



Issue 120 | June 2023

inpractice

Bulletin of the Chartered Institute of Ecology and Environmental Management

A Novel Approach to the
Translocation of Dingy
Skipper in Brownfield Sites

How do you Become an
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Invertebrates

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Editorial

Welcome

I'm not sure why, but as a youngster I wasn't that into birds, mammals or botany. From a young age, I was instead enthralled by caterpillars, moths and butterflies, beetles, bugs, spiders and woodlice. That is, all kinds of insects and other invertebrates, or what most people know as 'creepy crawlies'. I have vivid childhood memories of finding glow worms, ladybirds and Devil's coach horses and then being fascinated to discover that all are in fact different kinds of beetle. I also had a keen interest in tadpoles, newts and other amphibians and reptiles. I think it must have been something about interesting life cycles or metamorphosis that captured my imagination.

It was perhaps not surprising that I did my first degree in ecology and environmental science or that I chose for my final year project to study woodland invertebrates. I went on to study a PhD on wetland butterflies where, in truth, I spent most of my time studying their caterpillars. I then spent a few years working as a university lecturer in ecology, and was able to actively pursue my interests, becoming an active moth trapper and recorder of hoverflies and beetles. In the year 2000 I started my first job in consultancy (with Penny Anderson Associates) where, despite my remit having expanded to include mammals (i.e. water voles and badgers), as well as

amphibians and reptiles, I spent much of my time working with aquatic and terrestrial invertebrates.

Ultimately, my professional interests evolved into different measures of invertebrate species richness and diversity, and then more holistic biodiversity measurement and assessment.

Of course, the contribution made by insects and other invertebrates to global biodiversity is hard to overstate. They play an important role in many ecological processes and are critical to ecosystem services such as pollination. It is worryingly clear that insects are in severe decline in both abundance and richness, and this is a key conservation concern in the UK and Europe.

When we consider the current drive to ensure that developments achieve net gains in biodiversity, we are of course using habitat-based metrics, such as the Natural England Biodiversity Metric 4.0. I would suggest that it is going to be important to develop, standardise and implement specialist methods of assessing specific habitat features, microhabitats and microclimates for invertebrates too. Then, these methods can be applied alongside the habitat-based assessments to give a fuller understanding of holistic biodiversity. There is a fantastic opportunity here to expand our consideration of biodiversity and what losses and gains look like.



I'm really pleased to introduce this edition of *In Practice*, the theme of which is Invertebrates. We have features on: how to become an invertebrate ecologist; species articles on dingy skippers, freshwater crayfish, Roman snails and bilberry bumblebees; making invertebrate science more accessible; raising the profile of invertebrates in the planning process and marine invertebrates. So, a wide sweep across current practice in insects and invertebrates. Hopefully this will help kickstart renewed interest in the species that represent the powerhouse of global biodiversity.

Dr Mark Webb CEcol CEnv FCIEEM



Devil's coach horse beetle (*Ocyrops olens*)

Conferences Dates For Your Calendar!

Managing Ecological Impacts to Restore Water & Wetlands

Summer Conference, 1 full-day
13 July | Online

BOOK
NOW

Wetlands are amongst the most ecologically productive systems in the world, but they are under extreme pressure. It's down to ecologists and environmental managers to implement solutions that will restore and enhance them. Come along to our Summer Conference to learn the top mitigation, restoration and enhancement techniques for a range of wetlands including ponds, streams, rivers, lakes, floodplains and coastal areas. If your work involves aquatic ecology then don't miss this!

The Role of Trees in a Sustainable Future

Scotland Conference, 1 full-day
3 October | Edinburgh Area

BOOKINGS
OPENING
SOON!

The Scottish Government's vision is to expand Scotland's woodlands to cover 21% of land area by 2032. This will need to be carefully planned as it will inevitably have a major impact on Scotland's landscape, habitats, species, carbon storage and the economy. This conference will present what success will look like in Scotland, explore strategies to achieve this ambitious goal and identify outcomes that can create/influence change elsewhere. Although case studies will be focused on Scotland, the lessons learned will be applicable to the whole of the UK.

Modernising Ecology: Techniques and Approaches

Autumn Conference, 2 full-days
November | Location TBC

BOOKINGS
OPENING
SOON!

Meeting the challenges of protecting and restoring nature means building capacity in the ecology and environmental management sector and making best use of technology. What does advanced technology mean for ecology, how can modern molecular methods complement existing best practice, and what's coming over the horizon? Importantly, with critical skills shortages and with people from many backgrounds underrepresented – how do we attract, train, retain, and upskill ecologists to meet future demands? Find out how at our Autumn Conference.

Visit www.cieem.net/events to book



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Editor

Dr Nik Prowse (nikprose@cieem.net)

Internal contributions coordinator

Mr Jason Reeves

(jasonreeves@cieem.net)

Editorial Board

Dr Kate Bayley, Dr Joanne Denyer, Ms Ursula Digby, Mr Neil Harwood, Dr Claire Howe, Dr Sue Lawley, Dr Caroline McParland, Mr Ian Morrissey, Dr Patrick White

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CIEEM Office

Grosvenor Court,
Ampfield Hill, Ampfield,
Romsey SO51 9BD, UK

T: 01962 868626

E: enquiries@cieem.net

W: www.cieem.net

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Cover photo: Dingy skipper (*Erynnis tages*) on *Lotus*. Photo credit: Andy Jukes.

Nature In A Nutshell Podcast

Do you need something to listen to on your lunch break? Or on the drive to your next survey? Then don't forget to listen to the new CIEEM Nature In A Nutshell podcast, which breaks down the latest ecology news! Episodes 1 and 2 are already live, with 3 likely to be out by the time you read this. Find the podcast on all major streaming platforms, or on our website.

<https://cieem.net/i-am/nature-in-a-nutshell-podcast/>

If you love your job, then tell people about it!

Our new website, Green Jobs for Nature, is live! This website (<https://greenjobsfornature.org/>) is part of our campaign to promote jobs in our sector to young people and potential career changers. This website is packed with useful information about what a green job for nature is, how to get one, and who you can work for. We encourage you to help spread the word!

On the website is a library of job profiles from people in the sector to promote the variety of jobs and the wide range of employers available to future generations. We're looking for more people to get involved and submit a job profile (<https://cieem.net/green-jobs-for-nature/>).

Recent webinars

We continue to run a full and varied series of webinars for members and the sector. Readers may be interested in the below recent webinars that are available on the CIEEM Resource Hub.

- How to Become a CIEEM Trainer
- ASIG Meeting: The Cairngorms Connect Predator Project
- Diversifying our Woodland to Increase Resilience
- ASIG Meeting: A Focus on Badgers and TB

Past webinars are available in the CIEEM Resource (<https://events.cieem.net/Events/Event-Listing.aspx>).

Update to Membership Regulations

At its meeting on 22 March 2023, the Governing Board approved an amendment to CIEEM's Membership Regulations to clarify the expected behaviours of members and non-member applicants in their dealings with Secretariat staff and fellow members. The updated Membership Regulations are available from the CIEEM website (<https://cieem.net/wp-content/uploads/2021/12/Membership-Regulations-October-2021.pdf>) or by contacting membership@cieem.net.

Recent blog posts

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

- The River Thames Scheme: a Landscape-based Approach to Creating a Healthier, More Sustainable and More Resilient Community – by Jeanne Capey
- Why Are Soils Neglected? – by Chris Stapleton
- Nature Nurtures My Mental Health – by Charlotte Rose MCIEEM

- Soils in EIA – by Chris Stapleton
- The Power of Acoustic Monitoring, and Not Just for Bats! – by Dr Carlos Abrahams MCIEEM

If you would like to contribute your own blog, please contact sophielowe@cieem.net.

Staff changes

In April, **Natarnya Walcott-Burton** started as CIEEM's new Green Jobs for Nature Outreach Assistant. This is a full-time 12-month placement as part of the New To Nature Programme which has been part funded by the National Lottery Heritage Fund. The role will be supporting our Green Jobs for Nature campaign and promoting it to young people, especially those from backgrounds that are currently under-represented in our sector.

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.

CIEEM Conferences 2023

Date	Title	Location
13 July 23	CIEEM 2023 Summer Conference: Managing Ecological Impacts to Restore Water & Wetlands	Online
September 23 TBC	CIEEM 2023 Wales Conference: Is the Marine Environment All At Sea?	TBC
3 October 23	CIEEM 2023 Scottish Conference: The Role of Trees in a Sustainable Future	Edinburgh TBC

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

In Practice Themes and Deadlines

Edition	Theme	Article submission deadline
September 23	Diversity, Accessibility & Capacity in the Sector	n/a
December 23	Non-themed (submissions welcome on any topic)	18 Aug 23

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

UK

Good practice guidelines for long-term ecoacoustic monitoring in the UK

New good practice guidelines for long-term ecoacoustic monitoring in the UK have just been produced by Manchester Metropolitan University, Baker Consultants Ltd and a team of co-authors, on behalf of the UK Acoustics Network. The new guidelines aim to advise on the use of the rapidly developing bioacoustics/ecoacoustics approach for collecting and analysing ecological data, offering the potential for long-term biodiversity monitoring and ecosystem management. The guidelines advise on hardware, software and study design choices, providing evidence-based recommendations on deployments, data analysis, and metadata requirements.

https://www.researchgate.net/publication/368683386_Good_practice_guidelines_for_long-term_ecoacoustic_monitoring_in_the_UK

Northern Ireland

Northern Ireland publishes Greenhouse Gas projections

The Department of Agriculture, Environment and Rural Affairs (DAERA) has published its greenhouse gas projection statistics for Northern Ireland. These statistics are updated annually, and project emissions in Northern Ireland from 2021 to 2031. The latest inventory estimates that there has been there was a 24% reduction in CO₂ emissions in 2020 compared to 1990 and that by 2031 this number will have risen to a 34% reduction in greenhouse gas emissions.

<https://www.daera-ni.gov.uk/news/northern-ireland-greenhouse-gas-projection-statistics-released>

Wales

Wales to meet 100% of electricity needs with renewable sources by 2035| Cymru i ddiwallu 100% o anghenion trydan gyda ffynonellau adnewyddadwy erbyn 2035

The climate change minister for Wales, Julie James has announced that Wales aims to meet 100% of its electricity needs from renewable sources by 2035. Wales is already making good progress on its previous targets set in 2017, generating 55% of its current electricity needs from renewable sources. The minister stressed that improving infrastructure and supply chains were key to hitting this new target, and revealed a £1 million funding to further explore the potential of offshore wind in Wales.

<https://www.gov.wales/wales-aims-meet-100-its-electricity-needs-renewable-sources-2035>

England

New Environmental improvement plan for England

Defra has published a new Environmental Improvement Plan as the first revision to the 25-Year Environment Plan published five years ago. This plan aims to provide a comprehensive delivery plan for the Government's approach to halting and then reversing the decline in nature. The Government has said in its press statement that it will create and restore at least 500,000 hectares of new wildlife habitats, deliver a clean and plentiful supply of water for people and nature, transform the management of our countryside and boost green jobs. This plan hopes to underpin the ambitions of COP15 domestically, with progress measured against interim targets.

<https://www.gov.uk/government/news/ambitious-roadmap-for-a-cleaner-greener-country>

Republic of Ireland

Minister for the Environment, Climate and Communications announces €27 million for community climate action

Eamon Ryan, the Republic of Ireland's Minister for the Environment, Climate and Communications has announced €24 million in funding for Local Authorities to support communities in lowering their carbon output and scaling up climate action. Alongside this €3 million will be made available to support cross-border initiatives, as well as a drive for all-island community action. This funding comes as part of the Community Climate Action Programme, which was created to support projects and initiatives that facilitate climate action through education and capacity building within local communities.

<https://www.gov.ie/en/press-release/-minister-ryan-announces-27-million-for-community-climate-action/>

Scotland

98 new Scottish Heritage sites identified to safeguard trees from Climate Change

A new report published by NatureScot, and written in partnership with the UK Centre for Ecology & Hydrology, has taken a significant step towards preserving the highly threatened genetic diversity of Scotland's native trees by identifying 98 new sites for gene conservation. The purpose of this is to ensure trees are able to maintain their genetic diversity, increasing their potential to adapt as climatic conditions change. Currently, there are five of these gene conservation units in Scotland, representing four species of tree: Scots pine, silver birch, sessile oak and rowan.

<https://www.nature.scot/almost-100-new-scottish-sites-identified-safeguard-trees-climate-change>

A Novel Approach to the Translocation of Dingy Skipper in Brownfield Sites

Figure 1. Dingy skipper (*Erynnis tages*). Photo credit: Andy Jukes.



Andy Jukes
MCIEEM

Conops Entomology Ltd



Mark Morgan
MCIEEM

Ecology Practice Ltd



Andrew Arnott

Ecology Practice Ltd

Keywords: *Erynnis tages*, invertebrate, mitigation, open mosaic habitat, previously developed land

Dingy skipper (*Erynnis tages*) is an important priority species of brownfield sites, sites often lost to re-development. Traditional mitigation for the butterfly largely focuses on post-construction habitat provision, which risks losing populations. To overcome this risk, a novel approach whereby the larvae are translocated before construction has been undertaken at a site in Leicestershire. During the process of finding the larvae to translocate, a better understanding of the habitat requirements for dingy skipper has been obtained, increasing our knowledge on the ecology of the butterfly.

Introduction

The dingy skipper (*Erynnis tages*) butterfly is a NERC Act Section 41 species and as such is a species of principal importance, meaning that there is a duty to protect the species. It has declined in the UK by 61% since the 1970s (Butterfly Conservation 2022) and is listed as 'high priority' by Butterfly Conservation.

The butterfly is a flagship species for the habitat of principal importance known as open mosaic habitat on previously developed land, and a key indicator of sites of conservation value,

since its presence suggests that a site is of value to a much broader assemblage of invertebrates.

The larvae feed primarily on bird's-foot trefoils (*Lotus* spp.), a plant of low-fertility soils, whereas adults feed on nectar from yellow composites (Asteraceae) and trefoils (Fabaceae), among others. The female selects the leaves of host plants that grow prostrate over bare ground or very short turf. They preferentially select these leaves as the microclimate is elevated above the surrounding turf, thus aiding egg and early-stage larval development. The larvae hatch from mid-May to June and feed on the host plant up until August to early September, after which they begin to prepare a hibernation tent. Until now it was thought that larvae mainly used leaves of their host plants immediately adjacent to early successional patchworks used for breeding. We now know that the larvae use a much boarder range of plants and successional habitat stages.

In the following year, larvae hibernate until April, when they pupate and emerge as adults from late April to May. The primary flight period is late April to mid-June, peaking sometime around mid- to late May, depending on geography, which is the optimum period to survey.

Dingy skipper on brownfield sites

Owing to their low fertility and patchy mosaic, many brownfield sites that include the open mosaic habitat of principal importance are often highly suitable for dingy skipper and are also frequently subject to re-development. This developmental pressure puts existing dingy skipper colonies at risk. It is therefore vital that dingy skipper colonies and habitats are preserved for the ongoing conservation of the species. Developments that are mitigating impacts to dingy skipper tend to focus on future habitat provision and do not seek to protect the extant population from initial destruction during the constructional phase. Turf translocation is an option, although high costs and fragility of friable brownfield habitat can make it an unworkable solution for many sites.



Figure 2. A free-roaming *E. tages* larva on *Lotus*. Photo credit: Andy Jukes.

Background to the development and site

This article outlines one such project which introduces the novel approach of translocating larvae into a receptor site prior to site clearance. The development site, located near Ashby-de-la-Zouch in north west Leicestershire, is a former coal disposal point, abandoned for some 30 years and now hosting a range of post-industrial habitats. These included rich, damp, neutral grasslands (both sparse and dense swards), rank grass and ruderals, ephemeral vegetation, ponds, scrub, woodland, a watercourse and, importantly, vast coal and stone spoil, whereby dense swards of trefoils were previously scattered throughout, and which used to provide high-quality dingy skipper habitat.

In addition to two extensive biodiversity receptor areas being provided as mitigation (primarily in the interests of great crested newt, *Triturus cristatus*), significant on-site mitigation is being provided in the operational phase and through the core of the site, connecting both receptor areas with dingy skipper habitat. Following long-term monitoring of the dingy skipper colony, spanning 2012–2021, the core population and habitat were identified in the centre of the development area, meaning the butterfly and its habitat would be permanently lost. A strategic mitigation plan was required to conserve the species. The novel approach focused on the translocation of dingy skipper larvae, which was considered feasible and achievable because the species is

associated with early successional mosaics and is extremely mobile in the adult phase.

As a consequence of this work, new ecological understanding of the species has been uncovered with implications for dingy skipper conservation and developmental mitigation. Outcomes of this case study may also indicate that a similar approach may work with other butterflies such as the grizzled skipper (*Pyrgus malvae*).

Methods and results

Here we seek to describe the translocation process and provide advice to ecologists seeking to undertake similar work.

Pretext for translocation

Site clearance was restricted until great crested newt translocation was complete in late September–October. The creation of dingy skipper habitat in the operational phase would not have been possible, as existing breeding areas would be lost beforehand, during clearance, so a method to retain dingy skipper at the site needed to be undertaken prior to clearance. Late-autumn turf translocation of dingy skipper habitat was dismissed owing to the friability of substrates preventing turfs from being moved intact, and therefore putting larvae at risk of destruction. Therefore, dingy skipper needed to be translocated in August–September ahead of site clearance.

A temporary 'holding location' for dingy skipper was required, as was a

method for translocating the animals in late summer, whereby they could colonise and re-populate the site in the operational phase on the newly created habitat.

Preliminary surveys

Prior to translocation, it is important to assess the population of a donor site so that its future success can be measured. This is assessed using transect walks for adult butterflies. If only a single year is possible (but with more than two separate recording visits), this is considered sufficient to gauge the approximate population class.

There are no known thresholds that the authors are aware of for gauging what constitutes a small or large colony of dingy skipper, but from over 20 years recording experience (A. Jukes) the following is suggested. Based on average transect count results:

- small colony: <5 flying individuals
- medium colony: 5–9 flying individuals
- large colony: >9 flying individuals.

These preliminary surveys will also allow the invertebrate specialist to identify key 'hotspots' of adult butterflies and the likely locations of egg laying and larval activity later in the year.

Surveys of potential receptor sites should also be undertaken to identify if they hold their own dingy skipper populations and if they are suitable for translocating larvae into. Coupled with this, an assessment of the potential carrying capacity of the receptor site is recommended. There is no standard test for assessing carrying capacity and thus the experience and knowledge of the consulting entomologist will be key. However, assessing the extent and quality of suitable habitat is a good start.

Given that the habitat mosaic preference of the dingy skipper is also significant to other notable and scarce invertebrates, it is highly recommended that an invertebrate assessment is commissioned. In this way preparation of a temporary receptor site can be undertaken sympathetically and positively for any resident resource of scarce and high-fidelity invertebrates.

Providing habitat for larvae

A receptor site for larvae should include all the various features and plants required by the dingy skippers' life cycle.

An experienced invertebrate ecologist will be able to identify ideal locations to translocate larvae into. Suitable larvae hibernation vegetation is usually of a moderate to tall sward (≥ 15 cm), but abundant rank grass or scrubby areas are not thought suitable. These areas should form mosaics with short turf and bare ground for the emergence of the adult butterflies. Some remedial works may be needed, such as scrub clearance.

Searching for larvae

Searches are best undertaken when larvae are fully grown and preparing to over-winter (from mid-August to early–mid-September). The exact timing of the searches may vary between years and geographical locations but searches should not be undertaken past mid-September as the colder nights may be detrimental to hibernating larvae. Once a donor site has been searched and larvae translocated, repeat visits will be required as more larvae construct over-wintering tents. It is recommended that each key area is searched at least twice, and over two periods. For our case study, mid-August and early September were considered optimal times and each period proved highly productive.

Key areas of early successional habitat should form the focus of the initial searches for larvae and larval tents. Working outwards from these mosaics was found to be most practical. In this

way, surveyors reduce the risk of flattening or disturbing taller vegetation that has yet to be searched. The search should be undertaken on hands and knees as larval tents are invariably close to the ground, anywhere between 5 cm (if on shorter turf) to 20–25 cm in taller vegetation.

Once a tent, or free-roaming larva, is discovered, it should be transferred to a suitable cool and dark container. A cardboard box is suitable so long as it has a secure lid to prevent escape. Plastic tubs may be used but care should be taken when using them in warm weather so as to not let the animal(s) overheat. Depending on air temperatures, it is recommended that the box of larvae be transported to the receptor site within two hours. The contents should be emptied carefully into a suitable vegetation structure. While working, always keep the box cool and in the shade.

At the receptor site, each leaf containing a tent should be wedged or otherwise secured into host vegetation so that it does not blow away until such time as the larva leaves the tent to create a new, more secure one.

Free-roaming larvae can be carefully placed into broad-leaved vegetation so that they can search for a hibernaculum. Translocation zones in which the larvae are moved should be demarcated by



Figure 3. (a, b) Larval tents in common bird's-foot trefoil (*Lotus corniculatus*) demonstrating the range of ways in which larvae fold and gather leaves together. Photo credits: Andy Jukes.

survey marker flags to avoid trampling and allow for ongoing monitoring. If a larva is translocated with a tent, it is highly likely that it will vacate that tent and construct a new one. This is not thought to be a concern as, during our case study, many vacated tents were found at the donor site, suggesting larvae move and construct new tents,

possibly multiple times, before finally settling on a tent that is deemed fit for purpose as a hibernaculum.

Larval results

Table 1 notes each larva recorded during translocation, and the host plant. The range of plants was considerable. It was noted that larvae appear to prefer different plant species in different areas.

“ The butterfly is ... a key indicator of sites of conservation value, since its presence suggests that a site is of value to a much broader assemblage of invertebrates. ”

Table 1. All dingy skipper larvae captured and translocated in 2021, including the plant each individual was found in association with. The table is presented in hierarchical order of plant associations.

Larval tent plant species	Number of larvae							Total
	18/8/21	19/8/21	20/8/21	23/8/21	2/9/21	7/9/21	22/9/21	
Wild strawberry (<i>Fragaria vesca</i>)	–	3	15	6	3	4	3	34
Ribwort plantain (<i>Plantago lanceolata</i>)	5	2	5	11	1	5	1	30
Common knapweed (<i>Centaurea nigra</i>)	1	9	6	–	1	–	4	21
Bramble (<i>Rubus fruticosus</i> agg.)	–	2	5	4	1	1	–	13
Free roaming larvae	2	2	3	4	2	–	–	13
Colt's foot (<i>Tussilago farfara</i>)	4	–	–	7	–	1	–	12
Clover (<i>Trifolium</i> spp.)	5	–	–	6	–	1	–	12
Common bird's-foot trefoil (<i>Lotus corniculatus</i>)	2	1	1	4	–	–	–	8
Wild angelica (<i>Angelica sylvestris</i>)	–	–	–	2	4	–	–	8
Thistle (<i>Cirsium</i> spp.)	1	–	–	2	–	1	–	4
Creeping buttercup (<i>Ranunculus repens</i>)	–	–	–	–	1	1	–	2
Ragwort (<i>Jacobaea vulgaris</i>)	–	–	–	1	–	–	–	1
Oak (<i>Quercus</i> spp.)	1	–	–	–	–	–	–	1
Ribwort plantain and bird's-foot trefoil (combined in one tent)	–	–	1	–	–	–	–	1
Hogweed (<i>Heracleum sphondylium</i>)	–	–	–	1	–	–	–	1
Dandelion (<i>Taraxacum officinale</i> agg.)	–	–	–	1	–	–	–	1
Honeysuckle (<i>Lonicera periclymenum</i>)	–	–	–	–	–	1	–	1
Total	21	19	36	49	13	15	8	163

For example, where colt's-foot (*Tussilago farfara*) is present, they appear to preferentially select this plant, likely owing to the large soft leaves that are easy to fold over to form a tent. In other areas, wild strawberry (*Fragaria vesca*) was chosen where taller forbs were limited or not available. In taller swards (anything up to approximately 80 cm tall), commonly used plants are common knapweed (*Centaurea nigra*) and ribwort plantain (*Plantago lanceolata*). Often, larvae were found to pull together several leaves to create a tent, sometimes from different plants. This was most prevalent with narrow-leaved plants such as ribwort plantain where the larvae draw together two or more leaves to construct a suitable shelter (shown in Figure 4).

Post-translocation

In our case study, during the baseline survey of the receptor site, three or four adult dingy skippers were recorded. Following the translocation, a maximum count of 16 was recorded, demonstrating that the translocation of the larvae did not disrupt prehibernation tent-making. Interestingly, the peak



Figure 4. (a) Larval tent in ribwort plantain (*Plantago lanceolata*). The leaves of this plant can be folded over to form a purse, or two or more leaves brought together to create a spear shape, as here, and twisted round to form the tent. (b) Larval tent from (a) in situ. Photo credit: Andy Jukes.

count was not sustained and a rapid drop-off was recorded (see Table 2). This likely reflects the carrying capacity of the receptor site and that the artificially bolstered population may have been too high for this location. This is a consideration for future projects. The

excess of dingy skippers may not have died, but probably flew off to find new suitable breeding locations. However, it is also possible that the early season saw very early egg laying and subsequent die-off of adults. This outcome was anticipated, as the intention was for the



Figure 5. A translocation zone on the receptor site, demarcated by perimeter red flags. Photo credit: Andy Jukes.

Table 2. Receptor site adult counts in 2022.

Date and weather	Transect count				Mean transect count
14/5/22 Sunny, light breeze, 18°C	10	16	9	11	11.5
27/5/22 Sunny, breezy, 18°C	4	5	3	4	4
4/6/22 Sunny, 17°C	2	3	2	4	2.75

receptor site to act only as a temporary holding location for dingy skipper and for them to disperse following emergence into newly created habitats in the operational phase.

Unfortunately, owing to tight timescales and slippage in the project, a knock-on impact was that creation of dingy skipper habitat was not completed in time to benefit from the larval translocation and subsequent emergence of adults to disperse back into the donor site footprint. For future projects, it is important to incorporate sufficient time in the calendar to accommodate for slippage. Factors like butterfly emergence cannot be delayed or influenced, so all other project tasks need to align with this fixed point for a successful outcome.

Despite this, it is confidently predicted that once suitable habitat is created and established, the high mobility of the dingy skipper will lead it to colonise the new habitat. As recommended, future monitoring surveys are proposed in years 1, 2 and 5 following construction, with ongoing habitat management for 30 years.

Conclusion and key points

It is important to estimate the approximate adult population of dingy

skipper in a donor site using adult surveys. This will provide a gauge of what to expect from larval searches. Despite the species being associated with early successional habitats, it appears that this is purely for egg-laying, basking adults and early-stage larvae. As the larvae grow, it is likely that they move out of areas of short turf and into taller swards. As late-stage larvae, they can be found up to 10 m from the nearest short turf habitat and sometimes in quite tall grassland with scattered scrub and tall ruderals.

