local authorities – clearly consider that the action mainly lies with the CBD signatories (i.e. national governments). They request the CBD Parties:

- to have more bold and innovative action to halt biodiversity loss
- to be more inclusive in their approach by recognising the role of and seeking greater ambition from subnational authorities in aiming for the 2050 vision and the 2030 mission

“ The parties to the Edinburgh Declaration are committed to increasing resource mobilisation, aligning strategy and action, and delivering greater convergence between the various international instruments. ”



- to ensure that monitoring frameworks are included for the goals and targets
- to establish a multi-stakeholder platform for representation to support implementation of the post 2020 biodiversity framework.

The parties to the Edinburgh Declaration are committed to increasing resource mobilisation, aligning strategy and action, and delivering greater convergence between the various international instruments. They are also committed to building capacity, sharing best practice and raising public awareness, all of which align well with CIEEM member activities. They also wish to see active involvement by all levels of government, indigenous peoples and local communities, and the private sector including the financial sector.

### What is the status of the Declaration?

It is not a binding commitment, but a statement of intent by signatories that their organisations will work individually and collectively to develop new ways of achieving a reversal of fortunes for nature. They will work to gain additional commitments from international multilateral government bodies and state parties to achieve this. Testament to the strength of support are the signatories to date. In addition to the seven original signatures of subnational state parties from Europe, Japan, Quebec, Scotland and Wales, there are now (as of 1 March 2021) over 100 signatories from around the world. It is very encouraging that many subnational parties, such as regional and city governments in countries such as Cameroon, France, Germany, Ivory Coast, Japan, Nigeria, Scotland, Slovenia and Spain have also signed the Declaration. In addition, several NGOs, especially in Scotland have signed, together with some in Cameroon, Georgia and India. The Mexican government is so far the only state party to sign.

With this high and increasing level of support the CBD Secretariat has prepared a paper for the Subsidiary Body on Implementation (CBD 2021). The Secretariat specifically "recommends that the CBD Conference of the Parties, at its fifteenth meeting, adopt a decision focused on

“ CIEEM has signed the Declaration to signal its commitment to advocacy and action.

Action on the ground is the *raison d'être* of many CIEEM members. ”

subnational governments, cities and other local authorities, including an updated plan of action based on the outcomes of the Edinburgh Process consultation". It is highly likely that this recommendation will be endorsed by Subsidiary Body and in turn by the CBD Conference of Parties.

### What is CIEEM's role?

CIEEM has signed the Declaration to signal its commitment to advocacy and action to improve the prospects of reversing biodiversity loss and to lessening the effects of climate change. This is in tune with the ambition of the parties to the Declaration and to the post-2020 global biodiversity framework "to take urgent action across society to put biodiversity on a path to recovery for the benefit of the planet and people". This is an inclusive approach which embraces the role of NGOs and chartered institutes like CIEEM.

Action on the ground is the *raison d'être* of many CIEEM members, as testified by their day-to-day advisory and consultancy work and by their action as shown, for example, in the submissions to the Best Practice Awards each year. This is perfectly aligned to the Edinburgh Declaration's aim of building capacity for using Nature-based Solutions and developing blue and green infrastructure and sharing best practice. Advocacy by CIEEM has become an increasingly important role in recent years; based on members' input, informed by their experience as practitioners and as scientific experts on ecology and environmental management. Hence, CIEEM formally signing the Edinburgh Declaration is in keeping with its strategy and its commitment to a long-term vision of living in harmony with nature by working in partnership with others including chartered bodies, professional societies and governments.

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### About the Authors

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# Future Wales: The National Plan 2040



**Siobhan Wiltshire**

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Welsh Government published *Future Wales: The National Plan 2040*<sup>1</sup> on 24 February 2021 making it the first ever national development plan in the UK. The publication is the culmination of 5 years' work and, despite being delayed by the COVID-19 pandemic, it is a reflection of the importance of the planning system that Ministers prioritised its delivery in this government term.

Future Wales helps to define the planned nature of the planning system in Wales. It complements Planning Policy Wales<sup>2</sup>, which has been updated and republished alongside Future Wales. Planning Policy Wales introduced a planning system response to the Section 6 Duty of the Environment Act (Wales) 2016<sup>3</sup> by setting out a framework for planning authorities to maintain and enhance biodiversity in the exercise of their functions (providing a net benefit for biodiversity) and calling for a proactive approach towards facilitating the delivery of biodiversity and resilience outcomes by all those participating in the planning process. Both documents share an empowering and creative vision for the planning system which is focused more on the outcomes of our decisions on people and places rather than the processes which lie behind them.

Future Wales has development plan status. This means lower tier development plans must be in conformity with it. Furthermore, Future Wales must now be taken into consideration in the determining of planning applications under section 38(6) of the 2004 Planning and Compulsory Purchase Act<sup>4</sup>.

The success of Future Wales does not, however, lie in the statute. It needs to be put into practice and become embedded in the way we write plans, design schemes and take decisions.

Nested within Future Wales is Policy 9, Resilient Ecological Networks and Green Infrastructure, a high bar strategic policy that aims to further advance biodiversity and ecosystem resilience within the planning system, and to make it more part of the mainstream. Welsh Government now requires strategic action to safeguard ecological networks and secure biodiversity enhancement; this article reflects on the policy ambition of Policy 9 and highlights the empowering and creative way that the policy can be used.

The connection between local interventions adding up to national scale resilience drives the policy. There is an explicit requirement for all development proposals to demonstrate how they have taken action towards securing the maintenance and enhancement of biodiversity, and the resilience of ecosystems and green infrastructure assets. The policy also introduces a safeguarding approach; it asks lower tier plans to consider action to safeguard land which, for example, may be needed to connect or enlarge a wider network of habitats. Taking safeguarding at face value is about 'looking after something' for the long term. Future Wales is asking lower tier plans to 'look after' those critical ecological functional spaces, not necessarily prohibiting development but requiring a consideration of both the

long-term needs of the habitats and species it is intended to protect and improve and the present and predicted future needs for ecosystem services and functions. Safeguarding enables dynamic responses and long-term actions. It can realise creative thinking, be flexible and is responsive to the unique characteristics of places. Future Wales seeks to move planning away from a 'process space' and into an 'outcome space'.

Of course, Policy 9 of Future Wales will not operate in splendid isolation and alliances will be forged with other national and local scale policy objectives (and rightly so). However, it introduces a new framing narrative for ecosystem resilience in Wales and sets high expectations for practitioners and stakeholders tasked with implementing Future Wales.

We are keen to hear feedback, initial reactions and experiences of working within this new policy landscape, we can be contacted at [PlanningPolicy@gov.wales](mailto:PlanningPolicy@gov.wales).

## Notes

- <https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf>
- [https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11\\_0.pdf](https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf)
- <https://gov.wales/environment-wales-act-2016-factsheets>
- [www.legislation.gov.uk/ukpga/2004/5/contents](http://www.legislation.gov.uk/ukpga/2004/5/contents)



# Ecological Evidence: Sources and Opportunities



**Hazel Norman**  
Chief Executive  
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We all know and understand the crucial importance of evidence-based guidance for professional ecologists. Worryingly, the article *Good Practice Guidance: Where's the Evidence?* in this edition of *In Practice* highlights how much of that guidance does not have a sound footing. The article also raises the issue of free access to that evidence.

The British Ecological Society (BES) has some targeted, freely accessible, evidence sources designed for the professional ecologist and also provides opportunities for you to contribute to that pool of knowledge and expertise.

In spring 2021, the BES published *Nature-Based Solutions to Climate Change and Biodiversity Loss in the UK: A report by the British Ecological Society*. For the first time this authoritative report offers a complete assessment of the potential of nature-based solutions in the UK. It examines not just how nature-based solutions could be implemented to mitigate and adapt to climate change, but also their limitations and the inevitable trade-offs involved. It is comprehensive, evidence-based and impartial, having been led by world-class independent scientists and incorporating contributions from over 100 experts. We hope it will become an influential resource for all those who manage land and want to use evidence in their decision-making.

The BES *Journal of Applied Ecology* publishes novel, high-impact papers on the interface between ecological science and the management of biological resources. The Practitioner's Perspective series in the journal aims to bridge the gap between applied ecological research and the actual practice of species conservation, ecosystem restoration, pest management and the mitigation of environmental threats to biodiversity. They provide a platform for individuals involved in hands-on management of ecological resources – be they species, ecosystems or landscapes – to present their personal views on the direction of applied ecological research. Articles are of international relevance, even if based on a regional study, and make clear recommendations regarding how the issue can be taken forward to ensure improved science-based practice. The format is concise, making them easier to write and read, and at least one author has to have direct experience of the practical management of the environment. Topics for recent papers include integrating ecosystem services into environmental decision-making and setting the framework for a code of practice for mosquito management in European wetlands; articles are grounded in knowledge and expertise but widely applicable. Practitioner's Perspective papers are free for anyone to read.

