

# Post-fire tree recruitment in the U.S. northern Rockies: The influence of seed source proximity and environmental conditions

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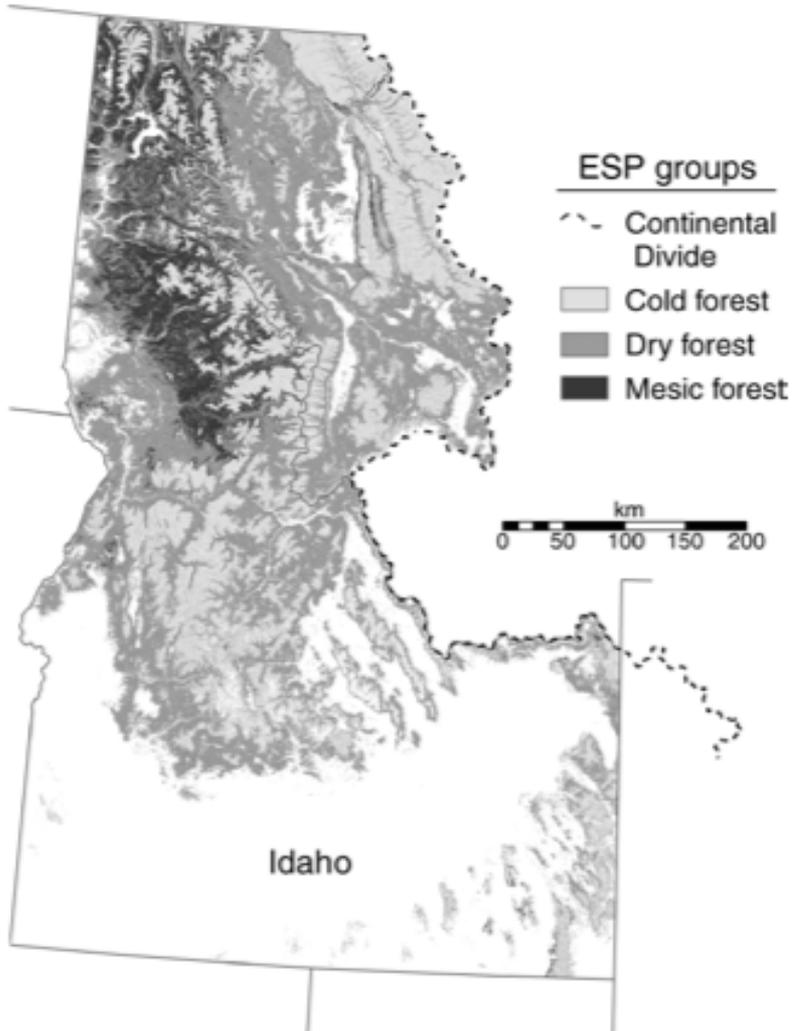
**ESA Annual Meeting  
14 August 2014**



Ashley Wells surveying the incoming storm on a ridge above Taylor Ranch Field Research Station, Frank Church-River of No Return Wilderness, ID; June 2012

# Background

## Dry-mixed conifer forests of the N. Rockies



# Background

## Mixed-severity fire regimes



**LOW**

VS.



**HIGH**

- Mixed evidence about historic patterns of burn severity in dry mixed conifer forests of the Northern Rockies. Support for low severity (Heyerdahl et al. 2008), moderate to high severity (Baker 2000), and mix of both (Pierce et al. 2004).
- Post-fire recovery patterns may depend of legacies and interactions of fire and the landscape.

