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An evidence-base for developing ambitious yet realistic national biodiversity targets

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Abstract

Biodiversity targets are a key tool, used at a global and national policy level, to align biodiversity goals, promote conservation action, and recover nature. Yet most biodiversity targets are not met. In England, the government has committed to legally-binding targets to halt and recover the decline in species abundance by 2030 and 2042. We present evidence from recent population trends of 670 terrestrial animal species (for which abundance time series are available) as a species abundance indicator, together with a synthesis of case studies on species recovery, to assess the degree to which these targets are achievable. The case studies demonstrate that recovery is possible through a range of approaches. The indicator demonstrates that theoretically targets can be achieved by addressing severe declines in a relatively small number of species, as well as creating smaller benefits for many species through landscape-scale interventions. The fact that multiple pathways exist to achieve the species abundance targets in England presents choices but also raises the possibility that targets might be reached with perverse consequences. We demonstrate that evidence on achievability is a necessary but not sufficient condition for determining what is required to deliver conservation outcomes and restore biodiversity.

KEYWORDS

biodiversity, conservation planning, convention on biological diversity, forecast, indicators, policy, recovery, SMART, targets

1 | INTRODUCTION

Biodiversity sustains life processes, supports functioning ecosystems, and underpins human well-being (Díaz, Settele, Brondízio, Ngo, Guèze, et al., 2019), but global biodiversity is declining (Butchart et al., 2010; Díaz, Settele, Brondízio, Ngo, Agard, et al., 2019; Tittensor et al., 2014). In response, the Convention on Biological Diversity (CBD) has set out an ambitious vision for biodiversity to be "valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering

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benefits essential for all people" by 2050 (UNEP & CBD 2000). Achieving this vision relies on the commitment and cooperation of CBD parties across the world via biodiversity targets (CBD, 2010). To date, international and national CBD targets have not been met, including the 2010 Biodiversity Target and the follow-up Aichi Targets (Butchart et al., 2010, 2019; Díaz, Settele, Brondízio, Ngo, Agard, et al., 2019; Hawkins et al., 2019).

The post-2020 Global Biodiversity Framework, agreed at the CBD Conference of Parties (COP15), sets the trajectory of ambition toward the 2050 vision and outline the goals for the current decade. New targets are required across the world, and these must avoid previous failings (Leadley et al., 2022). We are therefore at a critical juncture for the development of biodiversity targets.

Delivering global targets requires commitment from individual nations (Di Marco et al., 2016; Xu et al., 2021). Currently, efforts to embed national biodiversity commitments within legislation are lacking (Xu et al., 2021). However, there is increasing precedence for legally binding targets on climate (Carmichael, 2019). Following this, England has recently passed an Environment Act, creating legally binding commitments for biodiversity, and other priority areas (Environment Act, 2021). Creating legally binding biodiversity targets establishes accountability and commitment for their delivery but can create tension between ambition and realism. Targets must be ambitious enough to address the severity of biodiversity decline and inspire action, yet not unrealistic to the point of discouraging progress and trapping countries in their own legislation (Mace et al., 2018; Maxwell et al., 2015). Hence targets must be informed by evidence of what is achievable (Di Marco et al., 2016; Nicholson et al., 2012), as opposed to being merely aspirational.

The failure of previous biodiversity targets has been attributed to their ambiguity, unquantifiability, complexity, and redundancy (Butchart et al., 2016). The SMART framework (Lawlor, 2012) is a widely used tool for creating and improving targets (Díaz et al., 2020; Green et al., 2019; Mace et al., 2018; Perrings et al., 2010). SMART biodiversity targets are more likely to be met (Green et al., 2019; Maxwell et al., 2015). Key components of the SMART framework include making targets "measurable," "ambitious," and "realistic" (see Appendix S1 for contextual detail). New, legally binding biodiversity targets for England must meet these criteria. Thus, we need an approach to quantify a realistic goal and objectively measure progress.

Biodiversity indicators can provide policy-relevant evidence and support quantitative target development. Indicators aggregate and simplify complex biological data across multiple species (Figure 1), typically presenting a composite state metric of how biodiversity is changing over time (Freeman et al., 2021; Gregory et al., 2004). Abundance-based biodiversity indicators such as the Living Planet Index (Collen et al., 2009) and the UK priority species indicator (Eaton et al., 2015) have been crucial tools for monitoring and improving biodiversity, among other biodiversity indicators, such as the Red List Index (an indicator of extinction risk; Butchart et al., 2010), and the Wetland Extent Trends index (an indicator of ecosystem extent;