The latest addition to the BES journals portfolio is *Ecological Solutions and Evidence*, an open access journal publishing articles with direct relevance for the management of biological resources and ecological systems. It also has an article type specifically designed for professional ecologists – From Practice. These papers provide practitioners with a venue for communicating with a broad audience and are flexible in terms of subject matter and format. They can include case studies of successful

“ The British Ecological Society has some targeted, freely accessible, evidence sources for the professional ecologist and invites you to contribute to that pool of knowledge. ”

projects, calls for new approaches for dealing with persistent problems or perspectives on research topics relevant for management. The articles have clear recommendations on how the issue can be taken forward to ensure improved science-based practice. This newest journal forms part of an open access online repository called Applied Ecology Resources which provides a route to share and search for the valuable evidence that exists in documents such as reports, policy documents and guidance notes,

If you are looking for high quality, freely accessible evidence to support management recommendations and interventions, then the BES has lots of resources available for you. Even better, if you have the knowledge and expertise, we have the platforms to help you share and disseminate them with a global audience.

Find out more at:  
[www.britishecologicalsociety.org](http://www.britishecologicalsociety.org)

# Apprenticeships: A More Inclusive Approach?

## Peter Farrell

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With much discussion currently regarding the importance of creating a more diverse and inclusive profession, is it time to view traditional graduate entry as one, but only one, route into the profession? Degrees are expensive and employers often criticise the lack of practical skills and work-readiness of the graduates they produce. Of course, CIEEM's accredited degree programme seeks to address the latter by highlighting those degree courses and pathways that demonstrably 'raise the bar' in this regard. But, even so, lack of opportunity and the cost of a degree creates barriers for many who might want to enter the profession. Could apprenticeships become a more widely used route to a career as an ecologist or environmental manager?

## Apprenticeships: developed by employers, for employers

The recent introduction of relevant new apprenticeships in England, developed by employers and supported by training providers and professional bodies, opens new possibilities not only for school leavers or those seeking a change of career but also for employers. Both the Level 7 Ecologist and Level 6 Environmental Practitioner apprenticeships have been designed to deliver both occupational and professional competence.

Apprenticeships are made up of a 'Standard', which describes the Knowledge, Skills and Behaviours (KSBs), that the apprentice will learn and be assessed against at the end of their apprenticeship. In the case of the Level 6 Environmental Practitioner, the apprenticeship that the University of Bolton is a training provider for, the Standard also requires the completion of a Bachelor's degree in Environmental Sciences, which is done through the study and assessments undertaken during the apprenticeship period.

## How are apprenticeships funded?

With the launch of the apprenticeship levy for employers in 2017, the funding mechanism for all apprenticeships changed<sup>1</sup>. In England, employers no longer pay fees directly and apprentices receive all of the training and assessment related to the apprenticeship for free.

For those employers with a salary bill over £3 million per annum, the

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apprenticeship levy can be accessed when an apprentice is employed. Levy funds will be released from their digital apprenticeship account, and this will be topped up by a 10% Government grant.

For employers under the apprenticeship levy threshold, employers need to co-invest in the funding of the apprenticeship. By registering on the Government's apprenticeship service, employers will be able to receive funds to train an apprentice, and the Government will pay up to 95% of the training and assessment costs.

## Quality at the heart of apprenticeships

There are criteria that employers need to be aware of to gain access to apprenticeship funds.

The first is a requirement for a minimum of 20% of apprenticeship time being spent on 'off-the-job' training across the full duration of the apprenticeship.

The second is a recognition that apprenticeships are much more than a traditional academic programme: apprenticeships are a three-way partnership that must be forged between the apprentice, the employer and the training partner. All parties must commit and be contracted to an 'individual learning plan' developed in a way that is wholly aligned to the KSBs stated in the apprenticeship standard.

## Participating in professional development

Employers must support the broader development of the apprentice through mentored work-based learning and

the development of professional competence, alongside the degree programme that underpins the more academically focused learning outcomes.

The evidence gained through the combination of the degree, the work-based learning and the professional portfolio can then be used to ensure that apprentices are ready for their independent End Point Assessment (EPA), which completes the apprenticeship. The outcome of the EPA may be used to confer professional registration through a professional body such as CIEEM.

## Where can I find out more?

The University of Bolton has recently launched its Environmental Practitioner degree apprenticeship programme<sup>2</sup> and is now open to employers who are seeking to place apprentices. Our model is based on 6 week learning blocks over a period of 5 years; 2 weeks must be on campus, 2 weeks, remote delivery by video conference and 2 weeks optionally, remote or physical attendance to suit the preferences of apprentices. There are other training models at other universities that employers may wish to consider.

Please get in touch with us if you would like to know more or visit: [www.instituteforapprenticeships.org/apprenticeship-standards/environmental-practitioner-\(degree\)-v1-0](http://www.instituteforapprenticeships.org/apprenticeship-standards/environmental-practitioner-(degree)-v1-0)

## Notes

1. How to register and use the apprenticeship service as an employer. [www.gov.uk/guidance/manage-apprenticeship-funds](http://www.gov.uk/guidance/manage-apprenticeship-funds)
2. BSc (Hons) Environmental Science and Management (Environmental Practitioner) Degree Apprenticeship, University of Bolton. [www.bolton.ac.uk/course/ENG034-P-UOB-SS/2020-21](http://www.bolton.ac.uk/course/ENG034-P-UOB-SS/2020-21)

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# International Focus

## New IUCN Guidance: Mitigating Biodiversity Impacts Associated with Solar and Wind Energy Development



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As humanity makes progress with managing the climate crisis and reducing carbon emissions, it is clear that there will need to be a massive investment in renewable energy across the globe. This technology is automatically seen as being 'green' due to its lack of emissions, but its implementation could come with significant costs to biodiversity if it is not managed appropriately. This is the driving force behind the IUCN's recent guidance document: *Mitigating biodiversity impacts associated with solar and wind energy development* (Bennun *et al.* 2021). The key message is that acting early and implementing effective biodiversity management plans can turn these projects from being damaging for biodiversity to having positive outcomes.

Firstly, it is important to understand what the impacts of these projects can be, both positive and negative. Offshore wind farms can produce a high level of noise during the construction and operations phases, negatively impacting marine species, such as deafening fish populations or causing whales to move away from their breeding and feeding grounds (Weilgart 2008, Bergström *et al.* 2014). Electromagnetic fields

emanating from the cabling associated with offshore wind farms can harm fish by interrupting predation and migratory patterns (Bergström *et al.* 2014). However, these wind farms can also have positive impacts by creating artificial habitats and restricting fishing activities (Bergström *et al.* 2014).

Terrestrially, wind farms can detract from natural habitat with mowing practices that reduce floral biodiversity, which is key to many pollinator species. Onshore wind farms can be associated with bat and bird mortality directly and through habitat degradation. Both wind and solar technologies require the implementation of transmission lines, which can cause habitat fragmentation and bird strikes. These are just a handful of the potential impacts, and a key aspect of the IUCN document is to call for more research into these impacts – understanding them will be crucial to their mitigation.

In the biodiversity team at RSK's International Projects Group, we are no strangers to identifying these impacts and how they can be effectively managed. With any project that we take on, it is critical to determine the baseline conditions through resources such as the IUCN Red List, but crucially through fieldwork. This report is well-timed as we move into spring and summer, which are crucial times for establishing baseline conditions, for example, for identifying migratory birds.

So, what can be done to mitigate against these impacts? As mentioned in the opening paragraph, acting early is crucial according to the IUCN. When I say early, one of the main ways to reduce the project's biodiversity impacts was to put the project in the right place. In the webinar launch of these guidelines (IUCN 2021), the presenters highlighted that Rehbein *et al.* (2020) identified 2206 fully operational renewable energy facilities within the boundaries of Protected Areas, Key Biodiversity Areas and Wilderness Areas. Instead of building in these protected areas, the guidelines suggest using brownfield sites, roof tops or

agricultural areas. They also provide examples of how projects in agricultural areas or brownfield sites have improved biodiversity in the area.

The guidelines are too wide-ranging and detailed to discuss fully here, but there are a few key themes that run throughout:

- The target is biodiversity net gain from solar and wind infrastructure.
- The mitigation hierarchy should be applied throughout the project.
- Careful planning from the start allows for effective implementation throughout the project's life cycle.
- Ecosystem services are an important aspect of understanding how impacts on biodiversity in turn impact society.

It is clear that these guidelines are going to be invaluable to those of us whose job it is to minimise the impacts of these projects on biodiversity. They are a useful resource for their guiding principles but also for the case studies provided in the annexes. These guidelines will enable the ongoing conversation about how impacts on biodiversity are discussed during the decision-making process for wind and solar projects.

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# 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 March 2021 issue of *In Practice* we described a dilemma in which you are the in-house planning specialist working at an environmental NGO and had done a weekly check of the local authority's planning portal, discovering that one of your colleagues has submitted a planning application

to build a new hide and enlarge the existing wetland at one of your reserves. The reserve is a local wildlife site with a number of priority habitats and is regionally important for waders.

Unfortunately, when you review the planning application you find that the ecological assessment submitted to support it is far below the standards you would expect and, indeed, those you expect of external developers when reviewing ecological information in support of planning applications. There is an over-reliance on historic data/old survey information, the timings of some of the current surveys are questionable, at least two priority habitats are not mentioned and the proposed mitigation, especially in relation to the potential increase in visitor numbers, seems inadequate.

