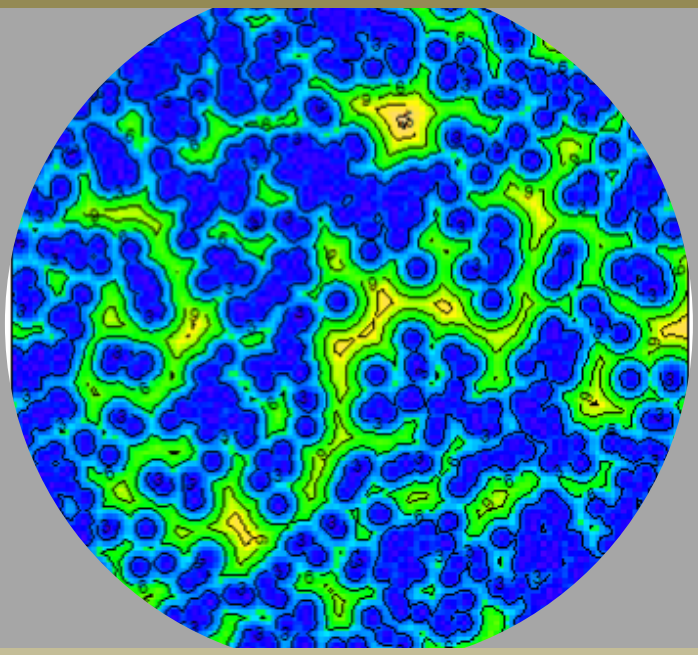
Evaluating fuels treatments' effects on structural arrangement in fire-frequent forests of Colorado



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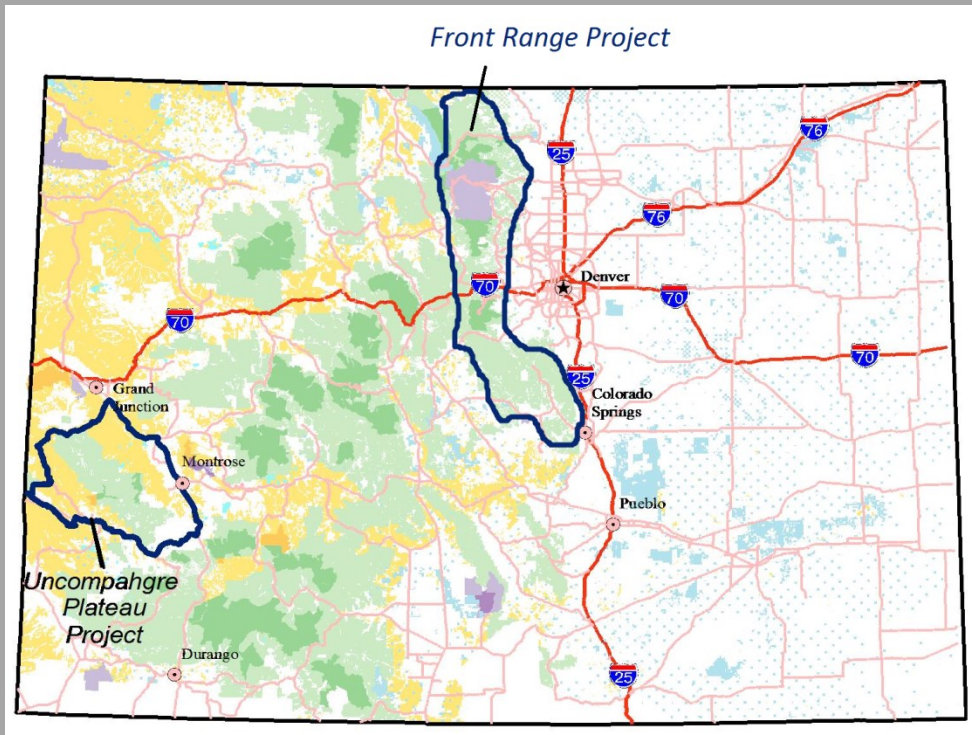
- Mike Battaglia, Research Forester, USDA Forest Service, Rocky Mountain Research Station

Background

- Two CFLRPs in CO, comprising 1.3 million acres
- Objectives: Use fuels treatments to increase forest resiliency, reduce fire hazard, and alter the vertical and horizontal structure
- Often desire creating a complex, clumpy structure



How do fuels treatments change structure?

Structure:

