Post-Fire Forest Regeneration Monitoring in California's National Forests

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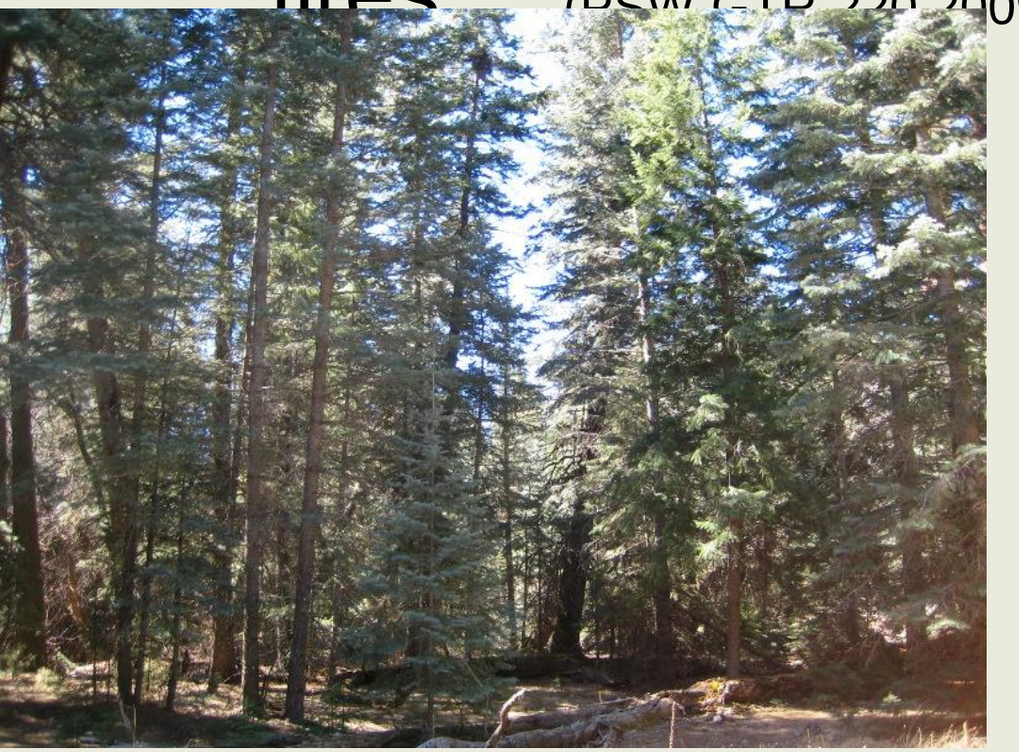
Wildfire on National Forest lands

- Fire as disturbance regime (Sugihara et al. 2006, North et al. 2009)
- Fire as a tool for ecological restoration, leading to spatial heterogeneity. In particular, low to mid-severity fires (PSW GTR 220 2009)



Increase in fire frequency & severity
(Miller et al. 2009)

What are the impacts of fire on forest recovery?

Regeneration in the Post-fire Environment

- Quantify natural regeneration patterns in spatial detail across a wide variety of low- and mid-elevation fires of similar age
- Monitor species-specific natural regeneration rates, accounting for differences in topography, fire intensity, and spatially explicit variables.
- Provide these data to parameterize Forest Growth Simulator models.
- Understanding regeneration is critical to effectively applying scarce restoration funds

My Research Questions

I. What factors are driving regeneration patterns? What is limiting tree seedling abundancies across a range of fire severities?

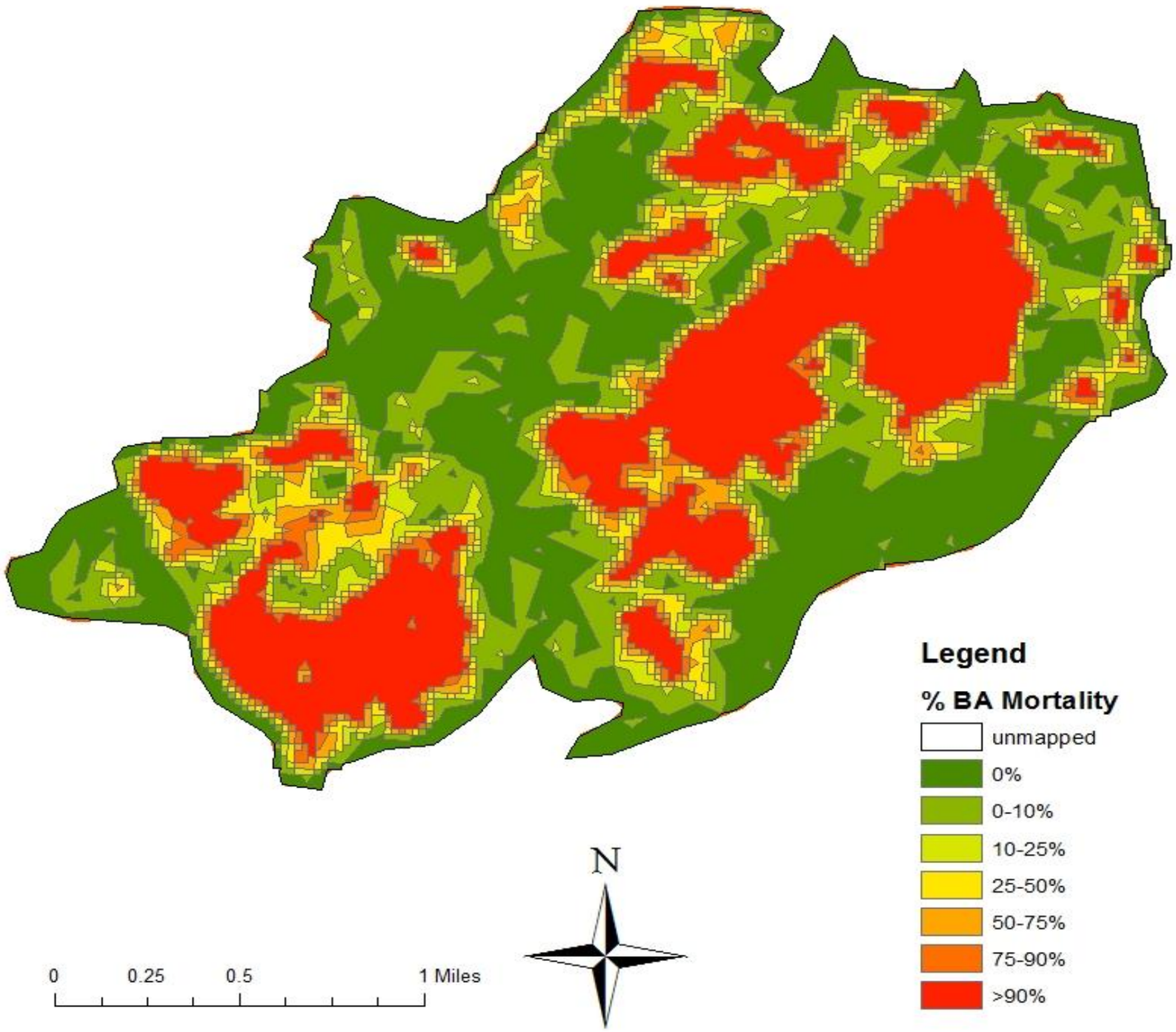
II. Do conifers respond differently than hardwoods to fire disturbance? Do conifers have a numerical advantage over hardwoods in the early stages of revegetation in the post-fire environment?

Future question:

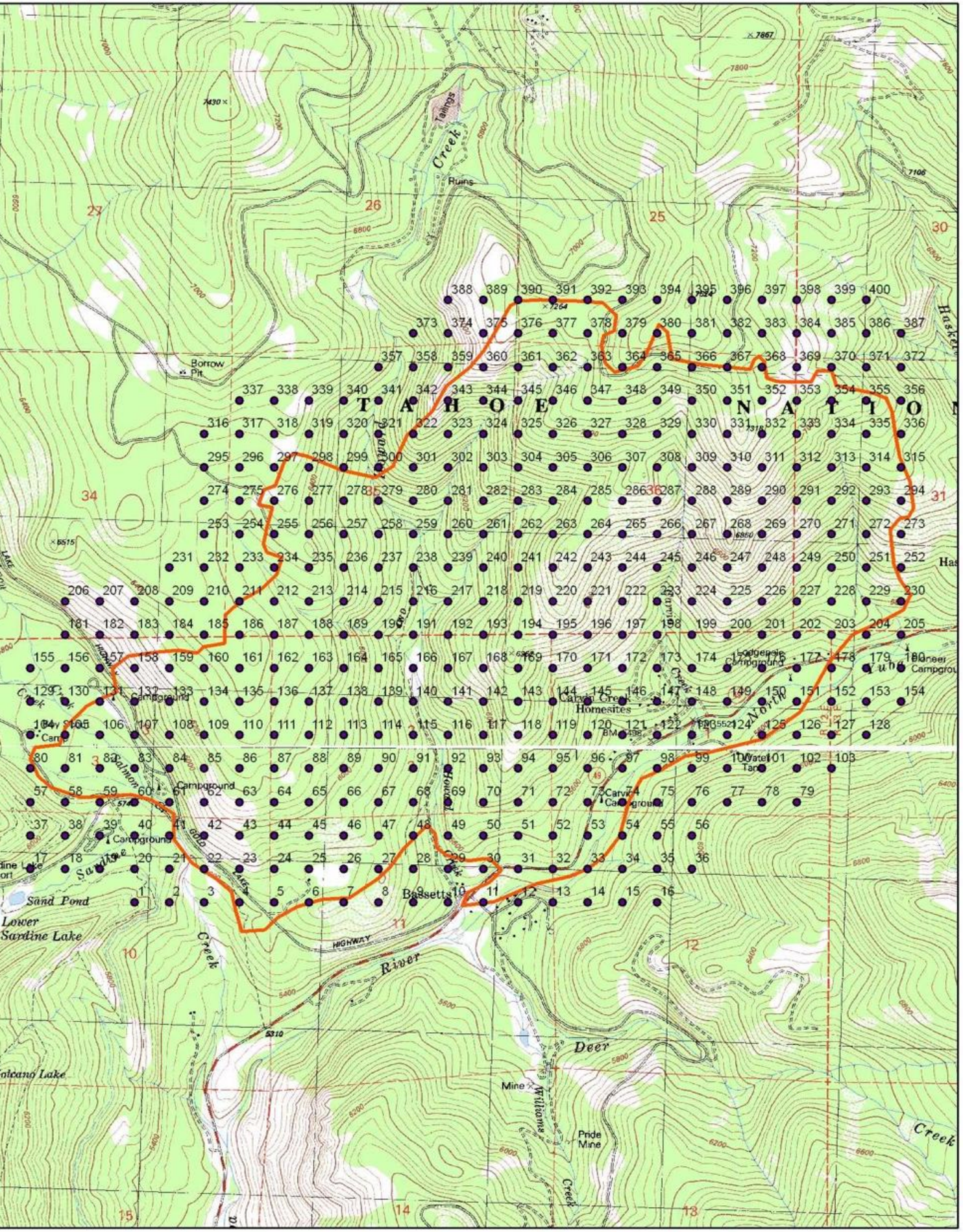
III. To what extent is regeneration dependent on interannual climate variation? And how might these year effects be mitigated through time?

