Assessing how far a 'Net Zero' strategy moves an organisation towards 'Nature Positive' contributions

Authors: C. Maddinson [1,2], T. Bromwich [1,3], T. B. White [3,4], C. Cox [5] & J. W. Bull [1,5*]

Affiliations:

[1]Department of Biology, University of Oxford, Oxford, UK.

[2]School of Resource Wisdom, University of Jyväskylä, Finland.

[3]Leverhulme Centre for Nature Recovery & Department of Biology, University of Oxford, UK.

[4]The Biodiversity Consultancy, Cambridge, UK.

[5]Wadham College, University of Oxford, Oxford, UK

* Corresponding author, joseph.bull@biology.ox.ac.uk

Abstract

'Net Zero' and 'Nature Positive' frameworks guide organisations to contribute towards climate and biodiversity goals, but are often implemented separately. It remains unclear to what extent achieving Net Zero strategies can help organisations to contribute towards Nature Positive goals. We apply footprinting methods to an illustrative case study (Wadham College, Oxford) to quantify whether a Net Zero strategy – focusing on GHG emission reductions – delivers biodiversity co-benefits. We find that implementing the college's 2035 Net Zero strategy could reduce biodiversity impacts from utilities, built environment, and direct land use by approximately 67%. However, the scope of Net Zero strategies often omit highly impactful activities for biodiversity. When landholdings were included within the scope, the Net Zero strategy reduced biodiversity impacts by approximately 5%. Our study implies pathways exist for achieving carbon and biodiversity objectives together, provided careful coordination between strategies and extensive compensation of residual impacts.

Key words: Net Zero; Nature Positive; footprinting; biodiversity strategy

Introduction

Climate change and biodiversity loss threaten the resilience of global economies, and undermine human societies (IPCC, 2023; Pörtner, 2021). According to international policy such as the Paris Agreement and the Global Biodiversity Framework, considerable transformation is now required to reduce greenhouse gas (GHG) emissions in line with acceptable warming scenarios and to 'halt and reverse' biodiversity loss (CBD, 2022; Díaz et al., 2019; Leclère et al., 2020; Mace et al., 2018; Pörtner, 2021; UNFCCC, 2015). In turn, transformative actions require explicit, precise, and measurable climate and biodiversity goals, supported by clearly aligned targets (Maron et al., 2021; Science Based Targets initiative (SBTi), 2024; Science Based Targets Network (SBTN), 2020). For organisations, this has led to the adoption of 'Net Zero' type targets (for GHG emissions) and, increasingly, targets aligned with a 'Nature Positive' objective within sustainability strategies (Addison et al., 2019; Hale et al., 2022; zu Ermgassen, Howard, et al., 2022).

'Net Zero' is well-defined and widely applied, denoting the goal for a given actor at any scale to achieve balance between GHG production and removal (Fankhauser et al., 2022), resulting in "net zero" addition of atmospheric GHGs. Analogously, the concept of Nature Positive has recently emerged around efforts to address biodiversity loss. The Nature Positive goal can be defined as a societal goal of 'halting and reversing' nature loss against a chosen baseline year (usually 2020), although a variety of linked definitions of Nature Positive (Nature Positive Initiative, 2024). This is analogous to the mission of the Global Biodiversity Framework, around taking 'urgent action to halt and reverse biodiversity loss', putting nature 'on a path to recovery' (Booth et al., 2024; Locke, 2020; Milner-Gulland, 2022; Nature Positive Initiative, 2024).

Nature Positive aligned strategies – often framed in relation to biodiversity trends – therefore require organisations to make efforts to prevent or reduce negative impacts across their full value chain compared to a baseline year, and compensate any remaining unavoidable negative impacts (Booth et al 2024). The Nature Positive framework builds on the well-established mitigation hierarchy, encompassing avoidance, minimisation, restoration and compensation for actions that harm biodiversity (Arlidge et al., 2018). To align with a 'Nature Positive' goal, organisational biodiversity strategies need to go beyond this level of ambition, also taking action to deliver transformative positive change for nature (Nature Positive Initiative, 2024; The Biodiversity Consultancy, 2024). However, robust quantitative biodiversity targets remain uncommon among organisations: of the Fortune 100 companies assessed by (Addison et al., 2019), only five had biodiversity commitments that were specific, measurable and time-bound, and none reported quantitative biodiversity outcomes.

The higher prevalence of climate change over biodiversity in organisational sustainability strategies reflects several factors. Compared with biodiversity, climate change receives greater attention from the media, policymakers, investors and other stakeholders and has more established measures and regulatory expectations (Mammides & Campos-Arceiz, 2025; TCFD, 2017; TNFD, 2023). Institutional theory suggests organisations are more likely to conform to external expectations supported by legal or regulatory enforcement (Oliver, 1991). As a result of the longer history of climate governance, stronger regulatory and stakeholder expectations, organisations have accrued more internal expertise and capacity in addressing GHG emissions, and climate change compared to biodiversity (Andersson & Arvidsson, 2026) (Andersson & Arvidsson, 2026; Arvidsson, 2024; Oliver, 1991). Biodiversity, in contrast, may still be treated primarily as a reputational concern rather than a core organisational responsibility (Smith et al., 2019). Integrating biodiversity is also more challenging because measures for quantifying and attributing impacts and gains are less established, uncertainty is greater, and organisations have less experience acting upon, and communicating their biodiversity impacts and dependencies (Bang et al., 2026; Durand et al., 2025).

Institutional pressures surrounding biodiversity are increasing as mandatory reporting requirements, such as the EU Corporate Sustainability Reporting Directive, require organisations to assess and report on a wider range of environmental impacts, including biodiversity (Andersson & Arvidsson, 2026; European Parliament & Council of the European Union, 2022).

Despite their physical interdependence, organisational climate change and biodiversity strategies and governance processes have largely been developed separately (Anthesis, 2025; UNEP, 2024). This separation is problematic because climate change is an important driver of biodiversity loss, meaning that action to reduce GHG emissions can also benefit biodiversity (Locke, 2020; Pörtner, 2021). Similarly, action to conserve and restore biodiversity can lead to large climate benefits e.g. in the form of carbon sequestration (aka nature-based solutions to climate change). Climate change and biodiversity therefore need to be addressed together (Pörtner, 2021; Seddon et al., 2020), and both EU and GBF guidance have recognised the need to consider the two together in environmental assessment (CBD, 2022; European Commission, 2013).

However, it has not previously been shown to what extent success under an organisational Net Zero strategy implemented in isolation can be assumed to also have biodiversity benefits that can contribute to Nature Positive goals. Climate change is one of several important drivers of biodiversity loss, with habitat loss, pollution, invasive species and overexploitation also representing major direct threats (Caro et al., 2022; Urban, 2024).Whilst action to address climate change may have positive impacts for biodiversity, action to reduce GHG emissions alone cannot be assumed to address the major causes of biodiversity loss. Separation of climate and biodiversity strategies - especially when there is a tendency for organisations to focus primarily on the former - therefore risks incompletely identifying and managing the connections between ecological and climate change drivers. In worst-case scenarios, the result could be sustainability strategies working against each other, inadvertently hindering progress in solving one, the other, or both issues (Pörtner, 2021; Seddon et al., 2020). Conversely, there are obvious benefits to identifying synergistic climate and biodiversity strategies, increasing the feasibility of the transformative pathways needed (T. B. White et al., 2023, 2024).

This leads to our core research question: to what extent will an organisation following an existing Net Zero strategy consequently end up delivering desirable biodiversity outcomes? We investigated the biodiversity outcomes of an organisation's Net Zero strategy by applying established footprinting methods for carbon and biodiversity (Bull et al., 2022; Taylor et al., 2023) to an illustrative case study organisation: Wadham College (hereafter referred to as 'the college'). The college is a useful example as (a) extensive operational activity data are available, and (b) the organisation has both a detailed and practical Net Zero strategy and an ambitious quantitative Nature Positive-type objective ('biodiversity net positive'). Wadham is a constituent college of the University of Oxford, providing educational, housing, catering, office and recreational spaces for staff, students and fellows, alongside owning substantial offsite land holdings and investments. The college's twin carbon and biodiversity strategies are well-resourced, and representative of the scale and ambition that may be needed to meet such sustainability goals at other organisations (Environmental Sustainability Strategy, 2021; Wadham College, Oxford, 2024).

