Gap dynamics help to maintain functional tradeoffs in Neotropical forest succession

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Fast growers

Grow fast, survive worse

Slow growers

Grow slow, survive well

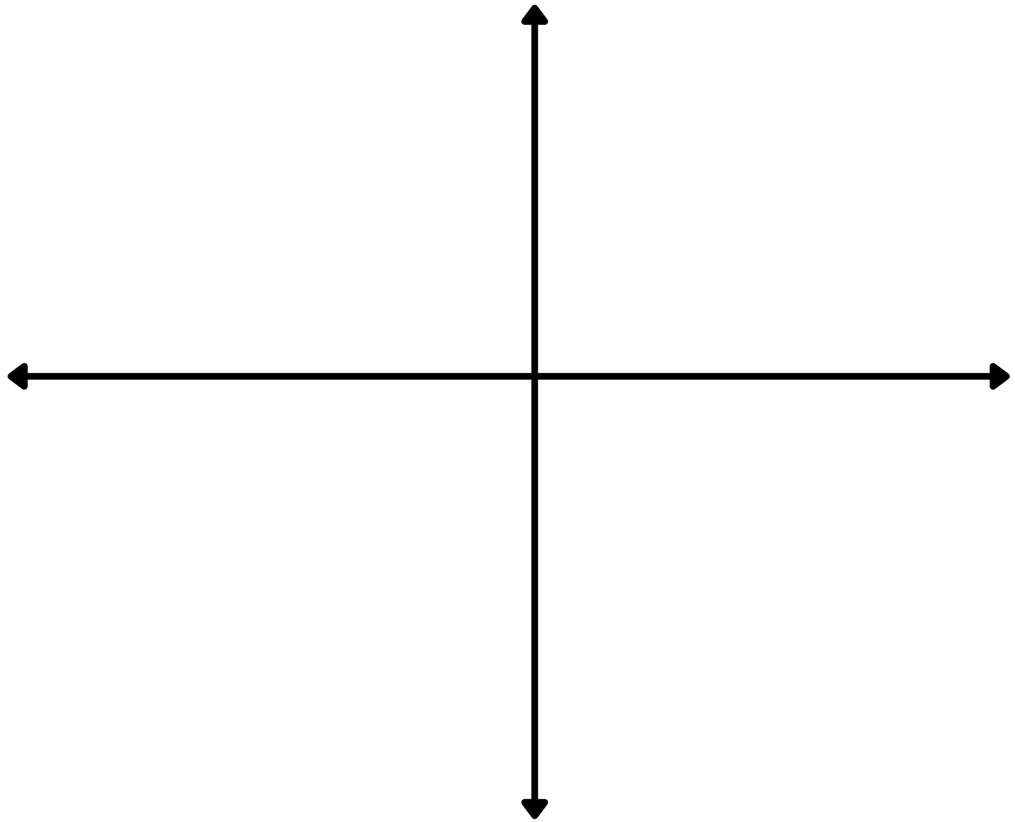
Rüger et al. 2020

Long lived pioneers

Grow fast, survive well, reproduce less

Fast growers

Grow fast, survive worse



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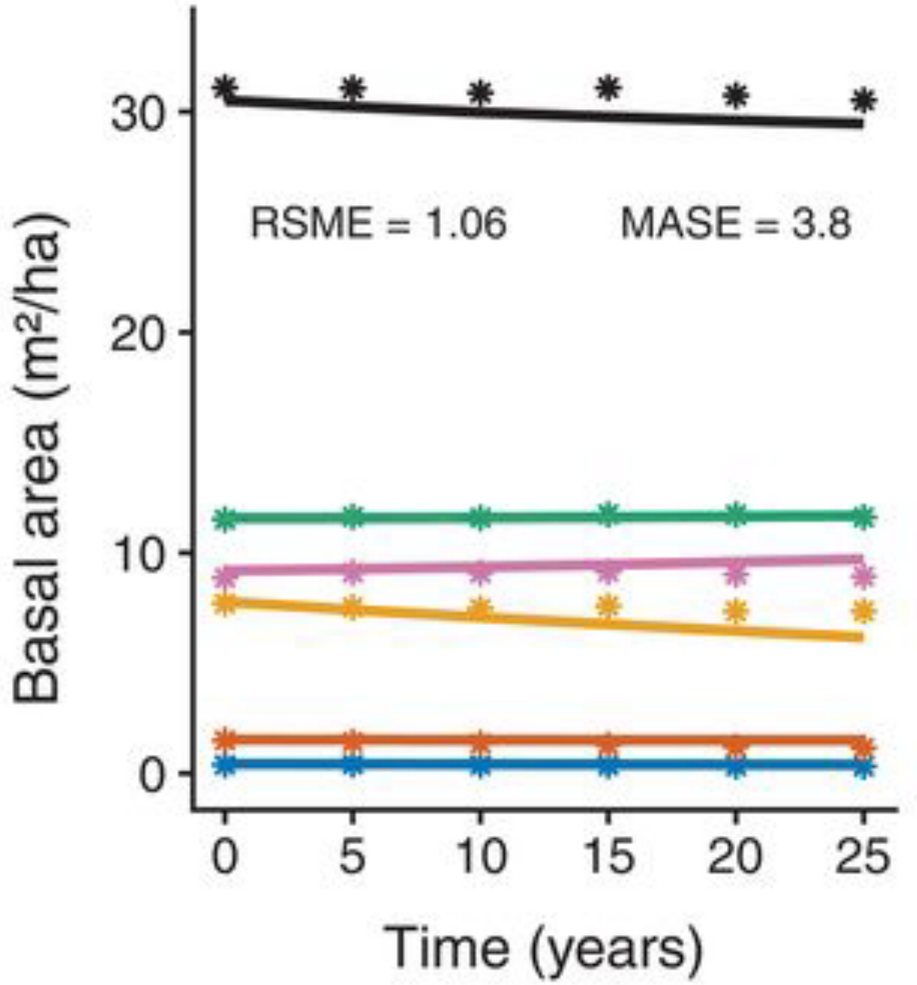
Intermediate growers

