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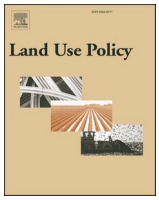

Local people's preferences for housing development-associated Biodiversity Net Gain in England

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ABSTRACT

Biodiversity Net Gain (BNG) in England is a recently legislated mechanism for ensuring that the biodiversity impacts of new developments are appropriately mitigated. Despite the assumption that some elements, such as the preference for locally implemented offsetting of impacts, should provide benefits for people, the policy's focus is on ecological outcomes. The social feasibility of BNG guidelines has not been properly tested, nor has their generalisability across people and places. Understanding the preferences of local project-affected people for Biodiversity Net Gain and incorporating this into both policy and project-level decision-making is a critical step for managing trade-offs ex-ante, thereby maximising the likelihood that BNG projects benefit people's wellbeing. Using a choice experiment of hypothetical BNG projects in the context of housing development, we examine the trade-offs between the features of the BNG project: distance from home; biodiversity level (species richness); off-site vs on-site biodiversity provision; public access to the offset site; and a non-biodiversity feature (provision of affordable housing). We found that public access and species richness were proportionally more important than proximity and the percentage provision of affordable housing. These preferences were of course, heterogeneous and determined by sociopsychological variables, e.g., captured in the notions of "attachment to place", connectedness to nature, socio-economic variables and rural versus urban location. The preferences expressed identify a range of BNG approaches that respect peoples' preferences and trade-offs, noting that acceptance depends to a great degree on outcomes that are either not an explicit priority (i.e., species richness) or are disincentivised (i.e., public access) by current BNG policy. For BNG to be publicly acceptable and socially sustainable, the study concludes that policy and practice must be flexible enough to incorporate place-specific preferences, especially relating to aspects of access to nature, localised notions of biodiversity, and broader cultural and aesthetic consequences of the development.

1. Introduction

The UK and other countries are orienting environmental policy towards biodiversity conservation in light of international commitments (e.g., the Kunming-Montreal Global Biodiversity Framework; Stephens, 2023), domestic policy changes (e.g., the Environment Act 2021 in the UK) and scientific evidence on the emerging biodiversity crisis and underappreciation of biodiversity (e.g., Dasgupta, 2021; IPBES, 2019). One notable concept in the policy response is that of Biodiversity Net Gain (hereafter BNG). The "Net" in BNG (cf. "No Net Loss" or NNL) implies a trade-off: losses in one place can be compensated by gains in another, necessitating biodiversity "offsetting". *Biodiversity Net Gain (BNG)* is introduced in the 2021 Environment Act, and operationalised within a wider national strategy to curb and reverse biodiversity loss and ecological degradation (see, The Environmental Targets (Biodiversity) (England) Regulations, 2023), the UK's 25-year Environmental Improvement Plan, (DEFRA, 2023b). Therein, BNG is balanced alongside linked goals of improving the flow of nature's contributions to social wellbeing (e.g., air and water quality, access, and beauty) (DEFRA, 2023b; Planning Advisory Service, 2023). Offsetting as a practice is complex, contested, ethically fraught (Apostolopoulou, 2020; Ives and Bekessy, 2015; Spash, 2015) and technically challenging (Gonçalves et al., 2015; Vaissiere et al., 2020; Bull et al., 2013) practice. Its assumption that biodiversity is quantifiable and fungible across time and

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space presupposes profound trade-offs within and between social and ecological realms (Griffiths et al., 2019a) that have yet to be fully explored in the context of BNG. In this paper, we investigate some potential trade-offs between ecological and socioeconomic aspects of BNG design to ascertain: firstly, whether these trade-offs exist; secondly, the role of individual and contextual factors in these trade-offs; and finally, how BNG might be implemented in a way that acknowledges and balances these issues given biodiversity offsetting's ecological imperative.

To date, the literature has predominantly focused on conceptual, ecological and economic concerns (Hrabanski, 2015; Gardner et al., 2013), such as outcomes for species (Hawkins et al., 2022), habitat (zu Ermgassen, 2019) and market functionality (Habib et al., 2013; Mann, 2015). Meanwhile, social and ethical implications have received less attention, despite compelling lessons from historical and analogous cases (e.g., protected areas and carbon offsetting, Benabou, 2014), and conceptual (Dasgupta, 2021; Tupala et al., 2022) and empirical evidence (Bidaud et al., 2017, 2018), illustrating the potential disruption of people-nature relationships at local levels and the knock-on effects for the wellbeing project-affected people; and portending unintended consequences related to environmental access, fairness and justice.

International best practice guidelines (e.g., Business Biodiversity and Offset Programmes, BBOP, 2012; and The Equator Principles, 2013) provide recommendations for the inclusion of the social considerations in offset design and management, but legal requirements and incentives vary widely (Droste et al., 2022; Tupala et al., 2022). Although empirical research into this process is mounting, shedding light on the socio-economic implications and nuances of offsetting in different contexts (e.g., Berninger et al., 2010; Burton et al., 2017; Griffiths et al., 2019b; Rogers and Burton, 2017; Scholte et al., 2016; Vaissière et al., 2018), tools and processes for assessing development impacts on people and communities (e.g., social and health impact assessments) are often theoretically and operationally disconnected from biodiversity offsetting procedures (CIEEM, 2021a, 2021b).

While BNG seems implicitly understood as a mechanism preconfigured, or with the potential, for win-win outcomes (Baker et al., 2020; Howe et al., 2014; Jones et al., 2019), such synergies are difficult to achieve in conservation practice (McShane et al., 2011; Woodhouse et al., 2015). The complexity of collective and individual needs, the multi-dimensionality of wellbeing, and trade-offs across multiple scales (McShane et al., 2011; Woodhouse et al., 2015) means conservation initiatives often involve competing rather than synergistic social and ecological objectives (McShane et al., 2011). The central mandate of BNG is the delivery of measurable ecological gains. As developers seek cost-effective compliance, the implementation of this objective, in line with the 'polluter-pays' principle under the economic constraints of private development, inherently creates a landscape of social-ecological trade-offs (Sonter et al., 2020). At the same time, ecologically "optimal" solutions might favour remote "fortress" style offsets free from disturbance, or habitats highly valued within BNG's metric, that conflict with public preferences for accessible, species-rich, and culturally meaningful green spaces (Kalliolevo et al., 2021). This tension is evident in the way that the provision of public access at offset areas is implicitly penalised as a limiting factor affecting habitat condition assessment within BNG's metric framework (DEFRA, 2025) i.e., any future of use that may "degrade habitat type and condition" should be taken in account. Thus, despite national agendas to improve local access to nature (i.e., 15-minute access to nature: Natural England, 2024a,b), within BNG, there is an incentive to limit access, and the associated disturbance effects, given its diluting effect on the 'unit' value of an offset area.

The development of operational principles governing BNG design has largely prioritised ecological appropriateness, standardisation and feasibility, exemplified in rules related to habitat equivalence and spatial proximity (e.g., Biodiversity Metric 4.0 - User Guide, Natural England and other parties, 2023; Suff, 2013). To date, this has given rise to largely homogenous approach in its early implementation (Bateman and Zonneveld, 2019; zu Ermgassen et al., 2021). The social appropriateness of these offsetting principles, and their outcomes, has received little attention. Assumptions of concomitant benefits, for local people and nature, arising automatically, such as via rules heavily favouring local offsets, are increasingly challenged as overly 'simplistic'. In fact, it is argued that there is real risk of such rules running contra to what would be economically efficient, ecologically effective and socially equitable (Bateman and Zonneveld, 2019). A more pragmatic and context-sensitive approach would recognise trade-offs as inevitable and should be made explicit at the project-level to support transparent negotiation and balancing between stakeholders.

An empirical investigation of the potential welfare consequences of development-associated net-gain activities for local people is timely and needed, providing a better understanding of the social appropriateness and perceived impacts of the projected outcomes of biodiversity compensation approaches such as BNG (Cole et al., 2022; Griffiths et al., 2019b). We present an empirical analysis using an econometric approach, which utilises stated-preference methods, i.e., a choice-experiment, to explore how local people evaluate BNG trade-offs in a real-world development context. We construct a stated-preference choice-experiment modelled on current BNG guidelines and trends reasonably linked to local wellbeing. We diverge from recent, related social valuation research that examined distributional effects tied up in people's willingness to pay (WTP) for BNG approaches (Faccioli et al., 2024), reasoning that WTP is potentially inappropriate for valuing biodiversity compensation for local development-affected people, where monetary considerations are implicit rather than explicit. We extend this by examining socio-psychological determinants of preferences that theoretically relate people's wellbeing to nature and their living environment; and complement this with scenario interviews, to investigate the relationship between expected prevailing approaches to BNG (i.e., zu Ermgassen et al., 2021) and the revealed preferences of project-affected people. We use a regional case study from the Southeast of England to ground the work. Hereby, we generate new knowledge for decision-makers on how to best design BNG to maximise acceptability and minimise perceived negative impacts for sensitive groups and individuals.