Our case study organisation – being one with considerable buildings, infrastructure and land portfolios – may be used to inform sustainability strategies in other organisational contexts. The college has a mix of historical and modern building stock, with the oldest building erected in the 1600s, major retrofitting occurring in the 1960s, and modern buildings erected in the 2020s. Many of the college's older buildings are thermally inefficient and a high proportion – more than 90% – rely on gas for heating and hot water (Wadham College, Oxford, 2024). The case study is therefore comparable to organisations with mixed property portfolios, and historical buildings including much of the UK housing stock, deemed the oldest and least energy efficient in Europe, and facing similar challenges (Energy Security and Net Zero

Committee, 2025; Peñasco, 2024; zu Ermgassen, Drewniok, et al., 2022). Fewer than half (42%) of assessed homes in England are rated thermally efficient and around 73% of UK households use mains gas as their only source of central heating (House of Commons Library, 2026; Office for National Statistics, 2021). The college also is a challenging context for implementing Net Zero targets due to the protected nature of some of their assets – a challenge faced by many organisations. For example, The National Trust cares for 28,500 structures across the UK, erected from the 16th century to the 21st century, with significant refurbishments needed to achieve Net Zero emissions and adapt to climate change, whilst protecting their historic heritage. Like the college, these buildings consume large quantities of energy, driven by inefficient buildings and user needs. The college's extant Net Zero strategy likely reflects priorities for these organisations, for whom reaching Net Zero goals will require retrofitting of existing building stock, coupled with decarbonisation of the electricity grid (zu Ermgassen, Drewniok, et al., 2022).

The college is also supported by significant endowment wealth, strong institutional capacity and will, and supportive governance structures, placing it in a relatively strong position to develop and implement ambitious sustainability strategies (Andersson & Arvidsson, 2026; Kumar et al., 2024; Singh et al., 2022). This makes the college a useful example of a leading organisation – representing the level of ambition in approaches organisations may need to take to reach Net Zero targets, and to integrate climate and biodiversity objectives. This provides important experience from which other organisations can learn.

Here, we provide the first quantitative estimate of the biodiversity impacts associated with an organisation's existing Net Zero strategy. Our approach provides insight into the opportunities and challenges of integrating Net Zero and Nature Positive aligned approaches, with relevance for organisations developing nature strategies in response to international environmental goals. Our approach further highlights that the biodiversity benefits of Net Zero action cannot simply be assumed; the extent to which an organisation's Net Zero strategy produces positive biodiversity outcomes depends on which parts of the strategy are considered and on methodological choices within the assessment.

Methods

Our study methodology consisted of three stages (Figure 1): (1) calculating the college's baseline GHG emissions and biodiversity impacts, based on available data on their built environment, utilities, and onsite-land use activities; (2) modelling GHG emissions and biodiversity impact trajectories following the college's Net Zero strategy; and (3) identifying the financial and embodied environmental costs driven by the Net Zero strategy.

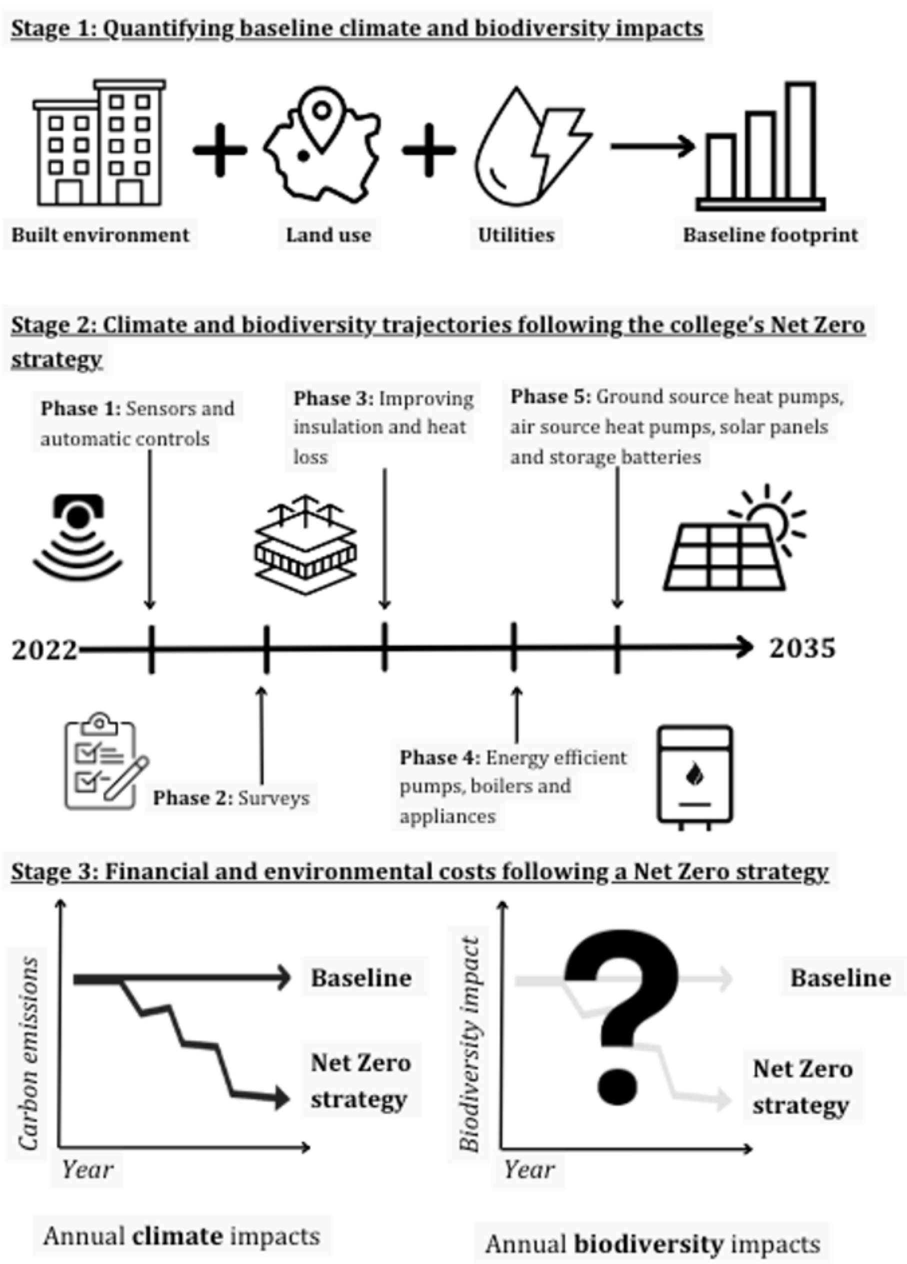

Figure 1: A graphical summary of the three stages of the analysis approach.

Scope of the study

To quantify the college's baseline GHG emissions and biodiversity impacts, we analysed data for utilities (water, electricity, and fuel use; water and general waste), the built environment (size and type of built environment), and onsite land holdings. These are referred to as 'within-scope' activities, and were calculated for the academic years 2016-2022 using data provided by the college's Estates Team.

The scope of the analysis was determined partly by the scope of Net Zero strategies and partly data availability: data was limited or unavailable for college commuting, procurement, or investments, and so was not included within our scope. Travel estimates are also not included in baseline climate and biodiversity footprints, as the data was of insufficient quality for the main purposes of our study, but are reported separately for comparison. Similarly, data for offsite land holdings was collated by the college Financial Bursar to contextualise our findings but have not been considered within our baseline impact calculations. We chose to leave out offsite land holdings as the college's land is leased in long-term tenancy agreements, making it financially and legally impractical for inclusion within the sustainability strategy. Our 'out-of-scope' activities may contribute substantially to organisational biodiversity impacts, but are often excluded from Net Zero strategies. Nonetheless, it is common for organisational biodiversity impact analyses to be forced to work with data limitations. We comment on the implications of our scope in the discussion, and note that such activities (food consumption and procurement, for example) have been explored elsewhere in the university context (Taylor et al., 2023).

