Tree crown damage and its effect on forest carbon cycling in a tropical forest

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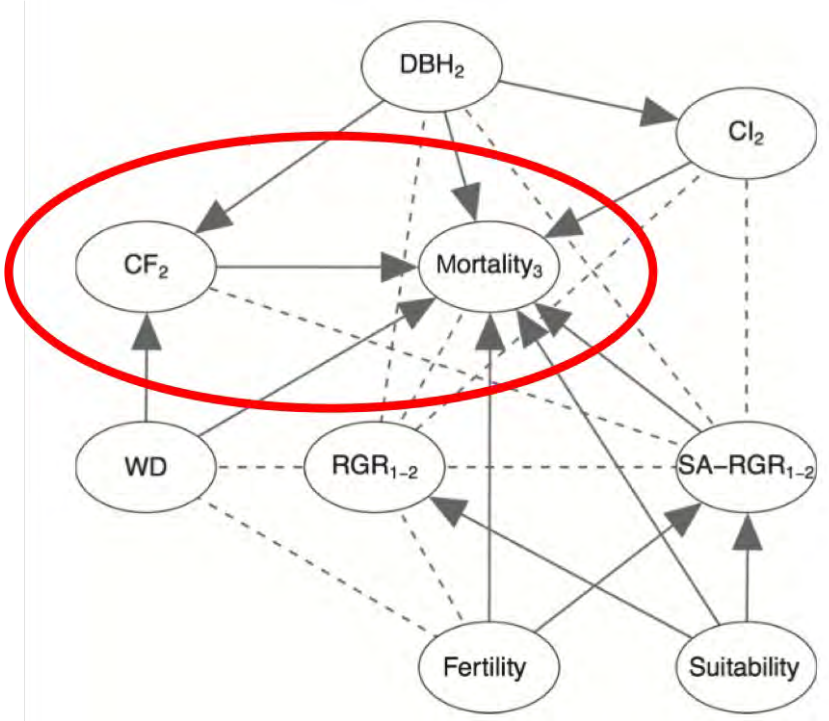
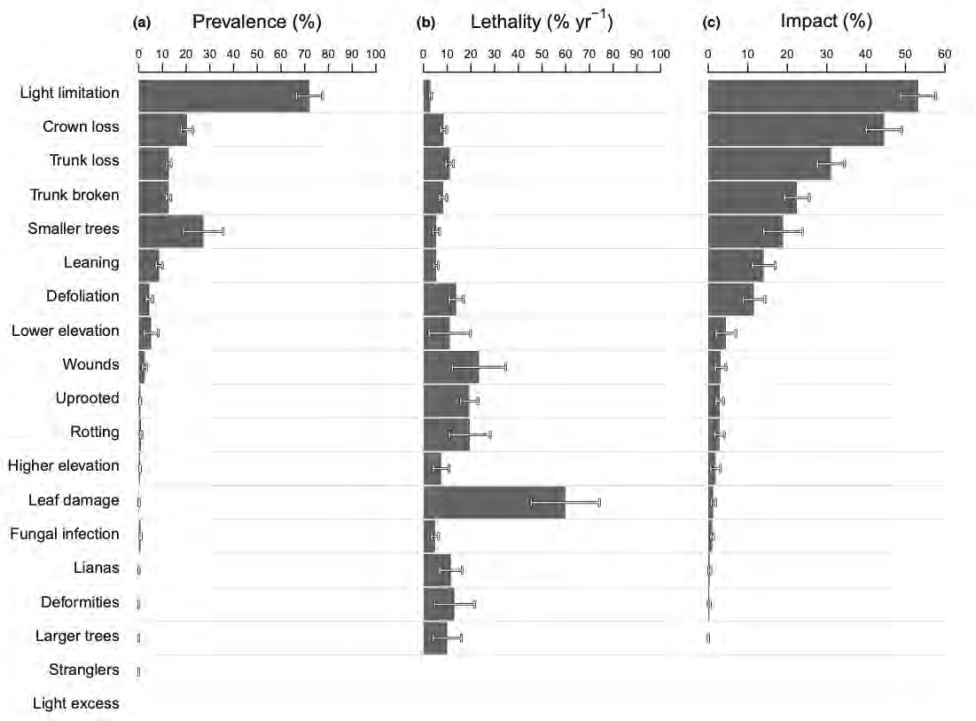
Crown damage is a significant predictor of mortality