Grow, survive, reproduce intermediately

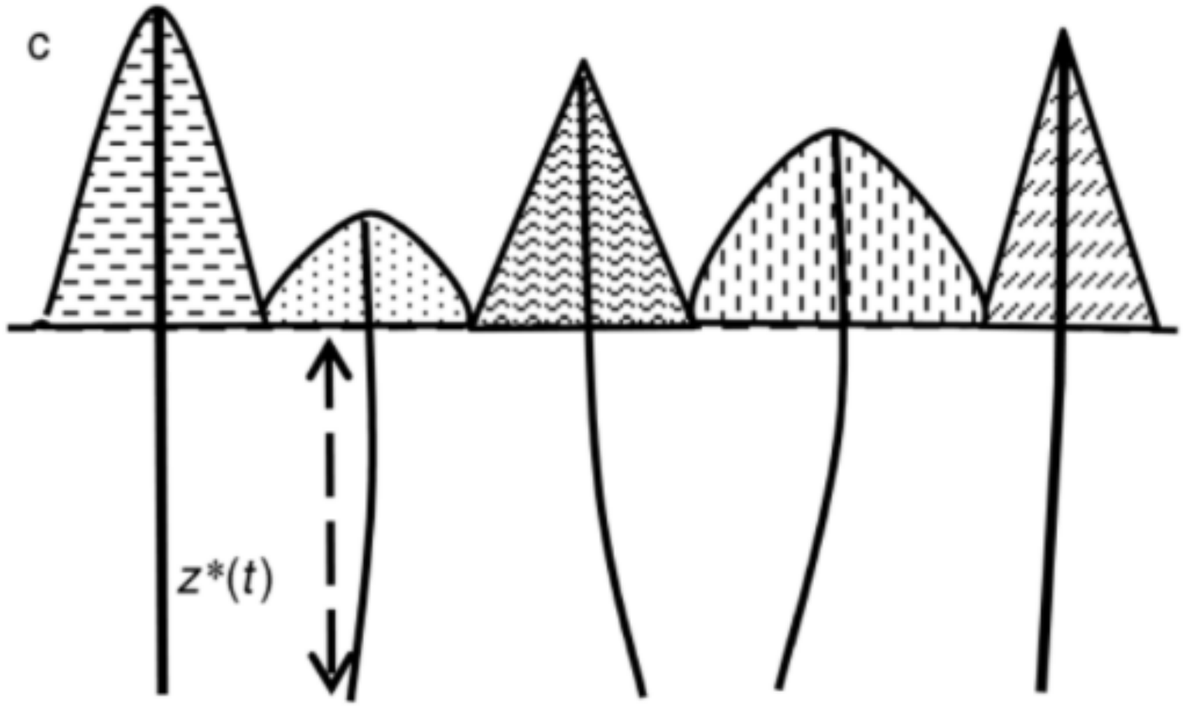
Total



Rüger et al. 2020

We found that gap dynamics can help maintain and stabilize coexistence when niche differences between species are taken into account.

Can the coexistence of different demographic strategies observed in the Neotropics be maintained through gap dynamics and height-structured competition for light?



Strigul et al. 2008

Forest dynamics
Perfect Plasticity
Approximation model

Metacommunity structure

Forest dynamics
Perfect Plasticity Approximation model

Density dependent reproduction

Metacommunity structure

Forest dynamics
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Stochastic, stand-clearing gap disturbances

Density dependent reproduction

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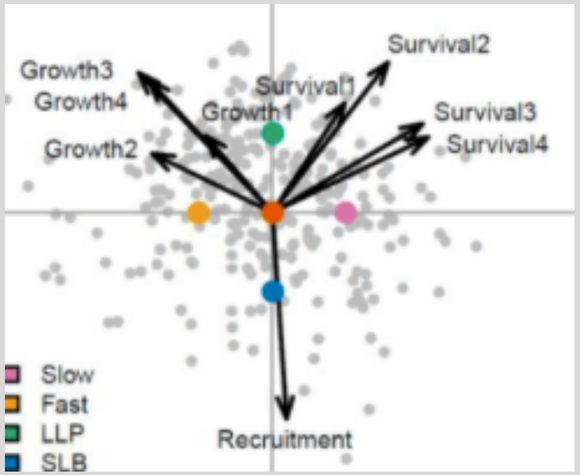
Forest dynamics
Perfect Plasticity Approximation model

Empirical parameterization



Stochastic, stand-clearing gap disturbances

Density dependent reproduction

Metacommunity structure

Forest dynamics
Perfect Plasticity Approximation model

Rüger et al. 2020

Model analyses with multiple stochastic runs, tracking the abundance of each strategy over time.

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Comparison of patch-level gap recovery to empirical data (Farrior et al. 2016).

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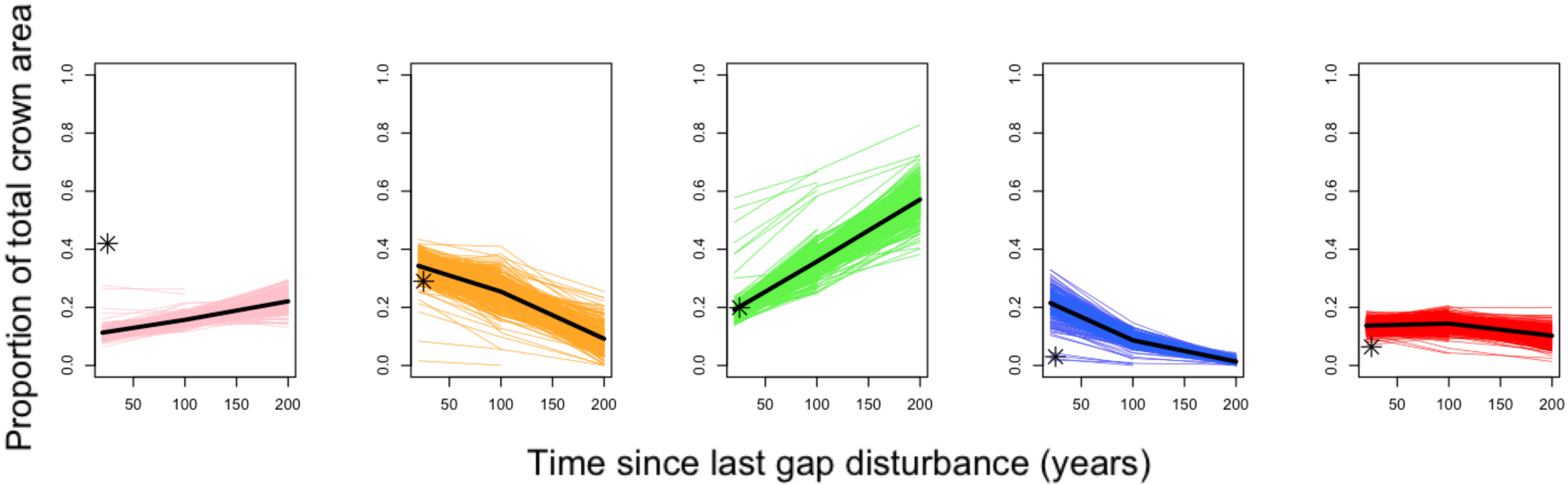
Comparison of patch-level gap recovery to empirical data (Farrior et al. 2016).

Coexistence time = Time when the first extinction of a seeded strategy occurs

Run with stabilized coexistence = $\frac{CA_{sp=1,t=20000} - CA_{sp=2,t=20000}}{CA_{sp=1,t=2000} - CA_{sp=2,t=2000}} < 2$

Our model accurately captures patch-level post-gap successional patterns.



