Surrey Wildlife Trust

Research Prospectus

2023-2024

Foreword

I am delighted to introduce this prospectus; highlighting the importance of continually identifying and implementing key areas of research which can support our decision making.

Surrey Wildlife Trust was established over 60 years ago and is a member of the Royal Society for Wildlife Trusts. One of our main objectives as a charity is for the benefit of the public through the advancement of science and natural heritage; to promote research in all branches of nature study and to publish the results.

Now annually reviewed, this prospectus is a significant step forward in meeting this mission objective and follows the publication of our Research and Monitoring Framework in 2019.

We know that we are facing complex challenges with ongoing biodiversity and bio-abundance losses as well as the impact of climate change. We also know that the restoration of biodiversity through a range of nature-based solutions is essential to achieve targets such as 30% of land protected and managed for nature by 2030.

In Surrey we have been building our knowledge and evidence base through work such as the State of Surrey's Nature, published in 2017. We know that over a third of species in Surrey are lost or in decline, mirroring the national picture. The role of research in guiding our work to halt and reverse this trend is vital.

Our strategic direction acknowledges that collaboration with a wide range of partners is essential, not only to implement but also to evaluate the interventions we make. This is where our relationships with academic partners and other specialist groups are so vital and this prospectus will encourage even more of these activities.

We look forward to working with you.

Sarah Jane Chimbwandira

CEO, Surrey Wildlife Trust

Introduction

At Surrey Wildlife Trust, we are committed to finding the long-term solutions to ongoing biodiversity declines that nature so badly needs in our county. Science is at the heart of our decision-making, and we strive to use sound scientific evidence to inform both our policy and our actions. Building this evidence-base is a continually iterative work-stream, ever growing with advancements in applied science and conservation experience. As part of this goal, we have signed an agreement to be an 'Evidence Champion' with Conservation Evidence to formally commit to contribute to this process, and use research outcomes to inform both ourselves and others. We are keen to work with external partners to further our collective understanding of the natural world. Our hope is that the work produced, and the collaborative relationships that develop through this research prospectus moves us closer towards bridging the gap between academia and biodiversity conservation practice.

There are six themes to this work:

1. Understanding the pressures on the natural world and how they impact both biodiversity and bio-abundance.
2. Understanding the causes for decline of key priority species in Surrey and establishing a course of action to reverse this.
3. Discovering better ways to manage and restore the natural environment to support biodiversity, bio-abundance and enhance habitat connectivity.
4. Understanding how new technology can be utilised for various applications across the field of nature conservation. For example, to capture monitoring information about the natural environment or as a tool to widen voluntary participation and accessibility.
5. Understanding how people benefit from and interact with the natural environment, from a variety of aspects including education, social responsibility, and health and wellbeing.
6. Understanding the economic and social value of natural assets (Natural Capital) within Surrey and how this can then provide the necessary evidence to influence local policy makers, to embed more sustainable practice within all forms of commerce, including the development sector.

We are also committed to investing in successor generations of scientists and researchers, and ensuring they are involved in worthwhile and meaningful projects during their secondary and tertiary education. Through our research placements, we aim to provide vital experience in the sector for young people and help them develop new skills in real-world research, monitoring and conservation work. By working as part of The Wildlife Trusts national movement, there will be ample opportunity for networking to promote future employment prospects.

Proud to be partnered with:

Conservation Evidence
Providing Evidence to Improve Practice

Working with Universities

Surrey Wildlife Trust has been working with local universities for many years.

We have a close relationship with the University of Surrey, with which we have had a variety of joint endeavours. Most recently, our flagship Space 4 Nature project is in partnership with University of Surrey's Centre for Environment and Sustainability, where we are also hosting a PhD student.

We also work closely with our other local university, Royal Holloway, with whom we have hosted several joint events and student placements. Additionally, Imperial College London conduct annual visits to the Trust as part of the Environmental Management MSc course. They receive talks from various departments and partake in practical conservation experience.

The University of Surrey's Biological Sciences BSc students have recently begun joining us for similar visits, where they learn about balancing the human and environmental demands on nature reserves.

Since the launch of our first Research Prospectus in 2021, we have continued to build strong relationships with other local universities including Kingston University, Reading University, Sussex University, and University College London.

Past Students

Opposite are two of the students we have worked with over recent years, talking about their experiences collaborating with us on their projects.

Rachel

MSc Environmental Technology, Imperial College London

I collaborated with the Surrey Wildlife Trust (SWT) on my postgraduate thesis during the summer of 2021. After listening to a lecture from SWT during my second term on the work that the Trust was conducting regarding connectivity, I reached out to and asked if they would consider supervising me, as I wanted to do a project on this too. They had previously worked with students on similar projects, so they were aware of the entire thesis process. SWT were incredibly quick to respond and supportive in helping me pick the direction I wanted to go, giving me freedom in doing so. I wanted to look at how collaboration between farmers could improve connectivity across landscapes. Through the support and the expertise from various members of staff, I was able to learn how to use new software programmes like GIS, which became integral to my project. As I was new to this software, I was able to ask for meetings at any point, which I found incredibly helpful as this project was done during the pandemic. Collaborating with the SWT also enabled me to learn from different members of the organisation, providing many contacts that I could interview to support and strengthen my work. It was a great experience being able to work with an organisation outside of an academic setting and I am incredibly thankful for the opportunity that SWT provided me.

Logan

MSc Conservation, University College London

Prior to choosing a dissertation topic, I was highly motivated to seek projects outside of the university in order to develop connections and an appreciation for the work that happens outside of an academic setting, which is how I decided to work with the Surrey Wildlife Trust. It was enjoyable to collaborate with this organization because they gave me the freedom I wanted in a dissertation while still offering any support I needed. I was interested in this grazing pig topic because of my background in animal science education as well as growing up in a rural setting where agriculture and ecological conservation are not mutually exclusive. This research provided me the framework to deepen my understanding of the theories and feasibility behind conservation grazing all while developing my fieldwork, GIS, and report writing skills.

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Applied Conservation Science

Project 1.1: Evidencing the Relationship Between Biodiversity & Bio-Abundance

The interdependence of healthy ecosystem function and maximised biodiversity is often assumed as a given but remains relatively poorly evidenced, at least for the purposes of confidence in practical environmental policy-making. Indeed, there is little agreement in how to monitor and quantify biodiversity change for the assessment of ecosystems and biodiversity for policy targets (Hill et al., 2016). In the absence of data on abundance, biodiversity serves largely as a proxy for bio-abundance, this being the more likely critical factor. Species richness, often used as the metric for biodiversity, tells us relatively little about important 'keystone' components driving ecosystems (Hillebrand et al., 2017). There has, in addition, been research which suggests that this assumption may be incorrect for some groups of animals (Nimmo et al., 2011).

This question remains relevant globally as well as locally. Surrey-based research could therefore attempt to explore and provide evidence for this suggested correlation of biodiversity and bio-abundance using our county as a case study. As a very mixed and highly crowded county in terms of land-use and habitat, it would hopefully provide a useful exemplar for global urbanisation impacts in general.

The project is somewhat open in terms of methods, but it is expected to be a desk-based study in which available data would be utilised to analyse the relationship between biodiversity and bio-abundance by investigating historical records for species relative to their changing statuses. Data would be provided by ourselves in collaboration with the Surrey Biodiversity Information Centre.

Key references:

Hill, S.L.L., Harfoot, M., Purvis, A., Purves, D.W., Collen, B., Newbold, T., Burgess, N.D. and Mace, G.M. (2016). Reconciling Biodiversity Indicators to Guide Understanding and Action. Conservation Letters, 9(6), pp.405–412.

Hillebrand, H., Blasius, B., Borer, E.T., Chase, J.M., Downing, J.A., Eriksson, B.K., Filstrup, C.T., Harpole, W.S., Hodapp, D., Larsen, S., Lewandowska, A.M., Seabloom, E.W., Van de Waal, D.B. and Ryabov, A.B. (2017). Biodiversity change is uncoupled from species richness trends: Consequences for conservation and monitoring. Journal of Applied Ecology, 55(1), pp.169–184.

Nimmo, D.G., James, S.G., Kelly, L.T., Watson, S.J. and Bennett, A.F. (2011). The decoupling of abundance and species richness in lizard communities. Journal of Animal Ecology, 80(3), pp.650–656.

Project 1.2: Post-Wildfire Recovery of Reptiles on Lowland Heaths

In recent years wildfires on lowland heathland have occurred with increasing frequency, related to higher temperatures and drought conditions associated with climate change. It is estimated that the number of days able to support serious wildfires in the south of England will climb from 20 per annum in 2020 to 111 by the 2080s (Arnell et al., 2021). These fires can be catastrophic for local wildlife populations, especially those with limited mobility such as reptiles. Modelling predicts that sites can take up to 10 years to fully recover from a sever burn (Hobbs and Gimingham, 1984).

In Surrey numerous sites saw their most extensive ever fires in 2022, but most have seen large burns in previous years over the last decade including a burn of over 30 hectares at Chobham Common NNR in 2020 (Countryfile, 2020). Surrey's heathland sites are home to nationally important populations of the six native reptile species, which are among the most impacted groups. With the increasing frequency of large-scale fires, it is crucial for us to better understand the long-term impacts of these now unavoidable events.

The project will involve a mix of field and desk-based work, including ecological surveys for reptiles in different heathland reserves and use of historical data. Genetic sampling may also provide insights into the inter-relatedness and relative isolation of populations. The data would be analysed using statistical software and mapped using GIS. Support would be provided for survey and sampling work, and species identification.

Key references:

Arnell, N.W., Freeman, A. and Gazzard, R. (2021). The effect of climate change on indicators of fire danger in the UK. Environmental Research Letters, 16(4), p.044027.

Countryfile. (2020). Chobham Common wildfire destroys vital wildlife habitat. [online] Available at: https://www.countryfile.com/news/chobham-common-wildfire-destroys-vital-wildlife-habitat/.

Hobbs, R.J. and Gimingham, C.H. (1984). Studies on Fire in Scottish Heathland Communities II. Post-Fire Vegetation Development. The Journal of Ecology, 72(2), p.585.

Project 1.3: Invasion of the Signal Crayfish Pacifastacus leniusculus

The Signal Crayfish *Pacifastacus leniusculus* is a non-native invasive species originally from western North America. It was imported into the UK in the 1970s as a commercial species, and soon escaped from commercial fisheries into UK rivers. The crayfish carries Crayfish Plague *Aphanomyces astaci* which, alongside their larger size and aggressive behaviour, has decimated populations of the native White-clawed Crayfish *Austropotamobius pallipes* (James et al., 2017; Hudina and Hock, 2012). The Signal Crayfish is an extremely successful invader, capable of covering distances of over 150 metres/day and have thus-far circumvented any pragmatic method of successfully controlling its population and spread (Chadwick et al., 2020)

We believe that *P. leniusculus* may have been present in Surrey from as early as the late '70s to early '80s, when it was found in many rivers across southern England. There are a handful of Surrey records from this period, with many more from the '90s onwards – following the trend of an estimated 43% increase in occurrence between 1997-2001 (GB NNSS, 2019). The native *A. pallipes* populations are limited to a few headwater sites where *P. leniusculus* has not yet reached. To inform the crucial protection of these refuge sites, we need to understand how far the invaders have travelled upstream and what is preventing them from travelling further. It would also be pertinent to reaffirm locations of persisting *A. pallipes.*

The project will involve a mix of field and desk-based work, including ecological surveys of Signal Crayfish in different headwaters across Surrey, with the potential for using eDNA to survey for *A. pallipes* (dependent on funding). The data would be analysed using statistical software and mapped using GIS. Support would be provided for survey work and species identification. This would best suit a university that is already comfortable with eDNA protocols.

