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Dealing with uncertain climate change projections in forest resource management

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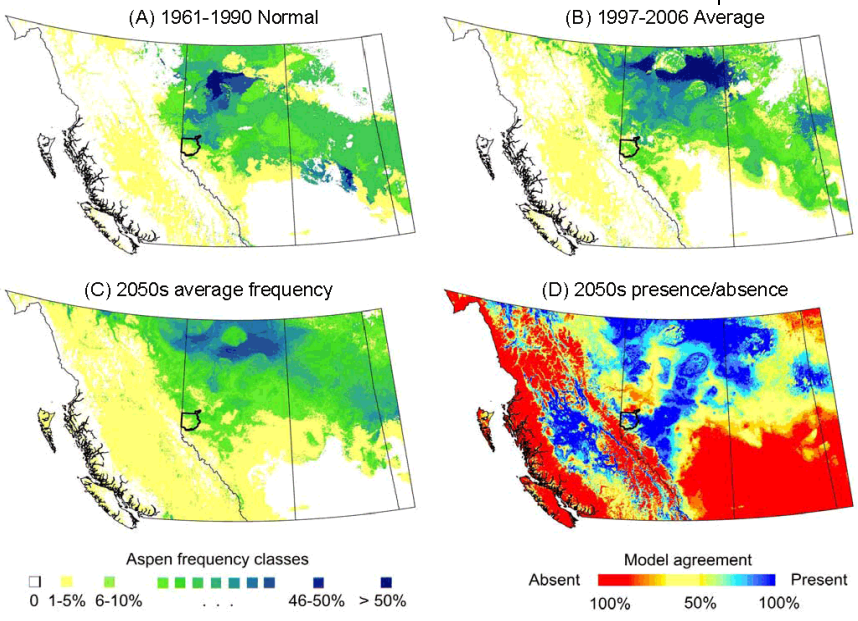
Over the last decade the reality of global climate change has gained wide acceptance among policy makers and natural resource managers, and the demand for modeling and forecasting climate change impacts on the biosphere is growing. A model class that is useful to guide climate change adaptation in natural resource management are bioclimate envelope models, for example through guiding species choice in reforestation. Projections of bioclimate envelope models, however, come with large uncertainties due to different climate change scenarios, modeling methods, and other factors.

Methods: We developed a novel approach to evaluate uncertainty in bioclimate envelope model predictions, which allows for narrowing the range of habitat projections that practitioners need to consider. Rather than evaluating variability in modeling results as a whole, we extract a particular statistic of interest from multiple model runs, e.g. species suitability for a particular reforestation site. Then, this statistic is subjected to analysis of variance, where sources of uncertainty are represented as treatments in a complete factorial design. We evaluated five sources of uncertainty: modeling methods, interpolation type for climate data, inclusion of soil variables, choice of general circulation models, and choice of emission scenarios.



Results: We find highly variable amounts of uncertainty in projections of suitable habitat depending on the species, location, and various model factors:

1) Including soil variables as predictors reduces projected habitat shifts, different climate change projections had major effects, and modeling methods had moderate effects on habitat projections.

2) Partitioning of variance components helps with interpretation of model results and reveals how models can most efficiently be improved. It also offers researchers the opportunity to filter out biologically and statistically unreasonable results, providing practitioners with an improved range of predictions.

Implications: The figure on the left aggregates results from more than 100 model projections of aspen habitat by the 2050s (Fig. C & D). We can now ask: what is the probability of maintaining suitable habitat for aspen in a particular forest management area? As an example, we evaluate FMA G16 (black outline in Figure), managed by Ainsworth Lumber for hardwood supply of its oriented strand board plant in Grande Prairie.

1) A quantitative assessment indicates that on average only 10% of aspen habitat is lost in FMA G16 by the 2050s (worst case scenario 20%), and we conclude that hardwood supply in this FMA should not be drastically affected under projected climate change by the 2050s.

2) In other areas of Alberta, however, foresty with aspen faces large uncertainties (yellow in Fig. D). Further, the species has already lost habitat due to observed climate change (white in Fig. B, central parklands), and it is likely to lose more suitable habitat in other areas (Fig. D, yellow/red, dry mixedwoods).

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