2. Research Design and Methods

2.1. Survey design

We assess the preferences and potential wellbeing impacts associated with the imminent proliferation of housing development-linked BNG for local project-affected persons (PAPs). The primary objective of this investigation is to provide an empirical case for exploring the implications of the best-practice guidelines and key operational principles of BNG in relation to achieving "no worse off" for local people (Griffiths et al., 2019a). The survey uses hypothetical housing development and associated BNG scenarios to measure acceptance and preferences for broad, strategic approaches to BNG design, estimating relative value of attributes based on existing principles and observed trends (off-site vs on-site delivery of offsets; distance to the offset; public access to the offset; enhancement of species richness; and the level of affordable housing in the development itself).

Attribute and level selection for the choice experiment were accomplished by conducting a literature review, which included governmental guidance documents and consultation reports on BNG and biodiversity offsetting, as well as journal articles. Balancing the need to reflect current theory and practice related to offset design and delivery while remaining accessible to local people resulted in attributes and levels derived from three interrelated strands: 1) to represent some of the broad rules and priorities relating to offset design from a spatial planning and offset delivery perspective which encompass economic, ecological and social trade-offs, based on current political and academic discourse; 2) to convey outcomes that, as per the literature and our own qualitative groundwork, are politically, socially and theoretically

relevant and consequential for people's preferences for and relationship with the local biophysical environment; 3) and, finally, to provide a useful and comparable indication of social acceptability relative to incremental, directional changes on a quantifiable scale (e.g., Distance). The provision of affordable housing was specifically included as a non-offset-related public good to assess the relative importance of offset features by permitting a trade-off against a highly salient, socially beneficial outcome associated with the development, the additional provision of which would incur increasing cost to the developer. The survey also allows for measuring group and individual-level factors that affect preferences for, or contribute to heightened vulnerability to, different approaches to BNG provision. These include observable socio-demographic variables and socio-psychological and attitudinal profiles drawing on constructs of nature engagement and connectedness; place attachment; and the economic and social legitimacy of the housing industry.

2.1.1. On-site vs off-site delivery

As per DEFRA (2019), developers can deliver their 10 % net-gain in biodiversity units either on-site by changing the spatial configuration of the site to retain more habitat and/or improving the condition or size of the habitat; or off-site by finding a local site on which to enhance the biodiversity of existing habitat or create new biodiversity-rich habitat. BNG is likely to be achieved by a combination of both on-site and off-site provision and the ratio has important implications for cost, ecological equivalence, strategic significance, and fairness. According to zu Ermgassen (2021), the vast majority (95 %) of biodiversity units under preliminary-BNG applications in England have been delivered within the development footprint (or directly-adjacent to the development). (DEFRA, 2023a) stated in an official summary of their BNG consultation that they "will continue to incentivise a preference for on-site gains over off-site gains."

2.1.2. Distance to the offset

Choices regarding spatial allocation of offset delivery are one of the most important considerations in relation to both biodiversity losses and gains and social compensation (Gonçalves et al., 2015). Assuming some biodiversity is delivered through off-site offsetting, how far away from the site-of-impact these units are is a decision that has implications for equivalence, fairness and a range of other considerations (Gonçalves et al., 2015; Moilanen and Kotiaho, 2018). Under current BNG rules and guidance, off-site offset activities far from the site-of-impact are disincentivised. Kalliolevo et al.'s (2021) study highlights the risk of negative impacts for local people associated with a pattern of offsetting-at-distance that emerged from the logic of Western Australia's offsetting system. However, others suggest that relaxing spatial restrictions and penalties would enable optimal allocation of biodiversity-restoration activities towards more ecologically-optimal outcomes, as well as supporting regional and national nature networks and biodiversity priorities.

2.1.3. Access

Currently there does not appear to be any explicit government guidance on whether habitat improved/created as part of BNG should be accessible to the public. Yet, the level of access to the compensation area will have meaningful consequences for the provision and receipt of resources, benefits and services, and is likely to be central to issues of equity, fairness and justice; as well as being important for public support (Bauer et al., 2004; Mcgonagle and Swallow, 2005; Newell and Swallow, 2013). Sullivan and Hannis (2015) noted that "reduced access to nature / greenspaces by local communities" formed a salient concern in written evidence submissions to the UK Parliament's Environmental Audit Committee's 2013 Inquiry into Biodiversity Offsetting in England. The Planning Advisory Service (2023) acknowledges that BNG relates to multiple socio-environmental agendas, including "access to greenspace and nature". On the other hand, biodiversity units delivered on inaccessible land are likely to be better protected from recreational disturbance, which can have deleterious effects on habitats and wildlife (Larson et al., 2019).

2.1.4. Species diversity

Currently, species outcomes are not a primary measure of the value of a biodiversity unit under England's BNG framework. Instead BNG uses a habitat-based approach to assess an area's value to wildlife (The Biodiversity Metric 4.0 – User Guide, Natural England and other parties, 2023). Preliminary evidence produced by Hawkins et al. (2022) suggests that this habitat-centric conception of biodiversity value is not a reliable indicator of the value of an area for species. Balmford et al. (2022) found that species richness is a significantly more important determinant of utility value than habitat or population-related aspects of biodiversity. Species richness at a site, both objectively measured and perceived, is also understood to generate greater psychological well-being benefits for people, including site-satisfaction and connectedness to nature (Fuller et al., 2007; Southon et al., 2018).

2.1.5. Affordable housing

The UK government's National Planning Policy Framework states that at least 10 % of new homes should be affordable (Ministry of Housing, Communities and Local Government; MHCLG, 2019b). Affordable housing is defined as housing for sale, at a price equivalent to at least 20 % below local market value, or at rent at least 20 % below local market rents. We included this attribute as a non-offset-related outcome to assess the relative importance of and, willingness to accept, alternative social benefits in the context of BNG delivery. This reflects a unique type of 'out-of-kind' compensation that does not directly benefit residents yet provides a societal good. This is effectively based on the assumption that perceptions of favourability of environmental or ecological compensation, e.g., biodiversity offsets, do not occur in a vacuum and are instead intertwined with and influenced by the acceptability and utility of the economic development that necessitates the compensation. This 'whole picture' theory also relates to the measurement of Social Licence to Operate, which presupposes that people's perceptions of the institution or industry responsible for the damage-causing enterprise will, in turn, influence their preferences for offset design and delivery. The hypothesis tested here is that people will be willing to accept trade-offs in offset-related utility in exchange for a housing development that appears to provide greater social benefits.

2.2. Sampling

The focal landscape for our research encompasses the counties of Berkshire and Buckinghamshire and Oxfordshire (approximately 300 km^2). This is an appropriate study site because it overlaps to a large extent with the Oxford-Cambridge Arc (2021), a priority area targeted for and actively affected by substantial economic growth and development. The vision outlined for the 'OxCam Arc' includes explicit commitment to "enhance the area's natural environment and biodiversity".

Our study included two different samples within this focal landscape; a purposively-sampled in-person survey representing different dimensions which we posited might influence utility for different BNG attributes. Specifically, this included different dimensions of urbanisation (towns, villages and city districts) and varying degrees of exposure to housing development activities either in the past, currently, or scheduled for the future. By necessity, this sample was small and not necessarily representative of the wider population of the landscape.

A second, larger, sample was sourced via a research panel facilitated by a market research and survey software company which specialises in the delivery of Choice Experiment surveys called SurveyEngine—Choice Modelling Systems and Methods (2001). Anyone 18 years and over living within the counties of Berkshire, Buckinghamshire or Oxfordshire was eligible to complete the survey. A quota of 500 responses was set,

which included specific quotas for county, age and gender. Buckinghamshire and Oxfordshire were allocated 200 responses each and, Berkshire, 100, which reflected (approximately) the geographical composition of our study's focal landscape. Partial postcodes consisting of the outward code and one character from the inward code (e.g., GL7 5; OX16 2) were collected for triangulation with socioeconomic and environmental secondary data. This sample allowed us to explore the extent to which the utilities expressed in the purposive sample were reflected in a sample that was more representative of the wider focal landscape and gave us a large sample for exploration of the determinants of the social acceptability of BNG.

