



Do more niches or better niches promote species richness?

Insight from local and regional drivers of lichen diversity across U.S. forests

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Background

How does the environment regulate species richness?

... of epiphytic macrolichens in U.S. forests?

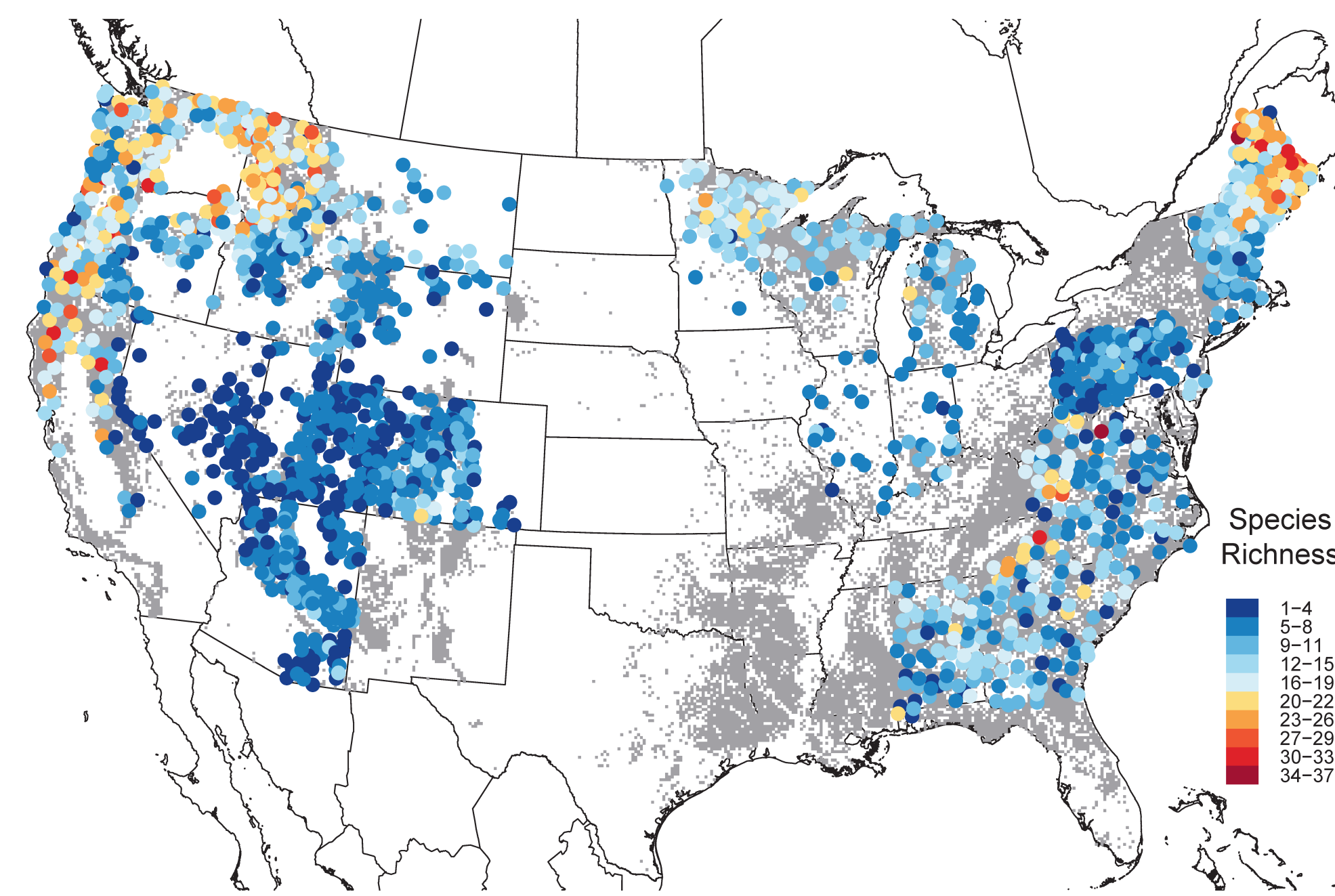
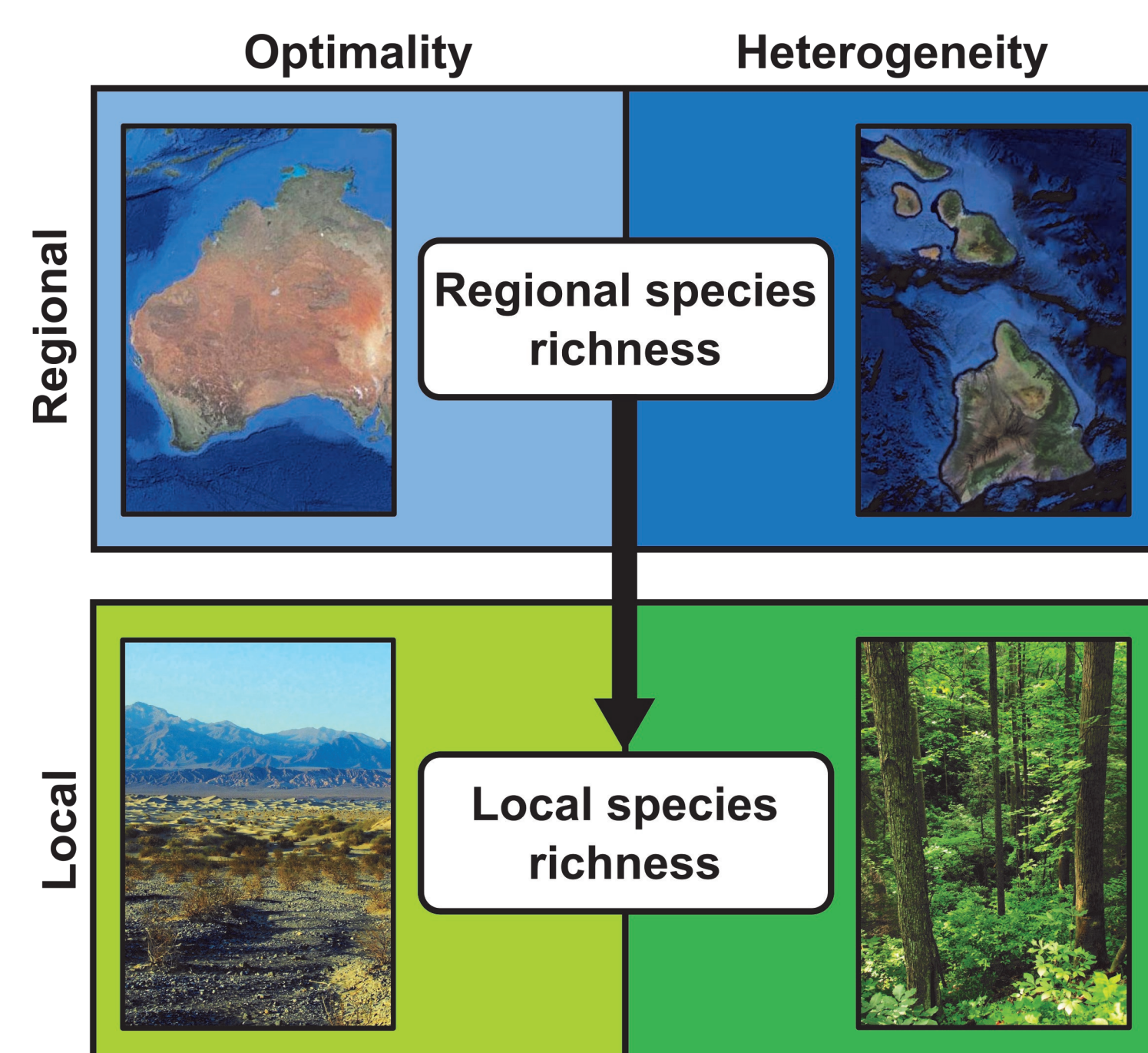


