NEW ZEALAND JOURNAL OF ECOLOGY

FORUM

# Facilitating better ecological outcomes from high-stakes decision-making requires evaluation of biodiversity models to address risk and transparency

Fleur J. F. Maseyk [1]*, Laurence P. Barea [2], Cassie Mealey[3], Ilse Corkery[4] and Justyna Giejsztowt[5]

[1]The Catalyst Group, Queens Wharf Business Centre, 1 Queens Wharf, Wellington 6140
[2]Department of Conservation, 73 Rostrevor Street, Hamilton Central, Hamilton 3204
[3]Department of Conservation, 10 Sewell Street, Hokitika 7810
[4]Department of Conservation, South End Avenue, Raumanga, Whangārei 0110
[5]Wildland Consultants Ltd., 238 Annex Road, Middleton, Christchurch 8024
*Author for correspondence (Email: fleur@thecatalystgroup.co.nz)

Published online: 26 March 2025

**Abstract:** Biodiversity offsetting and compensation are high-stakes endeavours. Much rests on the process by which an offset or compensation proposal is designed and the tools used to evaluate the proposal, as this has a strong and direct influence on the potential outcomes for biodiversity. Models by their nature are imperfect, but their ecological robustness, and therefore usefulness, can be improved by adhering to well-established principles of good model development. Model limitations need to be well understood and described to ensure that models are employed appropriately and with adequate caution. We welcome the response from Baber et al. (2025) to our opinion piece highlighting the risks of poorly designed biodiversity loss-gain models (Corkery et al. 2023). We are encouraged by the engagement and debate and urge the wider ecological community to further engage in this important topic. In this response, we identify the fundamental areas of agreement between the two papers, of which there are several. We then clarify our remaining concerns with the use of the Biodiversity Compensation Model (BCM). Despite the counterarguments provided by Baber et al. (2025) we remain concerned about the application of insufficiently robust models and the misuse of biodiversity models. The implications of decision-making based on potentially misleading information are of grave concern for biodiversity, especially when considered in the context of the dual biodiversity and climate crises.

**Keywords:** biodiversity offsetting, compensation, ecological modelling, loss-gain calculators, uncertainty

## Introduction

There is deep debate surrounding the legal, economic, technical, ethical, and cultural aspects of biodiversity offsetting in the international literature. The many risks and failings for biodiversity outcomes are well traversed (zu Ermgassen et al. 2019). It is therefore encouraging that this debate has extended to the Aotearoa | New Zealand context. There are several aspects fundamental to biodiversity offsetting (which seeks to deliver a measurable conservation outcome with a goal of at least no net loss, but preferably a net gain of the target biodiversity) and compensation (positive actions to compensate for adverse effects on biodiversity but which, unlike offsets, are not required to demonstrate a stated outcome) on which we and Baber et al. (2025) are agreed. First and foremost, that the effects management hierarchy must be adhered to. The effects management hierarchy requires that an offset is only applied to residual adverse effects after all efforts to sequentially avoid, minimise, and remedy adverse effects have been exhausted, and compensation must only be considered as a last resort when an offset cannot be demonstrated. It is also agreed that while compensation can in specific circumstances achieve high-value positive outcomes, compensation actions are not obligated to achieve specified outcomes for target biodiversity (unlike offsetting) within an Aotearoa | New Zealand statutory context. As such, the design process for and outcomes achieved via an offset or compensation differ.

We are reassured that there is agreement across these fundamental issues and a joint desire to improve biodiversity offsetting and compensation practice in Aotearoa | New Zealand, including a desire to develop improved tools. We are also grateful for engagement by the ecological community on this matter, and advocate for an ongoing discourse.

Baber et al. (2025) describe the Biodiversity Compensation Model (BCM) (Baber 2021a, 2021b) as a framework that facilitates "better ecological outcomes". We acknowledge the BCM's value as a pre-application sense check to gauge the potential level of effort required to manage residual effects, and to explore and compare potential options in the early stages of project design. We also consider that the BCM has merit for estimating the scale of compensation packages. As a compensation model, we assume that the claimed "better

DOI: https://doi.org/10.20417/nzjecol.49.3592

ecological outcomes" achieved by its use are compared to the outcomes of compensation proposals designed without the use of a model (e.g., those designed on the basis of personal judgement, gut feel, or the use of unsubstantiated ratios). In that sense, we agree that the BCM can be a useful tool to support better outcomes from compensation.