The most notable outcome is a greater understanding of the species' usage of open mosaic habitats on previously developed land and an alternative approach to dingy skipper mitigation for development. It is apparent that dingy skippers not only utilise rank swards and tall swards for shelter and roosting, but that these vegetation types are an integral and key component of larval success on a site. It is in these taller swards, with more opportunities to construct hibernacula and with added shelter, that more successful hibernation possibly takes place. Additionally, with careful planning, in developments the translocation of dingy skipper larvae can be a successful technique to conserve existing populations. This is opposed to relying solely on habitat provision in the operational phase, or turf translocation, which have been the traditional forms of mitigation in cases where dingy skippers may be impacted by development. The results achieved here may be applied to species with similar habitat requirements and ecology, such as the grizzled skipper.

From a project scheduling perspective, slippage of construction plans and habitat creation can have significant impacts on ecology. The resources and

effort are wasted costs for the client. In this instance, the lack of suitable habitat for dingy skipper to move back into is a lost opportunity for encouraging the rapid bounce back of the species at the site. Colonisation will take longer. Although slippage in this case study was unforeseen, for future projects it is critical that a fixed point (that is, the adult emergence of dingy skippers) is known by project managers for there to be successful outcomes for this and any other species being compensated for.

Reference

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About the Authors

Andy Jukes BSc(Hons), FRES, MCIEEM is an invertebrate ecologist with over 25 years' experience of field surveys and compensation with a particular interest in brownfield compensation. He is the director of Conops Entomology Ltd, a dedicated invertebrate consultancy specialising in survey, research and conservation advice.

Contact Andy at:

andy@conopsentomology.co.uk

Mark Morgan BSc(Hons), MCIEEM is based in north Wales and has a first-class degree in plant biology from the University of Aberystwyth. He is a Senior Ecologist at the Ecology Practice Ltd. Mark is primarily a botanist but undertakes a wide range of specialist ecological works in developmental settings.

Andrew Arnott HND is the Principal Ecologist for the Ecology Practice Ltd, with over 35 years' experience in ecology. His experience includes brownfield ecological assessments across the UK, looking at the impacts of development on both urban and rural sites. He is a vertebrate ecologist with wider experience in most aspects of terrestrial ecology.

“ The most notable outcome is a greater understanding of the species' usage of open mosaic habitats on previously developed land and an alternative approach to dingy skipper mitigation for development. ”

The North Yorkshire Crayfish Forum: Collaboration for Conservation

White-clawed crayfish (*Austropotamobius pallipes*)



Steph Renshaw
MCIEM
Yorkshire Water



Vanessa Barlow
Yorkshire Wildlife Trust

Keywords: conservation strategy, partnership, white-clawed crayfish

The North Yorkshire Crayfish Forum was founded in 2019 to aid in the conservation of white-clawed crayfish (*Austropotamobius pallipes*), drawing together organisations with an interest and passion in saving our native crayfish. This article describes what the North

Yorkshire Crayfish Forum has achieved so far and why we believe having a part-time officer, and why collaboration and sharing knowledge and resources between partners, have been key to its success.

Introduction

White-clawed crayfish (*Austropotamobius pallipes*) is the only native species of freshwater crayfish in the UK and it has suffered a large

population decline in recent years. This is due to a number of factors, predominantly the introduction of the invasive non-native species, signal crayfish (*Pacifastacus leniusculus*), into river ecosystems.

Individual organisations often conduct effective local species conservation projects, but these are frequently short-term and limited in scope due, in part, to independent working. The North Yorkshire Crayfish Forum (NYCF), hosted by Yorkshire Wildlife Trust, was founded in 2019 after several organisations decided they could do more to protect white-clawed crayfish in North Yorkshire (Figure 1) by working together. Before that point, most organisations had been conducting crayfish conservation work in isolation, on single river catchments or focused on single issues, with little knowledge of populations and conservation efforts in the surrounding catchments.

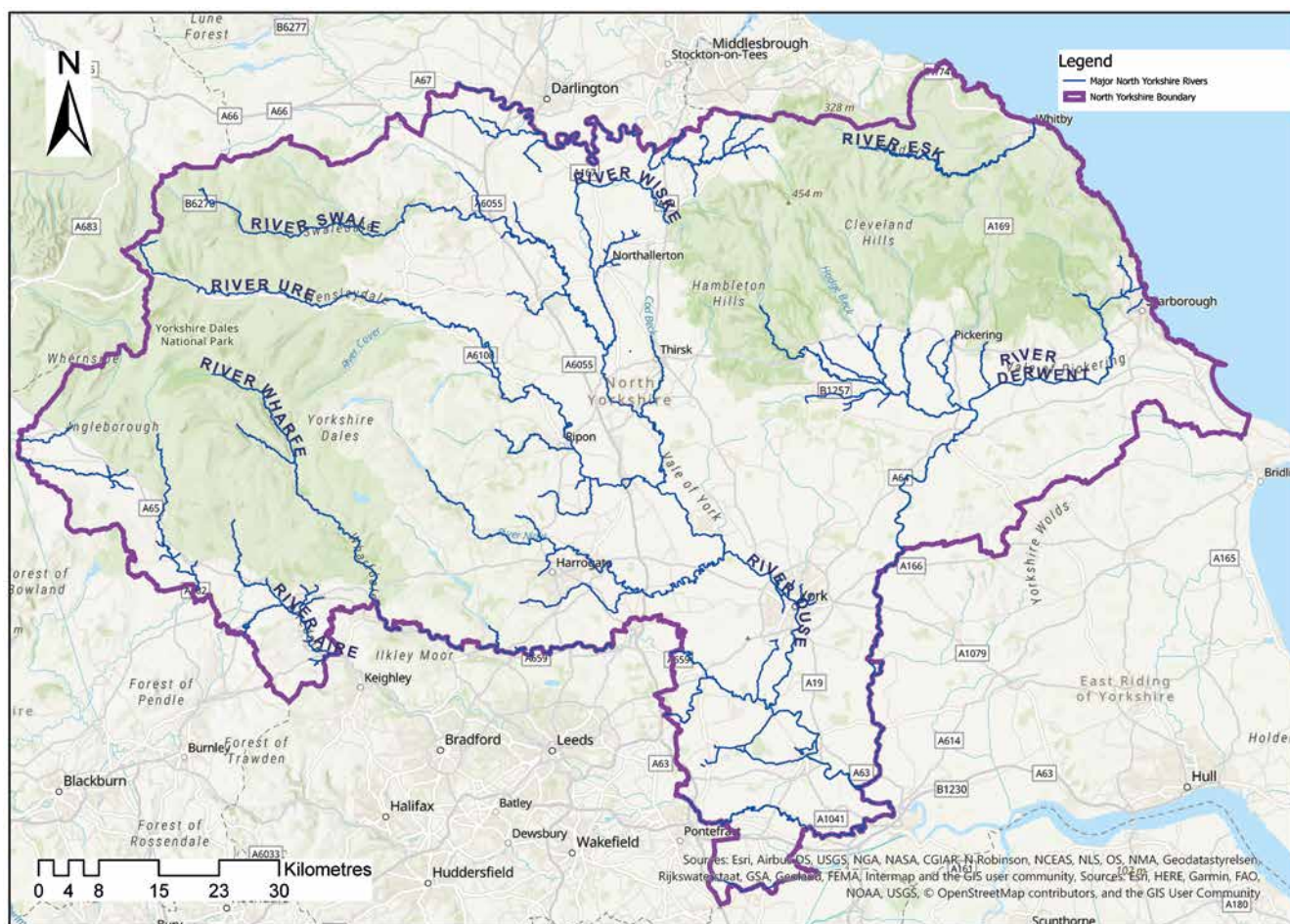


Figure 1. Map of the major river catchments in North Yorkshire.

Since that point, the impact of the Forum has increased tremendously and it is now made up of over 20 organisations including government agencies, national parks, conservation charities and representatives of recreational interests, all with a passion to protect the remaining white-clawed crayfish populations in North Yorkshire. The Forum is utilised to coordinate crayfish efforts across the county, promoting communication, collaboration and partnership development.

Although white-clawed crayfish conservation was often of interest to many organisations, it was generally lower priority than other key drivers, and people were unable to dedicate the time to certain tasks, such as creating a county-wide plan. To avoid the Forum becoming an area for discussion only, with no practical action, Yorkshire Wildlife Trust recognised that it would require staff resources to drive ideas forward. In 2020, Yorkshire Wildlife Trust applied for and received funding from Yorkshire Water's Biodiversity

Enhancement Programme to appoint a part-time officer. Their role was to:

- finalise the NYCF Strategy
- develop a 5 year delivery plan against the Strategy
- create a volunteer group of surveyors (Crayfish Champions) to improve baseline data and carry out ongoing monitoring
- develop materials, providing targeted advice and events to promote biosecurity measures
- identify suitable projects to deliver against the plan, and secure additional funding
- ensure that actions in the plan are undertaken and the right partner organisations involved at the right time.

Initially the position was for 18 months but due to the success of the role and achievements made to date the funding was extended by Yorkshire Water to spring 2025.

Challenges to white-clawed crayfish conservation

There are a number of challenges when working to conserve white-clawed crayfish. With the species' dramatic decline over the past few decades, data available (such as through local records, the National Biodiversity Network, etc.) have quickly become outdated. Opportunities to collect new data is low as surveys are not undertaken to inform the distribution and health of the population but predominantly carried out *ad hoc* as part of the Environment Agency's Water Framework Directive monitoring or for developments. The poor legislative protection afforded to white-clawed crayfish (it is only illegal to intentionally take them) means if developers do not remove them from the watercourse then no offence has been committed. While it is a species that is considered during the planning process, it is often the case that works that do not directly impact a watercourse do not require surveys. So the crayfish are not protected from disturbance and therefore survey data are limited.

Box 1. Case studies in North Yorkshire of lost white-clawed crayfish populations

In August 2020 a large number of dead white-clawed crayfish were reported on the River Ure, which held the third largest population of white-clawed crayfish in England. Follow-up testing showed that they had died of crayfish plague. It was concluded that the crayfish plague was introduced into the catchment by plague spores (not by signal crayfish) and then rapidly spread through the system. Testing of the catchment including its tributaries was conducted to understand the widespread effects, with plague spores still being recorded in 2022. The Environment Agency is currently looking at potential ark site locations (an ark site is a waterbody that acts as a safe haven for white-clawed crayfish to establish and thrive long term, safe from non-native crayfish and crayfish plague) to save the remaining population.

The River Rye fully dries out annually in some places during the summer months. Historically, a white-clawed crayfish rescue, led by the Environment Agency, would occur every year with hundreds of native crayfish translocated above a nearby barrier to deeper pools. With the increase in extreme weather events, the crayfish population will be put under more stress each year and it was decided that the annual rescue was not sustainable for the future of the population. Therefore, in 2020, Yorkshire Water worked with the North York Moors National Park Authority's Ryevitalise programme to find a suitable ark site that the Rye population could be translocated to. In 2021, the relevant licences and permissions had been granted to allow the creation of the ark site but when the river dried out no crayfish were recorded. Further surveys in 2021 and 2022 also yielded no crayfish. In the space of two years, despite active effort to conserve it, this population had completely disappeared without the reasons being fully understood.

Furthermore, river catchments are often managed in isolation within and between organisations, which can hinder the sharing of data that could be used to support crayfish conservation. Therefore, between their rarity and lack of recent survey data, white-clawed crayfish distribution is relatively unknown. Having up-to-date data on crayfish is imperative for conservation work to allow focused efforts to protect remaining populations.

White-clawed crayfish populations have the potential to be wiped out in a matter of weeks due to crayfish plague (*Aphanomyces astaci*), making their conservation extremely challenging (see Box 1). Longer term, they face threats from interspecific competition with non-native crayfish species, habitat loss and climate change.

North Yorkshire Crayfish Forum aims

On appointment of a dedicated officer, the creation of the NYCF Strategy was prioritised, detailing the key aims and objectives agreed by Forum members as being integral in the conservation of the species across the county. A five year delivery plan was then created to show in more detail which actions were needed to achieve the overall aims and

“Continual learning and collaboration are key to effectively undertaking conservation across connected river catchments and across large areas like North Yorkshire.”

objectives, which organisations were leading each action and the timescales associated with them.

Listed below are the seven aims of the Forum, with some of the achievements that have been made so far.

Theme: assess

Aim 1: Establish distribution status of white-clawed and invasive alien crayfish, monitor and keep up to date

Existing data were analysed for the presence of white-clawed crayfish and any signal crayfish populations (currently the only invasive non-native crayfish species) in North Yorkshire. A Crayfish Champion volunteer role was created and crayfish survey training was provided. Individuals could then assist in crayfish surveys, allowing for a greater survey effort (Figure 2).

Sixteen surveys across five river catchments and 320 volunteer hours have been recorded over the last two



Figure 2. White-clawed crayfish found through surveying. Photo credit: Jay O'Donoghue.



Figure 3. Volunteers processing white-clawed crayfish. Photo credit: Vanessa Barlow.

years (2021 and 2022; Figure 3). This allows for the crayfish distribution to be updated and maps are available for not only Forum members but wider stakeholders and the public.

The work of our volunteers in providing up-to-date survey data is a key aspect for proactive conservation and has already yielded valuable results. For example, the volunteers undertook surveys in 2022 and recorded signal crayfish on the same watercourse only kilometres away from where white-clawed crayfish had been reported earlier in the year to some of our members. This allows prioritisation of this watercourse for further surveys. This year surveys will be undertaken to understand if any in-channel barriers are present to stop the signal crayfish moving upstream and to identify potential locations for an ark site, if needed, to ensure the population is not lost. This example highlights the importance of communication between the Forum members and allows collaboration between different organisations to quickly identify and implement potential solutions.

Theme: plan

Aim 2: Work collaboratively to prioritise actions, increase efficiency and effectiveness and to maximise resources and impact

Forum meetings occur approximately every four months to maintain

communication, identify opportunities to share resource inputs and share knowledge. Smaller working groups have also been created in the NYCF so that interested parties or key technical specialists, for example biosecurity specialists, can work together for a shared goal.

Collaborative working with organisations such as the University of Leeds, allowing the most up-to-date research, can be tailored towards the NYCF goals as well as using existing projects within the Forum for research. The University of Leeds, the Environment Agency and Yorkshire Water have been exploring innovative ways of undertaking crayfish surveys, including use of environmental DNA. The initial methodologies are shared across the Forum to ensure there are no unnecessary overlaps, avoiding limited resources being spent doing the same thing, before the final results and any learning opportunities are shared.

Theme: act

Aim 3: Stop further spread of invasive alien crayfish and crayfish plague, through improved biosecurity measures and other interventions where effective and practical, to minimise future losses of white-clawed crayfish

During Forum meetings any updates on research, surveying methodologies or control measures for invasive crayfish

species are shared. The University of Leeds is currently investigating the use of novel technology including methods of monitoring and controlling invasive species, where any updates can be shared across the Forum.

As the crayfish surveying season is relatively short, to keep the volunteers engaged outside of this period other works are carried out to collect information, such as barrier surveys. These identify physical in-channel barriers that prevent the upstream movement of invasive non-native crayfish. Any key barriers identified are recorded and fed back to the relevant organisations to ensure they are not removed.

Aim 4: Ensure that ark sites, waterbodies and catchments with white-clawed crayfish populations are thriving and biosecure

A number of the Forum's projects are looking at the creation of ark sites. The surveys aim to identify which populations are at risk of crayfish plague introduction or signal crayfish invasion, and locations where populations can be re-established following their loss. A database is being created of suitable ark sites across North Yorkshire which can be utilised when a white-clawed crayfish population is threatened, allowing the sites to be used at short notice. This work was being carried out by separate organisations and is now being centralised to prevent the duplication of effort. Ideally, at least one ark site in each Water Framework Directive Operational Catchment will be identified, with catchments with known white-clawed crayfish populations prioritised. Additionally, this project will investigate why, if any, ark sites fail to work to ensure that lessons are learned even from unsuccessful attempts.

The part time-officer is additionally undertaking a feasibility study of a crayfish hatchery to ensure the longevity of ark site populations. Release into new ark sites is also being investigated.

Theme: engagement: education and raising awareness

Aim 5: Ensure that recreational river users and workers are aware of and follow biosecurity/Check, Clean, Dry procedures through the delivery of a county-wide biosecurity campaign

Biosecurity materials have been produced through the Forum and are given out at face-to-face events and engagements; they are also available to the public online as well as to members delivering biosecurity training (Figure 4). The materials have also been displayed at the number of events that have been attended by members of the forum, further promoting the importance of biosecurity. Every year a number of Forum members (Yorkshire Wildlife Trust, Yorkshire Water, University of Leeds, Yorkshire Dales Rivers Trust and Yorkshire Invasive Species Forum) share a stand on Invasive Non-native Species and Biosecurity at the Great Yorkshire Show, which is attended by around 140,000 people. One of the benefits of having multiple members in the Forum is events can be attended on a rotational basis, sharing the workload. The shows attract a lot of interest from the public, increasing the awareness for the species and its plight. The Forum has enhanced the documents and information available to the public using questions arising from the events attended, and everyone is encouraged to report crayfish sightings, increasing the data available.

Aim 6: Promote the importance of white-clawed crayfish and intact river ecosystems through the development and delivery of communication and education strategies

A Communication and Engagement Plan is currently being created through smaller working groups. This will allow the Forum to prioritise stakeholders and have a clear strategy on how best to deliver its aims to a wider audience using existing materials and communication channels. It will help further identification of methods that need to be developed.

Theme: networking and influencing

Aim 7: Develop a central hub where ideas, resources and expertise are shared and used, and through which we influence regional and national decision-making

A Storymaps site (<https://storymaps.arcgis.com/stories/1fc227560a6d45aba8cedf39a5ab0051>) has been created to provide various stakeholders (public, land managers and recreational users of waterways) with information on



Figure 4. Biosecurity training. Photo credit: Steph Bradbeer.

white-clawed crayfish and what they can do to help, as well as providing a number of resources. This is an up-to-date resource showing crayfish distribution maps, and it includes useful links to other websites, provides a pocket guide to crayfish, guidance for land managers, posters and an interactive map of existing projects that the Forum is currently working on and what has been learned so far. It also provides links to a separate page on biosecurity and signal crayfish with further information. The site provides a single location for all relevant information for white-clawed crayfish conservation across North Yorkshire in one location.

Conclusion

North Yorkshire is a stronghold for the white-clawed crayfish, but populations are still facing extreme pressures and uncertainty. The NYCF's work aims to ensure the long-term survival of this endangered species.

Having a dedicated project officer and multiple organisations with the same goal means that work time can be utilised by individuals and key aims/tasks are driven forward. The diversity in experience and specialisms of the members also allows for a range of viewpoints and different angles when looking at white-clawed crayfish conservation, with the project officer being able to tie together the various projects and skillsets, and to disseminate information.

A range of projects can be undertaken due to the number of organisations

involved, with few geographical constraints such as river catchments or operational areas. Knowledge sharing, including lessons learned, not only from successes but also failed conservation attempts, enables works to be carried out more effectively in the future. Continual learning and collaboration are key to effectively undertaking conservation across connected river catchments and across large areas like North Yorkshire. The NYCF has achieved a large amount in a relatively short space of time and there are plans to widen the NYCF to the whole of Yorkshire from 2025.

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About the Authors

Steph Renshaw MCIEEM is a member of the NYCF through her work as a Senior Ecologist at Yorkshire Water and has a particular interest in crayfish conservation.

Contact Steph at:
Steph.renshaw@yorkshirewater.co.uk

Vanessa Barlow, who is a qualifying member of CIEEM, is the Crayfish Stakeholder Officer at Yorkshire Wildlife Trust, working on crayfish conservation projects across North Yorkshire including being the part-time officer for the NYCF.

Contact Vanessa at:
Vanessa.barlow@ywt.org.uk

Ecological Detection Dogs to Aid Biosecurity Efforts: Identifying Signal Crayfish (*Pacifastacus leniusculus*)

Signal crayfish (*Pacifastacus leniusculus*)



Katherine Beale
MCIEEM

Nature's Rest
(formerly Geckoella)



Rachel Cripps
RM Conservation



Kate Hills
South West Water



Haleema Kara

Sarama Conservation
Dogs



Nicola Morris
South West Lakes



Lucy Wilde
Wilde Ecology Dogs

Keywords: biosecurity, ecology detection dogs, invasive species management, novel survey methods, south west England

South West Water and South West Lakes, as part of ongoing traditional and novel biosecurity efforts, are looking

into the management and biosecurity of signal crayfish (*Pacifastacus leniusculus*) across their sites. This project focused on two stages: first, scientific testing highlighted the effectiveness of using detection dogs to detect

signal crayfish and second, the methods were applied in an operational capacity. This new survey methodology could be applied to aid biosecurity management efforts and projects across the UK.

Introduction

UK freshwater environments and species are increasingly endangered by invasive non-native species (INNS), resulting in rising costs for waterway management. One of the most impactful is the American signal crayfish (*Pacifastacus leniusculus*), with recorded sightings in over 60% of the UK's waterways (Dudgeon *et al.* 2005; see also the NBN Atlas, <https://nbnatlas.org/>).

The UK has one native species of crayfish in its river network, the white-clawed crayfish (*Austropotamobius pallipes*). Both white-clawed and signal crayfish occupy the same habitat type, favouring freshwater streams and lakes with mud, rocky substrate and small crevices, although the signal crayfish can tolerate a much wider range of habitat conditions. Where the two species overlap, the signal crayfish outcompetes the native species for food and resources. The introduction of signal crayfish also brought crayfish plague (*Aphanomyces astaci*) to the native population, which has no resistance, further increasing the endangerment of the white-clawed species (Anderson *et al.* 2021).

In addition to ecological impacts, signal crayfish also pose a threat to the UK economy. Over £2,689,000 is spent annually on riverbank restoration and aquatic management, and its impact on recreation such as angling (previously stated by Defra 2020). The ability to increase the efficacy of both identification and subsequent trapping of signal crayfish, particularly at previously unrecorded locations, could offer economic benefits in the management of this species. South West Water (SWW) and South West Lakes (SWL) are investing in novel techniques for survey and control, alongside traditional methods.

Current biosecurity measures at the sites where crayfish are known to be present include encouraging visitors (particularly those engaged in angling and watersports) to undertake good practices including the Check, Clean, Dry principle. Both organisations are members of the AQUA biosecurity accreditation scheme, which works to help participants increase biosecurity efforts to combat the threat of INNS (SWW and SWL, personal discussion). As part of these increased efforts to

target INNS a trial of the use of detection dogs was proposed to help monitor population distribution and hence help improve biosecurity and improve control measures.

Ecology detection dogs

The olfactory capabilities of dogs have been harnessed to strengthen our ability to find targeted items and substances for centuries. During this time detection dogs have been used for the detection of explosives, illegal substances, human remains and diseases such as cancer. More recently they have been used in the field of ecology.

Detection dogs are selected based on breed (physical traits) and hunting characteristics (Beebe *et al.* 2016). The dogs are trained to give a passive indication (often a sit or stand at a suitable distance) on the target odour (Porritt *et al.* 2015) without risk of disturbance or damage to the study species. Detection dogs have been used successfully for monitoring and enhancing biosecurity efforts on other aquatic and invasive species, including the zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena rostriformis*) in North America (Richards 2018) but this has not been explored in the UK. The use of dogs to aid in aquatic biosecurity, in this instance for monitoring signal crayfish across SWW and SWL sites, was the primary focus of this project.

Field trial assessment

Two dog teams (Team A and Team B), each consisting of a handler and a detection dog, were used to test the viability of the training methodologies. The dogs used were a 3-year-old female working cocker spaniel (Team A) and a 7-year-old male black Labrador (Team B). These dogs were selected and trained by their owners as ecology detection dogs. To reduce bias, two trial coordinators assessed each search and recorded the results. Both trial coordinators are detection dog handlers with an ecological background, including experience in scientific testing and investigations.

The trials were undertaken at two different sites, Colliford Lake and Siblyback Lake, Cornwall. These sites were chosen as no crayfish species had been recorded here, eliminating the possibility of 'live' finds. Both sites represented suitable crayfish habitat, including areas of clay soils with rocky areas that crayfish would shelter under, and vertical sandy banks that crayfish could burrow into.

The trials were designed to reflect an operational search while incorporating the physical differences between the two dog breeds without bias. The trials were conducted using dead crayfish parts, under licence (Figure 1). The trial coordinators placed targets in the search areas up to 30 minutes before the first search. They both walked



Figure 1. A target fragment sample used during the field trials (under licence). Photo credit: Rachel Cripps.

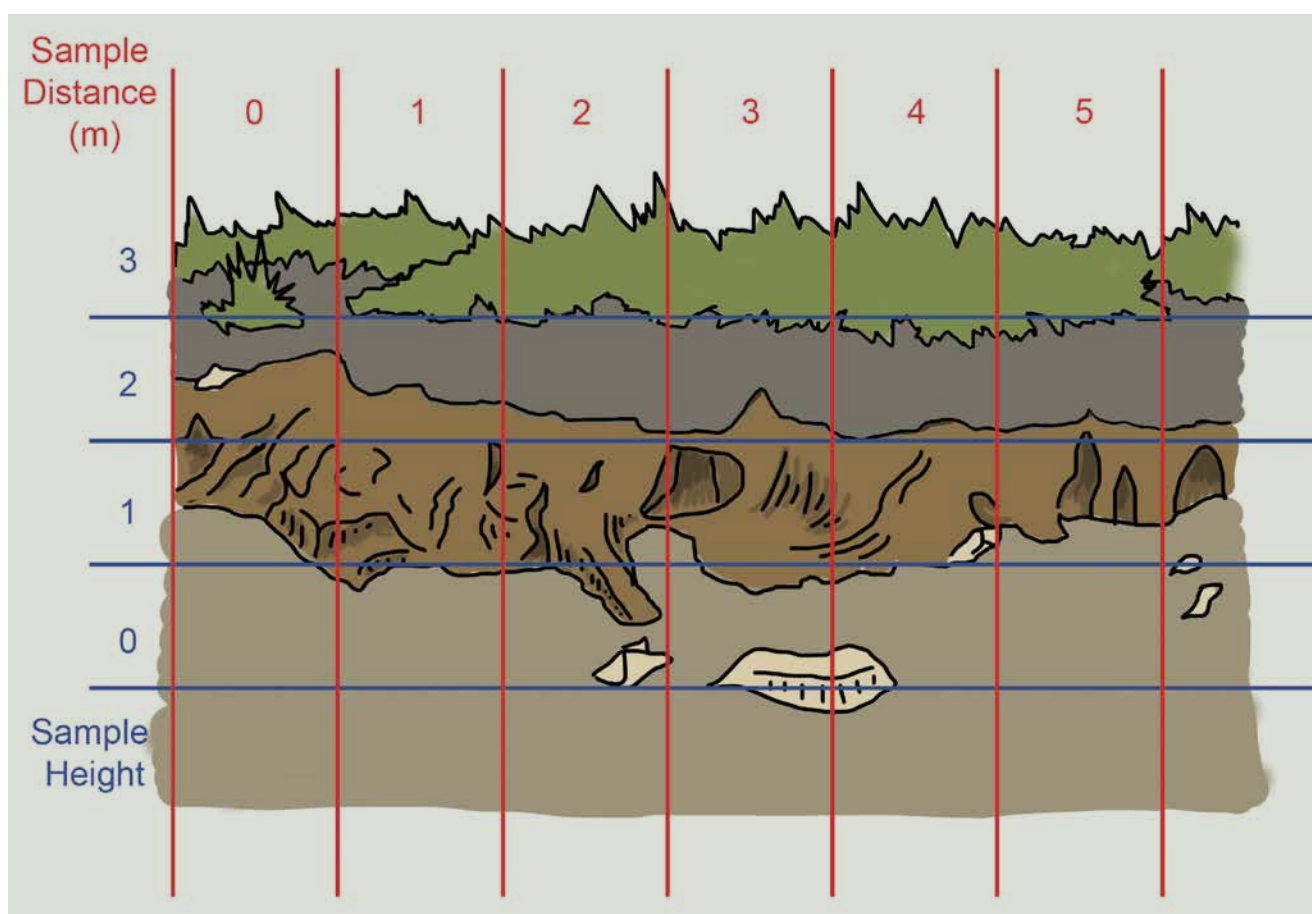


Figure 2. An example grid pattern was used to determine the location of crayfish targets in the bankside habitat using a random number generator.

randomly throughout each search area, creating disturbance in areas without crayfish to demonstrate that the dogs were not tracking or indicating on human disturbance. A random number generator was used to determine the location of each crayfish sample in each trial area, using a grid system covering both height and distance from the start, as shown in Figure 2. The target samples were placed in natural crayfish refugia, including in burrows, under rocks and in natural gaps under tussocky vegetation and thus were not visible to the dog handlers.