Bassetts Fire (2006)

Tahoe National Forest



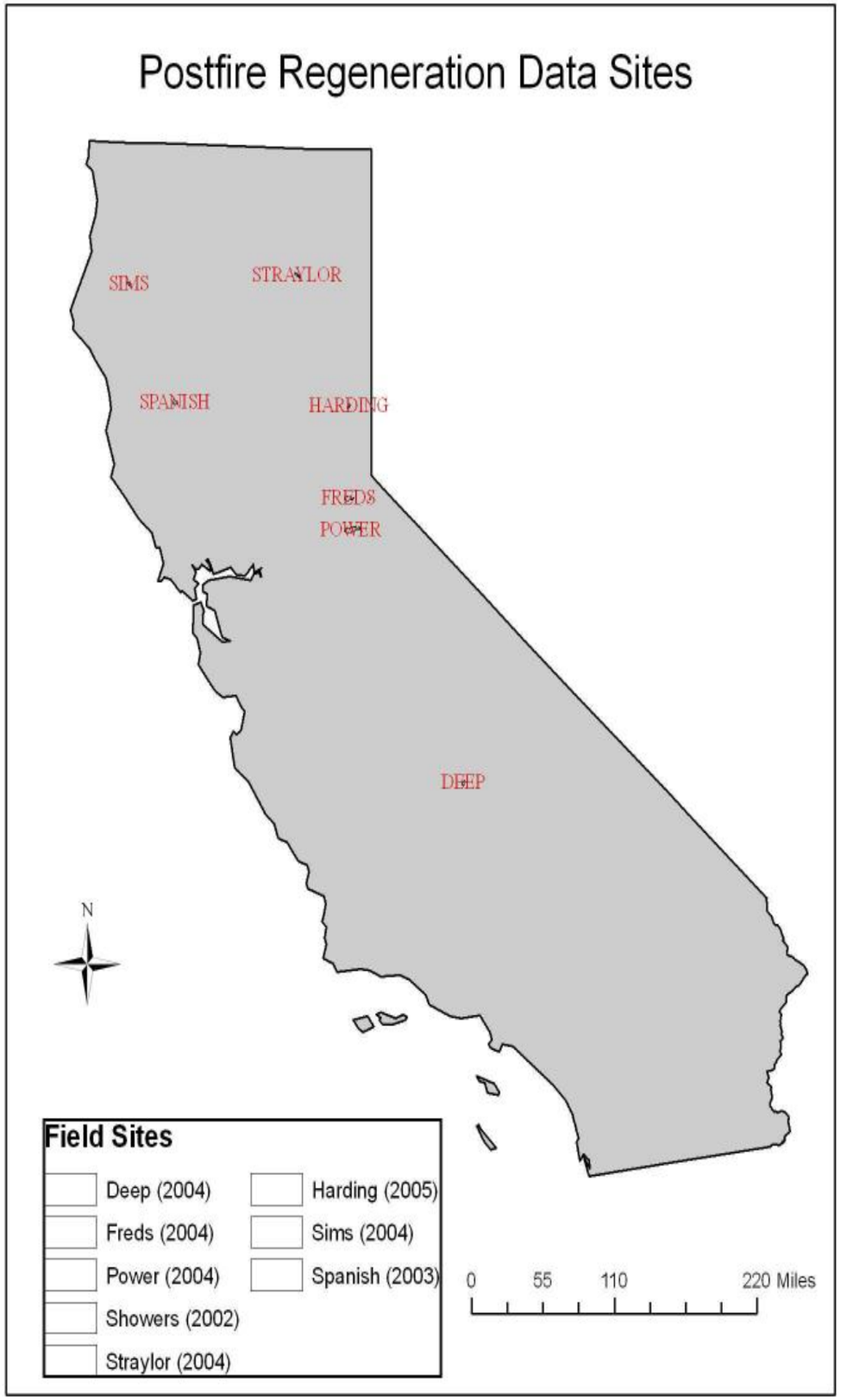
- Each LANDSAT pixel is assigned a fire severity class, using the relative dNBR (Miller & Thode, 2007)
- mixed conifer/hardwood forests; 200m grid is overlayed to represent a 10-acre sample point (660 ft interval, and 4 ha sample)



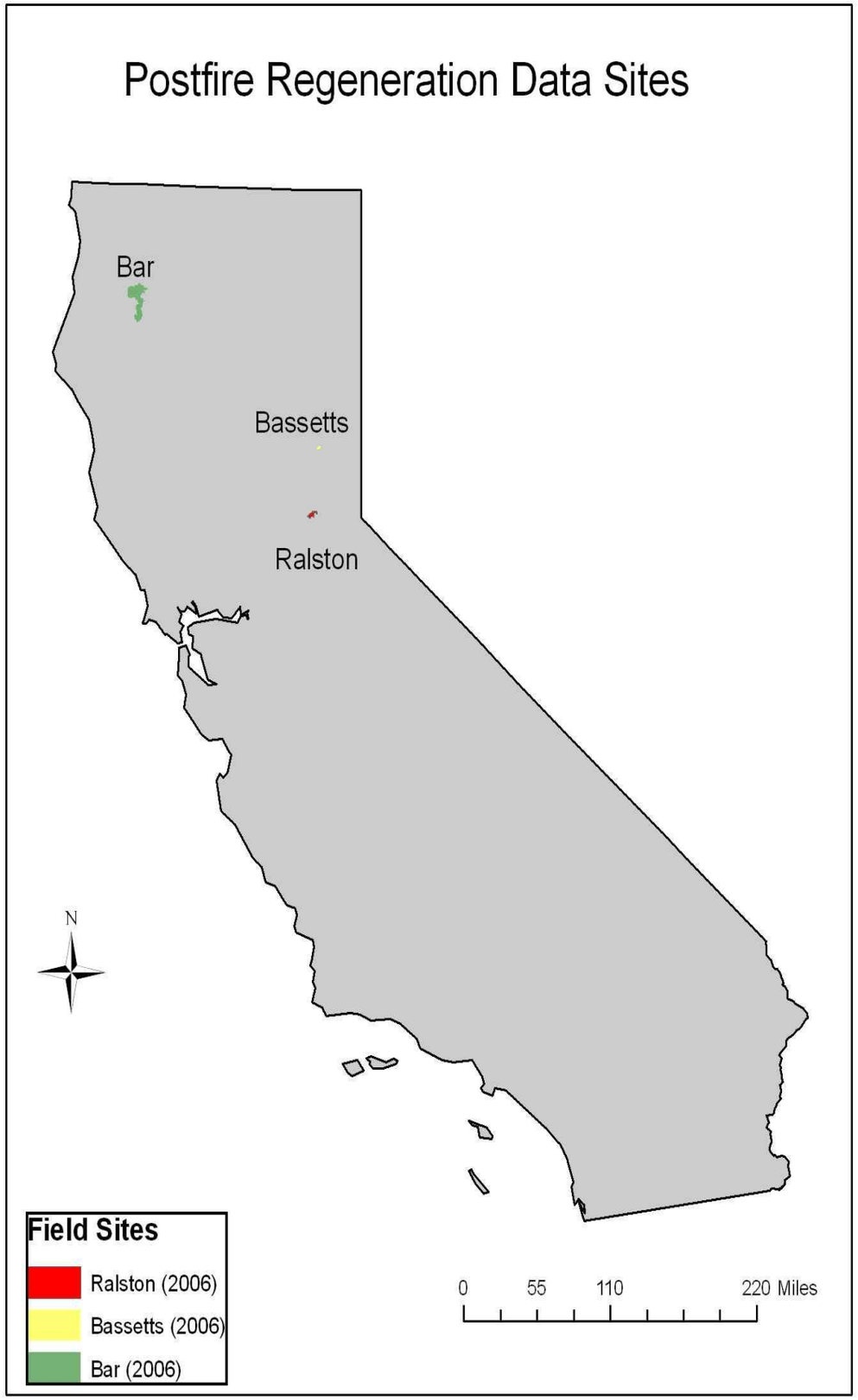
Bassetts Fire (2006)

Fire Severity	total # of plots
0	22
1	14
2	14
3	15
4	21
5	42

2009-10 Field Seasons



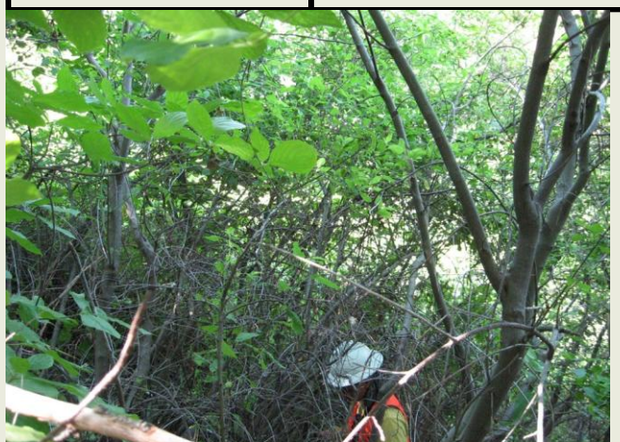
2011 Field Season



Regeneration Plots

Table 1: Sampled Fires

Fire	National Forest	Year	acres burned	Year sampled	Plots installed
Deep	Sequoia	2004	3,164	2009	24
Fred's	El Dorado	2004	7,471	2009	121
Power	El Dorado	2004	16,979	2009	155
Straylor	Lassen	2004	3,333	2009	62
Showers	Lake Tahoe Basin	2002	325	2009	17
Spanish	Mendocino	2003	6313	2010	145
Sims	Shasta-Trinity & Six Rivers	2004	3901	2010	88
Pendola	Tahoe & Plumas	1999	12,295	2010-11	180
Harding	Tahoe	2005	2291	2010	67
Bar	Shasta-Trinity	2006	101,652	2011	90
Bassetts	Tahoe	2006	2,600	2011	128
Ralston	Tahoe & El Dorado	2006	8,593	2011	94
		Total:	**168,917**		**1,171**