We part ways with Baber et al. (2025) on the necessary robustness of the BCM and its usefulness outside of very constrained parameters. Baber et al. (2025) have called into question the conclusions in our opinion piece (Corkery et al. 2023), and specifically our claim that poorly designed biodiversity loss-gain models facilitate biodiversity loss. We uphold the conclusions from our initial article, primarily those regarding lack of rigor, which increases in relevance when a compensation model, be it the BCM or any other compensation model, is used outside of its intended purpose. Additionally, we have observed recurring issues with how the BCM is applied during the resource consent process, including frequent misinterpretation of model outputs and their use as proxies for offset models (e.g. claims that the model demonstrates that a net gain is "likely"). We appreciate that Baber et al. (2025) have clarified that the BCM is intended specifically for compensation purposes, in alignment with the effects management hierarchy, and they do not describe model outputs as "offsets". However, the misrepresentation of outcomes based on BCM outputs by its users blurs the distinction between offsetting and compensation. Overall, it appears that there is a lack of understanding among decision-makers, planners, and some ecologists around the effects management hierarchy and the limits and uncertainties associated with biodiversity offsetting and compensation.

Differing contextual starting points are likely to explain at least some of the differences in opinion between us and Baber et al. (2025). Achieving favourable outcomes for developers while constraining costs has different motivations than considering biodiversity outcomes more generally. Fundamentally, it is our view that the disagreement around the appropriate use of the BCM remains because, despite the assertions of Baber et al. (2025), the use of the BCM has not been confined to the initial design of compensation packages. Rather, it is being used as a proxy for offsets, with misleading statements such as a "net gain is likely", to support decision-making processes in the Environment Court. Further, unjustified comparison to other models and frameworks obscures and sidelines the limitations of the BCM.

## Assessing the robustness of biodiversity models

Baber et al. (2025) imply that consent approval for development applications is an indication that the BCM is useful for decision-making and widely accepted. However, application status tells us nothing about the robustness or reliability of the model per se. More relevant tests for ecological models are independent peer review of the model itself in the first instance, and case-specific peer review of its application. Decision-makers are typically specialists in neither ecology nor ecological modelling, and thus are not appropriate peers. Indeed, an Environment Court judge has agreed: "The court… could not make a decision on the dispute over the construction and functionality of the BCM… as it is not within the court's functions or expertise" ([2023] NZEnvC 68 para [163]). In the absence of peer review, we consider that the acceptance of the model by numerous decision-makers is not proof of its adequacy. It is also important to remember that the Resource Management Act 1991 (RMA) does not require there to be no effects, and the decision-making process under the RMA weighs up many factors and can compromise on, or trade off, these values (e.g. cultural, economic, and social) subject to Part 2 considerations (matters of national importance) and s104D gateway tests (restrictions for non-complying activities).

The projects Baber et al. (2025) cite may or may not have had positive outcomes for biodiversity, but how the use of the BCM contributed to those outcomes remains unclear. For example, regarding the application by Waste Management NZ Ltd. for a regional landfill at Dome Valley, north of Auckland, most of the differences between the Biodiversity Offset Accounting Model (BOAM, Maseyk et al. 2016) and the BCM outputs for Hochstetter's frog are explained by poor data inputs into the models that led to overestimated gains. This was the subject of significant disagreement between ecological experts during conferencing when the case appeared before the Environment Court (as confirmed in the Interim Decision [2023] NZEnvC 277 paras [657], [786]), and ultimately there was not agreement amongst the relevant experts on either model in this application. At the time of writing, this case has not been closed. Regardless, we reiterate that the acceptance (or not) of a model by a decision-maker is not an indication of its ecological robustness.