Identifying study sites for the in-person survey sample involved a short desk-based information-gathering exercise. Firstly, a review of the strategic plans for the local planning authorities (LPA) was conducted and followed-up with a targeted search of their planning application portals to apprehend both the presence and extent of housebuilding at both the LPA and parish levels. Concurrently, the findings from this exercise were triangulated with secondary data at the lower-layer-super-output (LSOA) resolution for a range of socio-economic and environmental indices, sourced from various open-access databases and accessed via Local Insight (OSCI, no date). Based on this information, a long-list of study-sites was compiled, of which a short-list of seven sites was derived based on logistical considerations (see Table 1).

2.3. Survey Instrument

2.3.1. Stated Preference Choice Experiment

To explore localised values and preferences for Biodiversity Net Gain strategies held by the respondents, the framing for the choice experiment focused on the outcomes of BNG strategies associated with a hypothetical housing development project taking place close to (<5 km) the home of the respondent. In the online survey, the size of the housing development (i.e., the number of houses being built) cited in the framing was generated using feedback from the respondent on the number of houses built in the past 10 years within the same radius. 10 % was added to this range to ensure the development was proportionately-sized and realistic in the context of their current environment, while still representing a relatively significant intervention. In the locally-sourced survey, actual data on the number of houses that had been built in the area was used to generate the scenario.

The choice experiment was an unlabelled design and did not include an opt-out alternative, meaning respondents were presented with a series of seven choice sets (with one being a duplicate set), each consisting of two alternatives (hypothetical BNG approaches), which differed only in terms of the levels of each attribute. The absence of an opt-out alternative reflects the fait-accompli reality of BNG policy. Respondents were asked to select their most preferred BNG strategy (or alternative) for each choice set. Each alternative was defined by five attributes.

Table 2 provides the definition for each attribute and their constituent levels. Attributes and levels were discussed and refined with further input from expert informants and local focus group participants to ensure their feasibility and relatability. Four of the attributes consisted of three levels and the fifth attribute had two levels.(Fig. 1)

Conventionally, choice experiments include a monetary attribute for calculating respondents' marginal willingness-to-pay (WTP) for changes in attribute levels (Scholte et al., 2016). Similar to other choice experiment studies examining acceptability and preferences for offsets (Griffiths et al., 2019b; Rogers and Burton, 2017) it was deemed inappropriate to place a monetary burden on respondents, who were assuming the perspective of local residents, given that offsetting is based on the "*polluter pays*" principle, wherein the costs of offsetting are the financial responsibility of the developer. The trading of a secular value, like money, for an arguably "sacred" value like biodiversity or access to nature could also be considered taboo, or morally problematic, creating psychological discomfort (Tetlock et al., 2000). The omission of a WTP estimate was also epistemically, ethically and strategically motivated, given this study's objective of operationalising a cost-based approach to biodiversity valuation in public procurement projects, as proposed by the Biodiversity Working Group of HM Treasury. The cost-based approach aims to avoid the issues and confounding biases associated with explicit trade-offs between biodiversity and explicit monetary cost

Table 1
Fieldwork sites including key indices, comparative conditions and details of data collection activities.

Site	Brill and Oakley, Buckinghamshire	Barton and Sandhills, Oxford, Oxfordshire, UK	Maids Moreton, Buckinghamshire	Bicester West, Oxfordshire	Cuddington, Buckinghamshire	Steeple Claydon, Buckinghamshire
Settlement Type	Village	City (Suburb)	Village	Town (Ward)	Village	Village
Population (2021 Census)	592 (Brill) 1128 (Oakley) 1720 (Total)	7300 (Ward)	864	8847	592	2529
Exposure (to housing development over past 10 years)*	Low	High	Low (planned)*[1]	High	Low (planned)*[1]	High
Rural/Urban*[2]	Rural (75 %)	Urban (0 %)	Rural (83 %)	Urban (0 %)	Rural (74 %)	Peri-Urban (19 %)*[3]
Index of Multiple Deprivation (IMD)*[4]	Low (25860)	Low (30729) to High (6730)	Moderate (16946)	Moderate (20824)	Low (28488)	Low (25237)
ANGIPD (NE)*[5]	Moderate (M3)	Poor (L2 to L3)	Poor (L3)	Good (H2 to H3)	Poor (L3)	Poor (L3)
Age (% 65 +)	25 %	15 %	16 %	10.6 %	29.8 %	20.9 %
SAMHI*[6]	Low (−0.16)	Moderate (0.53)	Low (−0.13)	High (1.41)	Low (−0.24)	Low (−0.01)

*Exposure classified based on relative population growth since 2011 census and presence/absence of strategic allocation of housing in LA plan.
*[1] "(future)" indicates that, although population and housing growth for these sites has been low over the past 10 years, these sites are exposed to ongoing or planned housing development projects.
*[2] Site classified as rural if > 50 % of residents within LSAO classified as rural residents.
*[3] 18.7 % are classified as rural residents at the LSOA level, which encompasses nearby settlements. However, the village is described as "rural" in landscape and character in both the neighbourhood plan (Steeple Claydon Parish Council) and district council plan (Aylesbury Vale).
*[4] Index of Multiple Deprivation (IMD) is The IMD combines information from seven domains of deprivation for an overall relative measure of deprivation. This includes: Income deprivation; employment deprivation; education, skills and training deprivation; health deprivation and disability; crime (9.3 %); barriers to housing and services; and living environment deprivation (MHCLG 2019a).
*[5] Accessible Natural Greenspace Inequality by Population Density (ANGIPD) is derived from Natural England's ANG standard (ANGst) assessment and measures relative inequalities in the provision of access to natural green spaces, taking into account population density and IMD (see point above) (Natural England, 2024a,b).
*[6] Small Area Mental Health Index (SAMHI) is a composite annual measure of population mental health for each Lower Super Output Area (LSOA) in England, taking into account multiple indicators of mental health (e.g., prescribing data; mental health-related hospital attendances, etc) (Daras and Barr, 2021).

Table 2
Attributes (offset features) and levels used in the choice experiment.

BNG Offset area feature (attribute)	Different possible outcomes (levels) and CE descriptions in the survey
Off-site %	1. ***10 %*** "*Most of the improvements in biodiversity will be done within the footprint of the housing development*" 2. ***50 %*** *"Half of the improvements in biodiversity will be done within the housing development and half will be done away from the housing development."* 3. ***70 %*** *"Some improvements in biodiversity will be done within the housing development but more will be done away from the housing development."*
Distance	1. ***5 km (Parish Council)*** *"The portion of the offset that is off-site cannot be further than 5 km from the site of the housing development (the site of impact). This approximately represents the area governed locally by your parish council, the lowest tier of local government in England."* 2. ***20 km (Local District Council)*** *"The portion of the offset that is off-site cannot be further than 20 km from the site of the new housing development took (the site of impact). This is roughly equivalent to the area governed locally by your district council (e.g., Oxford City Council; Vale of White Horse; Cherwell, etc.)."* 3. ***50 km (County Council)*** "The portion of the offset that is off-site cannot be further than 50 km from the site of the new housing development took (the site of impact). This is roughly equivalent to the area governed locally by your county council (e.g., Oxfordshire; Buckinghamshire, etc.)."
Public Access	1. ***No public access*** *"The offset areas will be on private land. There will be no footpaths to or through the offset sites. This might benefit biodiversity at the offset areas by minimising human disturbance."* 2. ***Public access*** *"The offset areas will be publicly accessible. There will be footpaths to and through the offset areas. This will allow for members of the public to visit the areas and use them for recreation."*
Species richness	1. ***Low*** *"The number of different species within the offset areas will be low. There will still be a small number of different trees, wildflowers, insects and birds but these will likely be common species and sparse of each."* 2. ***Moderate*** *"The number of different species within the offset areas will be moderate. There will be a moderate number of different trees, wildflowers, insects and birds and there will be a moderate amount of each species. There will also be common wild mammals present, such as foxes or hedgehogs."* 3. ***High*** *"The number of different species within the offset areas will be high. There will be a significant number of different trees, wildflowers, insects, birds and mammals and each species will have a strong presence. There will be many common species, but the site has a high chance of supporting rarer species such as nightingales, greenfinch, dormice, and orchids."*
Affordable Housing %	1. ***0 %*** *"There will be zero affordable housing within the new housing development."* 2. ***30 %*** *30 % of the housing within the new development will be affordable housing.* 3. ***50 %*** *"50 % of the housing within the new development will be affordable housing.*

(IPBES, 2019; Paul et al., 2020) by implicitly appraising public valuation of biodiversity via relative preferences and trade-offs across multiple objectives for a policy target. Instead, the relative importance, or utility, attached to discrete changes in the levels of attributes and the implications for residents' welfare were the focus of this study. Average Marginal Effects (AME) were therefore calculated for the differences between the five attributes (Lanscar and Louviere, 2008).