Figure 1. Lichen species richness on 1,963 forest inventory plots

Models + Data

- Lichen richness & abundance, forest structure variables from 1,963 forest inventory plots (U.S. Forest Service, Forest Inventory and Analysis National Program).
- Regional lichen richness estimated from 148,282 herbarium records (Consortium of North American Lichen Herbaria) and functional richness calculated from 20 traits (LIAS database).
- Climate data (WorldClim, PRISM) aggregated into long-term average local and regional climate variables.
- SEM path analysis: total, direct and indirect effects of environmental variables on local and regional lichen richness.
- Variation partitioning among groups of predictors on GLMs of local and regional lichen richness with negative-binomial error and supported quadratic terms.

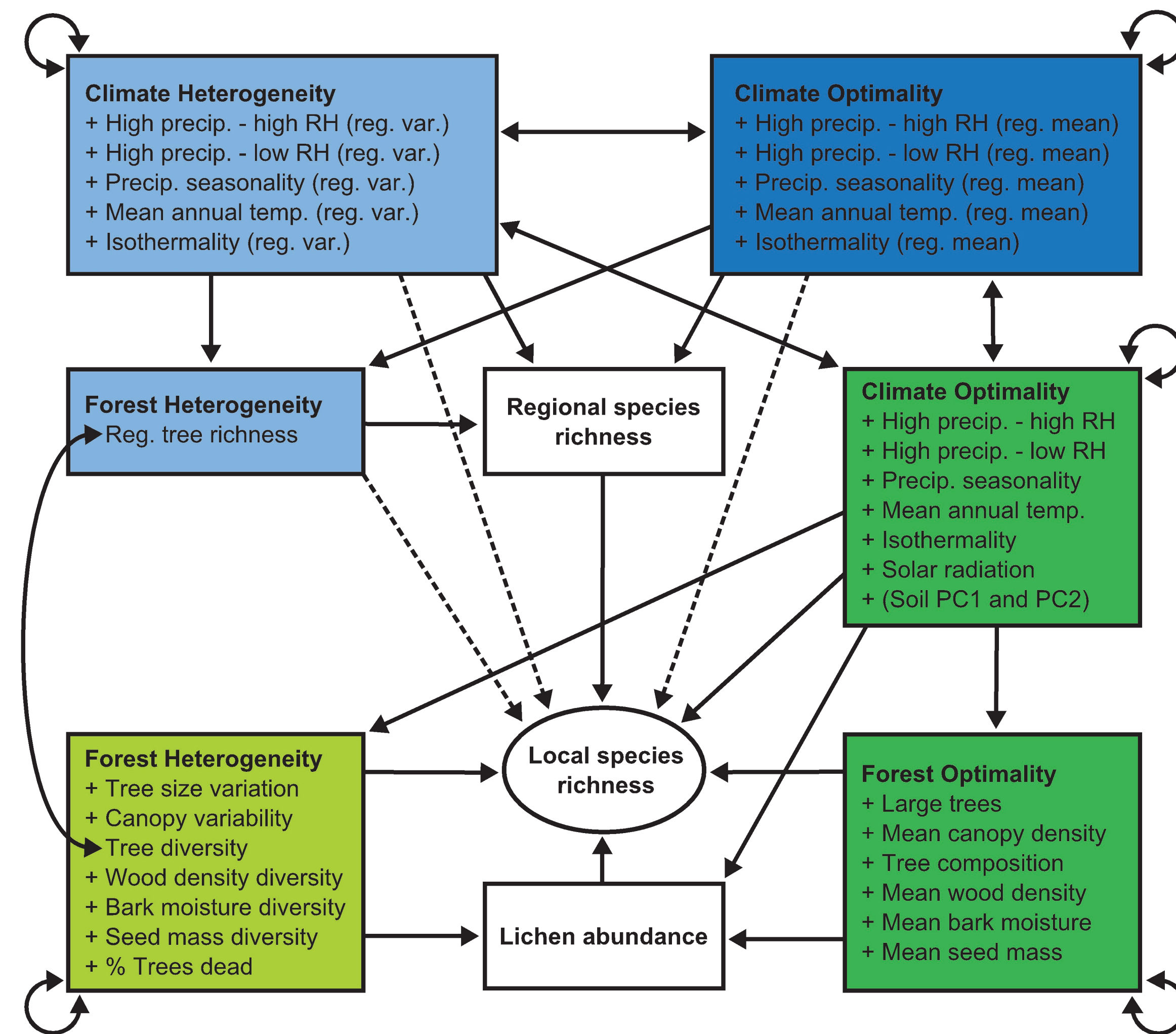


Figure 2. SEM model structure. Initial conceptual model did not contain direct paths from regional-scale variables to local lichen richness (dashed lines), but including these paths in the final model provided a better fit to the data.

Results

Predictions Tested

Local vs. Regional

- Regional or local model explains local richness?
- Regional variables act indirectly via regional richness or via local variables?
- Stronger effect of local or regional climate on local richness?