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Grow slow, survive well

Fast growers
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Long lived pioneers
Grow fast, survive well, reproduce less

Short lived breeders
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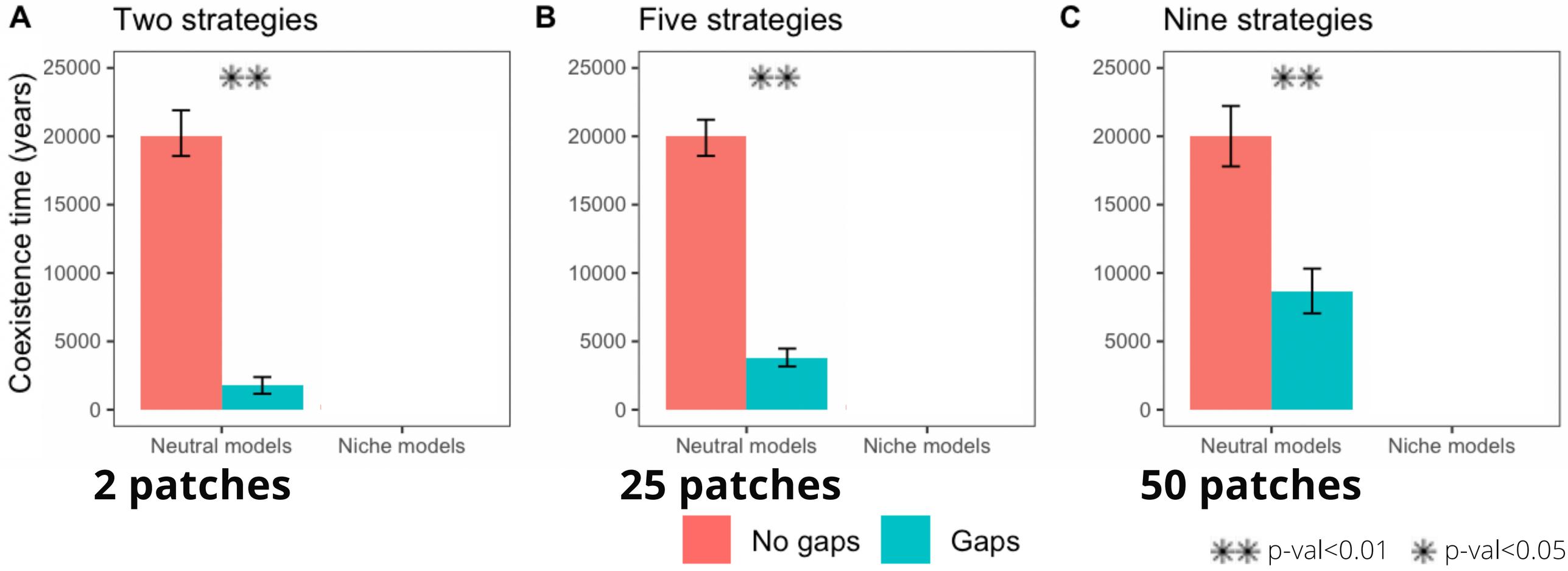
Intermediate growers
Grow, survive, reproduce intermed

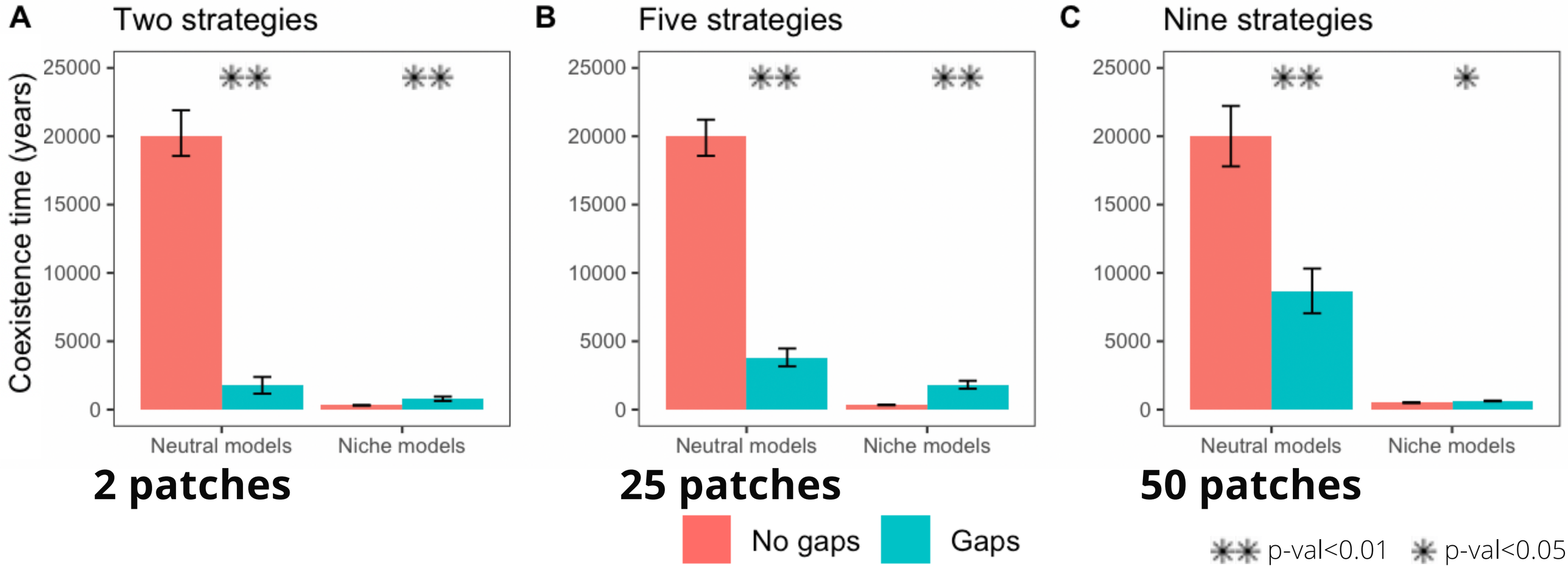
When we eliminate species differences, gaps hinder the coexistence of neutral models.

Coexistence time = Time when the first extinction of a seeded strategy occurs



When species differ from each other, gaps help maintain coexistence.