# Research Objectives

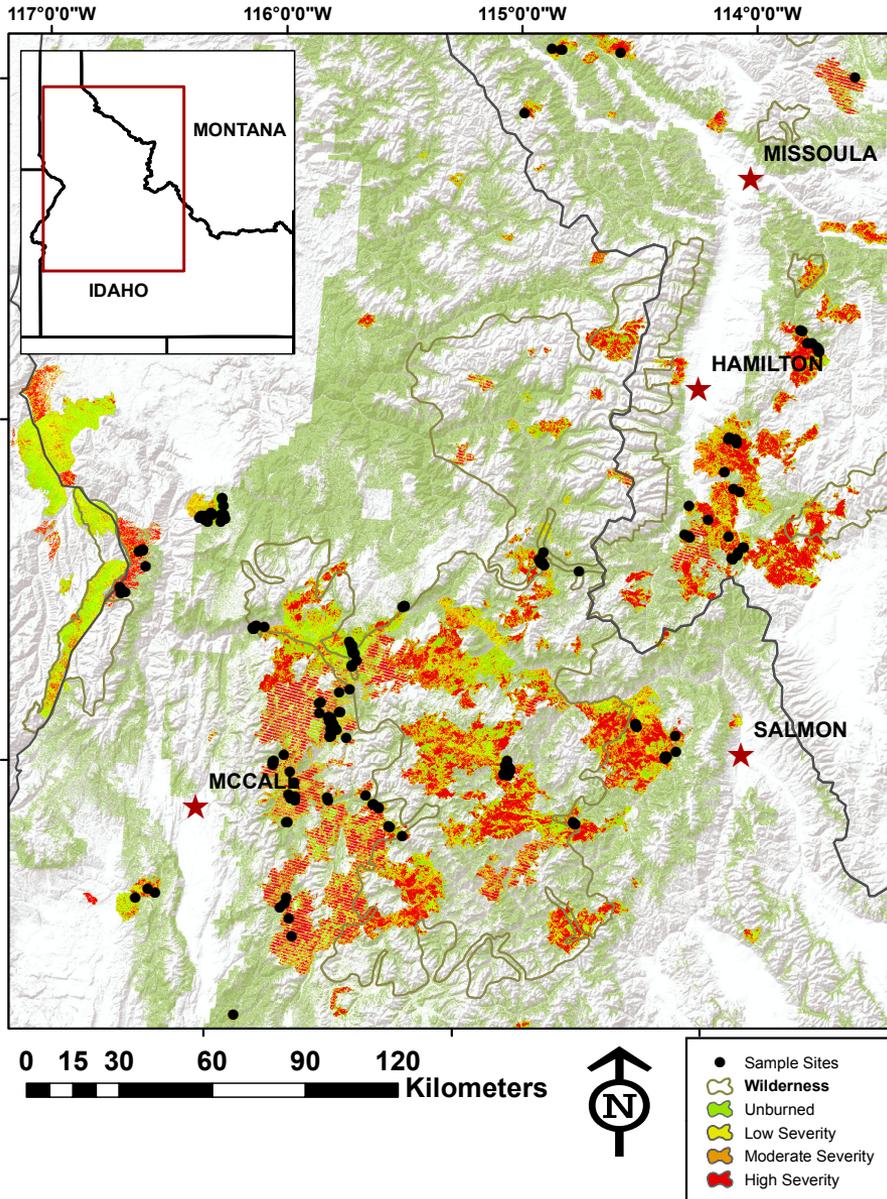
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## Questions

