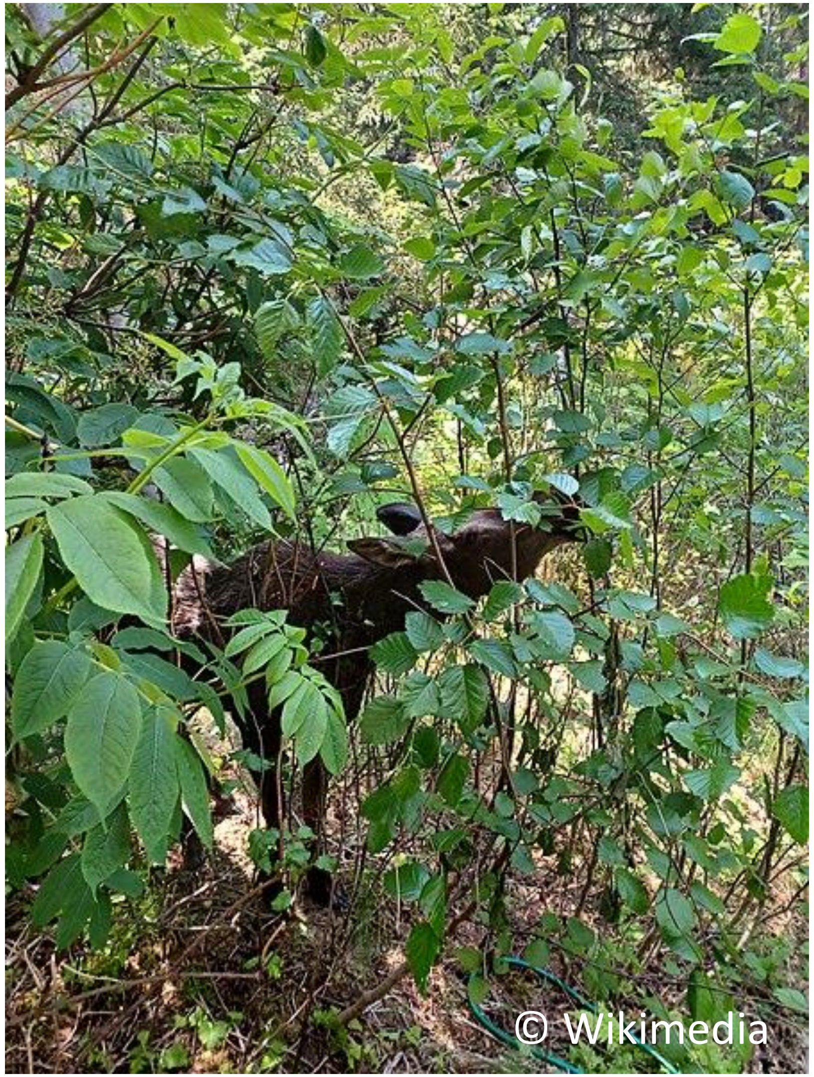
Scaling forest diversity across space and time in a non-equilibrial world

Dr. Sydne Record, Bryn Mawr College (UMaine starting Fall 2022),
John Grady (Washington University in St. Louis) & Noah Charney (U. Maine)

Forest structure influences habitat quality for many wildlife species



Forest structure influences habitat quality for many wildlife species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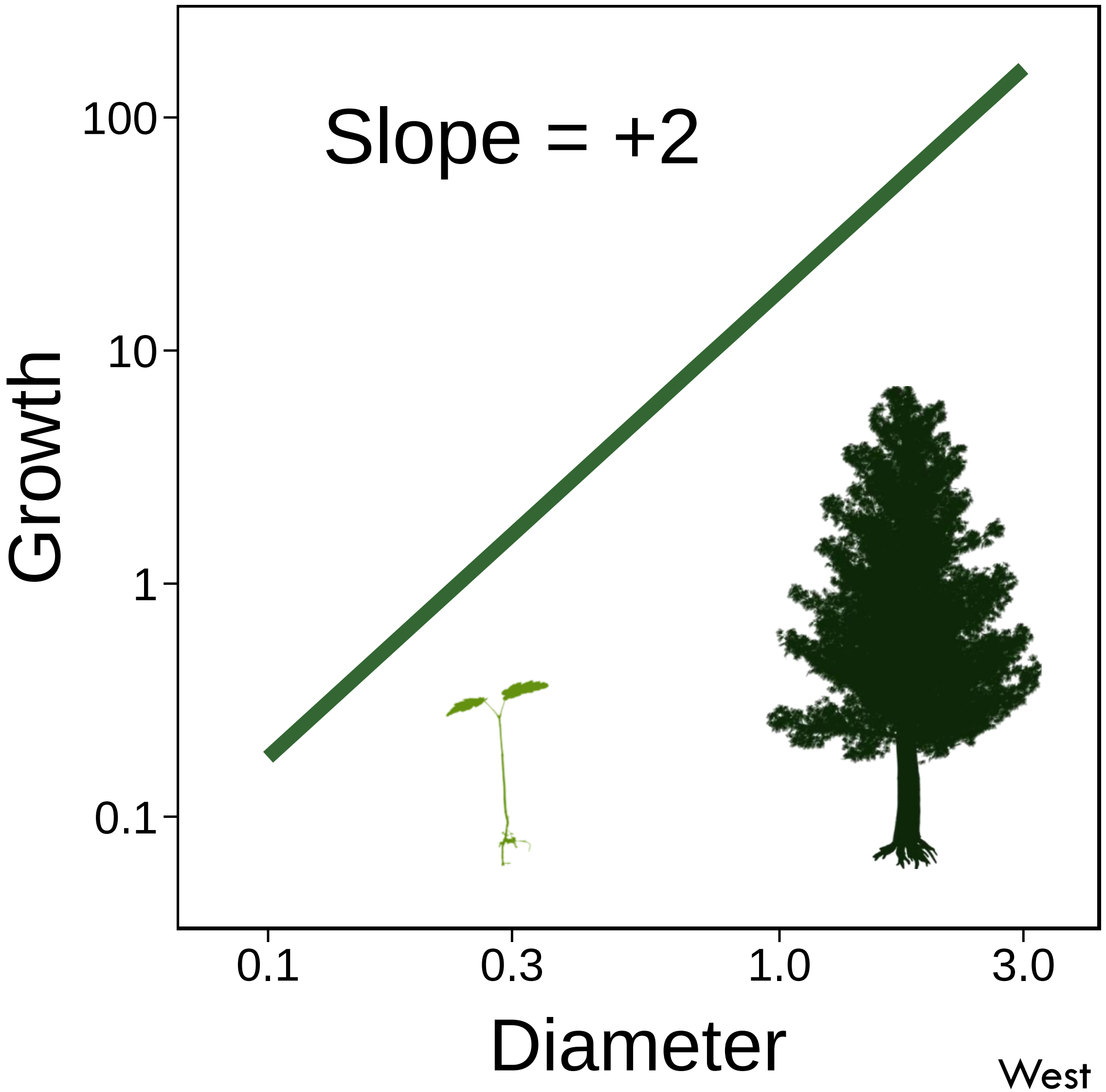
Challenges to understanding understory vegetation structure from remotely sensed data

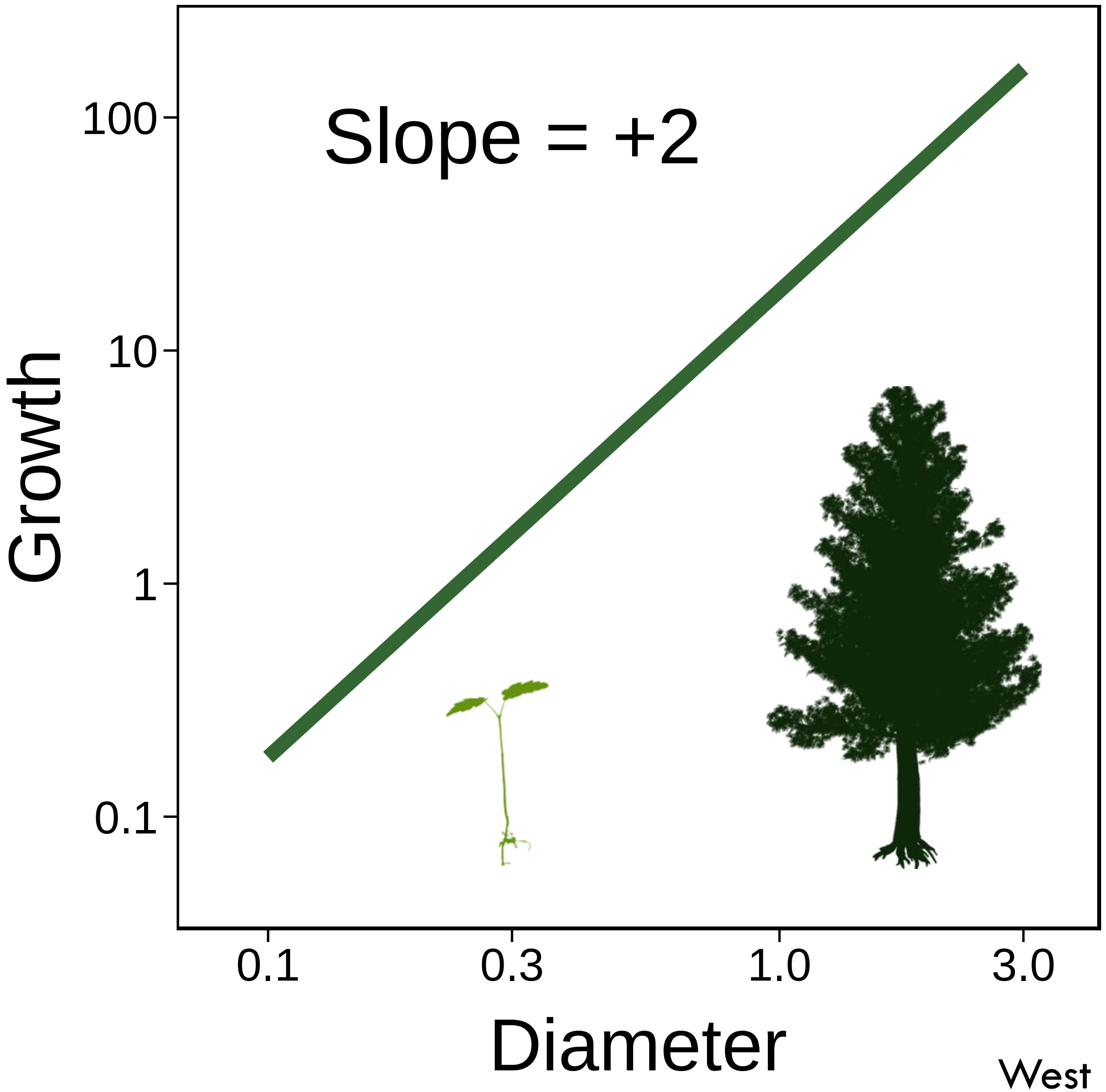
Can ecological theory improve predictions of understory vegetation structure from remotely sensed data?

