Leveraging Biodiversity Net Gain to address invertebrate declines in England

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Abstract

Meeting ambitions such as the Global Biodiversity Framework 2030 targets will require multiple conservation mechanisms that benefit the widest possible range of habitats and species. Here, we evaluate the likely impact of a novel and ambitious ecological compensation policy, Biodiversity Net Gain (BNG) in England, on terrestrial insects, spiders, and other arthropods ('invertebrates'), a functionally essential but rapidly declining group of taxa. Current implementation of BNG in England sets out to provide a 10% uplift in biodiversity when infrastructure development (such as housebuilding) occurs. However, BNG is a habitat-driven approach that risks overlooking important considerations relevant to invertebrate conservation, threatens to further reduce the size and quality of their habitats, and may increase habitat fragmentation. BNG - as currently implemented – therefore represents a missed opportunity to use a universally applied policy to benefit invertebrates and other functionally important components of biodiversity. We suggest ways forward to realign BNG with what we know to be crucial for successful invertebrate conservation, and with other policy mechanisms such as the National Pollinator Strategy. This will ensure that appropriate habitats and conditions for invertebrates are retained, enhanced, and created at a landscape scale, and that BNG is optimised to contribute to broader national conservation targets. As biodiversity accounting and offsetting schemes such as BNG are increasingly adopted around the world, the experience of BNG in England provides valuable insights into how ecological compensation programmes could be better designed, implemented, and monitored to ensure that benefits for a wide variety of taxa are achieved.

Introduction

Insects, spiders, and other terrestrial arthropods (here collectively referred to as ‘invertebrates’) comprise the majority of known species on Earth (May, 1986) and play a pivotal functional role in ecosystems. Invertebrate-mediated ecosystem functions include pollination, nutrient cycling, and decomposition, which are essential to ecosystem health, human society, and supporting land-uses enabling food security (Aizen *et al.*, 2009; Nichols *et al.*, 2008; Seibold *et al.*, 2021; SITC, 2024). There is growing evidence of declines in invertebrate populations (DEFRA, 2024a; Wagner, 2020). For example, in the United Kingdom, population declines of concern have been reported for some species of carabid beetles (Coleoptera; Carabidae) (Brooks *et al.*, 2012) moths (Lepidoptera) (Bell *et al.*, 2020), butterflies (Lepidoptera) (Brereton *et al.*, 2011), bees (aculeate Hymenoptera) and hoverflies (Diptera: Syrphidae) (Powney *et al.*, 2019). These declines have been driven by pressures including agricultural intensification (Habel *et al.*, 2019; Mancini *et al.*, 2023; Ollerton *et al.*, 2014), light pollution (Boyes *et al.*, 2021), and pesticide use (Sánchez-Bayo, 2014), as well as land-use change causing habitat loss and fragmentation (Rossetti *et al.*, 2017; Warren *et al.*, 2021).

Such serious reductions in invertebrate biodiversity have led to calls for, and implementation of, a range of conservation targets and policies (Cardoso *et al.*, 2020; Dicks *et al.*, 2016; Forister *et al.*, 2019). These include global targets such as the Global Biodiversity Framework 2030 targets (Convention on Biological Diversity, 2023) and various national targets. For example, in England, the Environment Improvement Plan (EIP) sets out the target to halt declining species abundance by 2030, and to exceed 2022 abundance levels by 10% by 2042 (DEFRA, 2023). The indicator in development to monitor progress toward the species abundance target includes 703 species of insects including for example 11 bumblebee, 34 beetle, 25 fly, 55 butterfly, and 446 moth species (DEFRA, 2024a). This overarching target sits within a wider body of conservation policies which are expected to contribute to its achievement, including species-focused legal protection under the Wildlife and Countryside Act 1981, and prioritisation of 'Species of Principal Importance' under the Natural Environment and Rural Communities Act 2006 (Natural Environment and Rural Communities Act 2006; Wildlife and Countryside Act 1981). However, these policies do not represent the full suite of invertebrates and are better suited to the conservation of larger, more conspicuous species, such as vertebrates (Duffus & Morimoto, 2022; Morris & Welch, 2023). More recently, the England Pollinator Action Plan (2021-2024) has been published under the National Pollinator Strategy (NPS) (DEFRA, 2022a). The NPS is a 10-year strategy setting out a suite of actions aimed at improving the status of pollinating insects by 2024. Although some of the actions are unique to the conservation of pollinators, others are broader, including the aim to provide "more, better, connected habitat" (DEFRA, 2022a). This type of conservation action is exemplified by the Buglife B-Lines project which aims to deliver 150,000ha of connected wildlife rich habitat (Buglife, 2023). These actions will benefit a wide range of taxa beyond insect pollinators and are in line with the principles of "bigger, better, and more joined up" habitat networks as outlined in the Lawton Review (Lawton *et al.*, 2010).