Life Cyle Impact Assessment

We converted the college's activity data into climate and biodiversity impacts by applying two life cycle impact assessment (LCIA) frameworks, ReCiPe and LC-IMPACT (Bull et al., 2022; Huijbregts et al., 2017; Verones, Hellweg, Antón, et al., 2020). LCIA tools build upon the established life cycle assessment (LCA) methodology, combining LCA outputs for the major drivers of biodiversity loss (square meters of land occupation, for example) with characterisation factors to estimate the biodiversity impact per unit of environmental driver. The resulting biodiversity impacts are aggregated across freshwater, marine, and terrestrial ecosystems, reflecting the impact of human activity throughout the biosphere (Figure 2). LCIA approaches are widely used to estimate biodiversity loss across complex value chains, enabling a comparison of environmentally impactful activities in a widely accepted, standardised method. LCIA methods are highlighted as potential tools in key frameworks (the recommendations from the Taskforce for Nature-related Financial Disclosures, and European Sustainability Reporting Standards, for instance) (TNFD, 2023).

LCIA tools are known to be subject to substantial limitations and uncertainties (Bromwich et al., 2025). LCIA characterisation factors rely on a number of assumptions, such as how midpoint environmental impacts drive endpoint biodiversity loss (Figure 2)(Maddinson et al., 2026). For example, midpoint impacts are assumed to impact all species equally, , LCIA tools typically address a limited set of biodiversity drivers, (Crenna et al., 2020) (Figure 2), and marine impacts are particularly underrepresented by LCIA frameworks (Damiani et al., 2023; Payne et al., 2016). Selection of characterisation factors entails further assumptions regarding the time horizon, cultural perspectives and value choices. Here, we have chosen to apply average, core characterisation factors for LC-IMPACT, meaning values of biodiversity loss are calculated with a 100-year time horizon (Huijbregts et al., 2017; Verones, Hellweg, Anton, et al., 2020). Given the substantial uncertainties and assumptions embedded within LCIA approaches, results should be taken as estimates of relative, rather than absolute, impacts, with correspondingly wide confidence intervals (Bromwich et al 2025).

We use two key metrics of biodiversity loss in our analysis: local species loss aggregated over time (species.year; ReCiPe) and potentially disappeared fraction of species over time (PDF.year; LC-IMPACT). The PDF.year metric can be understood as the fraction of global species that are at risk of global extinction if continuously impacted by a specific driver of biodiversity loss (Verones, Hellweg, Antón, et al., 2020). Conversely, ReCiPe measures biodiversity impact using the species.year metric, calculated as local relative species loss in terrestrial, freshwater, and marine ecosystems; species loss values are then integrated over space and time, and aggregated into a single unit (Huijbregts et al., 2017). Here we only present the ReCiPe results; LC-IMPACT results are provided in the SI to evidence the robustness of our findings across LCIA frameworks.

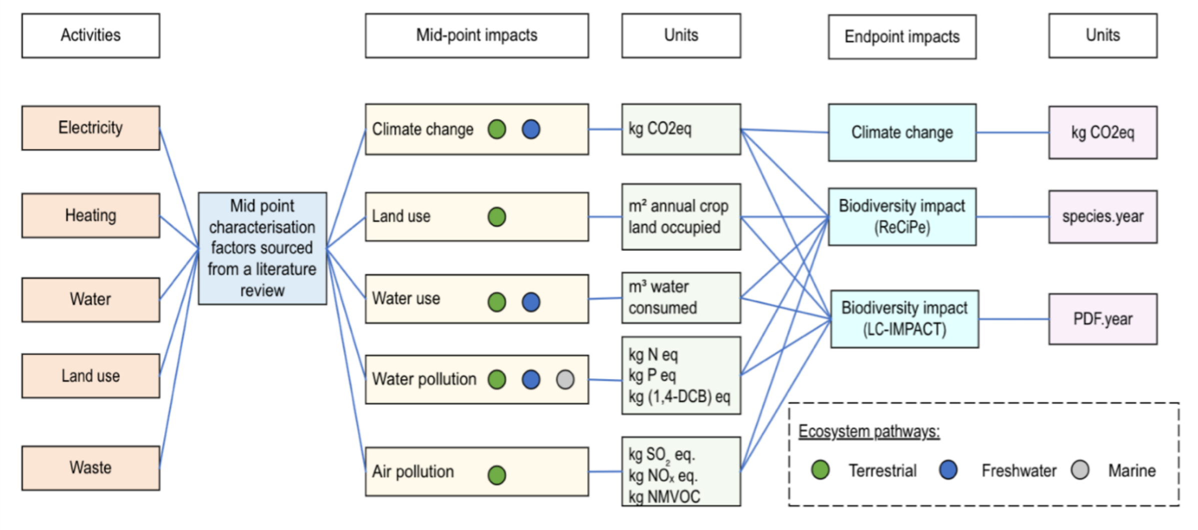

Figure 2: Assessment framework for the college's baseline climate and biodiversity impacts, adapted from (Bull et al., 2022)*. Dots represent quantified environmental pathways, across terrestrial, freshwater, and marine ecosystems.*

Quantifying baseline climate and biodiversity impacts

To quantify baseline climate and biodiversity impacts, we applied our chosen LCIA frameworks (ReCiPe and LC-IMPACT) to 'within-scope' activity data (i.e. data currently assessed in the college's Net Zero strategy, encompassing their built environment, utilities, and onsite-land use activities; Figure 1) from the academic years 2016-2022. We used average activity data to reflect the variation in the college's consumption and waste patterns each year. We first converted activity data into environmental impacts using characterisation factors, such as kg CO_2eq emitted per kWh of electricity. Characterisation factors were produced using best available estimates, prioritising sources that were published in the last 5 years within peer-reviewed journals or government institutions (Al Kez et al., 2022; DEFRA, 2023; United Nations Economic Commission for Europe, 2021) (for a list of sources, see SI). The full range of environmental midpoint impacts can be found in (Figure 2): LC-IMPACT and ReCiPe LCIA frameworks quantify the impact of broadly similar environmental drivers, but use different units and end-point calculations (Sanyé-Mengual et al., 2023). Notably, for electricity, we chose characterisation factors that reflected the full range of impacts from supply, construction, and operation (Ristic et al., 2019). We calculated the impacts of the college's electricity consumption using the UK's average electricity mix in 2022 (National Grid ESO, 2023). We also determined what the college's potential current electricity impacts would be under renewable energy sources only by scaling renewable sources to make up 100% of the grid.

To determine the college's environmental impacts from land use, we categorised land-based activities into a limited number of land use types, followed by conversion into a single 'annual crop equivalent' value. Environmental impacts were converted into end-point biodiversity impacts by applying ReCiPe and LC-IMPACT characterisation factors. Both ReCiPe and LC-IMPACT provide a range of characterisation factors based on the user's chosen perspectives ('value choices'). For ReCiPe, we used hierarchist characterisation factors, and for LC-IMPACT, core, and average/linear factors. For LC-IMPACT, we also applied country-specific characterisation factors where appropriate. Conversely, ReCiPe provides only global characterisation factors with the exception of water consumption. Our initial footprinting task resulted in quantified CO_2eq emissions, and two metrics of biodiversity impacts, as calculated by the chosen LCIA methods. Biodiversity impacts are therefore reported as both species.year impacts (ReCiPe) and PDF.year impacts (LC-IMPACT). All baseline impacts were reported as annual averages for the years 2016-2022.