Key references:

Chadwick, D.D.A., Pritchard, E.G., Bradley, P., Sayer, C.D., Chadwick, M.A., Eagle, L.J.B. and Axmacher, J.C. (2020). A novel 'triple drawdown' method highlights deficiencies in invasive alien crayfish survey and control techniques. Journal of Applied Ecology. doi:10.1111/1365-2664.13758.

GB NNSS. (2019). Signal Crayfish» NNSS. [online] Available at: https://www.nonnativespecies.org/non-native-species/information-portal/view/2498 [Accessed 18 Jul. 2022].

Hudina, S. and Hock, K. (2012). Behavioural determinants of agonistic success in invasive crayfish. Behavioural Processes, 91(1), pp.77–81. doi:10.1016/j.beproc.2012.05.011.

James, J., Nutbeam-Tuffs, S., Cable, J., Mrugała, A., Viñuela-Rodriguez, N., Petrusek, A. And Oidtmann, B. (2017) "The prevalence of Aphanomyces astaci in invasive signal crayfish from the UK and implications for native crayfish conservation," Parasitology. Cambridge University Press, 144(4), pp. 411–418. doi: 10.1017/S0031182016002419.

Project 1.4: Tracking Cattle Movement to Ground Truth Remote Sensed Grazing Patterns

In the UK, 80% of lowland heathland has been lost since the early 1800s. Species-rich calcareous grassland has suffered similarly. The protection of the remaining areas has provided a mosaic of different habitats which has prevented a wide range of specialist species from going extinct. Cattle grazing supports the restoration of grassland and heathland communities by supressing plants that would otherwise dominate the area (such as scrub or bracken), creating variety in the habitat by introducing grazed areas of varying sward heights, and reducing the nutrient availability which allows any single species to outcompete others.

Remote sensing techniques have the potential to monitor the restoration of grasslands and heathlands. Projects such as Space4Nature are currently training satellites to detect plant communities and assess their condition, including an estimation of grazing impact. This process requires hundreds of hours of manual surveys to provide ground-truthed data on species and their status. Tracking the movements of the cattle has the potential to act as proxy for grazing pressure and poaching in an area over time. This information could be used to inform habitat management planning across a site while also providing novel insights on livestock interactions with evolving restoration projects.

This project would involve a mixture of field and desk-based work as the student would need to model the relationship between patterns of cattle movement and satellite evidence of grazing, then evaluate their model by field-assessing the actual levels of grazing on site. Surrey Wildlife Trust has collected GPS tracking data from

cattle fitted with 'Nofence' collars which is waiting to be analysed. We can support the student with the use of GIS software, data access, and site access. This would best suit a university that is comfortable with modelling.

Key references:

Xu, D., Chen, B., Yan, R., Yan, Y., Sun, X., Xu, L., and Xin, X. (2018) "Quantitative monitoring of grazing intensity in the temperate meadow steppe based on remote sensing data" International Journal of Remote Sensing 40(5-6), pp. 2227-2242. doi: 10.1080/01431161.2018.1500733

Filazzola, A., Brown, C., Dettlaff, M., and Amgaa, B. (2020) "The effects of livestock grazing on biodiversity are multi-trophic: a meta-analysis" Ecology Letters 23(8), doi: 10.1111/ele.1352

Wang, L., Delgado-Baquerizo, M., Wang, D., Isbell, F., Liu, J., Feng, C., Liu, J., Zhong, Z., Zhu, H., Yuan, X., Chang, Q., and Liu, C. (2019) "Diversifying livestock promotes multidiversity and multifunctionality in managed grasslands" PNAS 116(13), pp. 6187-6192, doi: 10.1073/pnas.1807354116

Project 1.5: Quantifying the Value of Soil Health in Habitat Restoration

The importance of soil health in sustainable agriculture has been a key research focus for over a decade, but its wider role in nature recovery may have been overlooked. Changes to the chemical composition of the soil and microorganism exposure when the soil is disturbed can impact the community of organisms that area supports, which has the potential to create change across the connected ecosystem. Soils support a diverse community of microorganisms and invertebrates that comprise around a quarter of the biodiversity on Earth. Although quantifying these community compositions is often difficult, they are just as vulnerable to biodiversity loss as other groups and play a key role in supporting ecosystems. Alongside the obvious role of soil in physically supporting biodiversity through providing a growth substrate, healthy soil also sequesters carbon, increases drought tolerance by absorbing and retaining water, and influences the spread of diseases at a local and landscape scale. Considering soil health in management plans is therefore key for ecosystem recovery and resilience, and can feed into many other global biodiversity targets.

This project would be a combination of field, laboratory, and desk-based work as the student would need to evaluate soil community or chemical compositions at different sites, compare and contrast the impact of current land management practices on soil health, and create an evidence-based recommendation to improve these practices. There is also scope to collaborate with an industry partner on this project to increase the diversity of sites. SWT can arrange site access and provide management plans for our sites, as well as support understanding the wider ecological context for the work. This would best suit a university that has prior experience with soil analysis.

Key references:

Wall, D.H., Niel, U.F., and Six, J. (2015) 'Soil biodiversity and human health' Nature 528 pp. 69-76

Bach, E.M., Ramirez, K.S., Fraser, T.D., and Wall, D.H. (2020) 'Soil Biodiversity Integrates Solutions for a Sustainable Future' Sustainability 12(7) pp. 2662, doi: 10.3390/su12072662

Dubey, A., Malla, M.A., Khan, F., Chowdhary, K., Yadav, S., Kumar, A., Sharma, S., Khare, P.K., and Khan, M.L. (2019) 'Soil microbiome: a key player for conservation of soil health under changing climate' Biodiversity and Conservation 28 pp. 2405-2429

Project 1.6: Evaluating the Potential for Improving Biodiversity on Solar Farms

The current climate crisis necessitates a shift from fossil fuels to renewable energy to reduce greenhouse gas emissions. Solar farms are an increasingly popular green energy solution globally (Kruitwagen et al. 2021) and there is an ever-increasing number of planning applications submitted across the UK to create more. Large-scale solar farms require large surface areas which compete with agriculture, developments, and habitat restoration priorities. To balance this, there is an increase in 'agrivoltaic farming' - combining agriculture and farming on the same land (Handler and Pearce 2022) as well as pilot sites planting pollinator-friendly seed mixes in buffer zones around and between panels (Meyer et al. 2023). Despite the availability of practical guidance for increasing biodiversity on solar farms (Naturesave Insurance & Wychwood Biodiversity 2021), most often they present as simply panels over mown or grazed grass, providing little opportunity for complex ecosystems to establish.

The locations of these solar farms are generally ideal habitat areas for reptiles which could be supported if minor changes are implemented such as adding artificial refugia under panels and creating patches of bare soil for ground-nesting insects as a food source. Surrey is seeing a significant

increase in planning applications for new solar farms. Increasing biodiversity on solar farms and using them as corridors to connect habitats would feed into other local government environmental goals such as those of the Local Nature Recovery Network. To generate recommendations for encouraging reptile habitation on solar farms, we need to evaluate the effectiveness of available methods against the practicalities of implementation.

This project would be a combination of field and desk-based work. The student would need to review the suitability of solar farms for supporting reptiles and amphibians, as well as the steps necessary to transform a site into suitable habitat. They would then need to trial these methods and evaluate the cost-effectiveness of different strategies before making recommendations. This would be a joint project with SWT and the Surrey Amphibian & Reptile Group (SARG), who can provide expertise around the ecological requirements of the project. There is also potential here to link with industry partners and local planning authorities to inform the recommendations.

Key references:

Kruitwagen, L., Story, K.T., Friedrich, J., Byers, L., Skillman, S., and Hepburn, C. (2021) 'A global inventory of photovoltaic solar energy generating units' Nature 598 pp. 604-610

Handler, R., and Pearce, J.M. (2022) "Greener sheep: Life cycle analysis of integrated sheep agrivoltaic systems" Cleaner Energy Systems 3 pp. 100036, doi: 10.1016/j.cles.2022.100036

Meyer, M.H., Dullau, S., Scholz, P., Meyer, M.A., and Tischew, S. (2023) 'Bee-Friendly Native Seed Mixtures for the Greening of Solar Parks' Land 12(6) pp. 1265, doi: 10.3390/land12061265

Naturesave Insurance & Wychwood Biodiversity (2021) "Realising the Biodiversity Potential of Solar Farms – A practical Guide" [online] Available at: https://cdn.buglife.org.uk/downloads/realising-the-biodiversity-potential-of-solar-farms.pdf

Project 1.7: Evaluating the Current State of Ancient Woodland in Surrey

'Ancient woodland' is defined as an area of natural or semi-natural woodland that existed continuously since or before 1600 AD. These places are considered to be incredibly valuable both ecologically as biodiversity hotspots, and intrinsically for human use and well-being (Rackham, 2008). They are characterised by dynamic, heterogenous mosaics of woodland microhabitats, which are allowed to naturally fluctuate through the persistence of ecological processes as well as traditional management practices, such as coppicing. By their nature, they are irreplaceable habitats, and the remaining resource covers only 2.5% of the UK. Due to the national importance of these habitats, Natural England has maintained an Ancient Woodland Inventory (AWI) database since the 1980-90s, which holds information about over 52,000 ancient woodland sites across England (Sansum and Bannister, 2018).

In Surrey, we have a national stronghold of the UK's remaining ancient woodland, of which Surrey Wildlife Trust manages a considerable portion (over 1,300 Ha). This valuable woodland resource, however, is under threat from encroaching development pressure, as exemplified by the vast swathes of woodland threatened elsewhere to make way for HS2 (Razzaque and Lester, 2020). Whilst the AWI database provides important information about where ancient woodland is located within Surrey, the data does not include information about the management state and ecological health of this resource. This is a pertinent question, as it directly informs land management decisions, and the ability of these woodlands to support a complexity of species and provide key ecosystem services.

This project could take a variety of approaches, which may involve field work and use of remote sensing. Support and guidance would be provided by SWT. There is also potential for collaboration with other partners, such as the Forest Research Group.

Key references:

Rackham, O. (2008) 'Ancient woodlands: Modern threats', New Phytologist, 180(3), pp. 571–586. doi:10.1111/j.1469-8137.2008.02579.x.

Razzaque, J. and Lester, C. (2020) 'Why protect ancient woodland in the UK? rethinking the ecosystem approach', Transnational Environmental Law, 10(1), pp. 135–158. doi:10.1017/s2047102520000333.

Sansum, P. and Bannister, N.R. (2018). 'A Handbook for updating the Ancient Woodland Inventory for England'. Natural England Commissioned Reports NECR248

2

Priority Species Autecological

Project 2.1: Recovering Small Fleabane to Surrey

Small Fleabane *Pulicaria vulgaris* is a NERC Act Section 41 Species of Principal Importance, which has experienced a significant decline in the UK due to loss of habitat and declining condition of remaining habitat (JNCC, 2019). As its specific name would suggest, *P. vulgaris* ('vulgaris' = 'common') was formerly widespread in south-east England but is now restricted to a small number of localities in the New Forest, disappearing from neighbouring counties in the past 50 years (FWHT, 2013). The species is restricted to seasonally-flooded pond margins, hollows and grazed damp acidic grassland, the decline in management of which is often associated with that of 'commoning' as a modern agricultural practice (Lousley, 1976).

P. vulgaris is believed locally extinct in Surrey since the early 2000s, after the cessation of grazing on its former stronghold site on Backside Common. This site is a Surrey Wildlife Trust nature reserve where a restoration programme to involve suitable site management, seedbank recovery and monitoring is the only way back for this unspectacular but no less-deserving plant – a good indicator for the ideal management of formerly grazed common land. There is significant evidence that the species can recover from dormant seed-bank populations, as has been achieved at Backside Common previously, which may provide viable, genetically appropriate propagules for a reintroduction programme (Chatters et al., 2014).

