Supporting information

Unifying individual and metapopulation scales with stochastic population models: the effect of climate and competition on tree range limits

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0.1 Supplementary Material 1

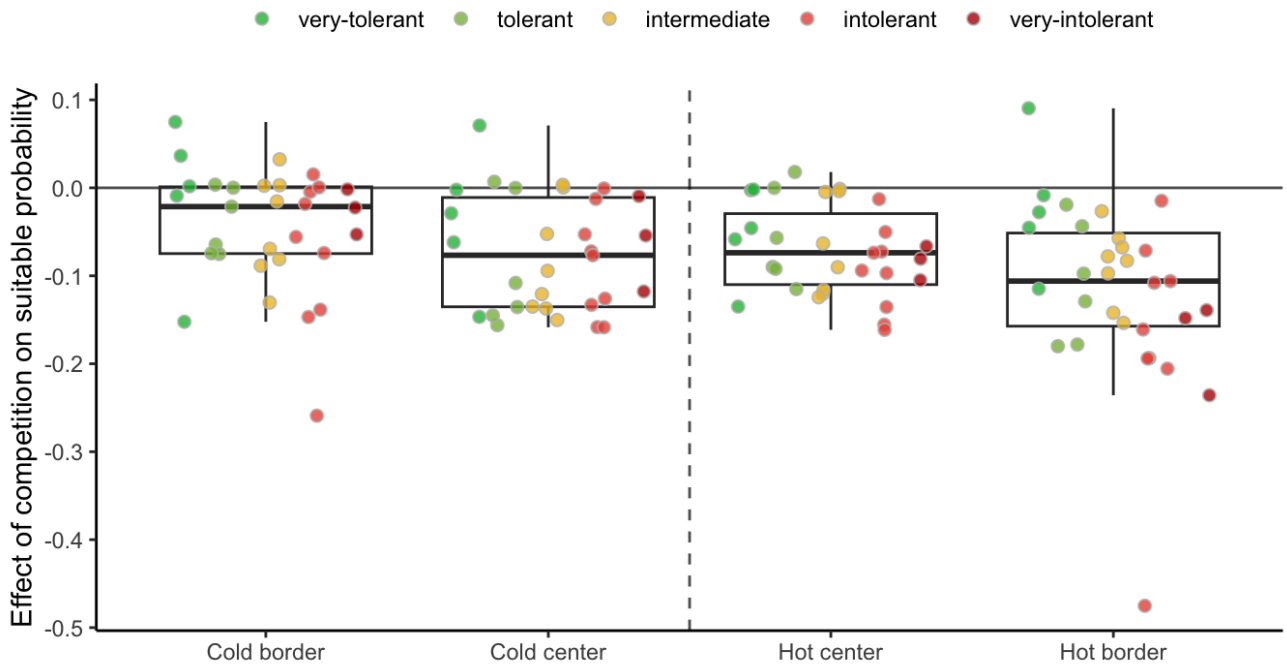

Figure 1: The effect of competition on suitable probability across the four range positions. We assessed the competition effect by subtracting suitable probability under heterospecific to suitable probability under no competition. A positive relative difference indicates an increase in suitable probability from the center towards the border, while a negative difference indicates a decrease. Each species point is color-coded based on its shade tolerance following Burns et al. (1990).

Table 1: List of species and their frequency across the dataset.

Species	Number of plots	Number of individual	Number of observation
Acer rubrum	13149	96739	235408
Abies balsamea	11932	247737	521565
Betula papyrifera	9508	78049	203500
Picea mariana	7869	186491	454246
Acer saccharum	7403	71961	184641
Picea glauca	5889	27641	65626
Populus tremuloides	5876	56010	127115
Betula alleghaniensis	5624	28872	73116
Quercus rubra	4549	18272	46341
Quercus alba	4200	20376	51466
Fagus grandifolia	3819	21784	51764
Prunus serotina	3730	12178	26464