Type

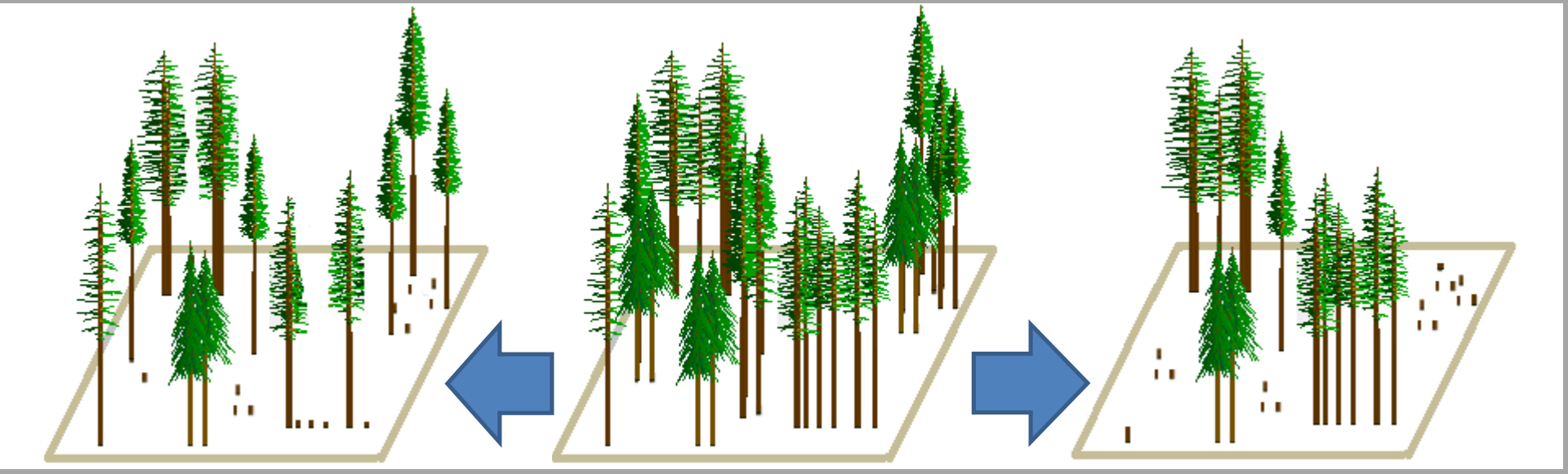
Size

Quantity

Arrangement

Pattern

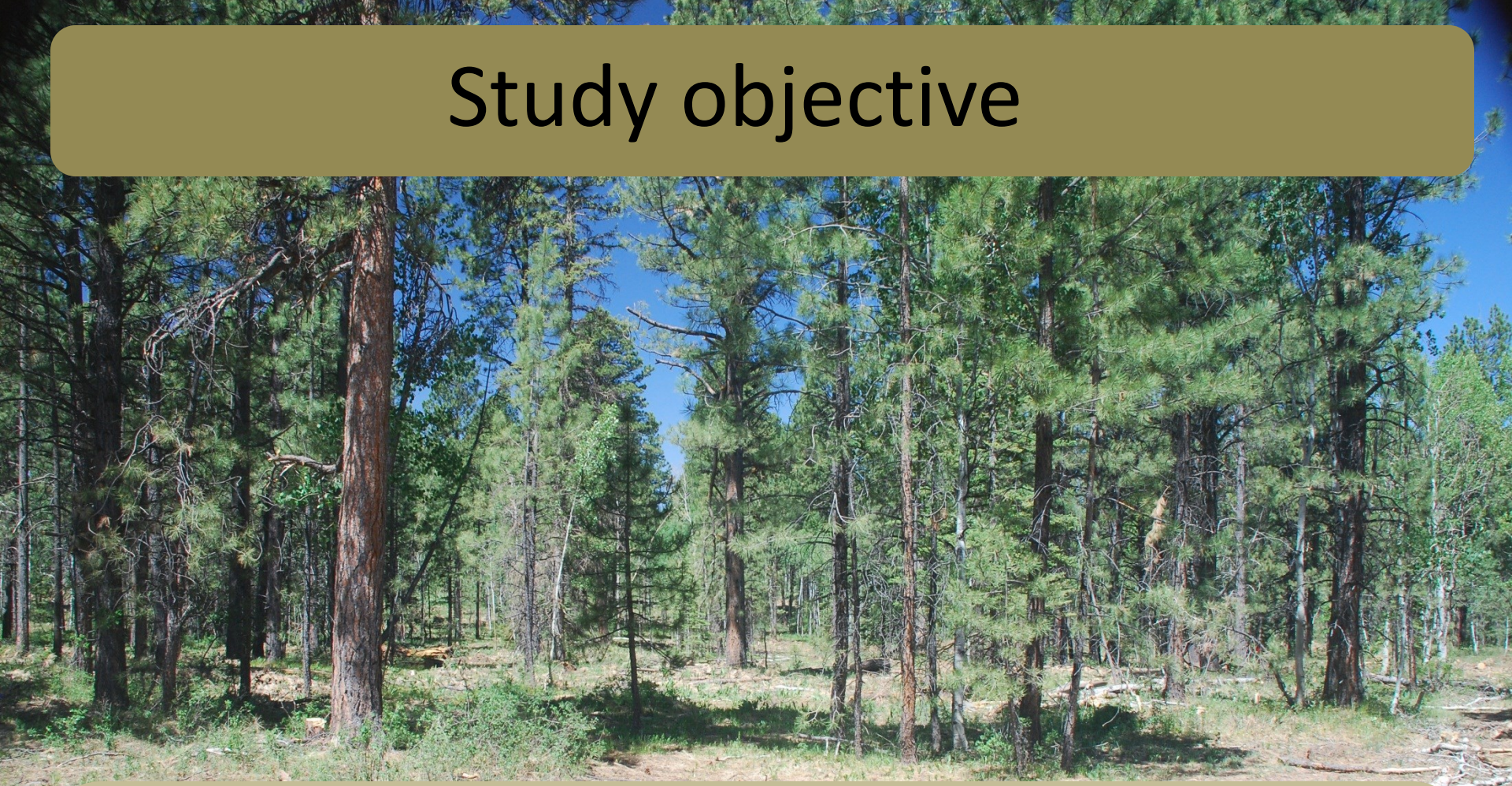
Complexity



Arrangement

Pattern and complexity are in a dynamic feedback loop with ecological processes and forest management

