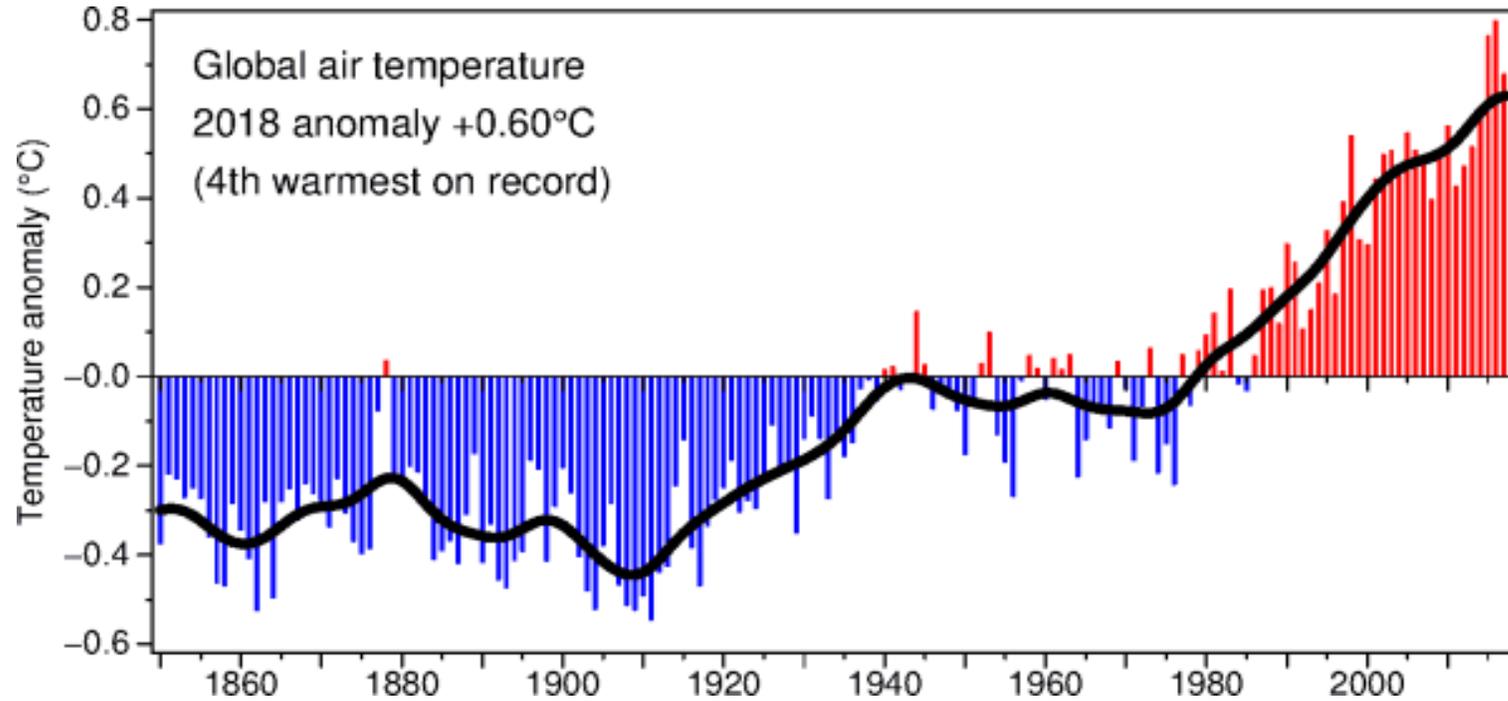


Space-for-time inferences about range-edge dynamics of tree species can be influenced by sampling biases

倪明 Ming Ni and Mark Vellend





Are plants migrating in response to climate change?