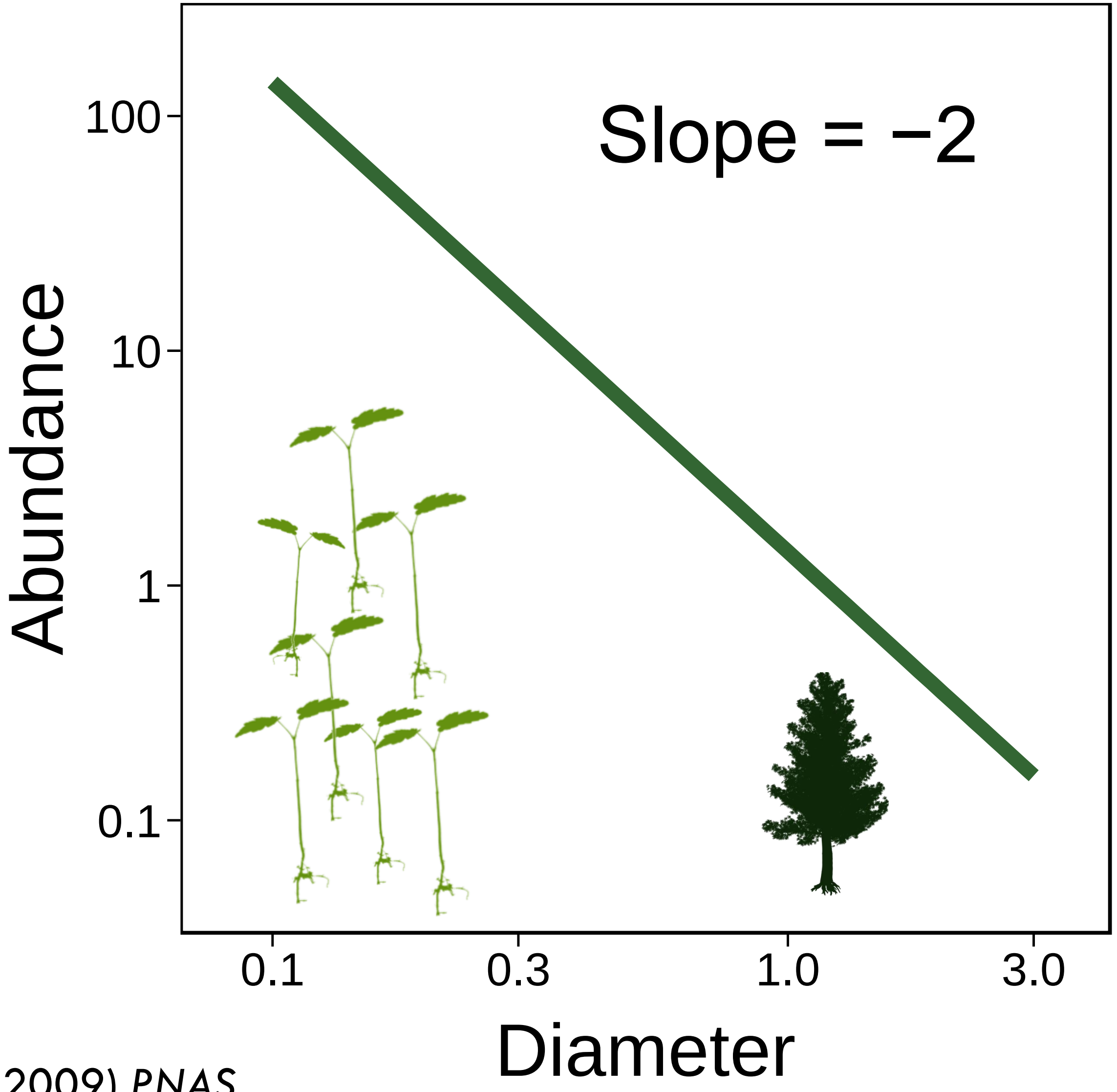
Metabolic scaling theory: general rules about growth, size, & abundance relationships



West et al. (2009) *PNAS*

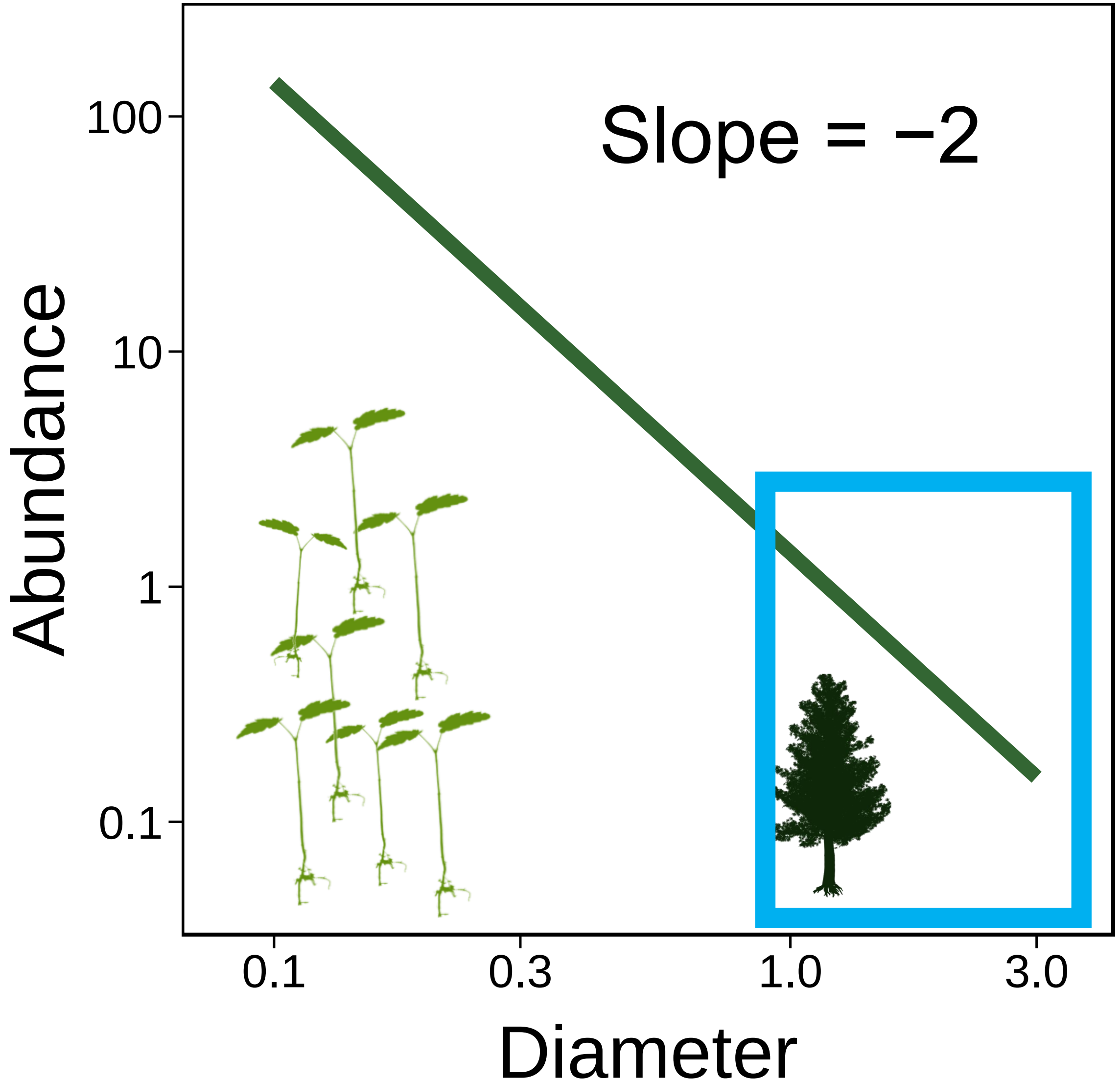
Metabolic scaling theory: general rules about growth, size, & abundance relationships





West et al. (2009) *PNAS*

Can ecological theory improve predictions of understory vegetation structure from remotely sensed data?