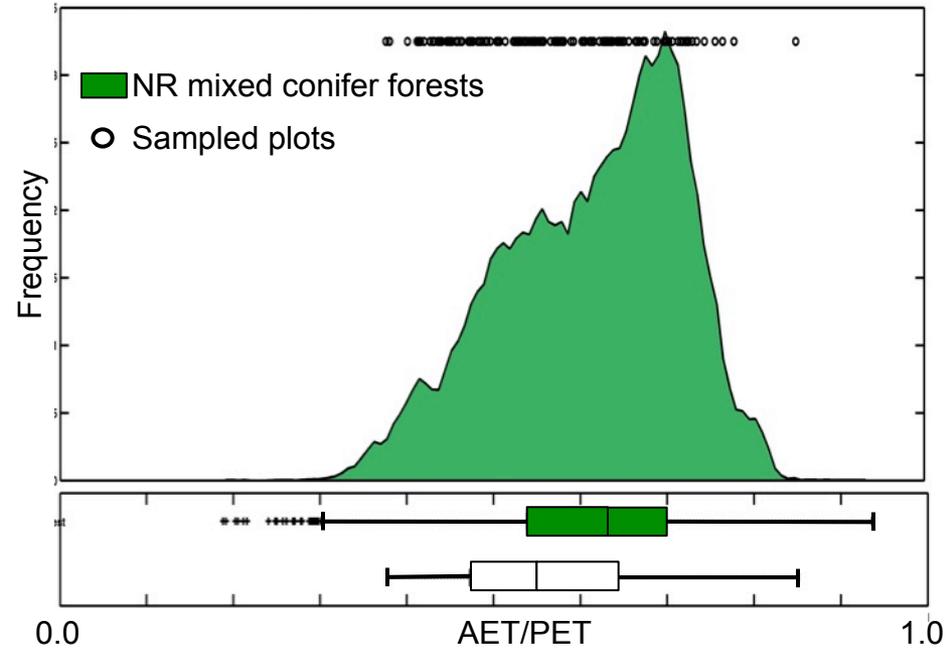
1. How do gradients in the landscape and patterns of the fire affect tree regeneration following mixed-severity fires?
2. Can we begin to infer how changing fire regimes may influence the resilience of these forests in the future?