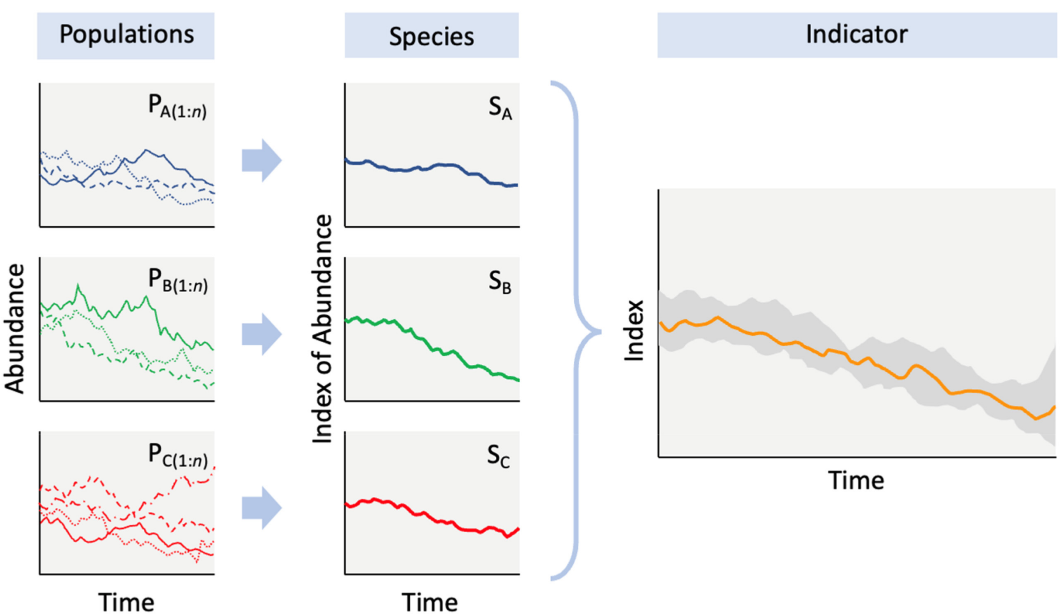

FIGURE 1 An illustrative example of how species abundance data can be synthesized into a biodiversity indicator. Abundance data for the population(s) of each species ($P_{A(1:n)}$–$P_{C(1:n)}$) are used to calculate an index of abundance for each species (S_A–S_C), which are then aggregated to produce a multispecies biodiversity indicator.

Dixon et al., 2016). If indicators and targets are co-developed then targets can be expressed in terms of a specific change in the measured indicator over a particular point in time, supporting SMART attributes (Appendix S1). Furthermore, indicators can help assess how ambitious or realistic proposed targets are based on historic trends and potential trajectories. In addition, examples of successful species recovery highlight the actions required to achieve change and provide evidence of what level of recovery is achievable. Thus, indicator analysis coupled with assessments of successful species recovery provides the evidence needed to evaluate the achievability of proposed targets.

In this paper, we consider the evidence for biodiversity targets in the context of England, where national progress is representative of international target failures. The evaluation of England's last biodiversity strategy highlighted the extent of failure: six out of the ten England Biodiversity Indicators show significant long-term declines across taxa and species outcomes have not been met (Hawkins et al., 2019). England is committed to legally binding biodiversity targets (DEFRA, 2020; Environment Act, 2021), including one to halt the loss of species abundance by 2030. Therefore, evidence is required to find a balance between ambition (the targets need to be ambitious enough to address the severity of biodiversity decline) and realism (the targets need to be realistically achievable). Our work is part of a co-development process, providing evidence for the ongoing development and implementation of biodiversity indicators and legally binding species abundance targets for England as set out in the Environment Act, 2021. We focus on a specific species abundance indicator and target, one of several indicators and targets for biodiversity in England (DEFRA, 2021).

Here, we combine evidence on recent species' trends with case studies of species recovery to find pathways toward an abundance target for England. We (i) constructed a multispecies indicator of abundance for England from 1970 to 2018; (ii) forecasted the indicator 20 years into the future to understand its trajectory in the context of the target; (iii) identified target-achievability pathways, that is, the degree to which species-level trends must change to achieve the target. Then, working with species experts, we (iv) identified case studies of species recovery and used these to develop a framework of conservation actions, with evidenced population growth rates; and (v) combined the indicator with the framework of conservation actions to produce "case-study informed" target-achievability pathways. Thus, we assess the achievability of the target in the context of observed species recovery, without the need for an exhaustive analysis of the pressures facing each species, and evaluation of the actions required to mitigate them. Our results provide a method and evidence on the degree to which biodiversity targets could be met, paving the way for the development of ambitious yet realistic targets, using an approach that can be generalized to different geographic and biodiversity contexts.

2 | METHODS

We constructed an abundance-based biodiversity indicator, forecasted its trajectory, and identified pathways to achieve the target. We also linked these pathways to successful conservation actions, to better understand the requirements, and achievability of the target.

We used R version 4.0.1 (R Core Team, 2021) for our statistical analyses. The R code summarizing the major analytical steps can be accessed at https://github.com/03rcooke/targ_ind.

2.1 | Biodiversity targets for England

The Environment Act (2021) created the provision for legally binding targets for England. The two targets for species abundance are: 1) to halt the decline in species abundance by 2030 and 2) to increase species abundance by at least 10% by 2042, compared to 2030 levels. Given the current declining trend (see below), meeting both targets (for 2030 and 2042) would result in the biodiversity index of abundance having approximately the same value in 2042 as in 2022. Thus, for this paper we focus on the 2042 target, which we interpret as "to halt the decline and recover the index to its current value, over a 20-year period." The long-term target requires that the multispecies growth rate needs to achieve a 20-year average of zero or greater. By contrast, the 2030 target requires that the growth rate achieve a value of zero or greater for that year. Our work applies this 20-year time frame (Environment Act, 2021) to currently available data (i.e., we evaluate the target based on 2018–2038 as equivalent to 2022–2042).