Coexistence time = Time when the first extinction of a seeded strategy occurs



Run with stabilized coexistence

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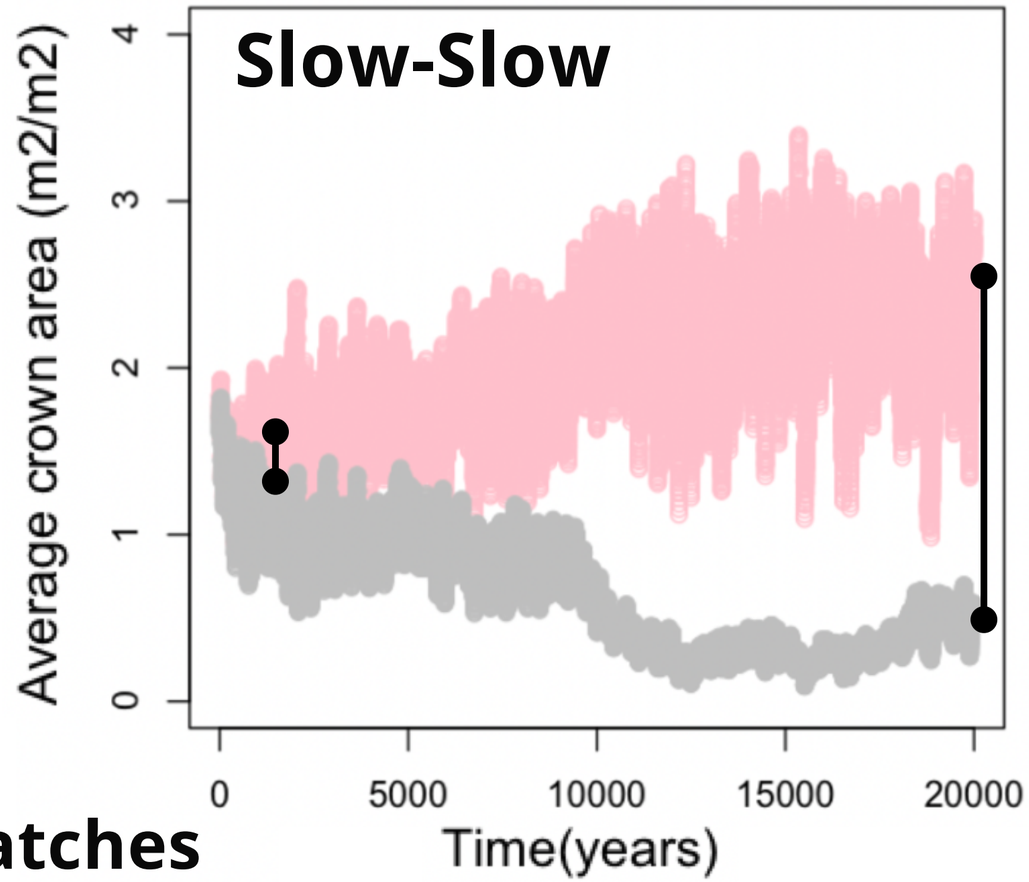
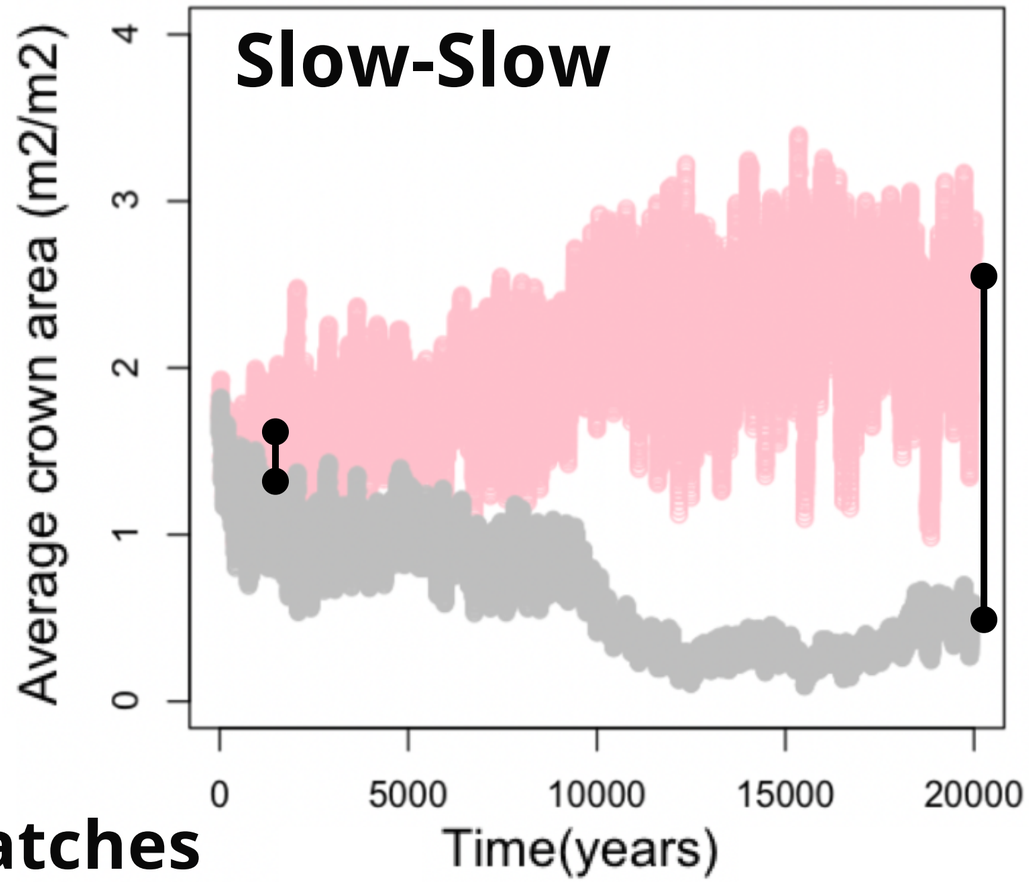
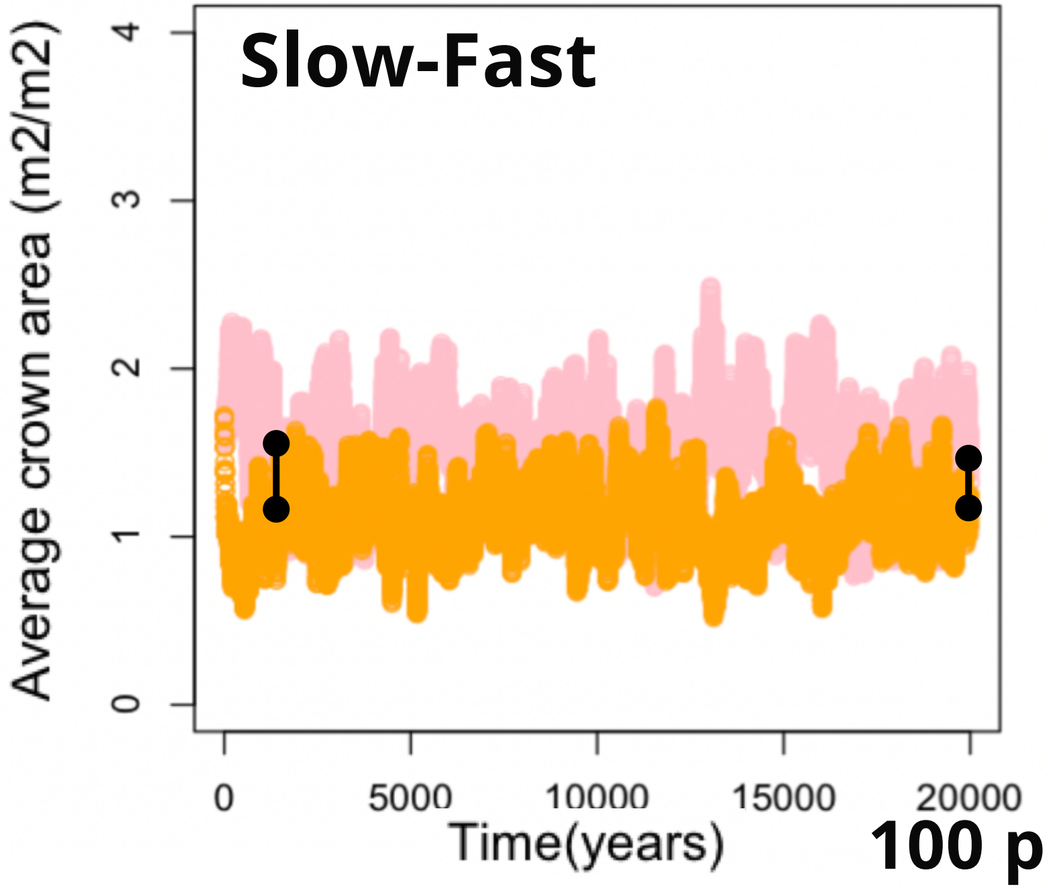