The project will involve a mix of field and desk-based work, including ecological surveys of Backside Common and experimental plots to germinate seed-bank propagules. Support would be provided for survey work and species identification. Further interested parties may include the Surrey Botanical Society and Plantlife.

Key references:

Chatters, C., McGuire, C., Rand, M. and Sanderson, N. (2014) Small Fleabane in the New Forest. [online] . Available at: https://www.hlsnewforest.org.uk/app/uploads/sites/3/2018/03/Small_Fleabane_report_140213_Final_Report_CC_CM.pdf

FWHT (2013) Creating ponds for Small Fleabane Pulicaria vulgaris [online] . Available at: https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/Small-Fleabane-new-logo.pdf

JNCC (2019). Report on the Species and Habitat Review (UK BAP) | JNCC Resource Hub. [online] Available at: https://hub.jncc.gov.uk/assets/bdd8ad64-c247-4b69-ab33-19c2e0d63736

Lousley, J.E. and Surrey Flora Committee (1976). Flora of Surrey. Newton Abbot: David & Charles.

Project 2.2: Impacts of Grazing on *Hagenella clathrata*, the Window-Winged Caddis

The Window-winged Caddis Fly is one of the rarest and most threatened caddisfly species in Europe and is known from only a small selection of sites across Northern Europe (Buczynska et al., 2012). It is also a Species of Principal Importance, which relies on lowland wet heath and transitional valley mire habitats, both now highly threatened by climate change. Decline in condition of the habitat is the prevalent cause of the decline of *H. clathrata* (Wallace, 2011). Relatively little research has been invested in effective conservation measures, but it has recently been proved that there is a clear co-occurrence of *Hagenella* with other endangered species (van Kleef et al., 2012).

There are two nationally important populations of *H. clathrata* in Surrey; at Whitmoor Common and Chobham Common, both of which are managed by Surrey Wildlife Trust on behalf of Surrey County Council. The Species Recovery Trust has supported the species' on-going monitoring, but there remains plenty of scope for autecological research into this charismatic species. In particular, the potential benefit of conservation grazing still requires assessment for future conservation strategies. Conservation grazing is widely practiced across Surrey's heathlands, so it is important we understand its impacts on *Hagenella*.

The project will involve a mix of field work in the spring and desk-based work, including ecological surveys of Whitmoor

and Chobham Commons, and possibly also on a newly discovered site in East Hampshire. The data would be analysed using statistical software. Support would be provided for survey work and species identification.

Key references:

Buczyńska, Edyta & Cichocki, Włodzimierz & Patrycja, Dominiak. (2012). New data on the distribution and habitat preferences of Hagenella clathrata (Kolenati, 1848) (Trichoptera: Phryganeidae) in Poland – the species from Polish Red Book of Animals. Annales - Universitatis Mariae Curie-Sklodowska, Sectio C. LXVII. 25-32.

van Kleef, H.H., van Duinen, G.-J.A., Verberk, W.C.E.P., Leuven, R.S.E.W., van der Velde, G. and Esselink, H. (2012). Moorland pools as refugia for endangered species characteristic of raised bog gradients. Journal for Nature Conservation, 20(5), pp.255–263

Wallace, I. (2011). Hagenella clathrata Contact details Species dossier: Hagenella clathrata. [online]. Available at: https://cdn.buglife.org.uk/2019/07/Hagenella-clathrata-species-dossier.pdf

Project 2.3: Rediscovering the Spider Assemblage at Chobham Common

Chobham Common National Nature Reserve is the most biodiverse site for spiders in the UK, with records of many nationally endangered, rare and scarce species. However, many of these records are now very old. The spider assemblage is moreover a notified feature of its SSSI status. A long-term monitoring project to review and update our knowledge of this important assemblage is long overdue.

The project would design and begin a long-term species recording and monitoring programme as an applied exercise in the purposes of ecological fieldwork, that would fully sample this extensive site within a decade; in combination with opportunistic autecological studies to ascertain the status of one or more species of conservation importance present on the site, such as *Cheiracanthium pennyi* (Endangered), *Lathys heterophthalma* (Vulnerable), *Dipoena erythropus* (Vulnerable), and *Notioscopus sarcinatus* and *Araneus alsine* (both Nationally Scarce).

The project would combine fieldwork and GIS mapping, providing experience on several applied survey methods including sweeping, pitfall trapping and DVAC sampling. Support would be provided for survey work and species identification.

Key references:

Dodd, S G. (2011). The Spiders of Chobham Common, Surrey [VC 17]. Surrey Wildlife Trust Ecology Services.

Harvey P et al. (2017). A review of the scarce and threatened spiders (Araneae) of Great Britain: Species Status No.22. British Arachnological Society

Spider & Harvestman Recording Scheme national database; [online] Available at: https://srs.britishspiders.org.uk/portal.php/p/About+the+Spider+Recording+Scheme

Project 2.4: Investigating Smooth Snakes *Coronella austriaca*

The Smooth Snake is the rarest reptile in Britain and is extremely secretive, occurring naturally on a handful of lowland heathland sites in Southern England. They are well protected by UK and European legislation but have experienced an estimated 90% population decline in the last century (Langham, 2018). Part of the difficulty studying the Smooth Snake is the fact that it does not habitually bask in the open like other reptiles; they are far more reliant on stands of mature heather, so therefore requires well-established dry heathland and is therefore very vulnerable to wildfires.

Surrey Amphibian and Reptile Group (SARG) has monitored the Surrey population carefully over the recent decades. Detailed biometric data exists for each individual snake, which will enable researchers to answer many questions about the snake's movements, behaviour and population dynamics. One question concerns the genetic distinctiveness of Surrey's Smooth Snake population, which could be provisionally answered using the biometric data. A previous study found that even within the Dorset populations initial genetic differentiations could be detected (Pernetta et al., 2011).

The project would combine primary data, collected in the field, with secondary data provided by SARG to investigate long-term trends in Smooth Snake populations. GIS and statistics would be used in analysis. Support would be provided for survey work and species identification.

Key references:

Langham, S. (2018.). SARG: Smooth Snake. [online] Available at: http://surrey-arg.org.uk/SARGWEB.php?app=SpeciesData&Species=smooth_snake.

Pernetta, A.P., Allen, J.A., Beebee, T.J.C. and Reading, C.J. (2011). Fine-scale population genetic structure and sex-biased dispersal in the smooth snake (Coronella austriaca) in southern England. Heredity, 107(3), pp.231–238.

Project 2.5: In Search of the Red-Barbed Ant *Formica rufibarbis*

The Red-Barbed Ant *Formica rufibarbis* is an extremely rare ant in the UK, with its own dedicated Species Action Plan and is a NERC Act S.41 Species of Principal Importance (Gammans, 2008). Part of its rarity in the UK can be attributed to its specific habitat requirements, as it is one of the most thermophilic species of the *Formica* genus and requires an open unvegetated habitat with sandy substrate to obtain sufficient warmth (Seifert and Schultz, 2009). However, due to its relatively small colony size and similar appearance to other formicine ants it is possible that there are a number of unknown populations on heathland and other non-heathland sandy grassland sites within the UK.

Whilst more common in continental Europe, the UK mainland population is restricted to 14 recently discovered colonies within Hampshire. Until their discovery it was confined to a single population within Surrey at Chobham Common (BWARS, 2002) However, this population has now been lost to *Formica sanguinea* slavery. *F. sanguinea* has become extremely prevalent in heathland sites in the south of England and as such it is unlikely that *F. rufibarbis* persists in heathland sites where *F. sanguinea* is present. Neighbouring sandy grassland sites in Surrey, especially those within a short distance of former populations, could support unknown *F. rufibarbis* colonies. If present, this would obviously have significant implications not only the protections of these sites but also their management.

The project will involve a mix of field and desk-based work, including ecological surveys of sites around Pirbright, Woking, Ash, Frimley, Chobham areas. The data would be analysed using statistical software and mapped using GIS. Support would be provided for survey work and species identification.

Key references:

Bees, Wasps and Ants Recording Society. (2002). Formica rufibarbis Fabricius, 1793 | BWARS. [online] Available at: https://www.bwars.com/ant/formicidae/formicinae/formica-rufibarbis [Accessed 18 Jul. 2022].

Gammans, N. (2008). Conserving the red-barbed ant (Formica rufibarbis) in the United Kingdom. Project Report 2008. http://hymettus.org.uk/downloads/F%20rufibarbis%20tech%20report.pdf

Seifert, B. & Schultz, R. (2009). A taxonomic revision of the Formica rufibarbis FABRICIUS, 1793 group (Hymenoptera: Formicidae). Myrmecological News, 12, pp.255-272.

Project 2.6: Brown Trout *Salmo trutta* in Headwater Streams

The native Brown Trout *Salmo trutta* is an anadromous species of fish that often migrates to sea, as a sea trout, from its birth-place in rivers (Klemetsen et al., 2003). Anthropogenic impacts on freshwater systems have led to the decline of many native fish populations. Particularly for salmonid fish like *S. trutta*, the historic construction of weirs across our river systems has limited their access to traditional breeding sites in the headwaters of our river catchments (Gosset et al., 2006).

Surrey's headwater streams are home to many genetically distinct populations of Brown Trout that have been isolated from other populations for centuries due to the impacts of instream barriers on fish passage. These isolated populations are very precious, however the extreme dry periods associated with climate change experienced in recent years are starting to impact Surrey's headwater streams, putting these populations under increasing pressure (Jonsson & Jonsson, 2009). We want to better understand where these populations are across Surrey and which of these are most vulnerable to climate change. This will help us target management interventions, at both the reach and landscape scale, to better protect them.

The project will involve a mix of field and desk-based work, including ecological surveys of brown trout in different headwaters across Surrey using eDNA as well as landscape analysis to map local pressures. The data would be analysed using statistical software and mapped using GIS. Support would be provided for survey work and species identification.

Key references:

Gosset, C., Rives, J. and Labonne, J. (2006). Effect of habitat fragmentation on spawning migration of brown trout (Salmo trutta L.). Ecology of Freshwater Fish, 15(3), pp.247–254. doi:10.1111/j.1600-0633.2006.00144.x.

Klemetsen, A., Amundsen, P.-A. ., Dempson, J.B., Jonsson, B., Jonsson, N., O'Connell, M.F. and Mortensen, E. (2003). Atlantic salmon Salmo salar L., brown trout Salmo trutta L. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. Ecology of Freshwater Fish, [online] 12(1), pp.1–59. doi:10.1034/j.1600-0633.2003.00010.x.

Jonsson, B. and Jonsson, N. (2009). A review of the likely effects of climate change on anadromous Atlantic salmon Salmo salarand brown trout Salmo trutta, with particular reference to water temperature and flow. Journal of Fish Biology, 75(10), pp.2381–2447. doi:10.1111/j.1095-8649.2009.02380.x.

Project 2.7: Exploring Cranefly Diversity at Bay Pond, Boldermere & Eashing

The craneflies or *Tipulidae* are an under-recorded invertebrate group and yet they represent an important ecological indicator of the quality of wetland ecosystems. Relatively little research exists around these insects, but their essential role in the diet of various bird species (Rhymer et al., 2012) is well understood. As with many insect taxa, recent studies have shown that the phenology and distribution of the Tipulidae is likely to be impacted by climate change, which could then have trophic impacts on dependent predators (Devlin et al., 2022).