Arellano *et al.* New Phytologist (2019)



Zuleta *et al.* New Phytologist (2021)

Crown damage in FATES reduces crown area and crown biomass

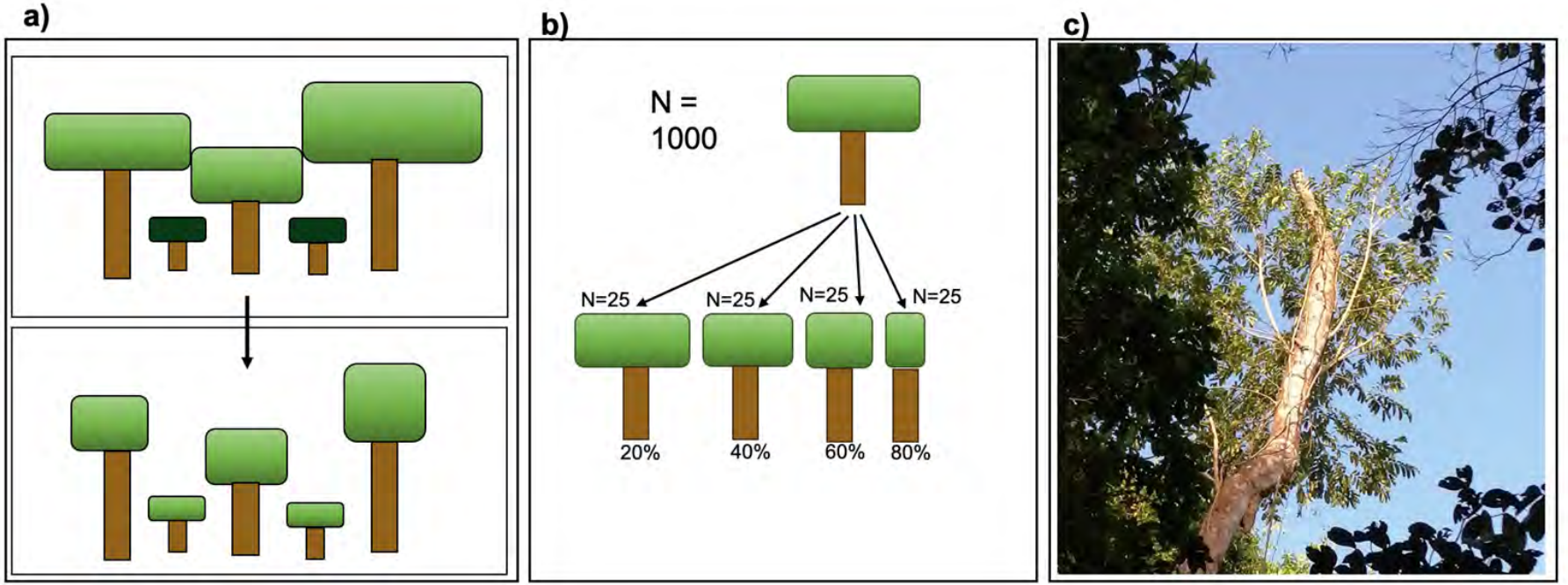


Photo credit: Pablo Narváez

Needham *et al.* Global Change Biology (accepted)

- **Do lags between environmental drivers and mortality matter for forest dynamics?**

- **How does the introduction of damage change simulated growth and mortality rates?**