Before determining the college's biodiversity and climate impact trajectories under a Net Zero strategy, we modelled the college's impacts following a business-as-usual (BAU) scenario. To achieve this, we extrapolated the college's baseline impacts from 2022 to 2035. We assumed that during this time the UK's electricity grid would gradually change from the 2022 average grid (National Grid ESO, 2023) to a 100% renewable grid by 2035. We modelled this transition to renewable energy to reflect the UK Government's renewable energy goals (HM Government, 2021). Importantly, we assumed that the rest of the college's impactful activities (water consumption, for instance) would remain constant from 2022-2035. In reality, organisational growth, occupancy changes, and behavioral shifts are all likely to alter the college's consumption patterns, reflecting a structural limitation in our modelling approach (Bagheri et al., 2025; Bull et al., 2022; Collins et al., 2010). Given the uncertainties of estimating BAU scenarios (and the aforementioned uncertainties of LCIA modelling), our results should be considered illustrative approximations of biodiversity and climate impacts with correspondingly wide confidence intervals. We comment upon the limitations of our approach further in the Discussion.

Modelling the carbon and biodiversity trajectories of the Net Zero strategy

After establishing the college's BAU scenario, we modelled the reduction in energy consumption if the college were to follow their existing Net Zero strategy (Figure 1). Energy savings were determined through a non-systematic literature review, drawing from scientific and grey literature sources including UK Government energy efficiency reports (International

Energy Agency (IEA), 2021; Parker et al., 2021). Percentage ranges were chosen to reflect the difference between expected and realised savings from Net Zero activities. Such differences are a major source of variation in the college's future climate and biodiversity impacts and are driven by factors such as heating system efficiency and occupant behaviour (Berretta et al., 2021; Mashhadi Rajabi, 2022; Parker et al., 2021). For example, we used the UK Government's 'Demonstration of Energy Efficiency Potential' report, which estimates that loft insulation results in a reduction of household fuel consumption from 3.9-17% (Parker et al., 2021). Further detail on individual strategy activities and predicted energy savings are reported in the SI.

Finally, we modelled how following the college's Net Zero strategy would change the college's carbon and biodiversity impacts from 2022-2035. To achieve this, we established a timeline for implementing Net Zero activities according to the college's existing Net Zero strategy (Figure 1). This timeline was combined with the calculated potential energy savings (per Net Zero activity), and the college's baseline biodiversity and climate impacts. We assumed that under the college's existing Net Zero plans, activities would be rolled out across the entire site unless explicitly mentioned otherwise. To prevent double counting, we assumed the energy savings realised from one activity would reduce the college's baseline impacts for the following activity. For instance, loft insulation was estimated to reduce fuel consumption by 3.9% -17%, reducing the college's fuel-based impacts to 96.1-83% of their original baseline values. Subsequent Net Zero activities which reduce fuel consumption would therefore act on reducing these new post-loft insulation values.

Estimating embodied impacts and financial costs

Potential carbon and biodiversity savings of following the college's Net Zero strategy were compared with the embodied impacts and financial costs of implementation. Embodied carbon and biodiversity impacts were established through the re-application of footprinting methodologies. We sourced environmental impacts for each Net Zero activity via a literature review of LCA and environmental product declaration (EPD) databases. Where possible, exact product matches were used as sources for environmental impacts; elsewhere, we identified closely related products for analysis. EPD databases provided a particularly useful source of environmental impacts: companies producing materials for the Net Zero transition often publish their EPD data online as proof of a product's sustainability and credibility.

Collated environmental impacts were subsequently converted into estimates of total carbon and biodiversity footprints per published functional unit. For this step, we used ReCiPe characterisation factors, using the same value choices as in the baseline biodiversity assessment (Huijbregts et al., 2017). When the estimated environmental impacts did not match the required units to be compatible with RECIPE's characterisation factors (for example, freshwater ecotoxicity was reported both in terms of CTUe and kg 1,4-DCBeq), we undertook additional conversions based on previous footprinting literature (Arendt et al., 2020). We did not use LC-IMPACT to quantify embodied biodiversity impacts as the EPD data was not well-matched to LC-IMPACT characterisation factors. The embodied biodiversity impacts of the college's Net Zero strategy are therefore reported in terms of species.year (ReCiPe) values only.

Carbon and biodiversity impacts were scaled to whole site level and paired with the financial data for each Net Zero activity. We applied conversion factors (provided by the Estates Manager) to scale up carbon and biodiversity impacts from published functional units to site-level impacts. For example, the Estates Manager estimated that the college would require 4900m^2 of mineral wool insulation to fully insulate the lofts across the entire site. Consequently, we scaled our impact values for mineral wool (initially reported per m2) by 4900 to determine the total carbon and biodiversity impacts caused by insulating all the college's lofts. This scaling approach was repeated for all Net Zero activities. We did not contest any data provided by the college and assume the uncertainties on provided estimates of quantities were much smaller than those arising from LCIA methodologies. Embodied carbon and biodiversity impact values were then paired with estimated financial costs provided by the Estates Manager. The output of this stage, therefore, was total embodied carbon and biodiversity impacts, as well as financial costs, per Net Zero activity and per year from 2022 to 2035.

Evaluating the college's Net Zero strategy

Using predicted energy savings and financial costs, we explored the cost-effectiveness of different strategies for reducing both carbon and biodiversity impacts. Where appropriate, the costs and impacts of energy-saving and preparatory activities (ground source heat pumps and underfloor heating, for example) were combined. In doing so, we produced a measure of cost-effectiveness that reflected the major infrastructure changes associated with many Net Zero activities. For each activity, cost-effectiveness was calculated by dividing carbon or biodiversity savings (minus embodied impacts) by financial costs. Embodied impacts were assumed to occur over a 20-year time horizon, reflecting the average lifespan of the products used in the college's Net Zero strategy. We reported net carbon and biodiversity savings per pound of financial spend, acknowledging the important role of embodied impacts in driving climate change and biodiversity loss. We then re-ordered the grouped Net Zero strategy activities in order of cost-effectiveness to determine the efficiency gains accrued by undertaking the most cost-effective actions first. Actions that must take place before undertaking retrofits (surveying building fabric, for instance) remained at the start of the college's cost-effective Net Zero strategy. We were therefore able to evaluate how considering costs could result in more efficient reductions in the college's climate and biodiversity impacts over time.

To determine the robustness of our cost-effectiveness scenarios, we undertook sensitivity analysis. Our original cost-effective calculations are dependent on a single data source – the college's financial accounts – and assume a fixed 20-year time horizon for financial impacts, without incorporating longer-term financial assumptions. In the sensitivity analysis, we therefore varied the financial costs, time horizons and implementation costs of the college's Net Zero strategy. In the worst-case scenario, financial costs were modelled to increase by 25% and the lifespan of products in the Net Zero strategy are reduced to 15 years. For the best-case scenario, we assumed that financial costs were overestimated by 25% and a product lifespan of 25 years.

Results

Quantifying baseline climate and biodiversity impacts

For the academic years 2016-2022, the college's within-scope activities released an average of 1.2×10^6 kg CO_2eq annually, and drove biodiversity impacts of 5.3×10^{-3} species.year. We found the activities driving climate and biodiversity impacts overlapped: combined, fuel and electricity consumption drove 97% of within-scope annual CO_2eq emissions, and 93% of within-scope annual biodiversity impacts (using ReCiPe LCIA approach) (Figure 3). GHG emissions emerged as the largest driver of biodiversity impacts, accounting for 63% of the total annual within-scope biodiversity footprint (Figure 3a). Land use emerged as the second largest environmental impact, contributing to 12% of the biodiversity footprint. Our results were consistent across LCIA approaches, highlighting fuel and electricity consumption as key drivers of the college's GHG emissions and biodiversity impacts from utilities, built environment and direct land holdings.