Using ontogenetic differences to infer tree migration

Sign of tree migration

Sign of range contraction

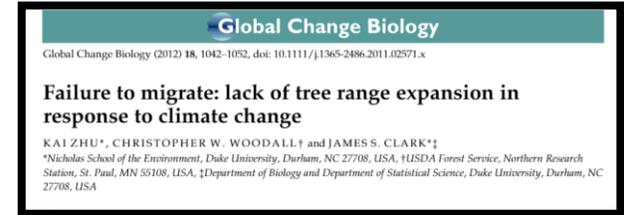
**Supported
by multiple
studies!**

Juvenile trees

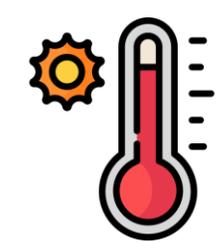
Adult trees
Juvenile trees

Adult trees

Temperature/Latitude

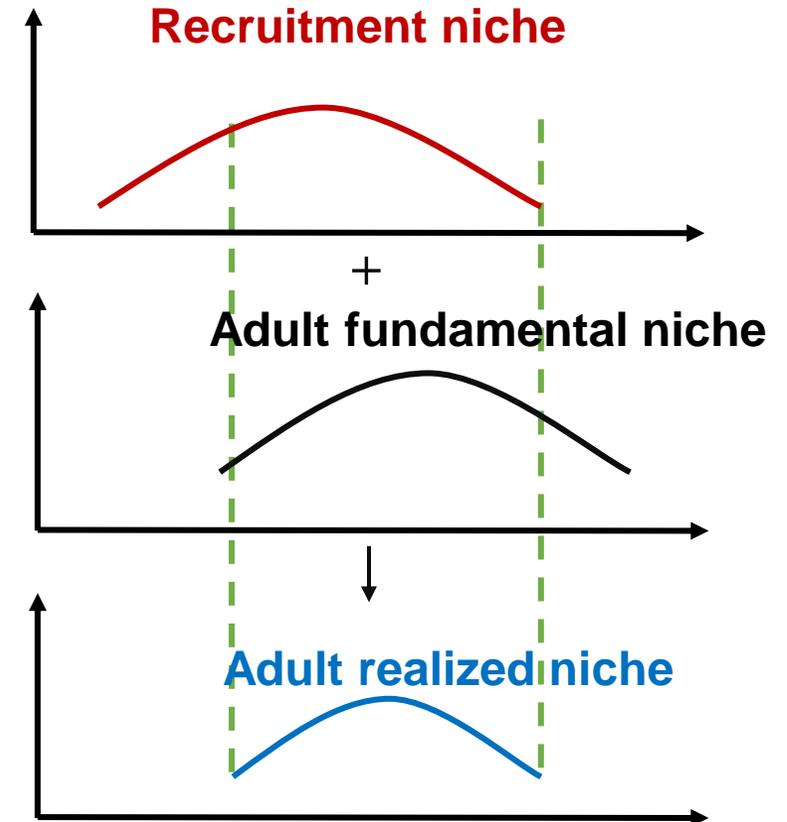
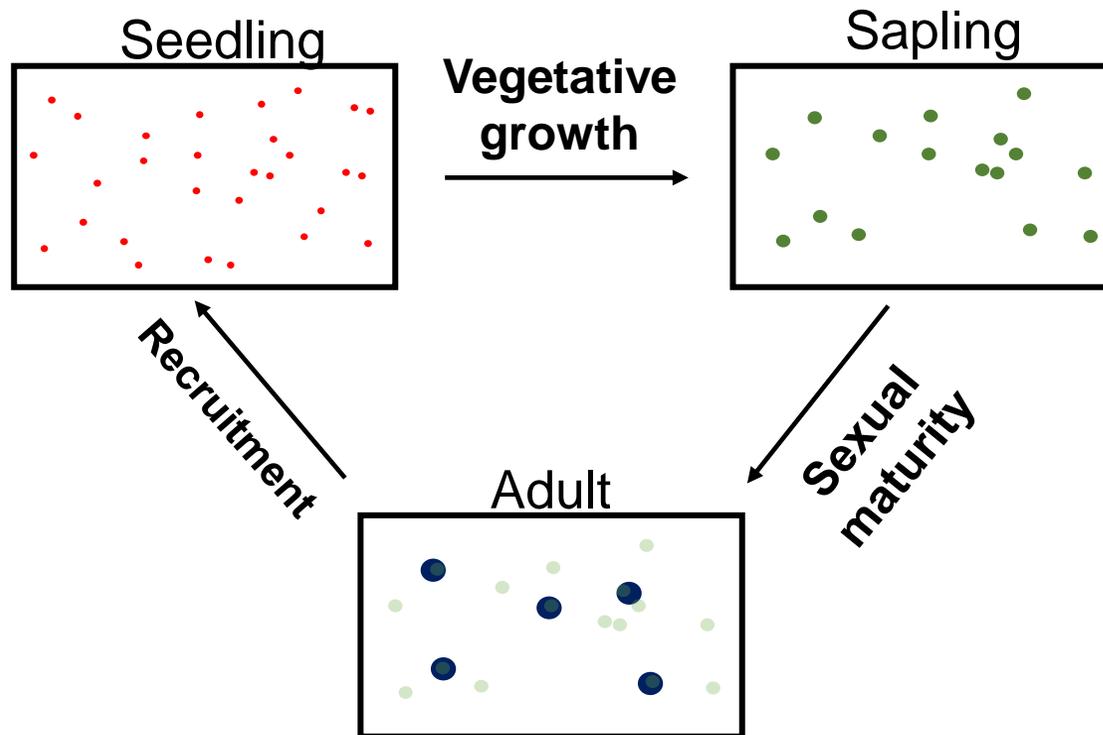


Juveniles contract behind current adult ranges



Problem 1: Intrinsic ontogenetic niche shifts

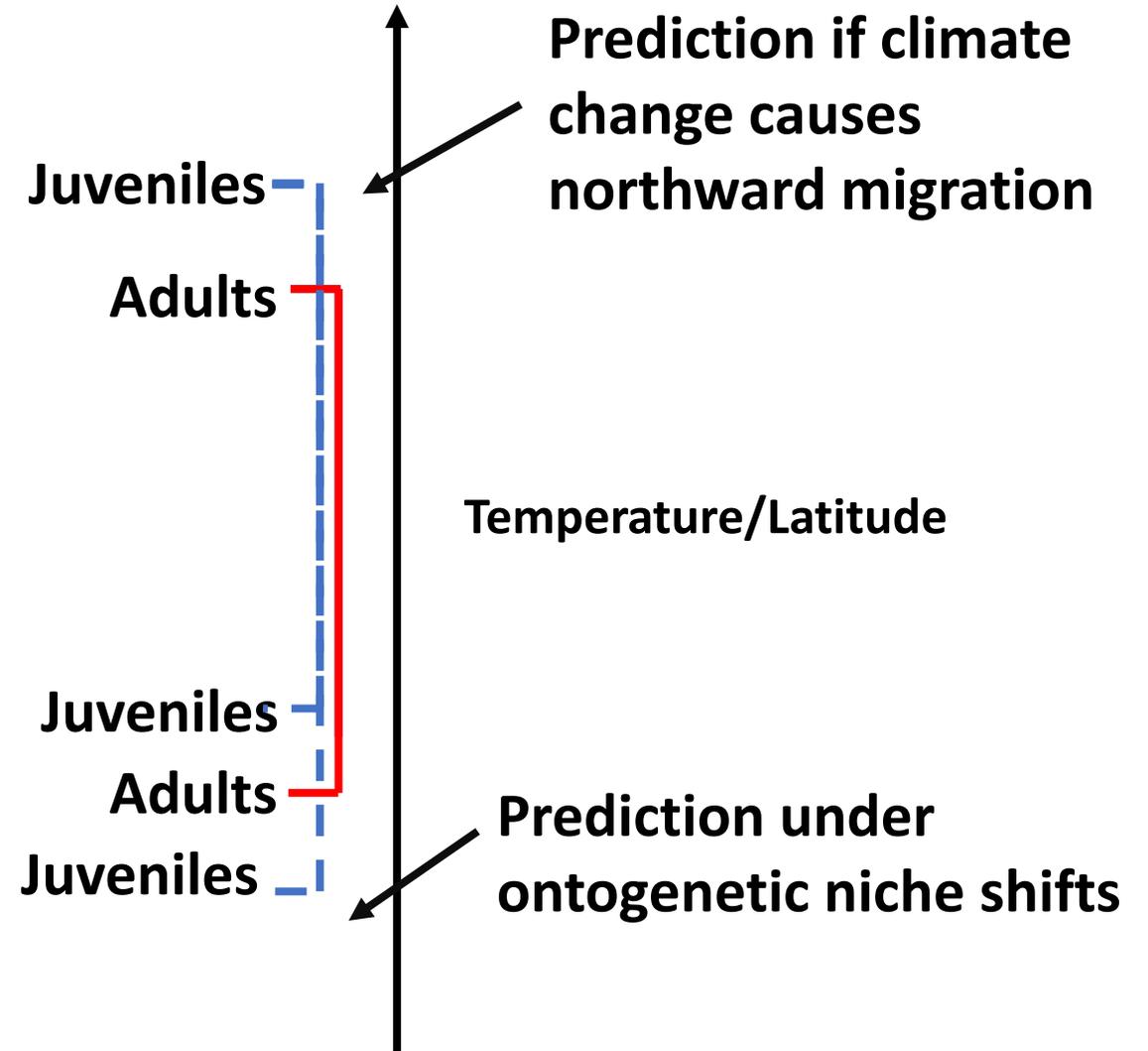
Ontogenetic niche contraction - Juveniles occur in habitats where seeds have arrived and germinated but where conditions are not suitable for adults