However, this theory ignores functional difference between species

Journal of Ecology
BRITISH ECOLOGICAL SOCIETY

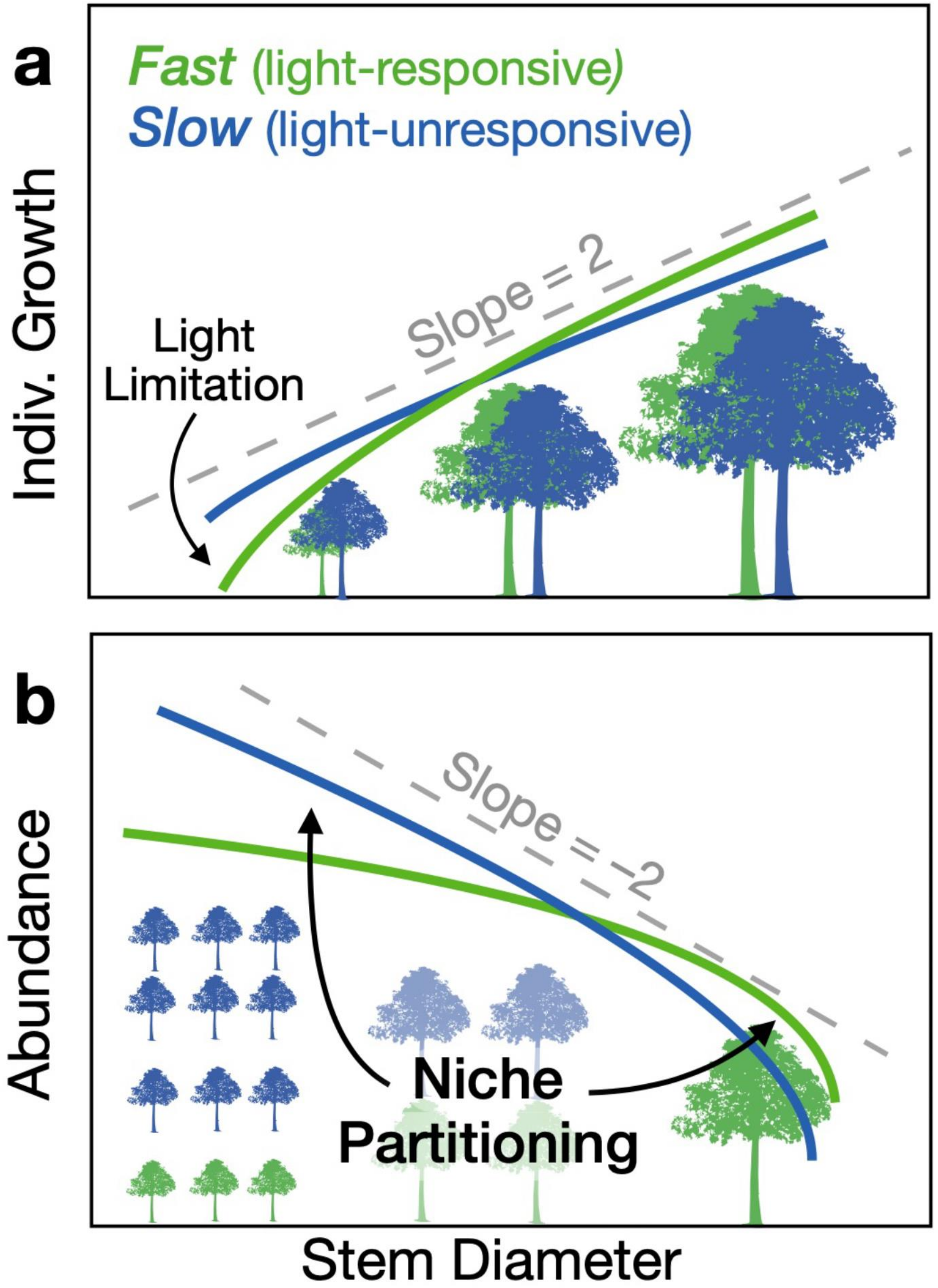
Special Feature: The Tree of Life in Ecosystems – Forum | Free Access

The world-wide 'fast–slow' plant economics spectrum: a traits manifesto

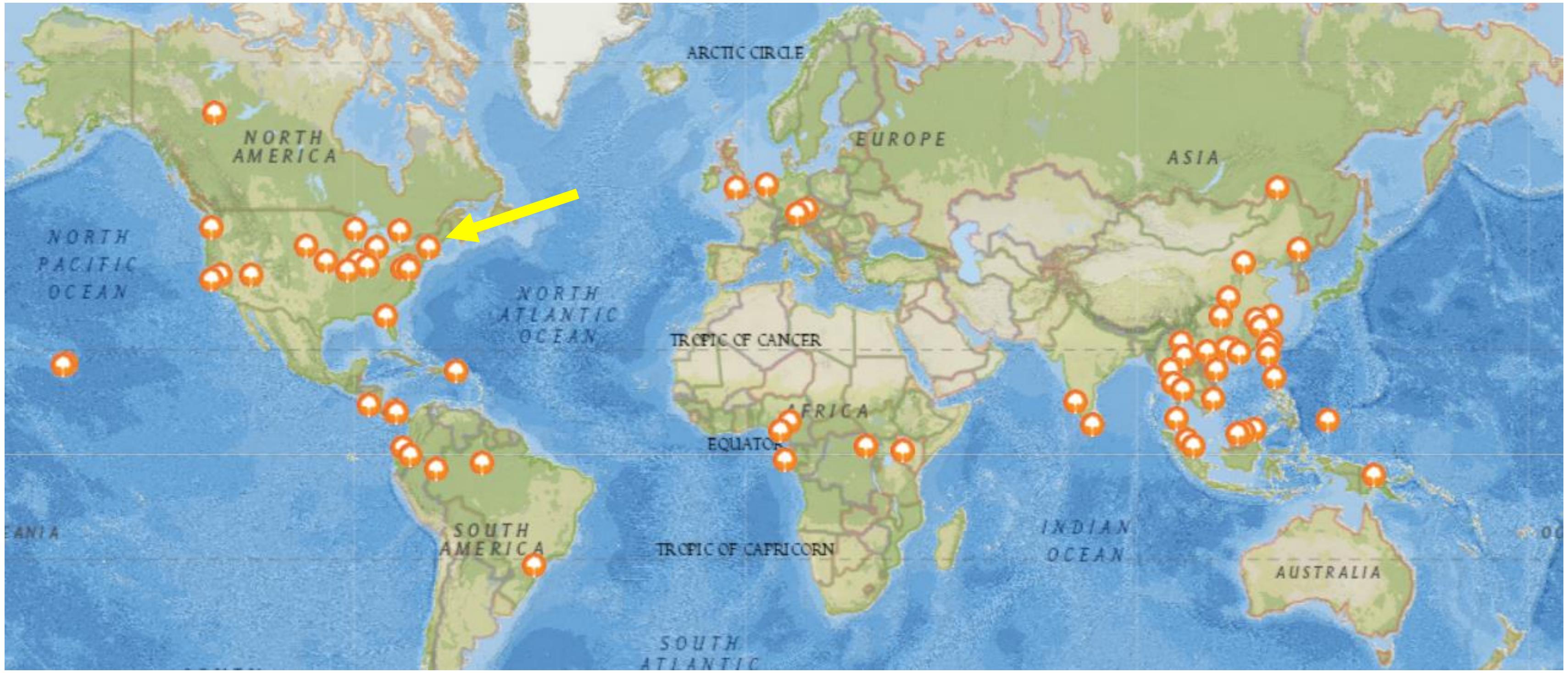
Peter B. Reich

First published: 19 February 2014 | https://doi.org/10.1111/1365-2745.12211 | Citations: 1,579

Predictions of theory incorporating fast-slow life histories



Exploring predictions at Harvard Forest



Exploring predictions at Harvard Forest

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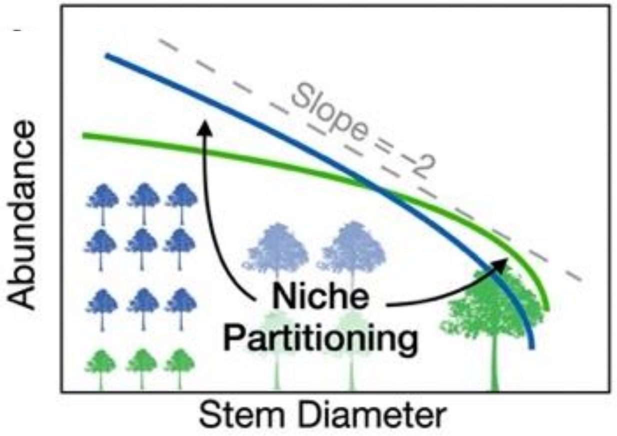
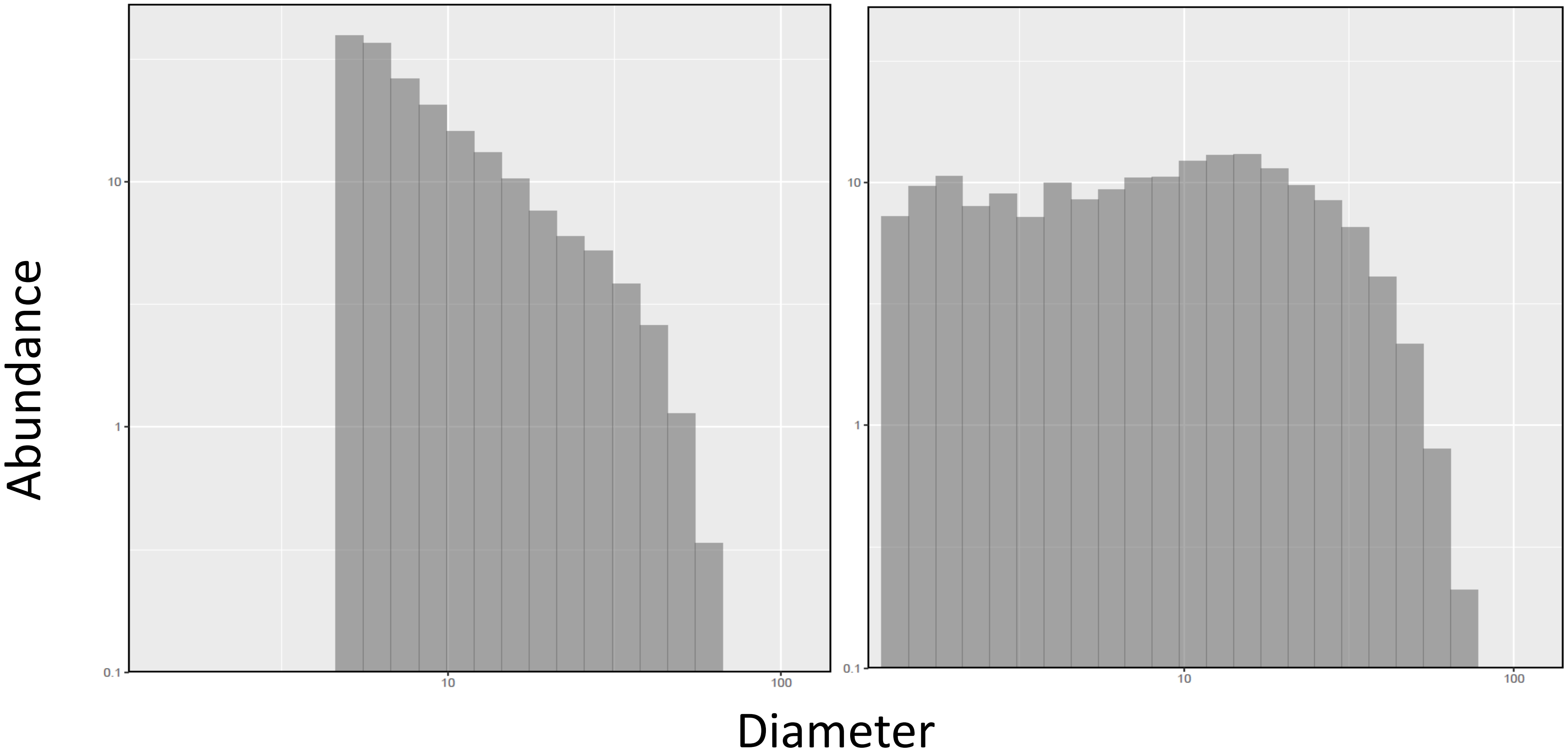
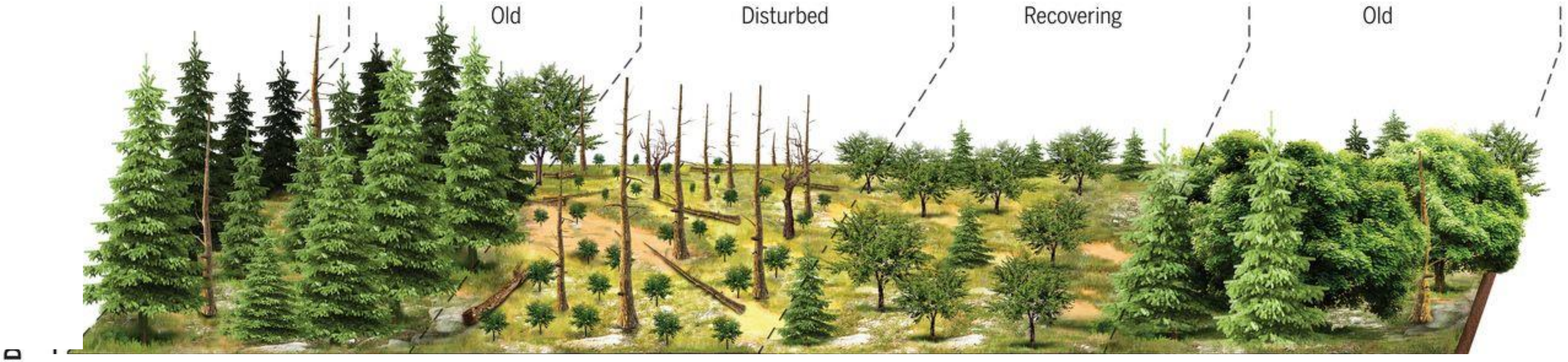