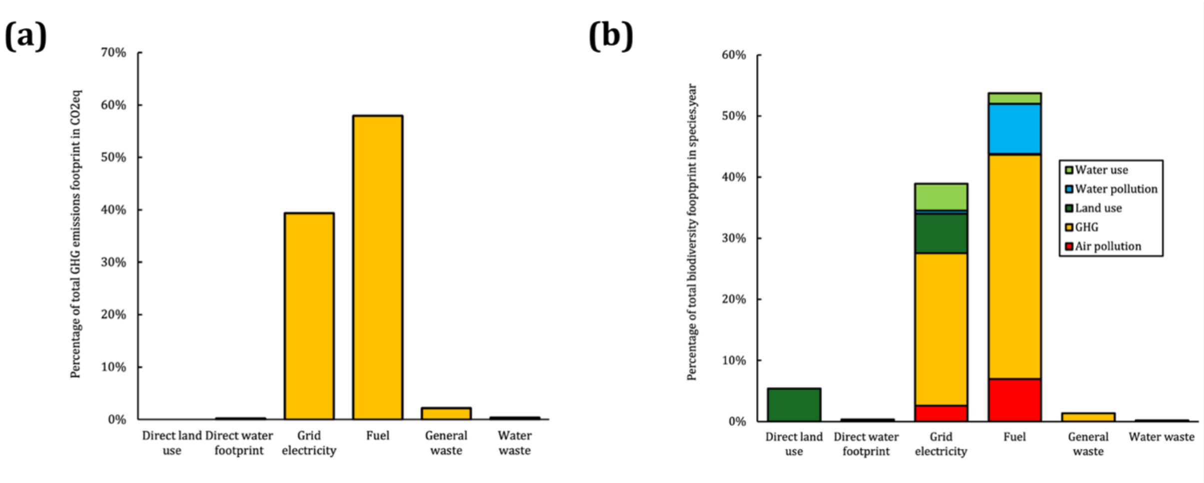

Figure 3: (a) The percentage of the college's total GHG emission footprint in CO2eq distributed across the different activities, reported as average annual impacts assessed for the baseline years 2016-2022; (b) The percentage of the college's total biodiversity footprint in species.year reported as average annual impacts for the baseline years 2016-2022, calculated using ReCiPe and distributed across the different assessed activities and environmental pressures (see key).

Climate and biodiversity trajectories following a Net Zero strategy

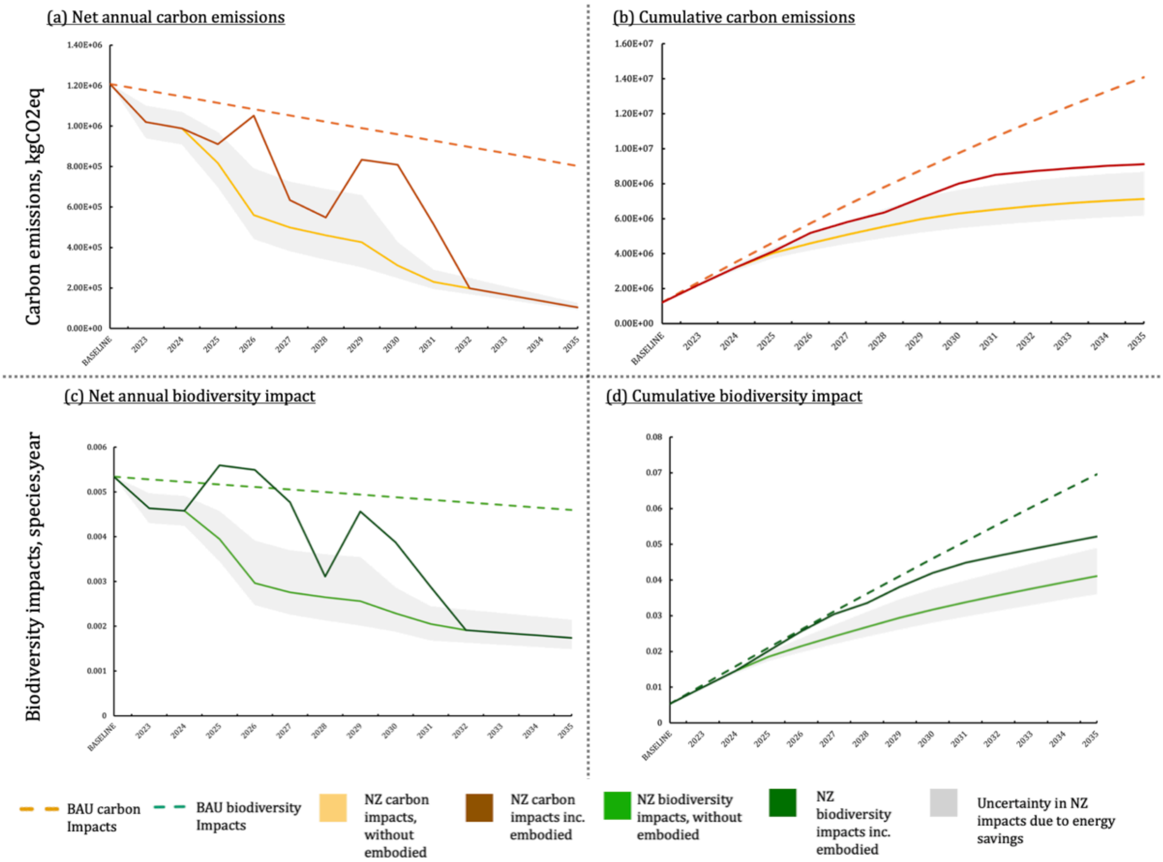

Figure 4: The college's carbon (a,b) and biodiversity (c,d) impact trajectories from the annual average baseline (2016-2022) to 2035. Trajectories are calculated for net annual impacts (a,c) and cumulative impacts (b,d). Trajectories under a baseline scenario (dashed lines) are compared against a Net Zero (NZ) strategy scenario that undertakes different activities each year to reduce impacts (solid lines). NZ strategy scenarios are displayed without the negative embodied impacts of specific NZ activities (light-colour solid lines, labelled 'without embodied') and with negative embodied impacts considered (dark- colour solid lines, labelled 'inc. embodied'. The estimated uncertainty in possible outcomes from Net Zero activities, driven by minimum and maximum variation in energy savings, is represented by the shaded grey bands.

We modelled the college's potential future climate and biodiversity impacts from utilities, built environment and direct land holdings based on their existing Net Zero strategy. 'Impacts were first modelled following a business-as-usual (BAU) scenario, extrapolating baseline impacts from the 2016-2022 annual average baseline to 2035. Under the BAU scenario, we calculated that the college's within-scope climate and biodiversity impacts would decrease by an estimated 33% (kg CO_2eq) and 14% (species.year) respectively by 2035 relative to the 2016-2022 annual average baseline Figure 4 a, c). We saw a smaller reduction in biodiversity impacts (relative to GHG emissions) due to an increase in non-GHG emission-associated impacts driving biodiversity loss. Such impacts are caused by the high infrastructure requirements of renewable energy technologies compared to fossil fuels, which would need to be mitigated for these project to help deliver nature positive biodiversity outcomes (Bennun et al., 2021). The estimated reduction in biodiversity impacts derived from a renewable electricity transition were more pronounced using LC-IMPACT than ReCiPe (27% decrease versus 12%, from the annual average baseline) due to the weighting of characterisation factors in the different LCIA models.

We then modelled the expected reduction in the college's within-scope carbon and biodiversity impacts between 2022-2035 following the existing Net Zero strategy (Wadham College, Oxford, 2024). Our models showed that the college's Net Zero strategy is likely to reduce some key sources of within-scope biodiversity impacts alongside reducing GHG emissions relative to our baseline analysis. By following the Net Zero strategy, the college could reduce within-scope annual GHG (kg CO_2eq) and biodiversity (species.year, ReCiPe) impacts by an estimated 91% and 67% respectively from 2022 to 2035 (Figure 4 a,c) relative to the college's baseline impacts. Impact reduction occurs in a stepwise manner, as the Net Zero strategy is rolled out in phases. Relative to the BAU scenario, the college's Net Zero strategy will reduce within-scope cumulative climate and biodiversity impacts in 2035 by 49% (kg CO_2eq) and 41% (species.year) respectively (Figure 4 b, d). Importantly, our results are indicative only of the college's impacts from utilities, built environment and land holdings. Additional actions are required to address the likely significant biodiversity impacts from out-of-scope activities.

