Report for Project entitled: Biodiversity metrics, public preferences, and the cost-based approach: **Summary For Policy Makers**

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Synopsis

One of the chief components of the values that people hold for the environment are existence values: the value placed on some aspect of the environment, including biodiversity, purely on the basis of the existence of biodiversity, ecosystem or some element of the environment not directly or indirectly experienced. Whereas many values associated with biodiversity can be reliably valued (e.g. natural flood management, recreation), it is difficult to obtain reliable monetary estimates for values of existence. The reasons for this unreliability in valuation are threefold. First, biodiversity is multifaceted, and including biodiversity-money trade-offs in choice experiments can result in participants not taking the time to understand the unfamiliar goods (aspects of biodiversity). Second, such trade-offs are controversial: people may see biodiversity as a "sacred" good and any simply entertaining any trade-offs with money "taboo". Third, Willingness to Pay estimates (WTP) for biodiversity from choice experiments are often thought unreliable due to hypothetical bias. The net results is to preclude the estimation of biodiversity's existence value from the typical application of CBA, often resulting in decisions *as if* these were zero. An alternative approach - as used to calculate the social cost of carbon - is to have some policy target and then calculate the marginal cost of achieving this, and taking this as the damage caused by any biodiversity loss; the so-called "cost-based approach". Of course, to do so requires choosing a metric - which should align with people's preferences for biodiversity. Not only is understanding what drives people's existence value key for a cost-based approach, it is also necessary for understanding whether other policy targets (e.g. Improving the England-level GB Red List Index of species extinction risk by 2042) accord with public preferences, and what metrics should form the basis of nature related disclosures within corporate "Environment and Social Responsibility" reporting. We address this gap through a conjoint analysis, and find clear evidence people have consistent preferences; above all else, lower extinction rates are key to determining existence values.

1 Policy background

Understanding the social welfare implications of different ways of measuring biodiversity has direct policy relevance globally, and particularly in the UK. As highlighted, determining the metric used is key to incorporating the cost stemming from a loss of biodiversity within the cost-based approach to CBA analysis. Second, stakeholders, and particularly investors, are increasingly expecting companies to report on measures related to their environmental and societal impacts. At present it is unclear how such companies are expected to report on the biodiversity impacts as they relate to their environmental effects; and the choice of metric will make a large difference to whether such reports convey meaningful information with regards to welfare. Indeed, to this end, the Taskforce on Nature-related Financial Disclosures - a leading light in trying to standardise the approaches - is actively seeking expert input on what metrics it should recommend be reported upon.

Within a UK policy context, the 2021 Environment Act sees the operationalisation of various biodiversity metrics into public policy. Operating at the scale of individual developments, the Environment Act makes in mandatory for all new developments in England from late 2023 onwards regulated via the Town and Country Planning Act to demonstrate they will achieve a 10% net gain in biodiversity ("Biodiversity Net Gain" (BNG)) relative to the pre-project baseline in order to secure planning permission. The same legislation will apply to all Nationally Significant Infrastructure Projects from 2025 onwards. Biodiversity is measured using the government's "Biodiversity Metric" (currently version 3.1, with the statutory version to be released in the next year following consultation), which is a simple composite indicator reflecting the area, ecological condition, and distinctiveness (a proxy for the degree of conservation value) of each patch of habitat within the development boundary. Measuring biodiversity in this way has significant implications for the kind of nature that will be delivered by the policy – for example, the Metric allows developers to compensate for the loss of area of semi-natural greenspace by promising to increase the ecological condition of the remaining habitat patches in the future. Recent empirical work has demonstrated that a sample of projects achieving BNG according to the Metric were therefore associated with a loss of over 30% of the area of greenspace present at the development sites, which potentially has substantial welfare implications. In a separate section of the Environment Act, the Westminster government commits to national biodiversity targets to develop an accountability framework to improve the state of nature across England as a whole. These targets are currently being consulted on, but the most recent suggested targets include:

- Halting the decline in wildlife abundance by 2030, then delivering a 10% increase from 2030 levels by 2042 (using a species abundance indicator comprising of changes in abundance in over 1,000 species with sufficient data)
- Improving the England-level GB Red List Index of species extinction risk by 2042, compared to 2022 levels; and
- Creating or restoring >500,000ha of wildlife-rich habitats outside protected sites by 2042 relative to 2022 levels.