'Slow'
Late Successional

'Fast'
Mid-Successional

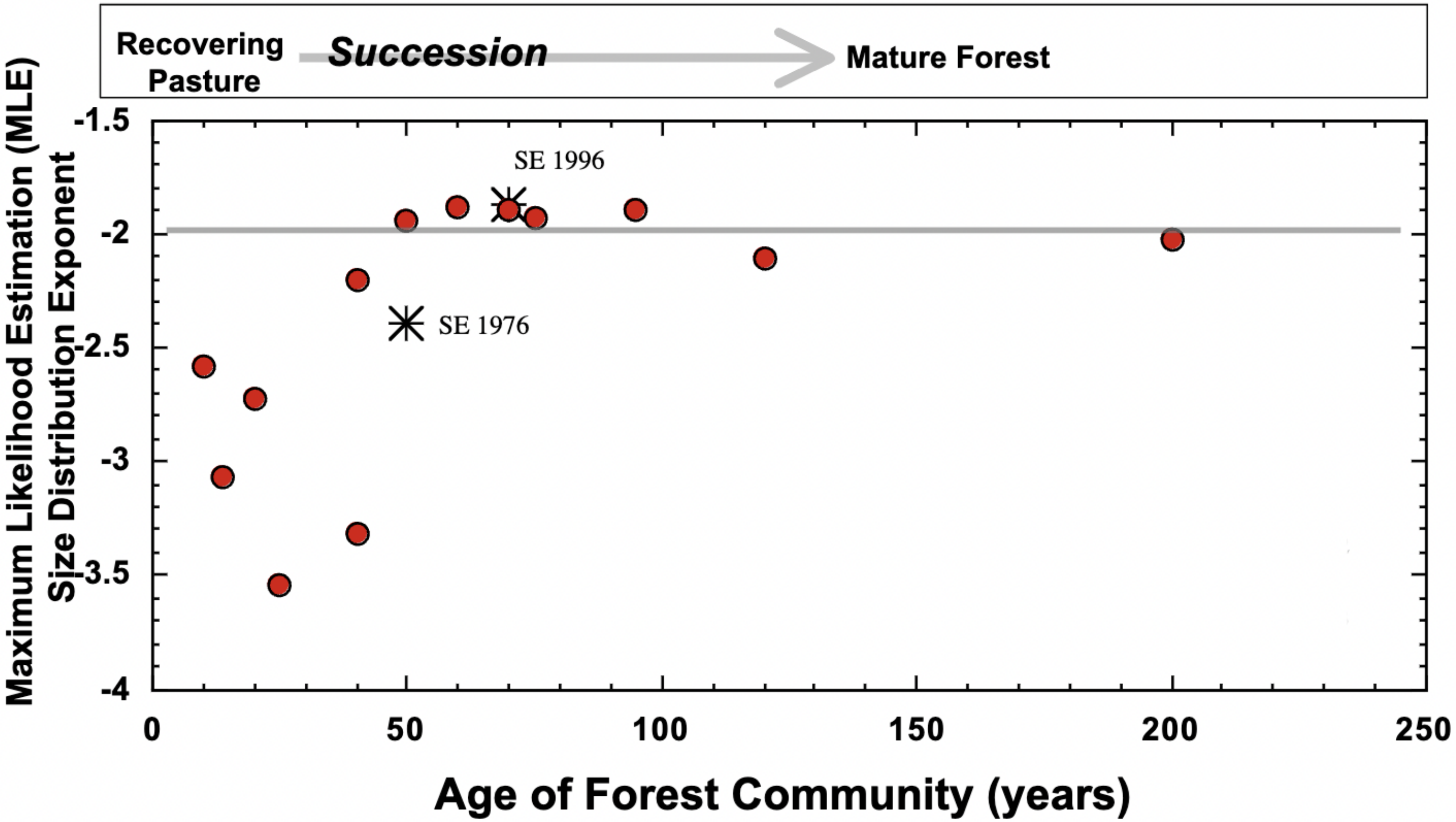


Also, this theory assumes equilibrial conditions



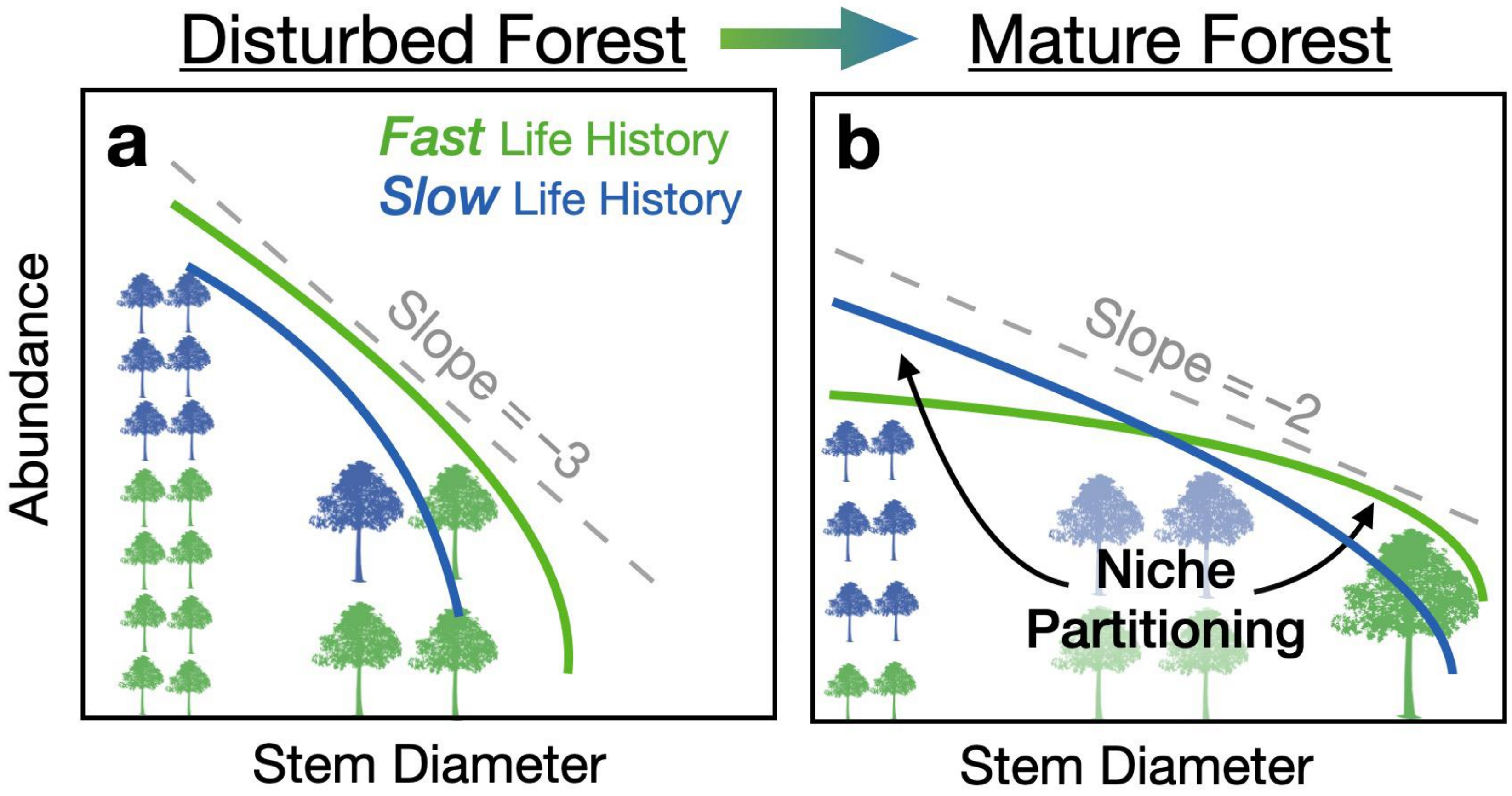
Macdowell et al. 2020

Successional convergence to MST



Enquist et al. PNAS | April 28, 2009 | vol. 106 | no. 17 | 7049

Prediction: Disturbance generates predictable deviations from Metabolic Scaling Theory