The effectiveness of Net Zero strategy actions may vary according to factors such as occupancy behaviour and location, presenting a large source of uncertainty in predicting the college's future carbon and biodiversity impacts. To address these uncertainties, we have utilised a range of possible energy savings for each Net Zero activity, providing an indication of minimum variation in our predicted results. Energy savings from loft insulation, for instance, are estimated to equal between 3.9% and 17.0% of total fuel consumption (Parker et al., 2021). The estimated minimum and maximum reduction in carbon and biodiversity impacts driven by the variation in energy savings are visualised in Figure 4 (grey bands). Using these ranges, we estimated that annual within-scope GHG emissions (CO_2eq) by 2035 will be between 90% and 92% lower following the Net Zero strategy (relative to the annual average baseline from 2016-2022). In the same scenario, within-scope biodiversity impacts (species.year, ReCiPe) are reduced by between 60% and 72%. However, our uncertainty bands likely underrepresent the total uncertainty of our study. Our analysis does not capture a range of uncertainties embedded in the LCA process such as characterisation factors, BAU scenario modelling, and LCIA method choice. Perhaps most significantly, our analysis does not capture impacts driven by outside of scope activities- procurements and investments, for example - which may be an order of magnitude larger than our within-scope results. We highlight the implications of this in the following section and the Discussion.

Net Zero strategies alone cannot be assumed to deliver Nature Positive outcomes

Our analysis shows that the college's Net Zero strategy will go a long way towards reducing within-scope GHG emissions, and, by extension within-scope biodiversity impacts. As is typical of Net Zero strategies, there will be at least some residual emissions which require offsetting to reach Net Zero. Delivery of college's Net Zero strategy will only partially achieve the college's separate Nature Positive-aligned biodiversity objectives, meaning compensation of residual biodiversity impacts is also required.

Critically, the 67% reduction figure for biodiversity impacts reported above describes only the college's within-scope impacts from utilities, the built environment, and onsite land use; and not a host of other impactful activities. There remain the likely very large biodiversity impacts of activities not included in the scope of our assessment, as they fall outside of the college's Net Zero commitment. Our analysis focused on impacts driven by GHG Scope 1 and 2 activities and associated supply chains; many organisations similarly set Net Zero targets around these GHG emissions categories, with less ambition on Scope 3 emissions (i.e. for them to plateau and reduce over time) (Science Based Targets initiative, 2024). To gauge the size of the impacts of the college's current within-scope activities relative to some significant out-of-scope activities, we estimated the biodiversity impacts of the college's offsite land holdings using the LCIA frameworks ReCiPe and LC-IMPACT. Using ReCiPe, offsite land holdings (predominantly used for arable cropping) had an estimated 12.5 times larger biodiversity footprint than the total footprint of reported within-scope activities; it should be noted that, due to the nature of Oxford colleges, this organisation likely has relatively large land holdings compared to other comparable organisations. Similarly, the estimated carbon footprint of the college's Scope 3 student and staff travel (provided by the college) was 7.5×10^5kg CO_2eq per year - equal to 62% of the college's within-scope baseline. When offsite land use is included within the college's scope, the Net Zero strategy will reduce biodiversity impacts by only 5% - 6% relative to baseline levels. We treat the issue of scope as central finding to our study and expand on its implications in the Discussion below.

Embodied carbon and biodiversity impacts associated with mitigation

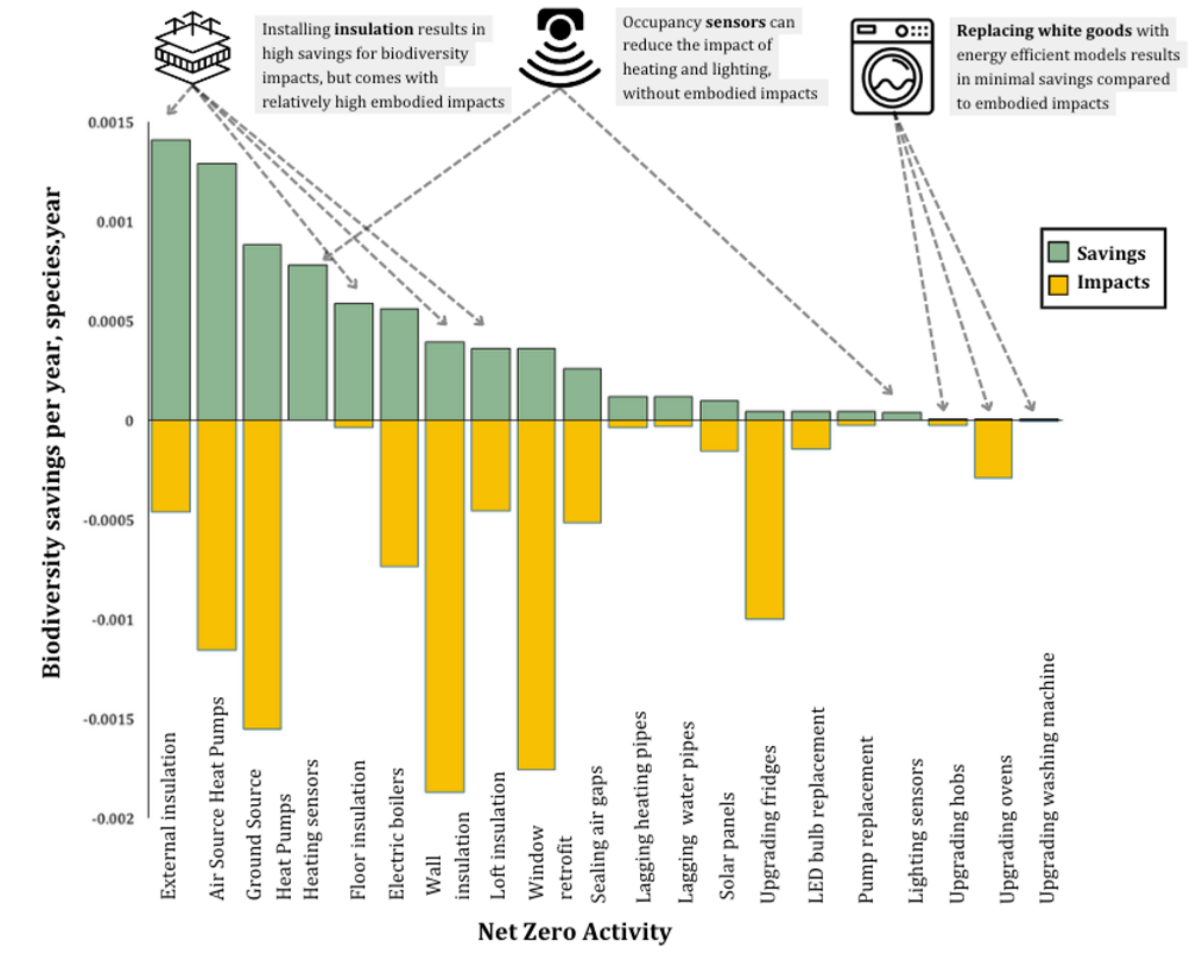

Figure 5: Embodied impacts and potential biodiversity savings of each Net Zero activity. Both the one-time embodied negative biodiversity impacts (yellow bars, negative values) and potential biodiversity impact savings (green bars, positive values) are reported in terms of annual values, i.e. occurring every year over the course of the college's Net Zero strategy for potential savings, and occurring once in the year of implementation for negative embodied impacts.

Our results highlight that there are trade-offs to be made to meet organisational climate and biodiversity targets concurrently; not least due to the embodied biodiversity impacts of Net Zero activities (for example, the materials and land use required for solar panels), and financial costs involved (Iacona et al., 2018; Squires & Garcia, 2018; T. White et al., 2022; T. B. White et al., 2024).