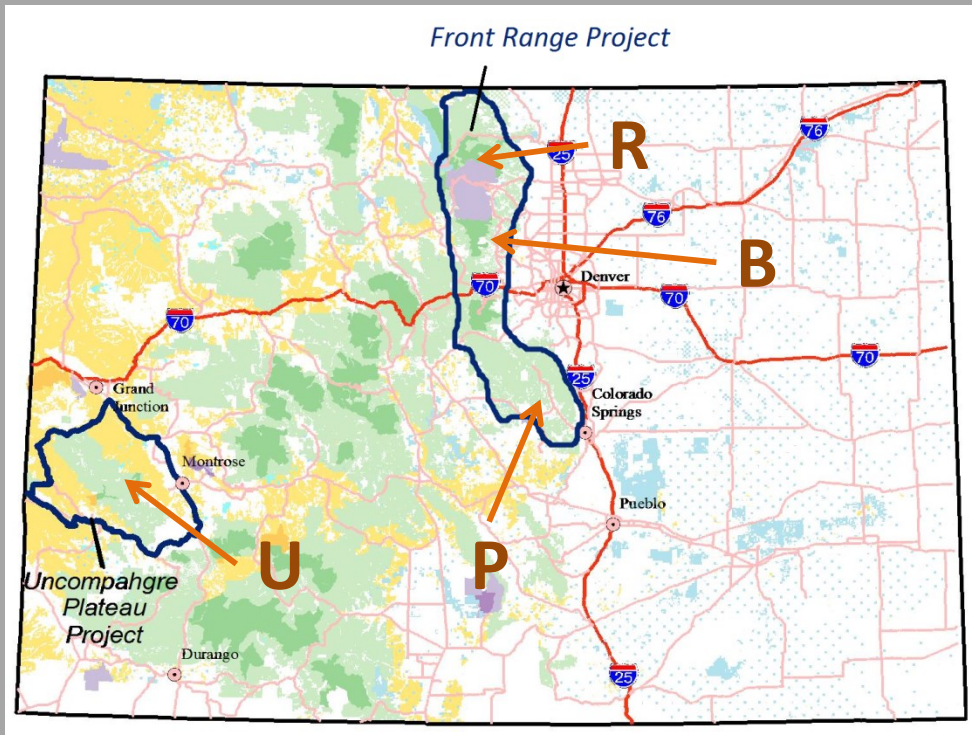
Study objective



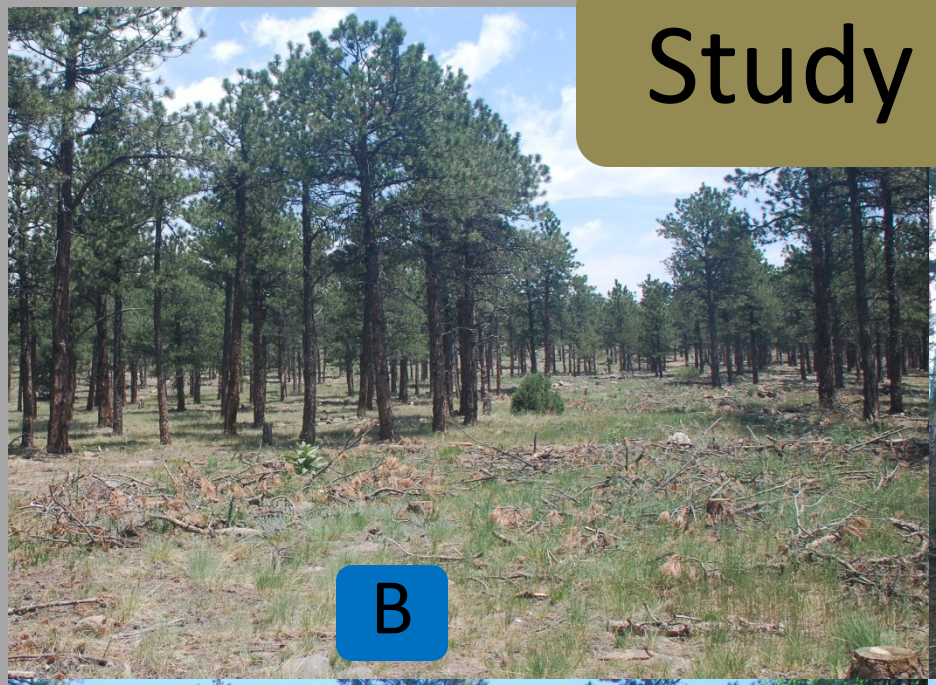
Quantify changes in spatial pattern and complexity following fuels treatment at both the global (site level) and local (within site) scale

Study sites

- Four 4ha plots following fuels treatment
  - Ponderosa pine to dry mixed conifer
  - 3 sites part of Front Range CFLRP
  - 1 site part of U.P. CFLRP
  - All sites mechanical
  - R also had RX burn