A key environmental initiative relevant to biodiversity recovery in England is Biodiversity Net Gain (BNG). As currently laid out in Schedule 14 of the Environment Act 2021, almost all developments of the built environment requiring planning permission (including housing, road or rail construction, and renewable energy development) will need to deliver a mandatory minimum of 10% BNG, secured for at least 30 years (Environment Act 2021). BNG is demonstrated using the Statutory Biodiversity Metric, which is intended as a proxy for biodiversity (DEFRA, 2024b). To calculate a biodiversity value, the metric takes the size, distinctiveness, condition, and strategic significance of a site, and converts these factors into numerical values that are multiplied together to give biodiversity units for area habitats such as grasslands or woodlands, and linear landscape features such as hedgerows and watercourses. A pre-development baseline calculation of biodiversity units is made and compared to the proposed future unit value of the site which is forecast using the same formula but with spatial, temporal, and (to account for uncertainty) difficulty multipliers. Higher values are assigned to future habitats which are a) more likely to be achievable; b) with little time delay after the initial impacts of development, and c) that are on or close to the development site. The projected post-development value of habitats must exceed the pre-development value by at least 10%. To achieve this net gain, adherence to the Biodiversity Gain Hierarchy is encouraged, where harm to habitats of medium distinctiveness or higher is avoided or mitigated and then unavoidable harms are offset by enhancing or creating new habitats on-site (within the development footprint), then off-site (The Town and Country Planning Order 2015). As a last resort, offsetting under BNG can be achieved by purchasing statutory credits from the government.

Given anticipated high levels of infrastructural development (The Labour Party, 2024), it is anticipated that BNG, alongside other tools such as the Green Infrastructure (GI) Framework (Natural England, 2024) are intended to play a large role in nature recovery in England by promoting biodiversity within and beyond the built environment. Consequently, BNG has huge potential to influence the creation and management of many habitats in England and through this to contribute to broader aims such as the species abundance target from the EIP. However, the conservation potential of BNG has been widely criticised. There is concern about the extent to which the metric accurately captures and represents important dimensions of biodiversity (Falk, 2021; Ollerton, 2023; Wilson, 2021), and there is no evidence of a consistent relationship between biodiversity units generated by the metric calculation and other measures of biodiversity (Duffus *et al.*, 2024; Hawkins *et al.*, 2022; Marshall *et al.*, 2024).

Given the fine spatial scale and the ubiquity of its adoption in England, BNG has the potential to be a powerful tool for invertebrate conservation. However, to be successful BNG should not neglect the habitat requirements of invertebrates and should generate habitats that support diverse and abundant invertebrate communities, including at the large spatial extent envisaged under policies such as the National Pollinator Strategy. Here, we detail some of the specific habitat requirements of invertebrates and discuss how the current implementation of BNG, as well as the design of the statutory biodiversity metric, are not optimised to provide those habitat requirements. Then, we discuss the potential to realign BNG with wider invertebrate conservation activities to create a more joined up policy landscape.