We found that implementing the college's Net Zero strategy would result in estimated embodied impacts of 2.0×10^{6} kg CO2eq emissions and 1.1×10^{-2} species.year biodiversity impacts by 2035. The climate and biodiversity outcomes of Net Zero activities therefore vary depending on whether the embodied impacts of activities outweighs their potential benefits. Occupancy sensors, for example, reduce both climate and biodiversity impacts, saving 1.9×10^5 kg CO2eq and 7.8×10^{-4} species.year respectively per year, with negligible embodied impacts (Figure 5). In comparison, tensions emerge between embodied costs and future climate and biodiversity savings from replacing white goods. Upgrading fridges, for example, confers one-time embodied climate and biodiversity impacts of 1.1×10^5 kg CO2eq and 1.0×10^{-3} species.year respectively, compared to annual climate and biodiversity savings of 1.3×10^4 kg CO2eq and 4.7×10^{-5} species.year (Figure 5). As such, it would take the college 21 years to 'pay back' the embodied biodiversity impacts of upgrading fridges, if relying on the impact reductions they alone provide.

Financial costs of mitigation

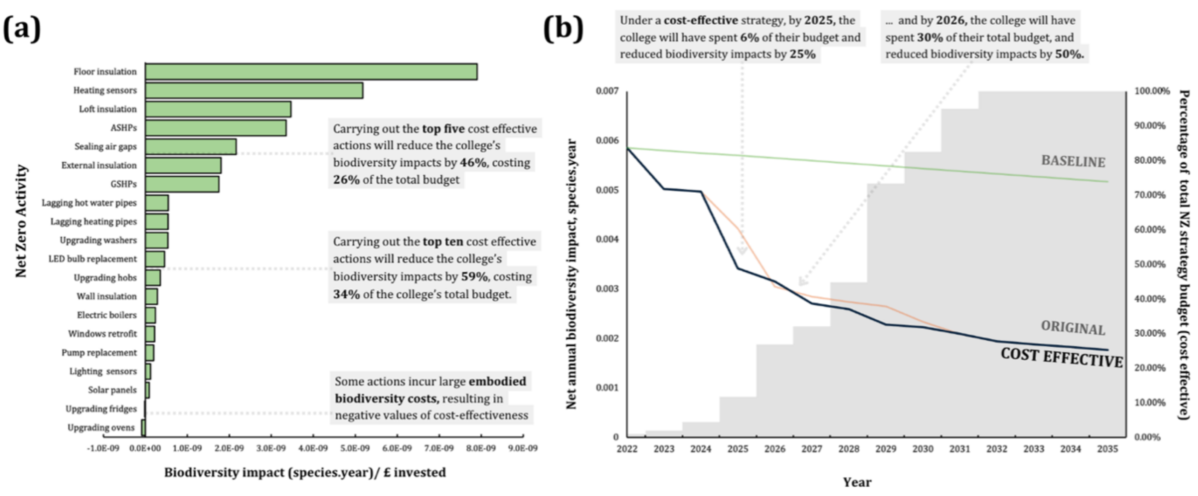

Figure 6(a) Cost-effectiveness of the college's Net Zero activities, reported in kg CO2eq emissions prevented annually, per £1 of financial spend. Figure 6 (b): Reduction in biodiversity impact from implementing the most cost-effective actions first (black line, 'cost effective') versus a business-as-usual scenario (green line, 'baseline') and the original Net Zero strategy (orange line, 'original'). Grey bars indicate the percentage of the college's total Net Zero strategy budget spent per year for the cost-effective strategy.

The financial costs and feasibility of actions must be considered in designing coordinated Net Zero and Nature Positive aligned strategies – both to ensure strategies are practical, and to help realise gains most efficiently and quickly (T. White et al., 2022). We assessed the cost-effectiveness of the college's existing Net Zero strategy activities by pairing the potential climate and biodiversity impact savings of each action with estimated financial cost. There was a high variation across different actions (Figure 6a) (kg CO2eq saved per £1 of financial spend). We included embodied impacts incurred by the college in our assessment of cost-effectiveness, distributed equally over a 20-year time horizon (based on average lifespan of materials used in the Net Zero strategy). Including embodied impacts revealed that some Net Zero activities (upgrading fridges, for instance; Figure 4) are cost ineffective over a 20-year timeframe and should potentially be excluded from the strategy.

We calculated potential efficiency gains realised through undertaking the most cost-effective activities first. Under the current strategy, a 25% reduction in the college's estimated within-scope biodiversity impacts (relative to the 2016-2022 annual average baseline) would cost 22% of the total Net Zero budget in 3 years, with a further 50% reduction costing 40% of the total budget in 5 years. If we shifted the order of the college's current Net Zero strategy to implement the most cost-effective actions first, in similar timescales to the original proposal (Figure 6b), we would see more efficient reductions in biodiversity impacts: a 25% reduction costing 6% of the total budget in 3 years and a 50% reduction costing 30% of the total budget in 5 years.

Sensitivity analysis showed that prioritizing the most cost-effective activities consistently produced greater biodiversity reductions per unit of financial spend, compared to the original strategy. However, the efficiency gains accrued from prioritizing the most cost-effective activities are dependent on the financial costs and time horizons of the Net Zero strategy. Under a worst-case scenario, where costs of Net Zero activities are increased and time horizons reduced, a 25% reduction in within-scope biodiversity impacts would require 8% of the organisation's budget over 3 years. Conversely, under a best-case scenario, the cost-effective approach would require only 5% of the college's budget to achieve a 25% reduction in biodiversity impacts over the same time frame.

A consideration of costs, alongside carbon and biodiversity impacts of different actions, leads to efficiency gains for Net Zero and Nature Positive aligned biodiversity targets. Furthermore, communicating the financial and environmental benefits of the Net Zero strategy may influence the college's occupancy behaviour (reducing personal energy consumption, for example). However, our analysis does not address the potential costs of inaction, or the costs of offsets or compensation payments. Such costs could be substantial if mitigation action is not undertaken (Kotz et al., 2024). We also do not consider the cost-effectiveness of activities outside the scope of the existing Net Zero strategy, which may have large climate and biodiversity benefits. Altered agricultural management practices of offsite land holdings, for example, could be a cost-effective mechanism for delivering environmental gains.

Our results represent a broad estimate of cost-effectiveness for an individual case study. Organisations adopting Net Zero strategies may further contend with opportunity costs, transaction costs of strategy integration, and economic disruption. Financial constraints may also differ across organisations, which may have smaller budgets to enact their Net Zero strategies.

Discussion

Nature Positive contributions demand greater levels of ambition

The college's existing Net Zero strategy will likely considerably reduce annual GHG emissions across buildings, utility, and onsite land use activities. But by following the Net Zero strategy, the college will likely also concurrently reduce their within-scope biodiversity impacts, a finding replicated across both of the two LCIA biodiversity footprinting approaches we employ here (relying upon ReCiPe and LC-IMPACT). Similar predicted carbon and biodiversity trajectories partially reflect the synergies between environmental drivers, as the college's within-scope biodiversity impacts are in a large part driven by GHG emissions from fuel and electricity consumption.

However, our results highlight that the college's scope for its Net Zero strategy does not capture the broad range of biodiversity impacts driven by their organisational activities. The college's Net Zero strategy does not currently address all drivers of GHG emissions (e.g., Scope 3) or of biodiversity impacts (e.g., from land use holdings, investments); further, it does not consider the embodied environmental impacts of implementing said strategy. Here we show that when offsite landholdings are included, the Net Zero strategy reduces biodiversity impacts by only 5-6%. Regardless of whether the college is responsible for land held in long term tenancy agreements, this raises an important question about scope. For example, if we were to extend our analysis to assess activities such as food consumption or procurement, we would expect to be able to rely even less on the current Net Zero strategy (if actions are not taken to address Scope 3 emissions) to deliver the necessary biodiversity outcomes (Bull et al., 2022). Similarly, changes in consumption patterns, for example driven by organisational growth, will also drive biodiversity impacts not modelled in our analysis (Bagheri et al., 2025; Collins et al., 2010). Understanding the full extent of the college's impacts would therefore require an extension of scope in both its carbon and biodiversity strategies, including impacts from offsite land use, upstream and downstream activities that impact biodiversity indirectly, and future consumption patterns. Biodiversity footprints, and consequently Nature Positive aligned strategies, must consider issues of scope (such as assets, or financial investments), and clearly define the boundaries of assessment and what impacts are deemed the responsibility of the organisation (Bang et al 2026).