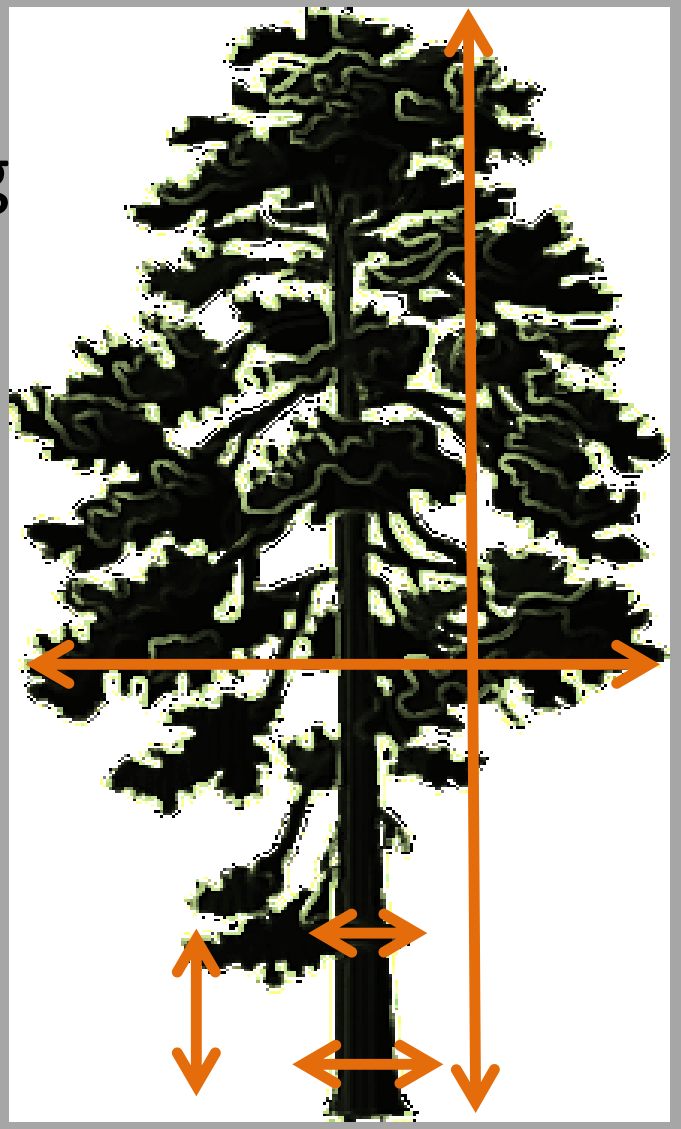


Study sites



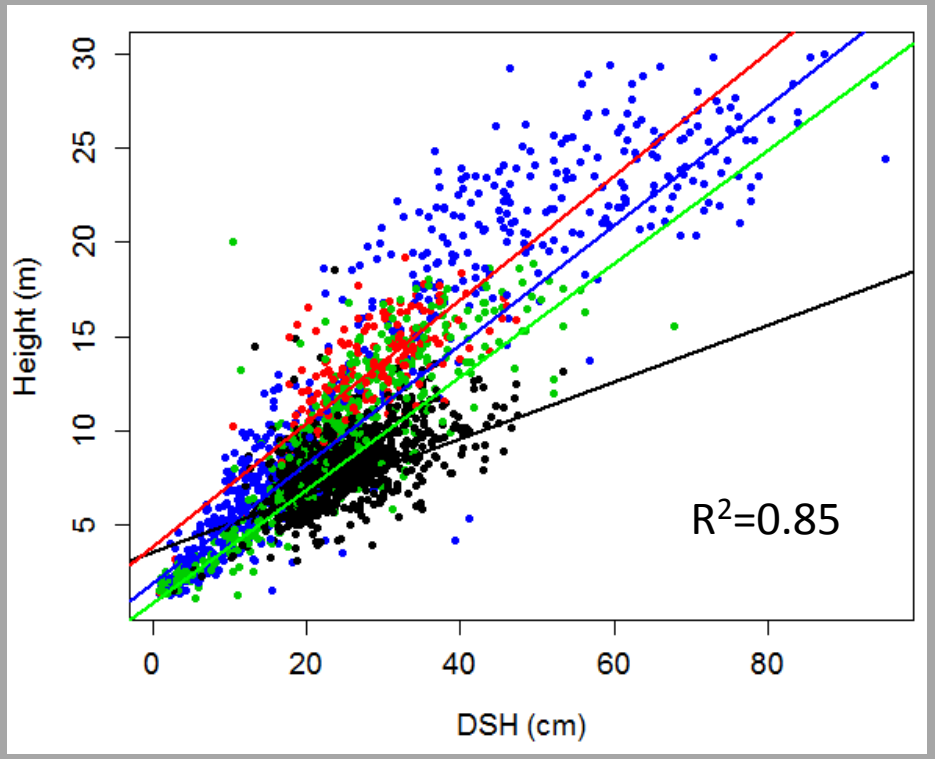
Methods

- All trees > 0.1 DBH were stem mapped and had the following measured
  - DBH, DSH, CW, HGT, CBH
- All stumps were stem mapped and DSH was measured



Reconstruction

- To reconstruct sites before treatment
  - Linear regression
  - DSH and site to predict individual tree measurements
  - Good fits were found for all variables
  - Applied to measured stumps



Framework for Analysis

Spatial patterns

- Global (site-scale)
  - O-ring function
- Local patterns (w/in site)
  - Patch detection

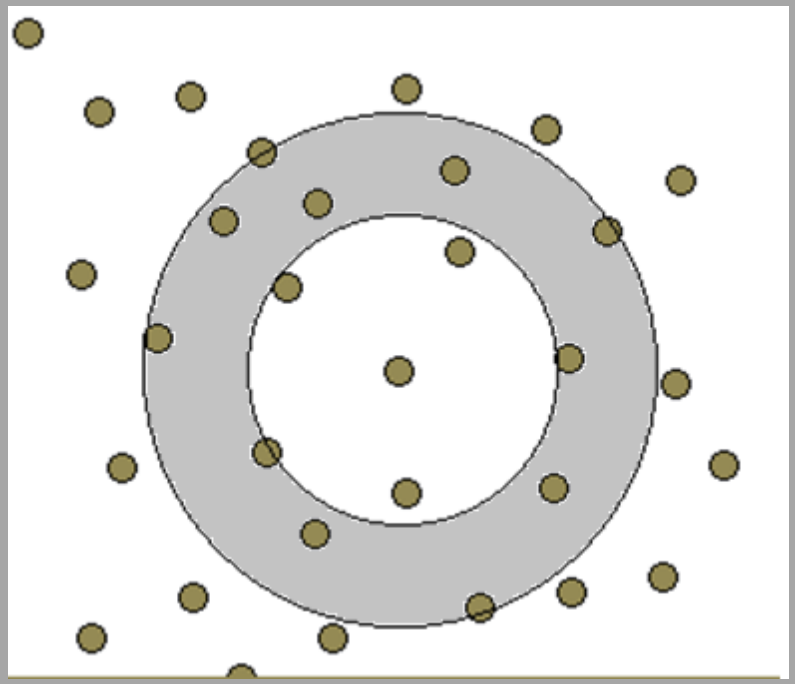
Complexity

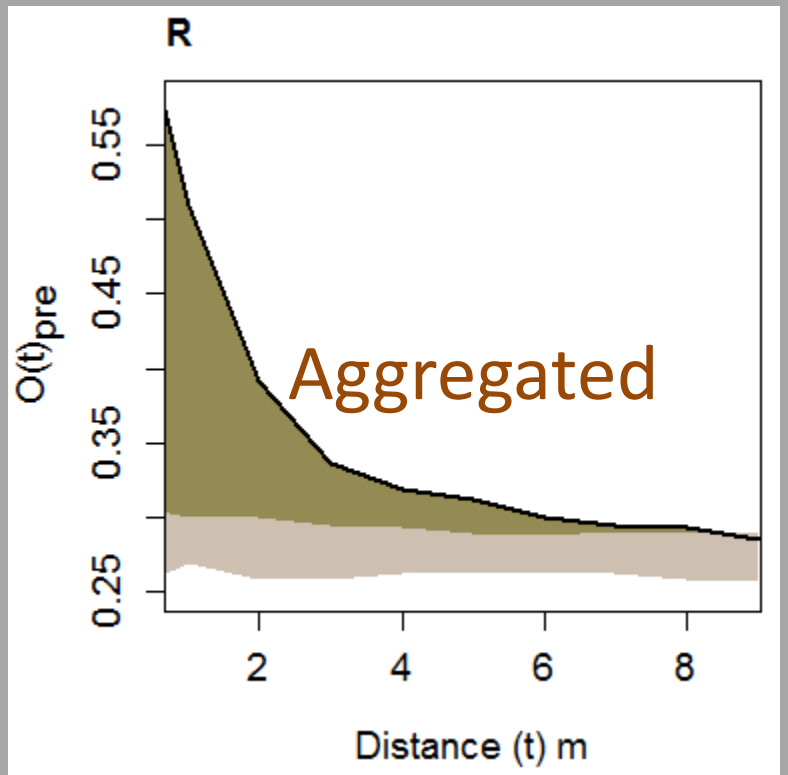
- Height Differentiation Index

Intro to global pattern analysis

O-ring function

- Similar to Ripley's K
- Used to determine spatial pattern of a distribution of points at multiple scales
  - Regular, random, aggregated