At Siblyback, the vertical bank was divided into four horizontal sections at 20 cm intervals (as shown in Figure 2). At Colliford, due to the gentle slope of the bank the vertical sections were divided into three 1 m sections. Both search areas were 50 m in length and divided into 1 m sections along this length.

Each team completed eight searches with a total of 16 trials for the assessment of the methodology. Trials were conducted blind with teams unaware if, or how many, samples had

been placed in the trial area. A maximum of 20 minutes was allowed for each search. The trial coordinator knew the locations of the crayfish targets so could confirm to the handler who then rewarded the dog for a correct indication (for both dogs this was a sit). To reduce the possibility of influencing the search but still allow effective communication, the trial coordinator was always a minimum of 5 m from the team while searching.

For each 1 m section of the linear search areas a result of true negative, false positive, false negative or true positive was recorded for each section. These results were used to calculate the sensitivity, specificity and precision of each team at detecting crayfish samples in each habitat, each team across both habitats and both teams across both habitats (see Table 1).

Table 1. Definitions and calculations used to assess the quality and ability of the detection dog team during the field trials.

Measure	Description	Calculation
Sensitivity	The proportion of all targets found	$\text{= true positive}/(\text{true positive} + \text{false negative})$
Specificity	The proportion of blanks that were correct	$\text{= true negative}/(\text{true negative} + \text{false positive})$
Precision	The proportion of all indications that were correct	$\text{= true positive}/(\text{true positive} + \text{false positive})$

True positive: correct indication on crayfish sample; false positive: indication on non-target odour; false negative: missed sample and no indication given; true negative: correct blank and no false indications given.

“ UK freshwater environments and species are increasingly endangered by invasive non-native species (INNS), resulting in rising costs of waterway management. ”

Field trial results and conclusion

The project trials were completed successfully with both teams able to accurately identify the samples. The combined scores for the two teams, as detailed in Table 2, indicate that the detection dog teams can successfully identify dead signal crayfish in areas representative of crayfish habitat with a high degree of accuracy. The high precision score demonstrates that neither dog was falsely indicating on other items and distracting scents in the natural environment and that the initial training on the target scent was carried out successfully. The results showed a variation between teams and sites, particularly in relation to the specificity and sensitivity scores. The possibilities for this variety in scores are considered to be external and environmental factors such as habitat, sub-optimal weather conditions, and team experience.

The results of the field trial show that ecology detection dog teams are able to successfully identify presence and likely absence of crayfish remains. Due to licensing restrictions white-clawed crayfish remains could not be used to test the dogs' ability to discriminate between the two species, but this is a potential area of future research.

Operational work

To build on field trials and test the teams in an operational setting, they assisted in identifying the spread of signal crayfish from Burrator Reservoir, Dartmoor, Devon. During 2022 a long period of drought reduced the water level to 36%. It has been suggested that this may have resulted in dispersal of the existing signal crayfish population. The detection dogs were used to identify individuals within the catchment to inform management and improve biosecurity measures. This site has no white-clawed crayfish but full biosecurity protocols to prevent crayfish plague spread were observed.

Table 2. Mean results for both teams across both sites.

	Mean sensitivity	Mean specificity	Mean precision
Siblyback Lake	77.8%	99.0%	100%
Colliford Lake	99.4%	99.7%	100%
Combined	86.1%	99.4%	100%

Individual search areas, minimum 50 m (Richards 2018) of suitable bankside habitat, were searched by the individual teams. Handlers noted areas where the dogs showed a change of behaviour (e.g. increase in intensity of sniffing, change in tail posture/movement, sudden movement of head in the direction of the odour), suggesting they had detected the odour of signal crayfish, or where a dog gave a full indication and informed the ecologist. The ecologist would then carry out a visual inspection of the area for evidence of signal crayfish; to assist in verification the ecologist used an

endoscope where possible. Where the presence of signal crayfish was confirmed the next search area was located at an accessible area, either upstream or downstream, at an increasing distance from the reservoir. The search locations were identified in this way until the results for the current search area produced a negative result, indicating the likely absence of the species from that area.

The operational searches were undertaken in December 2022, in sub-optimal weather conditions, and these limitations have been taken into account.



Figure 3. Detection dog teams A and B in action in two example habitats during the operational works. Photo credit: Katie Beale.

Operational work results and conclusion

The detection dogs were able to generalise from dead crayfish to live crayfish in an operational setting with positive indications on confirmed live crayfish in burrows (in detection dog training, generalisation is the dog's ability to detect odours similar to, but not exactly the same as, the original trained odour). The survey results identified the spread of signal crayfish upstream and downstream of the reservoir. Searches were conducted to a distance of 3 km south, with crayfish presence recorded at 2.7 km. Searches were conducted to a distance of 4.5 km north with presumed presence recorded at 3.9 km. A negative result and therefore presumed absence (see Box 1) of the species was recorded in Area 7 at 4.5 km. A total of 44 areas of interest were shown across all search areas. The results of the survey will help inform any trapping and control efforts within the Burrator and River Meavy catchment. Locations are shown in Figure 4.

The number of confirmed finds decreased as the distance from the reservoir increased. Although no population surveys were conducted it is considered that the density of confirmed finds could be an indication of the population size within the search area. As such it is likely that the trapping efforts will be able to be reduced further from the reservoir.

The project successfully identified the dispersal of signal crayfish north of Burrator Reservoir; however, the extent of the spread to the south could not be confirmed due to land access restrictions. The surveys conducted to date are being used to inform control efforts planned for the 2023 season.

“ The trials showed that the detection teams achieved high scores for sensitivity, specificity and precision ... leading to increased confidence in the results shown in the operational work. ”

Box 1. Definitions of presence and absence

Confirmed presence An area where dogs showed interest and/or indication. The area was then searched by an ecologist, with an endoscope, and the presence of an individual was confirmed.

Presumed presence An area where dogs showed interest and/or indicated; however when examined by an ecologist presence of an individual could not be directly confirmed. This was also noted where the dogs showed interest but, when examined by an ecologist, evidence was in the form of fragments in faecal matter.

Absence An area where dogs showed no interest or indication within a 50 m stretch of habitat, in line with methods presented in Richards (2018).



Figure 4. Confirmed presence and presumed presence results from operational searches along the Meavy River.

Conclusions

Ecology detection dogs have been successfully trained, tested and deployed on operational survey work, assisting SWW and the SWL as part of ongoing biosecurity management of their sites. The trials showed that the detection teams achieved high scores for sensitivity, specificity and precision, even with external and environmental factors such as sub-optimal weather conditions, leading to increased confidence in the results shown in the operational work. The teams will now assist in providing a significantly cost-effective tool for monitoring a large reservoir site where signal crayfish have been reported, but which, despite different survey deployments, have not been identified to date. Further opportunities for additional research have been highlighted allowing detection dog teams to further advance the long-term management of signal crayfish.

The success of these trials in training and operational work has the potential to provide a variety of benefits, including targeted trapping, monitoring and management efforts. The dogs are an exciting additional measure alongside other methodologies allowing for greater efficiency and economic value for organisations working to manage this species. The methodology used for training can also be extended to other INNS, allowing detection dogs to play a greater role in supporting identification and management strategies across the UK and further afield.

About the Authors

Katherine (Katie) Beale MCIEEM has been working in ecology for over 10 years, holds class and development licences for protected species, and is a detection dog handler. She has worked on a wide range of ecological projects, including development works, and conservation of species and habitat projects across England and Wales.

Contact Katie at:

katiebeale@naturestestco.co.uk

Rachel Cripps is Senior Conservation Officer at Lancashire Wildlife Trust and a detection dog trainer and handler. She has been working in the conservation sector for over 12 years and is the owner of RM Conservation, training and handling her own conservation detection dogs for a variety of projects. She has experience mentoring new dog-handler teams and is Chair of the Ecology Detection Dog Working Group.

Contact Rachel at:

rachel@rmconservation.co.uk

Kate Hills is the Biosecurity and Invasives Manager at SWW. She is responsible for developing biosecurity plans, training programmes and management on 2500 sites. She is keen to support collaborative research and innovative measures and sits on a number of local, regional and national steering groups.

Contact Kate at: khills@southwestwater.co.uk

Haleema Kara is an experienced detection dog handler and trainer with a background in operational explosives and pyrotechnics detection at large events including football stadiums. She is now the owner of Sarama Conservation Dogs, working on both biosecurity and protected species projects.

Contact Haleema at:

info@saramaconservationdogs.com

Nicola Morris is Head of Environment for SWL, overseeing the management of conservation, ecological and forestry work. Research includes public perception, biosecurity and invasion biology. She is Chair of the Cornwall Invasive Species Forum and Co-chair of the South West Invasive Species Forum.

Contact Nicola at: NMorris@swlakestrust.org.uk

Lucy Wilde is an ecologist, detection dog handler, trainer and groomer and is the business owner for Wilde Ecology Dogs. She is a qualifying member of CIEEM. She has worked on a range of ecological projects, and recently completed her master's degree looking into the ability of detection dogs to survey signal crayfish.

Contact Lucy at: l.a.wilde@hotmail.com

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How do you Become an Invertebrate Ecologist?



Spined mason bee (*Osmia spinulosa*). Photo credit: Baker Consultants.



David Goddard
MCIEEM

Baker Consultants

Keywords: assessment, career, entomology, identification, surveying, training

In this article I show how you could become an invertebrate ecologist, using routes including higher education, training modules, dedicated courses and mentoring. I also outline processes for invertebrate surveying, identification, assessment and reporting. Throughout the article I have given pointers to where you can find useful courses, identification books/guides and guidance on assessment.

Introduction

What does it take to become an invertebrate ecologist? What do you need to know to be able to undertake invertebrate surveys? How do you develop the subsequent skills needed

for species identification and reporting? In this article I will outline how to develop and answer all of the above questions and show how you can eventually become confident enough to

carry out surveys and identification for some of the UK's invertebrates.

Why do we survey for invertebrates at all? Well, there are invertebrates that receive either European and/or national protection. There are additional species that are listed as priority species of conservation concern and all such species could be material considerations for the planning stage of a development or proposed habitat enhancement work.

In addition, there are invertebrate species or groups of species that are good indicators of habitat quality. For example, dragonflies and damselflies are dependent on both good-quality water bodies in which to breed and good-quality habitat surrounding the water body for the adults to feed and find a mate before starting the whole cycle again. Finding freshly emerged dragonflies or their exuviae at a water body is an indication of good condition during the time that the larvae developed.

Where do you start?

First you need to have an interest in invertebrates. However, it shouldn't be too hard to find a group that excites you, as there are approximately 32,000 species recorded so far in Britain and they constitute approximately 95% of all animal species worldwide (JNCC (Joint Nature Conservation Committee) 2023b). Personally, I was curious about the invertebrates I had just seen, which spurred me to join a few societies. They are an excellent resource and full of knowledgeable people who are very happy to share their knowledge and skills.

By the time that I started my ecology degree I was already able to identify butterflies and Odonata (dragonflies and damselflies) and I was the county recorder for Odonata in Derbyshire and Nottinghamshire. I had also been contracted through the British Dragonfly Society to co-author a report for English Nature (now Natural England) on how to survey and monitor Odonata on all Sites of Special Scientific Interest (SSSIs) in England.

Having added experience in another two of the smaller groups I then added ladybirds and shieldbugs before moving to the larger and more complex groups such as ground beetles, bees, wasps and ants. In this way I was able to build up my skills over time without feeling overwhelmed by the sheer number of them and the difficulty differentiating between the species within some genus.

Degrees

There is currently only one university offering a specific entomology undergraduate degree that I am aware of: Harper Adams University. However, lots of other universities do offer courses with some modules covering entomology to a greater or lesser extent. I undertook an Ecology, Conservation and Countryside Management BSc at Nottingham Trent University and specialised in terrestrial and aquatic habitats and was thus able to apply my interest in invertebrates whenever possible.

There are also a few universities that offer entomology MSc degrees, such as Reading, Harper Adams and Derby. For

both BSc and MSc courses it is worth checking the university's website to see if they have links to external entomologists and/or if any of the tutors have a personal interest in entomology. This can also be done by looking at what papers they have published or contributed to.

Further training

There are a number of organisations that run events or training courses that you could attend to see how the experts do a survey and identify what they can on site. However, rest assured that even the very best entomologists take voucher specimens home to identify later using guides and a microscope. Voucher specimens can mean anything from the specimen from which a species is initially described – and usually held in a museum – to a specimen that you have collected and preserved as proof that a species was present at a site on a particular date.

Organisations such as county or regional entomological societies, the British Entomological and Natural History Society or the Wildlife Trusts, and organisations



Figure 1. Thick thighed beetle (*Oedemera nobilis*) on oxeye daisy (*Leucanthemum vulgare*). Photo credit: Baker Consultants.

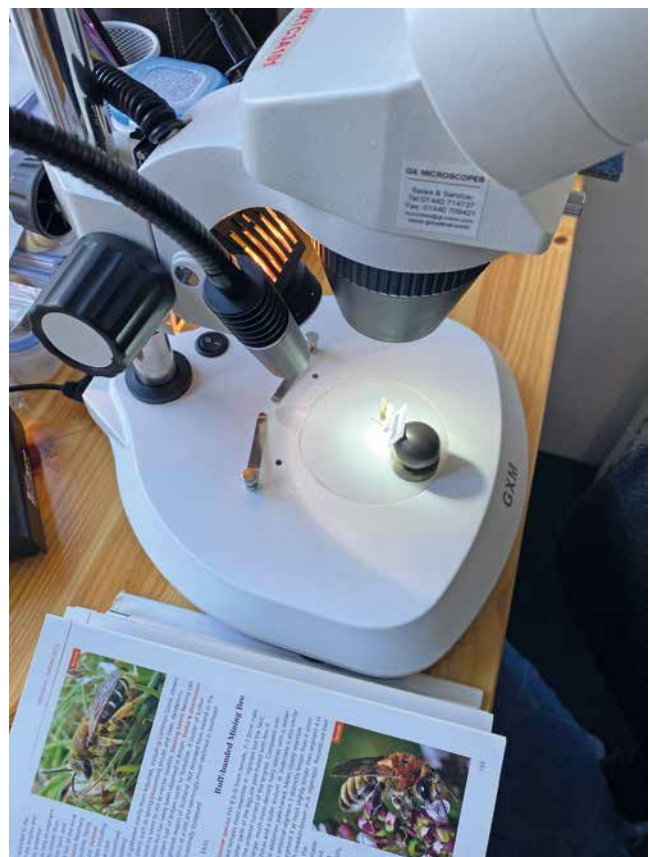


Figure 2. A bee being identified. Photo credit: Baker Consultants.



Figure 3. Dead wood, A46 near Newark. Ridge-backed fly fox (*Ectemnius cephalotes*) was recorded. Photo credit: Baker Consultants.

such as the British Dragonfly Society, run guided walks throughout the UK. Butterfly Conservation also do occasional field meetings.

The Field Studies Council provides training courses for specific species groups (e.g. solitary bees, ground beetles and solitary wasps), either online or in person. These courses are usually led by a known expert in their field and are an excellent way to learn from some very experienced people. The Bees, Wasps and Ants Recording Society has a members' weekend that includes training on species identification, sometimes using new keys that are being tested. The Freshwater Biological Association also runs courses, some of which are assessed and accredited, such as Invertebrate Identification for Biotic Assessment Accreditation, which I would recommend.

In the CIEEM *Good Practice Guidance for Habitat and Species* (CIEEM 2021) there

is a section on invertebrates which covers surveying, mitigation, management and monitoring invertebrates.

You can learn a considerable amount about survey techniques, handling invertebrates, equipment and useful books and guides by attending these events or courses. They are also useful for learning about species distribution and habitat associations for some groups. That might include the types of habitat that a species has/should be found in, or its association with a particular plant along with their phenology (i.e. the time of year that each of their life stages are found).

Many large museums have considerable entomological collections which have been identified by experts. You may be able to gain access to these collections, enabling you to check your voucher specimen against already identified specimens. There are often resident entomologists who can assist and the

museum may also welcome volunteers to help with the curation and digitising of their specimens.

Volunteering

Volunteering at a local nature reserve or with the county wildlife trust may enable you to help with ongoing invertebrate surveys, monitoring and report writing. An entomologist or more senior member of staff with experience of report writing will be able to guide you.

Some county museums contain natural history collections that include invertebrates. They are often

“ ... it shouldn't be too hard to find a group that excites you, as there are approximately 32,000 [invertebrate] species recorded so far in Britain ... ”

understaffed and would welcome help so you may be able to volunteer. However, do note that there may not be a resident entomologist to assist you and museums will usually only be open during working hours.

Being an ecological consultant

When I started as a consultant I was able to undertake invertebrate surveys on simple sites and produce reports with guidance from my colleagues. Over the years I have undertaken over 20 invertebrate training courses covering a wide range of species groups. These ranged from two to seven days in length with each day being around nine hours. So, you need to have enthusiasm for invertebrates and a willingness to spend quite a bit of time and effort to learn how to survey and identify species. Some of these courses were paid for by the consultancy I was working for while others I have paid for myself. As I gained experience in survey techniques, species identification and report writing, I was able to undertake surveys of more complex sites.

Mentoring

You may be working in a consultancy that already has an invertebrate ecologist and they will almost certainly be keen to help mentor you. This might include shadowing or assisting them during some surveys and the subsequent identification work, which is a great way for getting some one-to-one learning, helping you gain the practical skills required to become an invertebrate ecologist.

Desk study

When you ask for records from the local records centre to enable you to undertake desk study interpreting the data returned, do not be tempted to restrict your search for invertebrate records to just the last few years. Many invertebrate records are historical (i.e. over 10–20 years old) but they still provide important context to the potential importance of a site. In general terms, especially when compared to other species groups, there are not that many surveyors specialising in invertebrates and so such records are not updated as quickly as for other species.

Either that, or a site may not have been visited recently to record invertebrates. As a result, old records are still useful as they can indicate what species may be present on a site, even if the habitats have significantly changed since the record was made. If the desk study returns no or only a few invertebrate records, consider widening the search area to include similar or connected habitats; also consider the distance species may disperse to or from your site.

The National Biodiversity Network (NBN) Atlas can also give a useful indication of invertebrate species which may be present in your study area; however, note that you may not be able to use NBN records for commercial purposes.

For aquatic invertebrates you can also check the Environment Agency's online database (<https://environment.data.gov.uk/ecology/explorer/>) for information on invertebrates, fish, macrophytes etc. CIEEM have recently developed a competency framework for aquatic macroinvertebrates (CIEEM 2022).

Having obtained a list of potential species for a site you should check their status against the JNCC taxon designations spreadsheet (see Assessment of the Species Recorded below). You can also check the precise habitat requirements of species and their presence or absence at or near site.

Surveying

When planning an invertebrate survey the weather needs to be warm and if possible sunny, with light wind and no rain. Otherwise most, if not all, invertebrates will be hiding and you will under-record the true value of the site. Record the weather conditions at the start and end of a survey, to show that it was undertaken at a time and in favourable conditions.

Wherever possible, I try to identify species while on site so that they can remain there, but this is not possible for some species, so voucher specimens are taken home for identification. Some survey techniques will also automatically collect voucher specimens (e.g. pitfall and pan traps), which will involve killing some invertebrates. This may not be acceptable to everyone, so think about whether this is for you or not.

There are a wide range of invertebrate

“ [Invertebrates] are a very rewarding group to work with and give a different insight into the natural world, including ecosystem inter-dependencies and specific interactions that are often not applicable to some of the other species' groups we regularly survey for. ”

survey techniques. Each survey technique has benefits and disadvantages and is used for a particular range or groups of species. Further information on surveys techniques can be found in Drake *et al.* (2007), Eyre (1996), Hill *et al.* (2006) and Sutherland (2006).

Voucher specimens need to be stored until they can be identified, so special chemicals such as isopropanol and ethyl acetate may be needed so specimens can be preserved. There should always be a collection label and species identification label associated with each voucher specimen.

Identification of voucher specimens

The voucher specimens are prepared and viewed using a microscope and the species identified using books and guides. This takes skill and time, but with practice it becomes quicker as you learn more about the key characteristics of each species. There are many books covering the identification of invertebrates, as mentioned. The following publishers have a range of useful books and guides: Field Studies Council, Royal Entomological Society and Bloomsbury Publishing.

There is no invertebrate ecologist in the world that can identify every species they encounter and so you should always acknowledge your limitations. It is common practice to send samples to other experts for help with identification and also confirmation of your own opinions, particularly for some of the trickier groups! Other experts can be found via websites where national records for a group are listed: e.g. British Bugs (www.britishbugs.org.uk/) or Royal Entomological Society (www.royensoc.co.uk/understanding-insects/identification-help/).



Figure 4. The author leading a bumblebee course. Published with permission from Attenborough Nature Reserve.

Assessment of the species recorded

Once you have a species list of invertebrates, how do you determine which are protected and/or are notable? I always check my species list against the JNCC taxon designations spreadsheet (JNCCa 2023). This is a great resource and it is kept up to date by JNCC, as species statuses can change over time.

In some cases, depending upon the species, you may also need to check the SSSI selection criteria guidelines for invertebrates (JNCCb 2023; see Part 2, Section 20, Invertebrates).

You can also use PANTHEON (<https://pantheon.brc.ac.uk/>) to assess the invertebrate species list you have generated (see Heaver *et al.* 2017, Denton 2023).

Likewise, some counties also have local invertebrate red lists along with Local Wildlife Site (LWS) selection criteria for invertebrate species or species assemblages. In some cases, this might even mean that a site could qualify to be designated as an LWS, based on its invertebrate interest alone.

Hopefully, you will now have a species list and know which species are protected and/or are notable, as well as whether they meet any SSSI or LWS selection criteria. This should give you

all information that is required to write an invertebrate report, in which you can give advice on appropriate mitigation, compensation and enhancements.

Box 1. Case study

Working with Hymenoptera (social, solitary bees and bumblebees) has been a challenge recently as there are numerous species, some of which are aggregations of species (e.g. white-tailed bumblebee, *Bombus lucorum* agg.). Until recently there were no modern identification guides, only draft keys by George Else and older Royal Entomological Society keys. This was resolved by Falk (2016) and Else and Edwards (2018). But within a year of Falk's book, eight more UK species had been recorded. These publications have helped considerably and allowed assessment of a site for its ability to support protected and/or notable species or assemblages.

I also contacted David Baldock through the Bees, Wasps and Ants Recording Society, who was good enough to help with the identification of three bees and send me some specimens to start my reference collection.

After the publication of Falk's book I undertook a course run by the Field Studies Course on bee identification. It helped me with the detail required to identify the different taxa, down to species level, using known specimens and identifying specimens collected during field visits. These field specimens added to my reference collection as their identifies were confirmed during the course.



Figure 5. A Local Wildlife Site adjacent to the A46 near Newark. Photo credit: Baker Consultants.

Conclusions

Invertebrates are undoubtedly a very diverse and large group of differing species which can take significant time and effort to learn how to survey and identify. However, this can be done through training, attending courses and mentoring. They are a very rewarding group to work with and give a different insight into the natural world, including ecosystem inter-dependencies and specific interactions that are often not applicable to some of the other species' groups we regularly survey for.

About the Author

David Goddard BSc(Hons), MCIEEM became interested in invertebrates at 10 years old, learning to identify the butterflies from his garden and a local heathland by teaching himself the species found in *The Complete British Butterflies in Colour* (Newman 1968). He is now the Senior Invertebrate Ecologist at Baker Consultants with 15 years' experience in both terrestrial and aquatic invertebrate surveying and assessment. His time in the consultancy sector has allowed him to survey a wide range of habitats, from a potential SSSI, Local Wildlife Sites to old colliery sites and Ministry of Defence sites.

Contact David at:

d.goddard@bakerconsultants.co.uk

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Marine Macroinvertebrate Assessment: Challenges and Outlook

Magelona johnstoni. Photo credit: Thomson Environmental Consultants.



Daisy Chamberlain
Thomson Environmental
Consultants

Keywords: artificial intelligence, benthic macroinvertebrates, DNA metabarcoding, environmental assessment, taxonomy

“ Taxonomists continue to describe new [marine] species at pace, with over 2000 added to WoRMS annually in recent years. ”

Monitoring of marine macroinvertebrates is important for conservation, with assessments mostly done via taxonomic identification based on morphology. Experts to undertake this work are in short supply but new technologies may be able to help. DNA metabarcoding is faster than traditional

analysis and can detect species that may be missed or difficult to identify by morphology. Artificial intelligence, using machine learning to train neural networks to identify specimens from photographs, also holds promise. With the newly agreed United Nations High Seas Treaty and ever-increasing demands on

the marine environment, protection of marine biodiversity is a global high priority. New technologies could complement traditional methods and advance each discipline, significantly increasing our understanding, helping our efforts to protect biodiversity.

Introduction

The World Register of Marine Species (WoRMS) lists over 238,000 accepted species from marine habitats worldwide. Taxonomists continue to describe new species at pace, with over 2000 added to WoRMS annually in recent years. Of all these marine species, invertebrates are by far the most diverse group. Marine invertebrates provide many vital ecosystem services to human health and well-being and their essential roles in ecosystem functioning are relied upon by countless other animals. Amid the biodiversity crisis, protecting our seas is of particular importance given the pressure from anthropogenic impacts and climate change. Loss of marine invertebrate species will impair the quality of the ecosystem services they provide, likely with negative consequences for humans. It is sobering to think that many invertebrate species may go extinct before they are even discovered.



Figure 1. The protected species *Arctica islandica* (juvenile); the longest-lived non-colonial species known. The oldest recorded specimen is 507 years old (Butler *et al.* 2013). Photo credit: Thomson Environmental Consultants.