Ontogenetic niche expansion - Seedling regeneration can require specific conditions (e.g., fire), but once plants have established environments can change over time without killing adults

Do intrinsic ontogenetic niche shifts influence latitudinal differences in the distributions of juvenile vs. adult trees?

— — — — — Juvenile range
— Adult range



Problem 2: Different life stages are not equally represented in forest inventory datasets

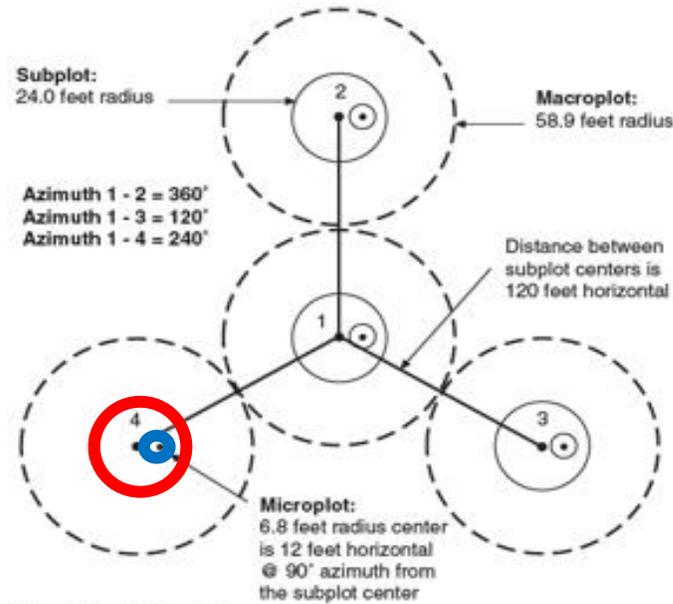
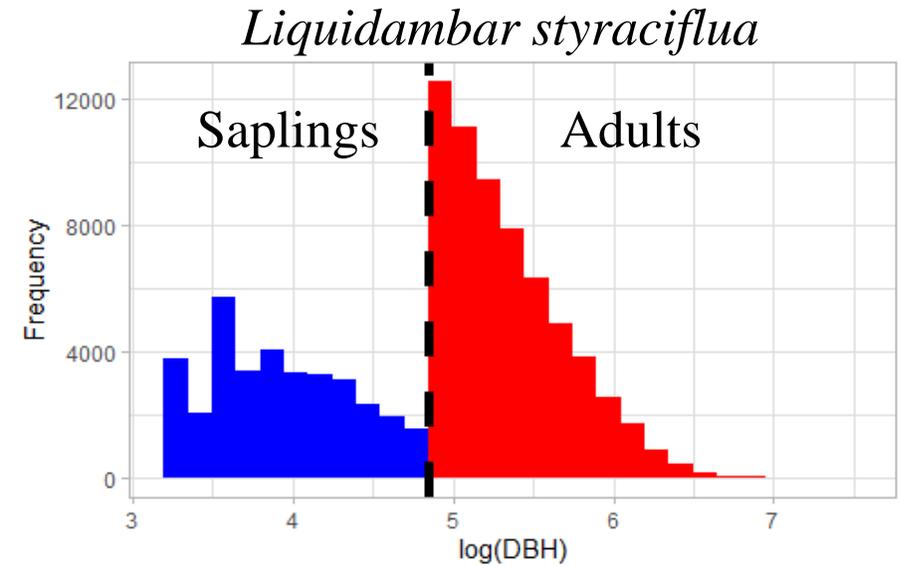
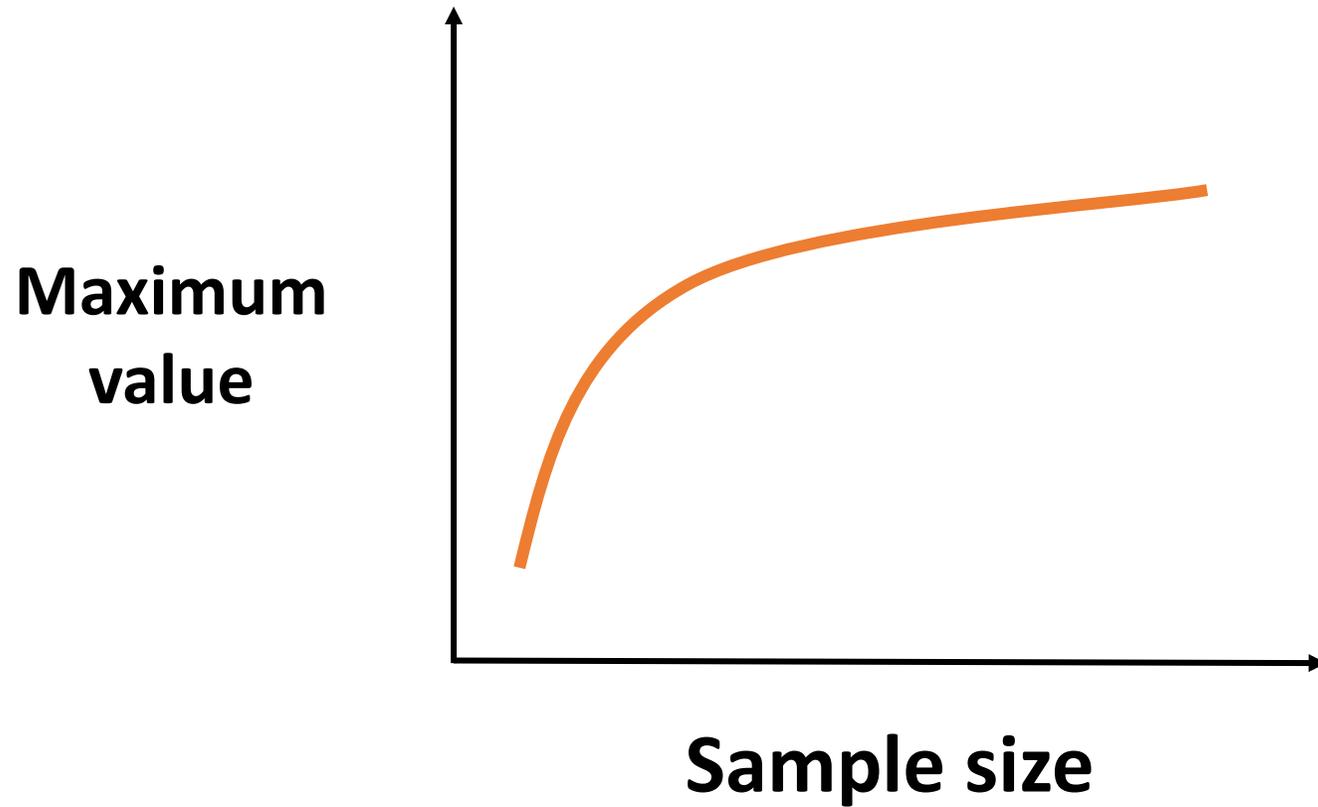