2.3.2. Questionnaires

Respondents faced a series of questions relating to various socio-economic and demographic information (age group; gender; ethnicity; annual household income; etc.,) and individual/household characteristics (e.g., length of residency; vehicle access; general health). These data were used to assess the representativeness of samples, as well as to gauge and control the influence of socio-demographic covariates that have previously been shown to be important for choice (e.g., Cole et al., (2022); Glenk, (2011); Griffiths et al., (2019b), well-being (Meyer, Castro-Schilo, and Aguilar-Gaxiola, 2014) environmental-attitudes (Alcock et al., 2017, 2020), place-bonding (Nielsen-Pincus et al., 2010), nature-connectedness and nature-contact (Martin et al., 2020) and, specifically residential differences, for housing in relation to environmental impacts (Gkartzios and Scott, 2013) Respondents to the online survey were also asked to provide their county of residence and partial postcode for triangulation of their data with secondary data collected relating to their area's social and environmental context.

The Office for National Statistics four-item Personal Wellbeing scale (Office for National Statistics, 2021) was used to measure respondents' self-reported wellbeing across four dimensions (Life-satisfaction; Worthwhile-life; Happiness; Anxiety) to both establish a baseline from which to assess individuals' perceived changes in wellbeing derived from the scenario interviews and to examine the relationship of personal-wellbeing with Exposure to Nature (Francis, 2011; Wood et al., 2019), Connectedness to Nature (Mayer and Frantz, 2004; Navarro et al., 2022) and Place Attachment (Raymond et al., 2010) scores and the interaction of this with individual preferences for different offsetting alternatives. We also measured the relationship between respondents' perceptions of the housing development industry's social licence to operate (Boutilier and Thomson, 2011) and their views on the acceptability of different offset attributes. Questionnaires used in the survey and the derivation of constructs used to measure these relationships are given in *appendix F & G* of the supplementary materials.

2.3.3. Scenario Interviews

A scenario exercise was conducted following the choice experiment task (c.f., Travers et al., 2019), to investigate the extent to which attitudes and behaviours, as a proxy for welfare, would be affected under scenarios characterised by four alternative approaches to Biodiversity Net Gain. Each scenario was framed around the respondent's local and regional natural environment and a vignette of the ecological, environmental, and structural changes associated with each approach over a 10-year period was given. As such, four scenario narratives were presented to each respondent. These involved 1) a status-quo scenario modelled on preliminary BNG trends (e.g., zu Ermgassen et al., 2019) wherein BNG has been delivered entirely on-site with no additional or alternative compensation; 2) a local recreation-focused scenario wherein BNG has been distributed regionally on private sites alongside a new local parkland characterised by amenity benefits and public access; 3) a local nature-focused scenario wherein BNG has been achieved via the establishment of a species-rich nature reserve close to the respondent's home but characterised by careful management (i.e., no dogs and strict footpaths); 4) and a regional Nature Recovery Network (NRN) scenario, wherein BNG has been achieved through the enhancement, expansion and connection of a regional network of nature reserves. Respondents were asked how they would respond to each on a five-point Likert-scale, ranging from −2 to + 2. To assess the perceived impact of each scenario, four proxy variables were measured: How fair each scenario was (Fairness); the expected change in perceived quality of life under the changes brought about by each scenario (Quality of Life); the expected change in time spent in nature under each scenario (Time Spent in Nature); the likelihood that the respondent would move home

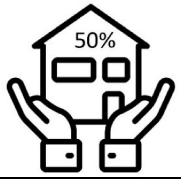
Attributes		Scenario 1	Scenario 2
	Percentage of offset that is off-site (vs on-site)	10%	30%
	Percentage of affordable housing	0%	50%
	Public access	Public Access	No Access
	Species Richness	Low	High
	Distance from site of impact	5km	50km
Which do you prefer? *(Select one)*			

Fig. 1. Example choice card used in the choice experiment. Each alternative (scenario) is described by five choice attributes that characterise the offset areas under a hypothetical Biodiversity Net Gain strategy associated with a housing development.

under each scenario (LMH). Respondents were then presented with an opportunity to reflect and explain their answers qualitatively. See *appendix C* (*Scenario interviews*) of the supplementary materials for the vignettes and response scales used for the four scenarios. The Kruskal-Wallis procedure (Kruskal and Wallis, 1952), a nonparametric analysis of variance technique, was used to preliminarily test for differences in response variables between scenarios. Following this, the four proxy variables were modelled separately using ordinal logistic regression models.

2.4. Data analysis

2.4.1. Importance of housing priority concerns

We carried out a Plackett-Luce Model (PLM) including worth estimates with significance levels, standard errors, and Z test statistics. Plackett-Luce modelling is a well-established statistical technique for analysing rank data (PLM; Plackett, 1975; see also Luce, 1959) that has been applied across a range of disciplines, contexts and issues (e.g., Bodington and Malfeito-Ferreira, 2017, Farias et al., 2013) including within ecological (Lohr, Cox, and Lepczyk, 2012) and econometric research (Garzon et al., 2016). The PLM estimates the probability of selecting an option, in this case a housing development concern, in a given set based on Luce's axiom (Luce, 1959) and is expressed in the PLM as item worth, which is an estimation of the importance of the particular option in accordance with the rankings made by respondents. We use the mean of the worth parameters as the reference point, which means that the individual worth of each concern represents the importance of that concern in relation the average worth and the p value, i.e., the extent to which that concern's worth diverges significantly and systematically from this reference point (Finch, 2022).

2.4.2. Choice Experiment Consistency checks

A basic validation of the 'rationality' and consistency of the choices made by respondents in the DCE was carried out using an additional 'dummy' choice card, which was an identical duplicate of one of the other choice cards in the same set. For the sample recruited using a market research panel approximately 98.5 % passed and 1.5 % failed (=6). Therefore, data from the remaining 396 'consistent' responses were included in the final analyses. Comprehension checks were included following practical instructions and explanations of attributes to ensure respondents were paying attention and understood the information. Respondents were not allowed to proceed to the next section of

the survey until they reviewed the information and answered correctly (see *appendix A*).

Most respondents (52 %) reported that they found it either "*very easy*" (13 %) or "*easy*" (39 %) to choose between the choice scenarios, while 27 % found it "*neither easy nor difficult*" and 20 % found it "*difficult*". Only three respondents (1 %) found the choice decisions "*very difficult*". The majority of respondents (80 %) were at least "*fairly sure*" (58 %) or "*very sure*" (21 %) about their choices, while 15 % were "*neither sure nor unsure*". Only 5 % reported being "*fairly unsure*" and two respondents (<1 %), "*very unsure*". Regarding the attributes, 87 % of respondents reported that they "*paid strong attention to all of them*" (32 %) or "*paid attention to all of them*" (55 %). 7 % were "*not sure*" whether they paid attention to each of the attributes equally, 5 % admitted they "*did not pay attention to some*" and 0 respondents "*paid no attention*". This feedback suggests that respondents generally found the choice experiment task easy to understand and not excessively cognitively-demanding. They also attended to all or at least most of the attributes in each choice scenario and were largely confident about the decisions they made.

2.4.3. Choice Experiment Modelling

We estimated several models but focus in the Results on the most flexible representation of preferences: the Random Parameters Logit (RPL) which allows preference parameters (hence tastes) to vary across individuals (Hensher et al., 2015; Mariel et al., 2013). Full details of the statistical models used can be found in *appendix b* (statistical design and empirical methodology) while full model output for the Multinomial Logit Model with main-effects (ME) and significant interactions between attributes is included in *appendix E* (supplementary statistical analysis and outputs).

3. Results

3.1. Sample characteristics

3.1.1. Paid Market Research Panel Sample

The paid-panel sample totalled 396 respondents, 57 % of which were men and 41 %, women, with 3 % unidentified; 4 % were aged eighteen to twenty-four 21 % were twenty-five to thirty-four, 16 % were thirty-five to forty-four (16 %), 19 % were forty-five to fifty-nine, and 39 % were sixty and over, 39 % of respondents were residents of Oxfordshire; 35 %, residents of Berkshire; and 26 %, residents of Buckinghamshire. 50 % of respondents said they currently lived in a town; 26 %, in a city; 23 %, in a village; and 1 %, in a single dwelling. 396 responses were included in the final analyses following screening and validation (see subsection: Rationality Test: Consistency of Choice) which resulted in the exclusion of 9 responses. The median completion time was approximately 29 min.

