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Feature

Monitoring Biodiversity Net Gain: Potential Contributions from Ecoacoustics

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Biodiversity Net Gain (BNG) schemes will require monitoring over a 30 year period. Habitats are proxies for wider biodiversity – meaning the value of offsets for preventing biodiversity loss is largely unknown. Habitat assessment and mapping by surveyors is open to significant biases, which limit consistency between schemes and years. Additional monitoring methods are required to deliver useful data, enabling the successes and failures of BNG policy to be reviewed. Ecoacoustic techniques can comprehensively capture a wide range of species and soundscape information, with the ability to archive, review and re-analyse this over the decades needed for BNG implementation. We recommend that best practice guidance for monitoring BNG, including robust methods such as ecoacoustics, is rapidly developed by consultants, local authorities and statutory agencies.

Introduction

The 2021 Environment Act will make it mandatory for many developments in England to demonstrate they will result in a 10% increase in Biodiversity Net Gain (BNG). BNG is currently measured in units described by the government's Biodiversity Metric, a simple indicator reflecting the area, ecological condition and distinctiveness (a proxy for conservation value) of each patch of habitat within the development boundary. The Metric does not consider faunal diversity, wildlife abundance, species conservation value or other legal/ policy factors to assess wider biodiversity values or ecosystem conservation status. The Act, however, requires developers to provide evidence that their BNG obligations have been met, and the requirements for management and monitoring extend for 30 years. With this long delivery period, there is a critical need to define standards for monitoring design, data collection, storage and analysis that will reliably demonstrate support for net gain outcomes, and for those standards to be sustainable and cost-efficient over decadal timescales. We recommend that these standards adopt a broad range of methods that can be conducted consistently and comparably alongside the Metric to verify that a wide cohort of species benefit from restoration projects, and that they are collectively contributing to the kind of landscape-scale change intended by the policy.

Habitats

Changes in habitat type, condition and area, as summarised in the Metric, provide one measure of ecosystem change, but it is widely recognised that this is only one blunt proxy for biodiversity, and is potentially biased and insensitive to wider changes. Furthermore, the 'if we build it, they will come' rationale for this approach assumes the UK landscape is reasonably intact, rather than being among the least resilient in the world (Burns *et al.*

2023). Many threats can impact the persistence of species without observable changes in habitat scores (e.g. impact of introduced diseases on red squirrels; Everest *et al.* 2021), and habitat creation does not imply the recovery of all plant or animal species (Fuentes-Montemayor *et al.* 2022, Hughes *et al.* 2023). There are winners and losers to any shift in an ecosystem, and explicitly promoting one group of plant species will produce sub-optimal conditions for an array of other plants, and does not guarantee they are well suited to supporting other wildlife (Gardner *et al.* 2022). As monitoring a wide range of species has traditionally been expensive, we have relied on a limited range of criteria to define habitat quality and value in the hope they represent most biodiversity values. Given the continued decline of biodiversity in the UK and globally we must question this approach (Starnes *et al.* 2021).

The Environment Act specifically requires the calculation of units impacted and delivered to be made using the Metric, and the base monitoring requirements are limited to a summary of habitat type, extent and condition, i.e. a repeat of the Metric habitat assessment every few years. This minimal and strict focus on habitats is, however, at odds with the broader objectives of the policy to restore biodiversity in the wider sense, for example in line with the Good Practice Principles (Baker 2016), which define BNG as "development that leaves biodiversity in a better state than before, and an approach where developers work with local governments, wildlife groups, landowners and other stakeholders in order to support their priorities for nature conservation". We would, therefore, recommend that good practice monitoring of BNG schemes should accept multiples lines of biodiversity evidence, including more detailed species assessments alongside habitat mapping. It is likely that this could often be enabled through the Environmental Impact Assessment process on development schemes, as part of the post-construction monitoring of impacts on protected or notable species.

The design of the Biodiversity Metric has had to deliver a balance between the need for a robust understanding of biodiversity values and the capacity of surveyors to deliver assessments with minimal training and field time. The unit scores produced by the Metric are highly sensitive to the type and condition of habitats that a user assigns, and some diagnostic features are difficult to interpret. It is well known that wide differences in the outputs of habitat mapping and assessment can occur due to individual surveyor biases (Cherrill and McClean 1999), and this can result in substantial variation in Metric calculations, even among experienced ecologists (zu Ermgassen *et al.* 2021). We might assume that comparisons over time are standardised because the surveyor's bias is the same, but given that agreements to deliver BNG will span decades, and changes in survey personnel, skill levels and technological advances in mapping, there are challenges to even comparing over time. The uncertainty this subjectivity will introduce is a key issue for monitoring the successes and failures of the BNG system.