Figure 3.1—FIA plot design.



USA Forest inventory and analysis (FIA) plot:
red for adult trees, blue for saplings/seedlings.

Might sampling differences bias ontogenetic comparisons?

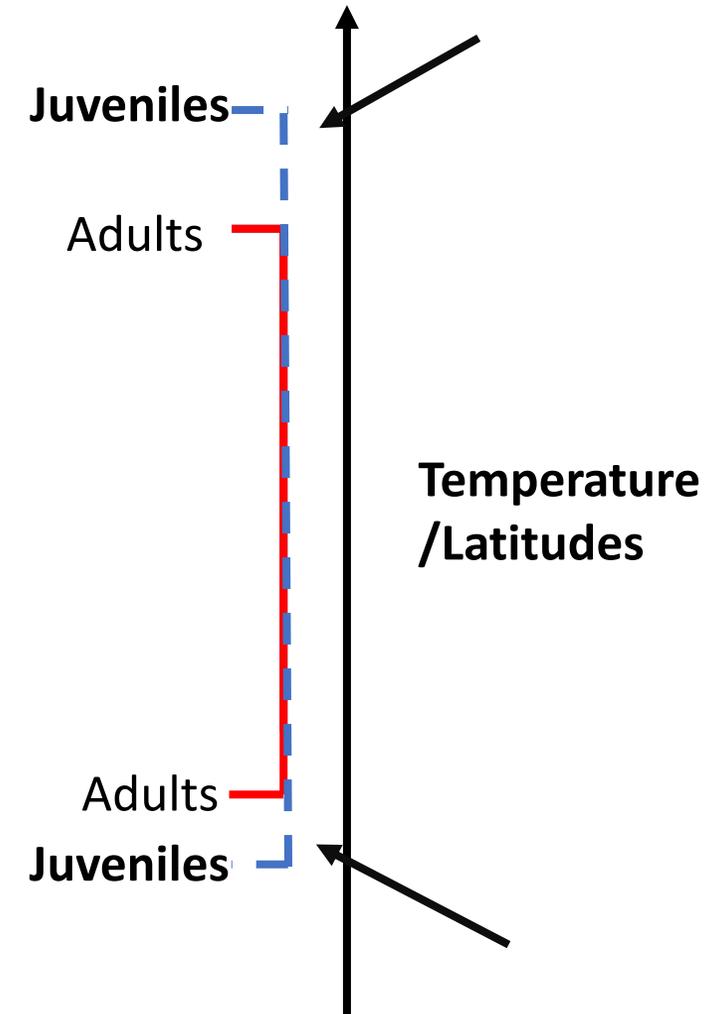


Range/niche limits are estimated by sample **extreme values**, such as maximum value/95th percentile, which can be influenced by sampling size.

Hypotheses:

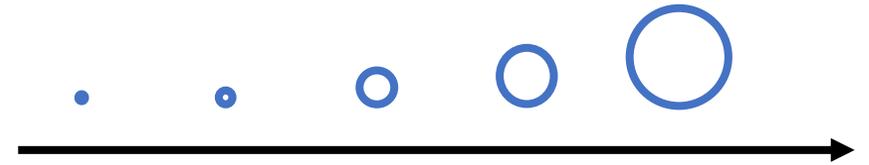
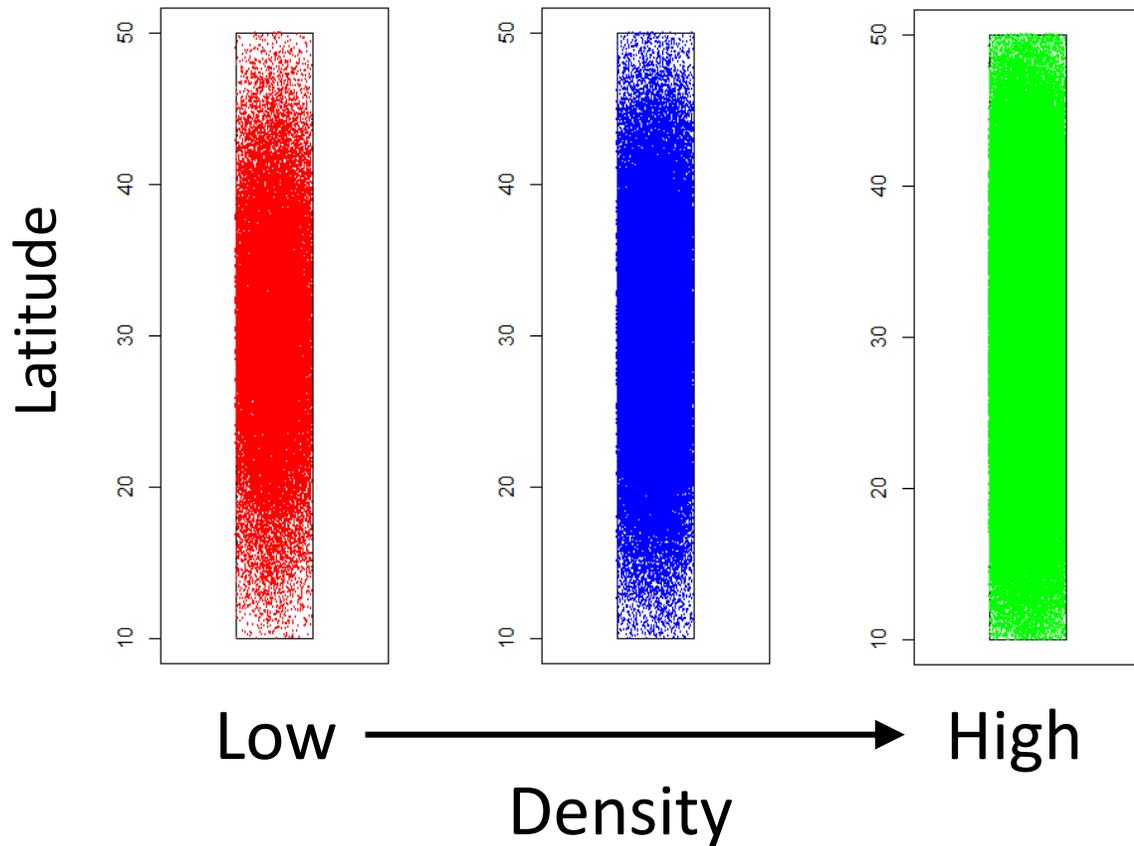
1. The estimated extent of population range limits increases with sampling intensity.
2. For most species, after **controlling for sampling biases**, **juvenile trees will generally show wider latitudinal/niche limits than adults** at both upper/lower range limits because of ontogenetic niche shifts.