# Sampling Design



## Site Selection

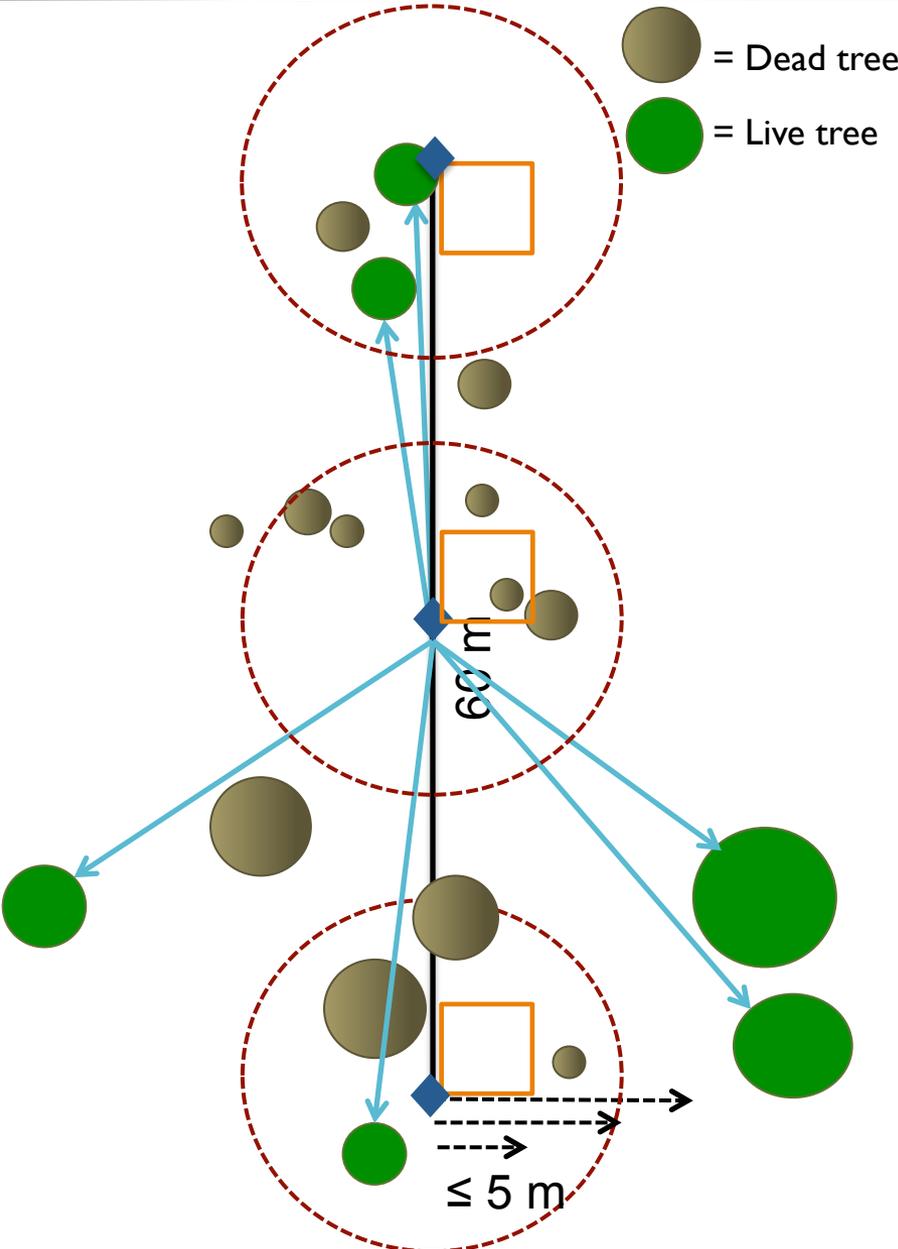


N = 182 sites  
21 fire events

### Sampled across gradient in:

- Elevation
- Latitude
- NE & SW Aspects
- Burn Severity

# Sampling Design



## Variables

**Burn Severity**  
(Categorical)

**Elevation**  
(Continuous)

**Aspect**  
(Continuous-Bounded [0 360])

**Slope**  
(Continuous-Bounded [0 90])

**Latitude**  
(Continuous)

**Distance to seed source** (Continuous; ≤ 500 m)

**Stand basal area**  
(Continuous)