You call your reserve manager colleague to find out more. They are more senior than you and sit on the NGO's management board. You don't

know them well as they are relatively new in post.

They tell you they are really excited by the development as they hope it will bring more visitors and increased revenue. They say the site is well managed and the NGO is a nature conservation specialist, so they expect the local authority will trust it and be able to make a positive decision based on the ecological assessment submitted. If further survey information is needed they suggest it is collected after the application is approved.

We asked how you would handle this situation with your colleagues, the local planning authority, and the local community.

## Our advice

The immediate priority in this situation is to escalate within your NGO to ensure that the potential risks are understood well enough to underpin good decisions. This is obviously a



tricky situation, given your colleague's seniority, but the impacts of this situation will be worse if mitigating actions are not put in place.

In many cases, your line manager may be able to offer support and advice. The best route for escalation will vary between NGOs, but could include the Area Manager, Operations Director or Chief Executive.

**In this case, the possible risks could include:**

|                     |  |
|---------------------|--|
| Environmental risks | Hide and/or wetland poorly sited, leading to direct damage to affected habitat, increased disturbance to birds, potentially exacerbated by a lack of appropriate construction management plan to ensure that works are undertaken at the right time of year, using least damaging methods. |
| Reputational risks  | Risk that Local Planning Authority will turn down the application based on lack of evidence, and that members of the public will note the lack of environmental information, with resulting objections and potential for negative publicity.   |
| Financial risks     | Need to collect further environmental information, with further fees, as ideally the planning application would be withdrawn and resubmitted. Should the application be approved, it could be at higher risk of Judicial Review. Risk of supporters cancelling their memberships.          |

Ensure that you clearly identify the risks when you escalate, provide some options to remedy and, ideally, a recommendation about which of those is preferred. Your options should be informed by what you perceive the potential risks to be, their significance, and likelihood. This should inform a proportionate and pragmatic approach that factors in relationship management with your colleagues (both within the NGO, and potentially those in the Local Planning Authority). You may want to think about the options for handling the short-term immediate issue, but also then think about how you can work the 'lessons learned' into some medium/longer-term actions that might prevent a similar situation from arising again.

An additional consideration might be whether the reserve manager is a CIEEM member. If so, then they may have been acting outside of their competence in preparing and submitting the planning application without appropriate support. Regardless, your CIEEM membership and your obligation to act with professional integrity will compel you to take action in this situation.

It is important to try and go into this resolution phase in a way that doesn't seek to lay blame, or judge others. The focus should be on fixing the issue, but not risking damaging relationships. There may well be other factors at play that you are not aware of, so try to steer clear of politics that may be unhelpful to resolving the immediate issue at hand.

**In this case, the options you may wish to present for handling the immediate situation might be:**

|          |  |
|----------|--|
| Option A | Withdraw the planning application and work with the reserve manager to scope and secure the additional environmental information needed to support the application (lowest environmental and reputational risk but potentially significant additional expenditure).  |
| Option B | Ask the planning authority to place the application in abeyance until such time as the NGO submits additional environmental information, work with the reserve manager to scope and secure that extra information (lessens the environmental and reputational risk compared with do nothing, and is lower cost than Option A). |
| Option C | Speak to the planning authority to test their position, if granting of planning permission is likely, then do nothing (environmental risks remain unchanged, reputational and financial risk lessened slightly) or, if permission is likely to be declined, action Option A or B.  |
| Option D | Do nothing (all risks remain).   |

Your recommendation would likely be Option A as it minimises risk. If any other option is chosen, proactive work should also be undertaken to ensure that communications and media enquiries can be handled promptly and positively. Consider if there are any other supporting actions required, such as liaison with the Local Planning Authority, Statutory Nature Conservation Organisation or community, in terms of managing any relationship or reputational issues.

For longer-term actions, you should consider what lessons can be learned from this experience. Consider some of the following prompt questions:

- Does the NGO have a robust induction process – such that new staff are aware of the expertise in other parts of the organisation?
- What other learning and development packages are offered internally to support wider business and sectoral CPD?

- How can you contribute to raising the profile of the work that you and your team do so that you increase awareness and understanding?

Consider the value of collaborating with the Reserves Manager, and others, to better understand each other's perspectives. Perhaps together you can find other ways to prevent similar issues from recurring.

Talk your options through with trusted peers and your line manager to see which seem like they would be most productive in the longer term – both in terms of minimising risk to the environment, and the reputation of the NGO, but also in terms of building stronger working relationships across the organisation.

### The next dilemma

So, now for this issue's dilemma.

You have recently joined an organisation as a senior ecologist. You like the work and get on well with your colleagues, so you feel it has been a good move. You then become aware that you have been shown as the reviewer of a report that you have not had sight of. The report has already been circulated as the final version. You check the report and it is of a high standard so you have no concerns about the quality, but you are concerned that you have wrongly been shown as having reviewed it.

You initially think that it was a mistake but, upon mentioning it to colleagues, you find that it is common practice to show reports as having been reviewed when that is not the case.

You approach your manager, who attempts to make some excuses around a tight turnaround time and a particularly difficult client. He also points out that others in the team have been 'ok with it' when it has happened on occasion in the past.

What do you do?

# Complaints Update

## Breaches of the *Code of Professional Conduct*

Following review of the outcomes of a professional conduct hearing held on 6 November 2020, Mr David Bennett of Clwydian Ecology has been excluded from membership of the Institute for a minimum period of 2 years.

At a professional conduct hearing held on 3 March 2021, Mrs Victoria Burrows CEnv MCIEEM of ERAP Ltd was found in breach of clauses 3, 4 and 6 of the *Code of Professional Conduct* in respect of habitat survey, assessment and reporting. Mrs Burrows has been reprimanded with conditions.

At a professional conduct hearing held on 3 March 2021, Mr Brian Robinson MCIEEM of ERAP Ltd was found in breach of clauses 3 and 4 of the *Code of Professional Conduct* in respect of habitat assessment reporting. Mr Robinson has been reprimanded with conditions.

At a professional conduct hearing held on 3 March 2021, Miss Amy Sharples ACIEEM of ERAP Ltd was found in breach of clauses 3 and 4 of the *Code of Professional Conduct* in respect of habitat survey, assessment and reporting. Miss Sharples has been reprimanded with conditions.



# Diversity and Inclusion Within Our Profession: The Survey



**Sally Hayns**  
**CEcol FCIEM**

Chief Executive  
Officer, CIEEM

Thank you to all the members (744 of you) who took part in our diversity and inclusion survey earlier this year. The full report from the survey has now been published (<https://cieem.net/diversity-and-inclusion-survey-report-published>) but we thought it important to share a few headlines here.

## Gender identity

Gender identity refers to an individual's personal perception of themselves. It may not match the biological characteristics of their sexual identity. Just under 56% of respondents identify as female and just over 41% as male. Eight respondents (1.08%) identify

as non-binary or gender fluid whilst 2 identify as intersex.

Just over 20% of respondents said that their gender identity had had a negative impact on their professional life. The most commonly reported impact was from female respondents citing:

- Hostile treatment in construction-site scenarios
- Unequal pay
- Impact of, or perceived impact by employers on, maternity leave and/or flexible working arrangements for care responsibilities, including reluctance to employ/promote women of child-bearing age.

## Religion

Almost 48% of respondents did not identify with a religion or faith and a further 20% described themselves as atheists. A fifth of members identified themselves as Christian. Agnosticism (8.5%), Paganism (2%) and Judaism (1%) were the next highest responses. Whilst three quarters of respondents who were open about their religion or faith at work felt that it had no impact in their professional life, over 10% felt it had, with some respondents being subject to inappropriate comments.

## Disability

Just over 7% of respondents have a disability. The majority of these were learning disabilities, mental health conditions or other long-standing health conditions. Where respondents had a choice about whether to be open about their disability, a quarter had been very open whilst a further 40% had been somewhat open. Half of these respondents felt that it had made their professional life harder, either because of the practical difficulties they experienced or because of the attitudes of managers/colleagues. However, a quarter of respondents felt that it had had no impact or made things easier, often because line managers and colleagues were more understanding.

## Ethnic background

Just over 95% of respondents identified as White English/Scottish/Welsh/Northern Irish/British, White Irish or Other White background. The majority felt that this had no impact or a positive impact on their professional life. Respondents who identified as an ethnic background other than white (e.g. people of colour) did not report being treated unfairly but did note that

they often felt 'different' because they reflected such a small proportion of the profession. Some white respondents reported that they had felt unfairly treated because of their accent or heritage (e.g. Eastern European working in the UK, Irish working in England or English working in Wales).

### Sexual orientation

Of the 13% of respondents who described their sexual orientation as anything other than heterosexual, 5% identified as gay or lesbian, 5% as bisexual and 3% as pansexual or asexual. A quarter of these respondents are very open about their sexual orientation whilst 45% are open with some colleagues/work-related contacts. Those who were selectively open or not open cited its lack of relevance to their professional life, the importance of the culture of the employer and wanting to benefit from 'straight privilege'. A fifth

of respondents felt that their sexual orientation had some negative impact on their professional life with instances of homophobic bullying, being the subject of banter and discrimination.