Prediction:



Methods 1 : Spatial simulations

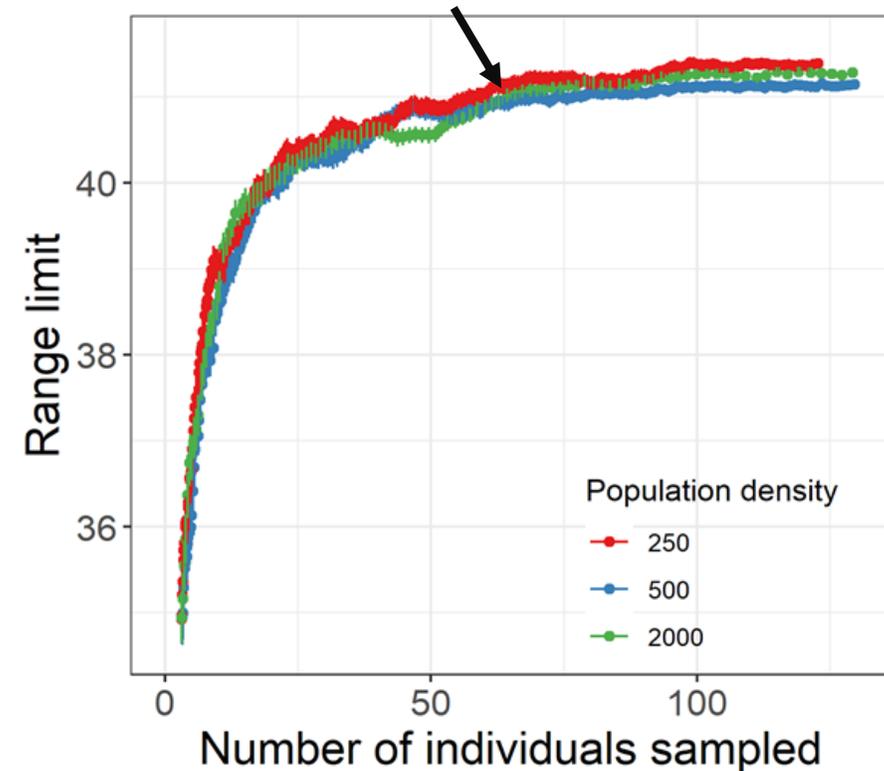
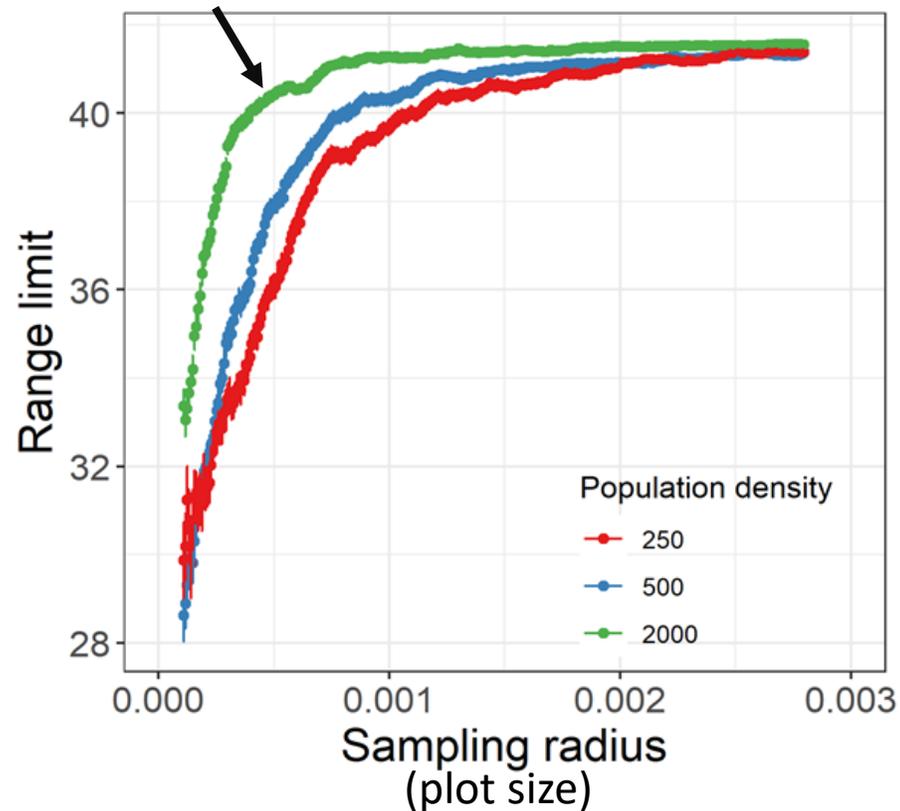
Constant range limits, different densities
(because juveniles have higher density)