At least two Trust-managed SSSI (Boldermere at Ockham Common and Bay Pond near Godstone) include important cranefly assemblages as one of their notified features. A further privately-owned site close to a Trust-managed SANG near Eashing also has this feature. These sites all support Alder-dominated wet woodland, which is known to be an important habitat for craneflies, however the assemblages at the sites have not been formally re-assessed since the early 1980s. As discussed above, it would be prudent to improve our understanding of the current status of these assemblages to effectively monitor these sites in the coming years.

This project would review the three SSSI-qualifying datasets, conduct the necessary fieldwork and prepare a report summarising findings, with recommendations for conservation management. It would be partnered with Natural England. A new field guide (Stubbs, 2021) is set to make this group far more accessible to would-be Dipterists and experienced entomologists alike, who would also boost the flow of much-needed records into the UK Cranefly Recording Scheme.

Key references:

Devlin, J.J., Thomas, R.J., Long, S.E., Boardman, P. and Dupuis, J.R. (2022). Impact of climate change on the elevational and latitudinal distributions of populations of Tipulidae (Diptera) in Wales, United Kingdom. Biological Journal of the Linnean Society, [online] 137(1), pp.30–46. doi:10.1093/biolinnean/blac079.

Rhymer, C.M., Devereux, C.L., Denny, M.J.H. and Whittingham, M.J. (2012). Diet of Starling Sturnus vulgaris nestlings on farmland: the importance of Tipulidae larvae. Bird Study, 59(4), pp.426–436. doi:10.1080/00063657.2012.725026.

Stubbs, A.E. (2021). British craneflies. Hurst: The British Entomological and Natural History Society.

3

Habitat Restoration: Methodology & Evidence

Project 3.1: Quantifying Landscape Resistance

Landscape resistance is commonly used in models analysing landscape connectivity for species movements (Zeller et al., 2012). Although much research already exists, and a variety of methodologies have been developed (Van Mooter et al., 2021), there remain many datasets reliant on assumptions and expert opinion rather than quantitative data collected from the field. Further work on the autecology and behavioural responses of these species will provide much needed insight, especially if this is conducted within direct context of the management activity under scrutiny.

Surrey Wildlife Trust has been working on quantifying landscape connectivity for several years and continues to develop and expand the methodology. Any work to further supplement the efforts to accurately model connectivity for the county would have vast applications throughout the Trust's projects.

There are a variety of approaches to this project. As a possible proxy value to test how isolated these species populations actually are within a fragmented landscape, their degree of interrelatedness may be researched by genetic profiling. Radio-telemetry of tagged individuals is also possible to research their dispersal movements (e.g. Sinsch et al., 2012).

Key references

Sinsch, U., Oromi, N., Miaud, C., Denton, J. and Sanuy, D. (2012). Connectivity of local amphibian populations: modelling the migratory capacity of radio-tracked natterjack toads. Animal Conservation, 15(4), pp.388–396.

Van Moorter, B., Kivimäki, I., Panzacchi, M. and Saerens, M. (2021). Defining and quantifying effective connectivity of landscapes for species' movements. Ecography, 44(6), pp.870–884.

Zeller, K.A., McGarigal, K. and Whiteley, A.R. (2012). Estimating landscape resistance to movement: a review. Landscape Ecology, 27(6), pp.777–797.

Project 3.2: Impact of Roadside Verge Management on Invertebrates

Whilst there has been some research on the role of roadside verges in promoting biodiversity, it is recognized that there are still large knowledge gaps concerning roadside management and its effects on biodiversity (Jakobsson et al., 2018). However, existing research includes a study from the Netherlands providing evidence that mowing roadside verges only twice a year was overwhelmingly beneficial for insect diversity and abundance (Noordijk et al., 2009), as also has a more recent UK-based study (Garbuzov, 2014). Given the benefits to biodiversity among a myriad other ecosystem services, there is urgent need for additional, preferably local evidence to support the case for conservation-focused verge management to assist our advocacy to responsible authorities as well as the general public (O'Sullivan et al., 2017).

In Surrey, there is a mixed approach among various management authorities, providing an opportunity for comparing alternative management approaches. There are also a variety of residential campaigns (including the 'Bookham Blue Hearts'), which could provide insight into the role of the local public. The Trust is engaged with both these sectors and supports the belief that with appropriate management roadside verges can sustain and boost local invertebrate populations, while also serving as effective corridors to enhance habitat connectivity in the wider landscape. It is, therefore, important we have robust research to support the case for managing verges for wildlife.

Fieldwork would be conducted to gather data on abundance and diversity of invertebrates, sampled from a variety of verges across the county managed under varying regimes. This will compare verges managed by the different LPAs. There is also potential for inclusion of a sociological aspect, gathering information and opinions from the public and their representative parish and district elected councillors. Data would be analysed using statistical software. Support would be provided for survey work and species identification. Partnered potentially with both SBIC and SCC.

Key references:

Garbuzov, M., Fensome, K.A. and Ratnieks, F.L.W. (2014). Public approval plus more wildlife: twin benefits of reduced mowing of amenity grass in a suburban public park in Saltdean, UK. Insect Conservation and Diversity, 8(2), pp.107–119.

Jakobsson, S., Bernes, C., Bullock, J.M., Verheyen, K. and Lindborg, R. (2018). How does roadside vegetation management affect the diversity of vascular plants and invertebrates? A systematic review. Environmental Evidence, 7(17).

Noordijk, J., Delille, K., Schaffers, A.P. and Sýkora, K.V. (2009). Optimizing grassland management for flower-visiting insects in roadside verges. Biological Conservation, 142(10), pp.2097–2103.

O'Sullivan, O.S., Holt, A.R., Warren, P.H. and Evans, K.L. (2017). Optimising UK urban road verge contributions to biodiversity and ecosystem services with cost-effective management. Journal of Environmental Management, 191, pp.162–171.

Project 3.3: Optimal Conservation prescriptions for Agricultural Land

Agricultural land has great potential to be restored into valuable space for wildlife whilst still providing benefits to the local economy (Newton et al., 2021). The Wildlife Trusts aims to restore 30% of land into beneficial management for nature by 2030, and agricultural land will be a key component of this. Restoration projects are essential to halt environmental degradation and biodiversity loss, and are also vital for optimising a holistic ecosystem service output from former agricultural land (Rey Benayas and Bullock, 2012). It is acknowledged that further research is needed to ascertain the functionality and ecological stability of restored land beyond elevated species richness (Walker et al., 2004).

Surrey Wildlife Trust began management of three ex-agricultural sites in spring 2021, which are designed as SANGs (Suitable Alternative Natural Greenspaces) and are all in need of restoration. Baseline surveys were conducted prior to intervention and the initial improvements are beginning to be appreciated. The aim of this project would be to assess the value of different management prescriptions (grazing, seed-sowing, mowing regimes etc.) in the context of reclaimed agricultural land, and to recommend an optimal management template for similar sites in the future.

This would be a field-based research project, involving botanical and faunal surveys of the three sites. Assistance and training would be provided for species ID and surveying.

Key references:

Newton, A.C., Evans, P.M., Watson, S.C.L., Ridding, L.E., Brand, S., McCracken, M., Gosal, A.S. and Bullock, James.M. (2021). Ecological restoration of agricultural land can improve its contribution to economic development. PLOS ONE, 6(3), p.e0247850.

Rey Benayas, J.M. and Bullock, J.M. (2012). Restoration of Biodiversity and Ecosystem Services on Agricultural Land. Ecosystems, 15(6), pp.883–899.

Walker, K.J., Stevens, P.A., Stevens, D.P., Mountford, J.Owen., Manchester, S.J. and Pywell, R.F. (2004). The restoration and re-creation of species-rich lowland grassland on land formerly managed for intensive agriculture in the UK. Biological Conservation, 119(1), pp.1–18.

Project 3.4: The perception & Value of Conservation Grazing Regimes

Conservation grazing is well established as a management practice for a variety of important habitats and has been shown to promote both plant and animal diversity (Small, 2010). A plethora of research has provided evidence that grazing, in most cases, has a better biodiversity outcome than mowing or manual cutting (Talle et al., 2016). Varied grazing regimes have been implemented across the county, and there is evidence that they result in differing species compositions for both plants and invertebrates (Lyons et al., 2017). Aside from biodiversity benefits, the use of livestock on nature reserves has been seen to contribute to positive public relations, but this area requires further research (Harvey, 2002).

Surrey Wildlife Trust uses a variety of grazing animals across its sites and has achieved excellent results from this – to the benefit of many rare species, such as the Small Blue and Adonis Blue butterflies and the Straw Belle moth. As above, there is a clear role for research into the outcomes of differing grazing regimes. Much of our grazing is undertaken on public facing reserves, which creates an additional dimension of public understanding of conservation practice. This project aims to review this in the context of Surrey, but crucially to also include the sociological effects such as public perception of and engagement with conservation work.

This project would be largely ecologically field-based but would also include a sociological approach. Fieldwork would involve botanical surveys, in addition to data gathered from questionnaires, interviews and focus groups within relevant demographies. Assistance would be provided in any ecological surveying and species identification.

Key references:

Harvey, P. (2002). Grazing in the urban environment: An economic and social appraisal of conservation

grazing schemes. Masters, Sheffield Hallam University (United Kingdom).

Lyons, A., Ashton, P.A., Powell, I. and Oxbrough, A. (2017). Impacts of contrasting conservation grazing management on plants and carabid beetles in upland calcareous grasslands. Agriculture, Ecosystems & Environment, 244, pp.22–31.

Small, R. W. (2010). Conservation grazing: delivering habitat management for conservation with livestock. Journal of the Royal Agricultural Society of England, 171, pp.38-44.

Tälle, M., Deák, B., Poschlod, P., Valkó, O., Westerberg, L. and Milberg, P. (2016). Grazing vs. mowing: A meta-analysis of biodiversity benefits for grassland management. Agriculture, Ecosystems & Environment, 222, pp.200–212.

Project 3.5: Monitoring the Effectiveness of Wetland Restoration

Restoration of degraded wetland and river habitats is internationally recognised as an important way to enhance biodiversity and ecosystem services (Peh et al., 2014). Such restorations also provide improvements in landscape character and opportunities for citizen science and community involvement, alongside accomplishing policy targets (Smith et al., 2014; Prior, 2016). Much research has been assembled surrounding the effectiveness of different restoration interventions, and there is a clear role for additional data in providing further evidence to strengthen restoration efforts (Smith et al., 2013).

This has been at the forefront of Surrey Wildlife Trust's work in recent years with around 30 habitat creation and restoration projects delivered. Despite this momentum, the Trust has been challenged to effectively monitor the outcomes of its efforts. Much of the restoration works carried out are supported by best practice guidelines, which focus on improving habitat primarily for fish species. A research project would provide the opportunity to robustly monitor our projects and their delivery methods and provide us with quantified evidence regarding the benefits of our interventions.

The majority of the project would involve fieldwork during the summer, focused on ecological surveys targeting priority species across a variety of comparable wetland restoration sites. These have been restored over a number of years and provide an ideal portfolio of case-studies to investigate the temporal impacts and longevity of restoration interventions. Work would contribute to a larger project suite, which would be split by species groups, offering a unique research question for a variety of students to partake. The options for the focus of a single project are macrophytes, invertebrates or amphibians.

Key references:

Peh, K.S.-H. ., Balmford, A., Field, R.H., Lamb, A., Birch, J.C., Bradbury, R.B., Brown, C., Butchart, S.H.M., Lester, M., Morrison, R., Sedgwick, I., Soans, C., Stattersfield, A.J., Stroh, P.A., Swetnam, R.D., Thomas, D.H.L., Walpole, M., Warrington, S. and Hughes, F.M.R. (2014). Benefits and costs of ecological restoration: Rapid assessment of changing ecosystem service values at a U.K. wetland. Ecology and Evolution, 4(20), pp.3875–3886.