Baber et al. (2025) offer Table 2 as examples of cases where the use of the BCM is unlikely to have facilitated biodiversity loss. However, Table 2 provides a list of management actions rather than the anticipated additional biodiversity gains attributable to those actions. Effort (e.g. planting x ha) does not necessarily equate to outcomes (e.g. establishment of x ha of an indigenous vegetation community of a particular type, structure, and condition within a specified timeframe). A full assessment of a model's success would require evaluation of the model inputs alongside the modelled outputs to illustrate how the model was used to support claims of anticipated biodiversity outcomes. It is assumed that the BCM input data were not included alongside the cases presented by Baber et al. (2025) due to space constraints, and we acknowledge that the input data are available in the publicly accessible documentation associated with each case. However, this data is essential to demonstrate the value of the BCM and substantiate claims that the use of the BCM to support offset proposals does not compromise biodiversity outcomes. Without that link, the impact of the using the BCM cannot be tested.

## Residual concerns around current use of the BCM

We retain three key areas of concern around the current use of the BCM that Baber et al.'s (2025) detailed response did not resolve: (1) the use of the BCM beyond its intended purpose, and particularly as a proxy for offsetting, (2) the implication that the BCM can overcome insufficient data quantity or quality and resolve uncertainty through the use of contingency multipliers, and (3) the portrayal of the BCM as on par with offsetting models and international practices, and the assertion that it can be used to estimate that net biodiversity gain is "likely".

### Current use of the BCM beyond its intended purpose

While we see value in the use of the BCM in precursory assessments and evaluations at the optioneering stage, we

stress that the use of compensation models must not circumvent appropriate application of the effects management hierarchy. We have observed recurring problems with the use of the BCM, a compensation model, within the resource consent process as a surrogate for an offset with a comparable output (e.g. a purported "likely" net gain). Compensation is purposefully listed after offsetting, at the bottom of the effects management hierarchy, as it contains substantial uncertainty and risks to biodiversity outcomes (Maseyk et al. 2018). The initial pre-application BCM sense check should not be used as a substitute for an offset at the consenting stage; nor should it be implied that its performance is similar to offset models. We stress that such misuse is not a problem with the BCM itself as a compensation model, but rather with its use beyond compensation contexts. This is not simply because such an approach can provide a false sense of confidence, but also because (as used by Baber et al. 2025) the input values, and therefore the output, do not reflect anything measurable on the ground. This means that the outcomes of management actions predicted by the model cannot be objectively verified. Further, the application of robust net-gain calculations to test the initial BCM sense-check should not be deferred to post-consenting or used for adaptive management via consent conditions. This is high-risk and provides no assurance that residual adverse effects will be appropriately managed in accordance with the effects management hierarchy.

**Use of the BCM when data are hard to obtain**

We are cognisant that applicants can be hesitant to invest in data collection to inform a robust and verifiable effects management package prior to consent approval. This presents a significant challenge for improving effects management, and we recognise the economic and political pressures that ecologists encounter in resource management. Making appropriate investments to accurately describe and measure the biodiversity affected by proposed developments is essential for informed and responsible decision-making. In response to a lack of investment in data collection, the BCM appears to offer a solution by incorporating several multipliers to correct for uncertainty. This risks the use of poor-quality data and a reliance on unverifiable expert opinion. In our opinion, it would be more appropriate to reserve the model for well justified data (as Baber et al. 2025 signals), which may be expert opinion where necessary, and to subsequently add uncertainty multipliers outside the model. This would create a transparent process whereby the excessive use of non-data-informed multipliers does not obscure poor data.

Baber et al. (2025) rightly raise the challenge associated with obtaining quantitative data or proxies for "complex habitats, rare, cryptic, or highly mobile fauna, or other biodiversity values for which cause and effect is uncertain" or where there is insufficient certainty associated with management actions to propose an offset. However, the BCM does not overcome these challenges; it simply inappropriately models these scenarios with user-decided ranks that lack a direct reference to anything on the ground. When sufficient information to adequately inform a model is lacking, or if the data show significant variance (high uncertainty) that cannot be accounted for statistically, the appropriate approach is to collect more data or to not proceed with modelling.