Thuja occidentalis	3230	51312	125811
Pinus strobus	3165	15638	38470
Fraxinus americana	2885	8942	21501
Quercus velutina	2722	10068	23298
Tsuga canadensis	2604	17914	45198
Nyssa sylvatica	2436	6275	15785
Quercus stellata	2279	14707	32102
Picea rubens	2190	16580	41674
Liquidambar styraciflua	2154	11655	29671
Fraxinus pennsylvanica	2149	9048	20588
Tilia americana	2059	8415	21412
Pinus banksiana	2057	34122	75372
Populus grandidentata	2015	13759	29358
Fraxinus nigra	1951	12633	31156
Liriodendron tulipifera	1912	8580	21071
Carya tomentosa	1636	3897	10590
Carya glabra	1622	4002	9916
Quercus prinus	1590	11000	27554
Juniperus virginiana	1571	9474	21400

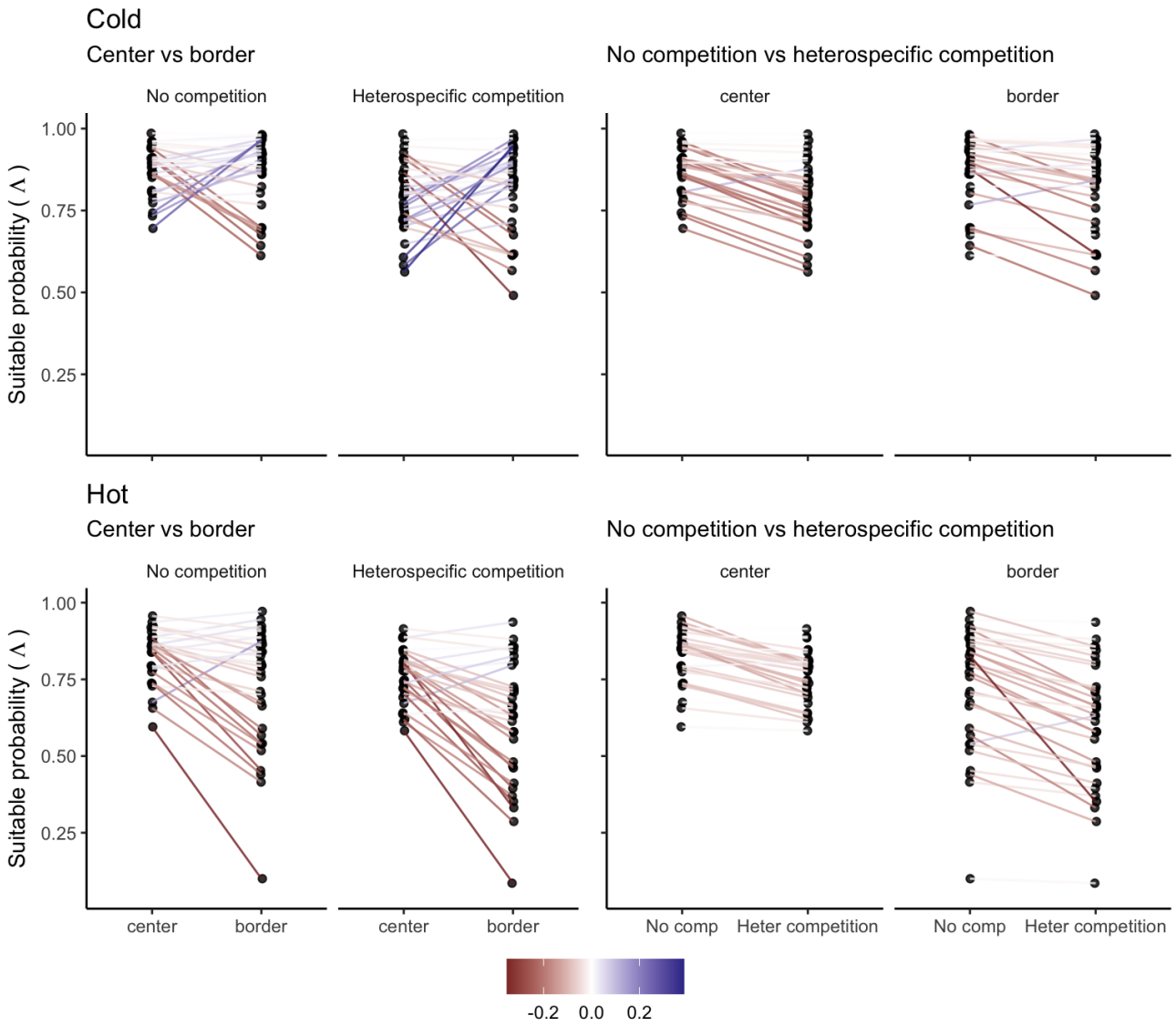

Figure 2: Difference in suitable probability between the center and border of the distribution (left panels) and no competition and heterospecific competition (right) for the cold (top) and hot (bottom) ranges. The color of the line connecting each species' conditions represents the intensity of change in suitable probability—the more intense the color, the greater the shift between conditions.