### Socio-economic background

The majority (80%) of respondents went to a state-run or state-funded school. Of the 14% that attended an independent fee-paying school, just under 5% were in receipt of a bursary. Two thirds of respondents have a postgraduate qualification, a further 31% have a first degree. Just over 50% of respondents were the first generation of their family to go to university.

### Next steps

We encourage all members to read the full report available on the website (<https://cieem.net/diversity-and-inclusionsurvey-report-published>).

Our Diversity and Inclusion Working Group is assessing the report and has identified a number of actions to take forward, both internally and externally, to help create a more diverse and inclusive profession. To help achieve the latter, we have formed collaborations with other bodies and organisations including Wildlife and Countryside Link, the Diverse Sustainability Initiative and Dialogue Matters. We are not going to change things overnight but CIEEM's Governing Board is determined that diversity and inclusion should be high on the agenda and have made it a key part of our current Strategic Plan.

You can also help. One of the most powerful ways to effect change is to share **your** story via a blog, *In Practice* article or case study for our careers webpages. If you would like any help or support to share your experiences and suggestions for change please do get in touch.

# CIEEM Welcomes New Fellow

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.



We are delighted to welcome another member to Fellowship:

### Dr Julie Fossitt FCIEEM

Dr Julie Fossitt has been an important contributor to ecology and vegetation history in Ireland and Britain for over 30 years. Julie's published work, from academic research conducted in the late 1980's and early 1990's on the history of vegetation of the northern and western regions of Ireland and Britain, has stood the test of time and is still the authoritative work on the postglacial record of the region.

After leaving academia, Julie compiled the first book describing and classifying Irish habitats whilst employed with the Irish Heritage Council – *A Guide to Habitats in Ireland*. This has since become a standard manual for all ecologists in Ireland and is widely used in education, nature conservation and environmental assessment.

Julie is currently Divisional Ecologist with the National Parks and Wildlife Service (NPWS) based in Galway and has worked in this role for the past two decades. She has advised on many development projects, both large and small, always trying to secure the best result for biodiversity conservation. This has included advising on the likely impacts of large-scale developments on Natura 2000 sites and in some cases, the robustness of her practical advice has been rigorously tested under cross examination at oral hearings for planning appeals. Her detailed knowledge and strength to stand by her principles has regularly drawn admiration from all sides.

Julie is considered an expert in her field and is passionate about sharing her knowledge with undergraduate students, less experienced ecologists and members of voluntary naturalists' groups in both professional and amateur settings.



# Latest Membership News



**Sarah Cox**  
Membership  
Operations Manager,  
CIEEM

At the time of writing, towards the end of March 2021, we have just passed the 1 year anniversary of the first lockdown due to the COVID-19 pandemic. Like many of you, our team did not expect to still be working remotely and be in a lockdown situation 12 months on. It therefore feels like a good time to reflect on the last year from a membership perspective and share with you some good news stories we have been able to achieve despite the challenging circumstances.

## Supporting members

As the pandemic unraveled last spring members of the Governing Board met regularly, almost daily, to review the impact of the pandemic on members and to support Secretariat staff to produce and issue guidance via a dedicated webpage. The Board also took the decision very early on to freeze subscription fees for the coming subscription year, and to waive fees associated with upgrading membership to support members wanting to make the most of some unexpected capacity whilst perhaps also facing some financial uncertainty. We brought forward the launch of the Member Assistance Programme (MAP), a new member benefit to provide members with access to an extensive package of

support including telephone advice lines and counselling services.

## Membership numbers

As an Institute we have continued to attract members and, importantly, retain members during these turbulent times. During the 2019–20 subscription year the membership team processed over 1500 applications in total – this is the most the team has ever processed! This total includes both new and upgrade applications and I must say a HUGE thank you to our hardworking membership application assessors who have continued to volunteer their time to review competency assessed applications throughout the pandemic. Additionally, 224 members benefitted from waived fees and submitted upgrade applications between April and August. The Institute has over 6100 current members and as a team we continue to look for opportunities to improve and develop our systems and processes.

## Banking competencies

Over the last year the team has continued to work closely with the Membership Admissions Committee and the Registration Authority to review procedures, update guidance and make improvements to application processes. With their support we have been able to introduce improved monitoring and auditing of our processes to ensure we offer fair but robust routes to membership. The most recent change to be implemented allows applicants to ‘bank’ competencies that are successfully evidenced as part of an application. This removes the requirement for unsuccessful applicants to resubmit an entire application, and also allows members aiming for Chartered Ecologist (CEcol) status to carry forward competencies already evidenced. This means that for several grades of membership we only require applicants to simply make up the additional competencies required to reach the next grade.

## Making sponsoring easier

Another change for applications to Associate and Full membership is that our sponsor requirements have been relaxed. Two sponsors are still required in support of an application, but sponsors will no longer be required to submit supporting statements in the summary of competence section of the form and instead will be asked to simply confirm whether they endorse the evidence provided by the applicant. And sponsors are no longer required to be CIEEM members.

## Extending the Qualifying grade

Following a recent survey of our Qualifying members on the effects of COVID-19 and the impact this has had on gaining experience and developing skills the Governing Board has approved a temporary extension to the time limit members can remain at this grade.

## Online applications

Right now, we are in the early stages of working with our IT partner to deliver to both existing and prospective members the option to upgrade and apply for membership online. Being able to offer members a user-friendly and more technologically advanced way to work on and submit applications and progress their membership journey with us has been an ambition the team has had for several years now. We hope to be able to share more details about this project later in the year.

Despite the disruption caused by the pandemic and Brexit, we are pleased we have been able to continue to provide so much support to our members and I hope that you can take some comfort and pride in knowing that you are part of a strong and growing Institute, striving to provide support to the sector during these challenging times.

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

# Policy Activities Update



**Amber Connett**  
GradCIEEM

Policy and Communications Officer, CIEEM

Through our policy work, we aim to be a powerful voice for our members in influencing nature conservation legislation, policy and practice in the UK, Ireland and Europe. We have recently published infographics showing just a snapshot of the ways we achieved that aim in 2020, from meetings with ministers, to working collaboratively with other environmental organisations. Check out the infographics in detail at our website Resource Hub.

We are pleased to announce that CIEEM has now been admitted as a member of the four UK Environment Link groups – Northern Ireland Environment Link, Scottish Environment Link, Wales Environment Link, and Wildlife and Countryside Link (the group for England). This will allow us to contribute to a stronger voice for the environment, bring opportunities to collaborate with a range of organisations in the environmental sector and assist with learning and sharing information with groups who share similar goals.

## UK and England

The All-Party Parliamentary Group (APPG) for Nature has continued its engagement activities this year, jointly holding an event in January on the impact of COVID-19 on conservation with the APPGs for International Conservation and for Zoos and

## CIEEM POLICY ACTIVITIES IN UK & ENGLAND 2020



## CIEEM POLICY ACTIVITIES IN SCOTLAND 2020



## CIEEM POLICY ACTIVITIES IN IRELAND 2020



## CIEEM POLICY ACTIVITIES IN WALES 2020





Aquariums. In April, the group also held its AGM where Barry Gardiner MP, Kerry McCarthy MP, Baroness Barbara Young of Old Scone, Alexander Stafford MP, Geraint Davies MP and Baroness Kate Parminter were elected as Officers. The AGM was followed by a roundtable discussion on Local Authority capacity to deliver the 25 Year Environment Plan and new measures in the Environment Bill. Speakers included David Lowe MCIEEM, Warwickshire County Council; Melanie Hughes, Natural England; and Elizabeth Milne, Association of Local Government Ecologists. Minutes and recordings of the events can be found at <https://cieem.net/appg-for-nature/>.

At the time of writing, we are producing a response to the consultation on the Draft Policy Statement on Environmental Principles.

## Scotland

In April, we published a follow-up briefing to the *Biodiversity Net Gain in Scotland* briefing paper. The new *Biodiversity Net Gain in Scotland: Briefing Note for Local Planning Authorities* provides Local Planning Authorities in Scotland with an overview of the Biodiversity Net Gain concept, the benefits it can provide and potential mechanisms for implementation in the terrestrial environment, learning from approaches being developed elsewhere in the UK and internationally. This paper was authored by Scotland Policy Group members, Hannah Williams MCIEEM and Sarah Kydd CECOL MCIEEM.

The Scotland Policy Group has also recently responded to the Clean Air in Scotland 2 consultation and Scottish Government's position statement on the National Planning Framework 4.

## Wales

We have continued our regular liaison meetings with Natural Resources Wales this year. At the latest meeting, we discussed better support for each other, the implications of easing COVID-19 restrictions, and Brexit implications on the sector. We have also continued our regular liaison meetings with Welsh Government civil servants, most recently discussing the publication of Planning Policy Wales 11.

The Wales Policy Group has continued engagement with the election processes, reviewed manifestos for their environmental commitments and is looking into the implementation of new agriculture schemes post-election.

## Ireland

The Ireland Policy Group has recently responded to two consultations: Environmental Plans, Principles and Governance for Northern Ireland (NI) and the Climate Change Bill Discussion Document. Our response to the former calls for a fully independent replacement for the role of the European Commission and Court of Justice of the European Union. If the Office for Environmental Protection is chosen to fulfil this role, we have also called for it to be co-designed by consensus between Belfast and Westminster and share representation. We support the introduction of a Climate Bill in Northern Ireland but feel there is more scope in the discussion document for integrating action on both the climate emergency and biodiversity crisis.