Measurable change

Putting to one side the suitability of habitat classes to represent the breadth of biodiversity, the ambiguity in how status or even some habitat classes are assigned poses clear problems for demonstrating *measurable improvement* for BNG. The legitimacy of offset systems rests on the assertion that (1) biodiversity units accurately portray the ecological value of different sites, meaning that compensation is proportionate to impact and results in a positive outcome and (2) the measured gains are the result of habitat creation/ restoration actions, not chance. While the scale by which the first point is measured has been the subject of the Metric's development, far less attention has been paid to how surveyors will effectively demonstrate gains have occurred on the ground. Payments for offsets will be based on biodiversity outcomes, not because landowners simply performed all the 'right' actions (Pressey *et al*. 2021). Despite this, information on the monitoring methods that should be undertaken for BNG schemes is scarcely mentioned in the legislation, policy or guidance. Defra's (2022) consultation documents have suggested that monitoring should provide a "summary of habitat type, extent, and condition (with a comparison where applicable against the expected condition)" – however, this limited information is unlikely to allow the success of wider BNG principles to be properly assessed. Site owners, land managers, local authorities and statutory agencies rapidly need to establish good practice for monitoring protocols and evidence types that will both satisfy the legal obligation to deliver measurable improvement and properly demonstrate that biodiversity is being conserved and enhanced.

Multiple lines of evidence

The new legislative requirements will require repeated habitat mapping surveys that cannot be achieved cost efficiently by increasing the time spent by individuals in the field – especially with the ongoing capacity crisis in the ecology sector (CIEEM 2022). Instead, we need to consider what tools are available for condition assessment of hundreds of individual sites and allow audit of the effectiveness of the BNG policy. One such technology that could serve this demand is ecoacoustic monitoring (Figure 1), alongside other methods such as satellite remote sensing, trail cameras and environmental DNA. Ecoacoustic monitoring is increasingly undertaken using automated recorders that minimise human involvement in fieldwork and enable consistent surveying across landscapes (Browning *et al.* 2017). Passive acoustic monitoring can record sound data over long time periods, allowing standardised reproducible protocols independent of observer biases (Stowell and Sueur 2020). The raw sound files can be permanently archived for comparison with data collected in the future, potentially using analysis methods that

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Figure 1. Acoustic recorder deployed at a restoration site. Photo credit: Alex Bush.

have not even been created yet. Developments in ecoacoustics have now progressed to such a point that good practices for survey and monitoring can be implemented (Metcalf *et al.* 2023).

Ecoacoustics can be used to survey a wide range of species or to gather data on the entire soundscape (including environmental sounds and human-generated noise) within an area. The breadth of taxa includes birds, mammals, orthoptera, amphibians and aquatic invertebrates. Additionally, soundscapes can be recorded above ground, below ground and in marine and fresh water (Farina and Gage 2017). The data gathered for all these species and ecosystems can provide information on changes in species composition, and the frequency of detection across sampling sites (occupancy) can act as an indicator of species rarity (Abrahams and Geary 2020). For some taxa, acoustic data may also provide an indication of abundance (Pérez-Granados and Traba 2021). The ecoacoustic approach is therefore well suited for long-term assessments of BNG compensation sites, offering an increased level of biodiversity information beyond that provided by vegetation assessments alone.

Development of ecoacoustic standards: habitat condition versus acoustic condition

Ecoacoustics could play a valuable role in biodiversity monitoring, combining with habitat assessment, or by providing an alternative perspective on the changes delivered by land management and restoration. However, more research is required to establish how closely acoustics data correlate with habitat condition in a BNG context. If the magnitude of change in acoustic communities (turnover in the composition and abundance of species) strongly correlates with changes in Metric values, acoustics could provide an alternative estimate of restoration impact at a site (Figure 2). In addition, if species are closely tied to habitat features that we can approximate from aerial/satellite maps and habitat surveys, we can begin to anticipate how individual restoration projects will collectively contribute to the recovery of landscape diversity. We can quantify and account for variability in acoustic detections, but uncertainty may also arise due to otherwise equivalent habitats being awarded different Metric scores, and this complementary evidence may provide valuable context for supporting assessments in which condition is difficult to judge but highly influential to the Metric score. It is also entirely plausible that changes in ecoacoustic data do not correlate strongly with the scales of Metric assessments (Figure 2). Such a weak association between the Metric and acoustic diversity, potentially coupled with low predictability of acoustic composition, would still be informative, as it would suggest processes outside the defined scope of habitat management are limiting suitability for those species (e.g. lack of roosting sites