Use different plot sizes (**100 radii in total**) to simulate empirical estimation of ranges limits

Results:

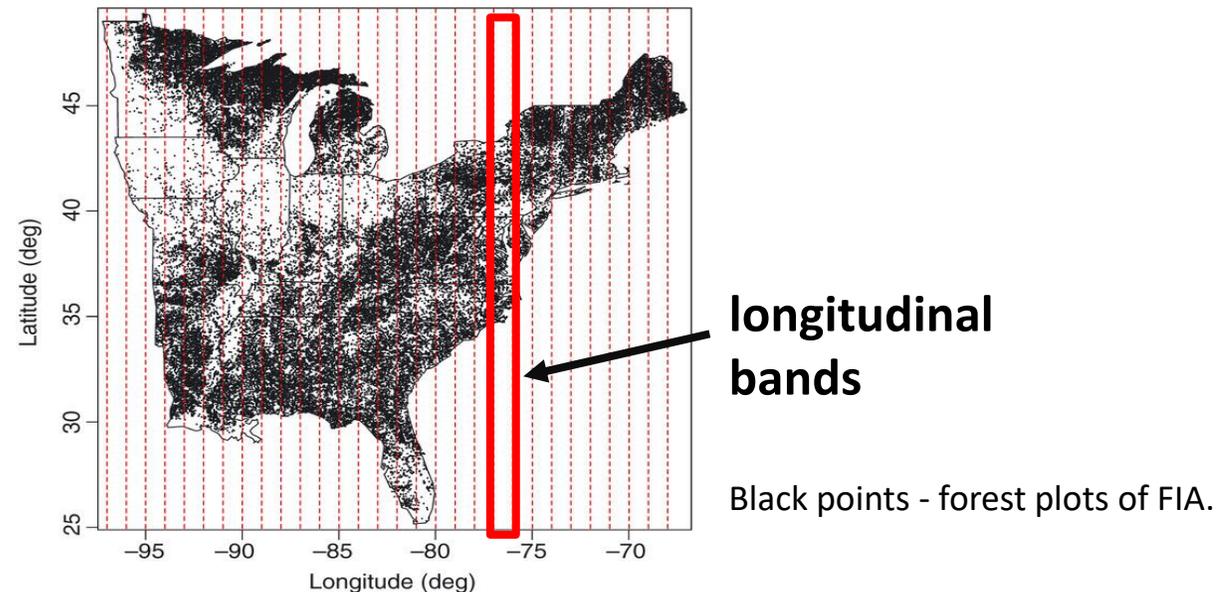
- Estimated northern range limits increase with plot size
- Different densities can lead to biased estimates of range limits
- Controlling for the number of individuals sampled can correct for this



Methods 2 : Empirical comparison of latitudinal limits between saplings and adults

Data: 92 native tree species: (1) **saplings** and (2) **adults** (dbh > 12.7 cm) from FIA

Range comparisons: in 1° wide longitudinal bands, calculate **5th** and **95th** percentiles of **latitudinal occurrences**; compare saplings and adults.