The group is also reviewing ways in which CIEEM can support the recently updated *All-Ireland Pollinator Plan for 2021-25* following our actions under the previous plan to raise awareness amongst ecologists and environmental managers.

## Future priorities

Over the coming months, we will continue to focus on our priority policy areas of land management, green recovery, the marine environment, and the climate emergency and biodiversity crisis. We will soon be issuing statements in the run up to the Biodiversity COP15 and Climate COP26 events and are currently organising joint events with organisations such as Society for the Environment and the Institution of Environmental Sciences.

All of our briefings and consultation responses can be found in our Resource Hub (<https://cieem.net/resources-hub>) under 'Policy Resources'.

### Contact Amber at:

[AmberConnett@cieem.net](mailto:AmberConnett@cieem.net)

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



# From the Country Project Officers



**Annie Robinson**  
– Scotland  
Project Officer

2021 seems to have been a busy year already. We have held a range of member

network events including a marine quiz, a talk and discussion on upland water voles, an event with external speakers promoting volunteer national recording schemes and a talk on the Natural Capital Laboratory.

I would like to thank all our Scottish committee volunteers and other volunteer members for the time they have put into these Member Network events as well as career events. By March we had already contributed to three career events with the latest being an event with Aberdeen University MSc students. These events offer a great opportunity for those interested in a career in Ecology and Environmental Management to chat with professionals working in different fields and sectors and pick their brains about how they got to where they are today. It is great to see students really engaged and making the most of the opportunities available.

2020 was a busy year for the Scotland policy group as shown in the policy infographic (see page 72 and the Resource Hub on the CIEEM website). We have carried this momentum into 2021 and we have already produced responses to consultations/calls for views (Draft Strategy for Environment, Natural Resources and Agriculture Research 2022-2027; Cleaner Air for Scotland 2 consultation; and NPF4 Position Statement response).

We are delighted to share a new publication – *Biodiversity Net Gain - Briefing Note for Local Planning Authorities* – which is available in the Resource Hub. A huge thanks to the authors, Hannah Williams and Sarah Kydd as members of the Scotland Policy

Group, for all their work on this.

In addition, one of our Scotland Policy Group members is part of the Scottish Government National Planning Framework 4 Securing Positive Effects for Biodiversity Working Group.

Planning is underway on the 2021 conference which will be ‘Greening Our Grey’ so look out for the Call for Papers.

For further updates check out the Scottish section newsletter and hopefully we will see you at one of the Member Network events.

**Contact Annie at:**  
annierobinson@cieem.net



**Elizabeth O'Reilly**  
– Ireland  
Project Officer

Hello from sunny Ireland!

Since our last update we have run a successful Irish Section conference. I am really grateful to all the amazing speakers and volunteers who made an engaging programme and to everyone who attended. There were some great conversations around Nature-Based Solutions and I am excited about following up on this in our future activities. We were particularly honoured to welcome Minister Malcolm Noonan, who oversees the National Parks and Wildlife Service (NPWS) in Ireland and also Minister for the Environment in Northern Ireland, Edwin Poots. It was great to have them open both days of the conference and were a great addition to the event.

The conference does take my focus during this time but there has also been ongoing activity on student events and network building with other organisations.

As we move into the summer season, our volunteers are usually busy in the field but I hope to offer some support though our regular Irish Section

Newsletter. I will also be building on the policy and network activities of the Section, and you never know, we might get a small in-person gathering in before the year is out. Here's hoping!

**Contact Elizabeth at:**  
elizabeth@cieem.net



**Mandy Marsh**  
– Wales  
Project Officer

S'mae pawb/  
Hello everyone

I joined the Institute at the beginning of April and I am gradually finding my feet and settling into the team.

I have introduced myself to various organisations and people throughout Wales, including Welsh Government and Natural Resources Wales, and am having ongoing discussions with the Wales Vice President, the Wales Section Committee and Wales Policy Group.

CIEEM has recently become a member of Wales Environment Link, so we are breaking new ground for both CIEEM and myself in building a new relationship with them. We have joined the special interest groups on Land Use, Biodiversity and Governance and I am liaising between the Groups and CIEEM.

I will be working with volunteers in Wales to progress our engagement and activities with members, stakeholders and policy-makers. I am also investigating how to make greater use of the Welsh language at events and in published material. My own Welsh language skills are middling – certainly not fluent, but if you would like to contact me in Welsh, please feel free to do so.

Edrychaf ymlaen at weithio gyda chi / I look forward to working with you

**Contact Mandy at:**  
mandymarsh@cieem.net



# British Ecological Society

## Nature-based Solutions: Tackling Climate Change and Biodiversity Loss in the UK



**Bethany Chamberlain**  
British Ecological Society

A landmark BES report offers the first comprehensive assessment of the potential of nature-based solutions in the UK.

We currently face immense environmental challenges including the climate emergency and catastrophic global biodiversity losses. The UK has committed to reaching net-zero carbon emissions by 2050 as well as halting declines in biodiversity over similar timescales, but the approach to meeting these targets is far from clear.

Nature can be our ally in responding to the 'twin-crises' of biodiversity loss and climate change through nature-based solutions (NbS). NbS essentially involve the protection, enhancement or sustainable management of nature in a way that helps to address societal challenges such as climate mitigation and adaptation, deliver biodiversity benefits and improve human wellbeing. To help policy-makers reach informed decisions about the role that NbS can play in addressing climate change and biodiversity loss, the BES has produced a report written by over 100 experts. The report examines the potential for NbS across a range of UK habitats, such as woodlands, marine and coastal habitats, urban environments and arable systems, while also discussing trade-offs, and looking at wider considerations of what is needed to deliver NbS at sufficient scales, including policies and financing opportunities.

The report identifies that a key advantage of NbS lies in their ability

to provide multiple co-benefits and tackle environmental and societal challenges simultaneously. For example, peatlands are among the most carbon-rich ecosystems and currently store approximately 3 billion tonnes of carbon in the UK<sup>1</sup>. However, as a result of their current degradation, they are emitting an estimated 23 million tonnes of carbon dioxide equivalent per year<sup>2</sup>. Restoration of UK peatlands through rewetting and revegetating bare peat can reduce and eventually halt these emissions, thereby playing a key role in climate change mitigation. Peatland restored to good condition can also reduce flood risk, by slowing the flow of water during storm events and thereby contribute to climate adaptation. Additionally, restoration can help re-establish rare and distinct peatland biodiversity.

To ensure positive outcomes are achieved through NbS, it is vital to understand factors such as baseline habitat quality, soil conditions and the potential biodiversity losses and gains that will result from implementing NbS. For instance, woodland creation on species-poor, low productivity grasslands may be a good NbS for climate change mitigation. However, on species-rich grasslands it would damage biodiversity; furthermore, where grassland is found on degraded peat soils, restoration by rewetting is likely to have better NbS outcomes for biodiversity *and* greenhouse gas reduction.

Effective planning for NbS at appropriate spatial scales can also help to capitalise on the co-benefits that can be delivered by NbS. For example, tree planting is an effective method of carbon sequestration and, if strategically planned, tree planting alongside rivers has the potential to sequester carbon, reduce flood risk, stabilise riverbanks and also cool water temperature for vulnerable species. Delivering the multiple benefits of NbS therefore requires the use of robust spatial datasets and careful



project planning, which is a key area of discussion in the report.

Ultimately, there are great opportunities to use NbS to tackle climate change through mitigation and adaptation, via processes such as carbon sequestration, flood risk reduction and increasing soil resilience. NbS can also enhance biodiversity by providing or improving habitats and creating ecologically connected landscapes. However, it is important to note that despite the huge range of benefits that NbS can deliver, they should be seen as complementary to other climate and conservation actions, not as a replacement to them.

The BES would like to thank all authors, contributors and reviewers for their efforts on this report.

### Notes

1. RSPB (n.d.). *Repairing Nature's Carbon Store*. [online] Available at: <https://storymaps.arcgis.com/stories/fe3455a345bf45ce9b72d70ae75f933b> [accessed: 01/03/21].
2. Evans, C., Artz, R., Moxley, J., Smyth, M-A., Taylor, E., Archer, N., Burden, A., Williamson, J., Donnelly, D., Thomson, A., Buys, G., Malcolm, H., Wilson, D., Renou-Wilson, F. and Potts J. (2017). *Implementation of an emission inventory for UK peatlands*. Report to the Department for Business, Energy and Industrial Strategy, Centre for Ecology and Hydrology, Bangor.

### Find out more

Read the report at [www.britishecologicalsociety.org/nature-based-solutions](http://www.britishecologicalsociety.org/nature-based-solutions).

# By Members For Members



## Volunteers making their mark

### Despite the challenges of 2020, our Member Network and Special Interest Group committees still impacted CIEEM's influence on our profession!

The past 12 months have been difficult for Member Networks and SIGs, as the restrictions imposed during the pandemic prevented in-person meetings of any kind. Nevertheless, our brilliant volunteer committees were able to adapt their practices and still deliver a wide range of support and activities to members to further CIEEM's mission.