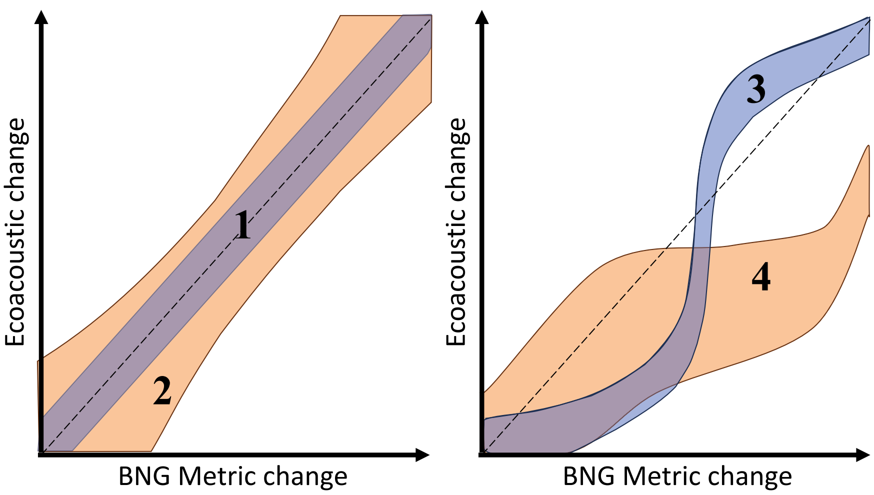

Figure 2. Theoretical relationships between measures of change in habitat type/condition by the Metric, and measures of change in the acoustic community. Acoustic species diversity may correspond strongly (1 and 2) or weakly (3 and 4) overall to Metric changes, and those changes may be highly predictable (1 and 3), or more variable and uncertain (2 and 4).

or seasonal food sources, grazing density, insecticide application or even conditions overseas).

Understanding how ecoacoustic information relates to and complements evidence from habitat surveys requires an understanding of how the design of ecoacoustic survey affects our ability to detect various species. The duration of a survey, and the time of day when recordings were made, naturally influence what species are detected – but the number of detectors that should be deployed in parallel is not clearly understood (Abrahams and Geary 2020). How comparable are surveys from different times of year, and to what extent does urban/suburban noise impact detectability relative to more natural habitats? The variation that results from these decisions can be incorporated into standard statistical models to moderate predictions, and to identify how much survey effort is needed to deliver a robust assessment with defined confidence.

Conclusion

There is an urgent need to develop guidance for the monitoring of BNG schemes that goes beyond the basics of occasional habitat mapping, with its attendant biases, which will be compounded over the 30 year periods required for implementation. To standardise the toolkit for good practice in BNG we should emphasise methods based on 'raw' field data, rather than an observer's impressions. Ecoacoustic data can be collected now, so that adaptive management of individual sites can be effectively delivered, and the overall effects of BNG policy can be reviewed. This would be of benefit to those responsible for scheme implementation, as well as other organisations such as financial bodies that are seeking to track and verify translatable units of biodiversity that can be reported and traded as credits. Many previous offset schemes have failed to deliver the expected benefits because insufficient attention was paid to the role of monitoring (zu Ermgassen *et al.* 2019). No one wants to waste this opportunity, and collaboration between business, government and academia – drawing from ecologists, economists and data scientists – is needed to transform landscapes for the better. The authors are currently engaged in research to illustrate how new monitoring tools like ecoacoustics could contribute and we would welcome contact from anyone else conducting BNG habitat assessments or acoustic surveys, who would like to collaborate.

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If you are interested in incorporating ecoacoustic surveys alongside your own BNG monitoring, or are already involved in ecoacoustics in the UK and would like to collaborate, please contact Alex Bush for more information.

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