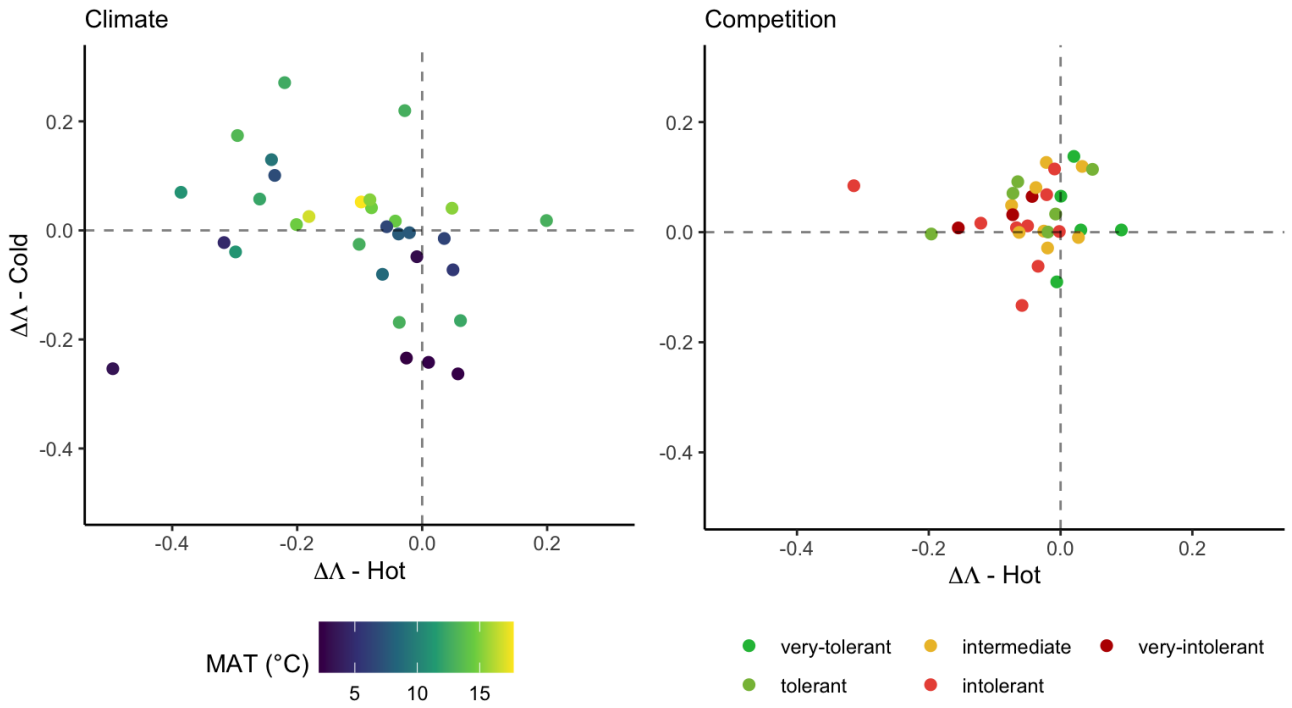

Figure 3: The relationship in the difference in suitable probability from the center to the border ($\Delta\Lambda$) between the cold and hot borders. A species at the bottom-left area (both $\Delta\Lambda$ are negative) indicates an unimodal decrease in suitable probability at the borders. Conversely, species at the top-right square exhibit an inverse unimodal shape. In the top-left or bottom-right areas, suitable probability linearly decreases or increases from the cold toward the hot border, respectively. For the climate effect (left panel), species are colored following the centroid mean annual temperature among all observed plots. In the climate effect (left panel), species are color-coded based on the centroid of mean annual temperature among all observed plots. In the competition effect (right panel), species are classified by shade tolerance following Burns et al. (1990).