100 patches

Run with stabilized coexistence $= \frac{CA_{sp=1,t=20000} - CA_{sp=2,t=20000}}{CA_{sp=1,t=2000} - CA_{sp=2,t=2000}} < 2$



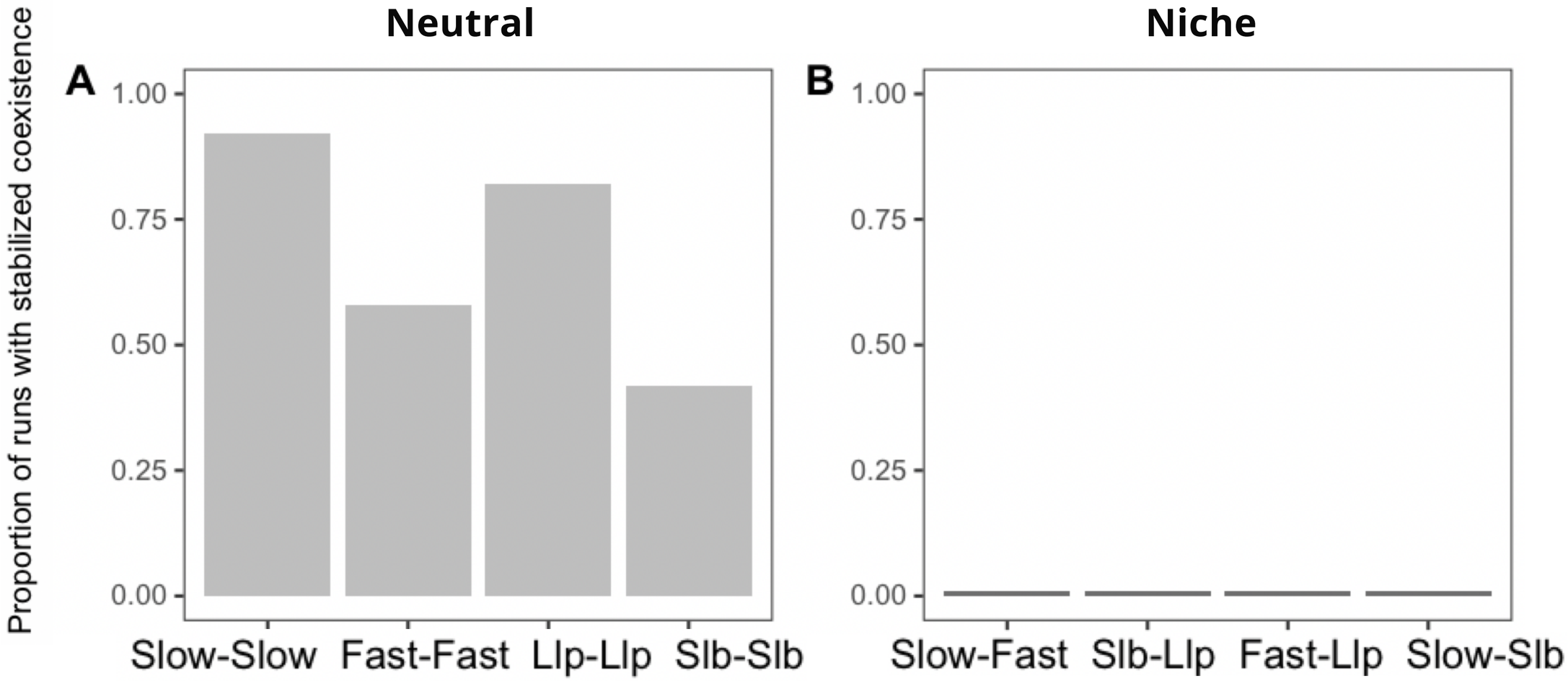


100 patches

100 patches

With a larger meta community and gap dynamics, gaps help stabilize coexistence.