2.2 | Building a biodiversity indicator

We constructed a multispecies, abundance-based biodiversity indicator for England from national scale monitoring schemes (e.g., Breeding Bird Survey, UK Butterfly Monitoring Scheme, Rothamsted Insect Survey; Appendix S2). The data consist of national estimates of species' abundance from 1970 to 2018. The underlying methods to obtain annual time series of abundance from the raw data vary in their specifics (Appendix S2) but are conceptually and technically similar, and have been applied to previous biodiversity indicators for England (Burns et al., 2021; Eaton et al., 2015). Our biodiversity indicator is an estimate of the geometric mean abundance across the included species, set to a value of 100 at the start year (the baseline). For further methodological details about the construction of the biodiversity indicator (e.g., the modeling approach), see Appendix S3. In total, we included 670 species, made up of four groups: birds (169 species), butterflies (55 species), mammals (15 species), and moths (431 species) (Appendix S2). These groups have good quality, long-term, national-scale, abundance estimates available for England, and are therefore used to represent wider biodiversity (Burns et al., 2021; Eaton et al., 2015). However, they do not fully represent the breadth of biodiversity and the official index is expected to include data from plants and freshwater ecosystems. In addition, we treat each species included as equal, given that the level of ambition in the targets was set with an unweighted (and steeply declining) index in mind. Statistical properties of the index under alternative weighting approaches are explored in Appendix S4.

2.3 | Forecast

To understand how ambitious or realistic the target is, we first evaluated the trajectory of the biodiversity indicator. We forecast the indicator from the present (here based on the latest available data: 2018) 20 years into the future (reflecting the timespan requirement of targets as outlined in the Environment Act, 2021); using Auto-ARIMA models (Hyndman et al., 2021; Hyndman & Khandakar, 2008). As the forecast was estimated from the history of the time series, it can be broadly interpreted as the expectation under business-as-usual conditions. Further details on the forecast modeling are in Appendix S5.

2.4 | Species' growth rates

We calculated species' percentage annual growth rates over the last 20 years (1998–2018) following Outhwaite et al. (2019):

$$\text{growth rate} = \left(\left(\frac{f}{s}\right)^{\frac{1}{y}} - 1\right) \times 100$$

where f was abundance in 2018, s was abundance in 1998, and y was the number of years. Species with time series starting after 1998 were removed from this analysis (18 species). We also investigated the sensitivity of our approach to the single-year (i.e., annual) growth rates compared to more smooth 5-year growth rates (where f was geometric mean abundance between 2014 and 2018, and s was geometric mean abundance between 1998 and 2002). We found that annual and 5-year growth rates were highly correlated (Pearson's $r = .88$), and that results produced using these different were almost identical (correlation for change in indicator between annual and 5-year growth rates; $r = >.99$). Hence, as annual growth rates are more sensitive and responsive (i.e., abundance change can be assessed and monitored every year) and more often used (Gregory et al., 2004; Outhwaite et al., 2019; Walker et al., 2018) we continued with annual growth rates only. Using these annual growth rates (hereafter growth rates), we identified species that are declining (growth rates <0) or increasing (growth rates ≥0), reflecting the expectation that conservation action will differ for these two groups (Gregory et al., 2004). Although the target could theoretically be reached based on growth across increasing species only, we avoid this pathway due to its potential for perverse biodiversity outcomes (e.g., overall elevated extinction risk; Newton, 2011; Purvis, 2020).

2.5 | Target-achievability pathways

We investigated what proportion of species' trends need to change, and by how much (based on the distribution of calculated growth rates), to meet or exceed the target. We termed these target-achievability pathways, as we directly quantified the amount of change required to achieve the target, rather than predicting change under alternative scenarios. We projected increasing species to continue to increase, on average, at the same rate as over the last 20 years, based on historic growth rates, allowing us to then focus on declining species. For declining species, we used combinations of the proportion of declining species (0–1, by 0.1; equivalent to 0%–100% of declining species, by 10%) and species' growth rates (−5% to 30%, by 1%). These combinations cover a broad region of parameter space and reflect the historical distribution of growth rates across the indicator.

Using the assigned growth rates for increasing and declining species we then projected abundance 20 years into the future by rearranging the equation for growth rates above (i.e., calculating future abundance based on current abundance and the assigned growth rate). We then calculated the projected indicator value as the geometric mean of the projected abundances. Subsequently, we converted the projected indicator values into measures of change.

When the proportion of declining species (i.e., species to be recovered into the future) was >0 but <1 we needed to select a subset of species to be recovered (i.e., growth rates to be improved). Initially, we hypothetically recovered the most declining (most negative growth rate over the past 20 years) species first, that is, a biological prioritization approach. For non-recovered declining species, we assumed that they would continue to decline, on average, at the same rate as over the last 20 years. This approach assumes that action is targeted at those species that are experiencing the most severe declines. Yet, the most severely declining species are likely to be the most difficult to recover and require complex targeted action (Joseph et al., 2009; Marsh et al., 2007).

We therefore contrasted the biological prioritization approach with an alternative in which we recover a random subset of the total declining species. This randomized approach reflects the fact that we do not know a priori how species would respond to policy interventions, and that severe declines might still be observed in species that are not selected for targeted action, for example, due to new and emerging threats. We repeated the randomized recovery of declining species 100 times and calculated the mean change in the indicator across the 100 runs.

Although we recovered species from the indicator directly, we were agnostic to species identity. Instead, the history of the indicator species represents a distribution of plausible growth rates, and we assume that these growth rates are the best available guide to the distribution of growth rates into the future. For instance, for our forecast above we assumed that the past informs the future, while for the biological prioritization approach we assumed that additional conservation actions (compared to the past) reduce the negative tail of the distribution of growth rates. By contrast, the randomized approach assumes that additional conservation actions shift the overall distribution of growth rates to the right (i.e., less negative/more positive growth rates on average).