As biodiversity offsetting proliferates globally, so too does the use of area and condition based biodiversity metrics. The metric used for BNG in England has been the direct basis for metrics proposed or implemented in a very wide range of contexts globally, including in Sweden (Ecogain, 2023), Singapore (AECOM, 2023), Scotland (NatureScot, 2024), Saudi Arabia (Miller, 2024), the Americas (Ramboll, 2024a), and even a 'global' biodiversity metric (Ramboll, 2024b). Therefore, a critical evaluation of the situation in England provides an opportunity to reflect on the likely consequences of such policies for invertebrates globally, and to highlight a range of considerations that could greatly increase the biodiversity benefits when designing biodiversity accounting and offsetting schemes and associated metrics.

Tensions between invertebrate conservation requirements and BNG

Habitat condition and heterogeneity

Under BNG, the statutory biodiversity metric takes a very simplified approach to habitat quality, assessing it as 'poor', 'moderate' or 'good' using a checklist of habitat features. Scoring habitat components in isolation risks failing to recognise the importance of structural complexity and heterogeneity of habitats, which can be important to support populations of many invertebrate species. Furthermore, the value of habitats will be scale dependent: any particular small area within a site might have low local (alpha) diversity, but in heterogeneous sites such areas will support dissimilar sets of species, enhancing diversity at a larger (site-level) spatial scales. The complex life histories of many invertebrates, with distinct larval and adult requirements, will inevitably increase the necessity for heterogeneous habitats. For example, while pollinators require a diversity of suitable floral and nectar resources as adults, their immature stages often depend on very different resources, such as the nutrient-enriched water sources favoured by the larvae of *Eristalis* spp. Hoverflies Latreille, 1804 (Falk & Castle, 2019), or dead wood, tree stumps and coppice stools required for breeding by bees such as the Fringe-horned Mason Bee (*Osmia pilicornis* Smith, 1846) (Falk, 2015). For such species, the proximity of features needed by adult and immature stages may be crucial, making heterogeneous habitat mosaics especially important. Ecotones (transitions between habitat types) also constitute important invertebrate habitats in their own right (Schirmel *et al.*, 2011). For example, the transition from grassland to tall grass sward and scrub habitats is known to support at least 2653 invertebrate species in the UK (Webb *et al.*, 2018).

As an example of over-simplification under the current condition assessment, for most grasslands to be categorised as ‘good’ condition, they must pass 5 or 6 criteria, including having no more than 5% cover of bare ground or scrub (DEFRA, 2024b). This low threshold fails to recognise the value of mosaics of bare ground, grassland, scrub, and woodland in providing a range of foraging, nesting and breeding habitats in close proximity. ‘Good’ condition grasslands must also have 20% of vegetation taller than 7cm and 20% shorter than 7cm (DEFRA, 2024b). The metric fails to recognise that satisfying this criterion is dependent on sampling season and the grazing or mowing regime, with that regime being equally if not more important than sward height to many invertebrates such as spiders (Lyons *et al.*, 2018). A further stipulation for ‘good’ condition grassland is that a set of plant species ‘indicative of sub-optimal condition’ cannot cover more than 5% of the grassland. Such species include White Clover (*Trifolium repens* L.), Creeping Buttercup (*Ranunculus repens* L.), Creeping Thistle (*Cirsium arvense* L.), and Common Nettle (*Urtica diocia* L.) (DEFRA, 2024b). Scrub, including Bramble (*R. fruticosus* agg.), must also account for less than 5% of grassland area. *Cirsium arvense, R. fruticosus* agg. and *T. repens* are among the most nectar-productive plants on pasture, supporting a known 730 species of pollinators throughout the season (DoPI, 2024; Timberlake *et al.*, 2019). Also of importance is *U. dioica* which is associated with 123 invertebrate species in the UK (BRC, 2023); shaded nettle beds maintain higher humidity and are an important resource which invertebrates use to over-winter or shelter during periods of high temperatures (Davis, 1983).