Without gaps



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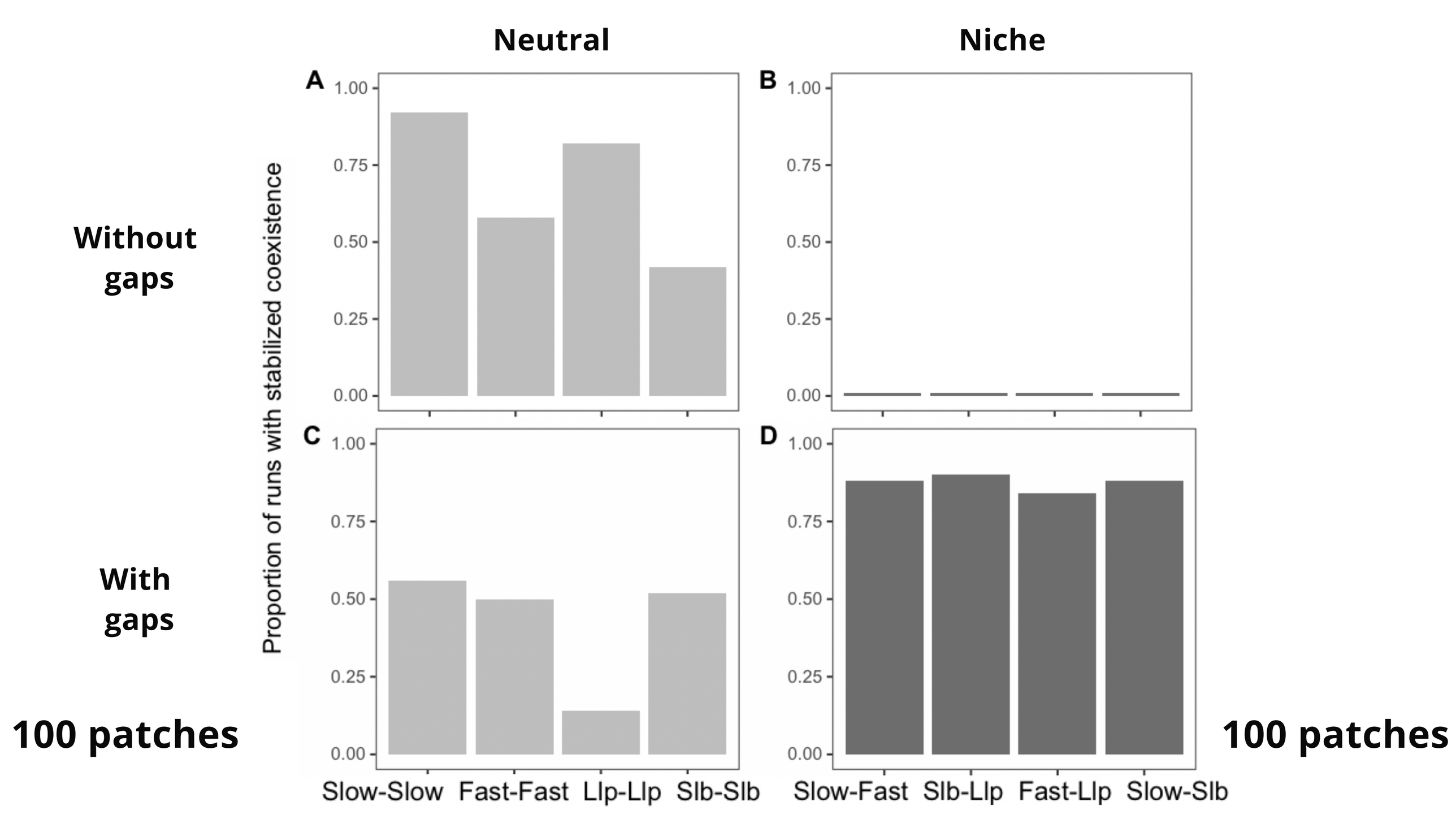
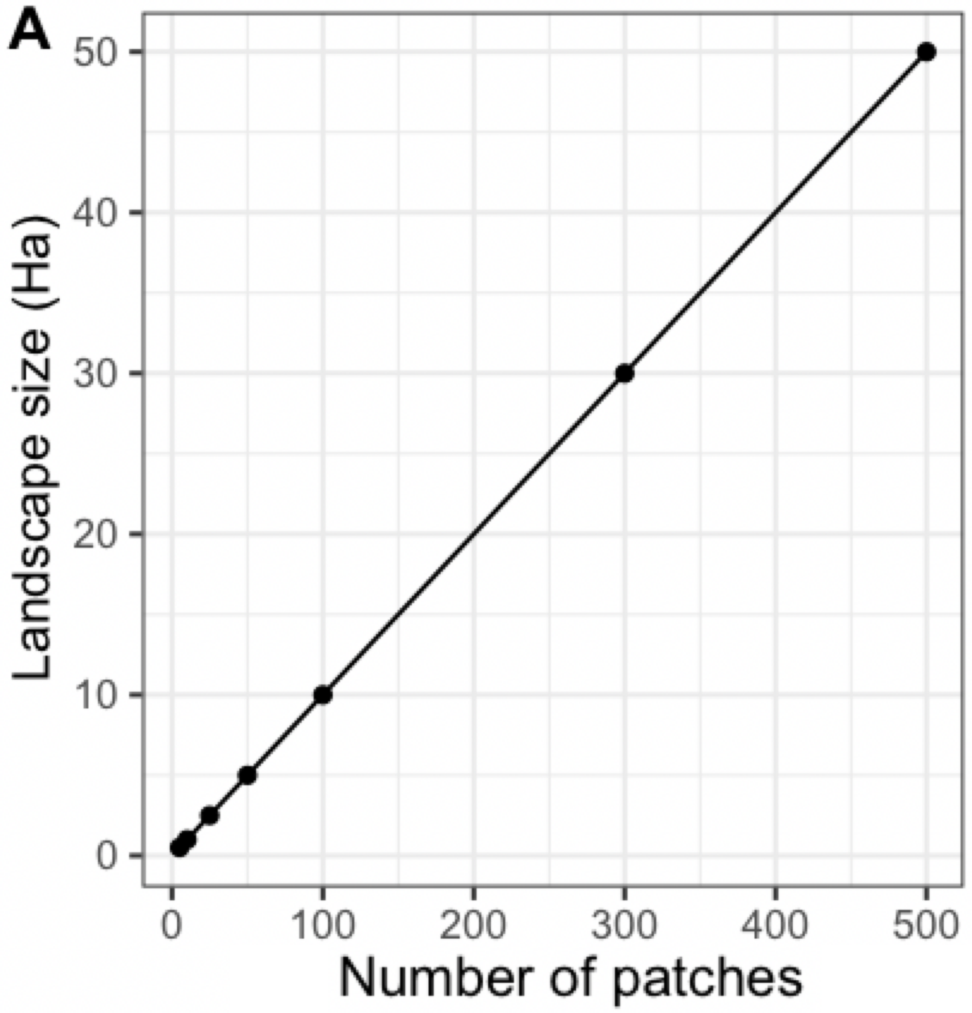

Neutral
Niche
Without gaps
With gaps
100 patches
100 patches
A
B
C
D
Proportion of runs with stabilized coexistence
1.00
0.75
0.50
0.25
0.00
Slow-Slow
Fast-Fast
Llp-Llp
Slb-Slb
Slow-Fast
Slb-Llp
Fast-Llp
Slow-Slb

In comparing five strategy neutral and niche models, metacommunity structure matters.



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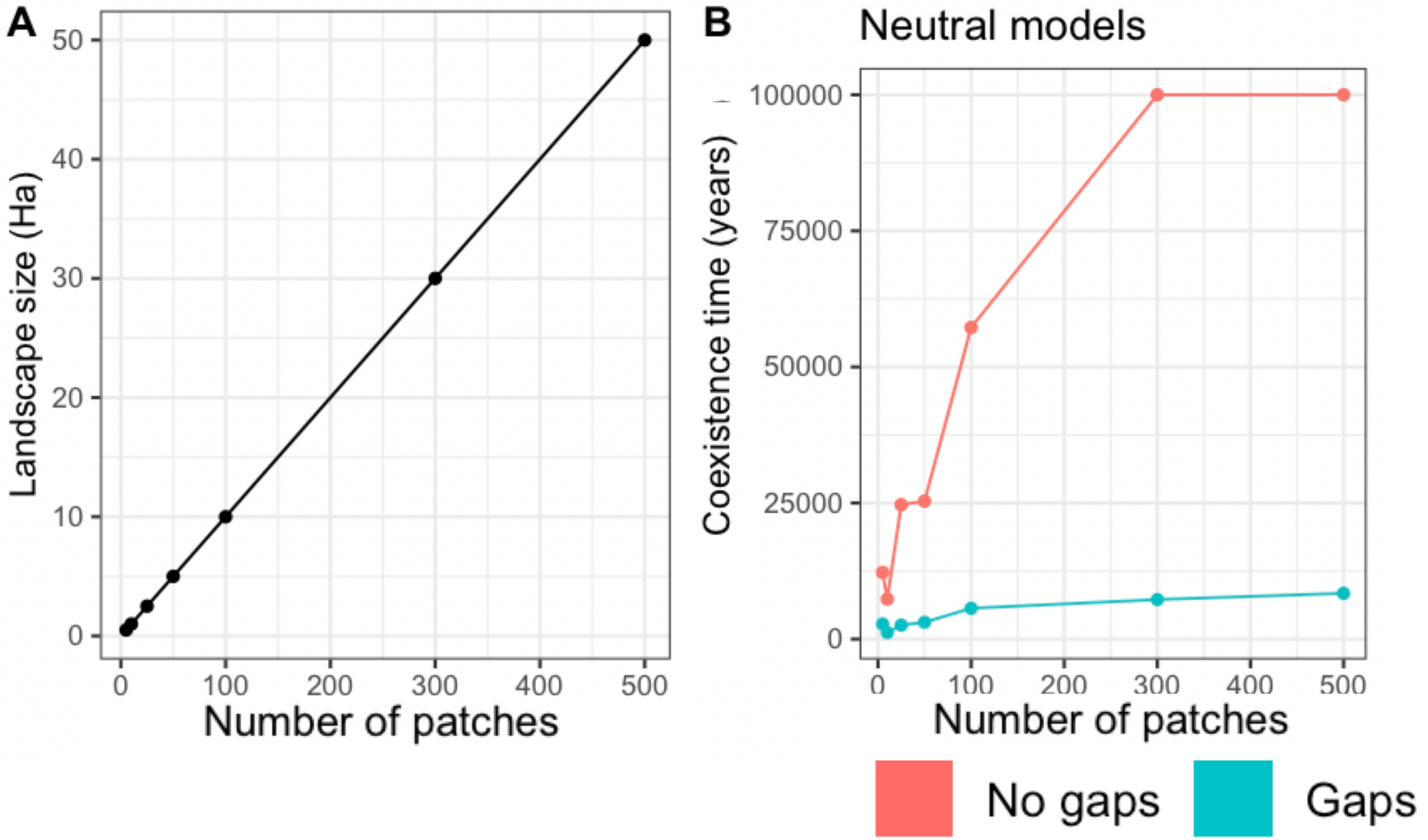