**Understory vegetation cover** (%)

**Canopy cover**  
(Continuous: 0 – 100%)

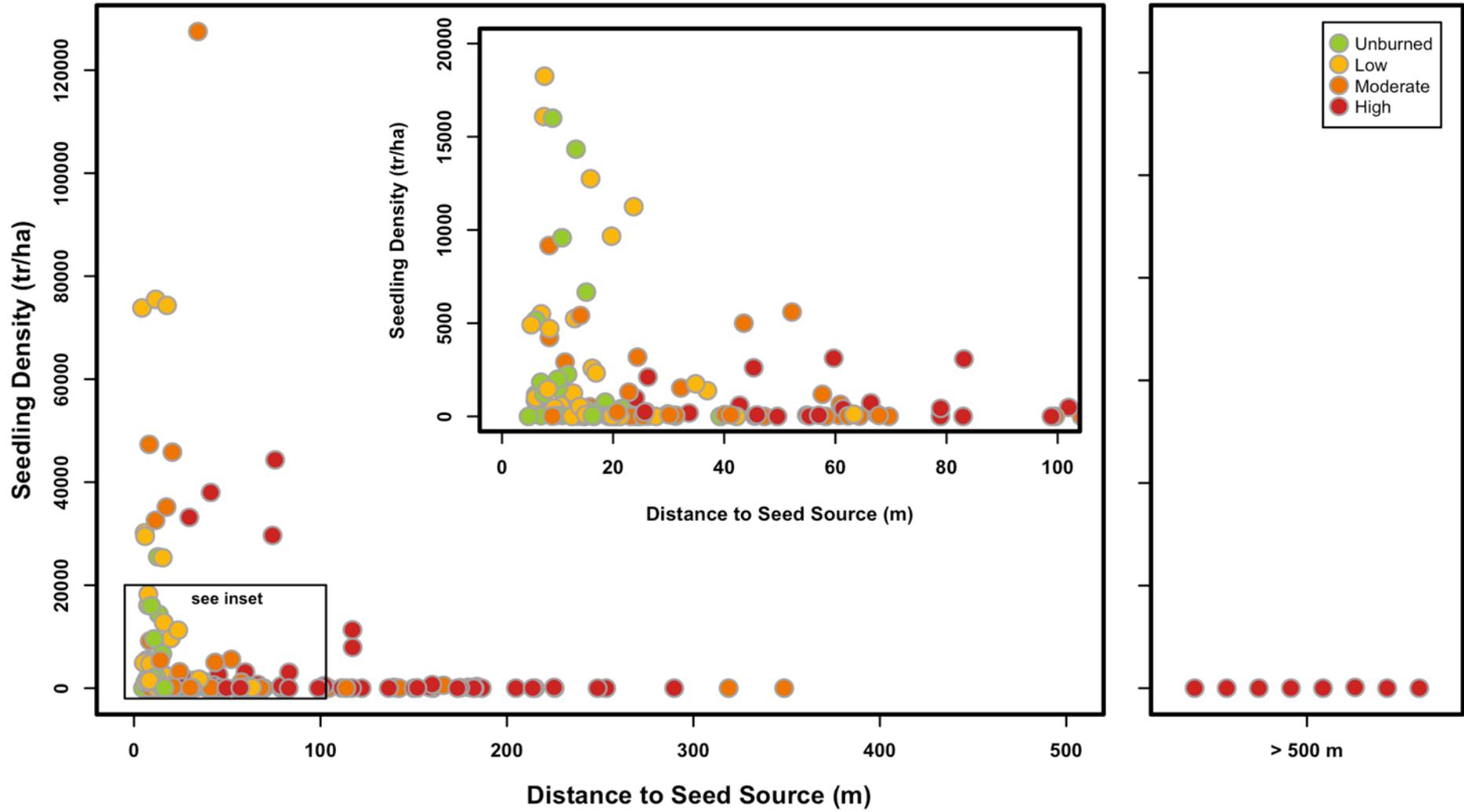
## Derived Variables

**Time since fire**  
(Continuous)

**Heat Load Index**  
(Continuous)

# Results

## Exploratory Data Analysis

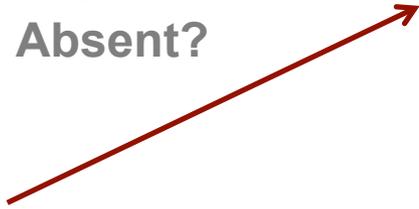


# Statistical Analysis

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## Logistic Regression & Count Models

Seedlings  
Present or  
Absent?