Other fires: Showers Fire, Story Fire, Cedar Fire, Angora, and Rich Fire

Seedlings

Pinus

Abies

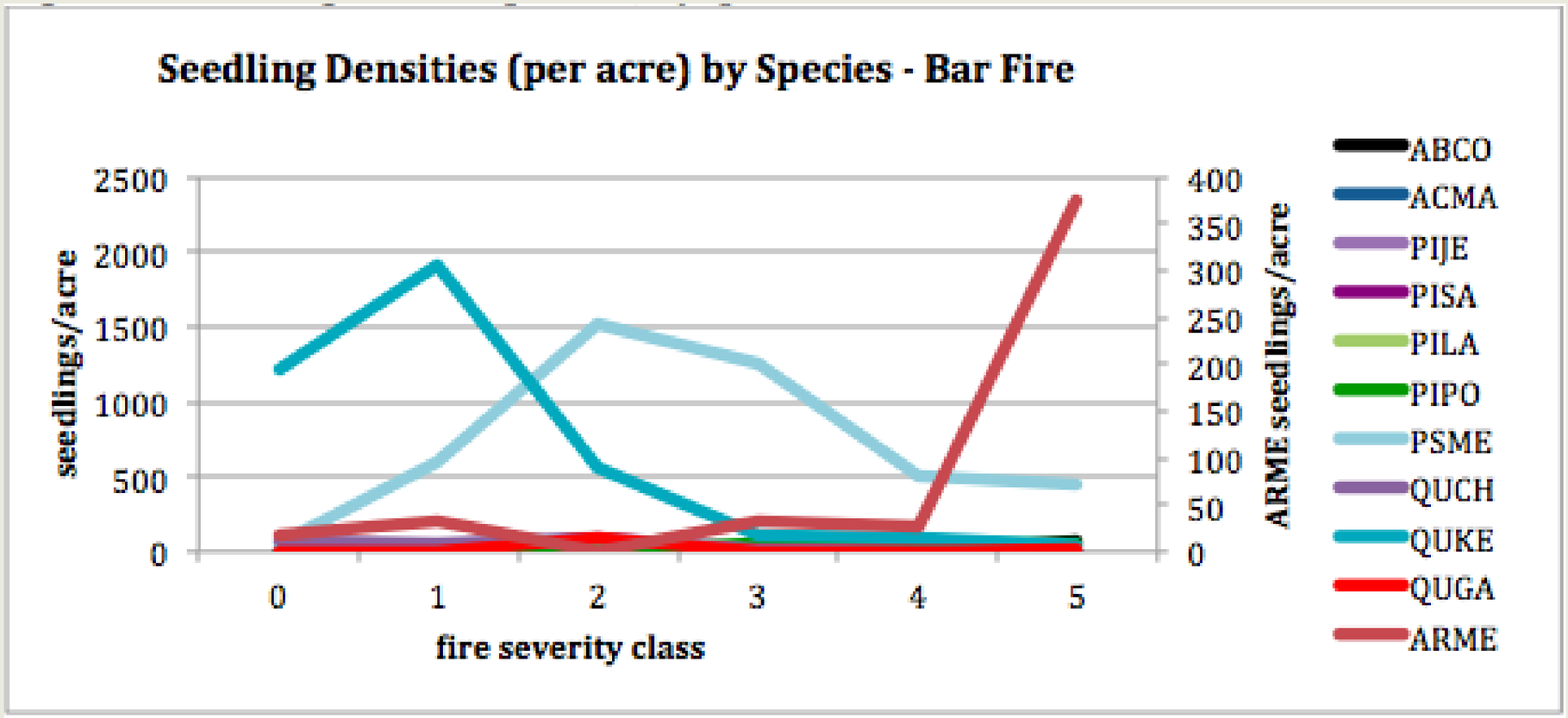
Hardwood resprouts

Quercus. . . .

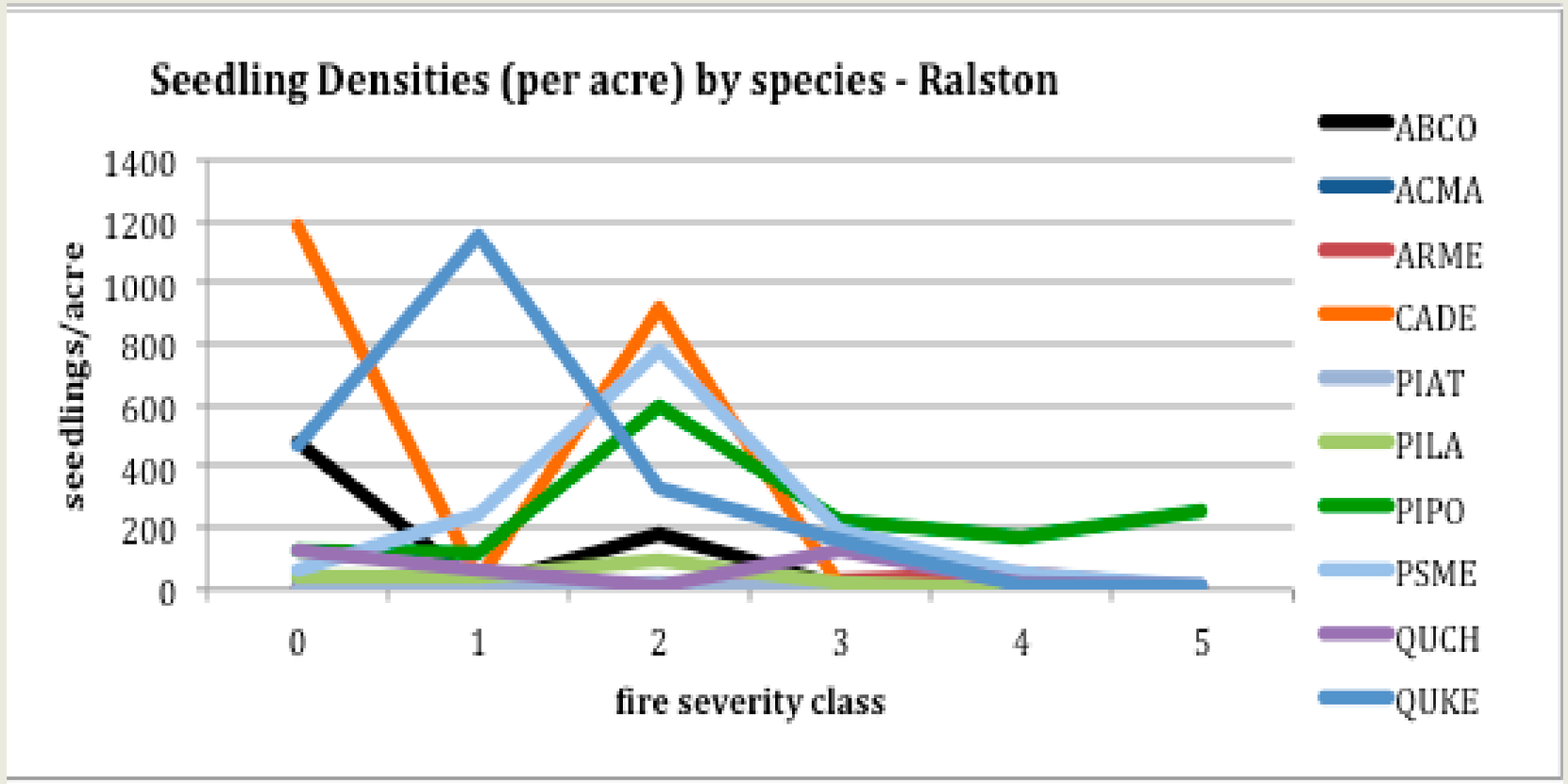
Competition/interaction with shrubs

- *Ceanothus*
- *Ribes*
- *Arctostaphylos*
- *Chamaebatia*

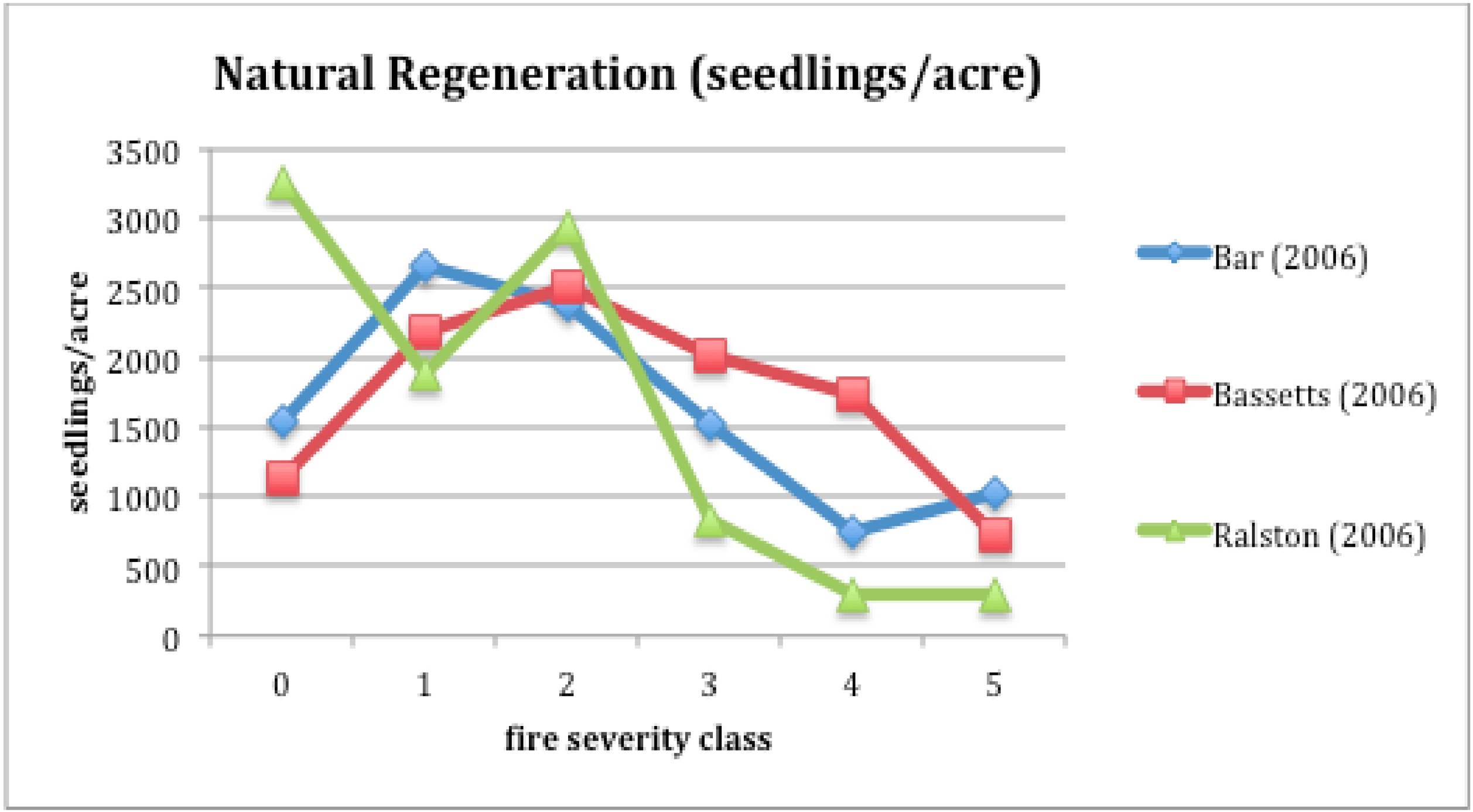
Natural Regeneration by Species



What does it look like when combined into one natural regeneration rate?