Objective: Spatio-temporal modeling of forest structure

In situ data across time

FIA

The Nation's Forest Census

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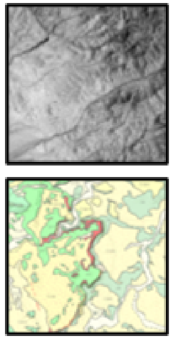
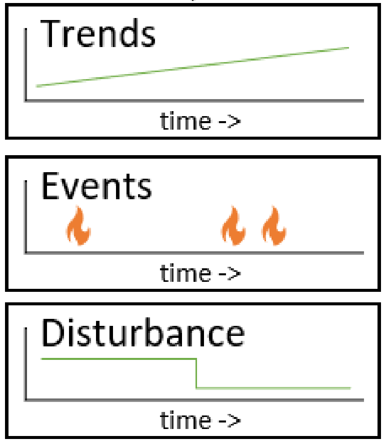
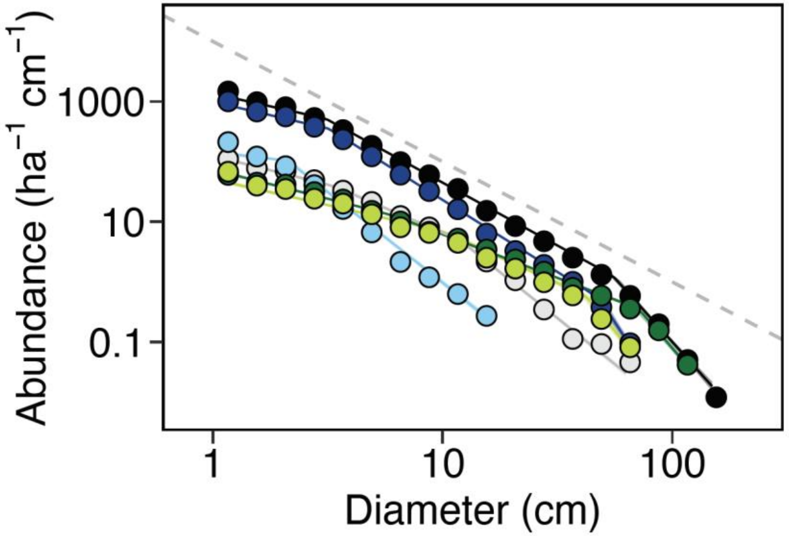
Static & Dynamic Remotely Sensed data



- Elevation
- sd(elev)
- other metrics

- Geologic types
- Shannon entropy
- other metrics





Spatio-temporal modeling of forest structure

In situ data across time

FIA

The Nation's Forest Census

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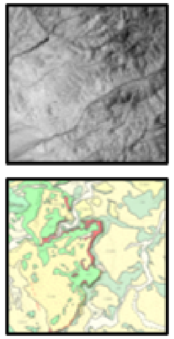
Static & Dynamic Remotely Sensed data



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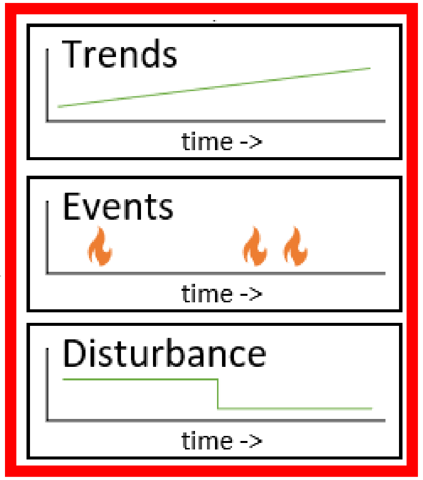

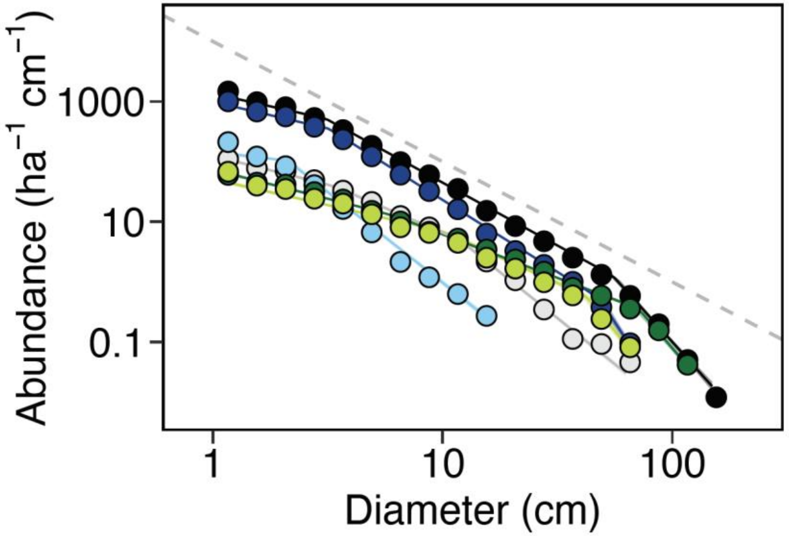

Data pre-processing
LandTrendr for Google
Earth Engine

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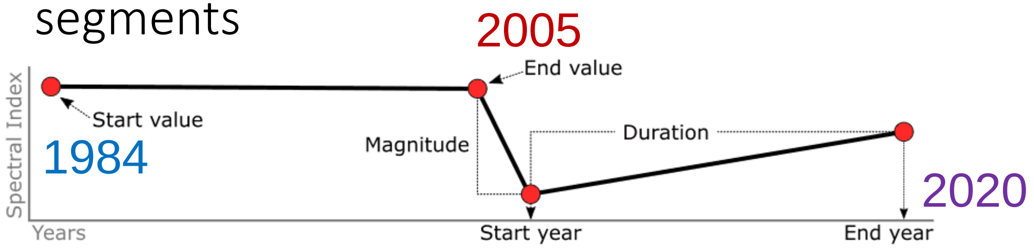
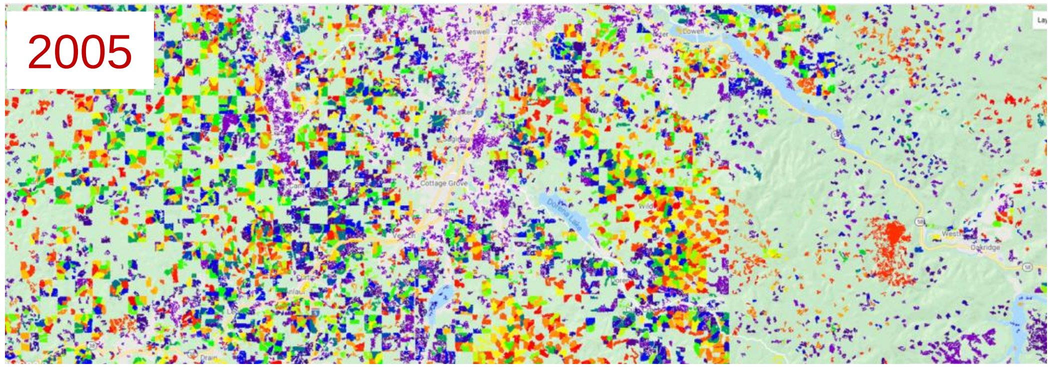
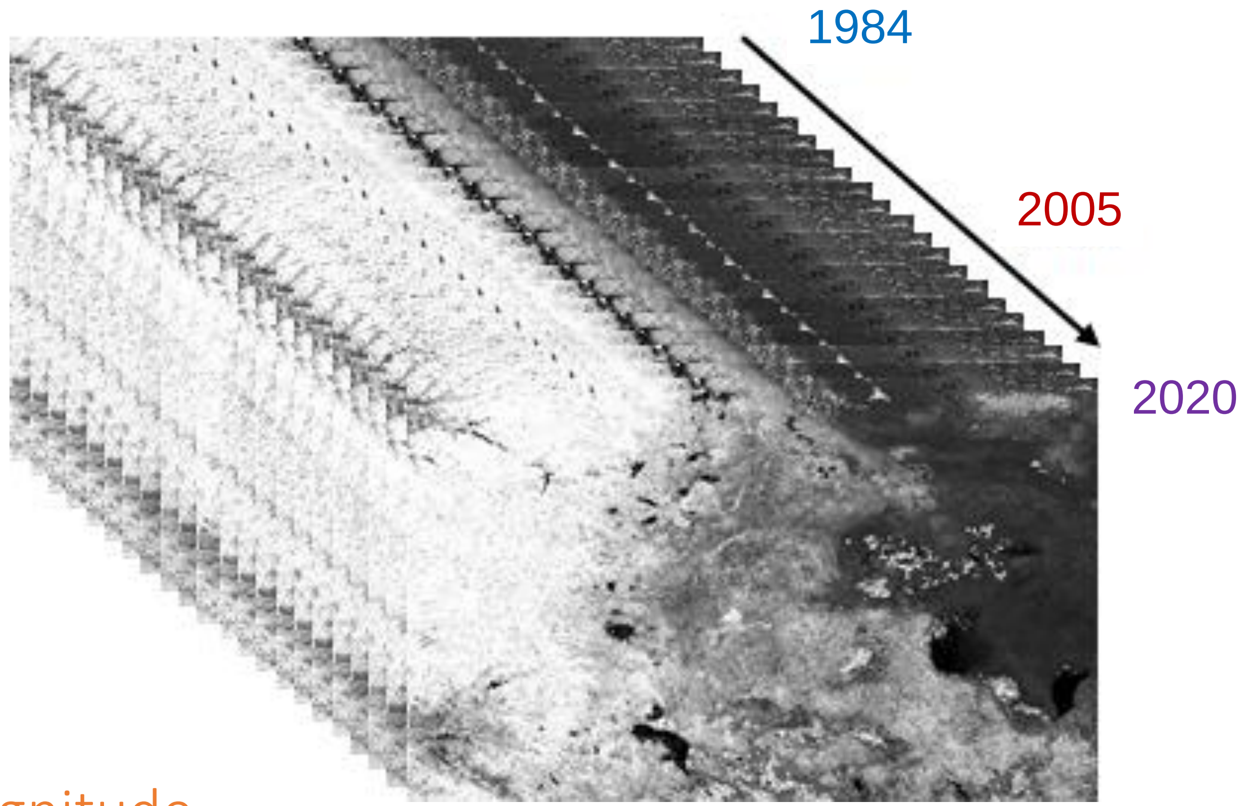
Each 30-m pixel timeseries broken into segments