Again, the exact biodiversity conservation actions and land-use policy required to deliver biodiversity improvements according to these metrics will likely differ substantially from that of alternative metrics, and so alternatives will all have welfare implications for the UK public.

2 Methods

The key method we employ is a conjoint analysis, garnering the views of a 1000-person sample, representative of the UK population. Specifically, we designed a state-of-the-art choice experiment which required participants to make 20 decisions choosing between pairs of sites described in terms of various attributes of the biodiversity located there. The attributes were selected by distilling down biodiversity metrics commonly used or recommended within the conservation, ecology and biodiversity economics literatures. The attributes that were selected, and their levels, are shown in Table 1. As such, we are able to not only determine what aspects of biodiversity drive people's existence value, but also how well these different metrics would reflect this.

	Level 1	Level 2	Level 3	Level 4	Units
Species richness	50	100	200	300	number
Probability of extinction	1	5	10	25	% species per 1,000 yrs
Population size	25	50	100	200	number
Population intactness	0.1	0.5	0.9		number
Habitable area	250	500	1000	2000	ha
Habitable area intactness	0.1	0.5	0.9		number
Distinctiveness	25	50	75		million years ago

Note: The attributes of biodiversity were selected to ensure cover the key concepts of biodiversity in common use, and hence so that they could be related back to as many different measures of biodiversity (used in practice) as possible.

Table 1: **Choice Experiment Attributes: Aspects of Biodiversity**

The experiment was also designed so that four of the 20 question pairs checked that basic assumptions about rationality were met, such that we could be confident that people understood what was required of them. The remaining 16 question pairs were generated to give a d-efficient orthogonal design, and there were four blocks of different 16 question pairs. In each of these four blocks, everyone saw the same 16 question pairs from the orthogonal design, and the same four rationality check pairs. Across blocks, the 16 question pairs were different, but the four rationality checks were all the same. Analysis of the data used the decisions made only in the 16 question pairs so not to bias the estimates. All analysis was performed in Stata, implementing the random utility model. To compare the performance of the different metrics, we also calculated the utility stemming from each option in each pair for these 64 question pairs. In calculating how frequent each metric gave the "right" answer, whichever generated higher utility within a pair was considered the "right" choice, and if the metric in question chose this one, it was deemed correct in that instance. To measure the utility stemming from a given metric, we summed the utility generated from the choices that that metric would make, and express this in percentage terms compared with the maximum that could have been achieved (that which would have been generated by following the estimated utility function).

3 Results

The first comment to make on the results of our experiment is that people clearly understood the concept of biodiversity and were comfortable expressing their preferences for different aspects. Of the overall sample, just 8% failed the transitivity test, and only 12% the dominance test (our two rationality checks), with a very large degree of overlap in failure rates of the two tests together. This is a similar rate of observed rationality compared to other choice experiments, that are often for far more tangible and familiar goods.

Second, people had remarkably clear, and consistent, preferences. Figure 1 displays the marginal effects on the odds ratio of a particular attribute. A coefficient of 1.2 (0.95) for an attribute means that a marginal change in that attribute would lead to a 20 (5) percentage point increase (decrease) in the odds of choosing that option. A reduction in the odds of choosing an option stems from the negative marginal utility that the attribute yields. It is clear, that in absolute terms, the key attribute that matters is mean extinction rate. Other attributes that matter a lot, albeit less, are the species richness and the time to last common ancestor.