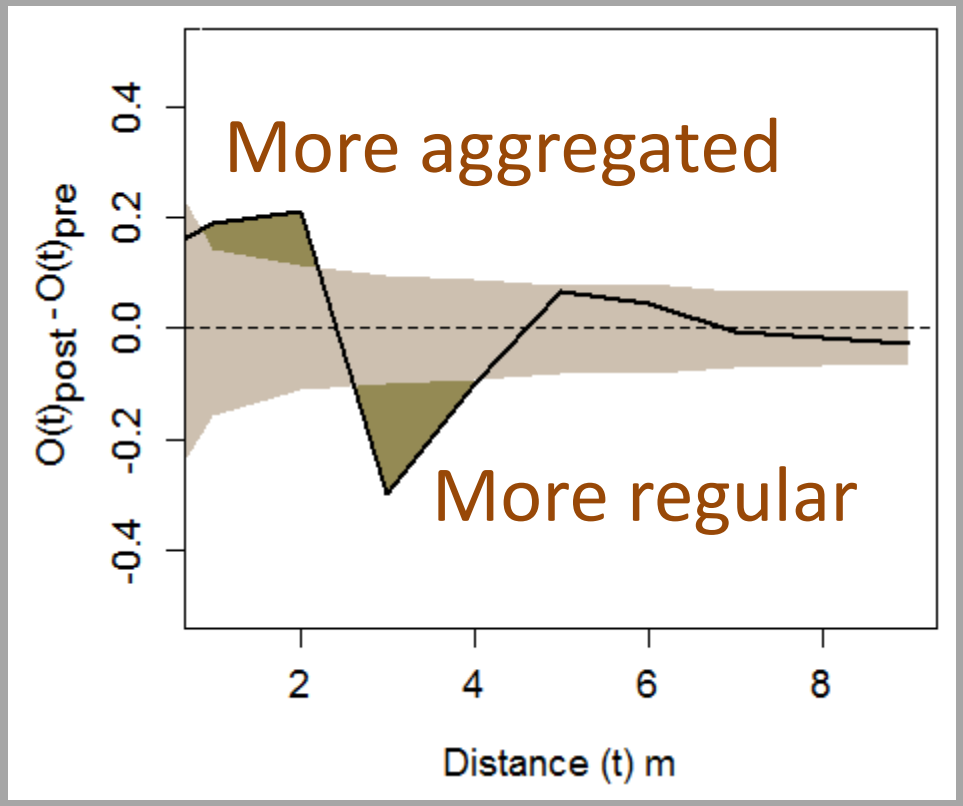
Treatment effect on global pattern

Did treatments change degree of aggregation?

- Calculate difference in O-ring statistics pre-post
- Simulate probable differences were pattern similar
- GoF test from 1-9m in 3m intervals

Above: more agg.

Below: more reg.