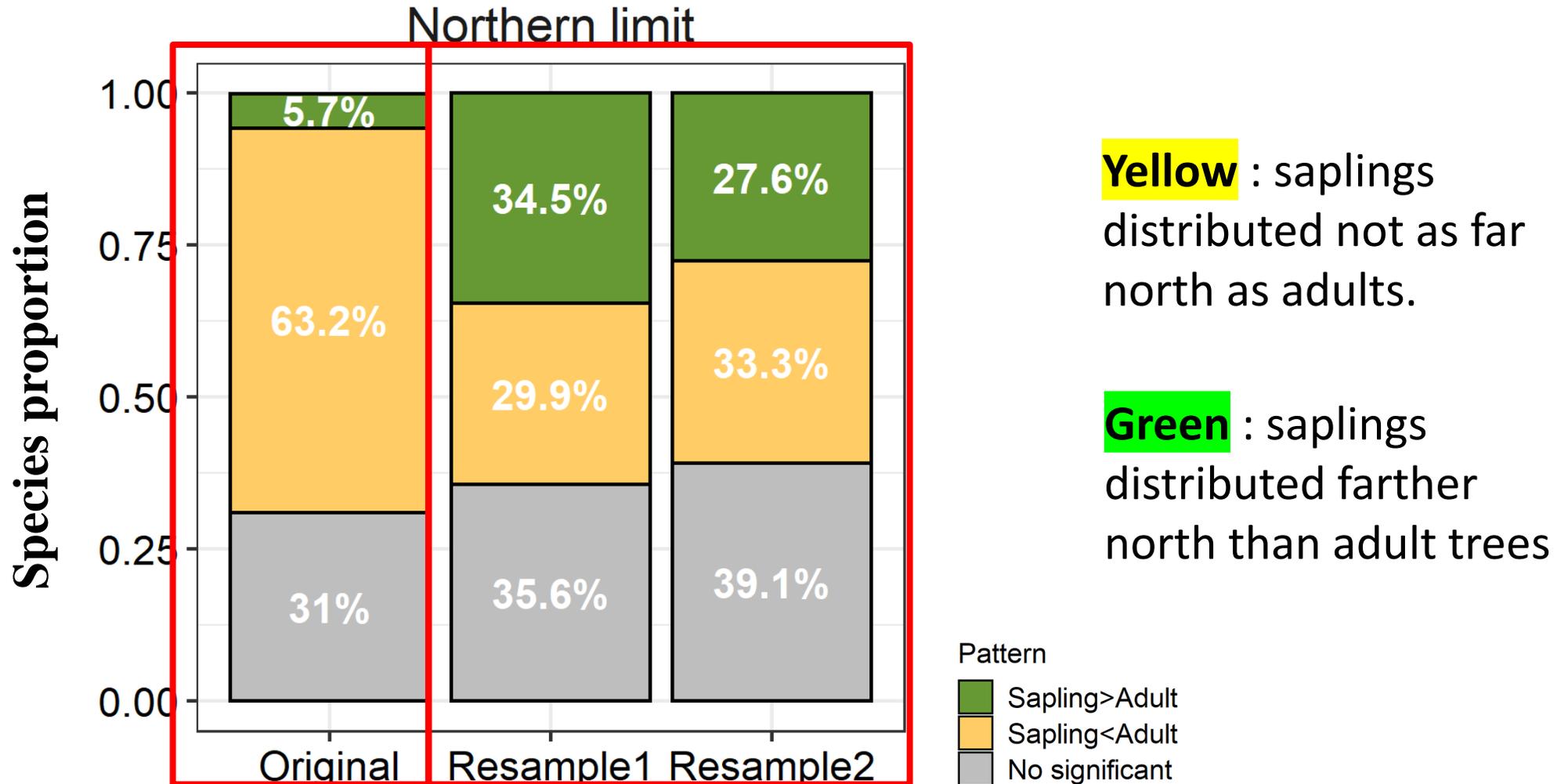


Resampling to account for sampling bias

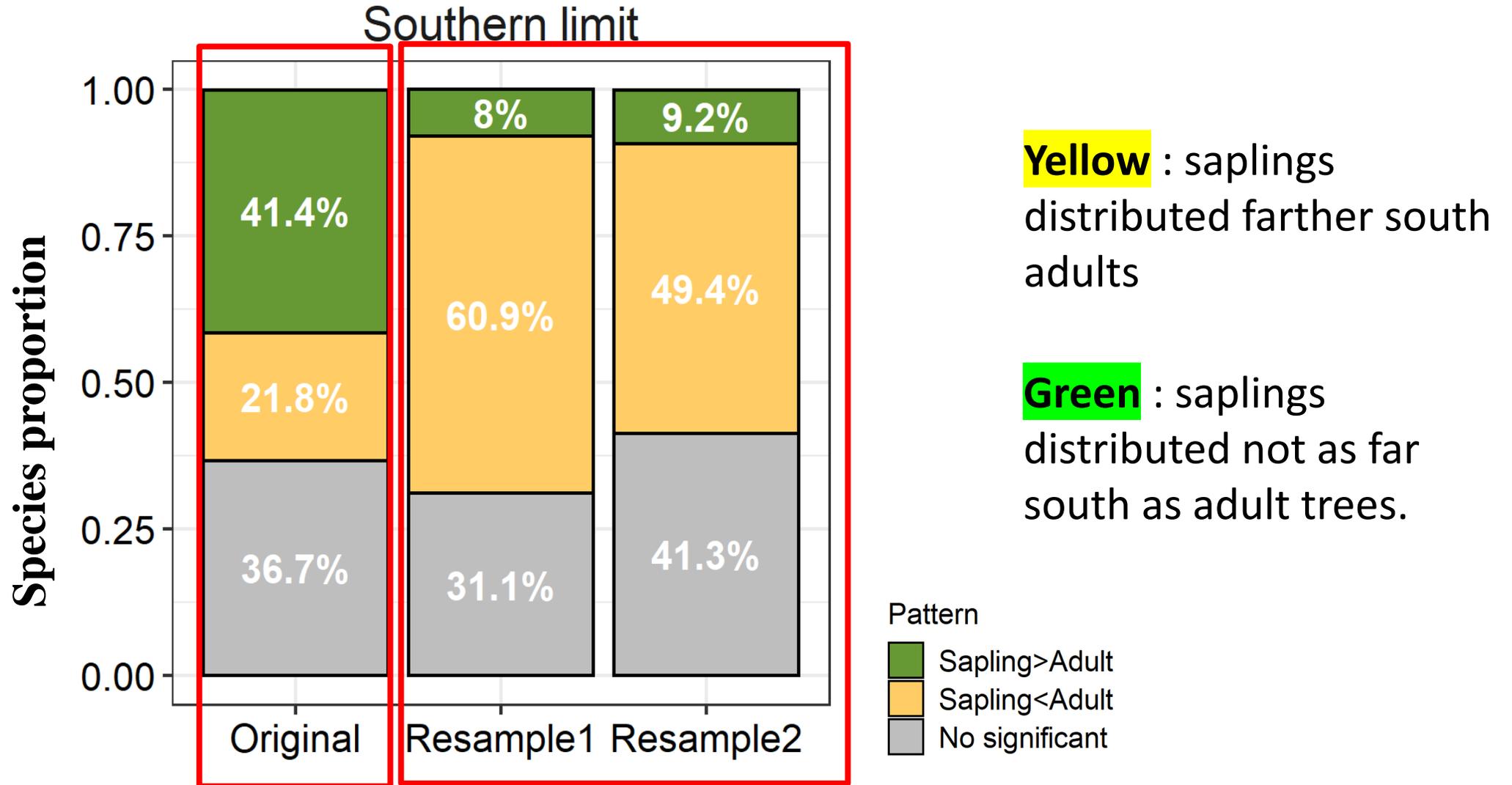
Resample1 randomly resampled 8% of adult individuals (across all species) in each plot, which **equalizes the sampling area** for the two life stages.

Resample2 randomly resampled adult trees or saplings (across all species) to force them to have the **same number** of individuals in each plot.