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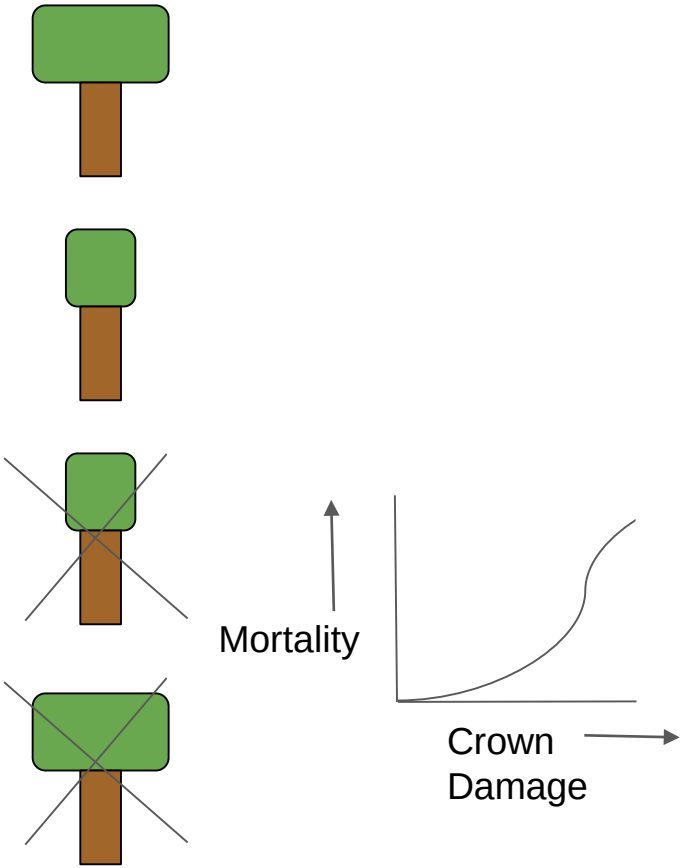
- **How does the introduction of damage change simulated growth and mortality rates?**

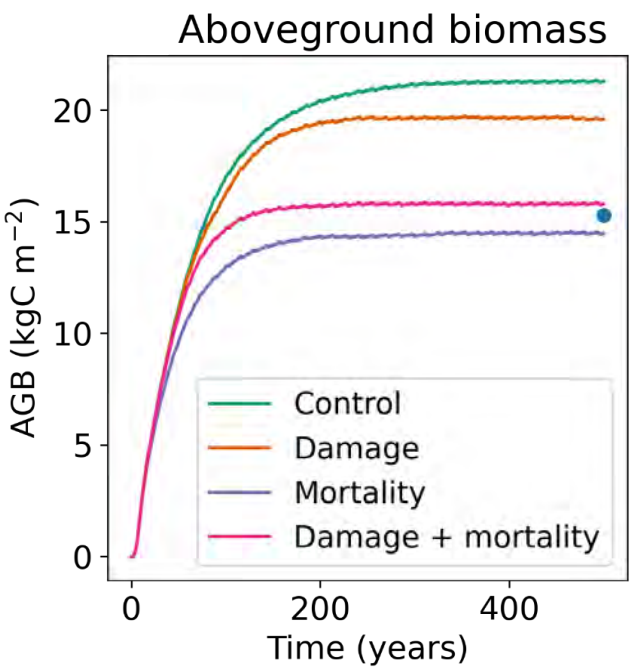
To test the effects of damage we run four model configurations