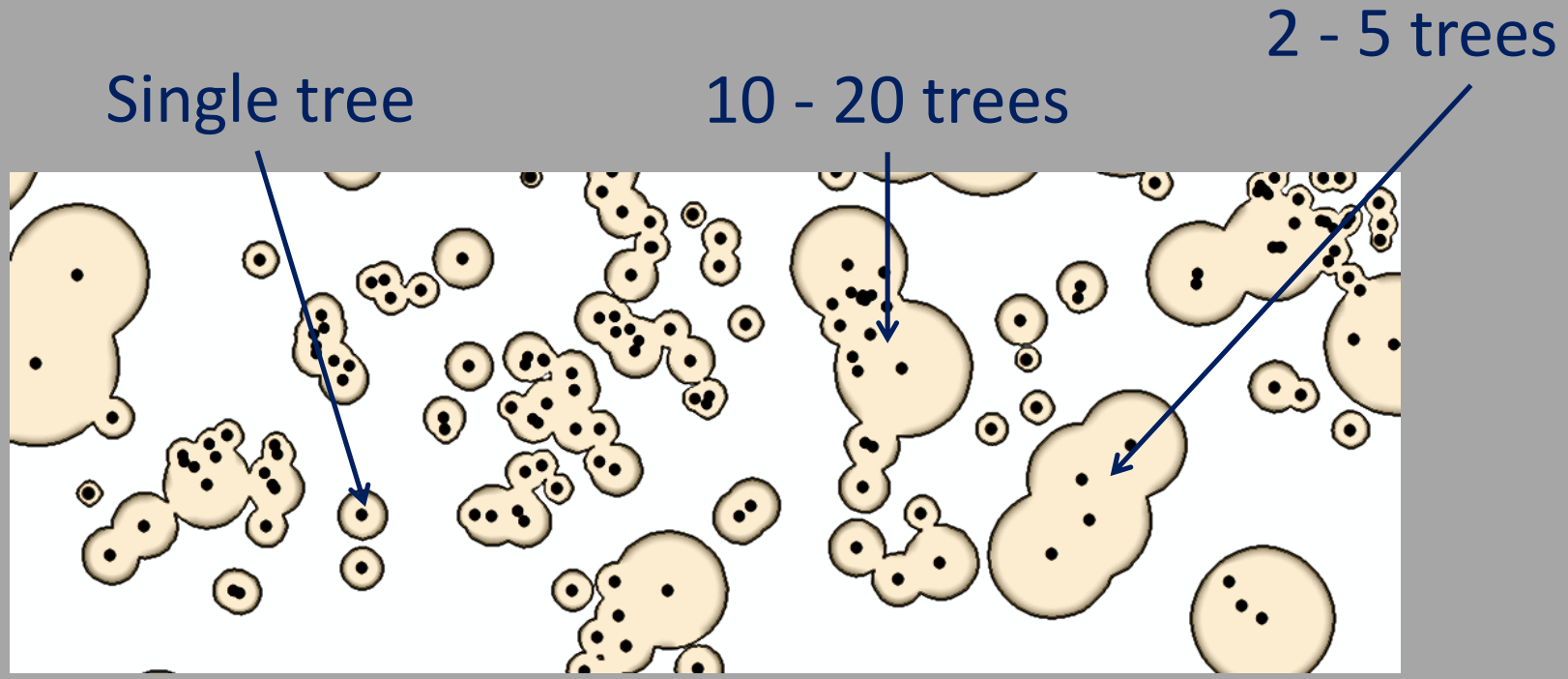
Local pattern analysis

Patch Detection

- Overlap of measured crowns

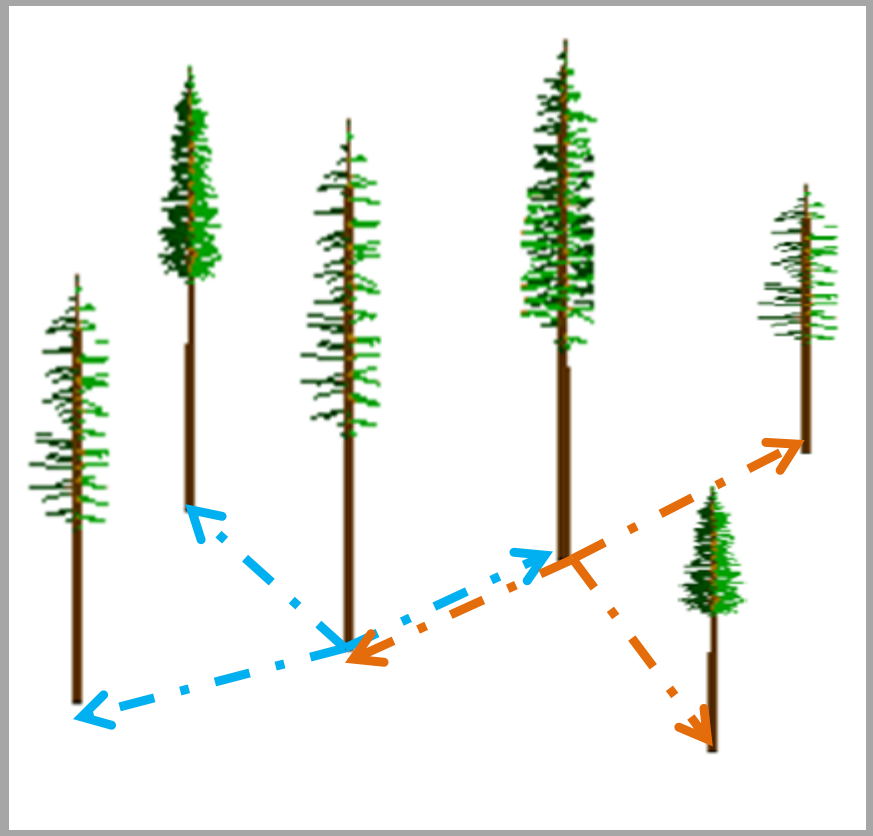
Categorized sizes of trees per patch

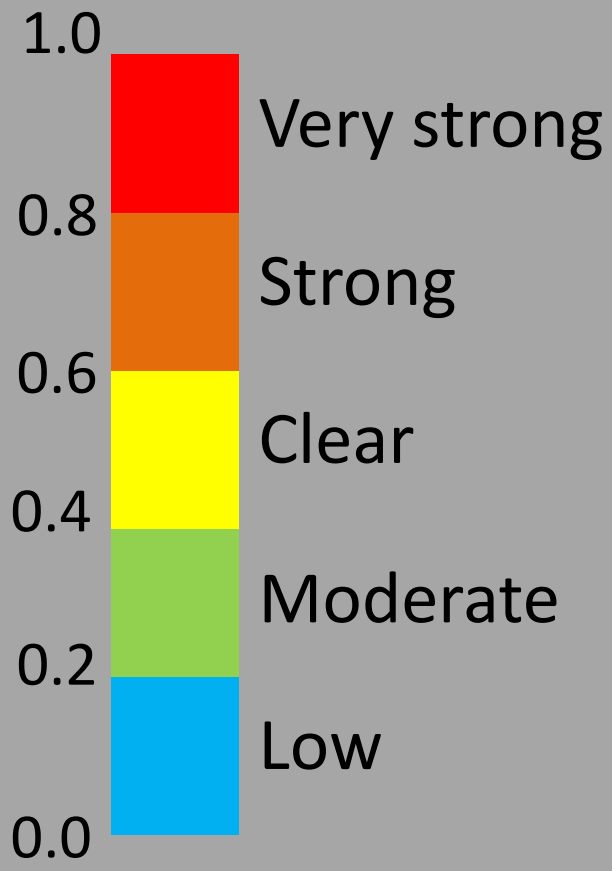
- Single trees, 2-5, 5-10, 10-20, 20+



Complexity analysis

Height Differentiation Index (TH)





Structure changes – quantity and size

Initial Basal Area: 30 to 14 m^2/ha

Initial Trees per Hectare: 400 to 900

	% Reduction		Absolute change	
Site	Basal Area (m^2/ha)	Trees per hectare	QMD (cm)	Mean Ht (m)
B	21	30	1	0
P	56	72	-1	0
U	60	48	1	1
R	36	66	7	2