“ The ‘taxonomic impediment’ is limiting advances in biodiversity knowledge and the situation seems set to continue for decades to come, with dedicated experts working even in retirement to keep the science alive. ”

Many national and international regulations aim to safeguard marine ecosystems. Meanwhile, marine industries continue to exert pressure on marine life, so regulations also mandate monitoring to inform management measures to help maintain healthy habitats. To protect biodiversity, assess impacts and measure recovery after implementation of restoration measures, we must first know how to assess the level of health of a given ecosystem. We must understand the extent of biodiversity and the way species interact with their environment. Benthic macroinvertebrates (>0.5 mm in size) are important indicators of the overall health of marine ecosystems. This is due to their predictable responses to stressors such as disturbance and pollution. Monitoring and baseline assessment of the ecological status of aquatic ecosystems is most often done by macrobenthic analysis, the focus of my career, which involves the taxonomic identification of species based on their morphology and yields data on diversity along with the abundance and biomass of different species.

These data are interrogated to classify sampling stations into habitats or biotopes and to calculate biotic indices that measure ecological quality status. Protected biotopes or species, such as



Figure 2. Ross worm (*Sabellaria spinulosa*). Photo credit: Dale Irvine, Thomson Environmental Consultants.

Ross worm (*Sabellaria spinulosa*) reefs (Figure 2), revealed through this research, allow policy-makers to make decisions and to design marine developments optimally to minimise their environmental impact.

Working with marine invertebrates

From worms to crabs, and clams to starfish, invertebrate life on the sea floor is incredibly varied. Taxonomists in benthic laboratories around the UK process thousands of benthic samples a year to identify these creatures, starting with sieving the sediment, extracting the fauna and finally identifying, counting and weighing each species. See Box 1.

Much of this sample analysis is done for governmental monitoring, required under legislation such as the Water Framework Directive, and for assessment of protected areas. In the commercial sector, macrobenthic analysis is required for Environmental Impact Assessments for all sorts of marine developments, including in the renewable energy and the oil and gas industries.

Experienced taxonomists and adequate resources are in high demand. With often high abundance and diversity of fauna, analysing just one sample can be days of work. Species-level identification can be hampered due to damaged specimens, the presence of unidentifiable life stages, undescribed species, other unresolved taxonomic issues or by lack of access to relevant information; for example, if older research is not digitised, or if type material is stored in another country or is in poor condition. Accuracy is key: care must be taken not to miss any species as diversity is an important metric. Without adequate quality assurance, the level of taxonomic expertise of an analyst could affect the results of sample analyses.

The constraints of expertise, resources and gaps in biodiversity knowledge are, together, known as the ‘taxonomic impediment’. This has been discussed in the scientific community, and in government, for over 30 years. The problems today are the same as when the term ‘taxonomic impediment’ was coined. Although we haven’t yet run out of taxonomists, as often predicted,

Box 1. What can be found in marine macroinvertebrate samples?

Most macroinvertebrate samples contain species across Polychaeta, Crustacea, Mollusca, Echinodermata and numerous other phyla, each with their own characteristics and identification challenges. When analysing samples from healthy, undisturbed habitats such as some Marine Conservation Zones, we regularly come across over 150 different species and several thousand individuals in one 0.1 m² grab sample. Across a study area, this can mean over 500 different taxa and tens of thousands of individuals in one project.

To quantify the health of an area, biotic indices such as the Infaunal Quality Index (IQI) are used to measure ecological quality status. The IQI uses taxonomic diversity and evenness, along with presence or absence of sensitive and opportunistic species, to calculate a score ranging from 0 (bad ecological state) to 1 (good ecological state).

A sample with a high IQI score indicates minimal disturbance. It would be diverse and contain sensitive species, which are only able to survive in relatively undisturbed conditions. Abundance may also be high but spread across many taxa rather than just one dominating species. A low-scoring sample, on the other hand, would have low diversity and either low abundances or potentially very high abundances of disturbance-tolerant taxa such as the polychaete worm *Capitella* spp.

To learn more about the marine invertebrate fauna of the UK, the *Handbook of the Marine Fauna of North-West Europe* (Hayward and Ryland 2017) is a useful introductory guide including dichotomous identification keys. Additionally, the Marine Life Information Network (MarLIN) website (www.marlin.ac.uk/species) gives a good basic introduction to some common species. For details on marine habitats, see the Marine Habitat Classification for Britain and Ireland by the Joint Nature Conservation Committee (<https://mhc.jncc.gov.uk/>).



Figure 3. *Patella pellucida*. Photo credit: Thomson Environmental Consultants.

experts are scarce. Working in a benthic lab, I continuously see how hard it is to find experienced taxonomists. Taxonomy is only touched upon in UK universities so training graduates is time-consuming; often the starting point is teaching them to tell apart complete specimens from fragments. It takes years for analysts to become proficient at species-level identification for all groups and taxonomists are crying out for new talent to join the field.

The taxonomic impediment is limiting advances in biodiversity knowledge and the situation seems set to continue for decades to come, with dedicated experts working even in retirement to keep the science alive. So new talent input into the field is sorely needed, but can new technology also help address these issues?

New technologies

Despite continuous advances in taxonomic research describing new species and their relationship to their environment, traditional macrobenthic analysis will always be labour-intensive. Research is being conducted into other methods, which could speed up the process and enhance the knowledge gained from traditional assessment.

Analysis of environmental DNA has revolutionised detection of targeted species in the freshwater environment, such as great crested newt (*Triturus cristatus*), and is now an accepted

method in freshwater systems. There has been a boom in research applying DNA-based methods in the marine environment, mostly multi-species metabarcoding studies that yield data on the diversity in a sample.

Another new technology in species identification is artificial intelligence (AI) image recognition. Although little research has been done into its application to marine macroinvertebrate assessment, there have been promising results in other invertebrate groups. AI could speed up the process of identification and reduce the amount of input required from experienced taxonomists.

Does the future of benthic assessment lie in DNA analysis?

DNA metabarcoding, where short sequences of DNA are used as barcodes to distinguish different taxa and reference libraries used to provide an identification, has been shown to have potential for monitoring of the marine environment. For example, analysis of samples taken in the North and Barents Seas around oil production installations and reference sites showed diversity was strongly correlated with pollution gradients (Lanzén *et al.* 2021). Advantages of DNA metabarcoding include the speed of analysis and detection of species not picked up via traditional methods, for example cryptic species that may be overlooked in visual analysis or morphologically similar

species that can be confused with close congeners. DNA-based identification could also assist in identification of juvenile life stages.

The need for multi-species metabarcoding in the marine environment, along with the more complex environment itself, means that application of DNA techniques to benthic assessment faces numerous challenges. Studies comparing DNA metabarcoding to traditional morphological identification show that congruence between the two is low (Willassen *et al.* 2022). This is the case even when entire bulk samples are analysed by both methods, which I have seen in comparative studies conducted between my lab and DNA labs.

The main reason for this low congruence is missing reference sequences in DNA databases, but technical issues may also prevent identification via DNA metabarcoding, even when species are present in search databases. Care must be taken not to artificially increase apparent benthic diversity by including species that are not the target of benthic macrofaunal assessments. Benthic sediments accumulate DNA from many other sources and can preserve it in the long term, making it challenging to determine whether DNA belongs to an individual living in the study area or even if that individual was alive at the time of sampling. While there can be advantages for certain applications to have an overview of the total biodiversity of an entire region or ecosystem, it is a limitation for benthic monitoring that targets a smaller study area.

Another limitation of DNA metabarcoding is the lack of information it generates on abundance and biomass, the latter being particularly important for assessing the health of habitats. Existing biotic indices need to be benchmarked, or new ones developed for use with DNA metabarcoding data.

DNA metabarcoding cannot simply replace taxonomy, even if the current issues were resolved, because it is not reliable without taxonomic expertise. DNA databases require authoritatively identified specimens. The reliability of such databases is currently suspect, as often the identifiers and identification resources used are not named.

Additionally, any 'new species' discovered through DNA barcoding must be formally described, which again requires taxonomic expertise. Otherwise, the taxonomic impediment is just compounded.

To negate some of these issues, taxonomy-free DNA approaches have been proposed using unidentified 'Operational Taxonomic Units' instead of naming species (Willassen *et al.* 2022) or using meiofauna or microbes as bioindicators. Using these for biodiversity assessments is currently hampered by a lack of knowledge of their ecology, functional roles and tolerances to impacts.

Clearly, there are many options for future application of DNA techniques to monitoring. Monitoring requires data comparability over time, so must be based on standardised methodologies. Given the huge variability between results of different studies, the lack of standards, best practice guidelines and quality control protocols, the field would certainly benefit from a focused approach to resolving the factors preventing DNA methods from being applied reliably.

Artificial intelligence and invertebrate identification

Invertebrate identification using AI involves machine learning to train neural networks to identify specimens

based on photographs. For example, researchers have developed an AI program that can identify six species of foraminifera, tiny marine protists, from photographs taken under a microscope (Mitra *et al.* 2019). Årje *et al.* (2020) created an identification machine for terrestrial arthropods that can also record abundance and estimate biomass. Using robotics, the machine will be improved to extract insects from bulk samples and move specimens to the imaging device, then sort them by flushing into different containers.

Robotic extraction of fauna from marine samples could semi-automate the process. However, extraction is a complex task, so a human would need to ensure no taxa are missed. As well as the huge variety in size presenting a challenge, cryptic species living in tubes or hidden in dead shells would mean manual extraction is required. However, initial extraction of the more obvious specimens could save a significant amount of time.

The major constraint for implementing AI identification with marine samples is the variety of fauna they contain. Machine learning requires suitable training, validation and testing datasets that are correctly labelled, with multiple examples of each taxon. Creating these for all marine benthic phyla would be a huge undertaking.



Figure 4. A *Spirobranchus lamarcki*. Photo credit: Thomson Environmental Consultants.

“DNA and AI are exciting topics but should not detract from the taxonomic issues that they don't address.”

Additionally, the variety of positions and conditions of animals would challenge AI programs. Although identification into groups would be relatively easy, species-level identification would likely not be possible for taxa requiring dissection or manipulation to see distinguishing characters. However, any form of pre-identification by a machine is likely to speed up the identification process for the taxonomist. As with widely available image recognition for plant species, AI programs give a few options of what the identification could be. Therefore, expert input would be required to validate results and manually inspect specimens identified with low confidence.

AI would be easier to apply to marine invertebrates as a time- and cost-saving measure than DNA techniques. The benefits are that the AI program will keep learning, and the expertise won't be lost when experienced personnel leave the field. Given the constraints and effort required to apply AI identification to all marine invertebrates, it would be sensible to focus on one group initially. Even if only family- or genus-level identification becomes reliable by AI, this could be a valuable training tool for new taxonomists, further reducing time input from senior staff.



Figure 5. *Sternaspis scutata*. Photo credit: Thomson Environmental Consultants.

Conclusion

With the newly agreed United Nations High Seas Treaty and the agreement to designate 30% of the world's oceans as protected by 2030, protection of the marine environment will be a high priority globally for a long time.

Although international agreements are promising, demands on the marine environment will continue to increase, such as renewable energy and food production for the growing global population. This combination means that there will be a continued and increased need for marine environmental assessments.

The traditional methods of marine environmental assessment are well established and accepted. We are a long way from being able to say the same for any other method. Ultimately, reliable species-level identification is the goal to understand ecology, infer environmental quality, monitor rare species and detect invasive species. As taxonomic composition is such an essential element of ecology, taxonomy will always be at the heart of marine environmental assessment.

Both DNA techniques and AI show great promise in complementing traditional methods. It is easy to envisage a time where more DNA than traditional samples will be collected, and AI speeds up the analysis of traditional samples. However, DNA- and AI-based results will likely always need ground truthing, at the very least, with traditional analysis. In parallel with developing these methods we need to advance taxonomy and increase the number of trained taxonomists. The limitations of the proposed new methods must be resolved before they are applied, even as complementary methods.

DNA and AI are exciting topics but should not detract from the taxonomic issues that they don't address. Furthering either technique to the point of widespread usage requires us first to increase our efforts in taxonomy; the rate at which new species are being discovered shows how much more there is to learn and the multiple issues of the taxonomic impediment are far from being solved. A 'unitary taxonomy', proposed by Godfray (2002), in which each group of taxa has a definitive revision on the internet as a single source

for the most up-to-date taxonomy, is still far from a reality. Achieving this and uniting 'old-fashioned' taxonomy with new technologies has the potential to dramatically advance each discipline and significantly increase our understanding, helping our efforts to protect biodiversity.

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About the Author

Daisy Chamberlain is a marine biologist and benthic taxonomist. She is a graduate of the University of Southampton and Head of Marine at Thomson Environmental Consultants. She is responsible for managing the benthic lab, and marine survey and consultancy services.

Contact Daisy at:

daisy.chamberlain@thomsonec.com

Increasing Baseline Knowledge of Invertebrates to Inform Effective Conservation and Management in UK Overseas Territories



Louise Soanes
Environment Systems Ltd



Farah Mukhida
Anguilla National Trust



Adam Sharp
Ascension Island
Government
Conservation and
Fisheries Directorate

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The UK Overseas Territories (UKOTs) are rich in biodiversity and unique habitats, and are home to a huge number of threatened and endangered species of which a significant number are endemic. Invertebrates form an important component of this wildlife. In recent years a significant amount of work has taken place in the UKOTs to increase understanding of the local biodiversity and to implement evidence-based conservation initiatives using this knowledge.

Comprehensive baseline data on species abundance, distribution and ecology and the identification of threats are essential to better manage populations and the habitats that they depend on. As in the UK, invertebrates are one of the most under-documented groups in the UKOTs. However, things are changing. Here we present two case studies from Anguilla and Ascension where local agencies have recently embarked on inspiring invertebrate-recovery projects that aim to increase baseline knowledge, identify threats and inform conservation action.

Introduction

Small islands hold a disproportionately large amount of the world's threatened biodiversity. Islands in particular hold many range-restricted species and have high levels of endemism compared to mainland areas (Kier *et al.* 2009). This is the case for the UK Overseas Territories (UKOTs), which are home to at least 1500 endemic species, compared to around 90 endemic species in the UK, amounting to 94% of known endemic British species (Churchyard *et al.* 2014).

Despite the high value of biodiversity in the UKOTs, our knowledge of species presence, distribution and status is, with a few exceptions, relatively poor and highly variable between taxa and islands. In general, this knowledge is far better for vertebrates and vascular plants than for small-bodied invertebrates and lower vascular plants. This is a pattern common elsewhere including mainland UK, for which good knowledge on status is available for 58% of vertebrates but just 4% of invertebrates (Hayhow

et al. 2019). In a comprehensive analysis, Churchyard *et al.* (2016) estimated that there are approximately 50,000 unrecorded species in the UKOTs. Around 2100 of these are undiscovered endemic species, and are predominantly invertebrates and non-vascular plants. But in our changing world species are becoming extinct and habitats are being lost at an unprecedented rate. This is likely to be further exacerbated by the effects of climate change. Without adequate knowledge of the number of species present or their status, particularly for island endemics, conservation actions cannot be taken to ensure their survival.

Here we describe two new innovative projects taking place in two geographically distinct UKOTs that focus on increasing understanding and conserving island invertebrates.

Case study: Anguilla

Background

As a small (91 km²) low-lying tropical island located in the Caribbean's Lesser Antilles, Anguilla (Figure 1) is particularly vulnerable to environmental stressors. Climate change is expected to bring more extreme weather events, including longer, more severe droughts and increased intensity of storms. Combined with concerted efforts to increase food security and the ongoing conversion of land for development, wild spaces in Anguilla are increasingly becoming fragmented. A heavy reliance on tourism, which often involves clearing large tracts of land and substituting native vegetation with less resilient, non-native ornamentals, is also impacting native species. Local agencies have become increasingly concerned about the status of the island's important and unique habitats and biodiversity. Having recognised data gaps in local biological knowledge combined with a growing concern about the global decline in pollinating species, particularly with regard to the potential impacts on local food security and ecosystem balance, a new project was instigated. In 2021 the Anguilla National Trust, in partnership with the Government of Anguilla's Department of Natural Resources Agricultural Unit, and Gender Affairs Anguilla, embarked on a novel project to build the resilience of Anguilla's pollinator species. The



Figure 1. The UK Overseas Territories, with Anguilla and Ascension highlighted.

project, A B-line to re-wilding: Anguilla's pollinator project, funded by the UK's Darwin Plus scheme and European Union's BEST 2.0, has adopted a 'joined up' approach to restore and conserve Anguilla's pollinators and degraded habitats through the following activities.

Baseline data collection

Recognising that there is limited knowledge and local capacity to conduct invertebrate surveys on Anguilla, we sought assistance from our neighbouring islands. During a 3 day visit to Anguilla in November 2021, regional experts from the islands of Saint Barthelemy and Guadeloupe were recruited to assist and train local staff in the methods of conducting rapid invertebrate surveys. During these baseline assessments, 86 previously unidentified species, including one potentially new bee species, were discovered in Anguilla. This rapid survey

increased Anguilla's invertebrate species count significantly, based on the previous invertebrate list of 36 species. Training was provided to local staff to continue to collect invertebrate data, and new methods for invertebrate data collection are being explored including moth light traps and acoustic monitoring.

Also recognising that the local agencies cannot build baseline knowledge of Anguilla's invertebrates alone, citizen science has been encouraged through the creation of an iNaturalist platform. To date, 64 members of the public have submitted 832 sightings on the Anguilla Pollinator Project page which is enabling the Anguilla National Trust to map distributions and understand the habitats and plant species that are important for pollinators in Anguilla (see www.inaturalist.org/projects/anguilla-pollinator-project; see also Figure 2).



Figure 2. Encouraging citizen science and increasing public understanding on the importance of Anguilla's invertebrates are key components of the project. Photo is of two of the Anguilla National Trust's environmental club members holding a frangipani worm, the caterpillar of *Tetrio sphinx*. Photo credit: Farah Mukhida.



Figure 3. A rewilding family activity held in Anguilla: the creation of bug hotels. Photo credit: Farah Mukhida.

Using data to inform policy and conservation

Using the baseline data collected and drawing on international best practice for conserving pollinators (e.g. the UK's National Pollinator Strategy 2016), a National Pollinator Strategy and a Pesticide Policy have been developed through stakeholder workshops attended by farmers, government agencies, the Anguilla National Trust, hotels, garden centres and local beekeepers (Figure 3). These important documents highlight urgent actions that need to be undertaken to support the recovery of Anguilla's pollinating species, including further research and data collection, rewilding initiatives and tighter controls on pesticide importation and use.

A key component of the National Pollinator Strategy is the expansion of natural habitats through ambitious rewilding targets including the creation and/or restoration of at least 162 ha of B-line (bugs, birds and bat) habitat pathways. Targeting individual households and the major hotels on the island as well as community spaces and government-owned land, native species such as the threatened lignum vitae (*Guaiacum officinale*) and buttonwood (*Conocarpus erectus*) are being grown in a project-specific nursery for distribution to hotels, households and communities.

Case study: Ascension

Background

Ascension is a land of extremes: sunbaked lava flows lead between rolling

volcanic scoria cones up to a mountain peak draped in lush vegetation (Figure 4). The 88 km² island is a relative dot in the centre of the vast Atlantic Ocean and is just 1 million years old. Such a young and isolated landmass lends itself to early successional native ecosystems and unique invertebrate species, as well as ecological vulnerability. Despite its comparative youth, numerous endemic invertebrates have evolved on the island. Those species represent incredible extremes in much the same way as Ascension's landscapes do. In terms of endemic invertebrate life, perhaps the most well-known species is the Critically Endangered *Garypus titanius*: the world's largest pseudoscorpion.

While only a handful of Ascension-endemic invertebrates have so far been



Figure 4. The interior of Ascension Island photographed from a coastal lava flow. The central 'Green Mountain' is surrounded by red-brown scoria cones. Photo credit: Adam Sharp.

assessed for the IUCN Red List, it is likely that the majority of the remainder will be classified in the same way as *G. titanius*. This is predominantly due to the myriad of invasive species that are now widely distributed across the island. Discovered in 1501, Ascension has been subject to centuries of planned and unplanned species introductions. Large expanses of the island are inundated with big-headed ants (*Pheidole megacephala*), black rats (*Rattus rattus*) and Mexican thorn trees (*Prosopis juliflora*). In fact, the seemingly entirely introduced beetle community of Ascension led Victorian naturalist Thomas Wallaston (1861) to despair of ‘the utter sterility of this miserable spot’.

Fortunately, more recent surveys unveiled a fascinating diversity of tiny or otherwise elusive endemic invertebrates that persist on Ascension. Island-scale surveys by Duffey (1964) and Ashmole and Ashmole (1997) were instrumental in describing many of the 30-odd endemic species known today. Following on from this work and recognising the need to better understand Ascension’s unique insect biodiversity, in 2021 the Ascension Island Government Conservation and Fisheries Directorate (AIGCFD) and the Species Recovery Trust embarked on a new project funded by Darwin Plus, with the aim of progressing the understanding and kickstarting long-term conservation of Ascension’s endemic invertebrates while addressing the management of non-native species.

Baseline data collection

General survey work began in January 2022, using strictly standardised methods to create an inventory of invertebrate species. Three separate sampling sites were allocated in square grid cells of 1 km² to represent diverse habitats and geologies across the entire island. Incredibly, over 50,000 invertebrates were recorded from these sites, from which the island distributions of all major non-native species could be determined.

Any new records of introduced species were confirmed for the island by taxonomic specialists at the Natural History Museum, London, and Fera Science, among other institutions. However, the sampling failed to detect many of the known endemic species and

it was clear that different strategies were necessary to assess the distributions of those highly-specialised taxa. Fine-scale surveying of Ascension’s most natural habitats followed; targeted sampling methods were employed on sites selected by means of on-island knowledge, known habitats of species closely related to those of interest and geological maps.

One endemic species which was detected only via such targeted sampling was the fungus moth *Erechthias grayi* (Figure 5). This species is the opposite in extremes from the mentioned pseudoscorpion – mature individuals are just 2 mm in length. The moth, notable for its significantly reduced wings and enigmatic hopping behavior, had previously been recorded from just two inland localities at middle to high elevation. Targeted sampling at sites of physical and ecological similarity to those localities unveiled multiple new areas of occurrence. While it was encouraging to discover that *E. grayi* had a greater distribution than was formerly evident, the sizes of its individual occupied habitat patches were cause for concern. Each of the three most significant patches were just 30 m or less at their widest and surrounded by thick invasive vegetation.

“Defining clear distributions of endemic species through intensive sampling is currently leading to the identification of occupied areas for protected area establishment.”

On top of this, all patches were abundant with non-native jumping spiders that were likely inflicting significant predation pressure.

Separate fine-scale sampling targeted the volcanic coastlines of Ascension. Two sites where mafic flows connect with the sea had earlier been highlighted as important habitat for the endemic *Discophallus* genus of scaly crickets (Figure 6). Past evidence suggested that these crickets were present only at sparse locations. However, sampling using strongly baited traps inferred that the cryptic *Discophallus* inhabited much of the barren igneous shoreline. Again, intensive surveying had revealed that a rare endemic was more widespread than once believed. It was also found that *Discophallus* avoided sites with encroaching invasive species, and therefore cricket occupancy was becoming severely reduced.



Figure 5. The 2 mm Ascension-endemic fungus moth (*Erechthias grayi*), resting on fine, branching lichen. Photo credit: Adam Sharp.



Figure 6. *Discophallus* cricket, probably *D. myrtaeae*, foraging on basaltic rocks at night. Photo credit: Adam Sharp.

Using data to inform policy and conservation

Intensive study undertaken as part of this project has now begun to highlight the huge extent to which Ascension is impacted by invasive species, and has greatly expanded existing knowledge on the island's unique native invertebrate diversity. Defining clear distributions of endemic species through intensive sampling is currently leading to the identification of occupied areas for protected area establishment. New protected areas will be accompanied by new management plans, which will outline long-term informed control of those invasive species ranked most threatening to endemic invertebrates. This will likely include removal of Mexican thorn trees and invasive ants. Trials on the removal of ants from key sites of conservation importance, focusing on the widespread big-headed ant and newly introduced pharaoh ant (*Monomorium pharaonis*) in particular, will commence in mid-2023.

Conclusion

The two case studies given here represent just two examples of the important research and management of invertebrate species that is occurring in the UKOTs. Both projects have benefited from the sharing of knowledge (internationally and regionally) and local capacity-building and as a result are

making a significant impact in increasing global understanding of island invertebrate populations and actively implementing management actions to halt declines.

About the Authors

Louise Soanes PhD has lived and worked in the Caribbean for the past 10 years working on a range of biodiversity-focused projects with the Anguilla National Trust, including the Darwin Plus-funded A B-line to re-wilding: Anguilla's pollinator project. Currently employed by Environment Systems Ltd, Louise now focuses on the use of nature-based solutions to mitigate threats to the environment.

Contact Louise at: louise.soanes@envsys.co.uk

Farah Mukhida MSc is Executive Director of the Anguilla National Trust and project lead on Anguilla's Pollinator project. Over the past 20 years Farah has managed countless conservation-focused projects in Anguilla including work on endangered species recovery, developing marine, terrestrial and endangered species management plans, invasive species eradications and biosecurity monitoring, marine and terrestrial habitat restoration and environmental education and outreach.

Adam Sharp is the AIGCFD Invertebrate Project Coordinator and is currently running all invertebrate projects on Ascension Island. He is a conservation scientist with interests in invertebrate species conservation, spatial ecology and biodiversity partitioning. Beyond tiny moths and scaly crickets, Adam is currently researching the biogeography of invasive ants, Red Listing endemic invertebrates and strengthening Ascension's invertebrate biosecurity.

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Bumblebees on the Mynd: Counting Bilberry Bumblebees



Male forest cuckoo bumblebee (*Bombus sylvestris*) at Fineshade Woods, Northamptonshire, May 2022. Photo credit: Jen Jones.



Jen Jones
JBA Consulting

Keywords: citizen science, conservation, heathland, monitoring, surveys

“ If management is inappropriate this can easily have knock-on detrimental effects on future bilberry bumblebee generations. ”

The Bumblebees on the Mynd project monitors the distribution of bilberry bumblebee (*Bombus monticola*) in habitats of the Stepping Stones National Trust project. The national distribution of the bilberry bumblebee has declined markedly; it was historically present throughout western and northern Britain. Distribution reduction due to the boreo-alpine ecology of this species has now resulted in it only being present across the UK in local hotspots such as the Long Mynd, part of the Shropshire Hills Area of Outstanding Natural Beauty. The Long Mynd is an example of an ideal habitat for this species if managed appropriately. This article provides an overview of bilberry bumblebee habitat and foraging requirements. A novel standardised monitoring method is proposed, and conservation focuses are suggested for the species and its associated habitat.

Introduction

Bilberry bumblebees

Populations of bilberry bumblebee (*Bombus monticola*; Figure 1) are declining due to the commonly stated reasons affecting all species: habitat loss, climate change and land use change. Specifically, for the bilberry bumblebee, land use change is due to agricultural improvement of grasslands adjacent to moorland (Rasmont *et al.* 2014, Jones 2021). Historically bilberry bumblebees were found widely in the north and west UK but now only remain in localised hotspots (Figure 2), including the Long Mynd (Shropshire; Figure 3), Stiperstones (Shropshire), Peak District



Figure 1. Bilberry bumblebee (*Bombus monticola*) nectaring on bilberry (*Vaccinium myrtillus*) flower on the Long Mynd, Shropshire, August 2022. Photo credit: Jen Jones.