3.1.2. Locally recruited Sample

A second sample characterised as "locally self-recruited", consisted of 120 respondents who were not paid for their participation. Separation of this subsample from the main analysis of the paid-sample is both i) theoretically justified, given differences in recruitment strategy and, consequently, distinctive individual motivations for participation (paid vs unpaid) and demographic compositions (see Table 3); and ii) statistically justified according to a loglikelihood ratio test (LLR: $p < 0.001$). For brevity, and because overall preferences and marginal rates of substitution were largely comparable, the choice experiment and scenario results for the locally-recruited sample are included in *appendix D* of the supplementary materials, while only the online sample results are presented in the main text.

3.2. Respondents' priorities for housing developments

Respondents were asked to rank a list of seven priorities that related various social, economic, and environmental considerations and impacts of housing development from lowest (7th) to highest priority (1st). Table 3 displays the descriptive statistics (i.e., mean ranking and standard deviations) for respondents' prioritisations of housing development concerns. Overall, respondents ranked preserving the "existing culture and character of the place" as the highest priority for housing development, closely followed by "protecting wildlife and nature" and the sustainability of homes and building materials. Respondents ranked benefits for the national economy delivered by housing to of lowest concern, followed by social housing.

Table 3
Paid online respondent ranking of priorities for local housing development. Priorities were from lowest priority (7th) to highest priority (1st).

Priorities for housing development	Mean Ranking (SD)
Preserving the existing culture and character of the place	3.4 (1.9)
Protecting wildlife and nature	3.5 (2)
Creating sustainable homes and using sustainable building materials	3.6 (1.9)
Improving the local economy	4 (1.8)
Providing starter homes	4.1 (1.9)
Providing social housing	4.4 (2.1)
Improving the national economy	5 (1.9)

Regarding respondents' housing priority concerns, the worths of 'culture and character', 'wildlife and nature' and 'sustainable homes and materials' were significantly and non-randomly higher than the average (Table 4). The worth of 'social housing' as a housing development concern was significantly and non-randomly below the average, in line with respondents' rankings. Results indicate that 'improving the national economy' was the lowest ranked concern with greatest effect and consistency across all respondents. The worths of local economy and starter homes did not differ significantly from the average ($p > .05$).

3.3. Choice experiment results

3.3.1. Preference heterogeneity across age, income and attitudes towards housing, nature, and place

All four attributes had highly significant effects on respondents' choices. The offset attribute and level with the highest marginal utility, and therefore, the most consequential for determining the acceptability of an offset, was existence of public ACCESS, *ceteris paribus* (Table 5). SPECIES RICHNESS showed the second highest utility, indicating that, as predicted, people prefer offset areas with a greater variety of wildlife.

The most significant differences between socio-demographic groups related to age and income. Respondents aged > 60 years had significantly different preferences on a number of dimensions, including for greater SPECIES RICHNESS ($b = .49$, $p < .001$), compared to those aged < 60 years. Those with equal-to or higher-than-average income than the regional average (≥£50,000) showed weaker preferences for increases in SPECIES RICHNESS ($b = -.57$, $p < .001$). Some near-significant variation in the choices of urban and rural residents was also observed, and women were more likely than men to choose choice sets

Table 4
Plackett-Luce model parameter estimates for housing priority concerns. Standard errors are in parentheses and significant parameter estimates are in bold. *** $p < 0.001$.

Priorities for housing development	Worth	*Z*
Culture & Character	**.34 (.06)*** **	6.13
Wildlife & Nature	**.28 (.06)*** **	5.02
Sustainable homes & materials	**.27 (.06)*** **	4.91
Local economy	.07 (.05)	1.21
Starter homes	−.05 (.06)	−.92
Social housing	**−.29 (.06)*** **	−5.01
National economy	**−.62 (.06)*** **	−10.32

Table 5
RPL model parameter estimates and standard errors for paid-sample data, with both the mean effect and the interactions with socio-demographic variables. Standard errors are in parentheses and significant coefficients are in bold. Significance thresholds are 1 % (***), 5 % (**) and 10 % (*).Mean RPL estimates substantiate the results of the MNL, with all attributes exhibiting a significant effect at the 1 % level.

Individual-specific variable interaction	Attribute				
	Offsite %	*Distance*	*Access*	*Species Richness*	*Affordable Housing %*
Mean RPL	**.18*** **	**−.229*** **	**1.103*** **	**.761*** **	**.44*** **
model estimate	**[.05]**	**[.043]**	**[.116]**	**[.089]**	**[.068]**
Age (>60)	**−.206** **	**−.191** **	−.186	**.486*** **	**.264** **
	[.103]	**[.09]**	[.202]	**[.159]**	**[.13]**
Gender (Woman)	.14	−.051	.134	169	**.246** **
	[.098]	[.063]	[.206]	[.146]	**[.12]**
Education Level (University Degree)	−.027	.005	.126	−.134	.053
	[.098]	[.083]	[.207]	[.149]	[.121]
Geography (Rural)	−.051	**.164***	.159	**−.267***	.039
	[.104]	**[.085]**	[.222]	**[.162]**	[.127]
Income (>£50,000)	.129	**.134***	**−.38***	**−.571*** **	**−.24** **
	[.096]	**[.081]**	**[.224]**	**[.148]**	**[.12]**
Berkshire	−.037 [.052]	.022 [.056]	−.004 [.095]	−.03 [.08]	.07 [.056]
Buckinghamshire	−.07 [.057]	−.022 [.06]	.124 [.103]	**.466*** [.174]**	−.042 [.061]
Oxfordshire	**.216** [.097]**	−.003 [.054]	−.099 [.094]	**−.283* [.154]**	−.032 [.054]
History (High Exposure)	.016 [.031]	−.012 .[027]	−.023 [.064]	.032 [.048]	−.029 [.038]
Economic Legitimacy (SLO)	**.103** [.043]**	−.062 [.05]	.062 [.12]	**−.196*** [.072]**	**.14** [.068]**
Social Legitimacy (SLO)	.009 [.046]	**.094** [.043]**	.127 [.109]	**−.133* [.071]**	−.020 [.066]
Connectedness to Nature (CNS)	−.034 [.07]	.065 [.064]	.111 [.144]	**.197* [.101]**	−.034 [.085]
Exposure to Nature (ETN)	−.036 [.062]	**−.085* [.046]**	**.223* [.117]**	**.277*** [.105]**	.022 [.074]
Place Attachment (Composite)	.104 [.064]	**.104** [.053]**	.174 [.141]	**−.174* [.096]**	**−.199** [.081]**
Place Attachment (Identity)	**.083* [.048]**	.037 [.039]	**.169* [.102]**	−.05 [.07]	−.089 [.055]
Place Attachment (Nature)	.015 [.043]	−.013 [.043]	.146 [.095]	**.106* [.063]**	−.077 [.055]
Place Attachment (Dependency)	**.085* [.048]**	**.089** [.039]**	.085 [.103]	**−.19** [.076]**	**−.122** [.057]**
Place Attachment (Social)	.03 [.049]	**.115*** [.042]**	.024 [.105]	**−.165** [.075]**	−.085 [.06]
Place Attachment (Family)	.063 [.047]	.054 [.039]	.035 [.094]	**−.198*** [.071]**	**−.155*** [.057]**

with higher level of affordable housing. However, there were no significant differences related to educational level.

Views about the housing industry's Social Licence to Operate also affected preferences. For example, respondents who had more positive views of the economic legitimacy of the housing industry tended to be less sensitive to gains in SPECIES RICHNESS ($b = -0.2$, $p < .001$). The effect of social legitimacy was weaker but included a preference for closer offsets. However, whether or not a respondent had a history of exposure to housing developments was not a factor in their choices.

As regards respondents' relationships with nature and their local environment, the strongest effects related to species richness. Respondents who reported spending more time exposed to and paying attention to nature (ETN) ($b = .28$, $p < .001$) exhibited stronger preferences for offset areas that support greater SPECIES RICHNESS, compared to those who scored as less 'connected' and less frequently exposed to, and engaged with, nature. The 'nature-bonding' dimension of the PA scale interacted positively and significantly with SPECIES RICHNESS ($b = .11$, $p < 0.1$). This was in contrast to interactions relating to more socially-based elements of place attachment, wherein weaker preferences for SPECIES RICHNESS were observed. As might be expected, those with greater social PA ($b = .12$, $p < .001$) ascribed greater disutility to increases in DISTANCE. Interestingly, those with higher levels of 'family'-associated PA ($b = .15$, $p < .001$) showed were less likely to pick choice sets with higher levels of AFFORDABLE HOUSING and species richness.