A further issue is that the metric is used by subdividing sites into homogeneous parcels of the same habitat type and condition score. For example, for an ecotone of grassland transitioning into woodland, the grassland and woodland might be delineated separately with a line positioned within the transition zone; or the transitional zone may be recorded as a separate parcel of scrub habitat. These categorisations are potentially confusing for the field surveyor, will depend heavily on skill and experience, and provide no mechanism to recognise ecotones, within-patch heterogeneity, and habitat mosaics which are important drivers of biodiversity (Hackett *et al.*, 2024; Martin *et al.*, 2019).

In summary, the reliance on condition-based assessments as currently designed, has the potential to be detrimental to invertebrate biodiversity because it fails to account for attributes that may be valuable for invertebrates. As a result, important invertebrate habitat could be undervalued pre-development, and during development the removal of features important to invertebrates could be incentivised.

Habitat Connectivity

At a larger spatial scale, connectivity of sites across the landscape is an important consideration that is not fully accounted for by the current implementation of BNG. The level and type of connectivity required for colonisation varies greatly among invertebrate guilds and depends on their dispersal capabilities, with less mobile species likely to require higher connectivity to maintain viable populations and to facilitate range shifts under climate change (e.g. Mason *et al.*, 2015). To avoid sites becoming too isolated from areas with similar habitat, connectivity can be improved by creating corridors or stepping stones of the same or similar habitat types, or linear features such as hedgerows, which can facilitate the movement of more mobile groups such as many pollinators (Cranmer *et al.*, 2012).

The metric currently attempts to reflect spatial priorities via a ‘strategic significance’ multiplier (DEFRA, 2024b). The multiplier assigns a higher value to projects which contribute to achieving Local Nature Recovery Strategies (LNRS), for example by creating new habitats within the Nature Recovery Networks (NRN) (DEFRA, 2022b). However, this scoring approach does not consider the habitat types of sites being connected, or indeed any actual permeability or functional connection, and thus the extent to which invertebrates will be able to disperse across the landscape and colonise new sites. The strategic significance multiplier also does not apply to habitats pre-intervention, therefore not valuing habitats that currently form important parts of connective corridors. Furthermore, sites within the NRN will not inherently hold higher value for invertebrates than those outside it; their relative value will depend on the habitat present and the strategic and taxonomic priorities and implementation of the LNRS (DEFRA, 2022b).

Habitat Size

The metric allows for large areas of either or both low distinctiveness or 'poor' condition habitat to be traded for smaller areas with higher distinctiveness and/or 'good' condition. Trading habitats in this way has been associated with a 38% reduction in green space post-development (Rampling *et al.*, 2023). The tendency to create small and relatively isolated sites, even if their individual biodiversity value is higher, is likely to compromise biodiversity outcomes, for two main reasons.

First, smaller habitats can support smaller populations which are less resilient to stochastic events and environmental changes which can drive local extinction (Hodgson *et al.*, 2011; Oliver *et al.*, 2013). Small sites also have increased edge effects and encompass less environmental heterogeneity, further eroding population resilience (Kuli-Révész *et al.*, 2021; Stein *et al.*, 2014). Collectively, this means that landscapes of more isolated smaller habitats will tend to support less biodiversity in the long term than those with larger ones (Connor & McCoy, 1979; Rukke, 2000).

Second, as discussed above, the transition from a 'poor' to a 'good' condition habitat might in fact reduce the quality and extent of habitat suitable for invertebrates. Populations in these smaller habitats will be even less resilient without measures to improve connectivity and thereby facilitate colonisation (Rösch *et al.*, 2013; Steffan-Dewenter & Tscharntke, 2002). In England, two of the most threatened bumblebee species, the Shrill Carder Bumblebee *Bombus sylvarum* Linnaeus, 1761, and the Moss Carder Bee *Bombus muscorum* Linnaeus, 1758 currently exist only in small, isolated habitat fragments. Consequently, these species have low effective population sizes and reduced genetic diversity, with evidence of inbreeding, reducing population resilience (Darvill *et al.*, 2006; Ellis *et al.*, 2006). Invertebrates that depend on highly patchy resources that occupy only a small fraction of any site may be especially vulnerable to isolation effects. One such resource required by many invertebrates of conservation concern is suitable dead wood; for saproxylic invertebrates such as longhorn beetles (Coleoptera: Cerambycidae), sites will need to be either large enough or connected enough to provide spatial and temporal continuity in the provision of this resource (Schiegg, 2000).