Prior, J. (2016). Urban river design and aesthetics: a river restoration case study from the UK, Journal of Urban Design, 21(4), pp.512-529.

Smith, B., Clifford, N.J. and Mant, J. (2013). Analysis of UK river restoration using broad-scale data sets. Water and Environment Journal, 28(4), pp.490–501.

Smith, B., Clifford, N.J. and Mant, J. (2014). The changing nature of river restoration. Wiley Interdisciplinary Reviews: Water, 1(3), pp.249–261.

Project 3.6: How Will Biodiversity Net Gain Impact Habitat Connectivity in Surrey?

Biodiversity Net Gain (BNG) is a new legal requirement of the Environment Act 2021 that will become operational in NJanuary 2024. The aim of BNG is to introduce a universal, measurable structure for biodiversity enhancements as required for granting planning permission. Any proposed development must now provide a detailed and legally binding plan for how they will increase biodiversity by a minimum of 10% compared to a baseline assessment of the current value of the site (Defra, 2023). The effectiveness of this in terms of its contribution to nature recovery (as a principal goal of the 25YEP) is dependent on the validity of habitat type and condition being a proxy for species abundance and diversity, and the role of biodiversity enhancements in promoting connectivity of habitats to facilitate the range expansion of constituent species, as an overall vehicle to elicit biodiversity gain. Whilst connectivity was originally included in the standard valuation metric to calculate BNG, it was later removed due to difficulties in standardising its measurement (Kor et al., 2022).

Recent research done by SWT in partnership with the University of Surrey has shown that connectivity remains as a critical factor to maximise the benefits for biodiversity under BNG (Martinez-Cillero et al., 2023). The modelling approach taken in the paper provides a framework for further research on the best approaches to multi-species connectivity models, as well as models covering a wider spatial

scale. By using available development plans from LPAs across Surrey we can model potential outcomes for county-wide habitat connectivity via BNG through different lenses, and then evaluate these models using the emerging Natural England register of offsite off-setting. These predictions could go on to inform local policy.

This is a desk-based project that would best suit a student with an interest in biodiversity economics or GIS modelling. Surrey Wildlife Trust has already developed a model for assessing the potential for habitat connectivity across the county, which we could support the student in adapting to this project.

Key references:

DEFRA (2023) Biodiversity net gain, GOV.UK. [online] Available at: https://www.gov.uk/government/collections/biodiversity-net-gain (Accessed: 14 September 2023).

Kor, L., O'Hickey, B., Hanson, M. and Coroi, M. (2022). 'Assessing habitat connectivity in environmental impact assessment: A case-study in the UK context', Impact Assessment and Project Appraisal, 40(6), pp. 495–506. doi:10.1080/14615517.2022.2128557.

Martinez-Cillero, R., Siggery, B., Murphy, R., Perez-Diaz, A., Christie, I. and Chimbwandira, S. (2023). 'Functional connectivity modelling and Biodiversity Net Gain in england: Recommendations for practitioners', Journal of Environmental Management, 328, p. 116857. doi:10.1016/j.jenvman.2022.116857.

Project 3.7: Evaluating "tiny forests" as a nature-based solution to global warming

Reducing global warming requires the removal of vast amounts of carbon dioxide (CO_2) from the atmosphere (Girardin et al. 2021) and one of the most effective methods for this is natural forest restoration (Lewis et al. 2019). A traditional forest can take between 40 and 150 years to mature in the UK depending on its species composition (Forestry England 2023) and requires large swathes of land to be repurposed from agriculture or building developments. One potential solution for this is to create 'tiny forests' by using the Miyawaki method of planting. For this method, 50-100 local native plant species from four categories ('main tree species', 'sub-species', 'shrubs', and 'ground-covering herbs') are selected and planted as seedlings in high-density clumps; 30,000-50,000 per hectare compared with 1000 per hectare in a commercial forestry. The site is then watered and weeded for 2 to 3 years while the plants establish, after which it can be left alone to flourish without intervention. The increased competition for light and water encourages plants to grow much faster than traditional methods, and forests can be established in an area as small as six metres^2.

The World Economic Forum is promoting these 'tiny forests' as a nature-based solution to global warming due to their potential for carbon sequestration; 85 have been planted in the Netherlands, and 40 in Belgium and France. The first Miyawaki forest was planted in the UK in March 2020, and there are now more than 17, as several community environmental groups have gone on to plant these forests as part of their activities. While their rates of carbon sequestration have been found to match other forest regeneration practices in the Netherlands (Boosten et al. 2022), their impact on urban cooling, water regulation, and biodiversity generally has yet to be quantified in the UK.

This project would be a combination of field and desk-based work as the student would need to compare data for Miyawaki forests with traditional forests in the same area. This project would also use GIS to model potential implementation sites for this method across Surrey. SWT can provide a model of urban Biodiversity Opportunity Areas and support with GIS for mapping potential forest locations.

Key references:

Girardin, C.A.J., Jenkins, S., Seddon, N., Allen, M., Lewis, S.L., Wheeler, C.E., Griscom, B.W. and Malhi, Y. (2021). 'Nature-based solutions can help cool the planet — if we act now.' Nature, [online] 593(7858), pp.191–194. doi:https://doi.org/10.1038/d41586-021-01241-2.

Lewis, S.L., Wheeler, C.E., Mitchard, E.T.A. and Koch, A. (2019). 'Restoring natural forests is the best way to remove atmospheric carbon.' Nature 568(7750), pp.25–28.

Boosten, M., Lerink, B., Lokin, V., and Schelhass M. (2022) 'Praktische handreiking voor effectief klimaatslim bos- en natuurbeheer en toepassing van hout. Herziening 2022' FACTSHEETS Klimaatmaatregelen met Bomen, Bos en Natuur

4

Technology & Conservation

Project 4.1: The Potential for Exploration of Lowland British Landscapes Through VR & Gaming

There is increasing recognition of the possibilities for digital media, gaming and augmented reality experiences to engage people with nature conservation and the natural world (Fisher et al., 2021). Whilst a perceived concern of environmentalists is for technology to have significantly contributed to 'Nature Deficit Disorder', emerging evidence is showing that 'Nature 2.0' can be utilised to inform, engage and motivate consumers (Fletcher, 2017), and in particular for people with accessibility issues or without local greenspaces. Here, these methods may be the easiest ways to engage with the natural world (Li et al., 2021).

The environments explored by these experiences are typically the more 'exciting' global biomes, such as tropical rainforests, deserts and coral reefs. There are few UK-focused digital experiences, and UK native species are not commonly used within media depicting real, rather than imagined wildlife. The Wildlife Trust of South & West Wales has developed several "WILD VR" experiences centred around Welsh landscapes as engagement tools. Something similar might be achieved for Surrey, exploring our key landscapes through similar methods such as filming with 360° cameras and considering the potential for the gamification of these experiences.

This study would involve the planning and creation of a VR experience and, in the very least, would ideally survey a participatory group to investigate the experiential outcomes in comparison with an actual outdoors nature walk. Assistance in filming would be provided by the digital communications team.

Key references:

Fisher, J.C., Yoh, N., Kubo, T. and Rundle, D. (2021). Could Nintendo's Animal Crossing be a tool for conservation messaging? People and Nature, 3(6), pp.1218–1228. doi:10.1002/pan3.10240.

Fletcher, R. (2017). Gaming conservation: Nature 2.0 confronts nature-deficit disorder. Geoforum, 79, pp.153–162. doi:10.1016/j.geoforum.2016.02.009.

Li, H., Zhang, X., Wang, H., Yang, Z., Liu, H., Cao, Y. and Zhang, G. (2021). Access to Nature via Virtual Reality: A Mini-Review. Frontiers in Psychology, 12. doi:10.3389/fpsyg.2021.725288.

Project 4.2: Novel Uses of UAVs for Invertebrate Monitoring

Unmanned Aerial Vehicles (drones) are rapidly becoming a staple of environmental monitoring methods. Whilst most UAV monitoring is achieved by sensors, there has been recent experimentation using UAVs to physically collect invertebrate samples, by attaching sweep nets to the drones (Ryu et al., 2022). These pilot studies found that the method was successful in showing a degree of representativeness similar to the traditional (manual) approach, as well as providing additional benefits of being minimally invasive and time efficient (Löcken et al., 2020).

Surrey Wildlife Trust manages multiple open habitats where this kind of monitoring could be trialled. In particular, chalk grassland reserves would be ideal for this approach due to their open nature and herbaceous vegetation, as well as the importance of these sites for invertebrates. In the published studies, the applications are largely related to pest-control in agriculture and have been conducted in the United States (e.g. Neufeld et al., 2019). This novel application of "Drone Netting" for conservation-based investigations could be valuable to the Trust for accelerating the monitoring of site habitat condition.

The project would involve field work, accompanying the SWT UAV operator in conducting a number of surveys across different reserves. The 'catch' of the surveys would then require identification; specialist assistance can be provided for this. Statistical analysis would also be necessary.

Key references:

Löcken, H., Fischer, O.W., Selz, J. and Boppré, M. (2020). 'Drone-Netting' for Sampling Live Insects. Journal of Insect Science, 20(5). doi:10.1093/jisesa/ieaa086.

Neufeld, J., J. Ryu, and J. Barbour. (2019). Development of a UAS-based insect scouting method. J of the NACAA. 12(2): pp.1–5.

Ryu, J.H., Clements, J. and Neufeld, J. (2022). Low-Cost Live Insect Scouting Drone: iDrone Bee. Journal of Insect Science, 22(4). doi:10.1093/jisesa/ieac036.

Project 4.3: Modelling Adder Meta-Population Linkages With GIS

Adders have experienced large population declines across the UK (See Project 1.5), largely driven by habitat destruction and degradation and it is estimated that their range has reduced by 39% in recent times (Gleed-Owen and Langham, 2012). Remaining priority heathland habitat remains largely fragmented, such that establishing corridors between these patches is vital for the conservation of remaining Adder populations. Barriers to dispersal across the landscape lead to Adder populations becoming isolated and vulnerable to genetic separation (Worthington-Hill, 2016).

In Surrey, Surrey Amphibian and Reptile Group (SARG) has identified several Adder metapopulations from many years of surveying these reptiles. Surrey's Adder population remains strong and hence we have a national responsibility for the species, but it is declining (Langham, 2018). It has been observed that Adders are reluctant to cross certain features, even with the introduction of solutions aimed at facilitating their movement. A better understanding of just how fragmented the landscape is for Adders is desirable if we are to continue to champion their conservation.

The project would be desktop-based, using GIS and connectivity modelling tools to investigate landscape resistance to Adder movement. Adder data will be provided by SARG and support would be provided for GIS work by SWT.

Key references:

Gardner, E., Julian, A., Monk, C. and Baker, J. (2019) Make the adder count: population trends from a citizen science survey of UK adders. Herpetological Journal, 29. pp. 57-70. ISSN 0268-0130

Langham, S. (2018). Surrey Amphibian and Reptile Group - Adder. [online] Available at: http://surrey-arg.org.uk/SARGWEB.php?app=SpeciesData&Species=adder.

Worthington-Hill, J. (2016). Reintroduction of the adder Vipera berus to Nottinghamshire: a feasibility study Final Report to People's Trust for Endangered Species. [online] Available at: https://ptes.org/wp-content/uploads/2016/11/adders-final-report.pdf

Project 4.4: AMI Traps - Using Machine Learning for Automated Biodiversity Monitoring

Insect biodiversity is thought to be in decline globally which poses a risk for insect-mediated ecosystem functions such as nutrient cycling, pest control, and pollination services among others (van der Sluijs 2020). Generating empirical evidence for these declines is difficult, however, due to a lack of historical baseline evidence for many species and biases in site selection and target species, as well as difficulties with identification of morphologically similar species (Didham et al. 2020). The majority of reliable recording data for insects originates from a relatively small group of expert individuals who perform surveys or verify identification of single sightings recorded by members of the public. Many locations have limited access which can prevent traditional monitoring techniques and limit the ability to track temporal patterns in species present over time. Monitoring the timing and geographic range of these species will become increasingly important for determining the effects of climate change moving forward.