CIEEM is fortunate to have over 170 hard-working and knowledgeable Member Network and SIG volunteers, who between them in 2020 organised 17 events (mostly online) which were attended by over 1400 delegates (including CIEEM members and non-members). They produced 15 eNewsletters for their members to highlight both regional and topical ecology stories and included links to useful resources and scientific journal papers. Thanks to the assistance of Member Network and SIG volunteers, the CIEEM policy team were able to publish position statements on the Environment Bill, Agriculture Bill, Green Recovery, Rewilding, and Strategic Protected Species Licensing, and submit 19 consultation responses during 2020. We also completed our first year of action under the Action 2030 project, for which Member Network and SIG volunteers are helping to roll out an action strategy to members so that we can carry this project forward. Volunteers also delivered presentations and represented CIEEM at 15 different university and college careers fairs for students, promoting the ecology and environmental management career path.

Given the circumstances, this is an impressive list of accomplishments and it is hoped that volunteers will continue to grow this incredible work in the year ahead. This final message goes directly to volunteers in our Member Networks and Special Interest Groups.

Take a moment to appreciate all your hard work in 2020 and be proud. At CIEEM, we are looking forward to seeing what the next year brings, and (at the time of writing) it has been a promising start for our members' groups. Keep up the fantastic work, and we simply cannot thank you enough for everything you do for us. Without you, we simply would not be able to make the impact on the sector that we do. Your continued efforts are hugely appreciated.

## South East England Geographic Section

### The urban greening challenge

The CIEEM South East Member Network was excited to host its online Annual Members Meeting (AMM), headlined by a selection of thought-provoking presentations focusing on how the ecology and environmental management sector can meet the challenge of greening up cities, especially in the context of current challenges including climate change, COVID-19 and the biodiversity crisis. The AMM was a chance for members to hear updates from central CIEEM, feed back to the Member Network committee and suggest any events and consultations they would like to be part of in the year ahead.

Following the AMM, the evening's presentations provided attendees with an insight into the urban greening challenge, and identified some innovative ideas on how we can bring nature into our cities. Peter Massini, Director of Future Nature Consulting,

showcased urban greening policy and practice. John Little of the Grass Roof Company highlighted uses of new brownfield landscapes, while Dr Caroline Nash, a Research Fellow at University of East London Sustainability Research Institute, focused her talk on eco-mimicry and urban green infrastructure design.

## Yorkshire & Humber Geographic Section

### Kickstarting ecology careers

Yorkshire-based students and recent graduates considering a career in ecology or environmental management were invited to join members of the CIEEM Yorkshire and Humber Member Network via Zoom for an insightful career event. Members of the committee, all experienced professionals in the ecology and environmental management sector, each gave a short presentation to illustrate their career journeys so far, and what skills and knowledge they had picked up and found useful along the way. Each member explained the jobs they currently undertake and described what a day in their working life might look like. This was followed by an informative question and answer session, where attendees were able to ask questions and gain advice from the professionals on their own future career paths.

The attendees were engaged with the session and asked some important questions regarding training, possible entry paths into the sector and uses of different academic qualifications. The session was well-attended, and the participants left feeling informed, excited about their career going forward, and with a knowledge of what is needed to overcome some of the potential barriers into the sector. These insights into the sector from those



who work in it are extremely valuable, and undoubtedly more of these events will be run by our Geographic Section Member Networks in the future.

## Scotland Geographic Section

### Water vole management discussion

The Scotland Member Network committee hosted a lunchtime discussion on whether the existing water vole guidelines are applicable for

management of these species in Scotland. It is one of our most threatened native mammals, and their habitat can become heavily damaged by overgrazing of bankside vegetation, or equally, dense growth of scrub as it reduces the grasses, sedges and rushes that make up their diet. Introductions to the topic were led by Matt Pannell (Senior Associate Director of Ecology, Jacobs) and Dr Mary Elliott (Independent Ecologist on the Glendoe Hydro Scheme

and various other upland projects), and the participants were invited to join in and share their thoughts and experiences on what should be the key considerations concerning Scotland's water vole management. The discussions considered how harsh environmental conditions in upland locations should change our approach to water vole management, and what we can learn from applied experiences and past practices.

**How are you?...**  
**No, really, how are you?**

The fact that everyone has been through an 'unprecedented' year doesn't necessarily make your own situation any easier.

If you have been struggling to find experience and opportunities to develop your career, confidence or competence, or if your organisation has been through some challenges, why not consider seeking advice and guidance from your peers through online mentoring. Registering is quick and easy via the 'My CIEEM' area of the website or at <https://cieem.onpld.com/>

And if you're coping really well just now, please consider registering to become a mentor and share your experience with other members in need of support.

But challenges are not just professional; sometimes we need a helping hand in other areas of our lives too. As a CIEEM member you can access a range of online resources on topics from finance to health and wellbeing, and can get free telephone counselling through a package of support we've made available for not only you, but your partners and dependants too. Just log in to the 'My CIEEM' area of the website and look for 'Member Benefits' in the menu for more details.

There's a good chance that right now you're busier than ever.  
*Remember to take care of yourselves!*

**CIEEM**



# Get Professional on Social Media

Every bit of experience counts and every contact you make may one day be useful. Professional social media is a great way to make links especially while we can't meet in person. Following organisations and people on LinkedIn and Twitter is a great way to learn about companies, business sectors, places you want to work and the people who work there.

## LinkedIn

LinkedIn is the social networking site for professionals. In a recent survey, over 72% of the students and graduates surveyed were using LinkedIn for careers purposes.

### Write an effective profile

You can write a profile covering your education, voluntary and work experience and skills. Think carefully about your headline – in a sentence or two get across what you are studying, what you are interested in and what you want to do.

Recruiters will find and view candidates using LinkedIn. An up-to-date profile and being active on LinkedIn will show recruiters that you have a genuine interest in their sector.

Find out further tips about creating a LinkedIn Profile at: <https://targetjobs.co.uk/careers-advice/networking/449493-the-graduates-guide-to-creating-the-perfect-linkedin-profile>

### Endorsements

You can get endorsements on your skills which can help add validity to your online resumé by backing up your work experience. So be sure to ask mentors, supervisors or line managers to add these.

### Making links

When sending a connection request, it is a good idea to add a note to it; that way the person knows why you want to connect. As you make connections, more potential connections will be suggested. Follow these up. Conferences and Member Network events are a great way to start the process of connecting with relevant contacts; follow-up with a connection request saying how you enjoyed their talk or presentation.

### Visit employer pages

What organisations do you want to work for? Check out their LinkedIn pages and view what they post and what current issues and topics they are working on. This can be great background information before you even get to interview stage. Employers will also advertise their job vacancies on LinkedIn.

### Join groups

You can join groups related to the sector, employer or job role you're interested in. It's a great way to start building your network and a way for like-minded professionals to share knowledge, opportunities and link up. You will be able to view the full profile of, and send connection requests to, people who are members of the same groups as you.

## Twitter

Twitter is a great platform for keeping up with what is happening in the sector and is a great networking tool. Start following people in the area you are interested in and comment on their posts. It's a great way of getting your name out there and potentially standing out from the crowd.

Once you are more confident, get tweeting yourself. Tweet interesting and relevant content and re-tweet posts made by others. Also consider using hashtags which are an effective way of finding relevant content and if used

effectively can help you to expand your Twitter audience.

Twitter can also be a medium for spotting job opportunities, posted either by organisations you want to work for or by organisations posting about opportunities in the sector.

### Be professional

Choose your e-mail and profile wisely. StanTheMan@hotmail.com may be an amusing e-mail address but think about what you are portraying if that is the e-mail you use when you are applying for jobs.

Think about what you comment on before you post it. It will reflect on you.

Keep your personal and professional lives separate. You could set up two different accounts – personal and professional – on a platform. Or you could use LinkedIn for job hunting and professional purposes and other platforms for your private life.

Review your profile visibility and privacy settings for your different social media accounts. Try searching for yourself (use an 'incognito' window so you don't influence the search results). See what comes up. Are you happy with the online snapshot of yourself?

### Make an impact

The old adage "*a picture [or video] tells a thousand words*" really does apply on social media. It helps posts to stand out and allows you to tag organisations and people on Twitter without using up your 280 character limit (you can tag 10).

### Be proactive

Once you have joined, jump in with networking, make the links and slowly but surely get yourself known. Show an active interest by liking or commenting on posts and re-share posts.



Once you have your first position don't stop there! Keep growing your network – it can be a strong source of advice and guidance, both while initially looking for a job and throughout your career.

The ecology and environmental management sector is a small world. Getting involved in social media is a great way to network, get yourself known and hear about opportunities.