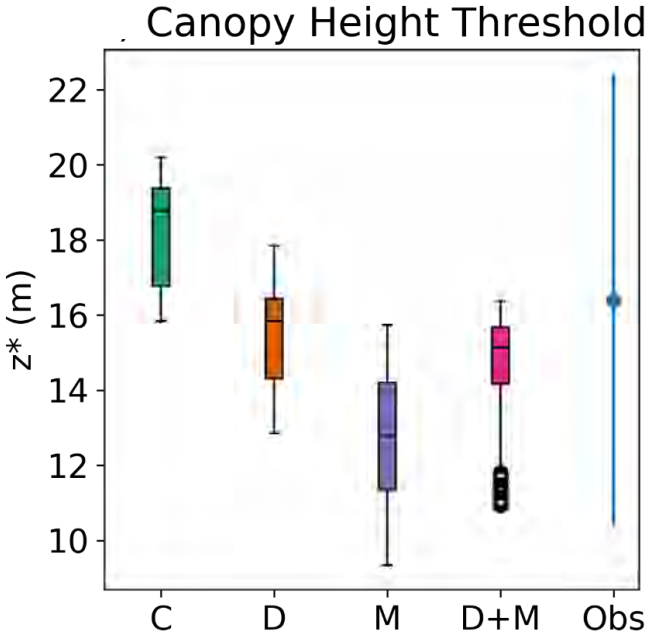
- Control
- Damage only
- Damage + mortality
- Mortality only



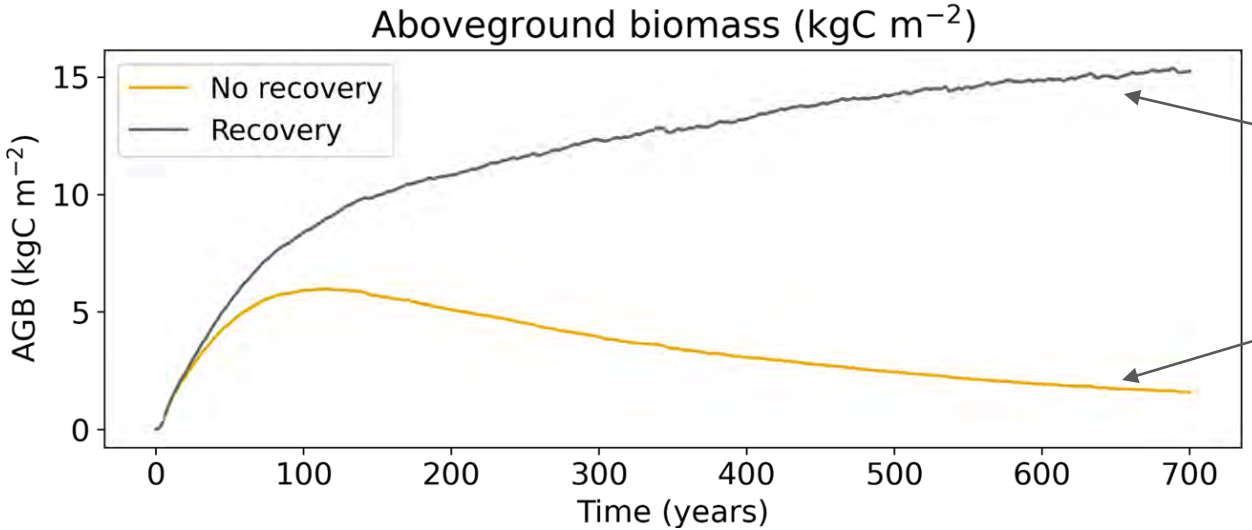
Changes to forest dynamics are mostly driven by mortality