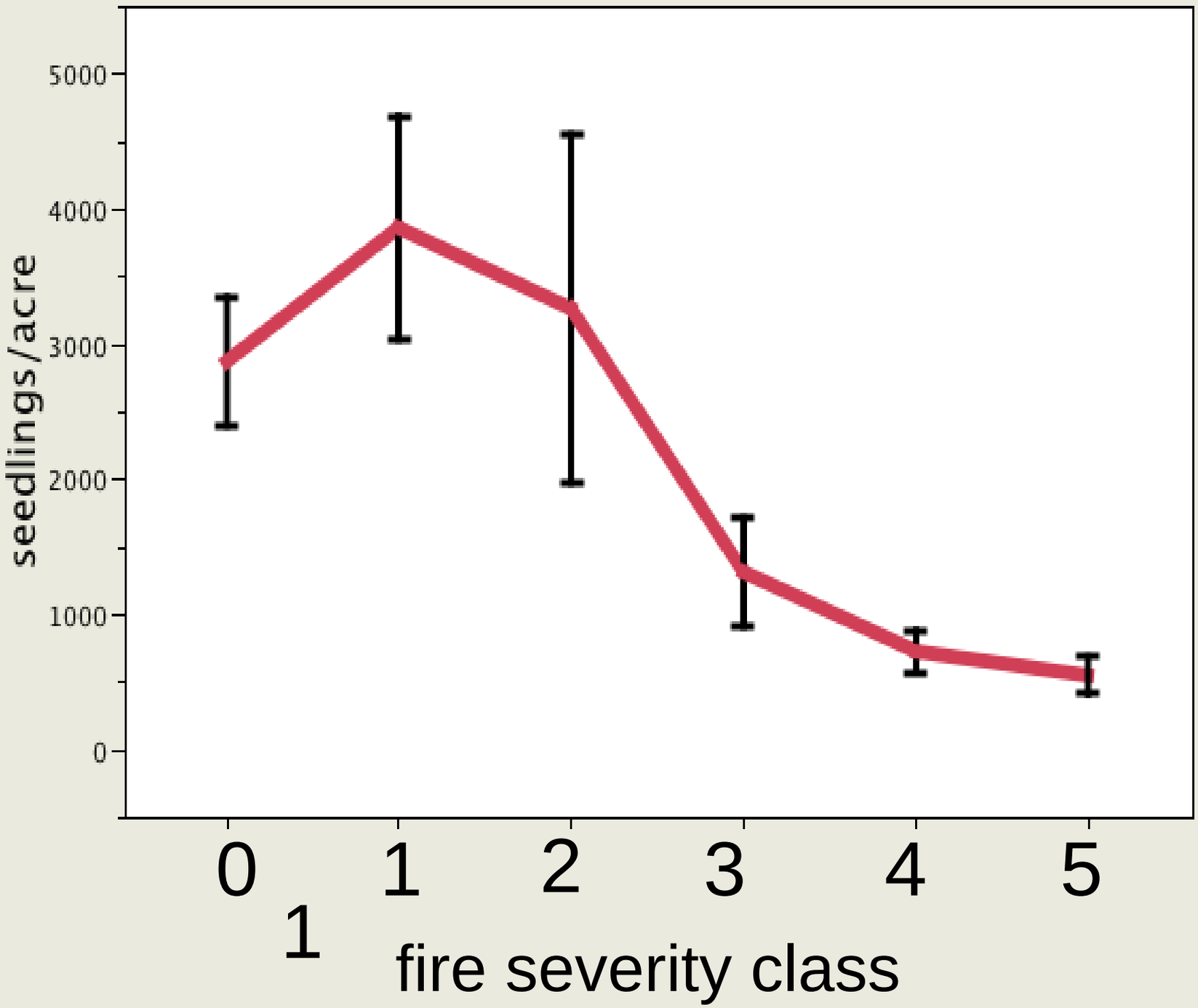


Natural Regeneration Rates

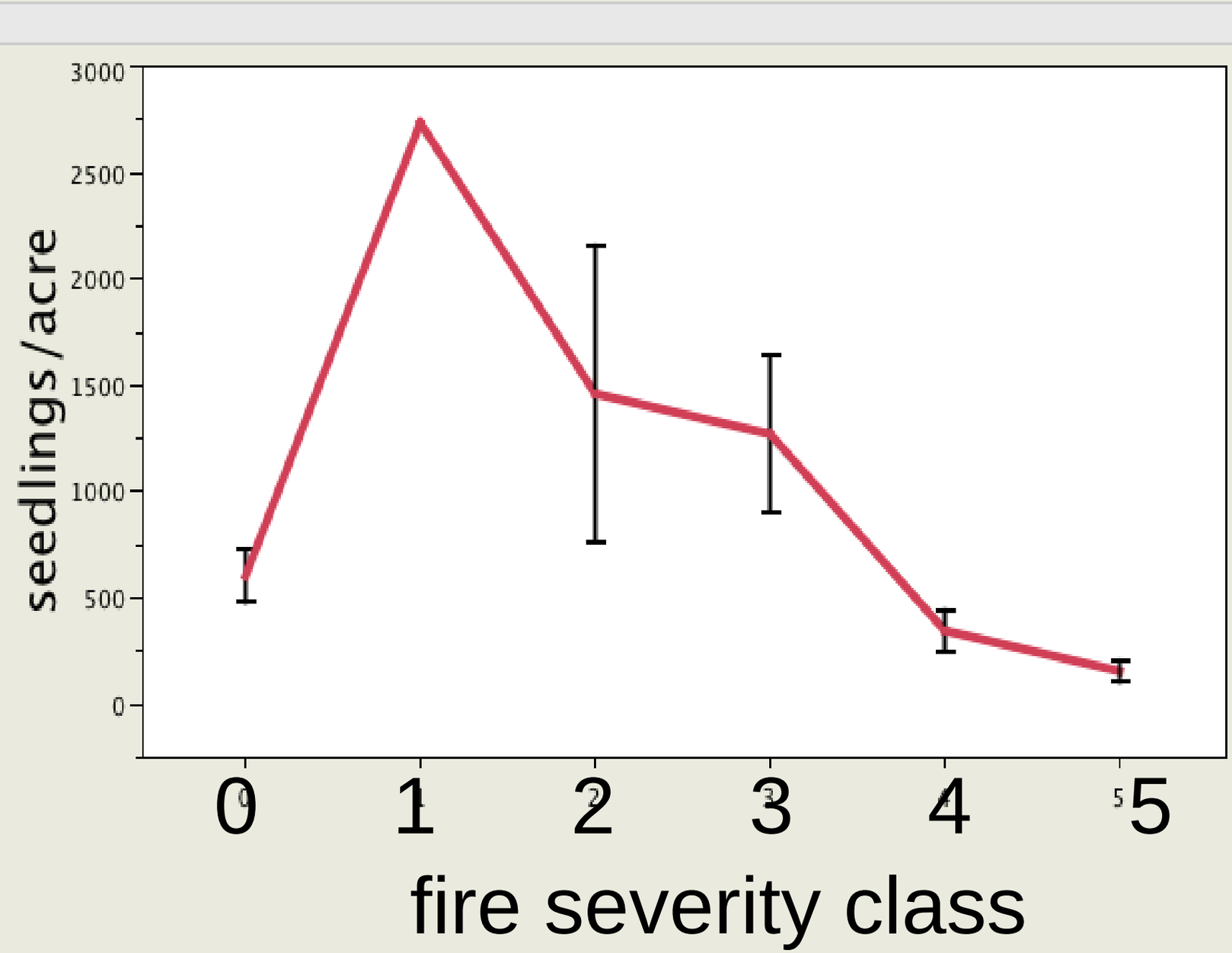


What is responsible for this shape?

Pendola Natural Regeneration:
11-12 years after the fire, TNF & PNF



Natural Regeneration (seedlings/acre)
Freds Fire



Why this shape?

Possible factors:

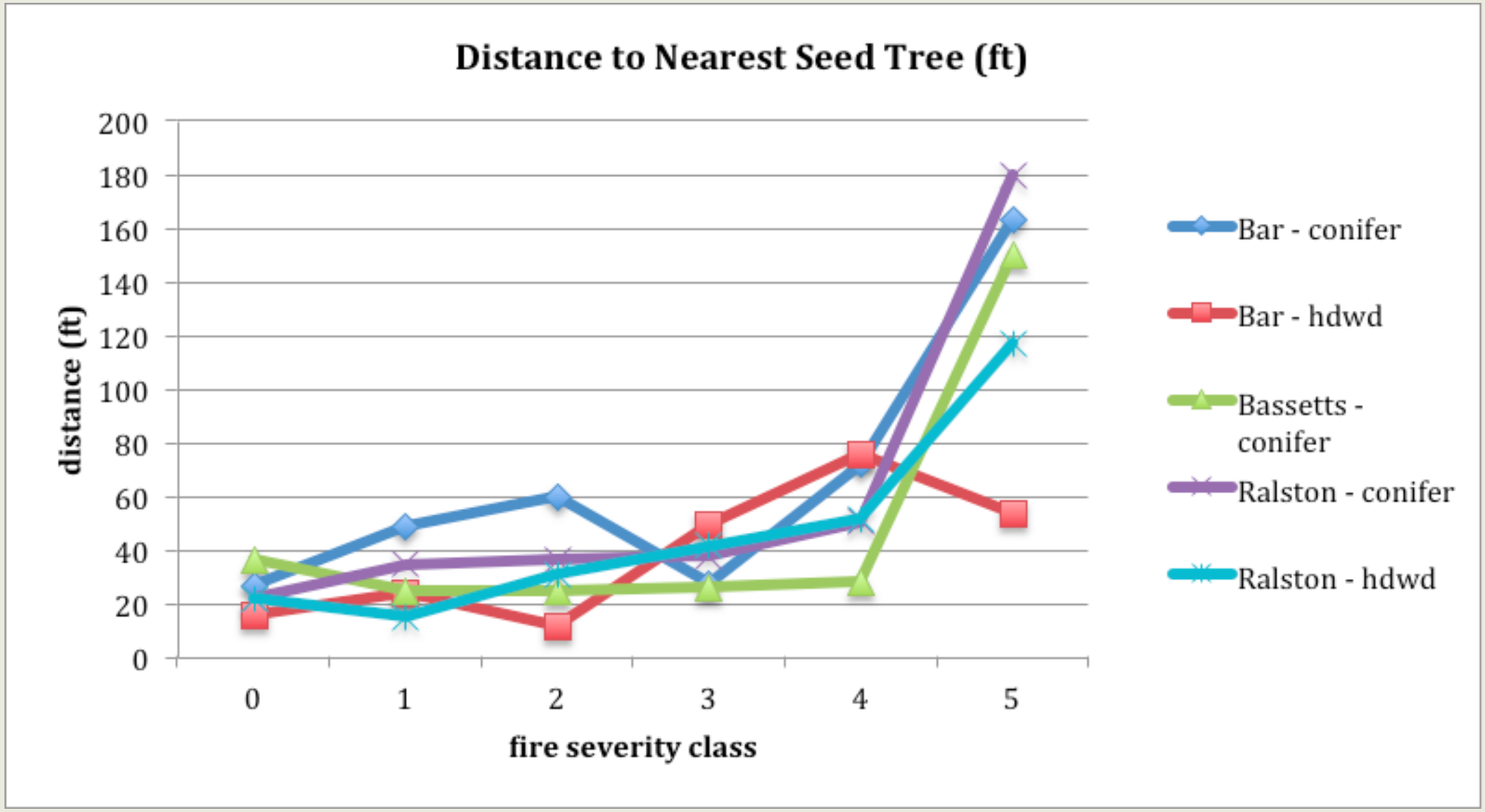
-seed mortality

-distance to potential seed tree

- harsh conditions; lack of safe microsites and favorable micro-climatic conditions

- competing/facilitating high shrub cove

Distance to Seed Tree



Classification and regression trees revealed that in most fires, distance to potential seed tree was the most influential predictor of regeneration

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Distance to Seed Tree

Ralston Fire

Figure 24: conifer density (seedlings/acre) by distance to con seed tree (ft) – Ralston Fire