(Derbyshire), north Wales and the Cairngorms (Aberdeenshire, Inverness-shire and Banffshire) (Yalden 1984).

Bilberry bumblebees are strongly associated with upland (≥ 300 m above sea level) dry heath moorland with a mosaic of heather (*Calluna vulgaris*), bilberry (*Vaccinium myrtillus*; Figure 1) and flower-rich grasslands, apparently nesting exclusively on moorland or close to moorland edge habitats and with dense vegetation cover (Benton 2006, Cheeseborough 2009, Edwards 2012, Evans and Potts 2013).

The forest cuckoo bumblebee (*Bombus sylvestris*) is the species of parasitic bee that uses bilberry bumblebee nests as a host (Bumblebee Conservation Trust n.d.). It is relatively common and is present in the same areas that bilberry bumblebees are found. Unlike bilberry bumblebees, this species has dark wing pigmentation, one yellow thoracic band, one yellow abdominal band and a white tail, with an orange or black tip (males and females respectively).

Upland heaths are often floristically poor in relation to nectar and pollen

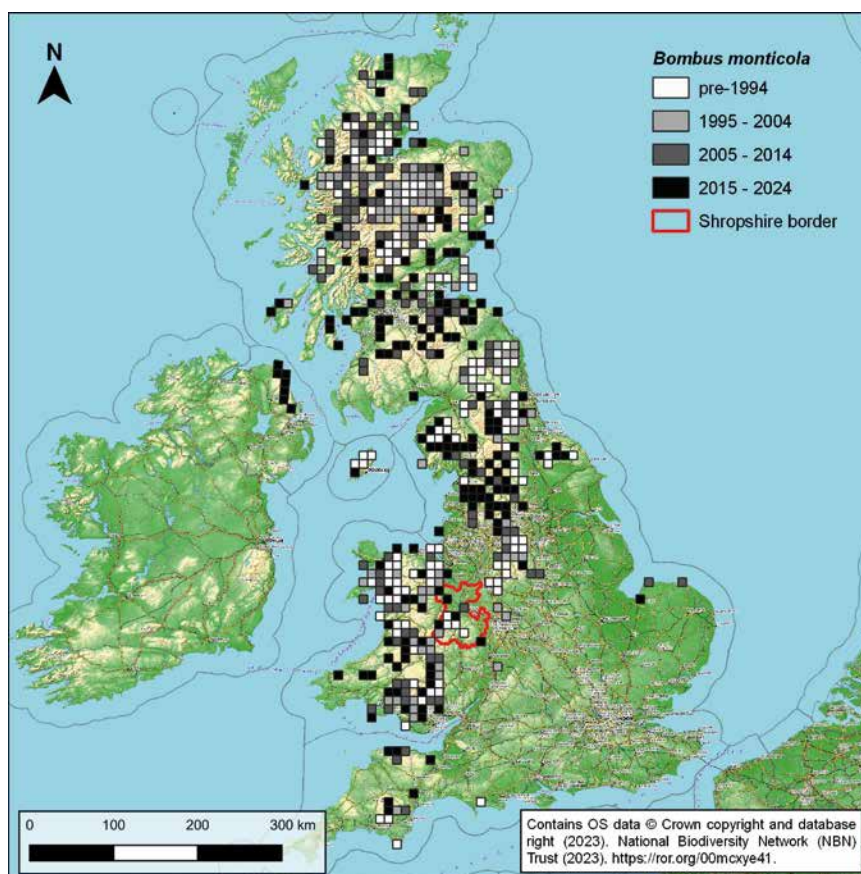


Figure 2. Bilberry bumblebee distribution data from NBN Atlas (10 km squares; April 2023) with topology data.

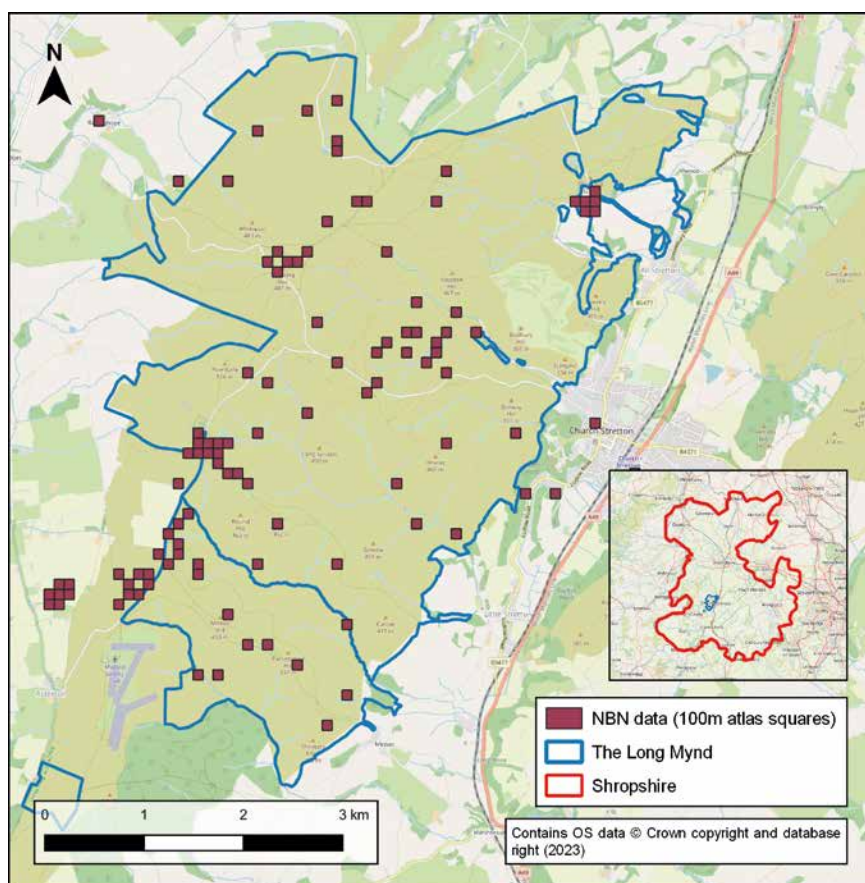


Figure 3. Bilberry bumblebee distribution data from NBN Atlas (100 m) for the Long Mynd (April 2023).

plants for pollinators. This is especially true in mid summer in the 'hungry gap' between bilberry (April–July) and heather (September–early November) flowering periods.

To combat this lack of forage, Jinlye Meadows (immediately north east of the Long Mynd) was acquired by the National Trust in 2014. The meadow is being managed to be a traditional hay meadow with late July cuts, sheep grazing and planting wildflowers including yellow rattle (*Rhinanthus minor*; Worker Drones UK 2020).

National Trust project

The Long Mynd is an example of an ideal habitat for bilberry bumblebees. The aims of this project were primarily to monitor their distribution to produce a baseline distribution map over 33 km², to raise awareness of bumblebees and to establish foraging and habitat preferences, including whether gardens and Jinlye Meadows were used in the hungry gap. Due to the findings, a novel standardised monitoring method has been proposed as bilberry bumblebees differ behaviourally from other

bumblebees when foraging. These differences make standard BeeWalk methods (Comont and Miles 2019) impossible in heathland habitats (Box 1).

Challenges of heathland monitoring

The Long Mynd and Jinlye Meadows were both surveyed. The dry heath habitat of the Long Mynd, which was included in the surveys, was subdivided into 33 km squares of varying priority level. This depended on dominant habitat type, and presence of bilberry and historic bilberry bumblebee records.

Whereas a BeeWalk (Box 1) is ideal for collecting bumblebee data in a varied landscape, bilberry bumblebees have very specific habitat (upland heathland, wildflower meadow and wet flush). Their preferred nectar plant, the bilberry, has dense foliage which obscures the pendular flowers hanging down inside the plant, making the bilberry bumblebee difficult to observe. Therefore, as fixed transects are more difficult to follow in well-developed heathlands, a different approach was developed. Transects were designed around each survey square, following

sheep paths or banks to keep these repeatable across the season. However, if conditions were particularly dry, wetter areas of habitat were focused on.

Other considerations included ensuring that ground-nesting birds and their breeding habitats were left undisturbed, hence the use of pre-existing sheep paths unlikely to be hosting bird nests. Biosecurity was also an issue as the bilberry-attacking fungus *Phytophthora* is present at the Long Mynd. Therefore, it was essential that volunteers disinfected their footwear before and after starting surveys and when moving between survey areas.

In 2020 there were challenges in recruiting and training volunteers due to COVID-19 restrictions; therefore transects were carried out whenever possible following appropriate regulations. Despite this, there were six regular volunteer surveyors working on the project.

Box 1. BeeWalk method

BeeWalk (Comont and Miles 2019) is a citizen science project from the Bumblebee Conservation Trust. BeeWalkers follow the same transect and record abundance within an area, or recording box, to standardise between habitats and observers. The results of the BeeWalk contribute to long-term bumblebee distribution and abundance trends which can help towards conservation measures and public awareness of bumblebees.

Transects are 1–2 km long including some flower-rich habitat. They are walked monthly between March and October (main flight period) when there is minimal rain and wind (between 11 am and 5 pm). Abundance of each species and caste are recorded on each transect section within the recording box (4x4x2 m). Flowers visited by bumblebees are also identified if volunteers are confident in botanical identifications. The recording box standardises recordings between structurally diverse habitats. However, BeeWalk monitoring is not suitable for heathlands as transects are difficult to standardise in mosaic habitats.

Methods for bee surveying on the Long Mynd

As with BeeWalk (Box 1), environmental and other conditions were recorded (weather and location data, date and time) along with habitat type. The bilberry bumblebee standardised monitoring method is detailed below.

1. Listen for the '*Bombus* buzz' which should sound relatively high-pitched due to the species' relatively small size.
2. Look for the bee and video or photograph it on the flower species it used (if trained, volunteers netted the bees for verification too).
3. Record the Ordnance Survey location of the bee; remain for 5 minutes in the same area and record all other individuals present (species, caste and abundance).
4. Move 25 paces after recording the bee before starting observations again to avoid re-recording the same bumblebees (see recording form, Figure 4).

Results

Bilberry bumblebees were observed between 26 May and 1 August 2020 by six volunteers. The average temperature was 17°C and 64% of the records were on a sunny day, reflecting unusually good conditions for field surveying. This may be why there was an unusually high number (74) of individual bilberry bumblebees recorded. The reduced human activity due to COVID-19 restrictions may also have been at play, allowing the bilberry bumblebees to be undisturbed.

Habitat preferences

The highest proportion of bilberry bumblebees, and inferred habitat preferences, were found to be mostly heathland (50%) and heathland with bracken (*Pteridium aquilinum*; 26.5%) habitat types (Figure 5), as other studies have observed. Acid-neutral flush habitats had 5.9% of the records, likely used during drier conditions, and semi-improved grassland (Jinlye Meadows) had 7.4% of the recorded bilberry bumblebees.

Foraging preferences

The recorded forage preference of bilberry bumblebees was dominated by bilberry, bird's-foot trefoil (*Lotus*

Recorder		Date	
1km ² Grid		Start Time	
Temp (°C)		Finish Time	
Average wind speed (0-6)	0 smoke rises vertically; 1 slight smoke drift; 2 wind felt on face; 3 leaves in slight motion; 4 dust raised and small branches move; 5 small trees in leaf sway; 6 large branches move & trees sway		
Weather conditions	Sunny	Sunny/Cloudy	Cloudy

Species	OS Reference	Caste	Number	Flower

Figure 4. Recording form for bilberry bumblebee surveys.

corniculatus), thistle (*Cirsium* spp.) and white clover (*Trifolium repens*) on the Long Mynd and Jinlye Meadows. This corroborated with other literature sources referenced in this report.

The Long Mynd records suggest bilberry bumblebees primarily used bilberry (97%) compared to thistle or white clover (1.5%) in spring. Later in the season, bilberry bumblebees were also found to use Jinlye Meadows and garden plants between bilberry flowering in spring/early summer and heather flowering in late summer. During this time the dominant forage plant recorded being used was bird's-foot trefoil (90%).

Recommendations

The standardised monitoring method for bilberry bumblebees proposed in this report was appropriate for monitoring this species in dry heath habitat. As this

methodology has been tested and found to be easy to follow for beginners and experienced surveyors, the same method should be used for future bilberry bumblebee surveys.

Recommendations for future monitoring

In future, and for other locations when surveying for bilberry bumblebees, the main focus should remain on dry heath habitats, especially those with large patches of bilberry as an indicator of possible hotspots. As nearly 6% of the records came from acid-neutral flush habitats, wetter habitats should not be discounted, especially during drier conditions. This may have further implications with the progression of climate change as weather becomes more unpredictable and extreme; these areas could act as a refuge during drier conditions or drought seasons.

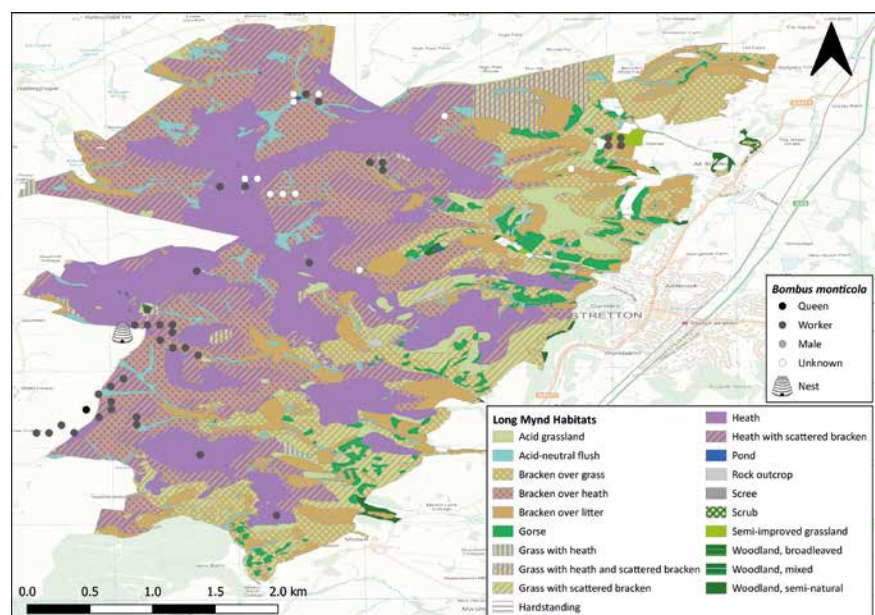


Figure 5. Habitats and locations of bilberry bumblebee records from the 2020 season.

Bilberry bumblebees can also be seen as generalist foragers with clear preferences which differ depending on activity period, location and flower availability (Edwards 2012). Therefore, forage plants used by bilberry bumblebees should be a future priority to record as this could inform management of hay meadows and other habitats on the Long Mynd, in the Shropshire Hills Area of Outstanding Natural Beauty and in the wider UK for bilberry bumblebees, for example, using a Species Recovery or Management Plan. Particular attention should be paid to the reflowering of bilberry in the summer as this appeared to be very important to the bilberry bumblebees and may be why so many individuals were recorded.

The flower-rich Jinlye Meadows were only used during the hungry gap; however, it is likely that other meadow plants will support bilberry bumblebees but as the survey was only a snapshot of what was being used, other species were not observed. Therefore, habitats like Jinlye Meadows (semi-improved grassland or hay meadows) should be a priority to survey for foraging workers in late summer.

It may also be useful to survey for the cuckoo of bilberry bumblebees (the forest cuckoo bumblebee) as a potential presence indicator of bilberry bumblebees. This species is distinctive and may be easier to identify in flight. It is also present in the same habitats as bilberry bumblebees. However, it is more common than the bilberry bumblebee so, if surveyed for, the results should be analysed with caution, and it cannot be assumed that bilberry bumblebees are present everywhere the forest cuckoo bumblebee is observed as it does not require the high altitudes and habitat mosaic that the bilberry bumblebee does.

Recommendations for habitat management

The recording of forage plants used by bilberry bumblebees could inform habitat management for a Species Recovery Plan. For example, a baseline assessment of plant and pollinator health may inform suggestions for the most beneficial species to plant (early pollen sources for queens, and later nectar sources for when floristic diversity

is lower on the dry heath), when to graze/cut hay meadows or how to maximise bilberry flowering quantity and quality. Suggestions for garden plants to encourage bilberry bumblebees and other pollinators could be included for volunteers or local community wildlife groups and landowners.

As well as this, heath management like cutting, burning and sheep grazing may stimulate bilberry growth and flowering, although overgrazing can significantly reduce flowering. If management is inappropriate this can easily have knock-on detrimental effects on future bilberry bumblebee generations. Bilberry plants reflower later in summer in some years which is extremely important for bilberry bumblebees; it is possible that sheep grazing may initiate or stimulate this. A future project worth investigation could study the effects of grazing bilberry plants on bilberry bumblebee foraging and survival. Bumblebees have been observed damaging and inducing early flowering in mustard plants (Pashalidou *et al.* 2020). In that study damage intensity varied with local flower availability so may be a survival technique used by bumblebee species. It is possible that the Long Mynd bilberry bumblebees took advantage of this in 2020 to induce more nectar and pollen resources.

Conclusions

This project was a huge success despite the difficulties of COVID-19 restrictions. The 2020 field season may have been the best survey effort possible despite fewer volunteers being available. In the first year of this project, this increase in time available for surveys enabled success, achieving all project aims and recording 74 individual bilberry bumblebees on the Long Mynd dry heath, including one queen, an active nest (with 11 bilberry bumblebees; nests are notoriously difficult to find even in more accessible habitats) and 10 individual bilberry bumblebees on Jinlye Meadows. Future survey inclusions have been suggested and conservation suggestions made that incorporate habitat management for bilberry bumblebees.

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About the Author

Jen Jones BSc, MSc, MemRES is a qualifying member of CIEEM and has been working in ecology and entomology for a number of years. Alongside her consultancy role at JBA Consulting as an Assistant Ecologist, she also has roughly 10 years' entomological and botanical recording experience.

Contact Jen at:

jennifer.jones.ecology@gmail.com

A Brief Guide to Roman Snails in the UK

Figure 1. Adult Roman snail (*Helix pomatia*). © Getty Images.



John Simper
MCIEEM
Tetra Tech

Keywords: exploitation, protected, restricted distribution, Roman snails

“ The species’ main strongholds are in southern England in the Cotswolds, Chilterns, North Downs and Mendip Hills, with a few outlying populations in places such as Cambridgeshire. ”

Roman snails (*Helix pomatia*; also known as the edible snail) are a rare and localised species that are found in scattered locations in England such as the Cotswolds, Chilterns and North Downs. Although not native, its localised distribution and vulnerability to over-collection as food has led to the species being added to Schedule 5 of

the Wildlife and Countryside Act 1981. This article gives a brief overview of the ecology, legal status, survey methods and possible habitat enhancement measures for this fascinating species.

Introduction

The Roman snail (*Helix pomatia*), also known as the edible snail, is a large species that is restricted to localised areas in the south of England. Here I set

out an overview of the ecology and legal status of this often underappreciated species, along with considerations for survey and mitigation design.

As indicated by the name, the Roman snail is thought to have been introduced by the Romans at some point between AD 43 and 410. The species’ main strongholds are in southern England in the Cotswolds, Chilterns, North Downs and Mendip Hills, with a few outlying populations in places such as Cambridgeshire. There are likely to have been a large number of other introductions of the species

across the UK but many of these are thought to have died out due to unfavourable habitat conditions.

The Roman snail is a highly localised species and, due to its sedentary nature, it is extremely poor at dispersing into other areas of suitable habitat even if this is close by. Collection for food has the potential to wipe out localised populations and because of this it is afforded special protection under the Wildlife and Countryside Act 1981 (Schedule 5). An assessment of the impact to this species is included in any Ecological Impact Assessment so it is important that ecologists are aware of the species and its habitat requirements.

Identification

The Roman snail is impressive, being the largest terrestrial snail found in the UK and one of the largest found in Europe (Figure 1). An adult Roman snail can measure up to 5 cm across the shell, which has a series of brown bands. The shells never have a zigzag pattern unlike the smaller, more abundant garden snail (*Cornu aspersum*). Most individuals have dark shells although some old and young individuals may be rather pale in comparison. The shells of dead specimens quickly lose their dark colouration and become very pale over a period of several months but retain the characteristic banding. The body of a Roman snail is a pallid grey/brown colour and can be up to 10 cm long in the largest specimens.

Habitat

The Roman snail has been recorded in quarries, scrub, open woodland, woodland edges, hedgerows, rough grassland and road verges (an example of woodland edge habitat that supports a colony of Roman snails is shown in Figure 2). Most colonies are found in areas with calcareous soils over chalk or limestone and they seem to be thermophilic, preferring south-facing slopes. The species burrows when hibernating and laying eggs and therefore is much more abundant in places with friable soils, although they appear to avoid very sandy soils. Roman snails prefer good vegetation cover, presumably to keep them safe from predators, and because they require high levels of humidity to survive. They are



Figure 2. Roman snail habitat along a woodland edge. Photo credit: John Simper.

therefore not generally found in open habitats or heavily grazed grassland.

Ecology

Roman snails are active during the warmer months of the year from May to August with peak activity earlier in May/June. The snails then burrow into soil and hibernate from as early as September before emerging the following spring. Unlike most snail species, the Roman snail creates a calcareous epiphragm (Figure 3) to seal in moisture during hibernation or

estivation (torpor). Roman snails may be found in high numbers in small, localised areas and individual snails may never move from an area of only 30 m². Like many snails, the Roman snail is a hermaphrodite and typically lays 40–60 eggs in a burrow in June or July. These eggs hatch after about a month and the young snails disperse. The species is relatively slow growing and does not reach sexual maturity until 2–5 years. Occasionally, individuals can reach 20 years in age but the majority probably seldom reach more than 10 years. The snail eats a wide variety of live and dead



Figure 3. Hibernating Roman snails showing the distinctive calcareous epiphragm. © shutterstock.com.

plant material and feeds using a structure called a radula, which is a chitinous plate or ribbon-like structure containing a row of tiny rasping teeth.

Threats and legal status

Roman snails are, in reality, no more edible than garden snails, but due to their large size are highly regarded by some people as a delicacy. Typically, the species can be found in high densities over small areas, meaning that harvesting them can be relatively straightforward, but also making them extremely vulnerable to over-exploitation. Poaching of Roman snails for either personal or commercial gain has been recorded on several sites in recent years.

As a result of the perceived threat to England's populations of Roman snails, the species was added to Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) in April 2008. This legislation makes it an offence to:

- intentionally kill, injure or take (handle) the species or
- possess a live or dead Roman snail if it was taken from the wild; it is also protected from sale.

The species' legal status means it should be picked up as part of any Ecological Impact Assessment. It is therefore important that ecologists working in areas where the species is potentially present are aware of the ecological needs of the species. It is not, however, an offence to disturb Roman snails or damage/destroy breeding or resting places. The Roman snail is protected in a number of other European countries but is not afforded European Protected Species status.

Surveys for Roman snails

There is no specific methodology for Roman snails but a combination of systematic searching of vegetation/refuges during the day and night-time searching with a torch for active

individuals are widely accepted methods. The surveys should be conducted during warm and damp/humid weather during May–September. Ideally several visits should be made in a season.

A combination of the existence of local records, location (if in a known hotspot for the species) and field signs (empty shells or live animals) noted during other surveys (such as Preliminary Ecological Appraisals) should trigger a need for further surveys to estimate the size and importance of Roman snails at the site/local level. Note that any intentional moving of the species as part of mitigation works must be licensed by Natural England. Licences

“ Roman snails are, in reality, no more edible than garden snails, but due to their large size are highly regarded by some people as a delicacy. ”



Figure 4. Woodland edge ecotone and calcareous grassland. Photo credit: John Simper.

are only issued for conservation purposes (not development) and will only be granted if it can be demonstrated that impacts are unavoidable. A benefit for the conservation of the species would also need to be demonstrated as part of the licence application.

Enhancements

Habitat enhancements that are likely to benefit Roman snails based on their ecological requirements may include:

- the creation of log piles and allowing scrub to partially colonise grasslands
- allowing woodland edge habitat to mature into an ecotone between adjacent, more open habitats (such as in Figure 4)
- management of mowing or grazing regimes to allow grassland to achieve taller, tussocky swards
- importation of soil that is friable and base-rich where this soil type is lacking.

Summary

The Roman snail is a scarce and highly localised species, but being relatively large and distinctive it is easy to identify. The distribution of the species is well understood, partly because Roman snails are not quick to colonise new areas naturally (which also leaves them vulnerable to local impacts). Ecologists working in areas where the species may be present, such as the Cotswolds or the Chilterns, should be mindful of the habitat requirements of the species and its potential presence, both to prevent significant impacts to local populations and to avoid the potential for an offence under the Wildlife and Countryside Act 1981.

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About the Author

John Simper MCIEEM is a senior ecologist at Tetra Tech and although he has a broad interest in ecology, he specialises in ornithology and entomology. He has worked in consultancy for 10 years, prior to which he was a research scientist with the Game and Wildlife Conservation Trust, specialising in farmland wildlife.

Contact John at: John.Simper@tetratech.com

entoLIVE: Making Invertebrate Science Accessible



Keiron Derek Brown
Biological Recording
Company

Keywords: annelids, arachnids, engagement, entomology, insects, invertebrates, marine, molluscs, research

entoLIVE is a new webinar series aiming to break down the barriers to accessing invertebrate research for audiences beyond academia.

“ Science isn’t finished until it’s communicated. The communication to wider audiences is part of the job of being a scientist, and so how you communicate is absolutely vital. ”

Sir Mark Walport, UK Government
Chief Scientific Adviser, 2013

Introduction

entoLIVE is a series of educational webinars (and resulting YouTube videos and blogs) focusing on invertebrate research that was launched in early 2023, with each one-hour webinar featuring a guest speaker presentation and live audience question-and-answer (Q&A) session. It gives invertebrate

researchers a platform to showcase their work and teach a wider audience about their results and conclusions, while also breaking down some of the barriers to accessing and interpreting invertebrate research that may be faced by audiences beyond academia, such as the amateur naturalist community, conservation practitioners and ecologists. It was launched by Keiron Brown through the Biological Recording Company and is funded through a combination of sponsorship, grants and donations.

Taxonomic bias

When compared to vertebrate and plant groups, invertebrates are under-represented in terms of policy, conservation and monitoring (with a few possible exceptions). Reasons for this could include identification difficulty, a lack of data and public interest bias for ‘charismatic’ species.

A 2017 study analysed the number of species occurrence records held on the Global Biodiversity Information Facility, the number of publications on Web of Science (as a proxy for research interest) and the number of web pages from Bing

searches (as a proxy for public interest) to investigate taxonomic biases for 24 taxonomic classes. This study found that invertebrates were under-represented in both the species occurrence and public interest datasets, though not necessarily in terms of research interest. A key recommendation was that scientists should advertise species considered less charismatic, for example by making them the focus of citizen science initiatives (Troudet *et al.* 2017).