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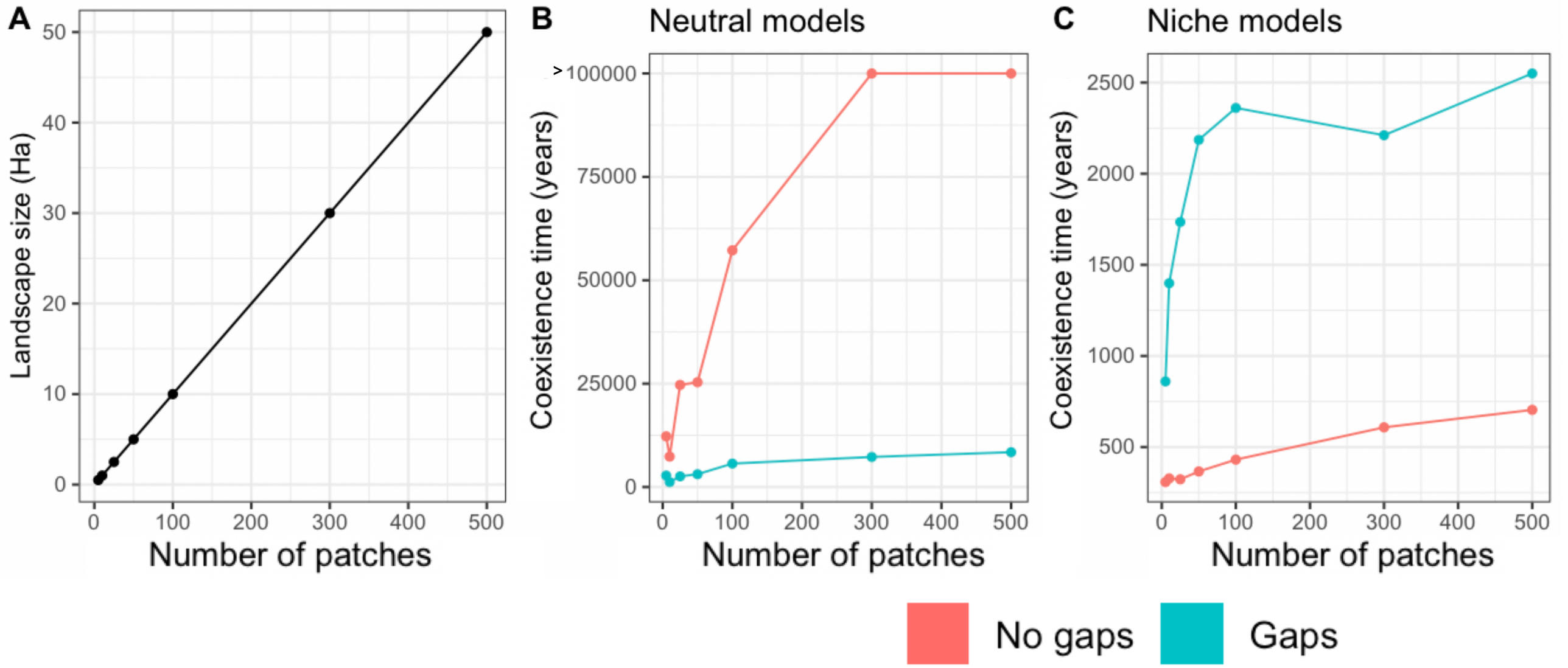
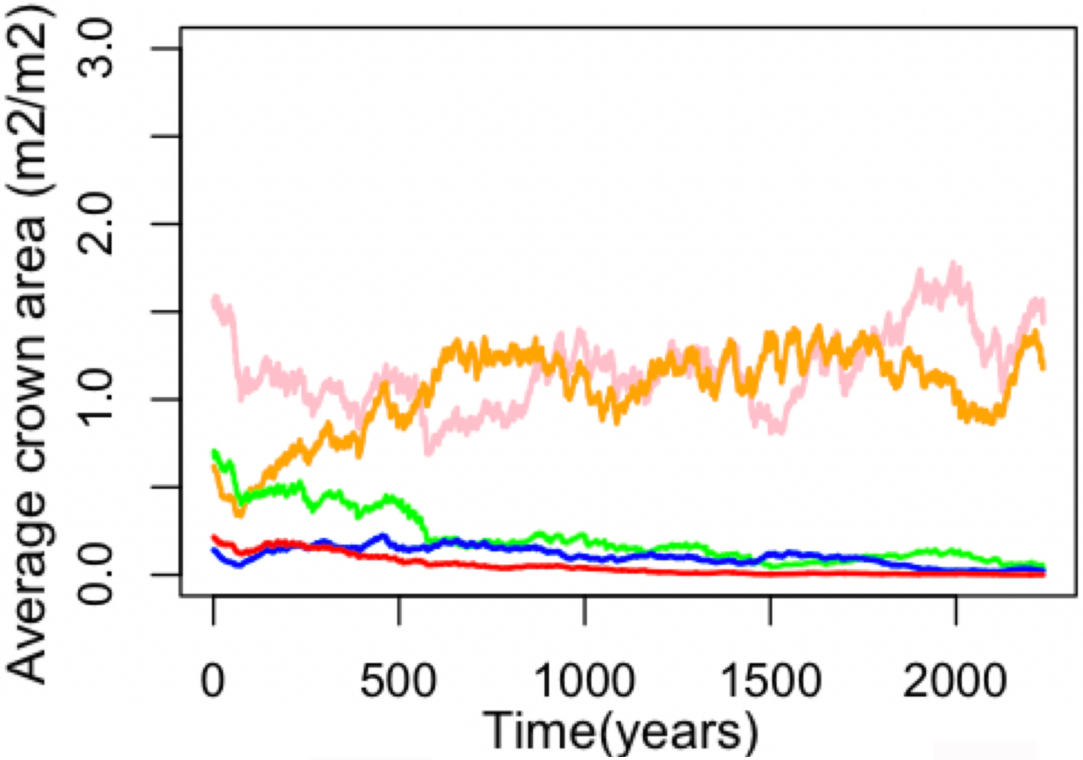


Future directions: Can realistic dispersal patterns further enhance coexistence of these different strategies?