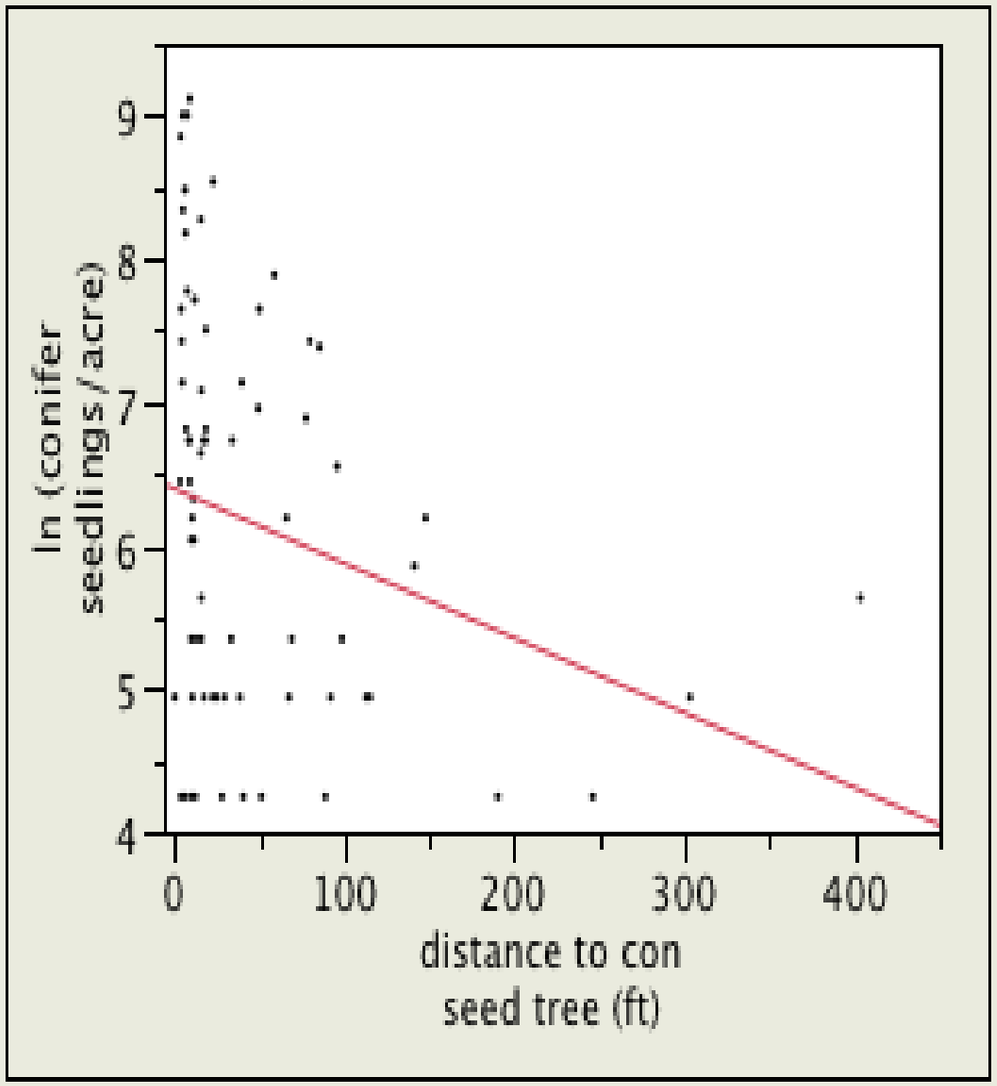

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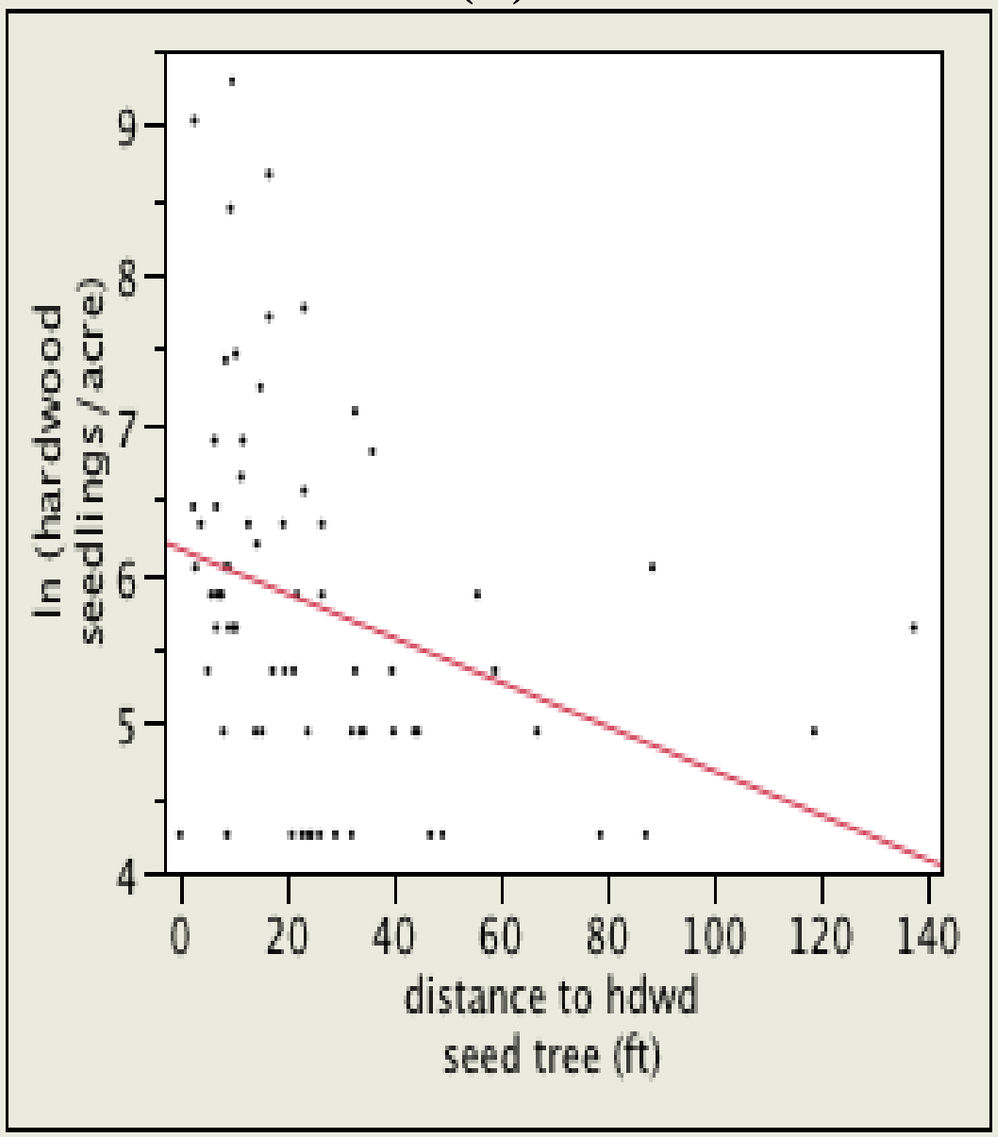
Figure 25: hardwood density (seedlings/acre) by distance to hardwd seed tree (ft) – Ralston Fire



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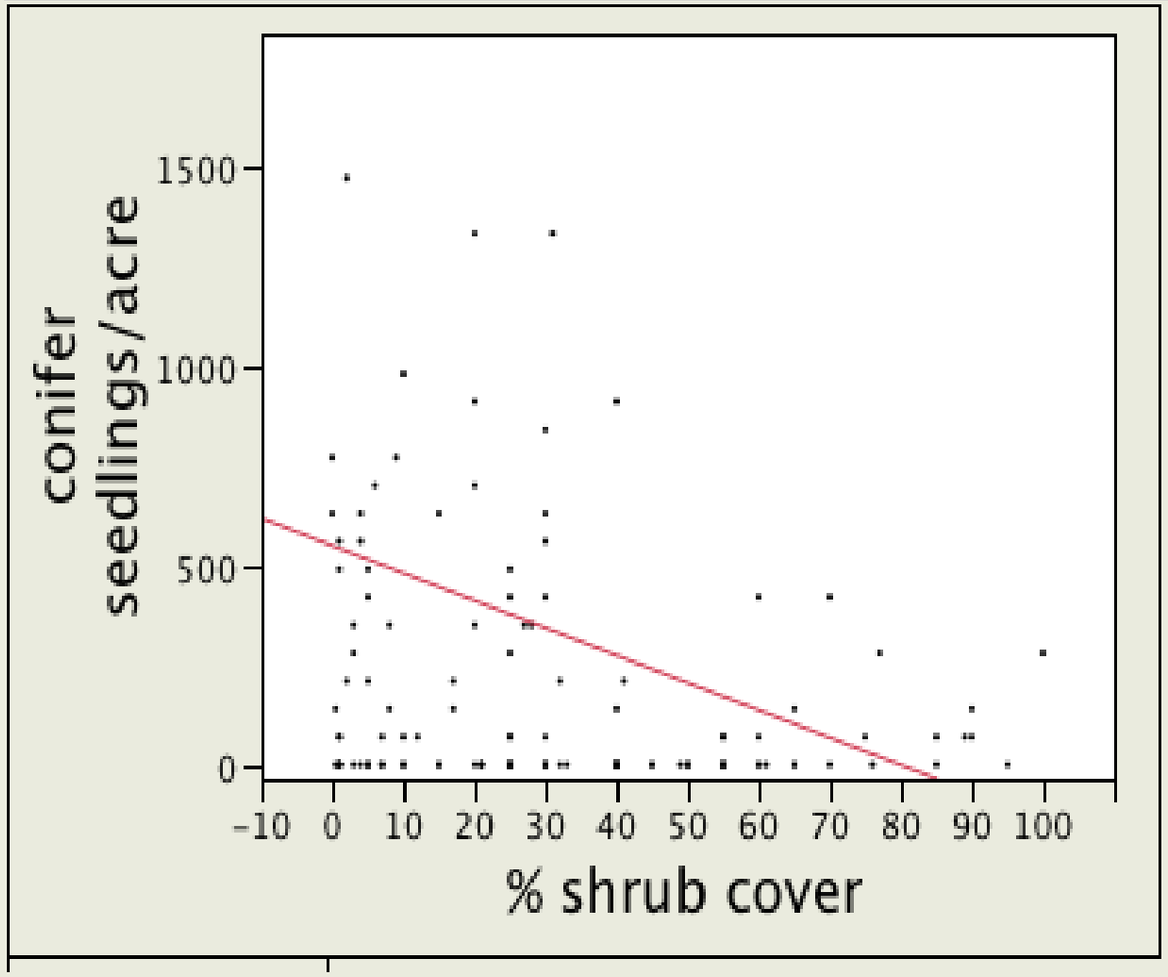
Effects of shrub cover on conifer seedling density