The UK Centre for Ecology and Hydrology has developed a new tool which uses machine learning to automate biodiversity monitoring of insects. These AMI-traps attract moths using UV and white lights, images the individual, and employs AI to identify the species. The traps are also fitted with bioacoustic monitors to detect bird and bat calls. They operate on solar power which allows them to be deployed for long stretches of time without intervention. This new technology allows us to explore what factors influence the community composition of insects, birds, and bats across different sites over time.

This project would be primarily a desk-based comparison of species records across and within several SWT sites. Data will be collected from the traps from Spring 2024 onwards. SWT holds data-sets for past records of species in two of the AMI-trap sites which we can use to investigate variation between manual and automated records, and look for differences in species phenology over time. SWT would be able to provide the data from the AMI traps and the historical records as well as management plans and ecological context for the sites.

Key references:

Ball, L., Still. R., Riggs, A., Skilbeck, A., Shardlow, M., Whitehouse, A., and Tinsley-Marshall, P. (2022) "The Bugs Matter Citizen Science Survey: counting insect 'splats' on vehicle number plate reveals a 58.5% reduction in the abundance of actively flying insects in the UK between 2004 and 2021" Technical Report Buglife and Kent Wildlife Trust

van der Sluijs, J.P. (2020) "Insect decline, an emerging global environmental risk" Current Opinion in Environmental Sustainability 46 pp. 39-42 doi: 10.1016/j.cosust.2020.08.012

UKCEH 'Automated monitoring of insects' [online] Available at: https://www.ceh.ac.uk/ukceh-ami-trap-automated-monitoring-insects

Project 4.5: Using Drone Footage to Monitor Deer Populations Following Wildfire Events

Deer-browsing can be an important management tool for restoring biodiversity and ecosystem resilience in heathland habitats, which are also prone to wildfires. The feeding action of deer can help to create natural fire breaks. Conversely, over-grazing can rapidly deteriorate heathland communities and may slow the post-wildfire recovery of the land (Silva et al. 2013), although not enough grazing may allow invasives to quickly dominate the vulnerable area. As climate change worsens, wildfires are likely to occur more frequently. Monitoring deer population sizes against their impacts on vegetation is therefore crucial for risk management and conservation strategies in heathland habitats.

Traditional census methods for monitoring large herbivores are often labour intensive, time consuming, and frequently inconsistent as they rely on chance sightings of the herd. This is compounded when a site has limited public access. Remote sensing techniques such as camera traps and Unmanned Arial Vehicles (UAVs) fitted with high resolution thermal imagers are increasingly being used to monitor deer populations. Drones are capable of identifying the species, sex, and in some cases potentially the age of the deer.

Surrey Wildlife Trust released Red Deer onto Pirbright Ranges in 2010 and has been monitoring the population ever since. There was a large wildfire on the site in 2022, from which it is still recovering. We have extensive drone and camera trap footage of the deer which could be used to understand sub-herd composition and distribution, capture current population sizes, behavioural patterns across the population, and potentially post-wildfire recovery. This would be primarily a desk-based project, and SWT would be able to provide support on GIS and spatial analyses.

Key references:

Ito, T. Y., Miyzaki, A., Koyama, L.A., Kamada, K., and Nagamatsu, D. (2022) "Antler detection from the sky: deer sex ratio monitoring using drone-mounted thermal infrared sensors" Wildlife Biology 2022(4) pp. e01034 doi: 10.1002/wlb3.01034

Tuia, D., Kellenberger, B., Beery, S. et al. Perspectives in machine learning for wildlife conservation. Nat Commun 13, 792 (2022). https://doi.org/10.1038/s41467-022-27980-y

Silva, J.S., Catry, F.X., Moreira, F., Lopes, T., Forte, T., and Bugalho, M.N. (2013) "Effects of deer on the post-fire recovery of a Mediterranean plant community in Central Portugal" Journal of Forest Research 19(2), doi: 10.1007/s10310-013-0415-0

Project 4.6: Using Satellite Imagery to Monitor Wildfire Recovery

Wildfires are becoming increasingly frequent globally as a direct result of climate change, with the global incidence of forest fires doubling since the mid 1980s (Mansoor et al., 2022). Increasing temperature leads to increased evaporation and dessication of soils and vegetation, which is then more liable to burning, and facilitates more rapid spread of a wildfire across a habitat area. Whilst wildfire is an important natural process in many systems, narrowing occurrence intervals are prohibiting the successful recovery of ecosystems between fire events. To better understand how habitats respond in the years following extensive burns, conservationists can use remote sensing data to provide insights. This is advantageous due to the long-term imagery available, and ability to infer soil moisture and vegetation health through the variation in spectral signatures recorded by many satellites (Leblon et al., 2016).

In Surrey, this is of particular concern for our internationally important lowland heathland habitat. Heathland is a landscape with a high risk of burning, where there are many

dry, woody and fine leaved plants which have co-evolved with various xero- and thermophilic species. Surrey Wildlife Trust manages over 2000 ha of lowland heathland and is responsible for supporting its recovery from severe wildfires which have occurred in recent years (Surrey Wildlife Trust, 2022). We also have a close partnership with researchers based at the University of Surrey, who have previously used remote sensing to examine impacts of wildfires on our reserves. Key questions, however, remain over whether these approaches can reliably monitor and predict species recovery, and which landscape features are key in assisting recovery efforts.

The project would be desktop-based, using GIS and remote sensing tools to investigate wildfire occurrences and impacts on heathlands in Surrey. Much of this data will be available online, but additional species and reserve data will be provided by SWT.

Key references:

Leblon, B., San-Miguel-Ayanz, J., Bourgeau-Chavez, L. and Kong, M. (2016). Remote Sensing of Wildfires. Land Surface Remote Sensing, pp.55–95. doi:https://doi.org/10.1016/b978-1-78548-105-5.50003-7.

Mansoor, S., Farooq, I., Kachroo, M.M., Mahmoud, A.E.D., Fawzy, M., Popescu, S.M., Alyemeni, M.N., Sonne, C., Rinklebe, J. and Ahmad, P. (2022). Elevation in wildfire frequencies with respect to the climate change. Journal of Environmental Management, 301, p.113769. doi:https://doi.org/10.1016/j.jenvman.2021.113769.

Surrey Wildlife Trust (2022). New research from Wildlife Trusts shows increased risk of fires and water loss as climate warms | Surrey Wildlife Trust. [online] Available at: https://www.surreywildlifetrust.org/news/new-research-wildlife-trusts-shows-increased-risk-fires-and-water-loss-climate-warms [Accessed 12 Sep. 2023].

5

Monitoring Public Engagement

Project 5.1: Landowner Relationships with Land Designations

Non-statutory sites identified for their biodiversity value (collectively known as Local Wildlife Sites) and recommended for protection in planning, represent an essential second tier system for protecting such sites, that is long established in the UK (Defra, 2006). Private landowners are central to delivering on these sites, and previous research has shown that there is a clear need for engagement with them and understanding of their motivations to meet the aspirations for these sites (Lawrence and Dandy, 2014).

There are 787 such sites, known in Surrey as Sites of Nature Conservation Importance (SNCI), chosen for various criteria such as species rarity and diversity (Surrey Nature Partnership, 2019). These include sites on and around Royal Holloway, University of London's campus, such as Cooper's Hill and the River Thames at Runnymede. These sites are selected by the Surrey Local Sites Partnership (SLSP), which also has a role in monitoring, promoting and advisory support for site management and strategy. These sites have a diverse ownership and the SLSP lacks the resource to deliver all its activities, but nevertheless aspires to further engage with the owners of these sites. To achieve this, the SLSP needs to better understand site-owners' knowledge of the designation and its role in landscape conservation especially, as well as their understanding of the ecological interest of their site(s), and their emotive feelings towards stewardship.

This project methodology would be to conduct an attitudinal survey of owners of Sites of Nature Conservation Importance in Surrey. Support will be provided in terms of connecting with appropriate landowners.

Key references:

Defra. (2006). Local Sites, Guidance on their Identification, Selection and Management

Lawrence, A. and Dandy, N. (2014). Private landowners' approaches to planting and managing forests in the UK: what's the evidence? Land use policy 36: 351-360

Surrey Nature Partnership. (2019). Policies and Procedures for the Identification & Selection of Sites of Nature Conservation Importance in Surrey & Surrey Local Sites Partnership - Terms of Reference

Project 5.2: The Ability of Volunteering with the Wildlife Trusts to Deliver Green Social Prescribing

There has been a large amount of research into the health and wellbeing benefits of our interactions with the natural environment, with significant benefits deriving from as little as two hours a week spent in nature (White et al., 2019). In more recent work, it has become apparent that even simple activities (such as the appreciation of flower-scent) and relatively low levels of nature connectedness are actually critical for improving health and well-being (Richardson et al., 2021). Our levels of nature connectedness have clear and intrinsic links with our emotional well-being, both from the pleasure and the intrinsic sense of meaning and connectedness derived from being outdoors (Pritchard et al., 2020). Very useful research could therefore be conducted into local consumers' propensity to pay for the ecosystem services benefitting health and wellbeing, especially as "green social prescribing" gains momentum amongst healthcare providers (Thomson et al., 2020).

In-depth, Surrey-centric research into this area of beneficial nature engagement would be desirable to better understand the role for green social prescribing in our county. This research would better inform Surrey Wildlife Trust on how to incorporate optimal health and well-being outcomes into our engagement provision, similar to the recommendations made in Richardson et al. (2021). A recent pilot study with the Trust as partners examined the experiences of conservation volunteering groups under the lens of green prescribing. The study found that it would certainly be viable to consider the volunteering offer as green prescribing, but that further work was needed to investigate, for example, the before and after impacts of activities.

The project would likely work with volunteer groups across the Trust to help understand if it is providing adequate green prescribing value. Methodology would primarily be sociological in nature, and likely involve questionnaires, interviews and focus groups.

Key references:

Pritchard, A., Richardson, M., Sheffield, D. and McEwan, K. (2019). The Relationship Between Nature Connectedness and Eudaimonic Well-Being: A Meta-analysis. Journal of Happiness Studies, 21(3), pp.1145–1167.

Richardson, M., Passmore, H-A., Lumber, R., Thomas, R., & Hunt, A.(2021). Moments, not minutes: The nature-wellbeing relationship. International Journal of Wellbeing, 11(1), pp.8-33.

Thomson, L., Morse, N., Elsden, E. and Chatterjee, H. (2020). Art, nature and mental health: assessing

the biopsychosocial effects of a "creative green prescription" museum programme involving horticulture, artmaking and collections. Perspectives in Public Health, 140(5), pp.277–285.

White, M.P., Alcock, I., Grellier, J., Wheeler, B.W., Hartig, T., Warber, S.L., Bone, A., Depledge, M.H. and Fleming, L.E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. Scientific Reports, 9(1).

Project 5.3: The Impact of Outdoor Learning on Attitudes to Learning

Outdoor Learning is a teaching approach that can be defined as simply as any lessons conducted in an outdoor setting, such as the school grounds. There is no strict requirement for utilising natural resources or teaching in nature reserves; the simple act of conducting learning in the school grounds has been proven to increase engagement in the subject and enhance wellbeing (Becker et al., 2017). While much research has investigated these benefits, we are yet to understand how it impacts students' attitudes to learning, and consequently their attainment at school (Mann et al., 2022). This could be a key motivating factor for teachers and decision makers to implement outdoor learning within their schools.