2.6 | Case-study informed target-achievability pathways

Defining successful species recovery is complex (Redford et al., 2011). Population size and growth rate contribute to population "viability" – one of the key dimensions of recovery (Akçakaya et al., 2018). To better understand the potential for species/species' populations to recover, and evidence our model, we identified case studies where conservation actions have led to a measurable population increase in the UK. First, we interviewed experts from Natural England and the Royal Society for the Protection of Birds (RSPB), and from their testimony, we assembled a list of case study species that represent recovery (Table 1). We sought a range of species with known conservation actions and sufficient data to characterize them as having undergone recovery, based on expert opinion. Second, we examined the conservation actions associated with these species and created a classification (Landscape, Targeted, Spotlight) based on the impact they would have in the indicator, resulting in a framework of conservation actions (Figure 2). This framework of conservation actions informed how we modeled evidence from different species in our analysis.

TABLE 1 Case studies of species recovery for which there is sufficient understanding of the causal link between action and recovery, and quantitative data available to support this

Species	Key conservation actions
Milvus milvus Red kite	• Protection against persecution • Reintroduction from Swedish and Spanish populations
Botaurus stellaris Bittern *Emberiza cirlus* Cirl bunting	• Habitat management • Targeted agri-environment scheme • Translocations
Dolomedes plantarius Fen raft spider	• Breeding program • Translocations • Habitat management • Water management
Eresus sandaliatus Ladybird spider	• Translocations • Habitat management
Polyommatus coridon Chalkhill blue	• Habitat management • Agri-environment schemes
Decticus verrucivorus Wart biter cricket	• Translocations • Captive breeding • Habitat management
Gryllus campestris Field cricket	• Translocations • Habitat management
Grus grus Common crane	• Habitat management • Reintroductions
Rhinolophus ferrumequinum Greater horseshoe bat	• Agri-environment scheme • Legal protection

To create case-study informed target-achievability pathways we used our framework, the observed growth rates from the exemplar case studies (Figure 2), and data on conservation actions provided by Natural England. The actions applied to 231 species (49 bird, 23 butterfly, 17 mammal, and 142 moth species) out of the 670 species in our indicator, as set out by Natural England, and its partners (Natural England, 2013). These were published in 2013 (updated in 2015) as part of the development of

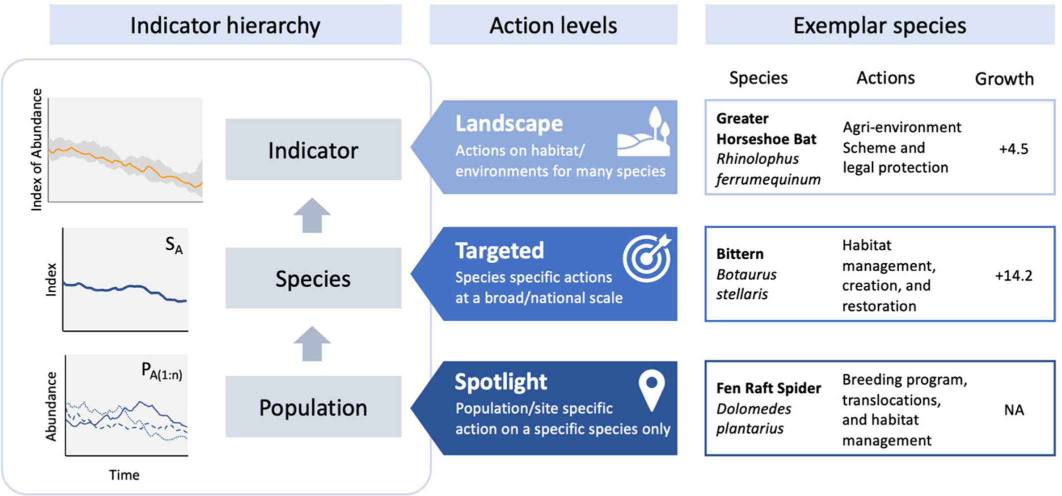

FIGURE 2 A framework of species conservation actions mapped on to the indicator. The indicator has a hierarchy: abundance data from multiple populations are combined to create species indices, which are combined to build the indicator (left panel). We determined that conservation actions, depending on their nature, impact the indicator at different levels. We defined and classified these different levels of actions as: Landscape, Targeted, and Spotlight (center panel), for the purposes of our analysis. Exemplar case studies of species with observed growth rates over the last 20 years are provided to illustrate each action (right panel).

Biodiversity 2020, setting out actions to bring about the recovery of England's most threatened wildlife (a.k.a. Section 41 species, S41). This was the most comprehensive source of collated species actions available, and the majority are not yet executed/ongoing, making it suitable for informing potential future actions.

First, we classified species in our indicator based on the Natural England conservation actions. For each species, we assigned an action level from our framework (Spotlight, Targeted, or Landscape) based on the highest priority action(s) planned for that species (See Appendix S6 for details). We classified species that did not have planned actions as landscape species - assuming that they benefit from broader landscape interventions (e.g., improvement to habitat quality, greater levels of protection, more connected habitats, and softening of the matrix; Isaac et al., 2018). In total, we assigned seven species as "Spotlight," and 20 species as "Targeted." Due to the small sample size of Spotlight species, we combined them with Targeted for modeling purposes to give 26 "Targeted" (nine of which are declining) and 638 species as "Landscape" (379 of which are declining).