E.g.: start year of segment with greatest vegetation loss



Disturbance

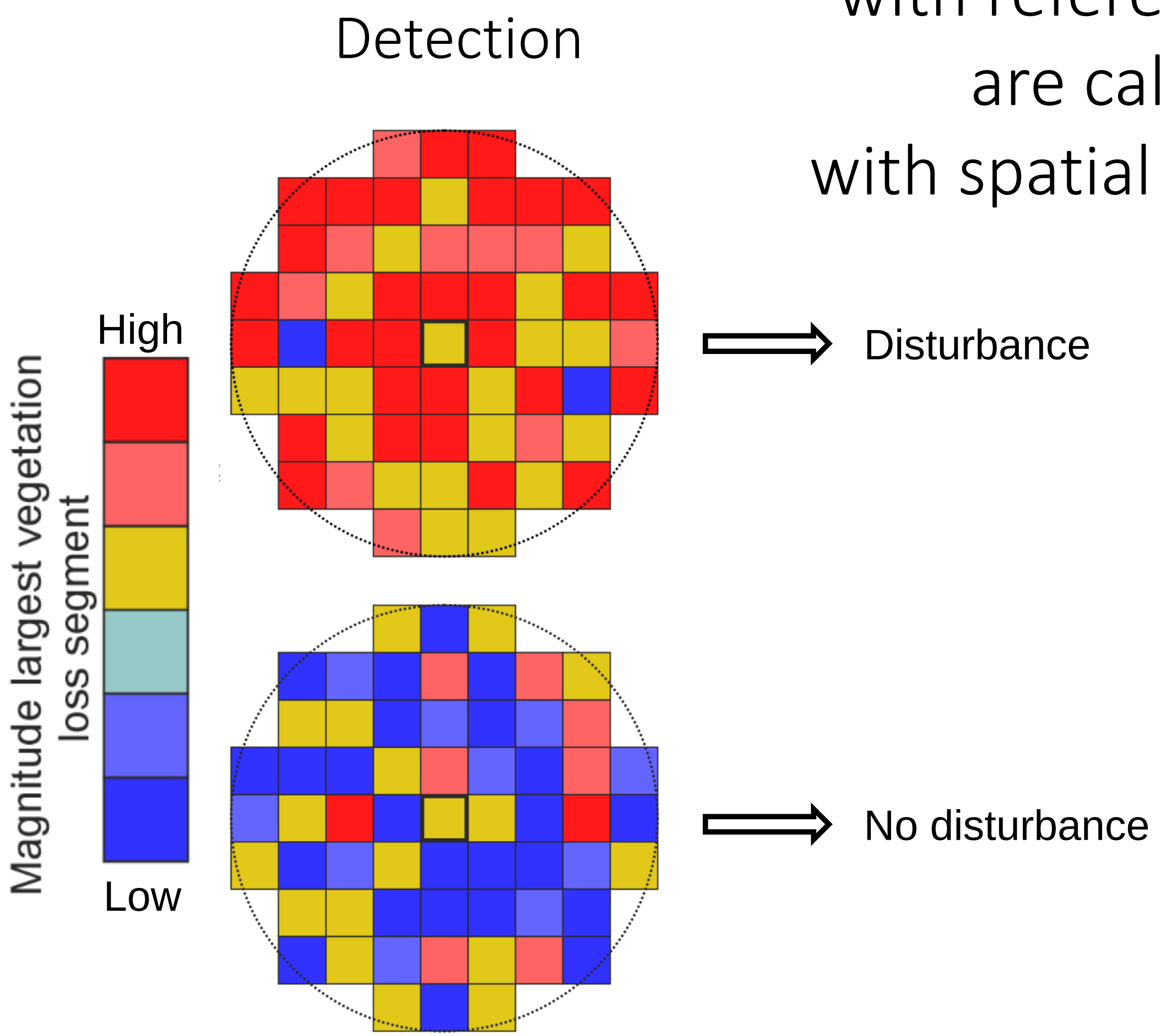


magnitude,
rate, &
duration of change

Van doninck et al. in prep

Disturbance

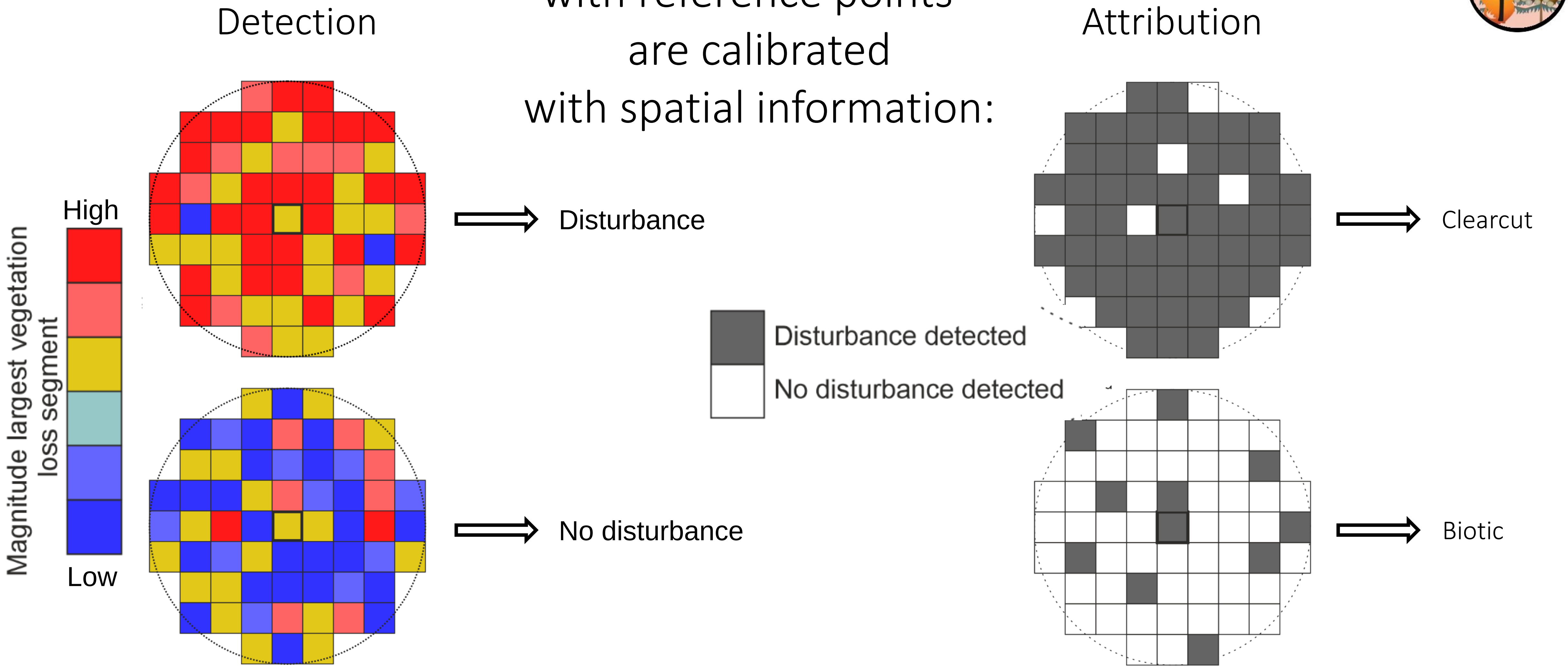
2 Random Forest models with reference points* are calibrated with spatial information:



*25,000 reference points across CONUS (1985-2020)

Van doninck et al. in prep

2 Random Forest models with reference points* are calibrated with spatial information:



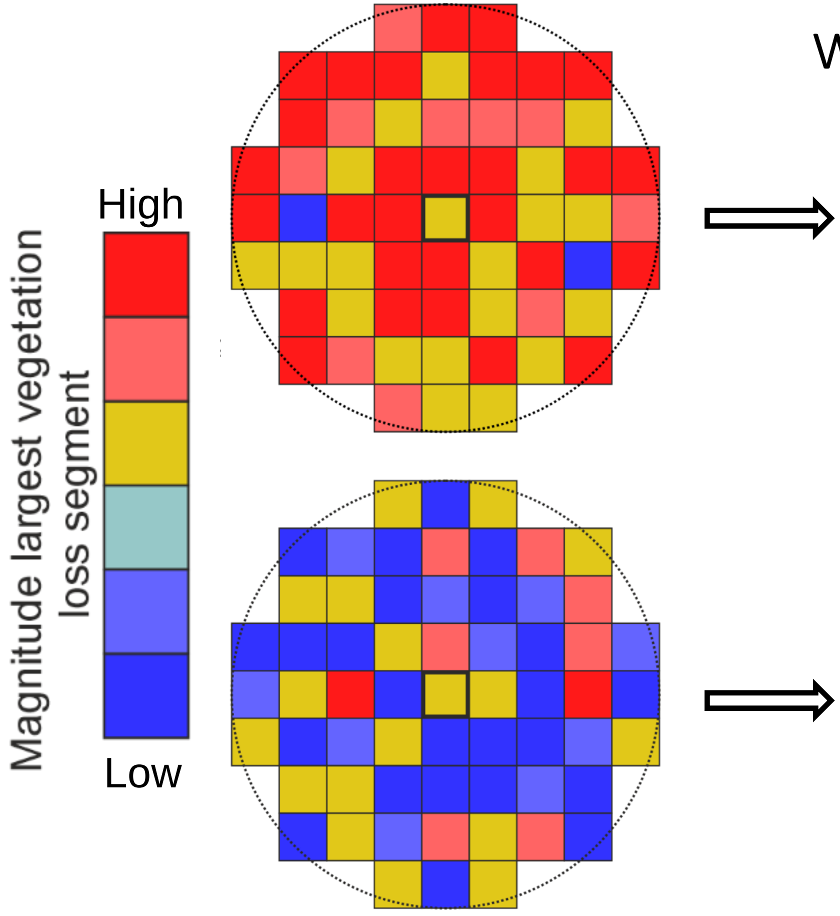
*25,000 reference points across CONUS (1985-2020)