Habitat Pressures Post-development

To date, sites delivered under early adopter BNG councils have primarily occurred "on site", i.e., within the footprint of the development (Rampling *et al.*, 2023). Smaller areas of post-development green space, such as those within housing developments, will face high levels of anthropogenic disturbance including erosion by footfall, littering, over-management, colonisation by Invasive Non-native Species (INNS), nutrient enrichment from domestic animal waste, pesticide use, and high densities of managed beehives in urban environments (Coleman, 1981; De Frenne *et al.*, 2022; MacKell *et al.*, 2023). Nutrient enrichment and pesticide use are of particular concern for invertebrates, and can have effects beyond the development site, with sealed surfaces creating run-off into sensitive water-dependent habitats, such as floodplain meadows or alkaline fens (Bart, 2022; Cook, 2007; Manninen *et al.*, 2010). BNG guidelines currently make no mention of restricting use of pesticides, despite their detrimental impacts on invertebrate biodiversity (Alkassab & Kirchner, 2017; Cavallaro *et al.*, 2019). Most gains made under BNG are likely to be within the built environment (Rampling *et al.*, 2023) where pesticide use is commonplace. Grounds managers regularly use dicamba and glyphosate for the control of 'weeds' in gardens and on hard surfaces and gravel paths (Garthwaite *et al.*, 2020). Both herbicides are directly harmful to invertebrates (Freydier & Lundgren, 2016; Smith *et al.*, 2021) and the plant species targeted such as Dandelion (*Taraxacum* spp.) are important resources for pollinators (Sirohi *et al.*, 2022). An additional route of pesticide input comes from domestic pets. The flea treatments imidacloprid and fipronil, commonly used on domestic pets, are concerning pollutants of aquatic habitats in England, particularly in urban areas (Perkins *et al.*, 2021). The NPS sets out plans to develop guidance for managers of amenity spaces, urging them to 'think carefully' about their use (DEFRA, 2022a) but as it stands, there is nothing to prevent sites retained, created, or enhanced under BNG receiving substantial pesticide inputs, compromising their suitability for invertebrates.

How to reconcile BNG with invertebrate conservation goals

At present, BNG misses the opportunity to provide habitats which serve the needs of invertebrates, making it inconsistent with policies for the conservation of invertebrates such as the Pollinator Action Plan. Important components of ecological resilience such as habitat size and connectivity risk being compromised, and resources and habitat features necessary for maintaining favourable conservation status of invertebrate assemblages are not recognised. These technical risks within BNG are likely exacerbated by (and may further exacerbate) the lack of invertebrate awareness within the planning system more broadly. Here, we set out possible pathways to optimise invertebrate conservation within BNG, and within the planning system.

Redefining Habitat Condition

The condition assessment within the metric requires a careful balance between ease-of-use and ecological resolution. Over-simplification is sometimes problematic, for example in the case of medium, high, and very high distinctiveness grasslands, where a single set of condition scoring criteria is applied to ten distinct grassland community types (DEFRA, 2024b). In the literature from which these condition scoring criteria were adapted (Joint Nature Conservation Commitee, 2019) each grassland type has its own set of criteria for assessing quality. Having the same criteria for all streamlines the assessment process but risks neglecting the differing ecologies of different grassland types and the fact that what is considered a favourable feature varies depending on the grassland type. For instance, what is considered an acceptable amount of bare ground will vary depending on the grassland type and soil substrate. While less than 5% bare ground could be considered favourable on lowland meadow, this could be considered too little on acid grasslands, where bare ground of 25-50% can be a favourable feature (Joint Nature Conservation Commitee, 2019).