If you don't already, follow and join CIEEM online:

|                |  |
|----------------|--|
| Twitter        | <a href="https://twitter.com/CIEEMnet">https://twitter.com/CIEEMnet</a>  |
| LinkedIn Page  | <a href="http://www.linkedin.com/company/chartered-institute-of-ecology-and-environmental-management-cieem-/">www.linkedin.com/company/chartered-institute-of-ecology-and-environmental-management-cieem-/</a> |
| LinkedIn Group | <a href="http://www.linkedin.com/groups/4306428/">www.linkedin.com/groups/4306428/</a>   |
| Facebook       | <a href="http://www.facebook.com/cieem91">www.facebook.com/cieem91</a>   |

# Career Profile

Interview by Ella Glover, member of CIEEM's Student & Early Careers Focus Group



**Name:** Laura Palmer MCIEEM

**Organisation:** Neath Port Talbot Council / Cyngor Castell-nedd Port Talbot

**Job title:** Biodiversity Officer / Swyddog Bioamrywiaeth

**Years in the sector:** 16

## How long have you been working in your current role? And has it changed in that time?

Eight years—and loads, absolutely loads. In Wales we've had a flurry of new legislation and planning policy. We have to have a plan on how we're going

to conserve and enhance biodiversity in all our functions, and I wrote the Biodiversity Duty Plan [for Neath Port Talbot] under the Environment Act Wales. We had to change my job description to actually fit it in!

## Since the environment is a devolved issue, does Wales come up with its own legislation?

Yes, and it's very different and a lot stronger in Wales. The Biodiversity Duty pertains to all public bodies, such as Welsh Water and the Police. As a Planning Authority when we give planning permission the applicant has to prove they've enhanced biodiversity. All authorities in Wales have actually got a letter from the Chief Planning Officer saying that you can refuse a planning application on biodiversity grounds—so it's a really strong backing.

## Do you experience much opposition to your work?

We actually have a lot of support and since we sit in the planning team, the planners take it seriously when we ask for something. We've had a much better dialogue in recent years, for example with the people that do the grass cutting. We have some beautiful verges in Neath Port Talbot covered in rare invertebrates and last year it kicked off massively when some were cut. It's difficult because we can't just turn up and say "stop doing what you're

doing: do it differently" and for years it was just "no no no". But these days we communicate better and work with them, for example, I've written a briefing note saying how we could change the regime and help them to buy better machinery. We've got a lot of support in the community and some great botanists who are happy to show up on our behalf and if something goes wrong they'll ask "Why didn't you listen to the biodiversity people?"

## What does a typical work week look like for you (pre-pandemic of course)?

I'm in the office a lot because most of what I do is comment on planning applications. Things like wind farms or household applications where, for example, they might have bats present. In Wales we have Sites of Importance for Nature Conservation (SINCs) and they're protected under planning policy. We get out to survey about 20 of these sites a year, to make sure each site is surveyed at least every 10 years. We also advise different departments; yesterday I was out on a flooding site where some vegetation needed cutting back and I advised them on when to cut back to avoid bird nesting season. We've also been looking at a lot of coal tips recently and colliery spoil sites are some of our best habitat—in the last few years we found a millipede new to science (which has been dubbed the 'Maerdy Monster')!

### I saw online that you do public talks and guided walks—could you tell me a bit more about those?

Yes, we do bat walks, in fact we often get asked to do them at Halloween but of course they're sleeping! We do bioblitzes on site where once a year we get different organisations to set up a couple of tents with wild cooking and some animals on display. Pre-COVID we did guided walks where we told groups all about the biodiversity in Neath. For Wales Nature Week last year our tech-savvy colleague organised a series of live events, so I did an hour of live bird watching from my garden and about 50–60 people tuned in!

### How has COVID-19 affected your work? And have you found that people are more appreciative of their outdoor spaces?

Working from home is weird but we still get out on site which is nice. We had a lot of money thrown at us at the end of the financial year and with just 6 weeks left to do projects, we managed to install some bat and barn owl boxes and a natural play area. I think lockdown has changed people's opinions: we're getting a much more positive response now. Some of the other offices have come around to understand why we've always been pushing this because suddenly they're appreciating their outdoor spaces. We've had a lot more queries from the public about things such as community gardens too.

### What project that you've been a part of are you most proud of?

Something I started in Cardiff is etching trails. We have these zinc plaques with raised images on that kids can rub crayons on, such as millipedes, bumblebees and butterflies. When I came to Neath I thought "*let's do them here too*". We're hoping to relaunch them and say "*here's some crayons, off you go*". It's such a simple idea—just cheap recycled plastic posts in the ground. I was also the main ecologist for us [Neath] and Swansea on the Tidal

Lagoon application in Swansea Bay which was absolutely massive—but I prefer to do an etching plaque!

### What inspired you to pursue a career in ecology and biodiversity management?

I did my BSc Hons Psychology with Theatre and Media Drama at the University of Glamorgan (as it was then), and literally the day after my graduation I went up to Anglesey to volunteer for the RSPB. I found out you could get paid to count puffins! So I went back the next year to point out puffins and drum up membership. When I was there, the MSc Ecology group from Bangor University came up and we told them about the site. I chatted to the lecturers who told me what they learn about in lectures and I thought "*I want to do this!*". I was eligible for the course so I applied and got onto it for the following year, and that was that really.

The reason I wanted to work in local government was when the Cardiff Bay Barrage happened I thought "*I can't really complain because I wasn't there, but if I can be the kind of person helping to make that decision and make it go well, I want to be a part of that.*"

### Do you have any tips for new ecologists?

Make sure you know what country you're in! Because one day you might get called up to do a survey in Wales and when you write it up, don't write down Natural England. Make sure you know what county you're in as well—it sounds daft but it happens a lot. Also make sure you're totally up to date on policy and local legislation especially if you're working on things that lead to a planning application. Obviously stick to the CIEEM guidelines as much as possible because they're the best!

You can't learn to be a planning ecologist, you just have to learn on the job. It's difficult to get experience in a local authority if you haven't had a role there before, so just try the best you can to gain some understanding of how the system works.

### What skills would you be looking for if you were to hire a new ecologist?

Definitely someone who understands the standard techniques for Phase 1 etc. Ideally someone who can use mapping software—we use QGIS because it's free and it's brilliant, so it's really helpful if someone knows how to use it. Volunteering is the main thing—just get out there, get the experience, understand what you're talking about. I'd recommend the Wildlife Trusts, BugLife, Bumblebee Conservation Trust and Butterfly Conservation, and doing transect walks with the Bat Conservation Trust. Volunteering with local organisations is great, but you're not likely to get the same level of experience and knowledge of the right techniques as working with some of the more established environmental organisations.

### Any other last tips?

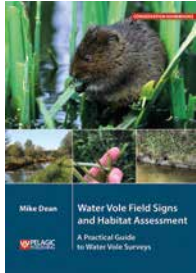
Just get your face known! And volunteer for everything—it's fun!

### Thanks Laura for your time and enthusiasm!



# BOOKS, JOURNALS AND RESOURCES

## Water Vole Field Signs and Habitat Assessment: A Practical Guide to Water Vole Surveys



Author: Mike Dean  
Price: £24.99  
Available from: [www.pelagicpublishing.com/](http://www.pelagicpublishing.com/)

This guide for surveyors and researchers provides detailed descriptions of all the habitats used

by water voles, including ideal habitats as well as less typical places, with annotated photos to help the surveyor home in on just the right areas to look. Also included is a reference guide and notes on how to identify field signs, and guidance on how best to record survey data.

## The Bird-Friendly City: Creating Safe Urban Habitats

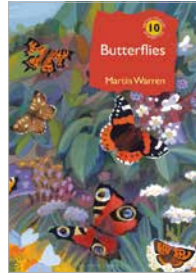


Author: Timothy Beatley  
Price: £26.00  
Available from: [www.islandpress.org/](http://www.islandpress.org/)

As the world has become more urban, noisier from increased traffic, and brighter

from streetlights and office buildings, it has also become more dangerous for countless species of birds. Timothy Beatley, a longtime advocate for intertwining the built and natural environments, takes readers on a global tour of cities that are using public education, urban planning and design, habitat restoration, architecture, art, civil disobedience and more to make urban environments more welcoming to many bird species.

## Butterflies: A Natural History

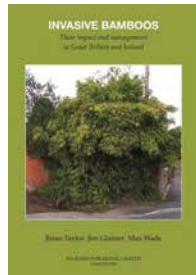


Author: Martin Warren  
Price: £31.50  
Available from: [www.bloomsbury.com](http://www.bloomsbury.com)

Written by the former Chief Executive of Butterfly Conservation,

Martin Warren, this book explores the lives of British butterfly species, revealing how they have become adapted to survive in such a highly competitive natural world. Chapters explore butterfly life cycles, how they are recorded, the change in their ranges and abundance during the 20th and 21st centuries, and the significance of managing habitats at a landscape scale.

## Invasive Bamboos: Their Impact and Management in Great Britain and Ireland

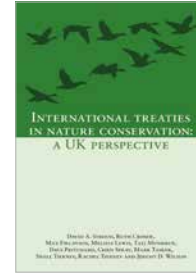


Authors: Brian Taylor, Jim Glaister and Max Wade  
Price: £34.99  
Available from: [www.nhbs.com](http://www.nhbs.com)

Many bamboos can be highly invasive and can impact negatively

on the built environment and local habitats, but are commonly used by designers, landscapers and professional gardeners. This book outlines the darker side of bamboo's nature and offers practical advice on how to deal with it. An overview of bamboo history, biology and ecology, and why planting some species of bamboo can be particularly problematic is provided. The authors also supply useful guidance for those who have planted, or wish to plant, bamboo, as well as giving practical advice for those wanting to remove it.