We then assigned growth rates to species based on those evidenced in our case studies (Appendix S6). Specifically, we assumed that "Targeted" conservation actions achieve high growth rates for single species, while "Landscape" actions achieve limited growth rates for multiple species. However, we acknowledge that this assumption is a simplification and that there can be high variability in the impact of targeted and landscape actions, for instance due to the types of actions implemented and the shared ecological requirements of species (Hawkes et al., 2019, 2021). Therefore, for targeted species, we applied growth rates of 0%–30% – reflecting a range in the success of the species-specific actions. For landscape species, we applied species' growth rates of −5% to 10% – reflecting the difficulty in achieving high growth rates for a high number of species with landscape actions. We also varied the proportion of landscape species selected (0–1, by 0.1) as landscape actions might not benefit all landscape species. As above, we projected increasing species to continue to increase, on average, and non-recovered declining species to continue to decline, on average, at the same rate as over the last 20 years. We used these combinations to generate case-study-informed target-achievability pathways.

3 | RESULTS AND DISCUSSION

3.1 | Forecast

Under the current trajectory, species will continue to decline. The multispecies indicator of abundance (Figure 3) has declined from a baseline value of 100 in 1970 to a value of 48.4 in 2018. Over the last 20 years (up to 2018), the indicator has lost −17.6 points. We forecast a change in the indicator 20 years into the future of −11.9 points (95% prediction interval: −22.8, +7.2) (Figure 3). Thus, to reach or exceed the 2042 target then a future decline must first be slowed/prevented, reflecting the interim target to "halt the decline in species

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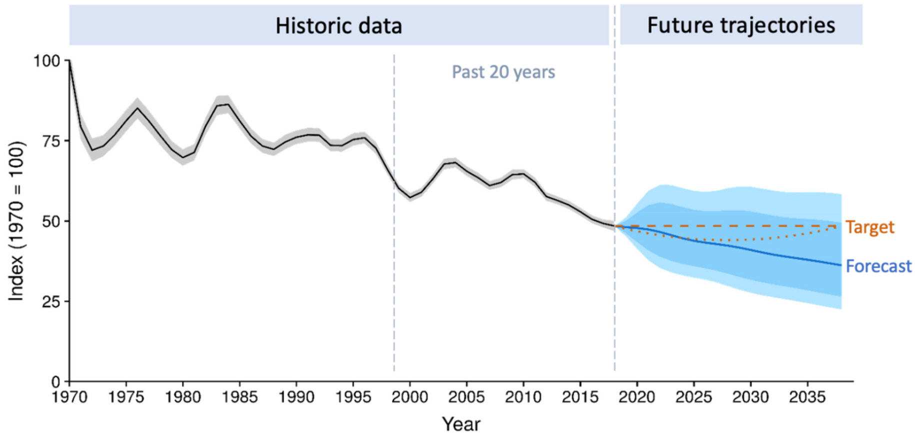

FIGURE 3 Changes in the abundance-based biodiversity indicator for England. The black line shows the historic trend in the indicator, with its 95% credible interval (gray envelope). The blue line shows the mean from the best ARIMA model (p, number of time lags = 2, d, degree of differencing = 1, q, order of the moving-average model = 0; forecast skill = 0.96; cross-validated mean absolute percentage error = 5.5%; see Appendix S5 for details) forecast, with the 80 (blue envelope), and 95% (light blue envelope) prediction intervals. The orange lines show the target (dashed line) and bending the curve toward the target (dotted line). The indicator is based on abundance data for 670 species: 431 moth, 169 bird, 55 butterfly, and 15 mammal species (Appendix S2).

abundance by 2030" (Environment Act, 2021). Indeed, we have illustrated how we might bend the curve of biodiversity decline (Figure 3 – dotted line; average growth rate across species is improved by 0.19% each year), such that most of the increase would be realized in the final years before the target date. This "inertia" in the indicator should be considered in the ambition and development of future targets and highlights that the target is more ambitious than simply allowing the current trend to continue (Figure 3). This is a vital consideration when ensuring biodiversity targets are both ambitious and realistic.

Abundance targets are commonly used as biodiversity targets (e.g., Butchart et al., 2010; Collen et al., 2009) as they are often more sensitive to change than measures of distribution, and relate to species functional contributions. Additionally, as the number of components (i.e., species) of a target increases, the target becomes harder to "game." If the target were solely based on (e.g.) farmland birds, then it's easy to imagine that the index could change without big benefits to wider biodiversity. But where the index contains several 100 species (as here) and has broad taxonomic coverage then it's harder to achieve the target without widespread benefits to all biodiversity. Still, abundance targets do not cover all aspects of biodiversity, where biodiversity is the sum of all biotic variation from the level of genes to ecosystems (Groombridge, 1992). For instance, abundance targets do not capture biodiversity dimensions such as ecosystem area and integrity, genetic diversity, or (directly) extinction risk (e.g., a sudden 25% reduction in all populations of wild species would cause devastating deficits and disruption in many of nature's contributions to people but no immediate extinctions; Purvis, 2020). Hence, abundance targets should be considered in the context of multiple complementary biodiversity indicators and targets (e.g., the 25-year Environment Plan Outcome Indicator Framework; DEFRA, 2021).

