Review of
"A Process-based Model Approach to test for evolutionary rescue in forest ecosystems under climate change"

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This manuscript, which I enjoyed reviewing, makes a significant contribution to our understanding of how forest management and inter-specific interactions influence the evolutionary rescue of forests under climate change. The authors have modified an existing individual-based model for the dynamics of multi-species forest stands, incorporating an evolution module and feedback between species composition and regeneration. They explored the impact of a two-species mixture, genetic enrichment, and species range shifts on evolutionary rescue following a period of climate warming and stabilization. The simulation plan is well-designed. The model is parametrized based on empirical data. The results illustrate that a two-species mixture can decrease the long-term recovery compared to a monospecific stand. Genetic enrichment can improve short-term recovery and increase the role of the trade-offs among traits and species competition on long-term persistence. Species range shifts could decrease the persistence of local species despite increasing the overall forest ecosystem persistence. Those results were reported for 16 evolutionary scenarios, giving a good sense of the robustness of the results. The presentation of the results and their discussion is clear. I have provided some comments and advice below to further enhance this great manuscript.

- **Title and abstract**
  - Does the title clearly reflect the content of the article? Yes
  - Does the abstract present the main findings of the study? Yes
- **Introduction**
  - Are the research questions/hypotheses/predictions clearly presented? Yes
  - Does the introduction build on relevant research in the field? Yes
- **Materials and methods**
  - Are the methods and analyses sufficiently detailed to allow replication by other researchers? I provided some suggestions to enhance the methods.
  - Are the methods and statistical analyses appropriate and well described? I provided some suggestions to enhance the methods.
- **Results**
  - In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)? NA
  - Are the results described and interpreted correctly? Yes
- **Discussion**
  - Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? Limitations are well described. I have suggested some additional points that could be discussed to enhance this section further.
  - Are the conclusions adequately supported by the results (without overstating the implications of the findings)? Yes

General comments

Evolutionary rescue could be better defined in the introduction (e.g. Bell, G. (2017). Evolutionary rescue. Annual Review of Ecology, Evolution, and Systematics, 48, 605-627.). It could be worth mentioning early in the methods that the basal area is used as a proxy for the abundance and that evolutionary rescue can be shown by a higher median final relative basal area than a median minimal relative basal area.

I did not understand the time step in the simulations. Is it a year, a month, a day..? I also did not understand how environmental variables change. Do they vary across months? Is there inter-annual variation in environmental variables?

A conclusion section could be helpful to put together the results and their interpretation. This conclusion could include the biological implications of the study i.e. what are the take-home messages for theoretical ecologists and forest managers? (see also my next comment)

The authors could broaden the impact of their study by discussing a little further the implications of the study for forest management. I give below some points to consider. These are just suggestions, and the authors are, of course, free to decide whether they are relevant to the manuscript's discussion.:

- Which decisions could be made by the forest managers to maintain forest productivity?
- What would be the most interesting time window for a forest manager? 100 years? In this time window, recovery is better for greater trait variability so decisions could be made to increase trait variability.
- What would be the number of years required to see a full recovery (in other words to not lose productivity) in the scenario h2=VR=0.3?
- Assisted gene flow could help but species range shift can decrease recovery of the species of interest.

Specific comments

l.21: consider making clearer which statement is based on empirical and/or simulation data. The next sentence should also be clearer about how your model is different from the previous ones. In its current state, it sounds a little like things have already been done in previous studies (even if the rest of the introduction makes the novelty of the study very clear).

l.43: we might want to have more details about the processes by which species diversity could be a buffer or reduce evolutionary rescue.

l.60: has extinction without evolution been shown in a previous study? If yes, I would here add a reference to this study.

l.78: could you give a brief description of the recruitment, growth and mortality processes in the methods or at least explicitly state that the description of those processes can be found in a previous publication?

l.96: if that is the case, mention that M is a continuous variable between 0 and 1. I am not sure to understand why M=1 corresponds to migration and local regeneration. Do you mean only migration?

l.131: I think there is a problem with this sentence. Do you mean “sigma_P values depend on the initial intraspecific trait variability (VR) which is set as a fraction of the interspecific variability in traits observed in the pool of species parameterized in ForCEEPS (Morin et al., 2021).”?