## International Treaties in Nature Conservation: A UK Perspective



Author: David Stroud et al.  
Price: £19.99  
Available from: [www.nhbs.com](http://www.nhbs.com)

This book provides a unique insight into the inner mechanisms of international

treaties – their history, development, successes and failures – from those who have spent their lives working with them. The authors delve into how treaties and global institutions came about, how they function in theory and practice, the main issues they address and the challenges they face both in making decisions and in their implementation. This will be useful for all involved in conservation policy, including policymakers, professional ecologists, advisors, students and researchers.

## Heathland



Author: Clive Chatters  
Price: £31.50  
Available from: [www.bloomsbury.com](http://www.bloomsbury.com)

Heathlands are ancient landscapes found throughout Britain that support a complex of inter-

related species and an immense diversity of habitats. In this latest addition to the British Wildlife Collection, Clive Chatters introduces us to Britain's heathlands and their anatomy. He concludes with a review of how people have perceived and used heathland wildlife over the ages, and sets out a future vision for this landscape, its unique habitats and the species that live there.

Free download that may be of interest to members:

IUCN (2020). *Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS*. First edition.

Gland, Switzerland: IUCN. Available at: <https://portals.iucn.org/library/node/49070>

# BOOKS, JOURNALS AND RESOURCES

## Bottom-up effect of eradications: The unintended consequences for top-order predators when eradicating invasive prey

Travers T., Lea M.A., Alderman R., Terauds A. and Shaw J.

*Journal of Applied Ecology* 2021, 58 (4): 801–811

Prey-loss and secondary poisoning were historically considered to have limited impact on native top-predators when planning eradications, but this has rarely been tested quantitatively. This study used a 10-year timeseries of brown skua *Stercorarius antarcticus lonnbergi* breeding surveys and dietary analysis to investigate the effects of prey-loss and secondary poisoning deaths resulting from the eradication of an abundant invasive prey species, European rabbits *Oryctolagus cuniculus*.

Correspondence: toby.travers@utas.edu.au

## Functional diversity and trait composition of vascular plant and *Sphagnum* moss communities during peatland succession across land uplift regions

Laine A.M., Lindholm T., Nilsson M., Kutznetsov O., Jassey V.E.J. and Tuittila E.S.  
*Journal of Ecology* 2021, 109 (4): 1774–1789

This study aimed to assess how functionality of successive plant communities changes with peatland development and the associated environmental gradients. Results show that, during peatland development, vegetation succession leads to the dominance of conservative plant species accustomed to high stress. At the same time, the autogenic succession and ecological engineering of *Sphagnum* leads to higher functional diversity and intraspecific variability, which together indicate higher resistance towards environmental perturbations.

Correspondence: anna.laine-petajakangas@gtk.fi

## Evolutionary trait-based approaches for predicting future global impacts of plant pathogens in the genus *Phytophthora*

Barwell L.J. et al.

*Journal of Applied Ecology* 2021, 58 (4): 718–730

Predicting the threat plant pathogens pose to plant health can be difficult without in-depth knowledge of behaviour, distribution and spread. This study evaluates the potential for using biological traits and phylogeny to predict global threats from emerging pathogens. Priority traits to measure for emerging species may be thermal minima, oospore wall index and growth rate at optimum temperature.

Correspondence: loubar@ceh.ac.uk

## Local-scale climatic refugia offer sanctuary for a habitat-forming species during a marine heatwave

Verdura J., Santamaría J., Ballesteros E., Smale D.A., Cefali M.E., Golo R., de Caralt S., Vergés A. and Cebrian E.

*Journal of Ecology* 2021, 109 (4): 1758–1773

Climate change and extreme climatic events have driven shifts in the structure of populations and the distribution of species in many marine ecosystems. However, responses are highly variable at regional scales, so there is a need to broaden evidence to focus on both local- and regional-scale processes. Findings from this study highlight that local-scale variability in the magnitude of extreme climatic events can lead to local extinctions of already fragmented populations of habitat-forming seaweeds, even towards the species' core range. However, the results highlight the potential for local-scale climatic refugia, which could be identified and managed to safeguard the persistence of canopy-forming seaweeds.

Correspondence: jana.verdura@udg.edu

## Ensuring effective implementation of the post-2020 global biodiversity targets

Xu H., Cao Y., Yu D., Cao M., He Y., Gill M. and Pereira H.M.

*Nature Ecology & Evolution* 2021, 5: 411–418

In 2010, the Aichi Targets were adopted by world leaders to address the crisis of biodiversity loss. Despite conservation efforts, none of the Aichi Targets have been fully met. Here, authors demonstrate that most parties did not set effective national targets in accordance with the Aichi Targets, and investments, knowledge and accountability for biodiversity conservation have been inadequate to enable effective implementation. This article recommends actions in setting a new Global Framework for Biodiversity that is achievable.

Correspondence: [www.nature.com/articles/s41559-020-01375-y/email/correspondent/c1/new](http://www.nature.com/articles/s41559-020-01375-y/email/correspondent/c1/new)

## Forest regeneration can positively contribute to local hydrological ecosystem services: Implications for forest landscape restoration

van Meerveld H.J., Jones J.P.G., Ghimire C.P., Zwartendijk B.W., Lahitiana J., Ravelona M. and Mulligan M.

*Journal of Applied Ecology* 2021, 58(4): 755–765

The impacts of forest restoration on local hydrological services (e.g. flood and erosion risk, stream flow during dry periods) are poorly understood. Using measurements from instrumented plots under three vegetation types in the shifting cultivation cycle in Madagascar's eastern rainforests (forest, tree fallow and degraded abandoned agricultural land), and infiltration measurements for the same vegetation types across the landscape, this study explores the impacts of forest regeneration on the ecohydrological processes that underpin locally important ecosystem services.

Correspondence: julia.jones@bangor.ac.uk



# Q&A

Barbara, Baroness Young of Old Scone, CIEEM Patron

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## How did you get into the sector?

It was a bit of serendipity. I was bored on a plane to Italy and saw the advert for the RSPB CEO job and thought I could do that even though I couldn't tell a robin from a ready-wrapped turkey! The headhunters were mystified and I think put me in the long list as a long shot!

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## What does your current role include?

Which current role? I have lots of lovely jobs, as Chairman of the Woodland Trust, a member of the House of Lords, Vice-President of RSPB and Fauna and Flora International and Birdlife International to name but a few. Oh, and I chair the Royal Veterinary College and sit on the Commission on Food, Farming and the Countryside. I suppose I am a jobbing environmental campaigner at heart.

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## What is your favourite part of your current role?

I love working with scientists and understanding science to use evidence as the start point for environmental policy advocacy and campaigning. I love being able to put pressure on for the environment in parliament. I love being part of organisations that buy and manage land. When I ran RSPB, we always said that if we couldn't protect a site in any other way, we would just buy the \$%£?!£ thing. It's a joy to be able to do that at the Woodland Trust, which is protecting more special woods and creating new ones.

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## Why did you get involved with CIEEM?

I arrived in the environment movement in the same year as CIEEM was founded, 1991 (I am very old!). David Goode, now one of my fellow Patrons, persuaded me to support the view that ecologists and environmental managers should be professionally recognised and qualified. Having experienced a highly

dodgy expert witness during a judicial review case against an environmentally damaging development, I readily agreed and the rest as they say is history. I was involved with the issue of professional standards when the case for Chartered status for environmentalists went forward and I was the very first Chartered Environmentalist (my certificate is numbered 001!). I think the range and degree of expertise which CIEEM members have gives them huge strength to make things happen for good, both as individuals and collectively.

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## Who is your hero and why?

Catherine the Great. Deposed her husband, got her daughter-in-law to bump off her useless son and take over the throne, had a thing about her horse. Perfect!

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## Who do you see as a great leader in the sector?

I greatly admire Christiana Figuerres who helped land the Paris agreement. But also Yossi Leshem who as an Israeli has nevertheless persuaded the Pope that biodiversity needs to be valued (and blessed). Lord Krebs (son of the Krebs cycle) does a pretty neat job as a campaigning scientist in the House of Lords.

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## If you could change one thing to make the world better for nature and biodiversity, what would it be?

Change the unit of world currency to the biodiversity.

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## What advice would you give to those just starting out in the sector?

You have the skills for this unique point in time when the environment and biodiversity decline are seen as the biggest global challenges. Be bold, use your skills and knowledge, stay true to your soul, see your life as a campaign, feel satisfaction in being on the right side.



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## What is your favourite species of plant, animal or bacteria?

My rare bird as a Birdlife International supporter is the lappet-faced vulture. I support it because it is so ugly even its own mother says so. With my Woodland Trust hat on, I am very partial to a small-leaved lime. I'm kind of off viruses and bacteria right now!

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## If you could be any species, what would it be and why?

Dotterel. Female has it sussed. Lays her eggs then slopes off for a continental holiday while her mate brings up the weans.

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## Can you tell readers something random about yourself?

I'm addicted to modern jazz, especially Cuban.



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