Van doninck et al. in prep

2 Random Forest models with reference points* are calibrated with spatial information:

Disturbance

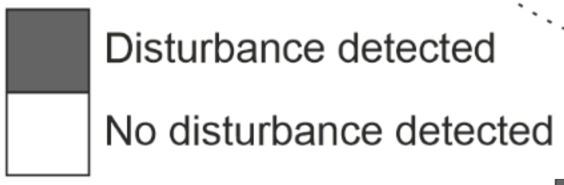
Detection

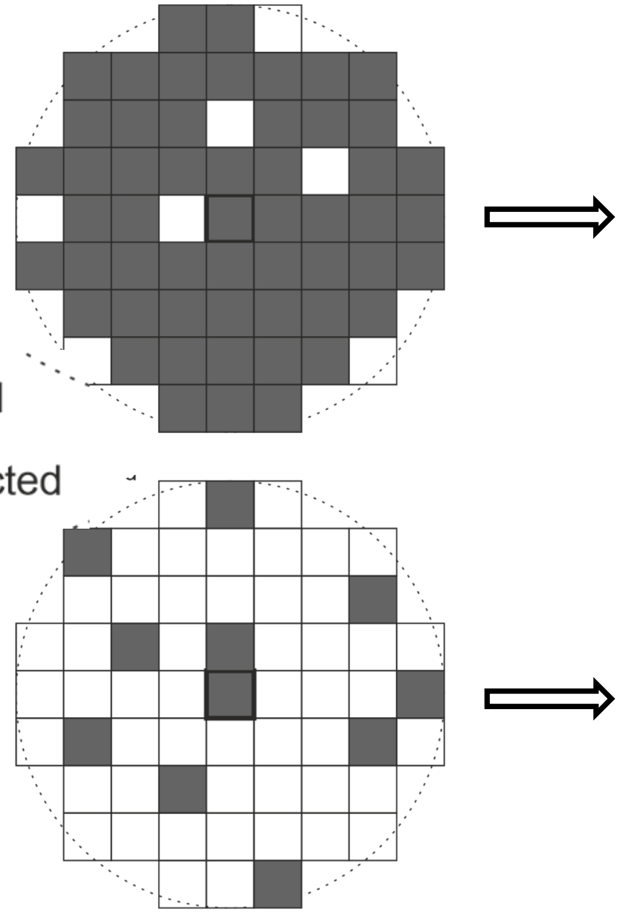


Disturbance

No disturbance

Attribution





Clearcut

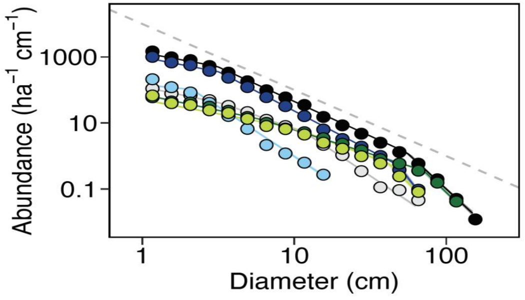
Biotic

*25,000 reference points across CONUS (1985-2020)

End Result: wall-to-wall 30-m CONUS map of disturbance variables & disturbance type (each year 1985-2020)

Van doninck et al. in prep

__Future directions:__ Using RS data and models to make predictions across space and time



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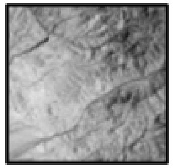
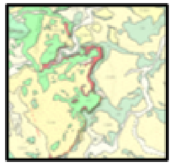
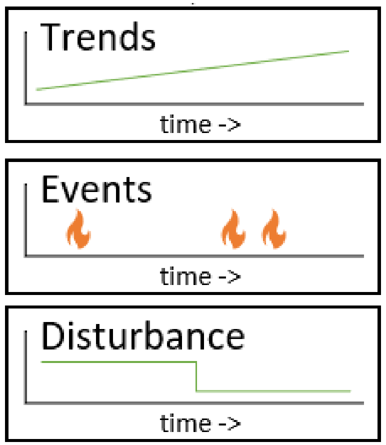
Static & Dynamic Remotely Sensed data



- Elevation
- sd(elev)
- other metrics



- Geologic types
- Shannon entropy
- other metrics



Predictions of functional group abundance and size across space and time

Thank you!

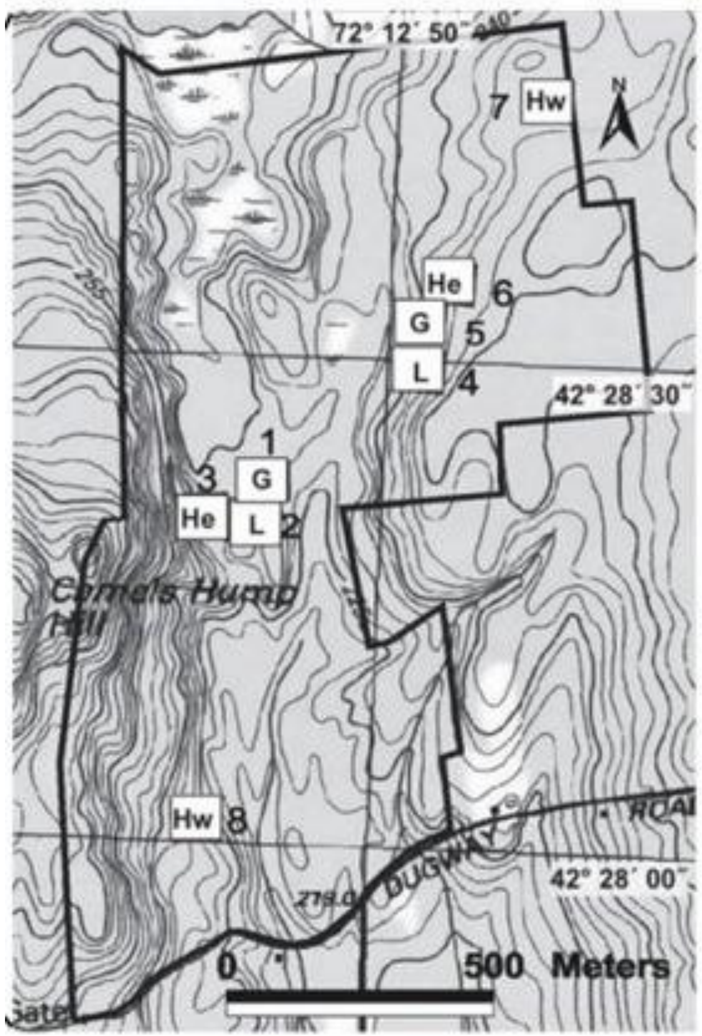
LTER NETWORK

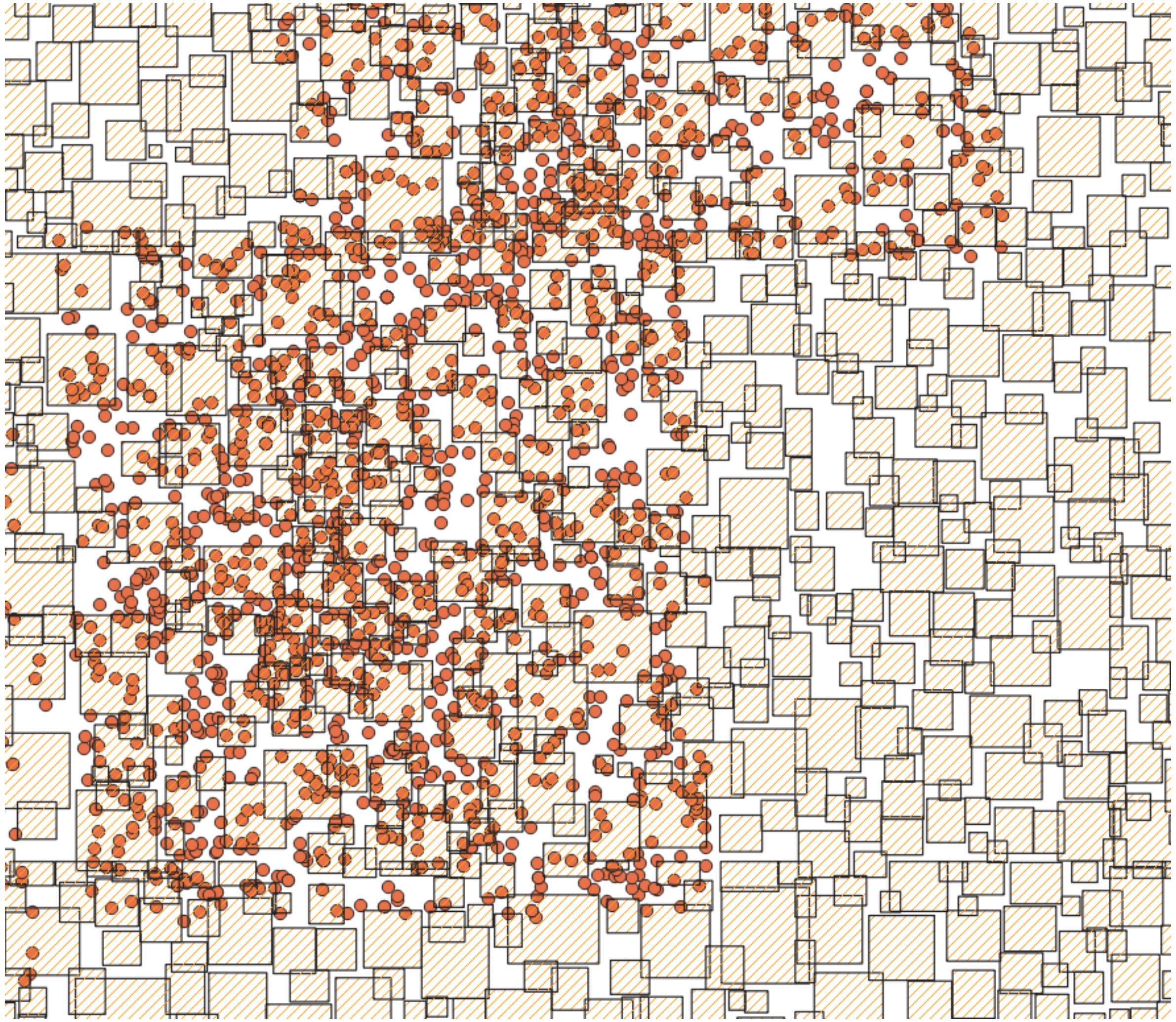
NSF-MSB-NES1926568

20-BIODIV20-0024

Email: sydne.record@maine.edu
@recordlab

NEON remotely sensed crowns & Hemlock Removal Experiment in-situ trees





Challenges to understanding understory vegetation structure from remotely sensed data

Global Ecology and Biogeography
A Journal of Macroecology

RESEARCH ARTICLE | Open Access

Towards mapping biodiversity from above: Can fusing lidar and hyperspectral remote sensing predict taxonomic, functional, and phylogenetic tree diversity in temperate forests?