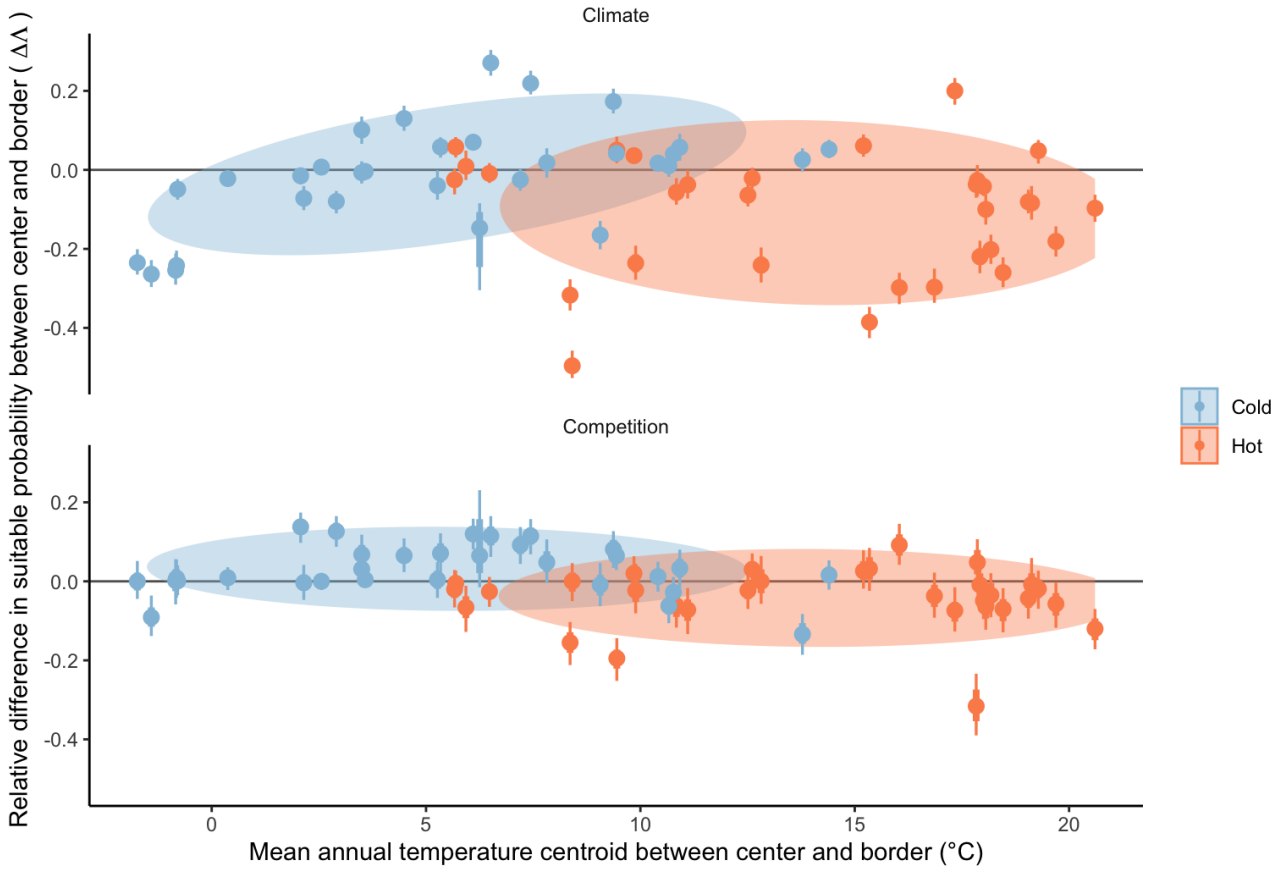

Figure 4: Relative difference in suitable probability between the center and border for climate and competition for 31 species located over the mean annual temperature gradient. Species points are grouped by a Multivariate Normal Density function with 75% probability.

0.2 Supplementary Material 2

The complete figures for the model fit for each species is available in the following link: https://willvieira.github.io/book_forest-demography-IPM/extinction_risk.html#appendices.

Each figures represents the model fit and the estimation of suitable probability for the cold and hot ranges for each of the 31 eastern North American tree species. The model's average line and 90% prediction intervals are estimated using 500 draws from the posterior distribution. The vertical dotted line represents the range limits of the observed mean annual temperature in the dataset.

References

Burns, R. M., B. H. Honkala, and others. 1990. Silvics of north america: 1. Conifers; 2. Hardwoods agriculture handbook 654. US Department of Agriculture, Forest Service, Washington, DC.