Heterogeneity vs. Optimality

- Landscape heterogeneity or average regional environment influences regional richness?
- Habitat heterogeneity or average habitat conditions influence local richness?
- Richness ~ average environment unimodal (indicating optimal niche)?
- Richness ~ environment heterogeneity linear (indicating more niches)?
- Strong local richness ~ local abundance correlation?
- Habitat conditions act indirectly on local richness via local abundance or habitat heterogeneity acts directly on richness?
- Habitat heterogeneity influences functional richness more than species richness?
- Stronger richness correlations with variables related to niche differentiation?

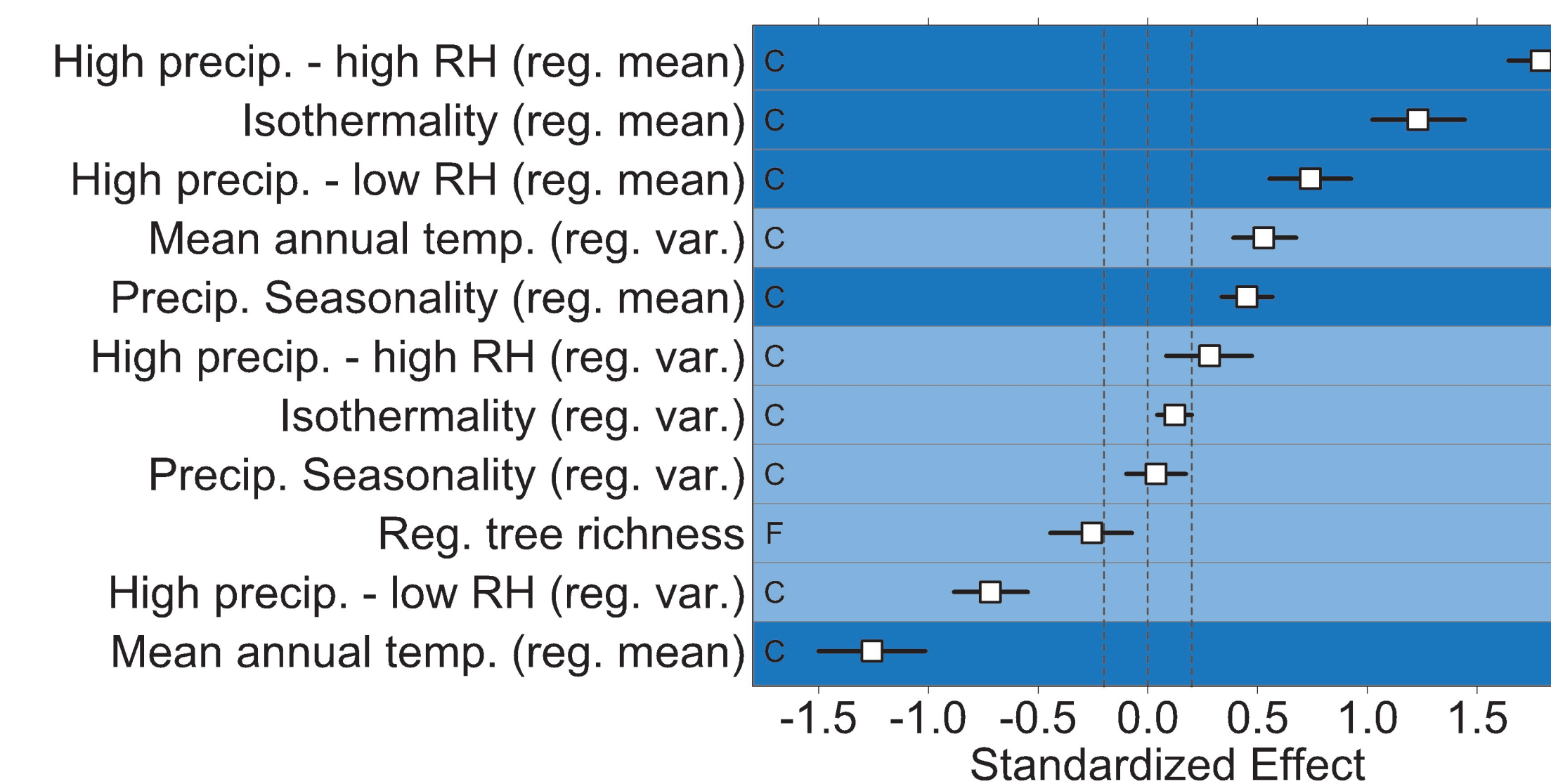


Figure 4. Direct effects of regional – scale variables on regional lichen species richness (A) and local-scale variables on local richness (B).