Freds Fire



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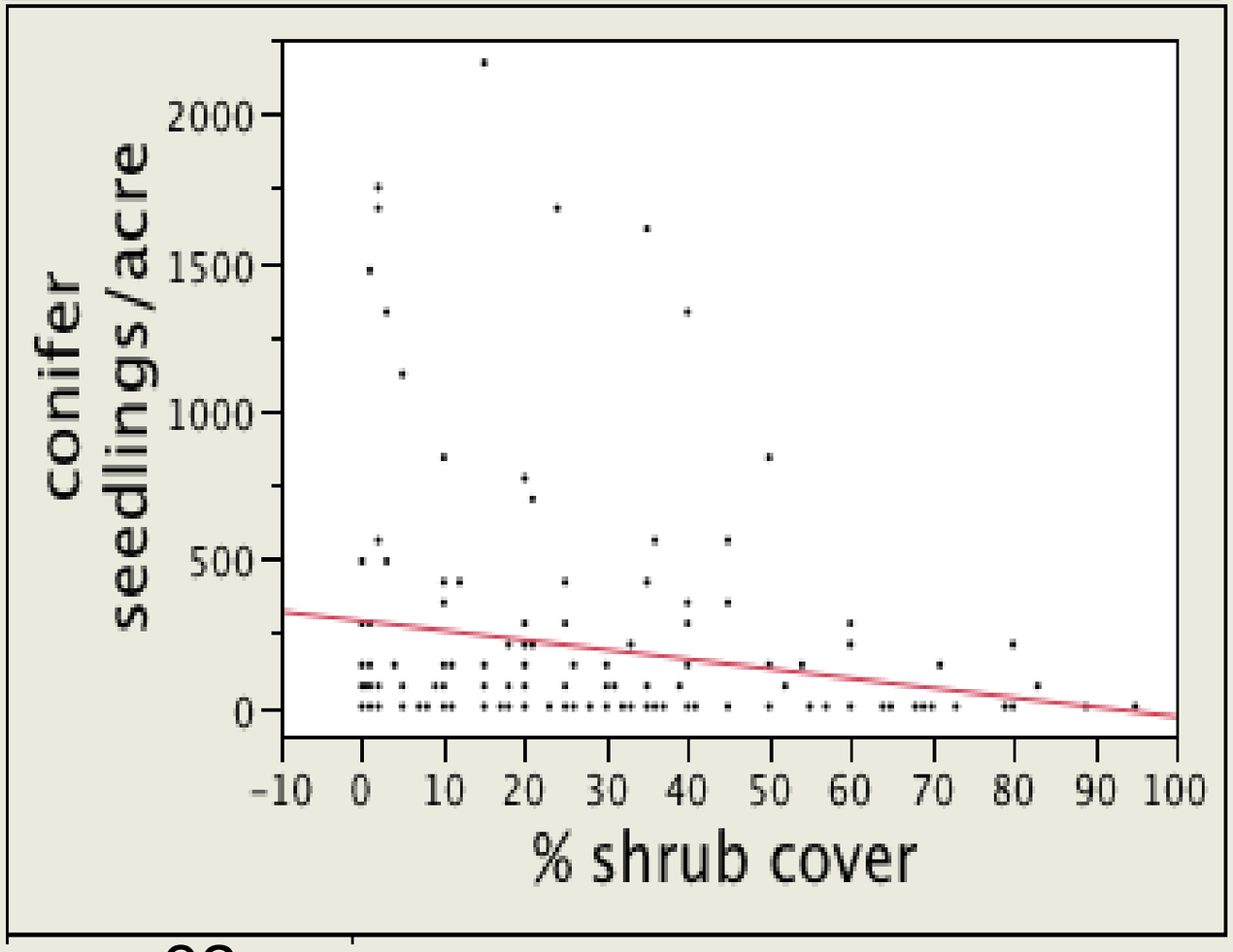
Power Fire



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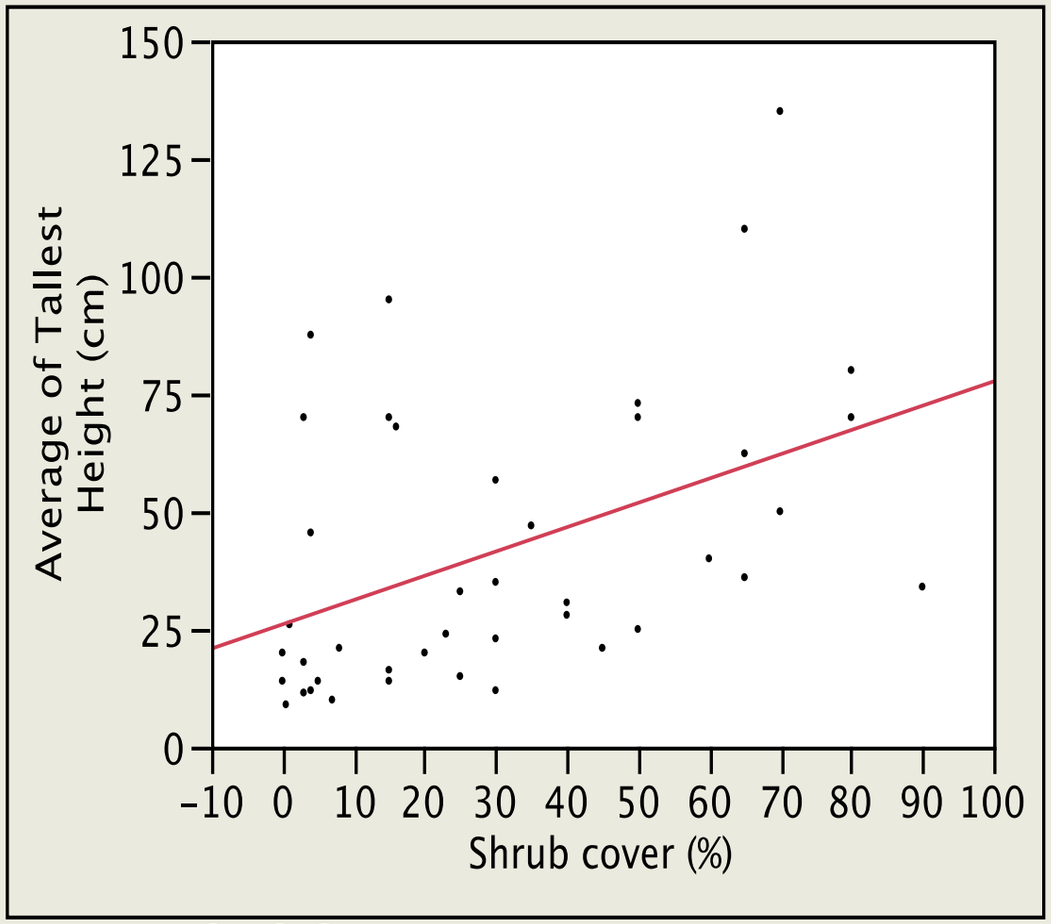
Competition for light, water, and nutrients

Interaction of shrubs with conifer heights & growth rates

Conifer Height vs. Shrub Cover - Bar Fire



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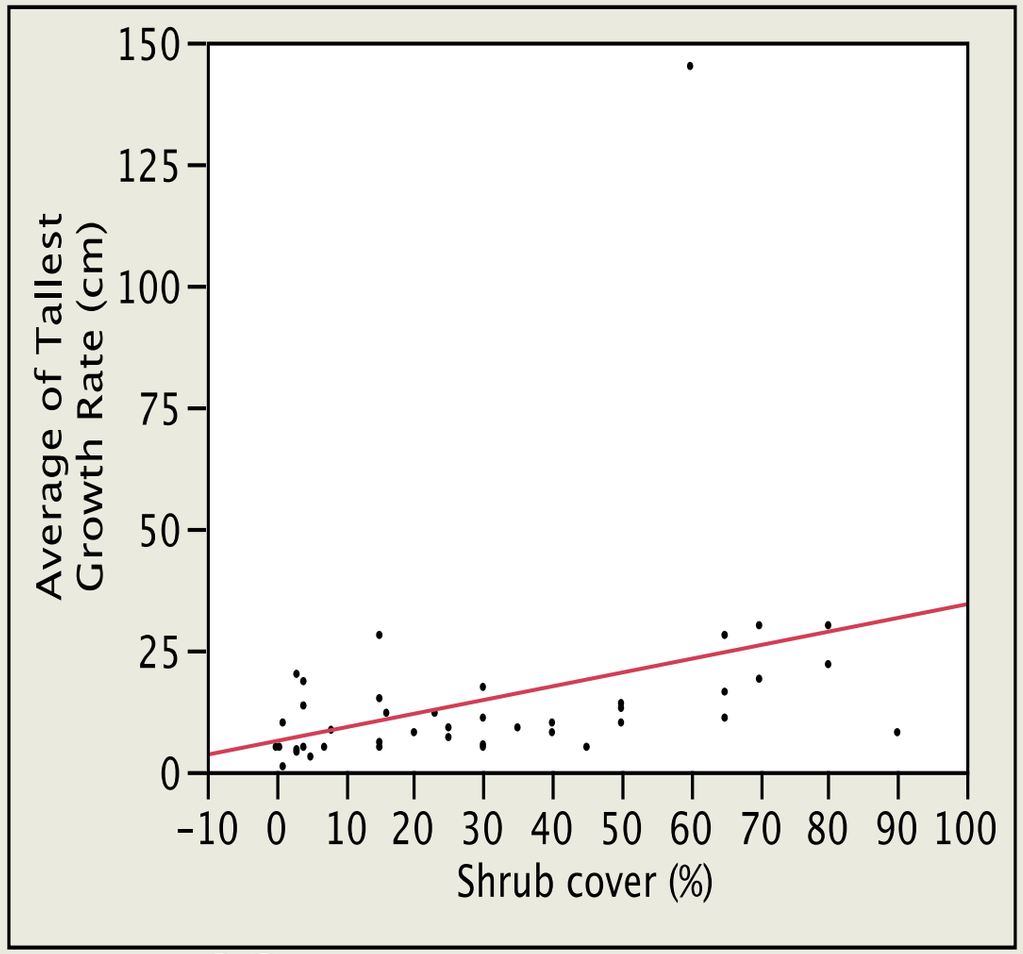
Conifer Growth Rate vs. Shrub Cover - Bar Fire