3.3.2. Willingness to Travel (WTT) between rural and urban people

As noted, the CE design did not include a monetary attribute. However, a willingness to travel (*WTT*) attribute was calculated and expressed in km based on the MRS between the DISTANCE attribute and each other attribute to illustrate the willingness of respondents to incur a cost (temporal, monetary or otherwise) for gains in other, positively-valued BNG approach attributes. Fig. 2. is a visual representation of this *WTT* estimate, for the whole sample compared to subgroups of *urban* and *rural* respondents. It demonstrates that in all cases higher WTT was expressed for publicly accessible sites, with a particularly strong effect for rural people who were prepared to travel 20–50 km for an accessible site. Species richness was also universally important, and rural dwellers were more willing to travel (to the offset area) if that was associated with affordable housing.

Average Marginal Effects enable the relative preferences for different attributes to be compared in terms of the marginal change in probability of choice associated with a step-change in that attribute (Fig. 3). In keeping with the results of the RPL, species richness and access were most consequential, but in all cases attributes were significant.

Table 6 provides further information about the relative contribution of each attribute level to the choice share (i.e., the proportion of scenarios wherein alternative A or B is preferred) of a specific alternative (i.e., a BNG offsetting scenario) by simulating an entire choice-deck wherein a chosen attribute is fixed at a specified level for one choice-alternative (E.g., Approach A vs Approach B) across every choice-card. This process involving simulating a random utility model in which the utility functions are functions the attributes (i.e., $x_1,\ldots,x_K$), which is then fitted to compute the probability for the sample of responses by describe the choice among J alternatives (i.e., $C_1,\ldots,C_J$.) (Hensher et al., 2015). Estimated separately in NLogit 6 by specifying fixed attribute values in the simulate function. The levels are specified in square brackets for each attribute (Access only has 2 levels).

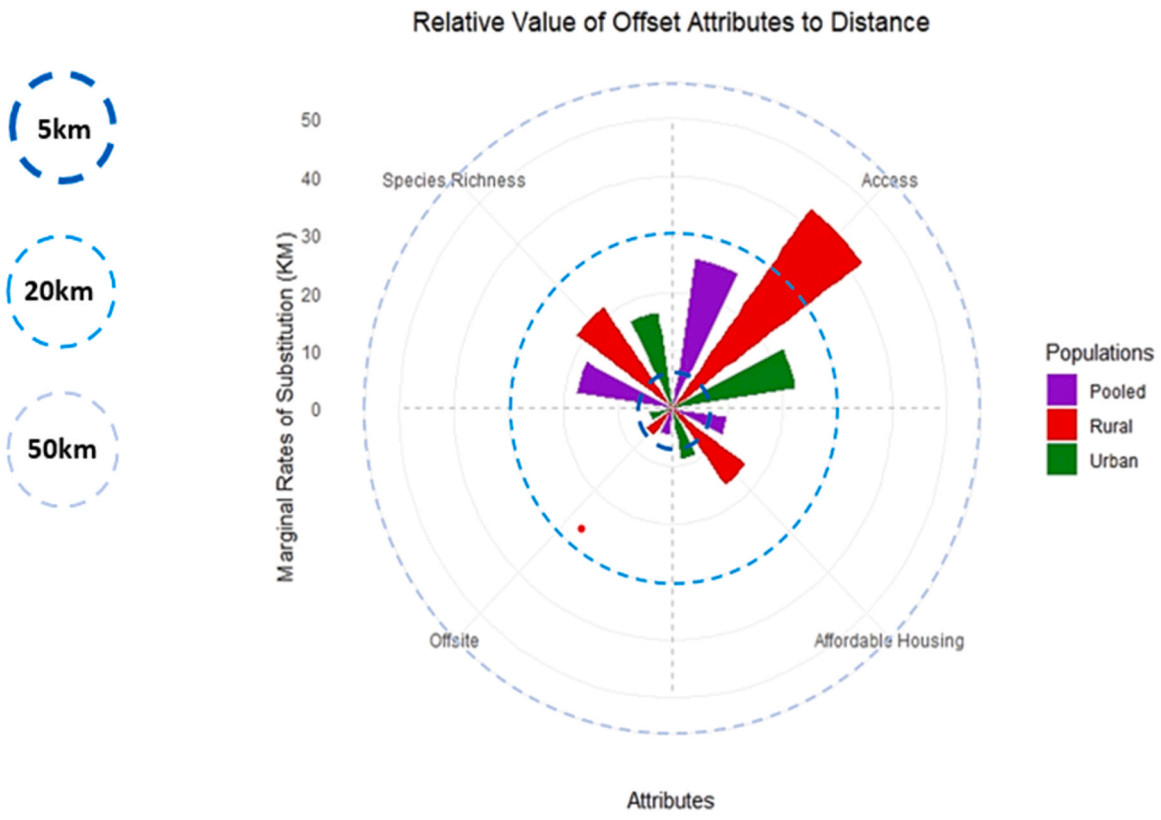


Fig. 2. Marginal rates of substitution for significant RPL parameter estimates for the pooled sample vs urban vs rural sub-samples. *Note:* All values are relative to the 'DISTANCE' attribute, reflecting a Willingness to Travel estimate for differently configured BNG offsetting strategies associated with local housing development. (MRS = (attribute's parameter estimate/parameter estimate for DISTANCE) * 5 km (reference level)).

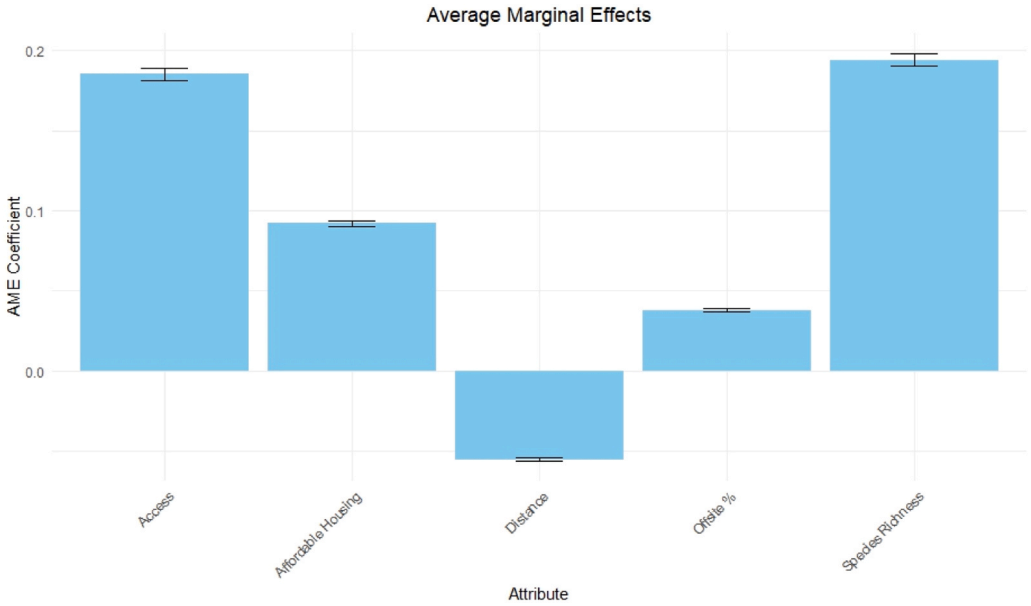


Fig. 3. Average Marginal Effects (AME). AMEs measure the percent change in the probability of choosing a BNG offsetting alternative when the attribute level increases from 0 to 1. Estimates include measures of uncertainty (standard errors are estimated automatically by NLogit 6 using the Delta Method). All AMEs are statistically different from zero.

ACCESS and SPECIES RICHNESS had the greatest effect on the probability of choosing a specific alternative. AMEs indicate that increasing the level of ACCESS from 0 (offset area on private land with no public access) to 1 (offset area with public access) results in a 18.5 % increase in the probability of choosing that BNG offsetting scenario. Similarly, a change of SPECIES RICHNESS from low to moderate results in a 19.4 % increase in the probability of choosing a specific alternative. Simulated choice-share analysis reveals a largely symmetrical change in choice share across levels for SPECIES RICHNESS, with level 1 (low species richness) resulting in a loss of 8.88 % and level 3 (high species

Table 6
Change in choice share for scenarios if attributes are fixed at specific levels (ME-only Model).