3.2 | Target-achievability pathways

Based on observed growth rates over the last 20 years, 60% of species are declining (388 species; median growth rate = −2.7), and 40% are increasing (264 species; median growth rate = +2.1) (Appendix S7). Put simply, to meet the target we need to shift species from declining trends to increasing trends. Given that biodiversity targets will be assessed using multi-species indices, there are multiple ways this can be achieved in principle.

Under our biological prioritization approach (the most declining species are recovered first), there are multiple pathways to meet or exceed the target (Figure 4a,c). For example, we would need half of the declining species (0.5 = 194 species) to show reduced declines on average of −3.1% per year for the next 20 years to meet the target (Figure 4a,c—label I) or for 27 declining species (0.07 = 27 species) to increase at 10% per year to meet the target (Figure 4a,c—label II). These pathways highlight a trade-off between smaller increases for many species or larger increases for fewer species (Figure 4c).

Under our randomized approach, the target could be met if half of the declining species (0.5 = 194 species) were to show reduced declines on average of −0.4% per year (Figure 4b,d—label I), or for 50 declining species

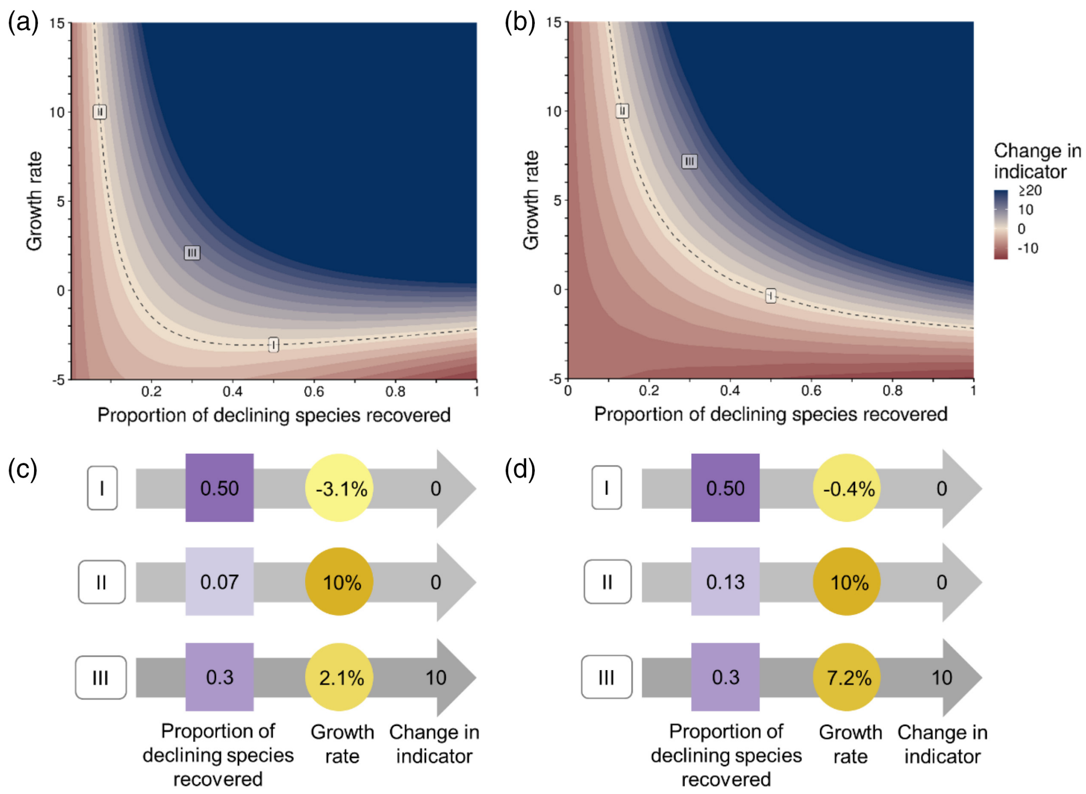

FIGURE 4 Target-achievability pathways. Contour plots (a,b) of the change in the indicator over the next 20 years, with a contour line at zero — reflecting the target (Figure 3). Example target-achievability pathways (c,d), Roman numerals relate to labels on the contour plots. Biological prioritization approach (a,c) — the most declining species are recovered first. Randomized approach (b,d) — recovered declining species are a random subset of declining species (mean across 100 random samples). For both approaches, increasing species continue to increase on average and non-recovered declining species continue to decline on average at the same rate as over the past 20 years.

(0.13 = 50 species) to increase at 10% per year (Figure 4b,d—label II). Thus, in terms of growth rates and/or proportion of species required, the target-achievability pathways are more difficult to achieve based on randomized species recovery compared to the biological prioritization approach (Figure 4).

Still, some steeply declining species require intensive conservation efforts, which may have little chance of success, whereas other moderately declining species can be recovered more easily by relatively modest actions (Marsh et al., 2007). The randomized approach could therefore reflect more flexible target-achievability pathways. In practice, the target may be more likely to be achieved through improvement in species that respond to broad actions or targeted toward those where there is a high probability of success or combinations of these factors (Joseph et al., 2009; Mace et al., 2007; Marsh et al., 2007). Pathways based on these factors are therefore likely to be more efficient than those based exclusively on species abundance. Furthermore, targeted actions (i.e., to recover the most declining species first) require detailed autecological knowledge that is likely lacking for most species in the indicator. Instead, species could be indirectly selected via landscape actions that benefit many, but likely not all, species (e.g., improvements in overall habitat quality; Isaac et al., 2018).