Surrey Wildlife Trust has recently piloted its Wilder Schools programme (Surrey Wildlife Trust, 2022), in which we work with schools and encourage them to utilise their grounds for outdoor learning. The Wildlife Trusts aims to make 1 in 4 people take action for nature and believes that any form of outdoor leaning provides the potential for increasing students' nature connection and therefore the likelihood of pro-environmental behaviours.

This project would be desk-based and involve qualitative methods such as interviews and analysis of data collected by the Wilder Schools project.

Key References

Becker, C., Lauterbach, G., Spengler, S., Dettweiler, U. and Mess, F. (2017). Effects of Regular Classes in Outdoor Education Settings: A Systematic Review on Students' Learning, Social and Health Dimensions. International Journal of Environmental Research and Public Health, [online] 14(5), p.485.

Mann, J., Gray, T., Truong, S., Brymer, E., Passy, R., Ho, S., Sahlberg, P., Ward, K., Bentsen, P., Curry, C. and Cowper, R. (2022). Getting Out of the Classroom and Into Nature: A Systematic Review of Nature-Specific Outdoor Learning on School Children's Learning and Development. Frontiers in Public Health, 10.

Surrey Wildlife Trust (2022). Wilder Schools. [online] Available at: https://www.surreywildlifetrust.org/what-we-do/outdoor-learning/schools/wilder-schools

Project 5.4: How do we Improve youth Engagement with Nature in Surrey?

There is strong evidence that supports the importance of engaging with nature on improving efforts to protect it, as well as improving the health and well-being of those participating (Richardson et al., 2016). The Wildlife Trusts, among other conservation bodies, have made considerable efforts to integrate and normalise nature engagement into daily social contexts, for example, through the "30 Days Wild" campaign which runs annually in June. There is also a national target for 1 in 4 people to 'take action for nature' by 2030, which is thought to be the tipping-point for a meaningful shift in social paradigms (The Wildlife Trusts, 2022). There is, however, a particular challenge with engaging young people (aged 16-30) in these campaigns, despite the urgency and importance of their involvement as stakeholders in both the biodiversity and climate crises.

As a response to this, there has been significant movement in recent years to provide spaces for young people within conservation on a variety of local and national scales (Zurba et al., 2023). In Surrey, for example, we have recently launched a Youth Action Committee to foster leadership amongst local young people, and provide opportunities for them to have a voice in environmental decision-making. Despite this, there remains a low representation of young people amongst SWT members, donors and volunteers. There are clearly a variety of influential pressures in this, as revealed by a pilot

study we conducted in 2020, but there is a need to better understand how to improve their willingness and ability to engage on a wider scale.

This study would be sociological in nature, likely taking the form of semi-structured interviews, focus groups or questionnaires. You would work closely with the co-ordinator of the Youth Action Committee and the Committee themselves.

Key references:

Richardson, M. et al. (2016) '30 Days wild: Development and evaluation of a large-scale nature engagement campaign to improve well-being', PLOS ONE, 11(2). doi:10.1371/journal.pone.0149777.

The Wildlife Trusts (2022) Bringing Nature Back: The Wildlife Trusts' Strategy 2030. The Wildlife Trusts. Available at: https://www.wildlifetrusts.org/sites/default/files/2022-04/TheWildlifeTrustsStrategy2030.pdf (Accessed: 14 September 2023).

Zurba, M. et al. (2023) 'Pathway to mainstream youth engagement and intergenerational partnership in nature conservation', Frontiers in Ecology and the Environment, 21(4), pp. 175–181. doi:10.1002/fee.2612.

Project 5.5: Evaluating the Distribution of 'Tree Equity' in Surrey

The inequality in access to nature and the services it provides is a well-known issue, especially for communities in low-income urban areas, and it is thus a key aspect of 'social justice'. Trees in particular, provide critical urban infrastructure that supports urban biodiversity, improves air quality, reduces the urban heat island effect and enhances human health and well-being (Pataki et al., 2021). Recent sociological research has begun to investigate the concept of tree 'equity'; that is, the even distribution (or not) of trees across urban areas, so that all citizens can access the benefits. So far, the majority of these studies have been based in the United States (Leets, et al., 2022).

Surrey is one of England's most wooded counties and boasts towns with among the highest national average tree cover (The Woodland Trust, 2021). Despite this, it is a divided county with pockets of deprivation amongst an otherwise largely affluent county, where residents do not have high access to greenspaces (Surrey Future, 2019). Surrey Wildlife Trust has begun working with some of these communities through our Next Door Nature project to improve their engagement with natural spaces, but there remains work to be done on improving the tree equity in these areas. In order to guide our approach to this work, it is pertinent to conduct a baseline evaluation of the current state of tree equity in the county.

This project could be undertaken with a variety of approaches but would likely involve desk-based data analysis and GIS, using land cover data as well as demographic data.

Key references:

Leets, L. et al. (2022). 'Promoting tree equity in Washington, D.C', Trees, Forests and People, 7, p. 100209. doi:10.1016/j.tfp.2022.100209.

Pataki, D.E. et al. (2021). 'The benefits and limits of urban tree planting for environmental and human health', Frontiers in Ecology and Evolution, 9. doi:10.3389/fevo.2021.603757.

Surrey Future. (2019) Surrey's 2050 Place Ambition. Available at: https://www.surreysays.co.uk/environment-and-infrastructure/placeambition/supporting_documents/Surrey%20Place%20Ambition%20Version%202%20%20Draft%20for%20Consultation.pdf (Accessed: 14 September 2023).

The Woodland Trust. (2021). State of UK's Woods and trees 2021 report. Available at: https://www.woodlandtrust.org.uk/publications/2021/04/state-of-uk-woods-and-trees-2021/ (Accessed: 14 September 2023).

GIS, using land cover data as well as demographic data.

Key references:

Leets, L. et al. (2022). 'Promoting tree equity in Washington, D.C', Trees, Forests and People, 7, p. 100209. doi:10.1016/j.tfp.2022.100209.

Pataki, D.E. et al. (2021). 'The benefits and limits of urban tree planting for environmental and human health', Frontiers in Ecology and Evolution, 9. doi:10.3389/fevo.2021.603757.

Surrey Future. (2019) Surrey's 2050 Place Ambition. Available at: https://www.surreysays.co.uk/environment-and-infrastructure/placeambition/supporting_documents/Surrey%20Place%20Ambition%20Version%202%20%20Draft%20for%20Consultation.pdf (Accessed: 14 September 2023).

The Woodland Trust. (2021). State of UK's Woods and trees 2021 report. Available at: https://www.woodlandtrust.org.uk/publications/2021/04/state-of-uk-woods-and-trees-2021/ (Accessed: 14 September 2023).

6

Valuing Nature: Natural Capital & Ecosystem Services

Project 6.1: How is the BNG Market Evolving in Surrey?

Biodiversity Net Gain (BNG) is a new piece of legislation coming into effect for major developments in January 2024 that requires planning applications to achieve at least a 10% increase in biodiversity from the pre-development site assessment. Where it is not possible to achieve this 10% onsite, developers are able to create or enhance habitats off-site, pay for a third party to generate the remaining biodiversity units, or purchase statutory biodiversity credits from Natural England (NE). This has established a new nature market for trading biodiversity units which spans not only developers and landowners, but also private sector suppliers, intermediaries, and consultants.

BNG deals are already being signed ahead of the Jnury start date. Surrey Wildlife Trust, for example, recently partnered with Shepperton Studios to offset their permitted expansion through restoration projects at Manor Farm, six miles from the new development. Defra released a price list for statutory biodiversity credits in July 2023 which they have clarified is set purposefully high so as not to compete with the market prices. It is still currently unknown what proportion of large developments will require off-site offsetting or what the availability of local credits will be. Monitoring how the BNG market evolves in Surrey during the first few months will be crucial for determining where resources need to be allocated to support the scheme and where communication needs to be improved to ensure market integrity.

This project would be desk based and would involve a combination of qualitative methods to assess views on the BNG market in Surrey, and a quantitative analysis of market trends across the county. SWT is able to connect the student with our established network of parties interested in BNG, and give a wider context of the background of nature markets in Surrey to date.

Key references:

HM Government (2023) 'Nature markets: A framework for scaling up private investment in nature recovery and sustainable farming' [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147397/nature-markets.pdf

Defra (2023) 'Guidance: Statutory biodiversity credit prices' [online] Available at: https://www.gov.uk/guidance/statutory-biodiversity-credit-prices

The Nature Conservancy (2021) 'Biodiversity Net Gain in England: Developing Effective Market Mechanisms' [online] Available at: https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_BiodiversityNetGain_England.pdf

Project 6.2: Quantifying the Economic Impact of Ecological interventions

Despite the global biodiversity crisis, public sector expenditure on biodiversity in the UK has fallen by 42% since 2008/9 (State of Nature 2019). The quantification of ecosystem services such as pollination, carbon sequestration, water filtration, etc. has allowed for estimates of the financial value of these systems, and the subsequent advent of nature markets. Restoring and creating sources of renewable natural capital (forests, agricultural land, protected areas, etc.) have become a part of sustainable development paths in higher-income countries and are becoming a key component for calculating global comprehensive wealth (World Bank Group 2021). The UK government has developed a Natural Capital Framework to assess the wider impact of different actions on stocks of natural capital and the wider effect on ecosystem services.

Ecological interventions have clear goals of improving an aspect of the natural environment. They often also have beneficial by-products of improving the green aesthetics of the area or improving floodplain management, for example, which ties into environmental goals for local governments. The work of conservation charities often therefore, has a wider financial benefit than the direct output of the intervention. In a time when public sector funding is scarce for conservation charities while the biodiversity crisis worsens, it is important to value the wider economic impact of actions for habitat recovery to justify petitions to government to divert funds.

This would be a desk-based project looking at the past and future ecological interventions performed by Surrey Wildlife Trusts and estimating the impact on local Natural Capital. This would be best suited to an economics student, SWT would be happy to provide all necessary information to complete the project.

Key references:

State of Nature Partnership (2019) 'State of Nature' Available at: https://nbn.org.uk/wp-content/uploads/2019/09/State-of-Nature-2019-UK-full-report.pdf

HM Treasury (2022) 'The Green Book: Central

Government Guidance on Appraisal and Evaluation' Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

World Bank (2021) 'The Changing Wealth of Nations 2021: Managing Assets for the Future.' © Washington, DC: World Bank. Available at: http://hdl.handle.net/10986/36400 License: CC BY 3.0 IGO.

Project 6.3: Why do landowners engage (or not) with Biodiversity Net Gain?

Biodiversity Net Gain (BNG) is a new piece of legislation coming into effect for major developments in January 2024 that requires planning applications to achieve at least a 10% increase in biodiversity from the pre-development site assessment. Where it is not possible to achieve this 10% onsite, developers are able to create or enhance habitats off-site, pay for a third party to generate the remaining biodiversity units, or purchase statutory biodiversity credits from Natural England (NE). The intention is for developers to enter into agreements with landowners local to their project, which is dependent on landowner engagement with the scheme.

To generate biodiversity units, a landowner may either enter into a legally-binding 30-year commitment to enhance or create new habitats on their land, or they may sell units they have already generated through their own restoration efforts – known as 'habitat banking' (Natural England 2022). Both methods are potentially very lucrative, but also have downsides; for example, the landowner is liable at the end of the 30-year commitment if they have not been able to generate the necessary improvements which makes the promise of generating units risky, but generating habitat in advance presents a large up-front cost. It is currently unclear how much landowners are willing to engage with BNG and therefore how much off-site offsetting will actually be local to the development after the policy is passed into law.