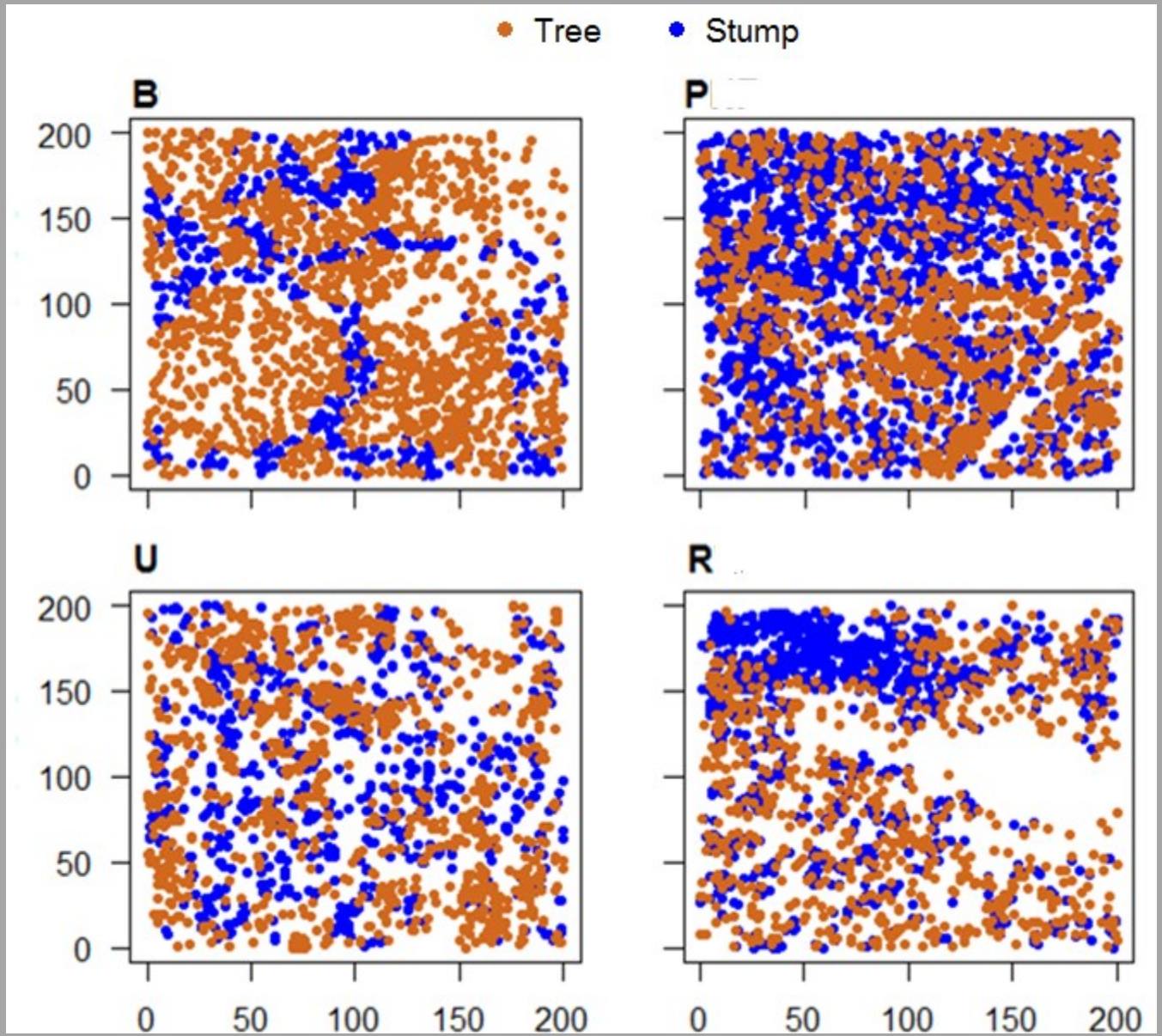
Structure changes – type

Site P- ↑ % PIPO; ↓ % Other conifers

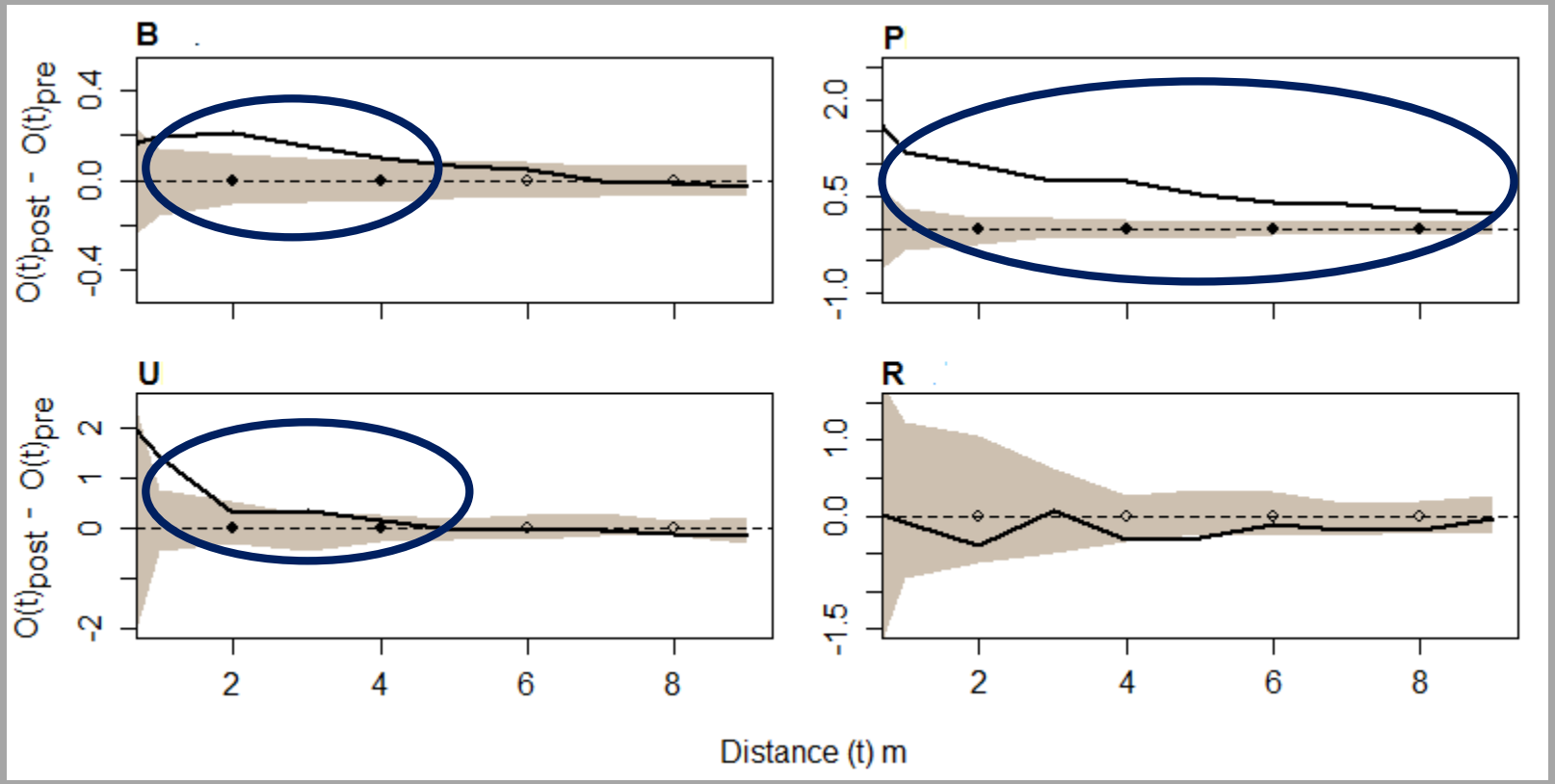
Other sites – Little change

Change in % BA (m^2/ha) by species					
Site	PIPO	PSME	Hardwood	PICEA	JUSC
B	0	0	-	-	0
P	+12	-14	10	-9	-
U	-1	-	3	-2	-
R	+2	+1	0	-	0