The biggest decreases in AGB and z* are from mortality





PFTs that recover outcompete those that do not



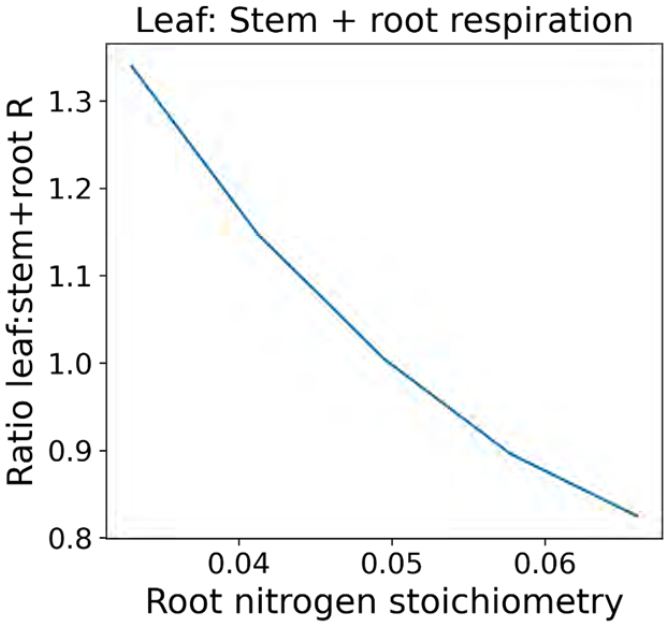
Allocates carbon to regrowing the crown

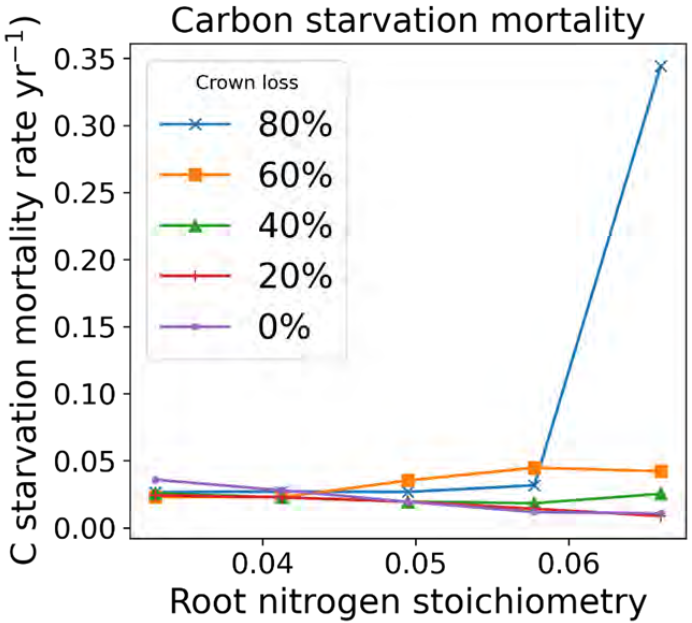
Allocates carbon to DBH growth without regrowing the crown

- Do lags between environmental drivers and mortality matter for forest dynamics?

- **How does the introduction of damage change simulated growth and mortality rates?**

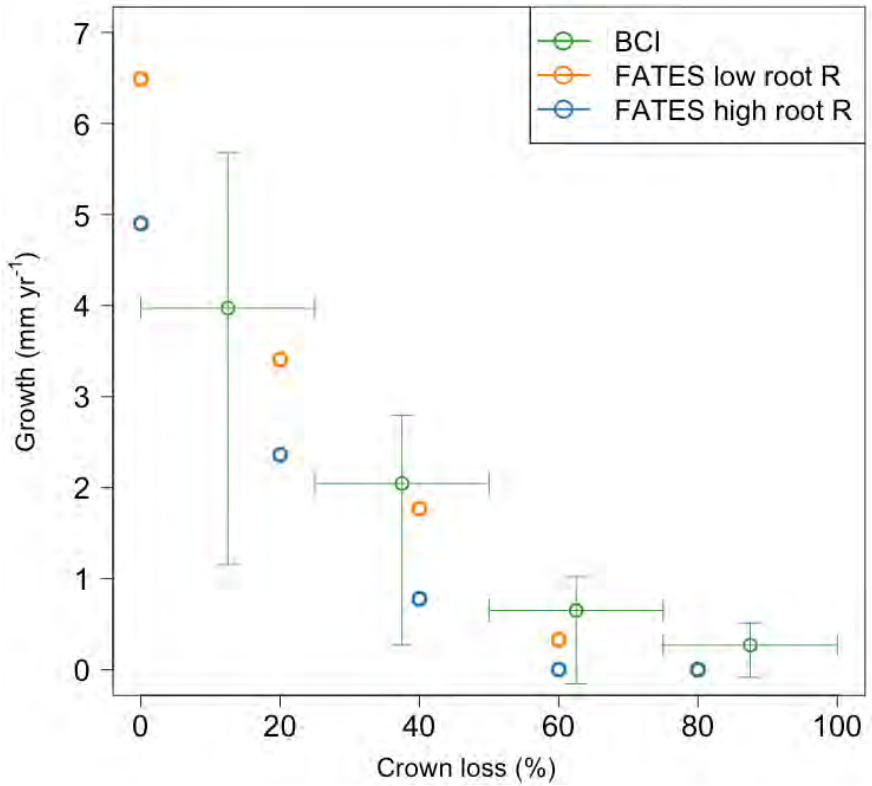
Altering carbon metabolism affects the impact of damage on demographic rates