This project will be looking at which landowners in Surrey are engaging with BNG and why, but is fundamentally dependent on the predicted future uptake in habitat and land banking. The project will be primarily desk-based and consist of interviewing landowners and making recommendations for how to improve engagement with BNG.

Key references:

Defra (2023). Biodiversity net gain. [online] GOV.UK. Available at: https://www.gov.uk/government/collections/biodiversity-net-gain.

Natural England (2021). The Biodiversity Metric 4.0 - JP039. [online] Natural England - Access to Evidence. Available at: https://publications.naturalengland.org.uk/publication/6049804846366720.

Natural England (2022) Biodiversity Net Gain Brochure [online] Available at: https://naturalengland.blog.gov.uk/wp-content/uploads/sites/183/2022/04/BNG-Brochure_Final_Compressed-002.pdf

Project 6.4: Reviewing the potential of urban greening methods

We are currently in a global climate and biodiversity crisis, and yet nature recovery methods inevitably compete for space with intensive agriculture, urban development, and even renewable energy 'solutions'. Trends in human population growth predict that 340,000 new homes will need to be supplied in England each year to keep up with demand (Barton et al. 2023). The populations of urban settlements are increasing faster than rural and fringe towns (Government Office for Science 2021), which forces urban areas to expand and/or become more densely populated. This potentially destroys or further fragments rural habitats, or reduces the greenspace available to urban wildlife. Many local governments have developed green and blue infrastructure policies to account for this that use small-scale interventions to generate or improve habitat availability, quality, and connectedness in urban areas, known as urban greening.

Urban greening can include and inform many forms of construction, from planting single trees or making 'living pillars' to 'greenscaping' roofs, creating 'tiny forests', 'daylighting' of culverts, or 'depaving' (replacing inorganic paving such as concrete with organic material). The efficacy of these methods is largely unquantified or is only measured through a single metric. Urban trees have been evaluated for their role as a heat-mitigation method in cities, for example (Schwaab et al. 2021), but we still lack precision metrics for the biodiversity supported by a single tree in different environments. In order to make recommendations for urban greening methods, we first need to appreciate the different methods available and next develop a framework for evaluating their effectiveness in nature recovery.

There is a wide scope for this project to combine desk and field-based methods depending on the student. This project would liaise with local planning authorities to review current approaches and

techniques in urban greening and ultimately generate recommendations for which methods to promote. SWT would be able to network the student with relevant interested parties.

Key references

Barton, C., Wilson, W., Rankl, F., and Panjwani, A. (2023) 'Research Briefing: Tackling the under-supply of housing in England' [online] Available at: https://commonslibrary.parliament.uk/research-briefings/cbp-7671/

Government Office for Science (2021) 'Guidance: Trend Deck 2021: Urbanisation' [online] Available at: https://www.gov.uk/government/publications/trend-deck-2021-urbanisation/trend-deck-2021-urbanisation

Schwaaab, J., Meier, R., Mussetti, G., Seneviratne, S., Bürgi, C., and Davin, E.L. (2021) 'The role of urban trees in reducing land surface temperatures in European cities' Nature Communications 12 pp. 6763

Project 6.5: How Does BNG Influence Planning Objections?

Biodiversity Net Gain (BNG) is a new piece of legislation coming into effect for major developments in January 2024 that requires planning applications to achieve at least a 10% increase in biodiversity from the pre-development site assessment. Regulations prior to this have required developers to follow a mitigation hierarchy to prevent or offset biodiversity loss but this "No Net Loss" approach was found to be inadequate, largely due to a lack of transparency in the data surrounding the ecological impacts of these developments (zu Ermgassen et al. 2019). To combat this, Natural England (NE) has designed a metric to standardise measurements of biodiversity across the planning sector (Natural England, 2021). This method uses the area and condition of the site, along with the local strategic significance and distinctiveness of the habitat to calculate the number of 'biodiversity units' pre- and post-development.

NE claimed that one of the benefits of this approach was that projects which had a BNG plan would be less likely to receive objections and be refused for reasons relating to nature conservation or ecological harm, because these would have been mitigated much earlier in the planning process. Environmentalists are concerned, however, that the complexity of the metric and the lack of any recognition of relevant species interests will prevent legitimate objections to planning applications. Areas with protected species are still subject to the same prohibitions to development as prior to BNG, but these provisions offer nothing new in light of this. The lack of ecological expertise across local planning authorities (LPAs) nationally may lead to BNG plans being approved which have a detrimental impact on local biodiversity, but nevertheless fulfils all the environmental legal obligations.

This project aims to understand how BNG influences planning objections going forward. It will be primarily desk-based and involve interviewing and collaborating with LPAs and environmental organisations to assess the general understanding of BNG and the biodiversity metric, and how this influences planning objections from January 2024 . The data will only be available for this from May 2024 earliest.

Key references:

zu Ermgassen, S.O.S.E., Utamiputri, P., Bennun, L., Edwards, S. and Bull, J.W. (2019). The Role of 'No Net Loss' Policies in Conserving Biodiversity Threatened by the Global Infrastructure Boom. One Earth, 1(3), pp.305–315. doi:https://doi.org/10.1016/j.oneear.2019.10.019.

Natural England (2021). The Biodiversity Metric 4.0 - JP039. [online] Natural England - Access to Evidence. Available at: https://publications.naturalengland.org.uk/publication/6049804846366720.

Defra (2023). Biodiversity net gain. [online] GOV. UK. Available at: https://www.gov.uk/government/collections/biodiversity-net-gain.

7

Examples of Ongoing & Completed Projects

7.1 Rewilding Private Land: An Analysis of Landholder Perceptions & Attitudes in Surrey

Maelle Jacqmarcq (Imperial College London)

Rewilding is an ambitious and powerful new zeitgeist in conservation, which has generated much attention from the general public as well as the scientific community (Jepson & Schepers, 2016). Over the last decade, several flagship continental rewilding schemes have been implemented and there is now a well-established bank of case-studies of the positive impacts rewilding can achieve (Egoh et al., 2021). However, there is a worrying lack of consensus around exactly what rewilding should entail, and the extent to which it is supported by scientific evidence (Nogués-Bravo et al., 2016). Rewilding has emerged as an unavoidably emotional subject, with media-stoked tensions between stakeholders becoming a necessary element of many rewilding projects (Wynne-Jones et al., 2018).

Within Surrey, there are many large estates which could be key players in rewilding projects across the county. This project interviewed several suggested stakeholders to explore their perceptions and any concern around the topical issues. The study found that landholder valuations of rewilding are significantly influenced by their personal interpretation of the term, with more favourable attitudes expressed towards active forms of rewilding that have a low impact on existing human activities. Uncertainty about rewilding's meaning and external sources of compensatory funding causes rewilding avoidance or delay among some landholders. There was significant concern around the need to balance rewilding goals with food security. Finally, the results illustrate that understanding and valuing of local views is essential to enable a better consideration of practical constraints, whilst helping to reduce polarisation, mistrust, and negative attitudes towards concepts of rewilding

7.2 The Impact of Demon Shrimp on Surrey's Rivers

Philip Murray (Royal Holloway)

Demon Shrimp (Dikerogammarus haemobaphes) is a highly invasive species that first invaded the UK in September 2012 (Environment Agency, 2012), and is thought to now be well established. There is a relatively poor understanding of the impacts associated with D. haemobaphes in comparison to the closely related Killer Shrimp (D. villosus), which has been extensively studied. This is concerning as there is some evidence to suggest Demon Shrimp could pose a similar threat to native organisms in freshwater systems.

The species was detected by the Environment Agency in 2015 in the River Wey. This project attempted to update the distribution map for Surrey, but surprisingly did not detect the species in any of the samples taken during the first field season which was undertaken in conjunction with the University of Surrey. Subsequent sampling detected Demon Shrimp in very low numbers which suggests that the initial invasion failed. Phillip is currently confirming the observed presence and absence in different areas by using eDNA to screen river samples for molecular evidence.

7.3 The Impact of Grazing Pigs on Ancient Woodland Flora

Logan Butler (University College London)

Ancient woodland in the UK is an irreplaceable resource for biodiversity and intrinsically valuable, yet up to 70% of ancient woods have been lost through anthropogenic change and the spread of invasive species. Deforestation has allowed native species such as such as Bracken Pteridium aquilinum and bramble Rubus fruticosus agg. to spread on the disturbed land and dominate the forest floor, outcompeting other ground floral species such as bluebells. The root systems of these pervasive species make them difficult to remove once they have established. Conservation grazing by cattle has been used in other habitats such as lowland heath to control the spread of these species and allow slow-growing species to grow.

This project looked at the potential for domestic pigs to act as conservation grazers in ancient woodland to control the abundance of bracken fern and bramble. Chinthurst Hill, a local nature reserve (LNR) in Surrey which comprises of mixed-species deciduous woodland and acid grassland, was dominated by bracken fern and bramble after extensive rhododendron removal in 2010, this made it a perfect pilot site. From 2012 to 2017, five sows were allowed to graze across a rotation of different compartments on the site ranging from 0.5 to 1.2 ha in size. Vegetation surveys showed an overall increase in species richness from 2012 to surveys from this project in 2023, although bracken continued to dominate the area. This study shows the potential for conservation grazing to be employed in a wider variety of settings, and highlights the necessity for ongoing long-term conservation management practices.

7.4 Comparing Methods to Quantify Recreational Natural Capital Benefits: A Case Study of the Holmesdale Biodiversity Opportunity Area

Anna Goodden (Imperial College London)

Natural Capital incentivises investment into the restoration of sources of natural capital (forests, agricultural land, protected areas etc.), and has become a key component for calculating global comprehensive wealth. In 2020, 57% of England's annual natural capital was attributed to benefits gained from recreational time spent in the environment – equating to £17.9 billion. Restoration projects often incorporate public access routes as a feature. Estimations of the natural capital potential of sites that are optimally located for restoration should therefore include a measure for the financial impact of these recreational areas. Quantifying the financial impact of recreation is difficult, however, as there are several different conflicting metrics.

This project reviewed different financial models for valuing recreation. It then compared the three most popular modelling tools by estimating the market value of restoration in the Holmesdale Biodiversity Opportunity Area (BOA) as a case study. The tools were: the HM Treasury-recommended Outdoor Recreation Value model (ORVal), the Integrated Valuation of Ecosystem Services and Tradeoffs tool (InVEST), and the Green Infrastructure Valuation tool (GI-Val). The study found that the use of these different models had a significant impact on the overall valuation. In particular, InVEST predicted much lower visitation rates that ORVal, resulting in a lower projected financial gain. This study demonstrated the variability in current estimations for market value of recreation and highlighted potential inaccuracies in the valuation methods, showing a need for a consensus model validated on primary user-based data.

Afterword

The wider aim of this research is to continue to challenge the conundrum whereby good scientific evidence generated by the academic sector routinely fails to usefully inform biodiversity conservation in practice. Historically, accessibility to research and evidence has been an issue and the majority of conservation actions have remained experience based and heavily reliant on anecdotal knowledge. We believe that evidence and the outcomes of applied ecological research should be freely available and as accessible as possible to land managers and decision makers. The Wildlife Trusts is well placed to act as a conduit for the dissemination of this information through both our own practice and our close ties with partner land managers. We hope that through the work produced by this research prospectus we can positively influence the discourse surrounding conservation actions and their relationship with academia and applied ecology.

The primary contact for research projects is viki.webster@surreywt.org.uk, please contact them in the first instance to express interest.

Please check the current version of the prospectus at: surreywildlifetrust.org/research

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