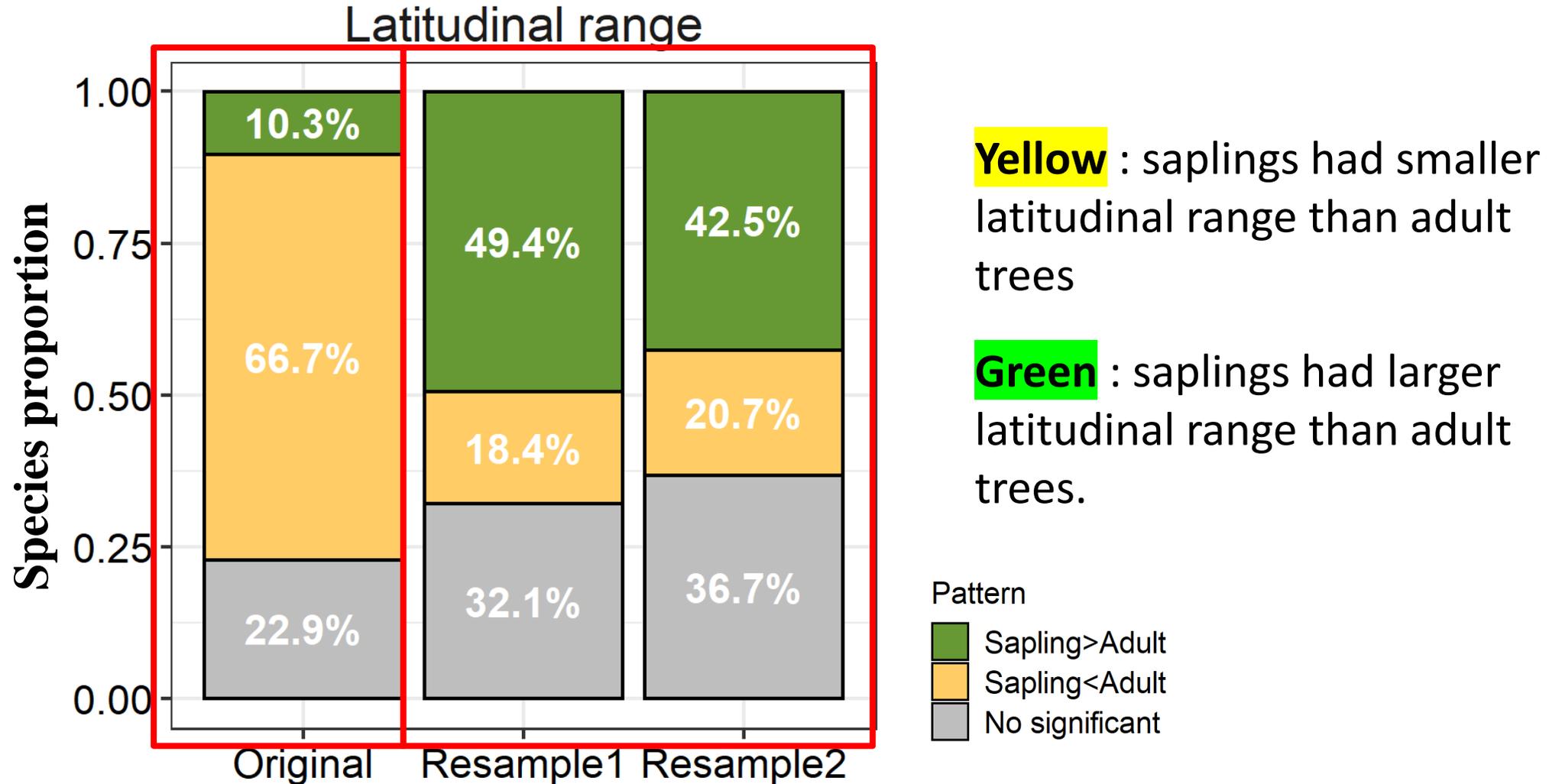
Results - Latitudinal limit comparison: Juvenile trees were not contracting at northern range limits after controlling for samplings bias.



Latitudinal limit comparison: Juvenile trees were distributed farther south than adults at southern range limits after controlling for samplings bias.



Latitudinal range comparison: Juvenile trees had wider latitudinal distributions after controlling for samplings bias



Conclusion

PRIMARY RESEARCH ARTICLE

Global Change Biology WILEY

Space-for-time inferences about range-edge dynamics of tree species can be influenced by sampling biases

Ming Ni  | Mark Vellend

1. For two populations or life stages with the same true range limits, estimated range limits appear broader with larger sampling areas or individual densities.

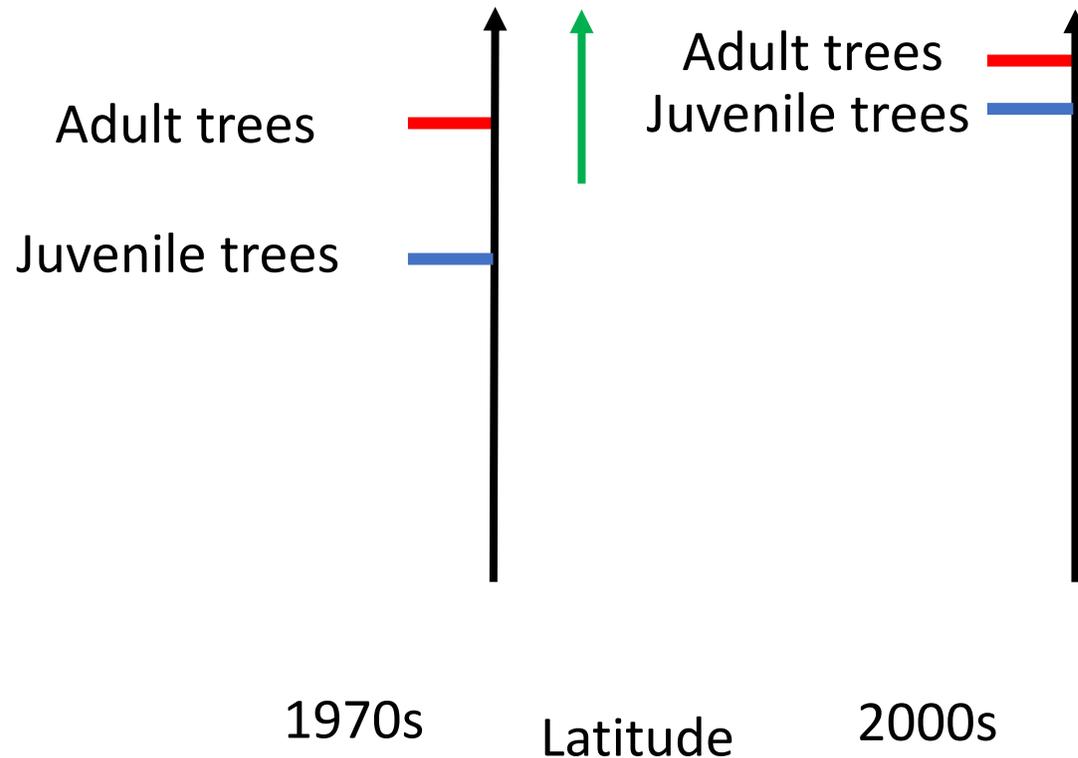
2. After controlling for the number of individuals sampled, we see that species intrinsic ontogenetic differences could influence the differences in geographic range limits between saplings and adult trees, especially at southern range limits in the FIA dataset. **These analyses call into question previous results suggesting that tree species ranges are contracting in response to climate change.**

Tree range expansion in eastern North America fails to keep pace with climate warming at northern range limits

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Temporal changes
in range limit





RESEARCH ARTICLE | ECOLOGY |



North American tree migration paced by climate in the West, lagging in the East

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