The use of several ad-hoc multipliers, or contingencies, within the BCM conflates predicted outcomes with error estimates, despite these being very different concepts. Where models do not effectively address uncertainty, this should not be obscured by multiple arbitrary multipliers which can overwhelm signals from real data. Rather, the uncertainty should be made transparent and explicitly acknowledged and addressed outside the model. While we commend the developers of the BCM (Baber et al. 2021a; 2021b) for proposing a model that attempts to account for compensation proposals, we consider that further work is needed to reach a best practice state.

**Comparisons of the BCM to offset models and international practice**

Simplistic comparisons between the BCM and established peer-reviewed models (e.g. Maseyk et al. 2016) risk creating a perception that they are interchangeable, the main difference being that the BCM is easier to apply. Baber et al. (2025) make several favourable, yet from our perspective insufficiently detailed, comparisons between the BCM and other offset models. This is concerning, as such comparison can translate to a perception by others that the BCM is on par with other models and approaches and can be similarly relied on.

While the BCM replicated the mathematical structure of the BOAM, it failed to apply the necessary data quality requirements and constraints to support the mathematical formulation and theoretical assumptions underpinning the use of area by condition currencies within loss-gain models (Corkery et al. 2023; Maseyk et al. 2016). Promoting a simplistic and potentially unreliable model poses significant risks to biodiversity outcomes.

Baber et al. (2025) also claim that the development and application of the BCM is comparable to the UK's statutory biodiversity metric calculation tool developed to calculate different types of biodiversity units for the purposes of determining biodiversity net gain (BNG) (Department for Environment, Food & Rural Affairs 2024a). We feel that this comparison is misleading. The UK metric tool is prescriptive, directly linked to legislative requirements and local policy guidance, and underpinned by a number of principles and rules, including trading rules that set minimum habitat creation and enhancement requirements (Department for Environment, Food & Rural Affairs 2024b). Importantly, the metric tool is underpinned by an accepted biodiversity classification system and by controls that objectively link the rank scale used as input data to measures on the ground; this ensures consistency in the quantity and quality of what is being traded. The BCM does not do this. In contrast, the BCM facilitates the use of rank scale inputs that lack an objective connection to the quantity and types of biodiversity being accounted for in the model. While the UK metric tool also utilises qualitative scores, these are supported with specific criteria that are known to be ecologically meaningful and repeatable in a given habitat. Furthermore, a method of assessment has been specified for each criterion. Thus, the UK metric tool is a fundamentally more prescriptive and robust approach.

Baber et al. (2025) quote the review by Borges-Matos et al. (2023) to suggest that using qualitative data in the BCM reflects current international approaches. However, while Borges-Matos et al. (2023) did identify that expert opinion was used in the biodiversity condition metrics they reviewed, they noted that this was done rarely. While Borges-Matos et al. (2023) did suggest that the use of expert opinion data (including traditional ecological knowledge) could be further explored, they emphasised that this should be done in a constrained context, alongside other components, and without losing information. Further, the same paper highlighted that

disaggregated currencies and measurement frameworks are preferable to aggregated approaches (such as the biodiversity value score the BCM uses), which run the risk of propagating unequal exchanges of biodiversity losses and gains (Borges-Matos et al. 2023).

We do not suggest that Baber et al. (2025) are intentionally misrepresenting the alignment of the BCM with other models and approaches. Nor do we suggest that the BCM (as a compensation model) must incorporate the same level of rigour as a robust offset model. However, it seems that favourable comparisons have been made between the BCM and selective elements of other approaches without considering the wider, rigorous context in which those elements sit. Our concern is that this selective comparison risks encouraging the BCM to be used beyond its intended purpose and implies a level of rigour that the BCM does not possess.

## Improving practice

We reiterate that it is our view that there are situations where the BCM might be a useful ecological tool, including: (1) where its use is confined to a precursory assessment at optioneering stages and early design phases to guide developers to avoid ecological features in the first instance; we also, however, caution against such early-stage rough assessments distracting from collecting adequate data at the outset of a development project; (2) when it is used to sense check a compensation proposal for residual adverse effects that cannot be offset, or to size additional benefits for biodiversity outside of the effects management response. However, we remain concerned about such sense checks being incorporated into expert evidence supporting "likely net-gain" outcomes; (3) when the use of biodiversity value scores can be tied meaningfully to on-the-ground measures of biodiversity, and can therefore serve as a suitable proxy for the targeted biodiversity feature.