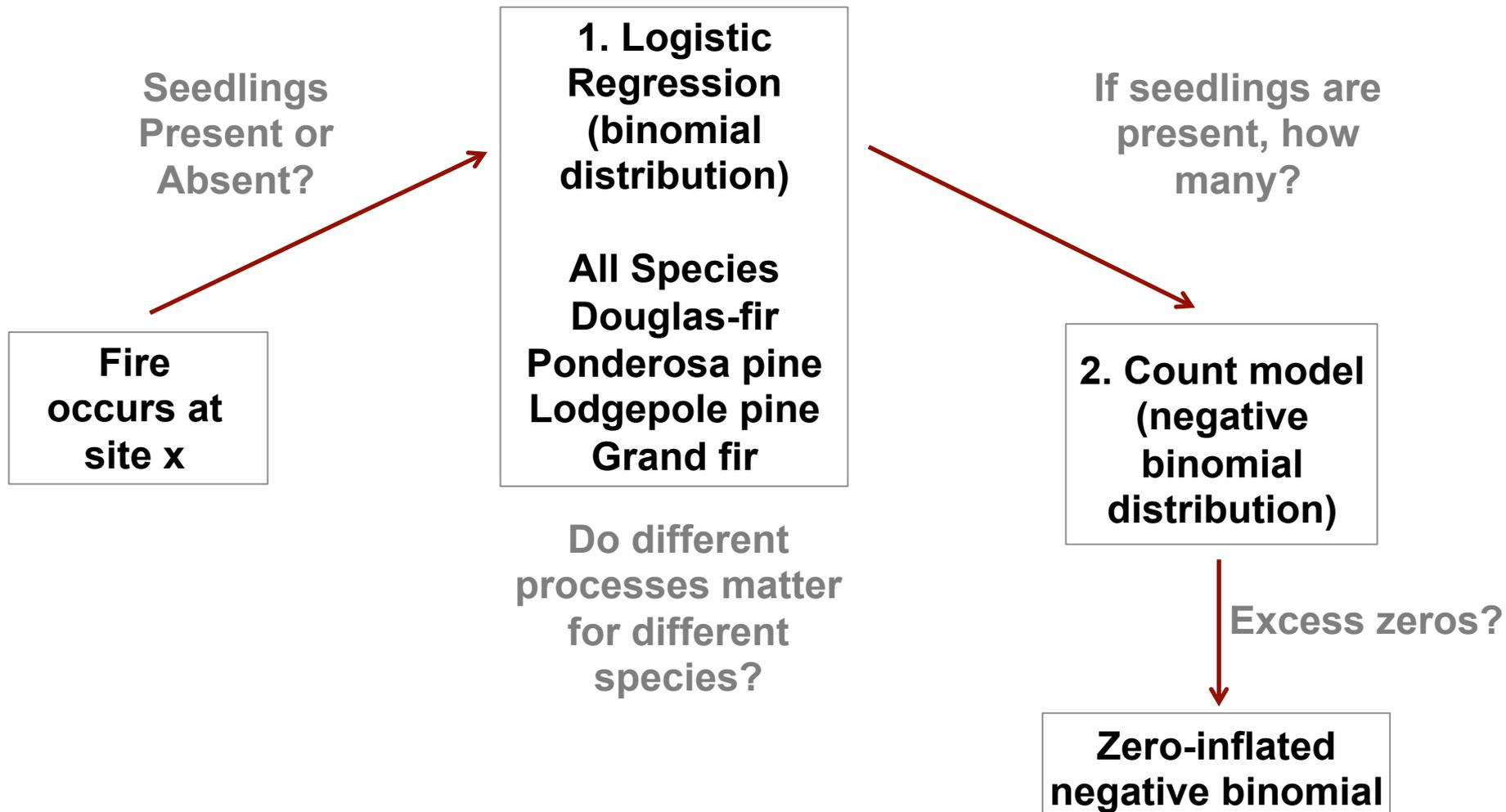


**Fire  
occurs at  
site x**

If seedlings are  
present, how  
many?