FSC BioLinks was a five year project by the Field Studies Council, ending in January 2023, that aimed to address gaps in identification skills and biological records submission for under-recorded taxonomic groups. During the development phase of the project, an online survey of biodiversity-sector professionals and amateur naturalists was conducted that received 326 responses. The survey results clearly identified that respondents believed that invertebrates should be prioritised in the project (with the exception of Lepidoptera and Odonata), and that respondents were generally less skilled in invertebrate (again with the exception of Lepidoptera and Odonata), fungi, bryophyte and lichen identification when compared to vertebrate and vascular plant groups. Interestingly, this illustrated that in the naturalist community there was higher demand for invertebrate identification training than for the vertebrate and higher plant groups (Brown 2017).

Barriers to using scientific outputs

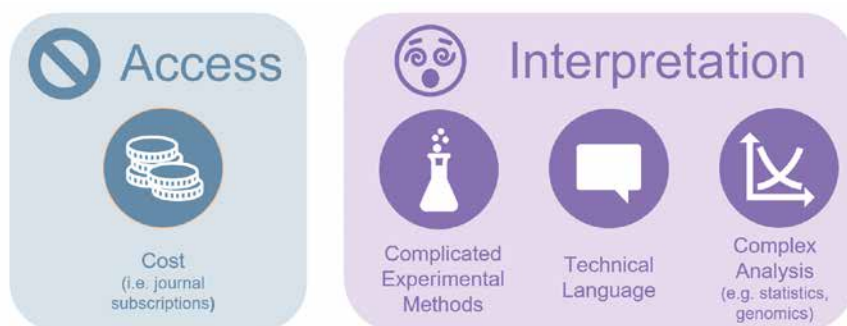


Figure 1. Barrier to using scientific outputs.

Barriers to accessing invertebrate research

To raise the profile of invertebrate research, it is important to first understand what the barriers may be to non-academics accessing research outputs such as journal articles, datasets and scientific or technical reports (Figure 1). Although ecology and conservation practitioners may have degrees in biology, ecology or related disciplines, their current roles may not enable them to access journal subscriptions. Journal subscriptions can be prohibitively expensive if not provided via an employer. Things are getting better, with the Research Excellence Framework encouraging articles to be published as open access or making pre-publication versions of articles available, through such as platforms such as ResearchGate. However, publishing a paper as open access often comes at a cost to the researcher (or their institution) in the form of publishing fees. Furthermore, interpretation of the content in scientific outputs can be difficult for those with no scientific background or limited knowledge of specific methodologies. For example, the technical language, complicated methods and complex analysis involved in genomics can result in research employing DNA analysis being very difficult to understand to some.

Despite these barriers, there are many roles outside of academia that would benefit from being able to access and interpret invertebrate science, such as conservationists, ecological consultants, policy-makers, biological recorders and environmental educators.

entoLIVE

The entoLIVE series consists of interactive webinars that link invertebrate scientists with a wider audience beyond academia. entoLIVE was launched in February of this year with the aim of raising the profile of invertebrate research by breaking down access and interpretation barriers, enabling wider use of research outputs by ecologists and conservationists to undertake evidence-based actions. The entoLIVE webinars are promoted through Eventbrite and are shared through social media and relevant stakeholders, such as the Bumblebee Conservation Trust, Buglife and the Marine Conservation Society.

Each one-hour webinar is delivered over Zoom, with an interactive presentation of around 40 minutes followed by a live Q&A session where the participants can put their questions to the guest speaker. The presentations are recorded and made publicly available alongside a

transcript of the Q&A, literature references and any useful links in the entoLIVE blog (shorturl.at/fjmLN). All webinars are free to attend, delivered by the Biological Recording Company and sponsored by both the Royal Entomological Society and British Entomological and Natural History Society (with discussions underway with a number of other potential sponsors in the ecology sector).

From earthworms to jellyfish to mayflies

The first entoLIVE showcased the National Earthworm Recording Scheme (Figure 2) and the current research utilising the data generated by biological recorders and earthworm researchers, including an upcoming provisional conservation status assessment commissioned by Natural England (Brown 2023).

Jellyfish were the focus of the second webinar, with the Marine Conservation Society reporting on 20 years of citizen science-generated data (Pilsbury and Brown 2023). Following the webinar, the guest speaker reported a spike in both views of the survey webpages and reported sightings.

The third entoLIVE webinar (Figure 3) delved into the impact of climate change on freshwater insects with Buglife. Participants were taken on a journey through previous studies before the recently published and upcoming research of the guest speaker were presented (Macadam and Brown 2023).

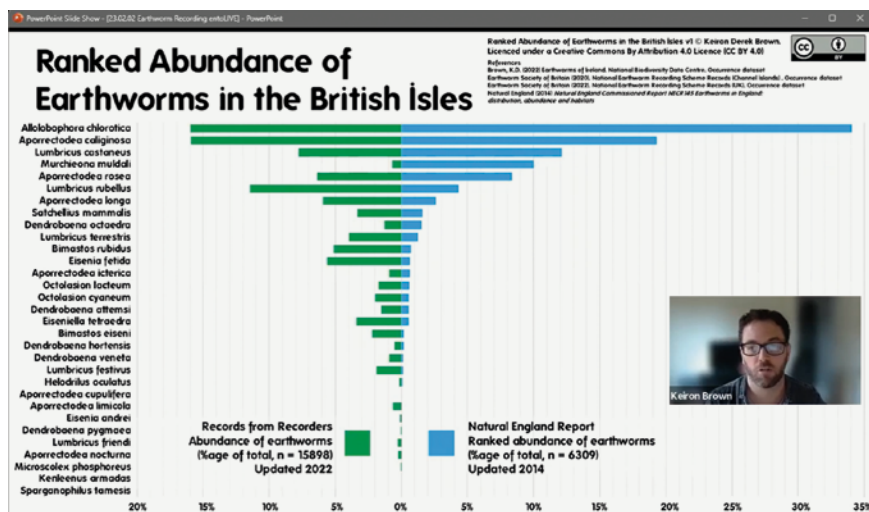
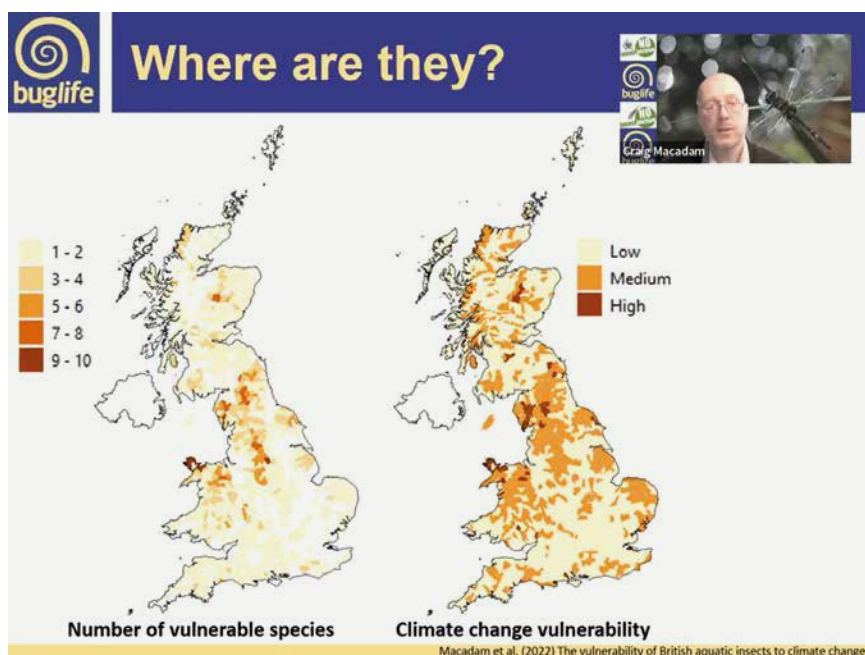


Figure 2. Keiron Derek Brown presenting the differences in recording scheme and research data for earthworms resulting from biases towards surveys of agricultural habitats.



Future topics cover invertebrate subjects across all environments, including:

- terrestrial, e.g. the state of UK butterflies with Butterfly Conservation
- freshwater, e.g. the American signal crayfish with Dr Nicky Green (Figure 4)
- marine, e.g. mass marine die-offs in the North Sea with Newcastle University.

The full programme of free webinars can be found on the Biological Recording Company Eventbrite profile: www.eventbrite.co.uk/o/the-biological-recording-company-35982868173.

Conclusion

With invertebrates traditionally under-represented in both academic research and conservation activities, it is important to showcase invertebrate research outputs to raise the profile of these resources and encourage more research on under-studied groups. The entoLIVE webinars and blogs aim to shine a spotlight on these research outputs and signpost them to a wide range of potential stakeholders, such as amateur naturalists, biological recorders, conservationists and ecologists. Furthermore, the wide range of

organisations represented through the speaker programme and the part-sponsorship funding model employed makes entoLIVE a truly collaborative programme that aims to bring together not just audience and speaker, but a whole sector.

To be considered a success, entoLIVE needs to evidence both high levels of engagement with non-academic audiences (i.e. average attendance of over 200 attendees per webinar) and increased use of invertebrate research outputs (to be established through a guest speaker follow-up survey). If these outputs can be demonstrated and funder interest can be maintained, the webinar series will be extended beyond 2023 and continue showcasing invertebrate research for years to come.

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About the Author

Keiron Derek Brown developed and managed the invertebrate ID and recording training project, FSC BioLinks, before setting up the Biological Recording Company to continue this work. He is also Chair of the Ecology and Entomology Section of the London Natural History Society and is the national recorder for earthworms.

Contact Keiron at:
keironderekbrown@googlemail.com



Figure 4. American signal crayfish: a losing battle? entoLIVE webinar by Dr Nicky Green. Image © David Perez. [co.uk/?s=Ain%E2%80%99t+No+Mountain+High+Enough%3A+Impacts+of+Climate+Change+on+Aquatic+Insects](https://www.britishecologicalsociety.org/applied-ecology-resources/document/20203291194/). Accessed 20 February 2023.

Raising the Profile of Invertebrates in the Planning Process: An Assessment using PANTHEON for Sites Across Southern England and Wales



Jonty Denton
CEcol MCIEEM

Keywords: invertebrates,
PANTHEON, site selection

The PANTHEON analytical program developed by Natural England and the Centre for Ecology and Hydrology provides a much needed comparative approach to assessing site quality based on the conservation status of invertebrate species. I have summarised my results from 114 sites surveyed as part of Environmental Impact Assessments across southern England and Wales sites since 2003. The strengths and weaknesses of the outputs and ways of adapting them to refine criteria for selecting Sites for Nature Conservation Interest and to put invertebrates in the Biodiversity Net Gain process are discussed.

Introduction

A large part of my work as a freelance ecologist for over 30 years has been to provide baseline invertebrate surveys (specialising in nationally reviewed groups which are considered as part of the planning process). I have surveyed hundreds of sites across England and Wales including some of our most important nature reserves, as well as

over 200 sites surveyed as part of Environmental Impact Assessment in relation to impacts arising from development or infrastructure works. That brownfield sites compare well with designated nature areas is clear (see Denton 2013). For over 20 years I surveyed sites and then had to give my professional opinion as to their value. It

was quite a responsibility, especially when trying to balance the requirements of invertebrate species against those of the flora and vertebrate fauna.

Between 2006 and 2010 I undertook many of the baseline surveys that were then used to develop Common Standards Monitoring (as part of the Invertebrate Species-habitats Information System (ISIS) programme) for Site of Special Scientific Interest (SSSI) assessment. These involved sampling multiple compartments across SSSIs with extensive salt marsh, mire and woodland. Other ecologists have worked on virtually all habitats present at SSSIs across England and the work to further refine the dataset on these and other habitats is still ongoing.

This resulted in PANTHEON, an analytical tool co-developed by Natural England and the Centre for Ecology and Hydrology, to assist invertebrate nature conservation in England, but which can be applied to the other home nations. A detailed introduction is provided in Heaver *et al.* (2017). Users import lists of invertebrates into PANTHEON (<https://pantheon.brc.ac.uk/>) and the species are then analysed, after which conservation status and habitat and resource associations are assigned to each.

Most active invertebrate ecologists quickly adopted ISIS, which was later renamed PANTHEON (Webb *et al.* 2018), as the outputs removed much of the subjectivity inherent in interpreting the value of long lists of species.

Interpreting PANTHEON results

How PANTHEON works

Once a species list is entered into PANTHEON the analysis button opens a plethora of options, from individual

species statuses to broad and specific assemblage types and lists of resource associations, such as dung and carrion, plant associations and even synanthropic species (meaning those living in association with humans).

For each list, the qualifying species that are used to define broad and specific assemblage types are pooled and scores generated for each habitat element. The numbers of species required to trigger favourable status varies among the 26 specific assemblage types (SATs).

Helpfully, the Reported condition column from the analysis may also indicate near-misses such as SATs where one or two more qualifying taxa would tip the balance. In practice, for time-constrained surveys if, say, Rich flower resource is a near miss, it is a fair assumption that more targeted sampling in good weather across all summer months might make all the difference. This is because the Rich flower resource species list is dominated by solitary bees which need sunny conditions to make an appearance.

Table 1. Summary of PANTHEON results for sites across southern England and Wales surveyed as part of Environmental Impact Assessments by the author since 2003.

	SSSI	SNCI/LNR	Brownfield	Greenfield	Quarry
Total	22	38	14	26	14
No. of sites with ponds or lakes	5	15	2	0	12
SATs in favourable condition					
F001 Scrub edge	15	21	6	12	5
F002 Rich flower resource	18	12	5	7	9
F003 Scrub-heath and moorland	16	12	2	3	1
F111 Bare sand and chalk	3	5	1	1	2
F112 Open short sward	7	9	6	2	2
A211 Heartwood decay	5	5	2	5	0
A212 Bark and sapwood decay	2	13	4	14	1
A213 Fungal fruiting bodies	3	2	1	5	0
A215 Epiphyte fauna	1	0	0	0	0
W211 Open water on disturbed mineral	1	2	1	0	7
W312 <i>Sphagnum</i> bog	2	1	0	0	0
M311 Salt marsh and transition brackish marsh	1	0	0	0	0
Mean no. of favourable SATs	3	2.2	2.2	1.8	2
Mean no. of species per survey	403	353	341	352	330
Mean no. of Nationally Rare/Red Data Book species	3.8	2.3	2.3	1.2	1.4
Mean no. of Nationally Scarce (NS)/notable B species	29	23	24.7	14.7	18

SAT, specific assemblage type; SNCI/LNR, Site of Nature Conservation Interest/Local Nature Reserve; SSSI, Site of Special Scientific Interest.

Outputs and example data

For comparative purposes in this article I have used the SATs. Table 1 summarises all the sites impacted by development or infrastructure changes for which I have generated PANTHEON scores with species lists over 150 species since 2003. For each site the species lists were analysed and the numbers of SATs in favourable condition recorded. The numbers of Nationally Rare and Scarce species were also pooled and average figures for each category are also shown. The total amounted to 114 sites which I then divided into three categories: existing SSSIs, Sites of Nature Conservation Interest (SNCI)/Local Nature Reserves, and Undesignated (sites without any formal protection). The 54 sites in the latter category were surveyed as part of impact assessment as they were wholly or partially under threat from development and were flagged as having potential (hence the baseline surveys). Most sites were deemed to require a baseline survey, with a few exceptions such as active arable, improved pasture and unvegetated concrete.

Examining specific habitat types

In all, 12 of the 26 SATs were found to be in favourable condition in these samples. Many of those that were not represented are absent in the south, such as upland moorland, or are largely restricted to high-quality wetlands, coastal and riparian habitats.

The Undesignated sites were then subdivided into greenfield (on agricultural land), brownfield (former development railway sidings, airfields) and quarry (stone, sand and clay pits). On average, these supported a similar number of favourable SATs to existing SNCIs.

The most frequently recorded communities in favourable condition were Scrub edge and Bark and sapwood decay. In many cases they were made up of records from hedgerows and associated standard trees, often set among rather dull arable or pasture (see above). Heartwood decay is invariably associated with mature trees, but the lower instance of favourable status for the Fungal fruiting bodies SAT is partly explained by the highly seasonal nature of this resource and the reluctance of survey

commissioners to allow time for autumn and early winter surveys.

Saproxyllic communities can persist among development, especially with adequate buffering. The main threats are from vandalism (setting fire to hollow trees and bark stripping). Scrub edge has considerable overlap with Scrub-heath and moorland, particularly species associated with gorse and broom. Therefore, careful interpretation of the results by an invertebrate specialist is essential. Scrub edge has, on the whole, increased in the post-industrial period, with the massive decline of the rabbit also a contributing factor, especially around abandoned pasture. Such sites, except for those colonised by exotics such as *Buddleja*, invariably develop interesting invertebrate assemblages (not to mention good nesting habitat for birds and cover for amphibians and mammals). Large stands of bramble scrub are often rather depauperate but in the medium term can act as nursery areas for native trees, which grow through and replace them. This is in most cases a much 'wilder' way of creating woodland than planting (with attendant mowing/spraying to suppress competition).

The Open short sward and Bare sand and chalk favourable SATs were all associated with brownfield sites (with former mineral workings/railway sidings)

and their maintenance remains a problematic area.

Open water on disturbed mineral substrates is often associated with ponds forming in quarries, sand gravel and clay pits, which are readily colonised by a pioneer community of mobile species. Commonly these are then replaced rapidly as the water body matures and becomes well vegetated. Maintaining such sites once quarrying ceases is often problematic and expensive. Seasonality is key, as occasional to regular desiccation and oxidation of much of the previous season's growth prevents excessive litter build-up, keeping draw-down zones relatively open.

Fifteen of the 49 undesignated sites had no favourable SATs, but still on average supported over six Nationally Scarce taxa.

Genuine rarities are invariably associated with rich assemblages, but, as we shall see below, not always on exceptional-looking sites. To elucidate the true value of a site requires proper surveys and the increased reliance on rapid assessment by non-specialists is in my view flawed.

An example of a near miss

This section gives an example that illustrates just how easy it is to overlook biodiversity hotspots. The site is a rather unremarkable looking area of mainly neutral grassland (see Figure 1) in north east Hampshire. My involvement with



Figure 1. A site in north east Hampshire that is the only mainland site for red-barbed ant, *Formica rufibarbis*. Photo credit: J.Denton.

the site, which had been deemed not to have any value or invertebrates, was to translocate the common lizard population. I admit that (largely as I was rather focused on the large reptile population) it was several days into the translocation before it became apparent that the place had a very unusual invertebrate assemblage.

It was the presence of primarily heathland species such as the heath assassin bug (*Coranus* spp.), ant bug (*Alydus calcaratus*; Figure 2) and the Nationally Scarce gorilla jumping spider (*Evarcha arcuata*; Figure 3; which is usually associated with damp heath areas) that set alarm bells ringing. But it wasn't until the second season of reptile capture that I encountered red-barbed ant (*Formica rufibarbis*; Figure 4). I knew its significance at once because I found the then last known mainland colony in Chobham, Surrey in 2008, which was subsequently wiped out by slave-making ants (*Formica sanguinea*).

Subsequent surveys have revealed that the site supports the following SATs in favourable condition: Scrub edge, Open short sward and, most significantly, Scrub heath and moorland. The latter is especially remarkable as there is not a single ericaceous plant on the site. Commendably, the site owners have designated the core ant area as a reserve and are funding management that is proving highly successful, with over 40 nests identified.

It is worth noting that a retrospective application of the Rapid Assessment Method outlined by Dobson and Fairclough (2021) would not have triggered follow-up surveys. The message should therefore be to err on the side of caution and commission baseline surveys, which in this instance would have identified the SATs to be in favourable condition.

Using PANTHEON to refine SNCI selection

Surrey Wildlife Trust's criteria for selecting SNCIs (Gibbs 2008) includes the presence of populations of species listed in the Red Data Book and as Nationally Scarce taxa, with the caveat:

Whether the assemblage or population is 'important' should be determined in consultation with



Figure 2. An ant bug (*Alydus calcaratus*) nymph ... not an ant! Photo credit: J.Denton.



Figure 3. Gorilla jumping spider (*Evarcha arcuata*). Photo credit: J.Denton.

appropriate experts as many species which are Nationally Scarce are widespread and abundant in parts of Surrey.

This adds subjectivity to the process. Instead, the outputs of PANTHEON could be developed into a scoring system, for example with any site with three SATs in favourable condition requiring consideration, and those with four or more SATs qualifying on invertebrate grounds alone.



Figure 4. Red-barbed ant, *F. rufibarbis*. Photo credit: J.Denton.

PANTHEON and Biodiversity Net Gain

PANTHEON outputs provide an unbiased measure of the key habitat elements for invertebrates on a site, and with regard to Biodiversity Net Gain they should be integral to decision-making when balancing trading. Without these inputs we may well end up robbing Peter to pay Paul, replacing locally important assemblages with generic but high-scoring habitats.

I am increasingly approached by consultancies who include the likes of the Royal Horticultural Society Plants for Pollinators guides in their reports and flag up 'improvement' packages for sites without any proper consideration of the existing intrinsic value. These aims may be laudable but in my view they are often misguided, especially when the enhancements are earmarked to be put on ground with interesting assemblages but limited aesthetic appeal, such as ruderal communities or open mosaic on previously developed land. In his analysis of Metric 3.1, Glenister (2022) points out that open mosaic on previously developed land is the joint highest-scoring high-distinctiveness habitat, but comments that it is 'unlikely to be a viable option on the majority of sites'.

Having sampled numerous 'green roofs' in Greater London, it is clear that in the medium term (especially as irrigation systems fall out of repair) those of the *Sedum* mix type develop into facsimiles of open mosaic typical of coarse disturbed substrates, with interesting invertebrate (and plant) assemblages developing, often 20 storeys up. So, incorporating at least patches of open mosaic at ground level will draw in potentially dozens of scarce species which would not thrive in closed swards. Such areas can even

be partly used as overspill parking/turning areas as the fauna and flora are in many cases encouraged by occasional ground disturbance.

It is easier to sell a generic 'wildflower area' or 'living wall' with messages about saving pollinators and cleaning air, but as useful as these areas are they are not the answer for the vast majority of native species. If they were, then suburbia would be a biodiversity hotspot for native species. Wildflower meadows are usually managed as traditional hay meadows with summer cut and collect; however (somewhat counterintuitively), this is disastrous for most phytophagous insects which cannot complete their life cycles before the cut (Denton 2003).

Conclusions

PANTHEON should in my view be further developed as the industry standard. Most invertebrate specialists have adopted its use for site interpretation and are familiar with its strengths and weaknesses. I believe funding should be increased so that the statuses can be periodically refined, and the weightings for indicator species changed where data show clear trends.

Development and refinement are ongoing, and the PANTHEON website allows users to keep site lists, which can either remain private or be added to the publicly accessible datasets. Entering species lists remains glitchy but steps to remove these problems are ongoing. Having a centralised system means that revisions could be applied to all uploaded datasets automatically. Adapting the outputs into a traffic light system like that used for our birds would be useful for non-specialists. This could be based on the number of favourable SATs (and/or) total scores per site.

Acknowledgements

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About the Author

Dr Jonty Denton FRES, FLS, CEcol, MCIEEM has been a freelance ecologist since 1995. He is county recorder for beetles, bugs and spiders in Hampshire and Surrey.

Contact Jonty at: jontydenton@aol.com

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 2023 issue of *In Practice* we described a situation where you are a senior ecologist in a medium-sized regional consultancy specialising in bats. You have been doing bat work for years and as such you have established links

with the local and national bat community. You have good links with several local councils and your name is provided as a reliable bat contact. Outside work, you organise research-orientated surveys for several county bat groups and have verbal approval by your line manager to assist several friends who undertake commercial surveys for their much smaller consultancies. This is seen to be a good thing for both you and your employer building on your existing skills and learning new techniques.

One of your friends calls to ask for assistance on a bat survey at very short notice. She is really stuck and she needs at least one surveyor. The survey was one part of a series of surveys so had to occur as planned. You have a free night and you agree to help. When you arrive, it is suggested that, due to your experience, you can lead the survey on the night – to which you agree. The site

is a large redundant water treatment centre and although survey locations have been identified and provided to you, you wondered about why more surveyors were not being used.

The survey was fine and no bat roosts were found in the buildings on the site. A few days later, following a quick catch-up with your friend, it was agreed that your name would be included in the report as the survey lead. You also agreed to receive a small payment to cover your travel. It was also mentioned that, due to confidentiality, you will not be provided with the report, but the report will be available on the planning portal once the planning application has been submitted.

Six months later you learn that the bat survey report had been rejected by the local planning authority. Apparently, the survey that you led did not have enough surveyors and that survey data was missing from several survey points. In

addition, the site needed further and more in-depth surveys which were not undertaken. You feel that these were survey design and management issues and not your responsibility. The planning application was withdrawn due to issues with the bat report.

Concerned, you immediately go to the planning portal but the application documents are no longer available. However, the applicants name has been left on the planning portal and it is a major national house builder who are your consultancy's main client and who you manage projects for. An internet search shows that the bat survey that you led was undertaken for a small local development company who then sold the site to the major national house builder soon after the bat survey was completed. You immediately contact your line manager to discuss the issue and learn that the major national house builder has recently organised an unexpected commercial meeting with your consultancy's owners regarding the professionalism of their ecologists.

What needs to be done now and what are the learning points?

Our thoughts

This bat survey of the water treatment centre may or may not be raised by the consultancy's main client. Even if it is not raised, the consultancy should agree a statement with the ecologist and provide it at the meeting as a move towards openness and getting all potential issues out in the open. Issues to include in the statement are:

- The role of the ecologist in the survey.
- Why they were helping another consultancy.
- An explanation as to why any failings in the report and subsequent management of the bat issues on-site were the responsibility of the smaller consultancy.

Learning points

There are some important lessons to be learnt here:

- Do not volunteer for anything unless you have i) time to assess how well

the project is being managed and ii) established how you will be referred to in the final document.

- Be clear about your role – is it appropriate to be listed as a lead surveyor on the report if you have not seen the report? Probably not.
- When you think there are issues with any part of a survey, even if acting in a voluntary capacity, raise them and do not carry on participating until you are happy with the explanation. Your professional reputation is at stake here.
- Taking money from a competitor may be a breach of your contract and could result in disciplinary action – be certain about this before proceeding. If in any doubt ask your line manager and obtain clear, preferably written, guidance.
- Be clear about payments from third parties.

The next dilemma

So, now for this issue's dilemma.

A planning application was submitted to add a modern extension to a large mid-Victorian building and to demolish a small 1990s add-on. The site was adjacent to a small parkland with mature trees, from where there was a set of season-long records of large numbers of soprano pipistrelle bats at a time of evening suggesting a very local maternity roost, possibly in that Victorian building. These records were held by the Local Records Centre (LRC) at the time of the application.

The developer submitted a planning application to the Local Planning Authority (LPA) to expand the original building, with its potential maternal bat roost. The initial application lacked any ecological appraisal or data, in spite of the LPA requirement for a Preliminary Ecological Assessment (PEA) to accompany applications. A quick 'PEA' was provided for the developer by a local consultancy, led by a CIEEM member.