Attribute	Level 1	Level 2	Level 3
OFFSITE [10; 50; 70 %]	−0.78 %	−0.1 %	+ 1.15 %
DISTANCE [5; 20; 50KM]	+ 3.13 %	+ 0.49 %	−2.2 %
SPEC. RICH. [LOW; MEDIUM; HIGH]	−8.88 %	+ 0.11 %	+ 8.76 %
AFFORD. H. [0, 30, 50 %]	−4.77 %	−0.55 %	+ 5.79 %
ACCESS [PRIVATE; PUBLIC]	−6.17 %	+ 6.2 %	/

richness) associated with an 8.76 % gain in people choosing one choice set over another. As expected, setting the level to 2 for the entire choice-deck (moderate species richness) had a negligible, albeit positive, effect on the choice share for the affected alternative (+.11 %). The AFFORDABLE HOUSING % attribute had a significant and moderately-sized effect on the probability of choosing an alternative with the overall increase in the likelihood of choosing a choice set changing by 9.2 % as the level moved from 10 % to 50 %. While the AME for OFF-SITE % indicates that a change in the attribute from 10 % off-site to 50 % off-site results in a 3.8 % increase in choosing a given choice set, the simulated choice-share analysis shows that a positive gain in choice share relative to the baseline choice-share only occurs when OFF-SITE % is set at level 3 (70 % off site); if OFF-SITE % is fixed at level 2 (50 %) this would not be sufficient to make an alternative more preferable overall. DISTANCE has a comparable but slightly greater effect on the probability of choosing an alternative (approximately −5.5 %), suggesting that when DISTANCE increases from 5 km to 20 km for a specific alternative, the likelihood of choosing that alternative decreases by 5.5 %. Simulations performed with fixed DISTANCE levels, however, show that an aggregate loss in choice share only occurred when DISTANCE is fixed at level 3 (50 km) for a specific alternative, suggesting that, all things being equal, level 2 (20 km) is well-tolerated and has little no effect on the overall choice-share (+.49 %).

3.4. 10-year BNG scenarios: Recreation for quality of life and Nature Recovery Networks for fairness

Locally-tailored scenarios of housing development were associated with significant effects on people's perceived quality of life and fairness, but not behavioural change (time spent in nature or moving away from the area). Ordered logistic regression indicated that respondents were more likely to expect a positive change in their Quality of Life (QOL) over a ten-year period under scenario two, a recreation-focused approach to local BNG compensation ($t = 2.18$, $b = 0.28$, $p < .001$), compared to the other scenarios, with 43 % of respondents expecting their quality of life to improve under this approach and a 46 % likelihood of a respondent rating their QOL as "better" or "much better". Whereas under scenario one, the status-quo option modelled on the current dominant approach to BNG in England (as per zu Ermgassen, 2021), respondents were significantly more likely to expect a negative change in their QOL ($t = -2.11$, $b = 0.22$, $p < .001$), with 25 % of respondents stating that they would expect their quality of life to decline as a result. Unexpectedly, scenario 3, framed around a regional nature recovery network approach to BNG, was considered significantly fairer ($t = -2.11$, $b = 0.22$, $p < .001$), with 56 % of respondents rating this approach as "fair" or "very fair", despite this being the least locally-focussed and most purely biodiversity-focussed scenario. (Table 7)

Table 7
Summary of results from ordered logistic regressions analyses of the effects for each 10-year BNG scenario on four response variables measured on five-point Likert scale. Response variables measured two attitudinal (Quality of Life and Fairness); and two quasi-behavioural (Time Spent in Nature) dimensions. Analyses performed using package "MASS" in R Studio. See *appendix E* for detailed model outputs. *** $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$.

Scenario	Response			
	Quality of Life	Fairness	Time Spent in Nature	Likelihood to Move
On-site (status-quo)	**−.22*** **	−.13	−.07	+ .05
Local recreation-focused	**+ .28*** **	+ .18	+ .12	−.08
Regional NRN	+ .21	**+ .25** **	+ .07	−.03
Local nature-focused	+ .18	−.04	+ .03	−.04

4. Discussion

We find a potentially significant divergence between the current trajectory of Biodiversity Net Gain policy and practice in England and BNG designs that would best serve the welfare of local people, as measured by preference and perceived utility. Our results reveal that the availability of public access and greater biodiversity at the offset site were, by a significant margin, the most influential drivers of social acceptability for a BNG project; and valued more highly than outcomes such as proximity to residents' homes and even alternative social goods like affordable housing. We propose that this presents a challenge to certain operational principles and guidelines within current BNG frameworks, which prioritise on-site delivery; rely on habitat metrics that are an imperfect proxy for species diversity; and implicitly penalise public access and use. We unpack these findings and discuss the implications of this divergence, including its tensions, trade-offs, and options for reconciliation in pursuit of socially sustainable BNG implementation.

To contextualise these findings, it is useful to consider the outcomes from preliminary implementation of BNG (zu Ermgassen et al., 2021), which indicates 95 % of BNG delivery has been on-site or site-adjacent. Furthermore, as BNG uses a habitat-based approach to calculating biodiversity value, species richness outcomes are a not a direct measure of success. While habitat creation, restoration and enhancement should theoretically correlate with gains in biodiversity indicators like species richness, the preponderance of on-site and developer-managed BNG means most gains fall within a governance gap where post-implementation monitoring, and therefore availability and quality of data, is undermined by weak enforcement mechanisms and low compliance (zu Ermgassen et al., 2021). Preliminary evidence also suggests that species richness does not correlate well with habitat quality as measured by the BNG metric (Hawkins et al., 2022). Meanwhile, the impact of BNG on access is not currently being formally monitored. It could be inferred that, in most cases, it has not been explicitly reduced given the predominance of on-site BNG. On the contrary, closer examination reveals that even on-site and 'nearby' BNG risks creating and exacerbating inequalities in greenspace access through real and perceived barriers to access within the developed area (Bateman and Zonneveld, 2019).

Given many of the wellbeing and sociocultural benefits of nature rely on physical exposure and close-proximity interaction, it is unsurprising that the ability to access nature-rich spaces was so favoured by our respondents (Kalliolevo et al., 2021; Marselle et al., 2021). Previous studies using econometric techniques to examine public preferences for ecological compensation have generally not included access explicitly (Burton et al., 2017; Griffiths et al., 2019b; Scholte et al., 2016); although there are exceptions which attest to the relative value of public access for environmental mitigation and green and natural space provision (see Bauer et al., 2004). Incidentally, Dow's (2022) study of workers' preferences for BNG associated with a science park development in Oxford, UK, found the strongest support for habitat enhancement scenarios that maximised amenity value and access, compared to those that prioritised biodiversity at the expense of access. Our finding, therefore, further corroborates what seems intuitive, but has significant implications for both management and social acceptance: public access

of some kind is not just important for public health strategies but also as a key mediator of public support for BNG policy and its implementation. This is pertinent given that BNG appears to implicitly discourage access, while strategically linked government agendas, like the 15-minute access to nature goal, champion it (DEFRA, 2019). This touches on a fundamental management challenge in balancing positive and secure biodiversity outcomes with benefits for people (Larson et al., 2016; 2019; Spaul and Heath, 2016). Resolving this requires intelligent planning and management of BNG sites with the involvement of local stakeholders and communities to understand and effectively navigate harmful recreational thresholds and trade-offs with local uses and values (Ferrarini et al., 2008; Larson et al., 2019; Vangansbeke et al., 2017).

The finding that positive outcomes for ecosystems and biodiversity are a key determinant of public support of environmental compensation policies, reflected in the high valuation of species richness, aligns with expectations and is largely consistent with previous studies of this kind (e.g., Cole et al., 2022; Bauer et al., 2004; Burton et al., 2017; Kermagoret et al., 2016; Scholte et al., 2016; see Griffiths et al., 2019b for exception). Ergo, by fulfilling its fundamental function of contributing to biodiversity restoration, BNG could support local people's welfare, in line with their preferences in this limited setting. Interestingly, an interaction with distance, coupled with the strong preference for access, suggests the positive welfare associated with species richness could be driven by people's use values and the enhanced wellbeing benefits associated with spaces perceived to be more biodiverse, rather than purely the intrinsic value of biodiversity (Burton et al., 2017; Dallimer et al., 2012; Fischer et al., 2020; Fuller et al., 2007; Southon et al., 2018). Similar nuance was encountered by Cole et al.'s (2022) in their survey of the Swedish public, wherein compensation addressing both recreational and "nature-focused" values was preferable to options that focused exclusively on one. Results here echo this, showing a dual preference for BNG delivery focused on supporting species richness at the offset areas and access to those areas.