## Conclusion

We are encouraged by the efforts of ecologists to engage in the ongoing debate surrounding tools used in biodiversity offsetting and compensation design and agree that there is a strong need to improve biodiversity offsetting models in use in Aotearoa | New Zealand. However, we remain resolute in our view that the BCM is not optimally designed, a limitation which is compounded by its to-date inappropriate use to claim more than it can deliver. Expediency for development projects should not be the principal driver behind the development of ecological models. We agree with Baber et al. (2025) that the BCM could have value in some situations but are strongly of the view that models with limited functionality and rigour should not be used beyond the purpose for which they were developed. We are aware of current use of the BCM that we feel misrepresents the rigour of the model, misapplies the effects management hierarchy, blurs the boundary between appropriate and inappropriate application of compensation models, and risks conflating biodiversity offsetting and compensation; all of which potentially facilitate biodiversity loss in Aotearoa | New Zealand.

## Acknowledgements

We thank the Editor-in-Chief for inviting this response and facilitating the debate in the journal.

## Additional information and declarations

**Author contributions:** All authors were involved in idea generation and conceptualising content; FJFM led the drafting of the manuscript, with all authors providing input and contributing to editing.

**Funding:** Not applicable.

**Data and code availability:** Not applicable.

**Ethics:** Not applicable.

**Conflicts of interest:** FJFM and LB were lead members of the team that developed the BOAM. At least one author has been involved in the resource management cases we cite, and in most of the cases cited in Baber et al. (2025). None of the authors represented the applicant in any of these cases.

## References

Baber M, Dickson J, Quinn J, Markham J, Ussher G, Heggie-Gracie S, Jackson S 2021a. A biodiversity compensation model for New Zealand – a user guide (Version 1). Tonkin & Taylor Limited. 33 p.

Baber M, Dickson J, Quinn J, Markham J, Ussher G, Heggie-Gracie S, Jackson S 2021b. A biodiversity compensation model for New Zealand – Excel calculator tool (Version 1). Tonkin & Taylor Limited. https://www.tonkintaylor.co.nz/expertise/environmental/biodiversity-compensation-models/ (accessed 6 November 2024).

Baber M, Quinn J, Craig J, Bramley G, Lowe M, Webb C, Ussher G, Whiteley C, Kessels G, Davies F, Markham J, Miller D, van Winkel D, Wedding C, Chapman S 2025. The biodiversity compensation model: a framework to facilitate better ecological outcomes. New Zealand Journal of Ecology 49(1): 3591.

Borges-Matos C, Maron M, Metzger JP 2023. A review of condition metrics used in biodiversity offsetting. Environmental Management 72: 727–740.

Corkery I, Barea LP, Giejsztowt J, Maseyk FJF, Mealey C 2023. Poorly designed biodiversity loss-gain models facilitate biodiversity loss in New Zealand. New Zealand Journal of Ecology 47(1): 3548.

Department for Environment, Food & Rural Affairs 2024a. Statutory biodiversity metric tools and guides. Government of the United Kingdom of Great Britain and Northern Ireland. https://www.gov.uk/government/publications/statutory-biodiversity-metric-tools-and-guides (accessed 6 November 2024).

Department for Environment, Food & Rural Affairs 2024b. The statutory biodiversity metric. User guide. Government of the United Kingdom of Great Britain and Northern Ireland.www.gov.uk/government/publications (accessed 6 November 2024).

Maseyk FJF, Barea L, Stephens RTT, Possingham HP, Dutson G, Maron M. 2016. A disaggregated biodiversity offset accounting model to improve estimation of ecological

equivalency and no net loss. Biological Conservation 204: 322–332.
zu Ermgassen SOSE, Utamiputri P, Bennun L, Edwards S, Bull JW 2019. The role of "no net loss" policies in conserving biodiversity threatened by the global infrastructure boom. One Earth 1(3): 305–315.

Received: 20 November 2024; accepted: 7 January 2025
Editorial board member: Thomas Etherington