Stem maps



Change in global pattern



- Increased degree of aggregation in three sites
- No change by treatment at RNF

Change in patch number and size

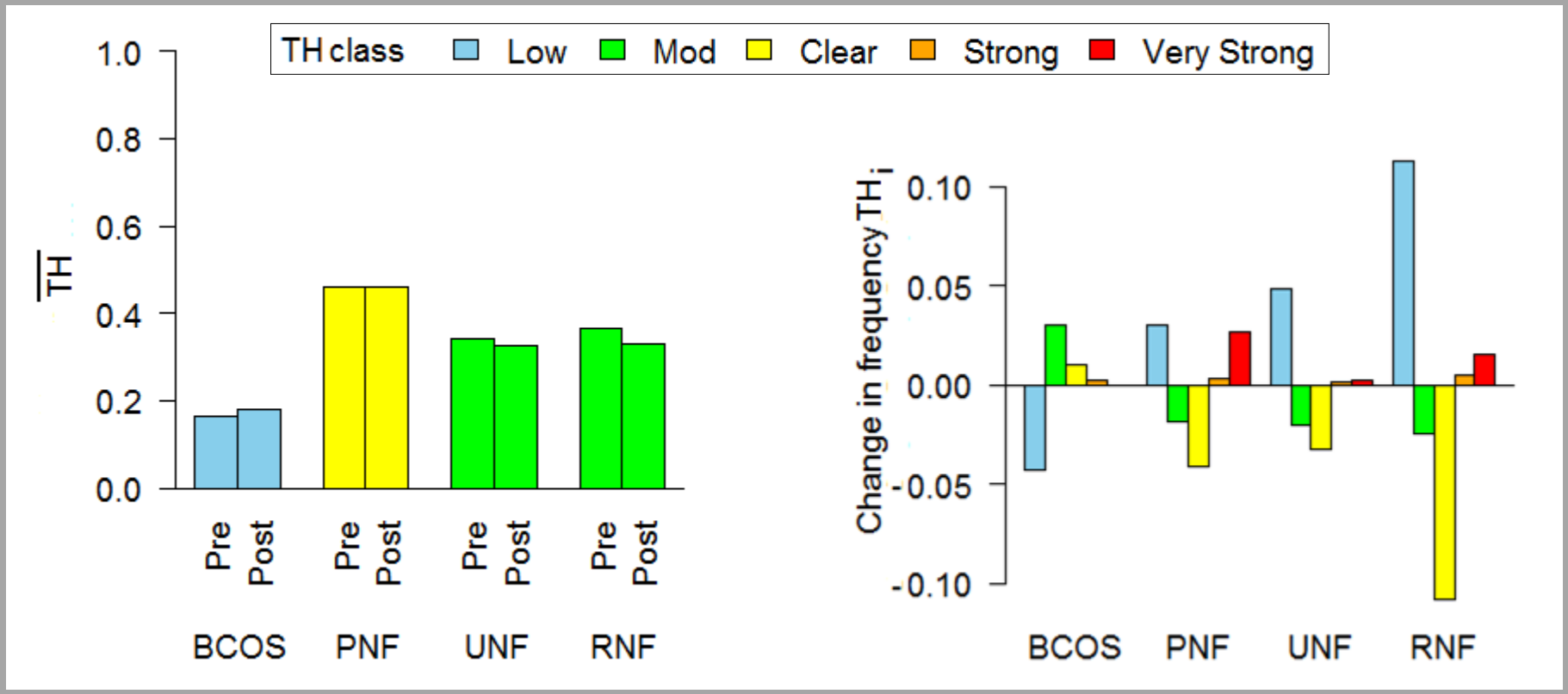
- 50 to 100 patches/ha pre-treatment
- 30 to 55 patches/ha post-treatment

Site	% change of single trees	% change of patch size			
		2 to 5 trees	5 to 10 trees	10 to 20 trees	20+ trees
BCOS	6	2	-1	-1	-1
PNF	24	17	-7	-4	-6
UNF	2	9	0	-5	-5
RNF	39	24	-6	-11	-8

Fewer patches that are smaller in size!

Change in complexity

Height Differentiation Index (TH) results



Little change in complexity globally masked by changes in both directions locally

Piecing it together

- Increased aggregation for three sites
  - One site showed increased aggregation across all spatial scales
  - One showed no change in amount of aggregation
- Fewer number of patches; more of them are smaller

3 treatments are meeting desired goals of increasing “clumpiness” at our site scale

- The other treatment still maintained “clumpiness”

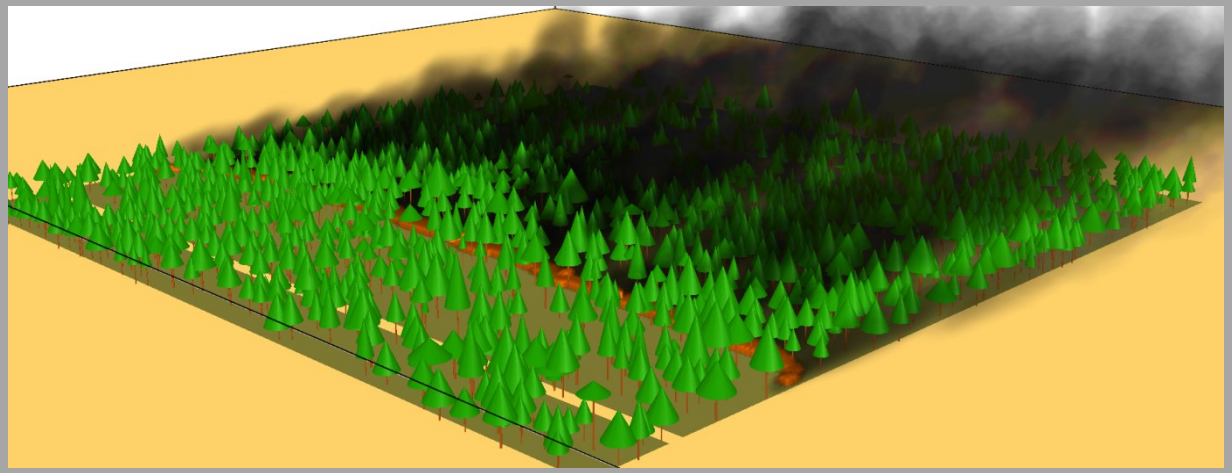
Piecing it together

- No wholesale change in site complexity
  - In 3 treatments, more neighborhoods of low and high complexity. Less of moderate complexity

  Treatments maintained stand complexity. It is unclear how local changes fit into management goals

Future work

- Expand number of sites included in this investigation
- Evaluate the influence of treatments on predicted fire behavior using a physics based model WFDS
  - Simulations will be conducted across a range of wind speeds
  - Input of individual trees in 3D space allows for structural heterogeneity



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Thanks! Any questions?