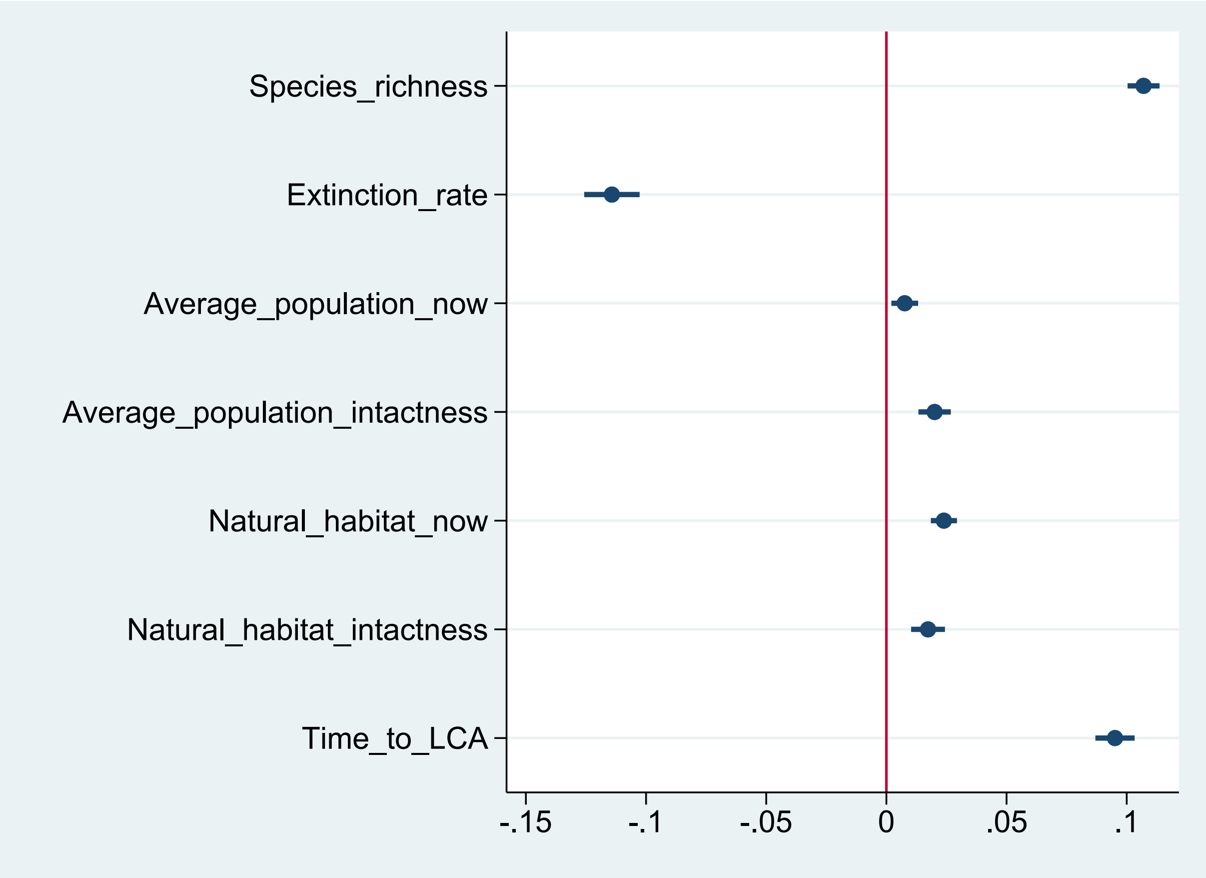

Figure 1: **The relative effect of biodiversity on well-being and choice.**

Turning to the performance of simple metrics, Figure 2 displays (blue, left-hand, columns) the proportion of the choices in which the metric chose the option generating higher utility, and (orange, right-hand, columns) the percentage of the maximum utility which is achieved by a given metric. Of course, on both measures, simply using the estimated utility function for all choices would result in scores of 100%. The key observation that emerges is simple metric (particularly mean extinction risk, and to a lesser extent species richness) can be very good at generating welfare. However, other (commonly used) metrics - like Mean Species Abundance and Species Habitat Index - perform extremely badly. Indeed, they barely perform better than simply picking at random on the likelihood that you choose the right option, and the welfare that the choices realise. If it is not possible to use the estimated utility function as the metric, then these results make stark that choosing the appropriate metric from the more common ones available is key.