A revised set of habitat condition scoring criteria could usefully draw on existing work evaluating sites for invertebrates using habitat features. One example is the Invertebrate Habitat Potential (IHP) Assessment (v3.07a Dobson & Fairclough, 2021). Much like the metric, IHP takes a habitat-led approach, assessing 11 site features, but bases the valuation on their potential to support invertebrates on a grading scale of A-E. Some habitat features such as bare ground are shared between the IHP and the metric but are treated differently. Whereas the metric uses a simple 1-5% threshold of acceptable bare ground, the IHP seeks to identify if the site has examples of un-shaded and well-drained bare ground which could be used for nesting or basking by invertebrates. The IHP also adds components lacking from the current metric condition score sheets, by assessing ecotones, decaying wood, still air (areas sheltered by wind breaks are often used for displaying and mating behaviours by flying insects), and structural patchworks. The present way that each habitat type is treated in isolation within the metric should also be addressed. For instance, by signposting ecotones and enabling them to be recorded as their own habitat type. This would make the retention of ecotones simpler than when they are delineated in multiple small parcels of differing habitat types. In addition, when considering the ecological condition of sites delivered under BNG, habitat management and pressures should be considered. For habitats delivered in the urban environment – the majority under the scheme (Rampling *et al.*, 2023) – the impact of disturbance, nutrient run-off, and pesticides, for example, will reduce the quality and utility of habitats for invertebrates.

Recognising Connectivity

There are many different approaches to quantify connectivity based on, for example, inter-site distances (Mancini *et al.*, 2022), and the capacity of species to colonise new sites (Hodgson et al. 2012). A previous version of the metric (Metric 2.0 - Natural England, 2020) did in fact use a specific connectivity multiplier value of low, medium, or high. Connectivity was determined by the number of 1km squares adjacent to a focal site with the same or related habitat types, accounting for the permeability of the wider landscape to species on the focal site (Hodgson *et al.*, 2011; Oliver *et al.*, 2013). Ultimately, this multiplier was removed from the metric, as it was only feasible for ‘high’ and ‘very high’ distinctiveness habitats and was challenging for users to implement (Natural England, 2020). From the perspective of resources and features supporting invertebrate assemblages within a site, this method of valuing connectivity appears more robust than the current strategic significance multiplier, as it accounts for the habitat types being connected. To make the strategic significance mechanism a more meaningful connectivity tool, one approach could be to use systematic conservation planning to set the spatial priorities of a Nature Recovery Network to explicitly consider functional connectivity and include species distribution data from biodiversity recording and monitoring schemes or distribution modelling in network design (Smith *et al.*, 2022).

Limiting Losses in Habitat Area

The overall reduction in post-development green space incentivised by the current implementation of BNG (Rampling *et al.*, 2023) is a significant challenge that will not be solved by improved condition scoring alone. It is driven by the trading of existing large, low distinctiveness, 'poor' condition habitats for future small higher distinctiveness, 'good' condition habitats under the assumption that newly created habitats will have increased biodiversity value. In reality, the timescales for restoring biodiversity on high distinctiveness grassland sites can be longer than the 30-year minimum requirement for BNG. In some cases, complete restoration of plant biodiversity can take 70-150 years depending on management (Woodcock *et al.*, 2011), and colonisation of the complete invertebrate assemblage could lag further behind that, depending partly on the degree of isolation from existing populations (Woodcock & McDonald, 2010).

One potential solution would be to impose a habitat area threshold for BNG, for example by requiring no net loss in overall habitat area, particularly for high and very high distinctiveness habitats. This would likely increase the need for developers to feed into the biodiversity offset market, generating greater financial investment into large offsite nature recovery projects (Hawkins *et al.*, 2023).