A threshold root N is reached that causes an increase in C starvation mortality

Damage leads to reduced growth rates -
especially when root respiration is high



Future directions

- **Does cumulative damage matter for final mortality rates?**

- **How does crown damage affect forest recovery following severe disturbance?**

Conclusions

- The damage module provides new capabilities for hypothesis testing
- The effect of damage on stand structure is mostly due to altered mortality
- Allocation to recovery is important for competitive dynamics between PFTs
- Damage causes increases in carbon starvation mortality and decreases in growth rates, but these results are sensitive to carbon metabolism
- Future work will examine how damage influences post hurricane forest recovery

Acknowledgements

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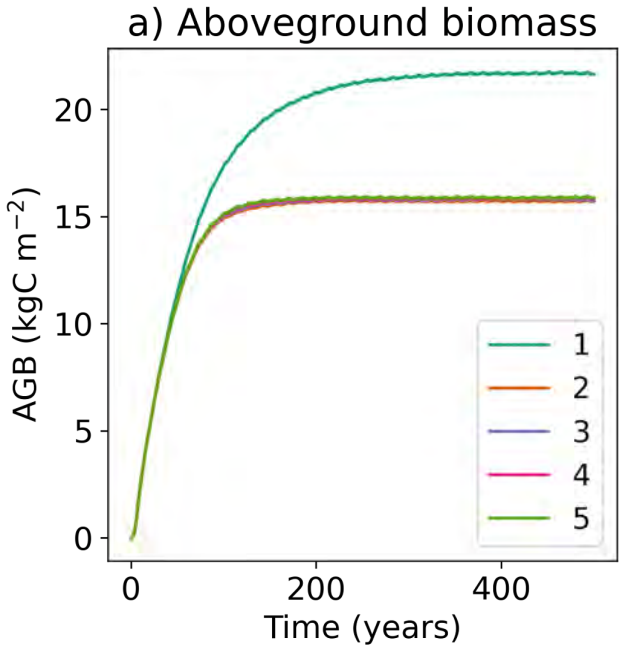
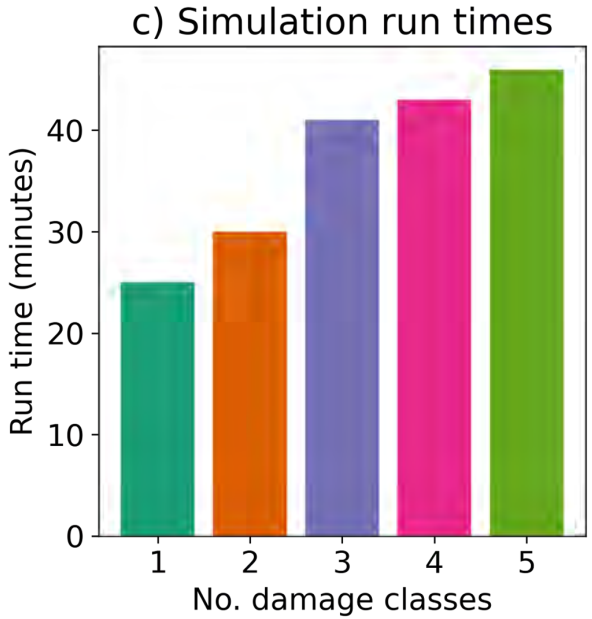
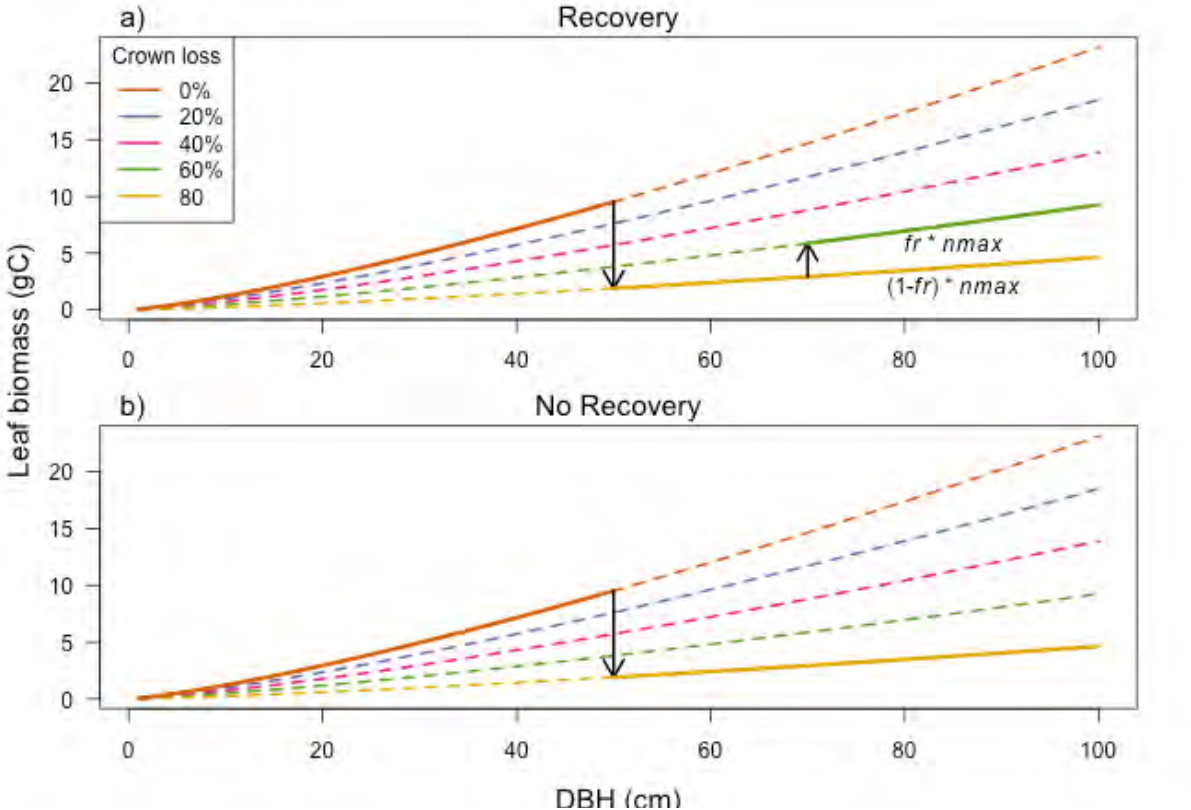
ForestGEO and BCI field workers and data managers

Simulating just two damage classes is sufficient to capture the effects of damage on forest dynamics





Cohorts can recover using available carbon



Crown growth over DBH growth

DBH growth over crown growth

Damage leads to increases in carbon starvation mortality -
especially when root respiration is high