Within the LPA there was strong political support for the development from the Council leader, and pressure on LPA staff to proceed quickly with the application, and for the planner to approve it based on professional judgement alone, without supporting data.

The 1990s add-on had a cursory check for bats, but the interior of the Victorian building was not examined by the consultants. The desk element of the PEA did not consult the LRC, and went instead to the National Biodiversity Network (NBN) to obtain data for commercial purposes, counter to NBN guidance. At that time, the bat data in the LRC were not showing on the NBN. The local bat group was consulted for records, but under the political pressure for progress, the consultancy published its PEA report before it received a response from the bat group, arguing that any results from the bat group would not have affected their report. In the absence of bat group responses, and without LRC

data, or an internal inspection of the old building, the consultancy stated to the LPA planner that there would be no likely impacts on protected species.

Under a call-off facility, the County Wildlife Trust adviser – also a CIEEM member – provided advice to the LPA too. But they failed to check for up-to-date records for bats at the LRC, did not ask for internal checks and omitted supporting evidence for their opinions. As time passed, the Leader of the LPA ratcheted up the pressure on their own staff to see the application pass through planning.

The development went ahead in spite of external protests about procedure at the LPA. Concurrently, a maternity roost (peak count >360 emerging individuals) was confirmed in the Victorian building.

What should the LPA planner have done under these circumstances where heavy, and consistent, pressure was applied to approve the application?

BNG Training Courses



Krystie Hamilton

Professional Development Officer (Training), CIEEM

CIEEM provides a range of training courses for Biodiversity Net Gain (BNG) Practitioners. These are all aligned with the CIEEM Competency Framework.

Below is an overview of each course and how they complement and fit together for example: to undertake a BNG assessment you would need UKHab, GIS, the Metric and Rivers courses. For BNG design you need the Designing for BNG course based on the Good Practice Principles and then the Habitat Design Checklist for BNG.

Using UKHab for BNG

This course will introduce environmental practitioners to the interface between Natural England's Biodiversity Metric 4.0 and UKHab. The course focuses upon the design of baseline habitat surveys and condition assessment for BNG and discusses feasibility and design of projects that have made a commitment to BNG. The course is taught in two online sessions with plenty of time allowed for discussion.

QGIS for BNG

Conducting a BNG assessment will soon become mandatory for most new developments. It is a new area of work and one that ecologists, particularly consultants, are having to adopt. Conducting these assessments requires specialist technical skills, and can be carried out using the freely available, open-source mapping software, QGIS. The course is suitable for delegates familiar with the QGIS interface who

have been using the product for at least three months. Ideally they will have attended an introductory QGIS course. The course will be delivered online using a range of tried and tested techniques including presentations, demonstrations, individual exercises and case studies.

Biodiversity Metric 4.0 Training

This course is based on the Biodiversity Metric 4.0 (Natural England 2023). It provides training on undertaking metric calculations for a development and its direct impacts on habitats. It also provides training on utilising the Metric to support designs of BNG both on- and off-site. Natural England have recently updated the Metric (to version 4.0) and we are updating course materials and re-opening this course shortly.

Introduction to the Rivers and Streams Metric for BNG

The Rivers and Streams Metric course provides an introduction on how to proceed with a Rivers and Streams metric assessment, explaining its context as part of the wider Biodiversity Metric 4.0; the seven individual components that make up the Rivers and Streams metric; what information is needed for each component in order to complete the Biodiversity Metric 4.0 River Metric spreadsheet, and how to access it; and how to approach a Rivers and Streams metric assessment for different types of project.

Designing for BNG

This course is for individuals wishing to advance their skills in designing BNG for development projects. Through presentations, case studies and practical work, the course focuses on designing BNG for various types, sizes and locations of development projects including small-scale to large-scale, as well as rural and urban locations.

The training covers BNG during the early stages of a project through to ecological impact assessments and the design stage. It touches on how BNG can

influence core project decisions such as master planning and optioneering, and the role of local planning authorities in embedding BNG within planning functions. The core element of the training is designing BNG, this includes: applying the mitigation hierarchy; habitat trading, ecological equivalency, promoting connecting, achieving additionality, and offsetting losses with gains elsewhere as the final stage of the mitigation hierarchy.

BNG Habitat Design Checklist

The course starts by introducing BNG including the Good Practice Principles, Natural England's Biodiversity Metric and how 'trading rules' influence the types of habitats to create and/or enhance to achieve BNG. The main part of the course is a Habitat Design Checklist that provides a practical, step-by-step approach on key considerations for BNG-led designs of habitat creation and enhancement.

Next Steps

The UK Government has recently published version 4.0 of the Biodiversity Net Gain Metric (<https://naturalengland.blog.gov.uk/2023/03/28/measuring-biodiversity-net-gain-publication-of-biodiversity-metric-4-0/>). This updates version 3.1 that was published in April 2022. This new metric (4.0) will be the version that will become statutory from November this year.

We are currently working with trainers to provide dates across the year for the range of BNG courses so please do check our Training and Events webpage (<https://www.cieem.net/events/>) for further course dates.

We are also looking to provide a course on BNG Management and Monitoring Plans to follow on from these and further details on this will be released later this year.

The range of BNG courses that CIEEM provide, are continuing to develop into a suite of modules that delegates will be able to book.

Policy Activities Update



Douglas Lewns
Policy Officer, CIEEM

Overall Update

Since the beginning of the year the UK Government has announced a new environmental plan and a suite of funding boosts for biodiversity. The new Plan for Water seeks to clean up UK waters and ensure a plentiful supply for future generations through increased investment, stronger regulation and tougher enforcements. The funding boosts include a new multi-million pound nature recovery scheme through the Darwin Plus Strategic Initiative for UK Overseas Territories and the Illegal Wildlife Trade Challenge Fund, aimed at tackling the illegal wildlife trade.

In March, CIEEM hosted its annual Spring Conference, and this year, it was all about soils, in particular the role of soils in nature recovery. The event was a fantastic opportunity for people from across the profession to share information and ideas, and attendees were treated to a range of different speakers from across the environmental management sector. These speakers detailed the management techniques and legislation that practitioners can get to grips with to improve the state of soils across the UK, ensuring we create nature rich environments, underpinned by healthy, and deep soils.

UK and England

In the UK and England our policy team and working group have responded to consultations on the UK Overseas Territories Biodiversity Strategy, the Office for Environment Protections Call for Evidence: Protected Sites in England and Northern Ireland and the Department for Levelling up, Housing and Communities consultations on

National Planning Policy Framework, Levelling up and Regeneration Bill: Reforms to National Planning Policy and Environmental Outcomes Report: A new approach to environmental assessment.

The UK Government has announced it will scrap the sunset date of December 2023 from the Retained EU Law Bill, meaning that EU-derived legislation and retained direct EU Legislation will no longer automatically expire after this point. Instead, the Government plans to amend the bill with a list of all retained EU law that it intends to revoke under the bill by the end of 2023. This is a very welcome change to the proposed bill, as there was not the capacity nor time to review, replace or update existing environmental legislation adequately, and removing all EU-derived and retained EU legislation abruptly could have been catastrophic for nature (and the economy).

Scotland

The Scotland Policy Group has responded to the Scottish Government's Consultation on Highly Protected Marine Areas (HMPAs), putting forward a detailed response and stressing the importance of strengthening the existing network of Marine Protected Areas.

The Group is currently engaging with the Scottish Government's workshops on the Scottish Biodiversity Strategy, contributing to the ongoing design process of this ambitious strategy to halt biodiversity loss and restore natural habitats across Scotland.

Wales

Our Wales Policy Group is continuing to engage with the Welsh Government's development of Net Benefits for Biodiversity, the Welsh alternative to Biodiversity Net Gain (BNG). This system

has the same intent as BNG but does not utilise a metric, instead putting emphasis on proactive considerations of biodiversity and the wider ecosystem benefits within a place-based context early on in the design process.

Members of the Wales Policy Group are now considering Natural Resources Wales's Consultations on the approach to regulating the release of gamebirds and the new flood risk management plan for Wales.

Ireland

The Ireland Policy Group has submitted a response to the Republic of Ireland's public consultation on Wild Birds Declaration as well as adding comments to the Northern Ireland Environment Link Response to the DEARA Ammonia Consultation.

The Group has also been kept busy by the CIEEM 2023 Irish Conference: Aiming for a Nature Positive Ireland. This conference examined what Nature Positive will look like within the context of the Island of Ireland, as well what success would look like and what is already being done to move towards this goal. The Group is now working on a position paper on BNG in Ireland and also on a broader briefing paper on what a nature positive Ireland looks like.

Future Priorities

Currently, we are all preparing for the many consultations that are currently live and more that are forthcoming, and are working with our LINK partners and the Environmental Policy Forum to boost the voice for nature throughout the UK and Ireland.

Contact Douglas at: douglaslewns@cieem.net

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



Membership Update

It's Not (Always) Rude to Shout



Stuart Parks

Head of Membership and Marketing, CIEEM

In March the CIEEM Secretariat got together with the Governing Board for what has become a valuable annual opportunity to step away from our respective desks for a day and to look together at the 'bigger picture' of an area of the Institute's work. The day also provides an important opportunity for Governing Board members to hear directly from staff about how CIEEM functions, to understand challenges and to celebrate successes.

This year's focus was on 'Membership Growth', so I thought I would use this opportunity to share with you some of the background information provided to set the context for the day. In recent editions of *In Practice* I have been pleased to provide updates on current membership application numbers, but how does this compare with previous subscription years?

Our total membership: a changing picture

Since the 2009-10 subscription year the number of applications we receive annually has in fact doubled. Note that these are applications to join CIEEM as well as applications to upgrade existing memberships. Chart 1 shows that the number of applications received remained consistent at around 900 or so per year. Halfway through the period shown we made several changes to

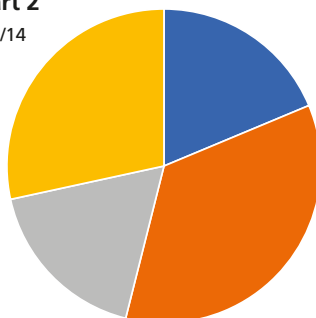


application processes, changed and indeed closed some membership grades and made considerable efforts to increase the relevance of membership to a broader audience. Since then, the number of applications received has grown at a considerably faster rate, seeing us receive just a handful under 1800 applications in the last subscription year (2021-22).

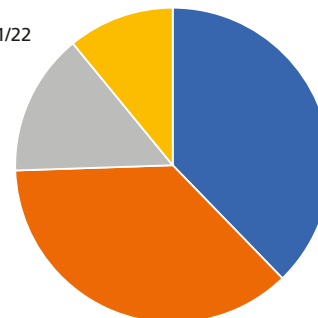
When we look in more detail at where these applications are coming from an interesting pattern emerges. In Chart 2 we can see the proportions of applications received from students, early-career professionals, mid-career professionals and senior professionals. In the 2013-14 subscription year 54% of applications processed were from either students or those recently qualified, and 28% were from senior professionals. In the last subscription year, with double the number of

applications, the proportion of applications from either students or those recently qualified had grown to 75%, with 11% coming from senior professionals. Amongst other factors, this illustrates the impact of our increased focus on attracting and supporting new professionals into the sector, with much more related marketing activity aimed at this audience. This healthy pipeline of new professionals is good news for the future of our membership, and more importantly for the sector, and reinforces the importance of keeping a high proportion of these new members within the Institute so that we can most effectively support them to build their competence and progress. It also highlights exciting opportunities for us to better understand and meet the needs of senior professionals working in sectors currently under-represented in our total membership.

Chart 2
2013/14



2021/22

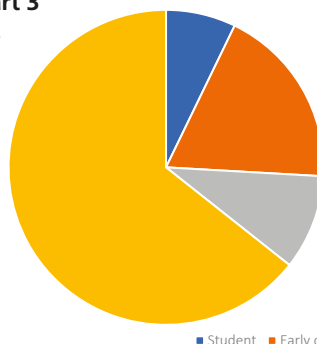


■ Student ■ Early career ■ Mid career ■ Senior professional

Inevitably, this shift in the types of application being received has led to a change in the overall picture of our membership. If we look at the same subscription years and compare the breakdown of our members' level of experience (as determined by their membership grade), we can see that we have gone from 26% of members being students or early career members and 64% being senior professionals in 2014, to 36% being students or early career members and 49% being senior professionals in the last subscription year (Chart 3).

Overall this represents a picture of a healthy membership body. We are seeing sustained and steady growth, with significantly increased interest from those new to the sector, whilst retaining a very healthy proportion of senior, experienced professionals whose knowledge and expertise underpins so much of the work of the Institute. It is also pleasing to see, though we do not

Chart 3
2014



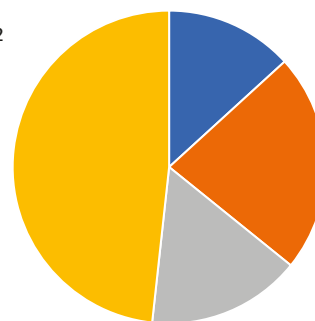
■ Student ■ Early career ■ Mid career ■ Senior professional

take it for granted, average retention rates for the mid-career and senior professionals sitting in excess of 95%. These retention rates, alongside the sustained interest from new members, has seen total membership rise from a little under 5000 in 2014 to approaching 7500 now.

So what next?

As much as we recognise the importance of investing in the next

2022



generation of professionals and diversifying our membership by reaching out to those under-represented sectors I mentioned earlier, making sure that our membership offer and services meet the needs of you, our current members, remains a strong focus. Understanding what you need and expect from your membership, and the extent to which this is changing, is our next challenge – and we look forward to working with you to meet it.

Welcoming New Fellow

Dr Martina Girvan CECol FCIEEM



Martina Girvan is currently the Senior Technical Director – Ecology at Arcadis Consulting Ltd and, in the opinion of the Fellowship Review

Panel, continues to make a significant contribution to the profession in many ways, including:

- Informing and shaping best practice within our profession and beyond through her significant knowledge and understanding of ecosystem services, Natural Capital and Biodiversity Net Gain. For example, in addition to being a contributing author for the Natural Capital Protocol and CIEEM's approaches to Environmental Net Gain, she has applied her knowledge to promote and implement the delivery of Nature-based Solutions through ecosystems services impact assessment, design including practical

and financial feasibility for Nature-based Solutions such as carbon reduction, water quality and biodiversity contributing to the education, health and wellbeing of communities.

- Forming the approach to Biodiversity Net Gain in England as a contributing author to the Biodiversity Net Gain Principles on behalf of CIEEM, CIRIA and IEMA, one of the founders of the CIRIA Biodiversity Awards and now Chair of CIRIA's Biodiversity Community of Practice and is working with clients, land managers, charities and communities to deliver Biodiversity Net Gain.
- Through her PhD and post-doctoral research into how soil biodiversity underpins ecosystem-services and is affected by land-use, which has informed the management practices during agricultural food production of two major industries in the UK.

In summary, the Governing Board agreed with the review panel that:

Martina is well known and highly respected by others in her relevant fields of work. She was recognised as the CIEEM Member of the Year for 2022 and listed on the World Resources Institute register of Ecosystem Experts. Martina has shared her knowledge through extensive contributions to guidance documents, knowledge sharing via webinars, and mentoring in the UK and internationally. Through her championing of biodiversity, ecosystem services and natural capital as subject areas that ecological consultants needed to take a lead role in, Martina has advanced the profession. Her contribution to our profession has been exceptional and conspicuous in its leadership, quality, originality and influence and is therefore well known by others both in and outside of the profession.

From the Country Project Officers



Elizabeth O'Reilly
– Ireland Project Officer

Dia Dhaoibh/Hello everyone,

I hope you are all

enjoying this year's survey season so far. 2023 is shaping up to be a good one for the Irish Section of CIEEM. We had a full house at our conference in Athlone in April, the first In-person Irish conference in four years. There was a great line up of speakers for the day which we were honored to have opened by the Minister of State Malcolm Noonan. I, personally, really enjoyed meeting and engaging with all of you on the day and I am looking forward to 2024 already.

Our Lunchtime Chat program continues with some exciting talks due in the Autumn. We were delighted to hear from Dr Kez Armstrong back in March on Kestrel populations in Ireland. I have been keeping an eye on her Twitter where she is live streaming updates from a Kestrel Nest. Check it out @alethionaut #KestrelCam.

CIEEM was delighted to sponsor the Best Biodiversity Presentation Prize at ENVIRON this year. The winner was Hannah Mealy from UCC on Carbon sequestration of a native woodland established on a cutaway peatland site in Ireland. Congratulations to Hannah, we are excited to see her progress and we will be sharing more about her work in our next Irish Newsletter.

The Irish Section's policy work also continues, with work on publishing our Biodiversity Enhancement for New Development in Ireland, as well as actions to address the capacity crisis in the sector. I look forward to updating you on these in the next edition. As always don't hesitate to get in touch anytime for a chat. Until next time.

All the Best, Liz

Contact Elizabeth at:
Elizabeth@cieem.net



Mandy Marsh
– Wales Project Officer

S'mae pawb/Hello everyone,

I'm delighted that our

Welsh Section Committee has had a burst of activity in recent months, leading to an exciting programme of events – walks round the Celtic rainforest at Ganllwyd and Rhos Goch SSSI, and talks on the Mammal Red List and using eDNA to identify fungi. Still to come – a webinar on red squirrels on 13 July, and some more events yet to be confirmed. Keep an eye on our Training & Events webpage for updates. Many thanks to all the volunteers involved.

The Committee will also be working with CIEEM's Marine and Coastal Special Interest Group to host a marine-themed, in-person conference in South Wales in September. Remember to book your tickets early! Details will be on our website soon.

Last year, after working with Welsh Government, we published our Net Benefits for Biodiversity (NBB) Briefing Paper. We will be following this up shortly with a Biodiversity Enhancements paper – keep an eye out for it via the usual channels. What has been your experience of working with NBB? We would love to hear from you; all feedback will be valuable in improving our understanding of how NBB can best help restore biodiversity. We have had enquiries about training for NBB; if this interests you, or you feel able to offer training, please get in touch.

Hwyl, Mandy

Contact Mandy at:
MandyMarsh@cieem.net



Annie Robinson – Scotland Project Officer

Hello everyone,

It's been a busy year already with lots of

member network events. Many of these have been part of our #TwentyTwentyTree series of events to tie in with the 2023 Scottish conference. Check out the 'By members, for members' page for a write-up from Loch Arkaig Pine Forest visit. We are very excited about the Scottish conference **The Role of Trees in a Sustainable Future** on Tuesday 3rd October in Edinburgh.

The Scottish Policy Group has already responded to the Scottish HPMA consultation and the Ending the Sale of Peat consultation. We have also been inputting to the Scottish Biodiversity Strategy Delivery Plans.

There is a fantastic number of nominees from Scotland in this year's CIEEM Awards:

- **Postgraduate Student Project** – Murray Borthwick
- **Higher Education Programme of the Year** – Scotland's Rural College HND Wildlife & Conservation Management
- **Best Practice Small-Scale Nature Conservation** – Garrell Burn River Restoration – North Lanarkshire Council/SEPA/WSP
- **Best Practice Large-Scale Nature Conservation** – Eddleston Water Restoration – Tweed Forum and partners
- **Best Practice Large-Scale Nature Conservation** – Scottish Invasive Species Initiative
- **Best Practice Knowledge Sharing** – Academy9 – Transport Scotland

Plus, all the small, medium and large-scale consultancies that have been nominated. A huge congratulations to you all. We hope you have a wonderful time at the Awards Ceremony.

Thanks, Annie

Contact Annie at:
AnnieRobinson@cieem.net

International Focus

Using Invertebrate Diversity to Understand Environmental Health



Olivia Guindon
Senior Ecologist,
SLR Consulting

Imagine a futuristic world without invertebrates where 'autonomous drone insects' are programmed and deployed to undertake one of the most important ecosystem services performed by insects – pollination. This is a frightening depiction of what life could perhaps be like if invertebrates were to become extinct and is only one illustration of how crucial they are in supporting essential ecosystem functions including pollination, pest control, soil formation, organic decomposition and water infiltration.

Biodiversity loss is thought to be a lot more pronounced in invertebrates than in other fauna and flora. Although the charismatic butterflies, dragonflies and beetles get some attention, historically invertebrate specific conservation has been a low priority as demonstrated by the fact that only a mere 0.5% of all described arthropods are listed on the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN) when most vertebrates have already been assessed (Cardoso *et al.* 2011).

When planning ecological surveys for international projects, invertebrates can often be excluded from ecological assessments on the grounds of practicality as the lack of background data and expert knowledge on their identification and distribution makes their evaluation an overwhelming task – a concept known as 'the taxonomic impediment'. To overcome this, it has been suggested that invertebrate surveys should focus on reducing effort and cost of sampling and should focus on summarising complex ecological links (Ward and Lavière 2004) through sampling and species surrogacy, a practice used in Australia. This entails reducing sampling effort whilst emphasising quality planning and surveying techniques as well as focusing on higher taxonomic levels. Whilst species specific knowledge is still necessary for conservation purposes, using indicator taxa can provide an accurate assessment of species richness. Additionally, focusing on specific taxa or groups of taxa enables the representation of communities and association with ecosystems. This can be used as a way of identifying habitat type and quality, however a good knowledge of habitat-taxon association is needed for a successful outcome.

The Bern Convention was one of the first international treaties that recognised the importance of invertebrates as potential bio-indicators for the condition of habitats. Indeed, the complexity of invertebrate communities serve as one of the best indicators of environmental health and they are therefore very useful in monitoring ecological status, thus facilitating adaptive management during the course of habitat restoration activities. Easier taxon-focused surveys could therefore help to achieve a



A female common blue butterfly in Georgia.

greater inclusion of invertebrates in ecological assessments and give us a better understanding of the status of ecosystems. This is essential when undertaking ecosystem services and habitat valuations in an international context. However, guidance from invertebrate specialists and ecosystem scientists is needed to better understand which groups of invertebrates to monitor in a particular habitat to enable accurate impact assessments and successful habitat creation/restoration by land managers especially in Africa, Asia and Oceania where these interactions have been poorly studied (Borges *et al.* 2021).

British Ecological Society

Publishing and Disseminating Resources for Practitioners

Phil Dooner and Minhyuk Seo

BES

The British Ecological Society highlights academic- and practitioner-led content relevant to invertebrate ecology published in *Applied Ecology Resources* and *Ecological Solutions and Evidence*.

Applied Ecology Resources (<https://www.britishecologicalsociety.org/applied-ecology-resources/>) is the British Ecological Society's growing platform collating resources relevant to environmental management. This includes reports, case studies, guidance notes as well as peer-reviewed research articles written by NGOs, ecological consultants, government agencies and academic ecologists.

At the heart of this platform is a growing open access journal, *Ecological Solutions and Evidence* (<https://besjournals.onlinelibrary.wiley.com/journal/26888319>), that publishes peer-reviewed research and insights that advances our knowledge of applied ecology, management and environmental policy.

In line with the theme of this edition of *In Practice*, we highlight content from both resources that are relevant to invertebrate ecology and management. All resources are free to read, download and share on the Applied Ecology Resources website.

The importance of ancient woodlands

In their review of the pollinators associated with decaying wood, old trees and tree wounds (<https://www.britishecologicalsociety.org/applied-ecology-resources/document/20210100953/>) published in *Applied Ecology Resources* (AER), the Woodland Trust identifies over 320 saproxylic insects (those dependent on dead or decaying wood), including beetles, flies,

bees and wasps, and that visit flowers on a regular or occasional basis.

The report highlights the huge variety of flowers visited by these insects and stresses the need to promote suitable flowery habitat at sites with old trees or dead wood (Document ID: 20210100953).

Invertebrate citizen science

Also in AER, the Field Studies Council (FSC) have published an evaluation report on their citizen science project, FSC Invertebrate Challenge (<https://www.britishecologicalsociety.org/applied-ecology-resources/document/20203205434/>).

The project aimed to develop and increase the number of volunteer invertebrate recorders, increase the number of accurate and reliable invertebrate records and raise the profile of invertebrates as indicators of healthy ecosystems. The project was also an opportunity to trial the use of smartphones and recording apps, and build on national examples of good practice in training volunteers and recording difficult species groups (Document ID: 20203205434).

The FSC have also published a guide for examining invertebrates under a microscope (<https://www.britishecologicalsociety.org/applied-ecology-resources/document/20230081475/>) as a resource for volunteers and organisers (Document ID: 20230081475).

New method for surveying crayfish

In *Ecological Solutions and Evidence* (ESE), Eleri Pritchard and colleagues present a novel quantitative survey method for crayfish: the "Pritchard Trap" (<https://besjournals.onlinelibrary.wiley.com/doi/10.1002/2688-8319.12070>). This quadrat-style sampler was extensively tested in headwater streams of North Yorkshire and successfully sampled both invasive and native crayfish.

The Pritchard Trap required substantially less sampling effort and resources than the 'Triple Drawdown' (TDD) dewatering method, whilst also posing less risk to non-target species. The study was shortlisted for the Georgina Mace Prize 2021 ([https://besjournals.onlinelibrary.wiley.com/doi/toc/10.1002/\(ISSN\)2688-8319.Georgina_Mace_Prize_2021](https://besjournals.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)2688-8319.Georgina_Mace_Prize_2021)) – the journal's annual award for the best early career researcher (Document ID: 20210251383).

Reintroducing the Manchester Argus

Andrew Osborne and colleagues present their study (<https://besjournals.onlinelibrary.wiley.com/doi/10.1002/2688-8319.12147>) exploring the ecology of Manchester Argus (*Coenonympha tullia* ssp. *davus*), a peatland-specialist butterfly, to ensure their successful reintroduction following the threat of severe habitat loss and degradation. A landscape-scale peatland restoration project was being undertaken on Chat Moss, Greater Manchester during this period of study and conservation translocations was an important component of the work.

The study aimed at quantifying the resource thresholds for the large heath butterfly to assess potential risks for the project and created baseline estimates of the minimum requirement near-optimum abundance of each resource for population survival.

The method has wider utility for quantitative assessment of habitat readiness before attempting reintroductions for other species (Document ID: 20220258874).

Further information

You can discover more evidence-based research, reports and guides on Applied Ecology Resources. www.appliedecologyresources.org

Want to share your organisation's work on our website? Get in touch about Membership options. hello@appliedecologyresources.org

By Members For Members

Introducing the NEW Freelance Practitioners SIG

We are very excited to announce the official launch of the CIEEM Freelance Practitioners Special Interest Group. There are many freelance/self-employed CIEEM members and non-members who work in the sector. While working in this way provides lots of opportunities and flexibility, there are challenges too. The exciting new CIEEM Freelance Practitioners SIG (FPSIG) is here to help.

This SIG aims to be a welcoming platform for freelancing and sub-contracting CIEEM members to network together through online events (and potentially in-person events as the SIG grows), exchange knowledge of this side of the sector, create best practice guidance and provide crucial peer support where needed. This SIG will be relevant to both independent freelancers as well as those working as part of a very small team. This new SIG aims to iron out the challenges that come with the territory of being freelance and give CIEEM members the best chance of being successful in this venture.