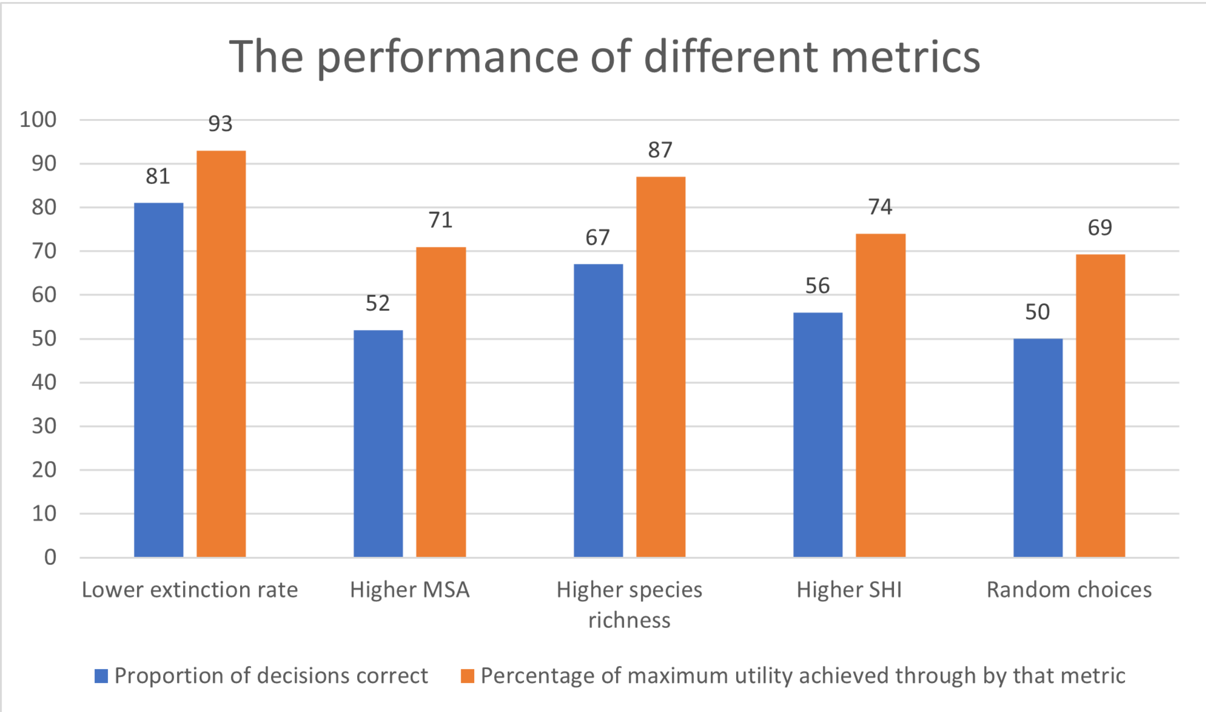

Figure 2: **The performance of *ecological* metrics of biodiversity versus *preferences* for biodiversity.**

4 Implications

The implications of this work are manifold. To summarise:

- The public has clear preferences over different attributes of biodiversity which contribute to the welfare they enjoy from existence value, and they are capable of expressing these within a conjoint analysis

- In general, extinction rate is the key driver of preferences, with species richness, and genetic diversity (time to last common ancestor) also important

- Concerning the cost-based approach, the estimated utility function herein offers the optimal metric against which to measure the cost to existence values from biodiversity loss

- Given the importance of existence value for welfare generation, policy targets based upon metrics which are poorly correlated with the generation of existence value (e.g. in regard to habitat provision) should be avoided and instead policy targets should focus upon more key drivers (e.g. lowering extinction rates)

- Financial disclosures are likely to generate the greatest impact for welfare through reporting on metrics which closely align with utility generation; not just directly, but also indirectly through likely having more impact upon the choices that key stakeholders (e.g. investors) choose to make