Aaron G. Kamoske, Kyla M. Dahlin, Quentin D. Read, Sydne Record, Scott C. Stark, Shawn P. Serbin, Phoebe L. Zarnetske

First published: 13 May 2022 | https://doi.org/10.1111/geb.13516

The core objective of this research is to :
incorporate disturbance through time and remote sensing
into a scaling framework of forest structure and functional diversity.

Objective 1: *Spatio-temporal modeling of forest structure and diversity*

In situ data across time

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In situ data across time

FIA

The Nation's Forest Census

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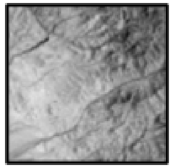
Static & Dynamic RS data



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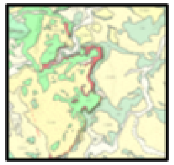
- sd(elev)
- other metrics



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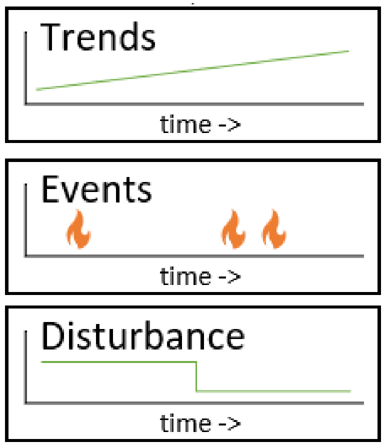
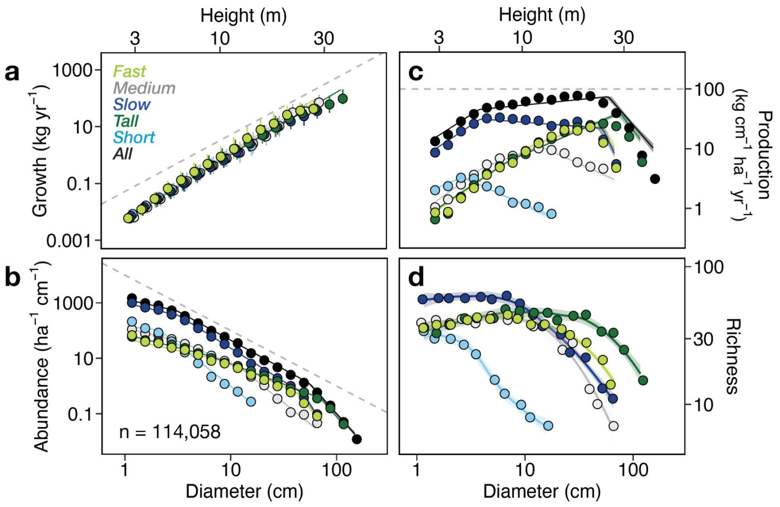
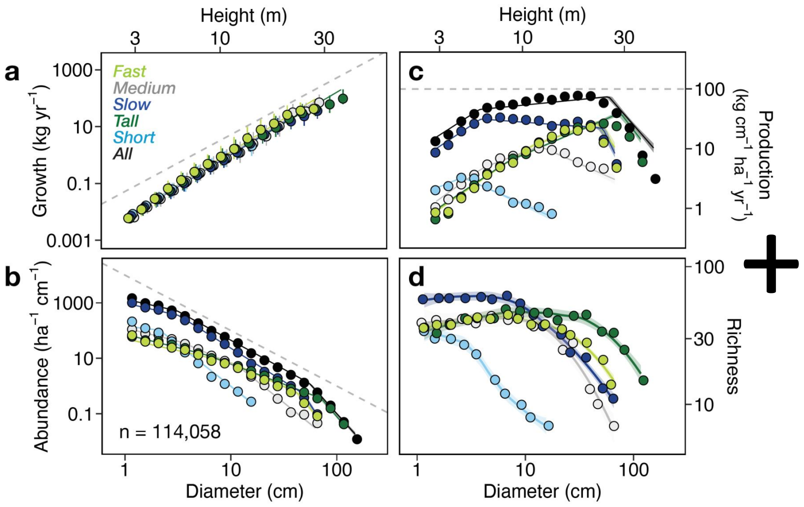


Objective 2: *Using RS data and models from Obj. 1 to make predictions across space*



Objective 2: *Using RS data and models from Obj. 1 to make predictions across space*

Static & Dynamic RS data



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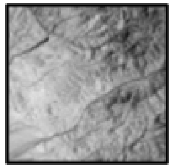

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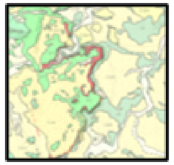

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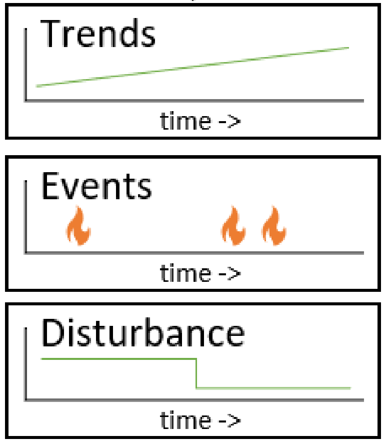

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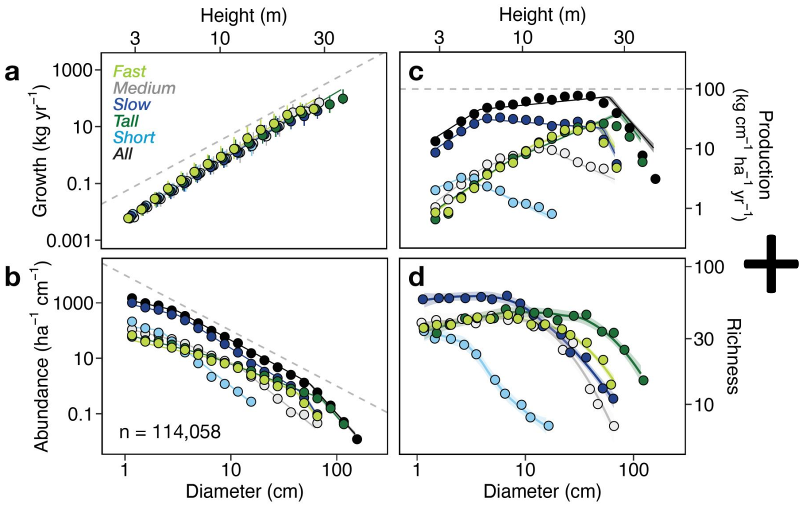

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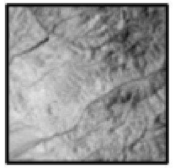

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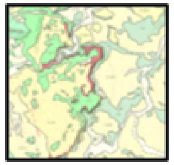

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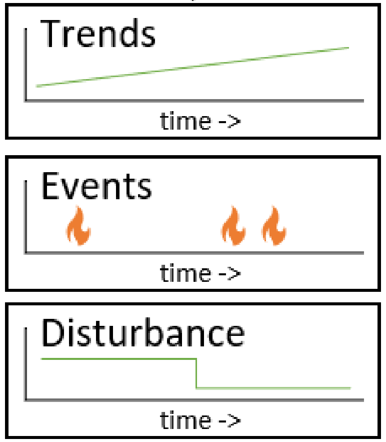
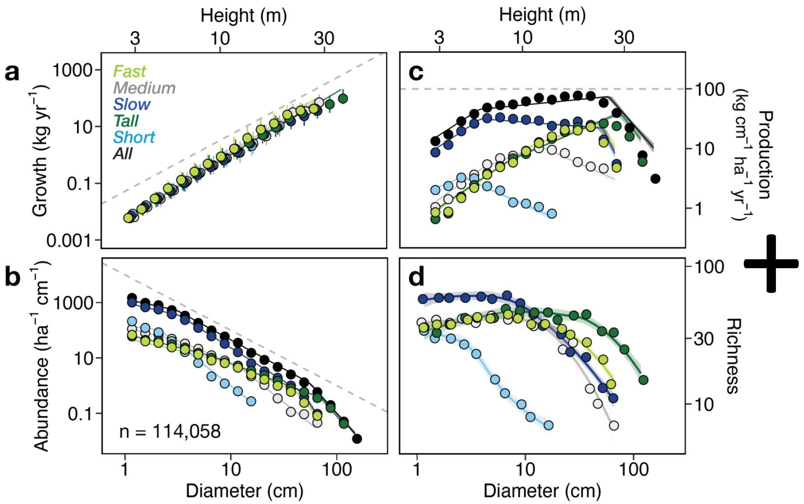


Predictions of functional group abundance and size across space

Objective 2: *Using RS data and models from Obj. 1 to make predictions across time*

Static & Dynamic RS data



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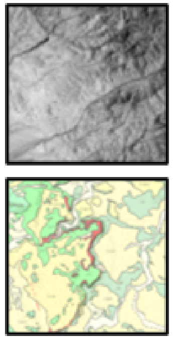

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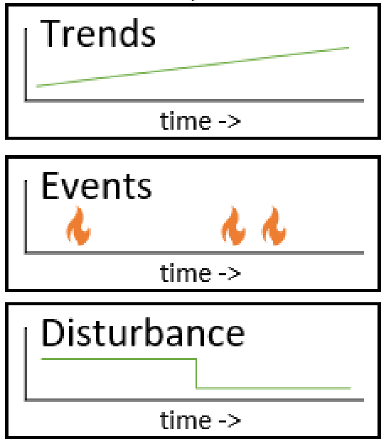

Predictions of functional group abundance and size across time

Validation