If you are a CIEEM member, you can sign up to the FPSIG mailing list by updating your preferences in the My CIEEM area of the website. This will mean that you will be first to hear about events and news from the group.

CIEEM Members can also become further involved as a Committee volunteer. The SIG currently has an engaged and knowledgeable team of six volunteer Committee members closely supported by the Volunteer Engagement Officer at the CIEEM Secretariat. However, this SIG is in search of a volunteer to take on the key role of Convenor, who would be responsible for



leading and inspiring the SIG Committee with their enthusiasm for the group's objectives. They will be required to delegate tasks to Committee members and ensure these are kept on track. They will chair bi-monthly Committee meetings and aid the SIG's volunteers in creating and running exciting, interesting topical events. The Convenor would be a crucial part of CIEEM's efforts to support its freelancing members. There will be opportunities to work with many friendly and knowledgeable people who themselves work freelance in the sector, and you will be able to maintain organisational skills that are vital for this role. Volunteering for a SIG contributes greatly to continued professional development (CPD), and provides opportunities to branch out and learn new skills and develop existing ones too.

Volunteers for SIG committee roles can be co-opted onto a committee at any time. This role comes with full inductions from the CIEEM Secretariat and lots of support from the current SIG Committee members too. To apply for the role of Freelance Practitioner SIG Convenor, email us at membersnetworks@cieem.net.

Drew Lyness

Volunteer Engagement Officer, CIEEM

Early Careers Special Interest Group

Tips, Tricks and Tales for the Survey Season

In March 2023, the Early Careers Special Interest Group led a webinar providing information on tips that early career ecologists have learned in their first few seasons, along with advice from senior staff on what is expected of new ecologists and how they can make the most of what there is to learn. The session included a section on what employees can expect from their employers in terms of good working practice, and ensuring that they provide the support and guidance needed to support employees in their roles. The second half of the event consisted of a panel discussion, responding to questions from the audience, enabling key points and questions to be investigated and explained in more detail. A rewarding session which hopefully is benefiting lots of early career ecologists out in the field as this edition of *In Practice* reached your letterbox!



Scottish Section News

Loch Arkaig Pine Forest

In March, Scottish Members joined Henry Dobson from Woodland Trust Scotland at Loch Arkaig Pine Forest for a day-long Member Network event. Near the west coast of Scotland, the southern shores of Loch Arkaig contain one of the last remaining areas of native Caledonian pinewoods. Following an overview of the site's history and restoration efforts, members had the opportunity to explore the woods and see various restoration practices occurring on site. Along the way, members enjoyed sightings of pine regeneration, ancient trees, rare lichens, interesting bryophytes and creative art installations.

Members were able to observe the results of various restoration techniques on site, including tree veteranisation, herbivore exclusion and the extraction of plantation stands. Extraction techniques included larger-scale mechanical felling, roadless timber extraction via barge, as well as hand-felling and horse-drawn extraction of smaller pockets of Sitka spruce. The site visit highlighted the importance of these patches of native woodlands for biodiversity, the planning and implementation challenges in undertaking native woodland restoration, and the opportunities that can arise through community partnerships.

Thanks to Juli Titherington (Scotland Vice-Convenor) for organising this event and Henry Dobson and Jessica Maxwell (Woodland Trust Scotland) for facilitating this #CIEEMScot Member Network event for #TwentyTwentyTree.

Julia McCarthy,
Scotland Committee member



Photo credit Julia McCarthy.



Henry examining epiphytes.
Photo credit Julia McCarthy.



Close up of epiphytes.
Photo credit Juli Titherington.



Henry Dobson. Photo credit Juli Titherington.



Photo credit Juli Titherington.



Photo credit Juli Titherington.

From the Patrons

Net Zero and Nature Positive – Making It Happen



Jane Davidson,
CIEEM Patron

Faith in political systems as a climate and nature activist can be hard. Reading scientific reports such as the most recent IPCC report¹ and the most recent Living Planet report² from WWF highlight the resolutely upward trend of global temperature and the corresponding rapid downward trend of species loss. Despite the many hours of discussion, the many thousands of journeys, the many millions of words of commitment by countries across the world, in fact very little effective global action is being taken to address either the climate or the nature crisis.

It must be desperately depressing sometimes to be an ecologist trying to secure the survival of species and habitats, and instead providing the evidence for the depletion of the very species that inspired you into your role. It can be very easy to feel that there is nothing that can be done, but as a stubborn optimist I believe passionately that we all need to continue to do as much as we can; to make our contribution to the survival of all species. What we can do will vary hugely, depending on our skills, our experience, specific opportunities, or even our appetite for confrontation. Although at the global level we're not seeing enough action, there are

absolute jewels of local ecological action which are models for the rest of us. As a patron of the Cambrian Wildwood in mid-Wales, I can see a landscape that is being transformed through excellent conservation practice. Across the UK, the work of the Wildlife Trusts is more important than ever, with 2,300 nature reserves ensuring that seeing wildlife in its natural habitat is somewhere close to us all.

As a policy professional, my contribution, such as it is, is to see how we can use law and policy to deliver better outcomes for the nature and climate. Based in Wales, we have a particular advantage through the Welsh Parliament having passed the Well-being of Future Generations (Wales) Act in 2015 which requires all public services in Wales to deliver on seven goals and five ways of working. Unusually, both the goals and the ways of working are on the face of the act, so public services must think preventatively, think long term, integrate goals' outcomes, collaborate with each other in the achievement of the goals and involve people about whom decisions are being made. The act itself has attracted a lot of international attention as Wales apparently is the only country in the world which has a legal mechanism to deliver on the UN Sustainable Development Goals. The act's goals require decisions to recognise environmental limits, require biodiversity to be enhanced, and require the public bodies to ensure that any of their behaviour outside Wales is conducted under the same principles as within Wales (i.e. no offshoring of actions hostile to nature).

The Welsh Government and Plaid Cymru currently have a Co-operation Agreement in place, which represents nearly two-thirds of the Welsh Parliament. I was pleased to be invited by both parties to bring together an independent group "to examine potential pathways to net zero by 2035 - the current target date is 2050. This will look at the impact on society and

sectors of our economy and how any adverse effects may be mitigated, including how the costs and benefits are shared fairly." I have been joined in this mission by a group of experts with specific expertise in all the key emission production and reduction areas. However, the most significant aspect for me is that our search for net zero delivery pathways by 2035 will not be in the context of technology which is not yet developed, but in the context of being nature positive and ensuring a just transition as required by the Well-being of Future Generations Act.

I hope the journey that we are going to take to create such pathways is one in which members of CIEEM will also contribute. We need to know where the best practice of land restoration is, where the best practice of blue carbon is, where the best practice of agricultural transition is – and what lessons we can learn from such practice. Please get in touch if you can help us create delivery pathways for emission reduction and the enhancement of biodiversity in Wales. Our country needs you!

Notes

1. <https://www.ipcc.ch/report/ar6/syr/>
2. <https://www.wwf.org.uk/our-reports/living-planet-report-2022>
3. <https://janedavidson.wales/book>

About the Author

Jane Davidson is a Patron of CIEEM, Chair of Wales Net Zero 2035 Challenge Group, and author of *#futuregen: Lessons from a Small Country*³.

Contact Jane at: jane.davidson@uwtsd.ac.uk



New To Nature Placement



In previous editions of *In Practice*, we have looked at the new Green Jobs for Nature website that CIEEM has developed with partners to promote the range of jobs in the ecology and environmental sector to young people and potential career changers. In this edition, we would like to introduce you to our new Green Jobs for Nature Outreach Assistant – Natarnya Walcott-Burton – who is supporting the Green Jobs for Nature project, developing the website, and supporting outreach and engagement activities.

Please tell us a bit about yourself

I'm Natarnya, the new Green Jobs for Nature Outreach Assistant. The role is a year-long placement which is part of the New To Nature programme and is funded by the National Lottery Heritage Fund to mark the Queen's Platinum Jubilee. The programme is delivered through a partnership between Groundwork, the Prince's Trust,

Disability Rights UK and Mission Diverse, with extra support from the Youth Environmental Service. I feel very lucky to have the support of these organisations alongside the wonderful team at CIEEM. I joined CIEEM in April, just weeks after completing a traineeship with Birmingham and Black Country Wildlife Trust, which was perfect timing.

I haven't always had a goal of working in the environmental sector although I have been mindful of sustainability and nature since I was very young. A few years ago, I graduated with a degree in Modern Languages at the University of Cambridge. Having a passion for education and promoting opportunities for young people, I sought out work experience during my year abroad which would reflect this. First, I worked at a startup in Paris at an admissions consulting company where I assisted French students with their applications to UK universities. Proofreading CVs and offering advice on personal statements. I also had a chance to develop and translate content for the website, writing up profiles on universities around the world and interviews with international students to showcase their experiences. I enjoyed the work but while living in the city, I was craving more access to nature so before returning for my final year of university, I decided to escape to the French countryside! I worked there for a couple of months at an outdoor activity centre, where I guided British school children to practice their French through fun activities. In my free time, I explored the nearby forest, admired the landscape and the drystone walls, and wished that I knew how to identify the trees by their species.

Connecting with nature

After graduating during the COVID lockdowns, I took time out to explore what I wanted to do in my career. I also spent a lot of time outside, noticing how it supported my wellbeing and beginning to learn more about local wildlife. A chance encounter with a volunteer leader from Groundwork (who I spotted at the nature reserve holding invertebrate field ID guides) led me to begin volunteering with local conservation groups. This gave me a great sense of purpose, opened my eyes to the range of wildlife around me and introduced me to many supportive and enthusiastic people working in the sector. Volunteering at Saltwells National Nature Reserve with the wardens, as well as on the reserve's friends committee, really inspired me and I knew I wanted to spend more time working in conservation. This led me to apply for the Education and Engagement traineeship with the Wildlife Trust where I worked on a variety of sites and had the chance to lead motivated volunteers and assist school groups with environmental education and forest school sessions. Through all this, I became more acquainted with the sector as a whole and boosted my species ID skills in a very natural way.

Seeing the advert for my current role at CIEEM, it looked like a great opportunity to bring together my skills in digital content management and community engagement, and to develop these further in a sector which continues to inspire me. In my role I have the opportunity to develop my skills creating social media posts and blogs and promoting the project to CIEEM members and at events.

Promoting opportunities

I'm grateful that CIEEM and the New to Nature programme have allowed me to take on this new challenge and exciting opportunity. I know first-hand what a difference it makes to have people who can advise and support you when making the first steps in your career, so I am very happy to be supporting the Green Jobs for Nature project. I hope the project and the website will help many young people and career changers to make new connections within the environment sector and to discover purpose-driven work in a role that suits them and benefits nature.



**Green Jobs
for Nature**

How you can get involved

If you would like to help showcase the range of roles in the sector, then have a look at

<https://greenjobsfornature.org/> to help inspire you and upload your profile.



Made possible with

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How did you get into the sector?

My career has been convoluted, and dependent on chance. My grandfather, a miner from North East England, took me out looking for newts and lizards and set pitfall traps in his garden, and I've been fascinated by nature ever since. After a Zoology degree at the University of Aberdeen, I volunteered and worked in practical conservation and land management in Wales and Scotland. After funding finished for a charity project I was running, I set up as a sole trader doing practical conservation and land management work – this was the origin of Caledonian Conservation. Meanwhile I continued to do voluntary invertebrate, herptile and bird surveys. I was recommended to a windfarm developer for bird surveys on a site where I had done the black grouse fence marking, and moved into ecological consultancy. I then took roles in larger multi-disciplinary engineering consultancies, before taking on a part-time role at Buglife as a conservation assistant for Scotland and planning casework officer for the UK. I resurrected Caledonian Conservation in 2010 to fill the other part of my time, incorporating as a limited company to enable direct contracts with large developers. Caledonian Conservation has since gone from strength to strength, and the team has grown. I've now been working in the ecology sector for 18 years.

Why did you join/get involved with CIEEM?

I believe it is important to share experience and knowledge. This is why I publish papers and am a member of CIEEM and other organisations. I also continue to volunteer with conservation charities, sitting in board and trustee positions, and provide free training to other volunteers.

What do you think is the biggest issue facing the sector?

The ecology sector is not valued as equivalent to other similar professions. I believe this is a big factor affecting recruitment and causing skills shortages. I know many people who are extremely well qualified and experienced as ecologists but who have chosen to leave the sector due to low pay and long anti-social hours.

Who is your hero and why?

Helen Smith, Conservation Officer of the British Arachnological Society, is a brilliant arachnologist who has really driven spider conservation in the UK – notably running the Fen Raft Spider Conservation Programme and sitting on the IUCN Spider and Scorpion Specialist Group. She's truly inspiring, and always seems to find the time to encourage and support other less experienced arachnologists.

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

Particularly in the world of invertebrates, Craig Macadam is a fantastic leader. Having driven invertebrate conservation in the UK for many years, with great achievements in riverflies, brownfields, and pollinators to name just a few topics, he is now Conservation Director for Buglife, and is leading on a truly global platform.

If you could change one thing to make the world better for nature and biodiversity, what would it be?

A greater appreciation for the positive roles that invertebrates play in agriculture and commercial forestry – such as pollination, pest control, nutrient cycling and soil structure.

What advice would you give to those just starting out in the sector?

Volunteer, volunteer, and volunteer some more! Get out there, learn new skills, meet new mentors. Nothing is more valuable than experience, and there is always more to learn!

What is your favourite species?



My favourite group is spiders, and my favourite spider is the bog sun-jumper (*Heliophanus dampfi*). But I don't think I like them any more than my favourite beetle, the short-necked oil beetle (*Meloe brevecolis*), bird, the red-throated diver (*Gavia setiflata*), or reptile, the slow-worm (*Anguis fragilis*).

Can you tell readers something random about yourself?

I volunteer with the Ghostbusters of Glasgow, who raise money for children's charities such as Glasgow Children's Hospital charity. My eldest son spent a fair bit of time there when he was younger, so there's a real personal link.



BOOKS, JOURNALS AND RESOURCES

Compiled by the Academia
Special Interest Group

Paper Review  OPEN ACCESS

Assessing habitat connectivity in environmental impact assessment: a case-study in the UK context

Laura Kor, Ben O'Hickey, Matthew Hanson and Mihai Coroi

Impact Assessment and Project Appraisal, (2022) 40:6, 495-506.

<https://doi.org/10.1080/14615517.2022.2128557>

This paper highlights the lack of consideration of landscape-scale impacts and associated mitigation within environmental planning. Using the Heathrow Third Runway Expansion Project as a case study, the authors demonstrate how habitat connectivity can be incorporated into the Environmental Impact Assessment (EIA) process and provide greater benefits for species and habitats at the landscape-scale. The study considers a range of approaches and activity tools for assessing connectivity which were trailed in a pilot study to determine the most suitable approach. The Circuitscape tool was used to assess connectivity and the study focussed on the functional connectivity of two species: grass snake *Natrix helvetica* and soprano pipistrelle *Pipistrellus pygmaeus*. The habitat mapping identified vulnerable areas of landscape connectivity for the species which provided a useful visual tool to inform impacts and mitigation. The study demonstrates how this approach can be used to quantitatively assess habitat connectivity in EIA and identify areas of enhancement which can also be used to inform Biodiversity Net Gain. Whilst the study highlights some difficulties with landscape-scale approaches and the data and area extent needed to assess connectivity impacts, it concludes that if this approach is adopted at a wider scale and supported by policy it could provide better informed mitigation and benefits for nature and its conservation.

Paper Review

The Flowering Plants Handbook: A practical guide to families and genera of the world

James W. Byng (2014)

Plant Gateway Ltd., Hartford, UK. ISBN 978-0-9929993-0-8

Parochial natural history can lead to a good field knowledge of local plants. It doesn't, however, provide the skills needed to hit the ground running with a foreign or unfamiliar flora. Professional botanists often need to do the latter. Traditional botany degrees provide the foundation to begin botanical work anywhere in the world and learning to identify the vascular plant families provides the key. Byng's guide to the Angiosperm families of the world offers this support. The book provides identification keys, photographs and text covering 413 families and notes for over 6,000 genera with reference to the APG III classification system.

This is a readable, attractive, and highly informative book with useful sections including lists of diagnostic features for individual families. Strongly recommended for field botanists who wish to understand world flora or to put that of the British Isles into perspective.

Paper Review  OPEN ACCESS

Assessing the accuracy of free automated plant identification Applications

Hart, A.G., Bosley, H., Hooper, C., Perry, J., Sellors-Moore, J., Moore, O. and Goodenough, A.E.

People and Nature, (2023) 00: 1–9.

<https://doi.org/10.1002/pan3.10460>

Use of mobile phone applications (apps) in field survey is increasing. When a specimen is examined with the phone's camera, such software may offer suggestions and probabilities for likely species identifications. These tools are potentially very useful but only if the identifications provided are reliable. The authors examined the efficacy of five, free, plant identification apps, testing them against images of known genera and species. With some caveats, the authors' report is encouraging, one application correctly identifying 96% of the images on first suggestion.

This is a timely and useful paper. Of course, traditional field identification guides don't need phone chargers or an internet signal and, in this reviewer's experience, are 'only rarely' snatched by passing ecologists of questionable character.

Transforming Conservation: A practical guide to evidence and decision making

Edited by W. J. Sutherland (2022)

Open book publishers downloadable from <https://www.openbookpublishers.com/books/10.11647/obp.0321?fbclid=IwAR3Xm7B-fltNnhrb0Jf3RGE02ccs2V--eEbgEnqZsnK-ftApBbljd11nzYg>.

You Tube introduction: <https://www.youtube.com/watch?v=Js9liVXdh20>

This new book from the Conservation Evidence group was launched in December 2022, with contributions from 76 international authors. It begins by introducing problem recognition and barriers to finding effective solutions using learning from evidence-based medicine to demonstrate the vital importance of looking critically at the conservation sector. That we have a biodiversity crisis is a clear indication that this is urgently required. It questions current approaches, including relying on 'expert' opinion and citing the questionable scientific basis for much current guidance.

This book runs to 430 pages but don't be put off – it is a potential game changer (and it's free). Chapter 5, improving the reliability of judgements, is well worth a read – if only to stimulate self-reflection on our own practice. The third section is where it gets practical, with Chapter 7 devoted to problem framing and identifying solutions; Chapter 10 considers how evidence can be derived from conservation practice. Chapter 12 provides useful downloadable checklists, for example for ensuring reports are evidence based, with the final chapter provides additional online resources.

The aim of this book is to help develop better, more structured ways of making decisions, using robust, scientific evidence for action to ensure conservation objectives are achieved and resources are not a wasted. Practical methods for adopting this approach are provided although the need for structural change, from government through organisations and individual businesses – and funding bodies – will be required for real success.

The future of Ecological Research in the UK

Malhi Y. *et al.* (2023)

British Ecological Society, London, UK

Available at: https://www.britishecologicalsociety.org/wp-content/uploads/2023/03/BES_Future_of_Ecological_Research_Report.pdf

In this report, subtitled *A Research Agenda for the Next 25 Years*, five priorities for ecological research are set out, reflecting the urgent need to address the combined crises of climate change and biodiversity loss. These are:

- Novel futures
- Living laboratories: these provide opportunities for research, including citizen science
- Dynamic Ecological Systems
- Wholescapes
- Frontiers of Discovery

This, the result of a widescale consultation exercise, is effectively a call to re-evaluate our thinking, consider how environmental change is impacting ecosystems and accept that we cannot keep things the same. Greater understanding of the ecological response to the multiple pressures can help to develop ways to increase resilience but the shift in values, for example to novel and formerly non-native species, and the need to focus on ecosystem function, is acknowledged.

Call rate as an index of nest count in wading bird colonies

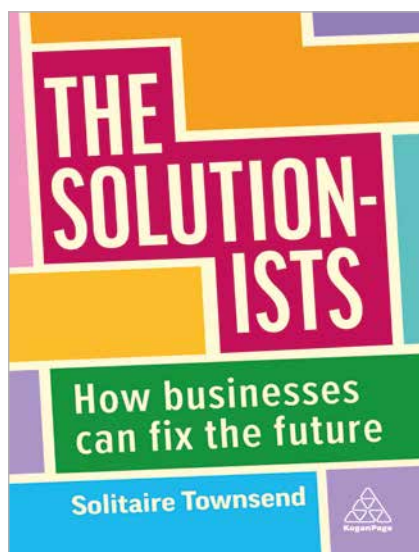
Larson, R.C. and Gawlik, D.E.

Ibis, (2023) 165(2), pp.504-516.

<https://doi.org/10.1111/ibi.13163>

Because traditional methods of counting nests in colonial waterbirds can be costly and potentially disturbing, the authors tested whether the call rate of chicks (per minute) detected on autonomous recording units (ARUs) could be used as a reliable index for nest count at colonies of three heron species in Florida. Nests were counted independently using traditional survey visits, and at the same time an ARU was recording each colony (from one hour before dawn to one hour after dusk). Chick calls were identified using a classification algorithm with a combination of training data and manual verification, detailed in the paper (precision and recall rates are reported in detail). Several variables including wind speed, nest height and duration since colony initiation impacted on chick call rate. For example, for great egret, the denser the vegetation, the lower the chick call rate. However, after controlling for these effects, there were significant, positive, and linear relationships between chick call rate and colony nest count, with similar values across great egret and two small heron species (snowy egret and tricoloured heron). The authors conclude that such acoustic methods could be used to look at long-term trends in the size of water bird colonies, reducing the need for resource-intensive manual counts. In a UK context, with different species and environmental conditions, any such study would need to re-test the approach, but the study indicates the potential for a more efficient way to compare waterbird colony numbers over space and time, potentially aiding wetland conservation and restoration efforts.

BOOK REVIEW



The Solutionists: How Businesses Can Fix the Future

Solitaire Townsend

ISBN: 1398609323

Published: April 2023

I merrily agreed to review *The Solutionists*. It's written by one of my green heroes, Solitaire Townsend. I pre-ordered it so I could get my hands on it as soon as possible. What's not to like? Turns out it's been a challenge to review a book unlike anything I've read before!

It's so informal (even well timed swear words), so easy to read, so inspirational, so rounded, so playful. It's a book you want to both gobble up in one sitting whilst also taking the time to savour and ponder each new morsel.. Most importantly, it's so encouraging! And boy do we all need encouraging!

This is a book to interact with – not keep immaculately on your shelf. Mine is covered in underlines, exclamations marks, smiley faces, exclamations of 'yes!' and turned down corners – not something I usually do but all so I can re-find the abundant gold nuggets. And each chapter ends with Solitaire's 'Solutions Starters' – questions to ponder and act on.

When it comes the nature and climate crisis, I've found my identity: I am not a pessimist, nor unrealistic optimist, nor idealist (I've been accused of all three), turns out I am a Solutionist "on a

lifelong quest to discover new things and find new answers". So, if this sounds like you, this book is definitely one to read and "if you are not one already you will be by the end of the book". No light claim: Solitaire describes the mindset and strategies to make that a reality.

Science trained environmentalists like things evidenced and whilst playfully written, this book is. Solitaire has done her research. She's spoken with myriads of changemakers, CEOs and pioneers and there are 16 pages of references. But you hardly notice – it is so easy to read!

From all her research she has teased out the Solutionist's mindset (vision, grit, flex, fun and soul), the unique strengths of different kinds of Solutionist – architect, accelerator or actioner – and the benefit of combining your kind with others. And all this peppered with inspirational stories.

Her 'Fix it formula' is about solution 'stacking'. The intertwined crisis (nature, climate, food, water, energy, health, and social justice) results from negative effects dominoing through the complex system... but that means solutions can too – sending ripples through the tangle to amplify and multiply wins.

Hope, in Solitaire's world, is a business plan! She explores nine spheres spanning energy, infrastructure, transport, food, material, financial, nature-based, digital, to culture. For each, she outlines where things have got to (much better than you probably imagine) and the priority challenges for Solutionists to get stuck into.

In the environmental world we are all too aware of the physical and ecological tipping points. But there are social tipping points too – and here lies hope of exponential positive change. Solitaire provides insights into social tipping along with storytelling to inspire change and common myths and traps to recognise and counter.

This book is so packed with ideas and solutions it could leave you feeling a tad overwhelmed – but Solitaire knows that and makes the case for taking care of

yourself. She even does that as you read her book playfully suggesting that: "If you've got time to read my brilliant book then you have time to rest your brilliant self. Take 5 or 10 minutes before you come back to the next chapter (which is an intense one)."

And it is intense, the chapter 'Signal Boost' is close to my heart challenging the urgent need to learn from those who are too rarely at the table: indigenous people, young and older, black, brown, female, neurodiverse, LGBTQIA+, and disabled. So much lived experience of what's wrong and what works. We need to shape the future with, not for, each other.

Book reviews are meant to include critique. The only one I can come up with is the subtitle: 'how businesses can fix the future'. If you are not in business this could put you off. Don't let it. Solitaire herself says her book is for Solutionists everywhere: whether professional, activist, private or public sector, environmentalist or not.

After all: "We are in a perilous moment between disaster and opportunity, and everything Solutionists do right now matters". "It's too late to be a pessimist". So go get the book. Lift your spirits, draw from the wisdom, fun and ideas. Hone the mindset, deploy the strategies and in her words "go save the damn planet".

About the Reviewer

Diana Pound CEnv FCIEEM is Managing Director at Dialogue Matters. She has an environmental background but has fused this passion with her skill for facilitation to create a much-needed niche in the sector.

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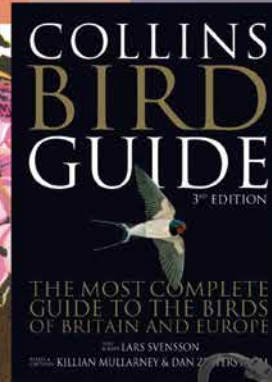
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13 June Biodiversity Metric 4.0: everything you need to know and more Online Webinar	13 June Bats Impact & Mitigation Ireland	13 & 20 June Designing for BNG Online	21 June Introduction to Fern ID Bristol
20 & 21 June A Habitat Design Checklist for Biodiversity Net Gain London & Online	29 & 30 June Plant Identification and Botanical Keys Online	5, 6 & 7 July Working with Crayfish: Survey, Methods, Ecology, Mitigation, Licensing and Invasive Species Yorkshire	12 July Heathland Plants Identification: for botanical surveying and habitat classification Shropshire
12 & 13 July Beaver Ecology and Management Devon	13 July CIEEM 2023 Summer Conference: Managing Ecological Impacts to Restore Water & Wetlands Online	9 August Aquatic Plants Identification Wales	10 August Understanding the Vegetative Key: An essential tool for Ecologists for extending the survey season Shropshire
16 & 17 August National Vegetation Mire and Heaths Scotland	16 & 17 August An Introduction to Practical Rewilding Devon	Early September CIEEM 2023 Welsh Conference TBC	6 September Fern Identification for botanical surveying and habitat classification Shropshire
14 & 15 September National Vegetation Classification Woodlands Scotland	21 & 22 September Phase 1 Habitat Survey Scotland	3 October CIEEM 2023 Scottish Conference: The Role of Trees in a Sustainable Future Edinburgh	3 & 10 October Positive Planning for Biodiversity – First Principles Online

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