Respondents' preference for nearby offset areas is consistent with previous research (Burton et al., 2017; Cole et al., 2022) and supports the spatial principles of BNG's current guidance, which favours offset delivery close to the site of original impact. However, this preference appears negotiable. Only 40 % considered distance an important constraint in a public consultation conducted by the European Commission (2014) on mitigation and compensation actions relating to NNL (Cole et al., 2022). However, differences in framing and spatial relationality (e.g., the clear local impact orientation of this study and Cole et al.'s (2022) compared to the country-level scale of Burton et al.'s 2017 study), could explain this. Given that, overall, respondents regarded the Nature Recovery Network as the fairest option in the scenario interviews and that proximity was far less important than access and species richness outcomes, our results suggest that high quality, but distant, offsets could contribute to social acceptability. This lends tentative support to propositions like Bateman and Zonneveld's (2019), which puts forward a spatially-unconstrained BNG approach based on a model of ecological and socioeconomic need and equity. Interestingly, despite favouring nearby delivery, respondents preferred BNG that is predominantly delivered outside of the footprint of the development. This could reflect concerns about the security of biodiversity conservation within highly populated spaces (zu Ermgassen et al., 2021), a view that aligns with our finding that people with low trust in the housing industry were more likely to favour nearby offsets. It might also reflect apprehensions about distributive unfairness, wherein biodiversity gains are enclosed within new housing developments, creating real and perceived barriers to access for the wider community (Bateman and Zonneveld, 2019). This strengthens the case for reforming rules that incentivise entirely on-site delivery towards a mixed approach that includes both on-site and off-site provision.

It is critical to note that preferences were not uniform and we observed considerable heterogeneity in preferences across most of the attitudinal dimensions and sociodemographic characteristics. Age and income, for example, had a significant effect on almost all attribute valuations, while people's place-based attachment and exposure to and connectedness to nature also influenced their responses. In the same vein as Cole et al. (2022), this reinforces the point that a granular, context-specific assessment for projects is likely to produce much more nuanced local priorities than a top-down approach, and highlights the importance of seeking diverse representation in consultations. In the case of individual heterogeneity, the influence of social licence to operate (SLO) granted to the housing development industry was a noteworthy finding. Here, those who exhibited a higher SLO score (i.e., more trust) placed less importance on species richness outcomes. The role of perceptions of government and regulating authorities in terms of their trustworthiness, integrity, competence, and even values, in the formation of attitudes towards environmental policy is gaining attention (e.g., Gutiérrez et al., 2015; Kitt et al., 2021; Lee and Oh, 2021). Our findings add to this and demonstrate the usefulness of SLO as a construct for assessing this quantitatively. Given the move towards statutory biodiversity credits (Burke, 2023; Simpson et al., 2022) further research into the role of public trust and related perceptions for different BNG providers would be interesting and valuable.

Our finding that respondents prioritised preserving the "existing culture and character of the place" above all else, even, albeit marginally, protecting "wildlife and nature", is worth discussing. It emphasises that BNG projects are not judged in a vacuum but are evaluated by stakeholders within the broader context of a development's overall impact, a revelation further supported by respondent's willingness to trade-off BNG attributes for other social goods like affordable housing. While concept like 'culture' and 'character' are broad, the latter is often understood as an emergent quality of the landscape, inclusive of its natural aspects (Tudor, 2014), and it is robustly linked to a sense of local identity and place, which the natural environment forms a key part (Raymond et al., 2010). To make BNG projects more palatable and socially sustainable, developers might need to complement them with qualitative, participatory engagement that acknowledges these place-based values. This could, in turn, strengthen long-term ecological outcomes by fostering deeper connections between people and created or restored natural spaces within their local environment.

Choice experiments (CEs) are a useful tool for assessing the social feasibility of biodiversity offsetting and conservation policies. They enable the capture of stakeholder preferences at multiple scales and the estimation of the welfare value of different project attributes in relative or monetary terms (Cole et al., 2022; Griffiths et al., 2019b), which can parameterise and inform decision-making around trade-offs and constraints. However, CEs are fundamentally reductionist. By disaggregating landscape and community impacts into discrete, tradeable components, and ascribing marginal, quantiatie values, they risk oversimplifying complex relationships and commodifying nature, human wellbeing and the relations in-between (Scholte et al., 2016; Swanwick et al., 2007).

To prevent cognitive overload and ensure statistical reliability, CE design demands parsimony regarding the complexity of information, and necessitates hard choices over attribute selection. Our CE distilled down to five operationally, ecologically, and socially important considerations, but several omitted alternatives merit further consideration. These include 1) the SIZE or AREA of the offset sites, which has been shown to affect public support for compensation schemes (Cole et al., 2022) and contributes significantly to biodiversity unit calculations under the BNG metric (Martínez-Jauregui et al., 2021); 2) HABITAT type, which could shape public preferences as perceived cultural or ecological value might not necessarily align with habitats favoured by the BNG scoring system based on distinctiveness, condition and size (zu Ermgassen et al., (2021); Dow, (2022); Fischer et al., (2020); Southon et al., 2018); and 3) nuanced ACCESS, disaggregated beyond the two levels in the present study to better reflect a model for intelligent-design options that address the management challenges associated with recreational use (see examples: Bauer et al., 2004; Newell and Swallow,

2013). As well as more granular access levels, future CEs in this space could explore alternative non-offset social benefit attributes, such as local discretionary funding (e.g., section 64). Finally, tools like Willingness to Allocate Public Budget (WTAPB) or Flexible Participatory Value Evaluation (FPVE) could offer more defensible valuation methods for community-level decisions under polluter-pays principles, where traditional WTP estimates are arguably inappropriate (Mouter et al., 2019; Nunes and Travisi, 2009).

5. Conclusion

This study represents an empirical application of some of the best practice recommendations for biodiversity offsetting related to social wellbeing, described and evidenced by Griffiths et al. (2019a), (2019b) and others (e.g., Bidaud et al., 2017; Bull et al., 2018; Martinez-Cillero, 2023; Tupala et al., 2022). To achieve this, we experimentally elicited people's preferences for Biodiversity Net Gain projects associated with hypothetical housing developments close to their homes. This is in the national context of ubiquitous and expanding domestic housing developments, the environmental and social impacts of which are often intertwined and experienced locally. In addition to reaffirming the case for including local people and communities in environmental decision-making and development design via context- and place-sensitive assessment of social values, we also provide novel primary evidence that caveats the assumptions underlying some of BNG's operational principles with regards to their social feasibility. At the same time, we highlight that people's priorities and support for BNG are prone to mediation by individual demographic characteristics and sociopsychological and attitudinal variation, relating to relationships with place and nature. Our findings also suggest that individual perceptions of legitimacy, trust and risk associated with the body responsible for impacts and the associated offsets could moderate what is required from a BNG project for local people to feel satisfied that compensation is sufficient.

Win-win outcomes in environmental policy and management become more difficult to achieve as objectives, stakeholders and constraints multiply (Hegwood et al., 2022; McShane et al., 2011) and hard choices must be made. However, by considering local-scale preferences, BNG policy and practice can meet ethical and social obligations, minimise unintended consequences and be better able to provide sustainable, people-positive biodiversity conservation outcomes. Evidence has shown that biodiversity offsetting can easily fail to achieve this potential in practice and, in many cases, can do more harm than good, disenfranchising local land-users, displacing ecosystem services and failing to integrate localised and plural values. These values have legitimacy in terms of people's wellbeing and contribute to the long-term sustainability of these kinds of biodiversity compensation-restoration schemes (Bidaud et al., 2017; Griffiths et al., 2019a, 2019b). There had been little deliberation or investigation to date into the overall social appropriateness and welfare implications of the core operational principles governing BNG's implementation, which have been conceived primarily from the standpoint of ecological feasibility (see Bateman and Zonneveld, 2019; and Faccioli et al., 2024 as exceptions). Yet this is an important step towards achieving win-win or "no-harm" outcomes for BNG given the complexity of implementation. We hope to have contributed to this by highlighting which types of impacts are important for local people's welfare and acceptance of BNG projects, as well as demonstrating the need to reconsider any assumption of the generalisability of these principles across contexts and individuals.

CRediT authorship contribution statement

E.J. Milner-Gulland: Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Ben Groom:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Butler Amber J W:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Amber Butler reports financial support was provided by UK Research and Innovation Natural Environment Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2025.107758.

Data availability

Data will be made available on request.

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