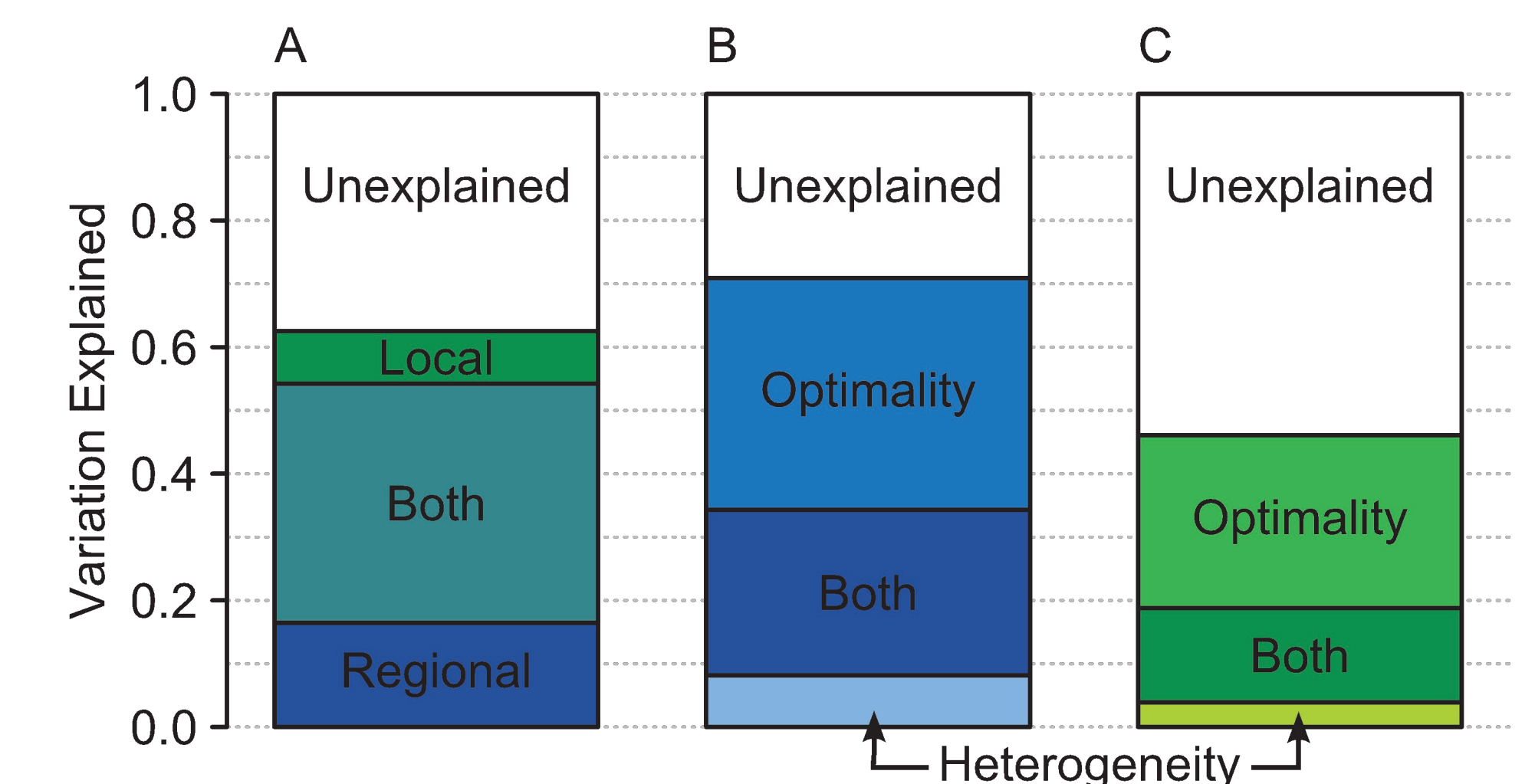
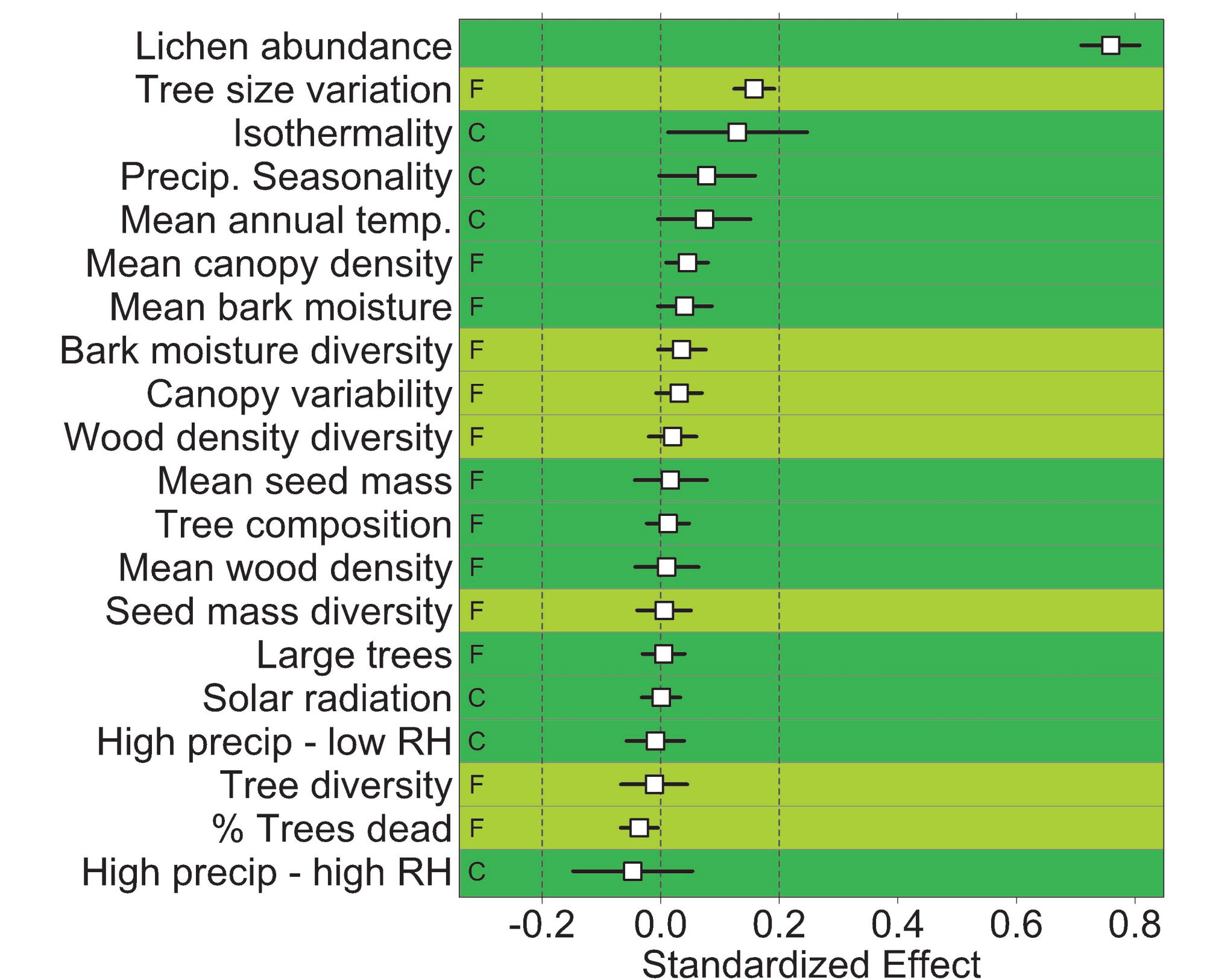


Figure 3. Proportion of variation in local (A & C) or regional (B) lichen species richness explained by different types of environmental variables. The model with regional-scale variables uniquely explained twice as much variation in local richness as the model with local-scale variables (A). Models with variables measuring environmental optimality uniquely explained much more variation in both regional (B) and local (C) richness than models with variables measuring environmental heterogeneity.



Acknowledgements



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Conclusions

- Regional processes play an important role in regulating lichen species richness of local communities.
- Climate is a better indicator of processes regulating richness than forest structure.
- Little evidence for a relationship between environmental heterogeneity and species richness at local or regional scales.
- Lichens: sensitive physiology + similar environmental requirements = more species under more optimal conditions?