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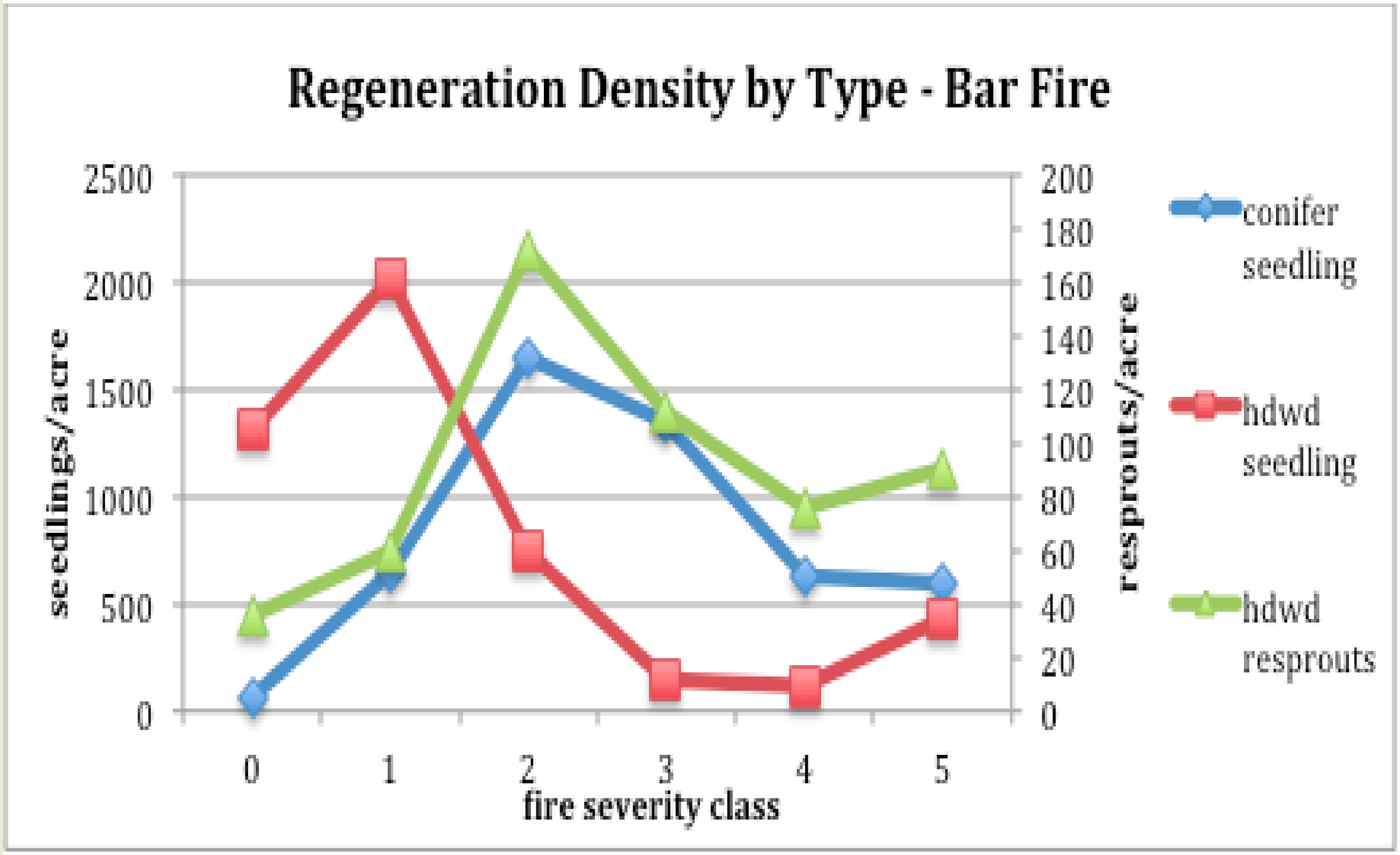
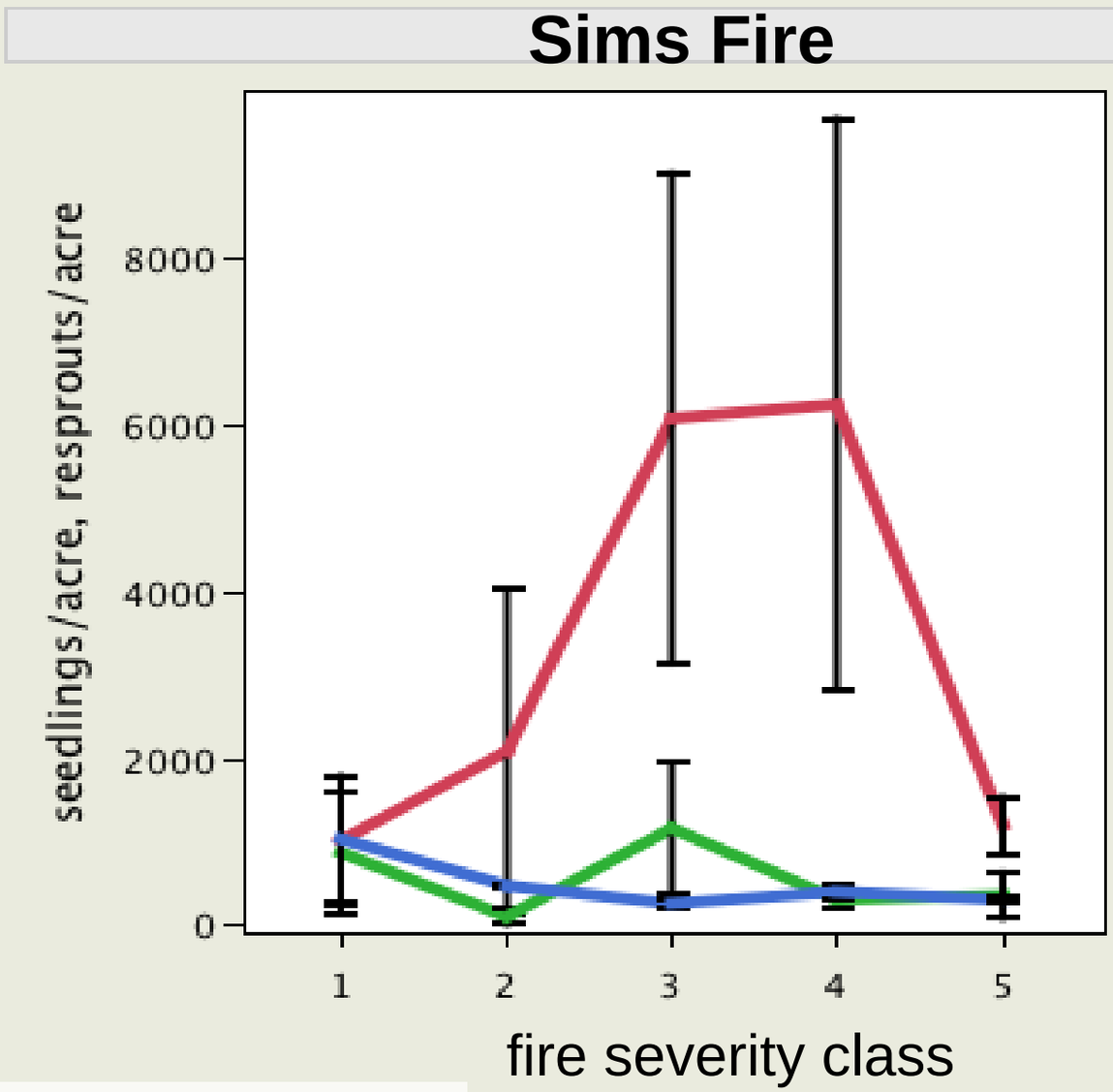
depends on species and life history traits too

II. Natural Regeneration by Type and Resprouting Hardwoods



note: hardwood resprouts are plotted against a 2nd vertical axis (resprouts/acre).

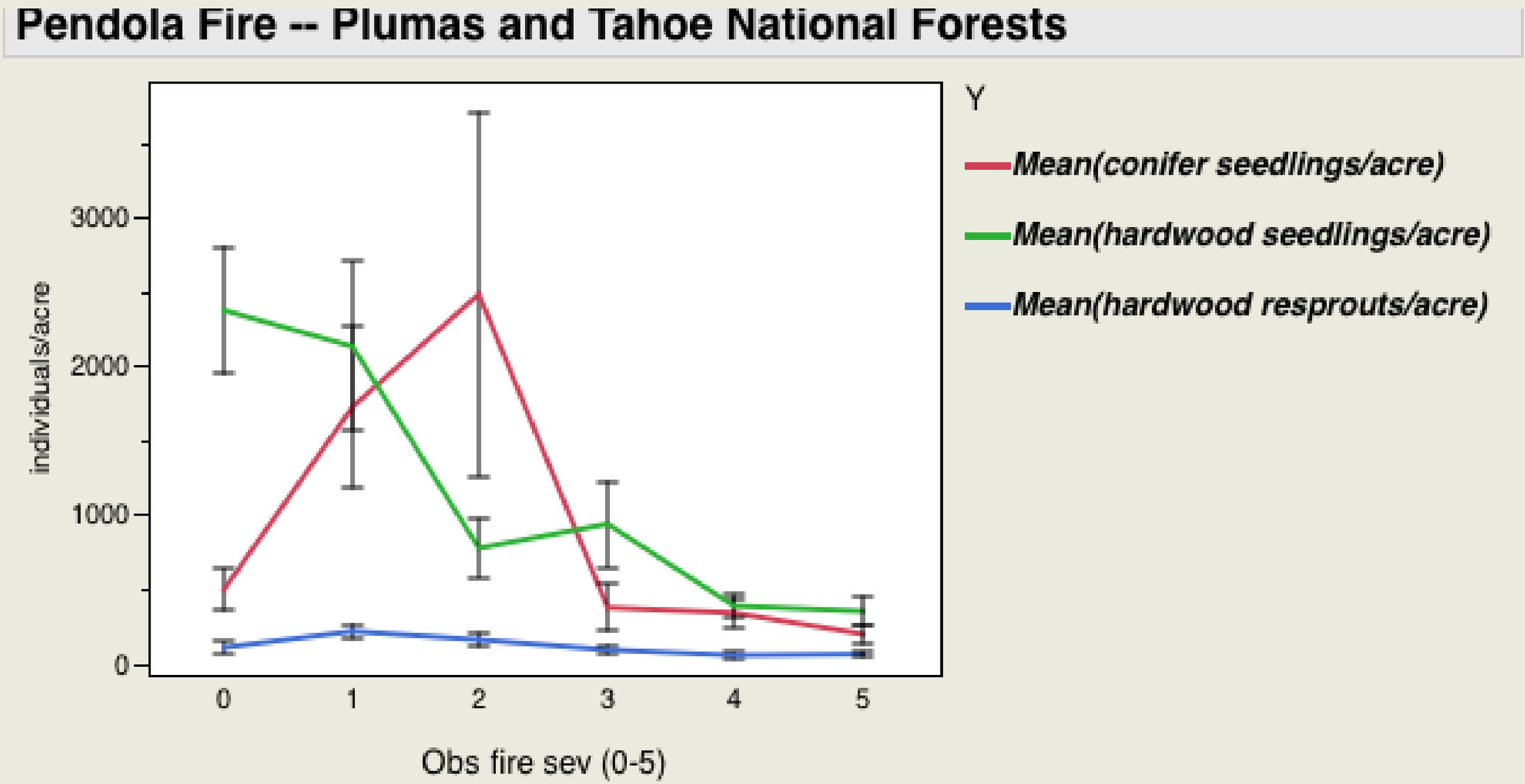
Natural Regeneration by Type & Resprouting Hardwoods