Standardised Guidance on Surveys

Currently, there is no consistent approach for including invertebrates as part of Ecological Impact Assessments (EcIA), an existing suite of ecological surveys that are undertaken during the planning application process. Within the context of EcIA, faunal surveys have historically shown a strong tendency to focus on a small set of protected vertebrate species, although anecdotal observations suggest that scoping-in of follow-up invertebrate surveys is increasing.

Sixteen invertebrate species have some legal protection as European Protected Species and 50 invertebrate taxa are protected under the Wildlife and Countryside Act 1981 (as amended) (Natural England, 2022). In England, Section 40 of the Natural Environment and Rural Communities Act 2006 (as amended by the Environment Act 2021) (Environment Act 2021), requires decision makers such as local planning authorities to conserve and enhance biodiversity based on a 'Species of Principal Importance' list published by the Secretary of State. Commissioning a standardised invertebrate survey before development allows for a better-informed, tailored BNG approach which retains, creates, and enhances habitats, features and resources recognised as significant for maintaining the conservation status of a site's invertebrate assemblage.

Not all application sites will require an invertebrate survey. Justification for when one is needed may draw on existing biological records, a scoping survey or the ranking and scoring of important habitat features, as for the IHP (Dobson & Fairclough, 2021). Standardised approaches to surveying a range of taxonomic groups such as Arachnida, Coleoptera, Diptera, Lepidoptera, Hemiptera, and aculeate Hymenoptera can then be applied at sites where an invertebrate survey is deemed necessary (Drake *et al.*, 2007). Species from these taxa (among others) are included in the Pantheon database (Webb *et al.*, 2018), which allows users to identify which key features, habitats, or resources are needed by the species recorded. Results of such surveys stand in their own right as considerations within the planning process, particularly as they provide information on the rarity and vulnerability of species present on a given land parcel. In addition, used correctly they can also ensure that habitat features on which invertebrates depend are not overlooked or penalised within the BNG process.

New technologies also have the potential to streamline the invertebrate identification process within such surveys. These include automated monitoring approaches such as camera traps for moths (UKCEH, 2023) and DNA-based technologies, which are becoming increasingly cost-effective. While work is still needed to overcome primer biases and increase taxonomic coverage in DNA barcode libraries (Rees *et al.*, 2022), approaches such as DNA metabarcoding and environmental DNA have the potential to generate extensive data on species composition and richness rapidly, extending the range of taxa included within survey work (Mata *et al.*, 2021; Ritter *et al.*, 2019). Using these approaches for pre-development surveys would be another way to generate data to inform the habitat design and development under BNG in a way that benefits invertebrates.

Conclusion

Biodiversity Net Gain in England seeks to mediate the conflict between infrastructure development and biodiversity, by seeking to leave biodiversity in a better state post development. Flaws in the design of BNG and the metric mean that, as it currently stands, it may not have the intended positive outcomes for biodiversity. Here, we have detailed ways in which this is particularly true for invertebrates, which have specific habitat requirements not recognised in the metric, and require heterogeneous, connected habitats which project proponents are not incentivised to provide under BNG. By failing to create habitats with high invertebrate conservation value, BNG risks missing opportunities to support larger overarching targets to halt and reverse declines in invertebrate biodiversity, including the species abundance target in the EIP. Given that BNG and similar schemes elsewhere will drive large amounts of nature provision within developments and contribute financially to nature recovery through an offset market, it is vital that the mechanisms for habitat assessment and creation are ecologically sound.

As approaches to biodiversity accounting and offsetting proliferate globally, such insights should be widely relevant to informing the design of area and condition metrics for measuring biodiversity. This is of particular significance for diverse invertebrate communities, which thrive in complex heterogeneous habitats.

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Author Contribution Statement

O.T.L. and N.E.D. conceived the idea for the paper. N.E.D. collated ideas and information from all co-authors and synthesised the first draft. All authors contributed to subsequent iterations of the paper and approved it for final submission.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Data Availability Statement

This article does not use any data

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