3.3 | Case-study informed target-achievability pathways

We identified 10 exemplar case studies of successful species recovery, demonstrating that success is possible and have been achieved through a variety of conservation actions, ranging from highly targeted species-specific management to landscape-scale conservation projects (Table 1). The case studies confirm our findings from the biological and randomization prioritization of target-achievability pathways — there are multiple pathways to the notional targets. Different policies and interventions will affect different types of species, to different degrees. We found the successful recovery of a small number (nine) of *Targeted* species (Figure 2) has the power to increase the achievability of the targets (Figure 5). Specifically, by reducing the proportion of declining species that need to benefit from landscape actions (Figure 5a,b),

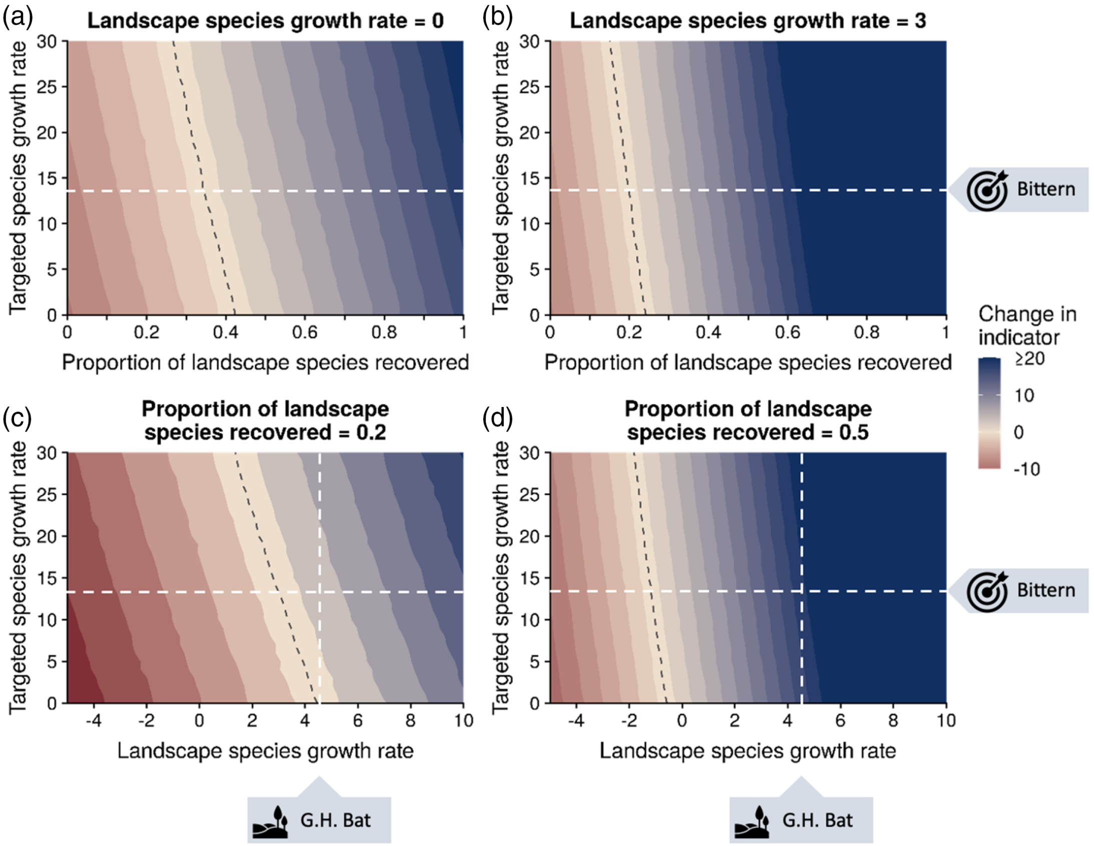

FIGURE 5 Case-study informed target-achievability pathways. Contour plots of the change in the indicator over the next 20 years, with a contour line at zero, reflecting the target (Figure 3). Targeted species growth rate refers to the growth rate achieved for declining targeted species with prescribed species-specific actions (nine species), landscape growth rate is the growth rate achieved for recovered landscape species (up to 379 species) (Figure 2). All plots follow the randomized approach — recovered landscape species are a random subset of landscape species (mean across 100 random samples). Increasing species continue to increase at their current (over the last 20 years) growth rate and non-recovered landscape species continue to decline at their recent rate. (a,b) Show fixed growth rates for landscape species. (c,d) Show fixed proportions of landscape species. Gray labeled white lines indicate growth rates equivalent to those exhibited by case study species illustrating "bittern-like" recovery and "greater-horseshoe bat-like" recovery.

and/or the average growth rate required for *Landscape* species to meet the target (Figure 5c,d). For instance, to meet or exceed the target, if species-specific actions are unsuccessful (targeted species growth rate = 0%) then ≥42% of declining *Landscape* species (163 species) need to be stabilized (growth rate = 0%), whereas only 27% of *Landscape* species (102 species) need to be stabilized if we see highly successful species-specific actions (targeted species growth rate = 30% for nine species) (Figure 5a). In addition, if the declines across half of the *Landscape* species (190 species) are reduced to −1% and the species-specific actions are unsuccessful then we will fall short of the target. However, if the species-specific actions lead to increases at 14.2% (equivalent to that seen for Bittern over the last 20 years) we will instead exceed the target (Figure 5d). Thus, several successful species-specific actions combined with more general landscape actions can increase the achievability of the target. Combinations of species-specific and landscape actions can therefore be used to outline ambitious yet realistic target-achievability pathways (Figures 4 and 5). Notably, the scarcity of examples of successful recovery highlights the ecological, political, and financial challenge of recovering biodiversity. However, our framework and pathways demonstrate how previous success can be used to inform future actions and contextualize the achievability of targets.