These findings have both ecological and strategic implications. Ecologically, offsite land under arable management and other currently out-of-scope activities, such as Scope 3 travel, are associated with very different biodiversity pressures from the utilities and building-focused activities addressed by the college's current Net Zero strategy. Biodiversity impacts can arise through a range of direct, indirect and value-chain pathways, and these may require different forms of action and assessment (Bang et al., 2026). The college's Net Zero strategy is therefore not well-positioned to address some of these pressures to biodiversity within its current scope. Strategically, organisations risk overstating the biodiversity credentials of a Net Zero strategy if reported results are drawn only from a narrow operational scope. A 67% projected reduction presented without reference to the scope used could give stakeholders a misleading impression of overall biodiversity performance of a strategy, whereas the 5–6% reduction once offsite land is included in scope provides a more defensible basis for organisational reporting and target-setting. This is consistent with recent guidance emphasising that credible corporate nature strategies need to extend beyond directly owned operational sites and account for relevant value-chain impacts (Panwar et al 2022; Bang et al., 2026). These implications are also likely to become more important as disclosure frameworks increasingly require organisations to assess and report impacts across their value chains (TNFD, 2023).

To address the major biodiversity impacts that lie outside the current scope of the Net Zero strategy, the college could pursue several avenues. For offsite land holdings, altering agricultural management practices on tenanted land – for example, negotiating biodiversity-friendly farming conditions within existing tenancy agreements – could be a comparatively cost-effective mechanism for delivering environmental gains, notwithstanding the financial and legal constraints of long-term leases. For Scope 3 travel, the college could introduce sustainable travel policies or offsetting schemes targeted specifically at staff and student travel emissions. More broadly, the college could extend biodiversity screening to its investments and endowment, mitigate biodiversity impacts within its supply chains and procurement decisions, and invest directly in restoration projects onsite or offsite to compensate for impacts it cannot avoid (Leitch et al., 2026).

This scope sensitivity in our analysis shows the importance of the boundaries applied to organisational Net Zero strategies. Credible Net Zero approaches require broad coverage of emissions sources, including those that are difficult to address (Fankhauser et al., 2022). However, corporate standards recognise the difficulties of addressing Scope 3 emissions and allow narrower coverage in the near term; for example, SBTi requires near-term Scope 3 targets to cover at least 67% of Scope 3 emissions (where Scope 3 accounts for 40% or more of total emissions), increasing to 90% for long-term Net Zero targets (Science Based Targets initiative, 2024). Nature-focused target-setting similarly recognises the practical challenges of comprehensive assessment and allows organisations to take a phased approach, while ultimately requiring consideration of material pressures on nature across organisational activities and value chains (Science Based Targets Network (SBTN), 2020). Our results show that this distinction can be particularly important for biodiversity, because activities falling outside a narrower operational boundary can account for a large proportion of an organisation's biodiversity impact (Peura et al 2023; Bull et al 2022). Quantifying the biodiversity impacts associated with these wider activities can itself be challenging, particularly across complex value chains where data availability, traceability and methodological uncertainties limit the reliability of biodiversity footprint estimates (Bang et al., 2026; Bromwich et al., 2025). If organisational Net Zero strategies to support Nature Positive goals, broadening their scope matters not only for achieving robust Net Zero, but also for identifying and addressing biodiversity impacts that might otherwise remain outside the strategy.

Improving assessment of carbon and biodiversity footprints

LCIA approaches alone are insufficient for informing strategies which jointly achieve Net Zero and contribute to Nature Positive goals. Our methods have applied current best practices to produce a set of relative carbon and biodiversity trajectories that help assess the biodiversity implications of an organisation's Net Zero strategy. Climate change is often one of the largest drivers of biodiversity loss in LCIA studies (e.g. (Bull et al., 2022; El Geneidy et al., 2026; Martínez-Ramón et al., 2025); however, alternative biodiversity assessments (Jaureguiberry et al., 2022; Maxwell et al., 2016) identify land use change and direct exploitation as the most significant drivers. Recent analysis has identified that GHG-driven biodiversity impacts are consistently weighted higher than other drivers of biodiversity loss, within LCIA methodologies (Maddinson et al., 2026). There is a significant risk, therefore, that applying LCIA methods may cause organisations to overestimate the impacts of their carbon emissions on biodiversity, hindering effective strategy design (Caro et al., 2022).

Due to inevitable uncertainties when using LCIA methods (Barahmand & Eikeland, 2022). , we risk organisations exploiting LCIA uncertainties to pursue climate and biodiversity goals which do not fully address the extent of their impacts. LCIA approaches should be used alongside other tools to prioritise action, for example those which assess site-level biodiversity impacts (Martínez-Ramón et al., 2025). Despite this, since addressing the climate and biodiversity crises is time sensitive, strong arguments exist for working with best available methods while taking an adaptive approach (T. B. White et al., 2025).

Towards joint carbon and biodiversity strategies

The burgeoning threat of the climate and ecological crises demand that we recognise the connections between climate, biodiversity, and human development (Pörtner, 2021). Our case study's Net Zero strategy likely reflects the approaches of leading organisations in this field, at a time where many are grappling on how to implement ambitious climate and nature goals concurrently. Other sectors, such as UK housing stock, can learn from the actions of our case study organisation to better integrate their own strategies and governance, while acknowledging that their own resources and capacity may be more limited. Regardless, the key takeaways from our analysis remain consistent across organisations, demonstrating the important role of case studies and institutional knowledge for developing sustainability strategies.

Here, we show that it is possible to estimate the biodiversity impacts of an existing carbon strategy; identify actions that jointly target parts of an organisation's climate and biodiversity impacts with limited trade-offs (including embodied impacts and financial costs); and determine the most efficient next steps for impact reduction where additional actions are needed for biodiversity and/or climate.

The findings presented also help develop the theoretical understanding of the relationship between Net Zero and Nature Positive strategies. We demonstrate that GHG-focused activities deliver measurable but partial biodiversity co-benefits, and provide empirical support for the interdependence between climate and biodiversity action (Pörtner et al., 2021). Our results also illustrate how the ability to integrate biodiversity into existing climate governance depends not only on organisational capacity and sustainability competence (Andersson & Arvidsson, 2026), but also on the availability and quality of information needed to identify and quantify biodiversity impacts (Bromwich et al., 2025; Bang et al., 2026).

These findings have practical implications for organisations seeking to address Net Zero and Nature Positive aligned goals together. An existing Net Zero strategy can provide a useful starting point for identifying actions that also benefit biodiversity but should not define the scope of an organisation's biodiversity strategy. Organisations will also need to consider impacts outside the scope of their climate strategy, including those associated with land use and wider value chains that may be important for biodiversity, despite not being priorities for GHG reduction. Where these impacts are difficult to quantify, gaps in data and traceability should be identified and reduced over time, rather than used as a reason to exclude them from scope (Bromwich et al., 2025; Bang et al., 2026). In addition, clear considerations of financial costs can help identify the most cost-effective measures to most efficiently reduce impacts – recognising that many organisations may have limited capacity to take all necessary actions. Phased approaches may be necessary where data, methods, and organisational capacity are initially limited, but where this is the case assessment boundaries need to be clearly communicated and broadened over time to avoid results from a narrow scope being interpreted as representative of whole-organisation impacts (SBTi, 2024; SBTN, 2025; Bang et al., 2026).

To address Net Zero and Nature Positive aligned goals together, we need to identify synergies between GHG emissions and biodiversity impact drivers across a greater range of sectors; quantify the climate outcomes of biodiversity strategies; and evaluating broader sustainability strategies (those focused on food system change, for instance) for their climate, biodiversity, and financial outcomes. It is hoped that this proof of concept can be extended to other contexts, including organisations with large property and land portfolios. More broadly, we highlight some of the opportunities and challenges of addressing ambitious sustainability goals in tandem, seeking to facilitate efforts to tackle the climate and nature crises at the same time.

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