Global dispersal **50 patches**



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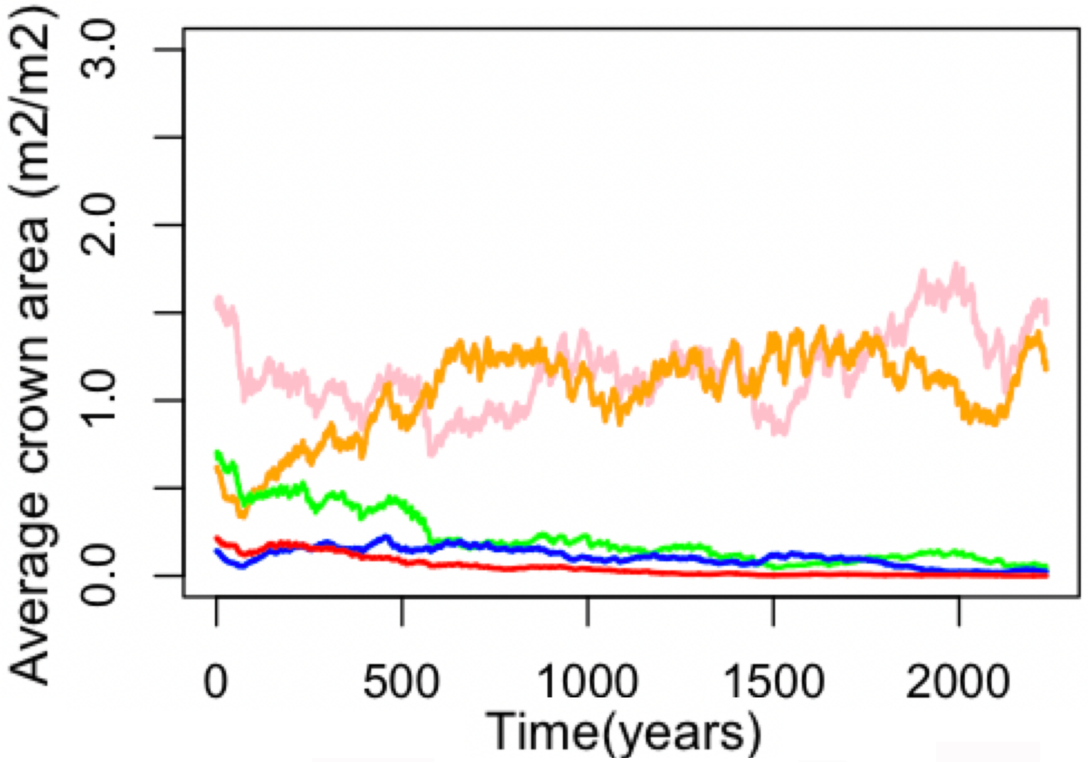
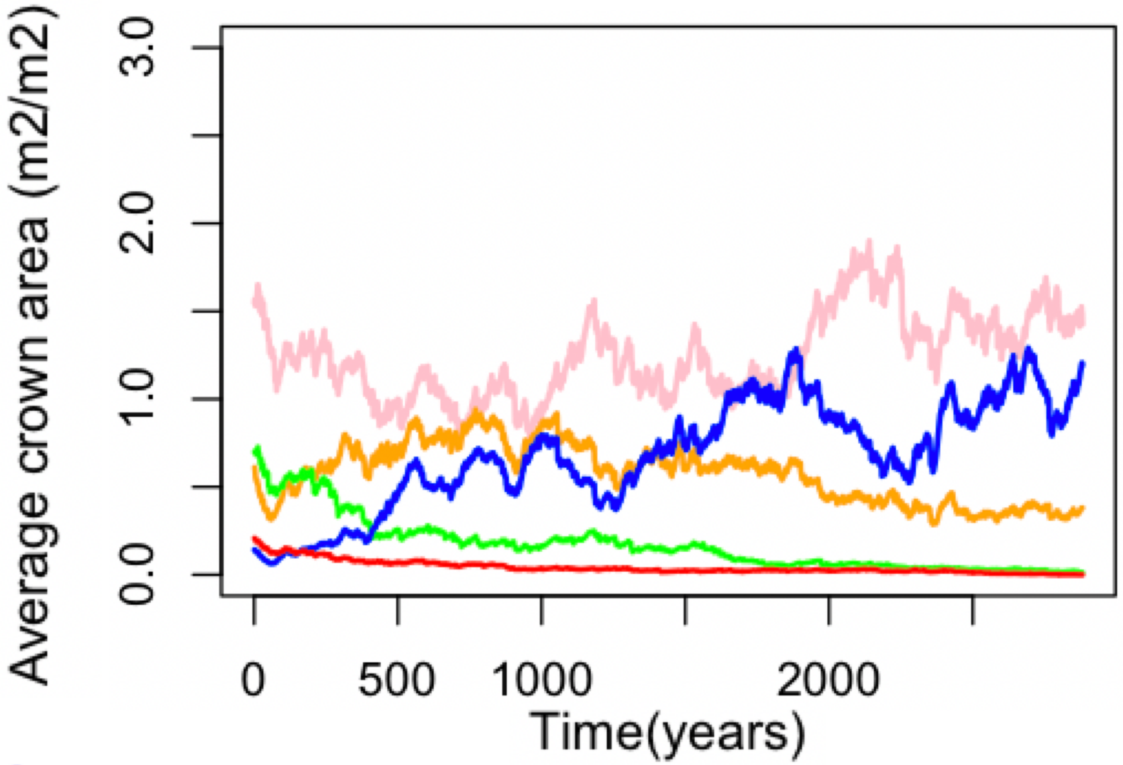


Semi-local dispersal **50 patches**



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A simple model of competition for light following gap disturbances can promote empirically observed demographic diversity.

However, the findings that neutral species coexist better than those with different strategies highlight the need for still other mechanisms to explain observed tropical forest demographic diversity.

Thank you for watching my talk!

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Condit R., Perez, R., Aguilar, S., Lao, S., Foster, R., Hubbell, S.P. 2019. Complete data from the Barro Colorado 50-ha plot: 423617 trees, 35 years, 2019 version. https://doi.org/10.15146/5xcp-0d46