4 | CONCLUSION

We have shown that assessing the feasibility of achieving any biodiversity target is possible by analyzing recent trends, which reflect prevailing pressures and policies. Crucially, for progress we need to understand the momentum of biodiversity –– illustrated by the current trajectory of a biodiversity indicator. We have translated the target for England of "halting and reversing the ongoing decline in species abundance to at least the current baseline" into target-achievability pathways, determining how many, and by how much, species need to change, based on modeled and evidence-informed species recovery. We show that recent population trends and case studies of conservation success provide complementary insights into the degree to which biodiversity targets might be achievable. This is an important prerequisite for ambitious yet realistic evidence-based biodiversity targets to be embedded in policy. These insights can contribute to the development of SMART targets, thus increasing the likelihood that international commitments on biodiversity will be met (Díaz et al., 2020; Green et al., 2019).

Our work demonstrates that multiple pathways exist for achieving a quantitative target for species abundance. This implies choosing between high-impact conservation actions targeted at a few species with specialized requirements versus diffuse landscape actions (such as agri-environment schemes) that might have small benefits for many generalist species. The former might be more attractive from a nature conservation perspective (i.e., to reduce extinction risk), but the latter could be more effective for ensuring the flow of ecosystem services (i.e., maintaining abundance-driven multifunctionality) (Purvis, 2020). These options are not, however, mutually exclusive, and some blend of targeted and landscape actions is more pragmatic. Still, this dichotomy illustrates that selecting which interventions to pursue needs to consider the ultimate purpose of developing the target, in addition to factors such as the costs of implementation, the likelihood of success, and complementarity with other policy target areas (e.g., climate mitigation).

Indeed, decisions need to be taken in the context of the multiple dimensions of, and thus multiple indicators and targets for, biodiversity (e.g., extinction risk, ecosystem extent and condition, genetic diversity). For instance, an indicator and target of habitat connectivity are currently under development (Mancini et al., 2022), which could influence decisions regarding conservation actions for species abundance, with potential co-benefits or trade-offs.

It also follows that setting realistic targets does not insure against perverse outcomes (a perverse effect contrary to what was originally intended). Perverse outcomes are a major concern when target setting, exemplified by Goodhart's Law — when a measure becomes a target, it ceases to be a good measure (Hoskin, 1996; Newton, 2011). Following Goodhart's Law, efforts shift to improving the indicator itself, rather than supporting the underlying values that the target seeks to realize (i.e., biodiversity conservation). In other words, the indicator can be "gamed" (Díaz et al., 2020; Newton, 2011). This gaming of the targets can lead to misallocated conservation actions. It will be important to ensure that the approach to delivering targets, considers the long-term goals for biodiversity conservation as well as incentivizing actions to meet the target. Systems should therefore be put in place to prioritize holistic actions (actions that contribute to multiple different targets within a framework), thereby reducing the risk that the targets are achieved without also achieving the overarching goal (Díaz et al., 2020). Moreover, steps should be taken to ensure transparency around the use of indicators and the assessments on which they are based; to ensure that the information they provide is objective and reliable (Newton, 2011). Ultimately, biodiversity goals can only be met through a coherent framework of mutually supporting targets, such as the CBD Global Biodiversity Framework.

A major next step would be to translate these target-achievability pathways into the potential policy and management interventions that could contribute to achieving these targets, that is, a Theory of Change. Specifically, action-oriented analyses could help unpick the response of species to distinct conservation actions (e.g., Walker et al., 2018). For instance, what effect does improved management in protected areas have on species, or which agri-environment schemes have the biggest benefit for species (Staley et al., 2021)? We also need to better understand how quickly these actions could be implemented, how successful these actions might be, and how rapidly species respond to different actions (i.e., temporal lags in species' responses to conservation action; Watts et al., 2020). This further work could shift policy toward actionable pathways.

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CONFLICT OF INTEREST

The authors would like to declare that there are no conflicts of interest to report regarding this work and its publication.

DATA AVAILABILITY STATEMENT

The data used in this study are held by the data providers and/or are available online. Specifically, for birds, see https://www.gov.uk/government/statistical-data-sets/env08-wild-bird-populations-in-england, https://rbbp.org.uk/, https://jncc.gov.uk/our-work/seabird-monitoring-programme/ and https://www.bto.org/our-science/projects/bbs. For butterflies see https://doi.org/10.5285/657a64b2-8c34-43d2-a0f0-662ddf73c720. For mammals see https://www.bats.org.uk/our-work/national-bat-monitoring-programme and https://www.bto.org/our-science/projects/bbs/latest-results/mammal-monitoring. For moths see https://doi.org/10.5285/0a7d65e8-8bc8-46e5-ab72-ee64ed851583 and https://butterfly-conservation.org/our-work/our-conservation-strategies. Further information on the datasets used in this study is available in the Supporting Information, Appendix S2. The data were collated by Fiona Burns (Fiona.Burns@rspb.org.uk). The R code underpinning the analyses, as well as the produced biodiversity indicator values, are available at: https://github.com/03rcooke/targ_ind.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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