l.133: how is VR calculated when indicated at the level of the whole forest? is it an average of the species-specific VR weighted by their relative abundance?

l.158: consider mentioning earlier that there are evolving and non-evolving traits and why using non-evolving traits.

l.166: I find the second part of the sentence a little confusing. Consider something along the lines of “as at equilibrium the variance in the population converges to twice the segregation variance.” I also wonder if the clarity of this paragraph could benefit from switching this sentence with the next one i.e. “Under the infinitesimal model, (…). Without selection, setting its variance to half the starting genetic variance (…).”

l. 176: as h^2 et sigma_E are fixed, how do you control for sigma_G after local and migration regeneration?

l.213: the scenario-specific patch number is confusing to me. I assume all the patches are not run together within a simulation. It is either 50 patches of mixed beech-fir or 42 patches of monospecific beech or 11 patches of monospecific fir. Could you indicate the initial number of trees?
In the section about the limitations of the model, you could discuss the choice of fixing the initial number of trees. Are the densities resulting from the initial number of trees consistent with the ones in the field? Did you get a chance to explore if the results are robust to the initial number of trees? If yes, I think it would be worth mentioning. For instance, would that change the reference period basal area and thus the final relative basal area and the dynamics of evolutionary trajectories?

l. 231: a limit to this scenario is that a single migration rate has been investigated. This limit could be mentioned in the limitation section. Do you have any intuition or simulations available to predict the outcome of a lower migration rate? Would the replacement of beech and fir be avoided or just take longer, and would that lead to the extinction of the whole forest? If you don’t have any intuition, I would still suggest mentioning the possible outcomes as it could inspire future work in this direction.

Paragraph l.249: I would add that the median percentage of reference basal area indicates recovery: 100% corresponds to perfect recovery, values lower than 100% correspond to partial recovery, and values higher than 100% correspond to higher basal area than initially.

In general and on Fig2D: does the median minimal forest basal area rebound before the end of the warming period?

l.265: “beech was favoured because its populations were initially larger”. What is the initial number of beech and fir trees and why is the beech number higher than the fir number? This should be mentioned in the methods (maybe around 212).

l.276: do you mean “the same Delta_DrTol values”? It is not clear to me that, for Fir, “recoveries are better in monospecific than in mixture treatment (Fig. 4).”

l.281: I might not read well fig 5B but it seems to me that g evolves and fluctuates over time (like ShTol).

l.289: I think fig 2A and C have to be compared to illustrate evolutionary rescue.

l.303: “evolution speed was no longer the limiting factor for species and community recovery, … “. I might be wrong but I understand that evolution for drought tolerance is not limiting but instead, evolution for shade tolerance is limiting, so evolution speed is still in action here. However, I agree that there is a trade-off among traits for competition for light.

l.315: cite fig 5.B at the end of the sentence.

l.355: consider stating that this is only true in the short-term

l.377: I am unsure why competition for water would act differently from competition for light. We might need more details here to clarify this point.

l.381: Godineau et al. (2023) modeled vigor

Editorial comments

l.80: “primary driver of the dynamics of the temperate forests”

l.113: “a compilation from previous studies (…)”

eqn 1: in the literature that I used to read, vectors are denoted by a bold letter (instead of an arrow over the letter)

l.138: check for citation formatting throughout the manuscript

l.159: “while the phenotypic values”

l.170: “regardless of the distributions”

l.183: “Beech-fir forests are a typical ecosystem of montane forests in Europe”

l.185: “site and climate data”

l.194: “which were organized into three periods”

l.273: consider replacing “what’s more” with “furthermore” or another synonym

l.340: I think it should be “limitations of the model”

l.351: “the speed and the absolute values of changing climate matter, …”

Figure 4: figure legend should explain delta corresponds to t=3100-2100

figure 5: consider increasing the size of panel B e.g. by moving panel B under A

Supplementary Information: legend boxes are missing in some of the figures

Figure S5: consider making the labels on the x-axis consistent. Consider also showing mixed in second position instead of third (like on other figures)