Legend

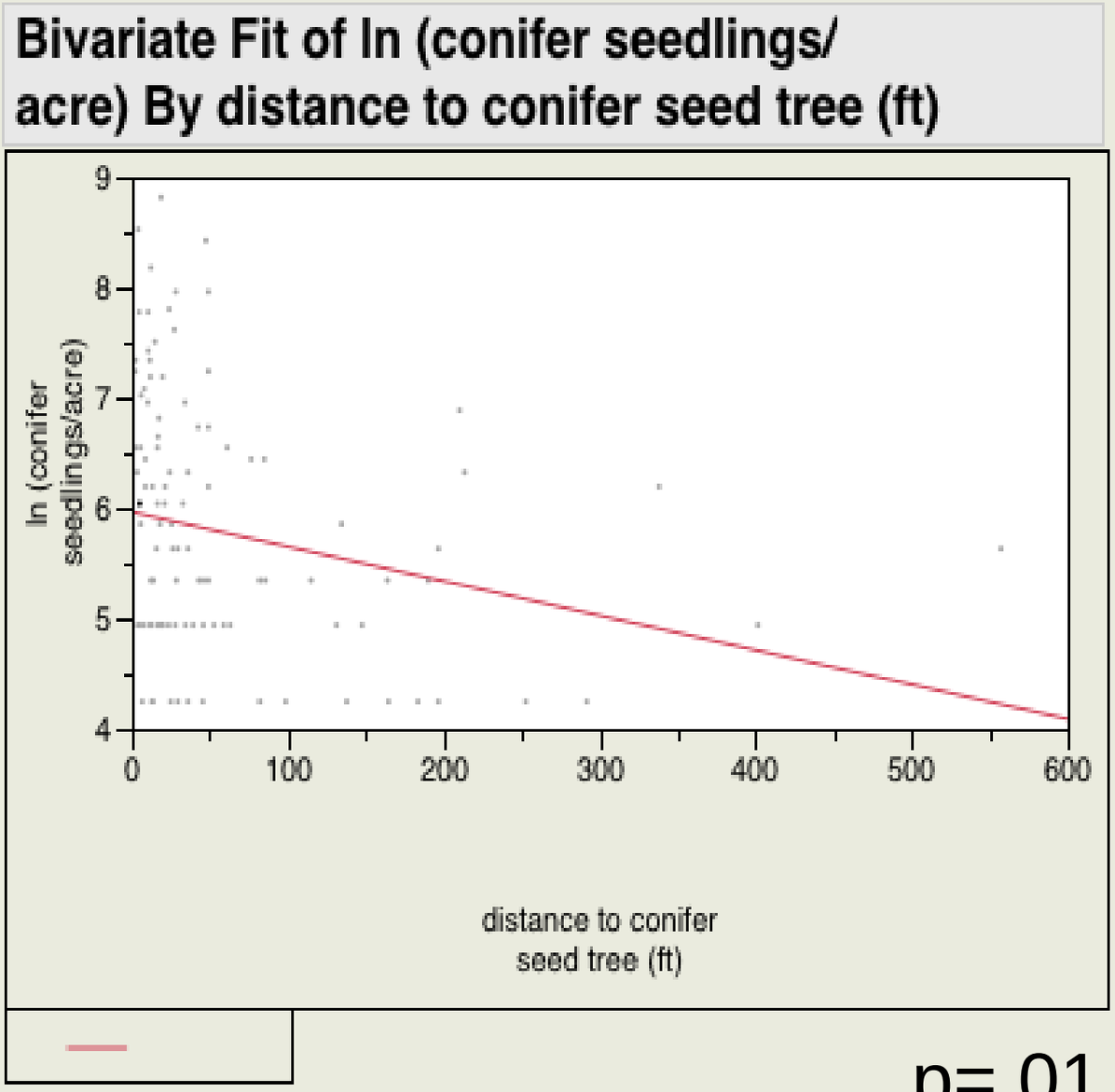
- Mean(conifer seedlings/acre)
- Mean(hardwood seedlings/acre)
- Mean(hardwood resprouts/acre)

Conifers and Hardwoods 11-12 years after the Pendola Fire



Pendola:

conifers and hardwoods 12 years after the fire



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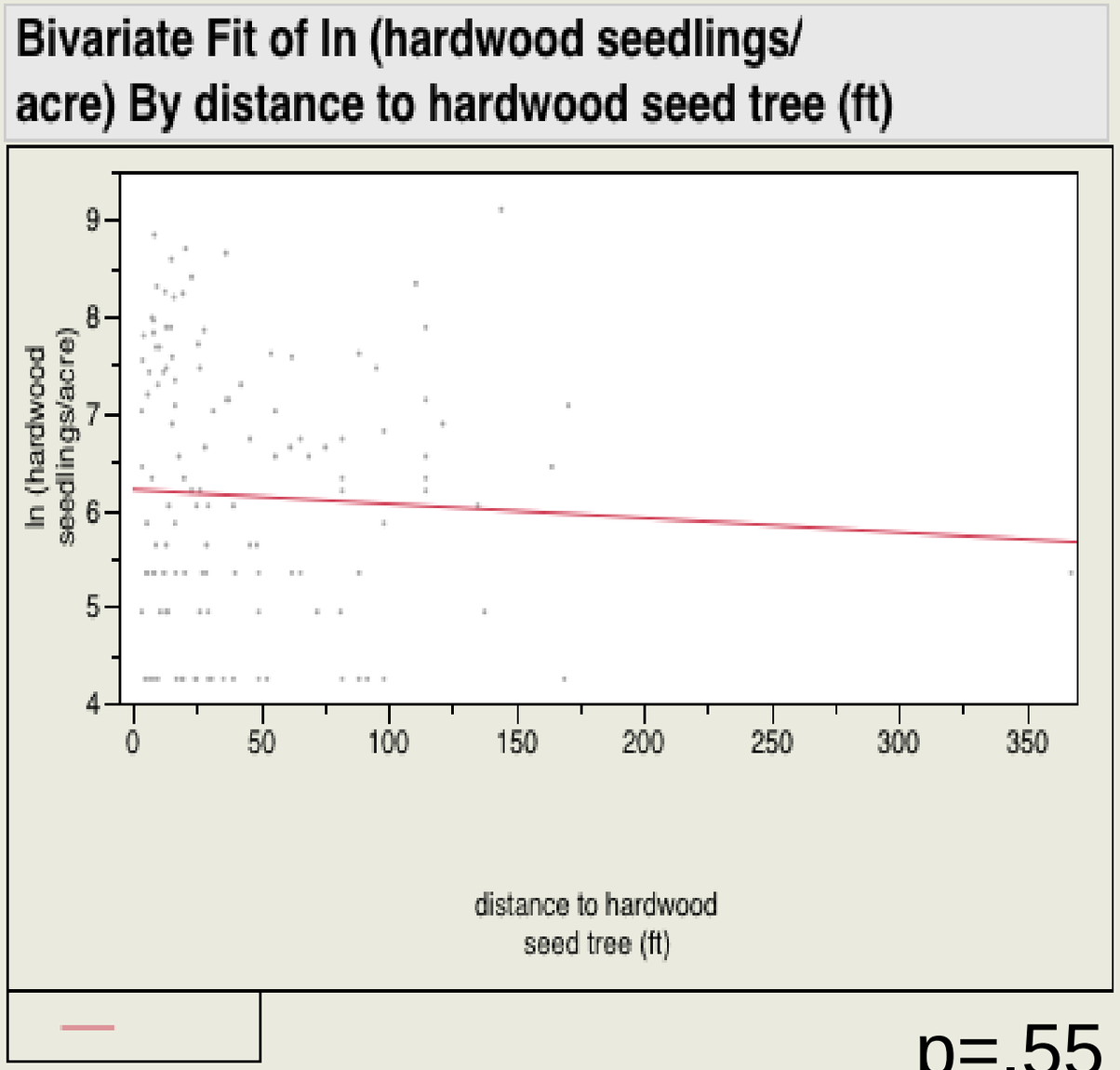

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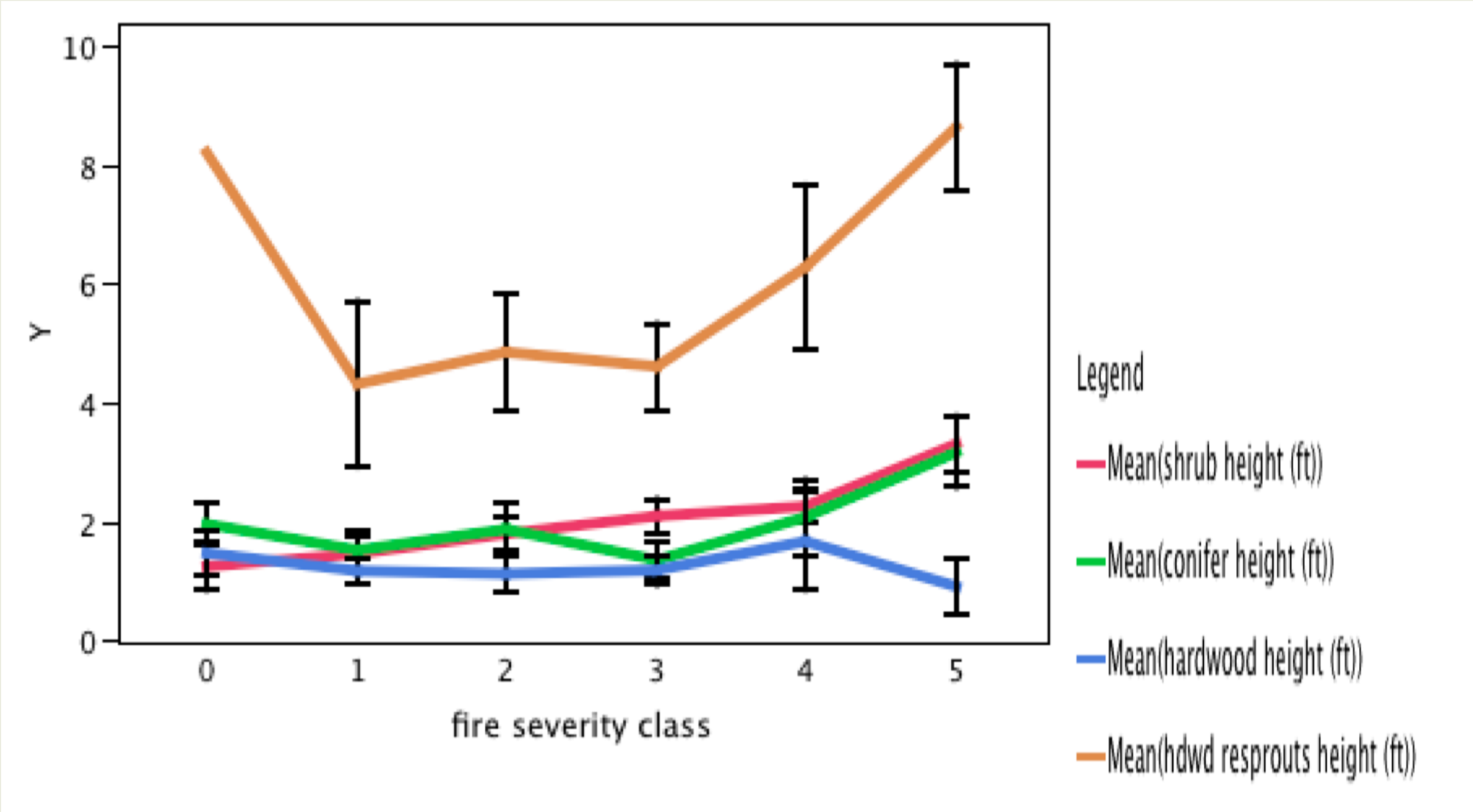
Future analysis includes comparing covers

Mean Maximum Heights (ft) of Woody Vegetation
Ralston Fire



Competition for light and water resources

Conclusions

- Fires show a generally unimodal relationship between fire severity and natural regeneration rates, with a peak in low severity class 2 and consistently declining to class 5
- Distance to potential seed tree an important factor in driving regeneration patterns
- Conifers are outcompeting hardwoods through seedling production in the first 5-7 years. Does this change through time with the competition of hardwood resprouts?
- In some fires, shrub cover negatively affected conifer seedling density
- Timing of burn, year effects, and conditions in consequent years are all important factors

Future Potential Uses of Data

- Provide spatially-explicit, species-specific regeneration trends and models
- Permanent plot networks for future monitoring (long term succession, climate change effects)
- Evaluation of effects of postfire management practices
- Facilitate decisions about restoration activities
  - Where to replant; shrub and understory thinning?
  - Where will natural regeneration do the work?
- Information sharing among forest districts.

Acknowledgements

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