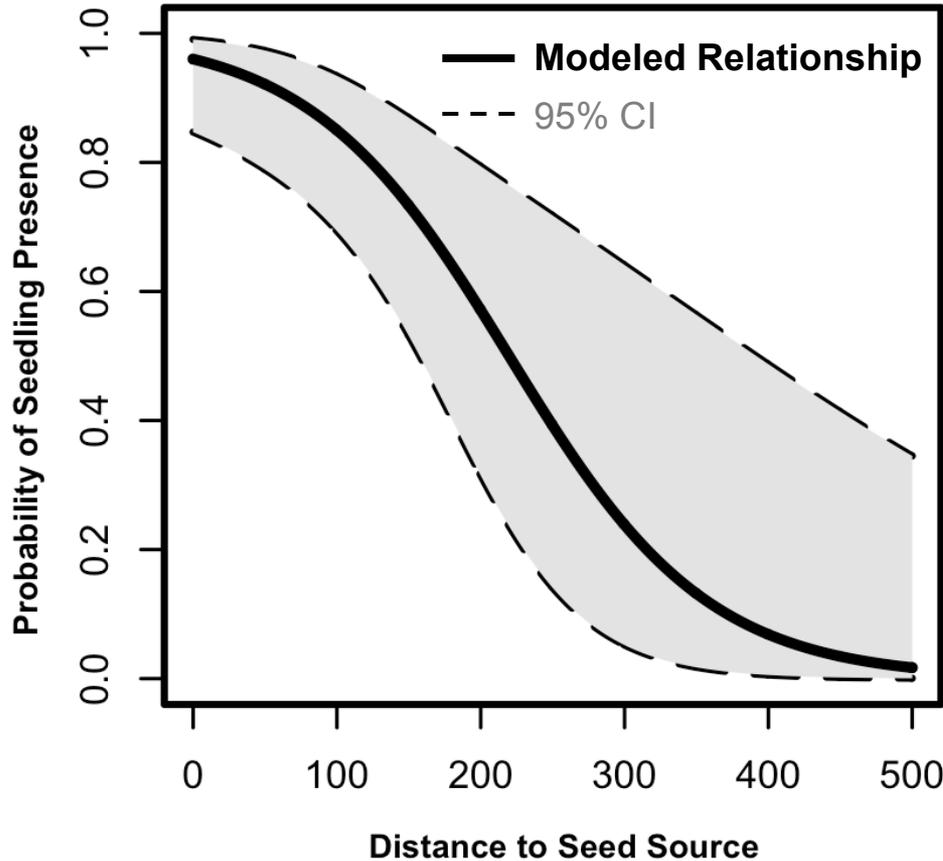
# Statistical Analysis

## Logistic Regression & Count Models

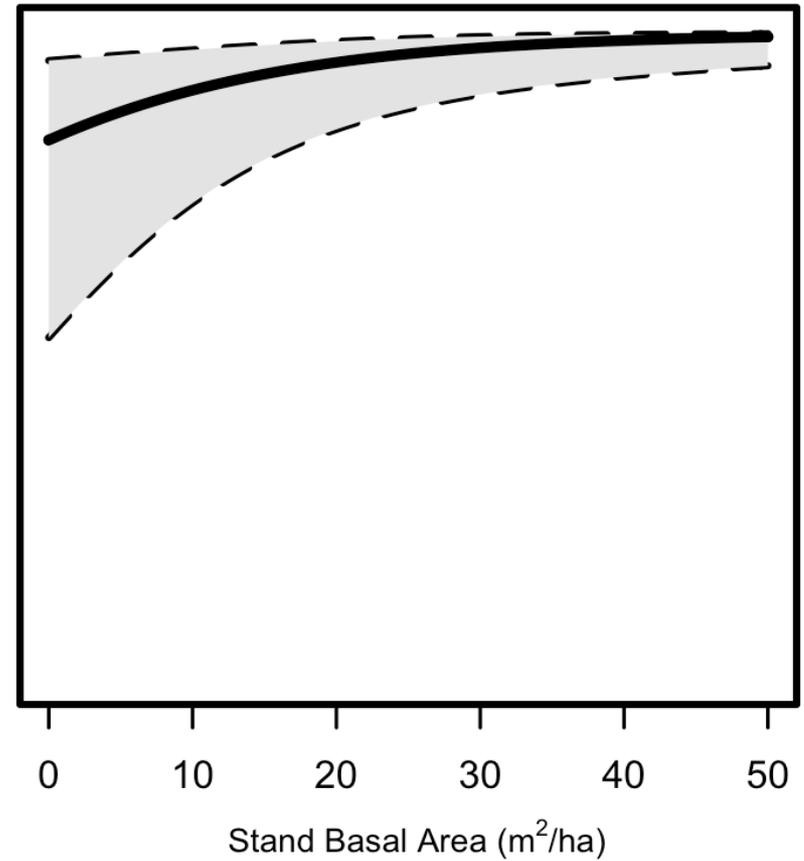


# Results

## 1. Logistic Regression All Spp.



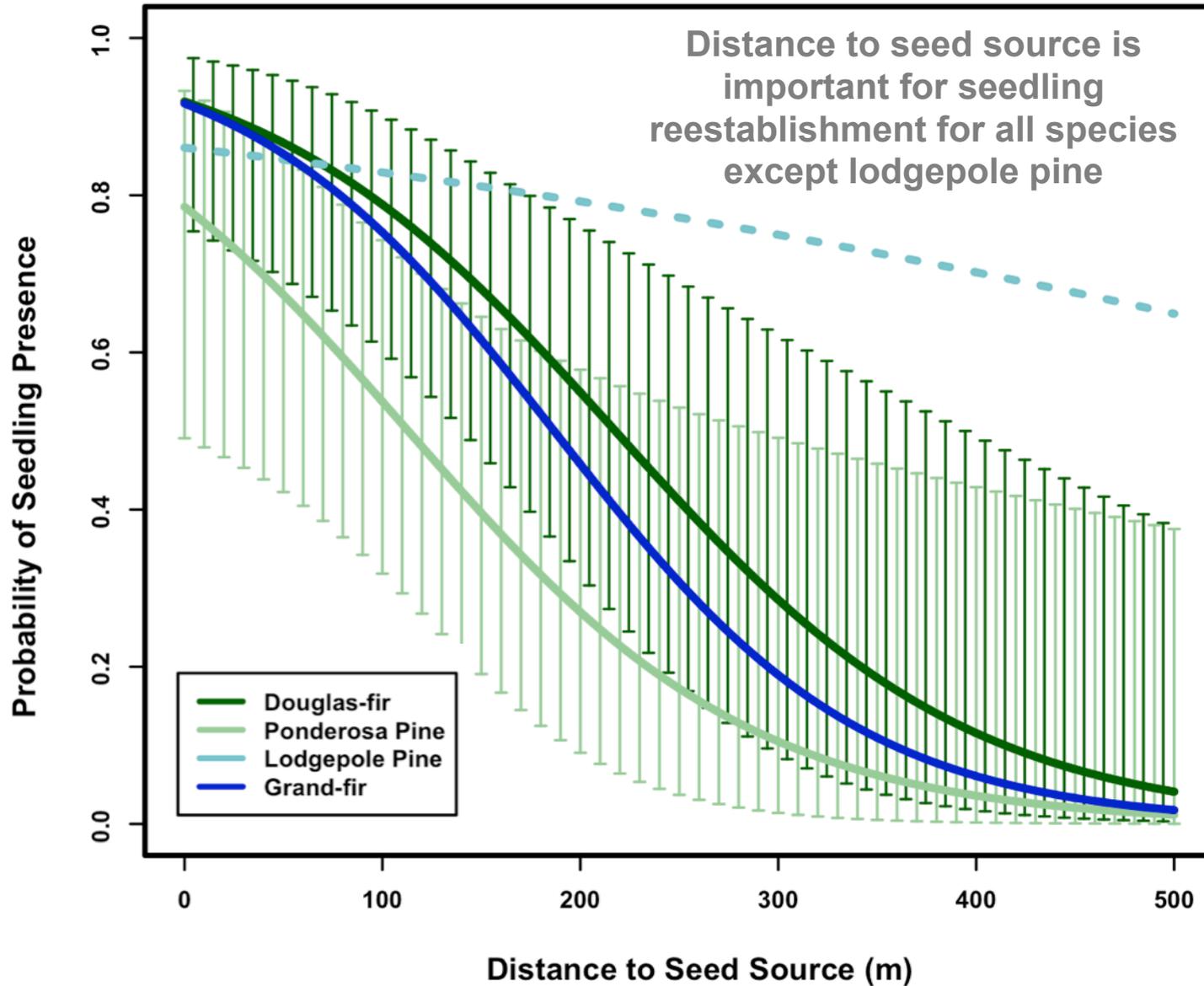
Probability of seedling establishment below 20% beyond about 300 m from a live seed source



If sites are productive ( $> 20 \text{ m}^2 \text{ ha}^{-1}$ ), high probability of seedling re-establishment

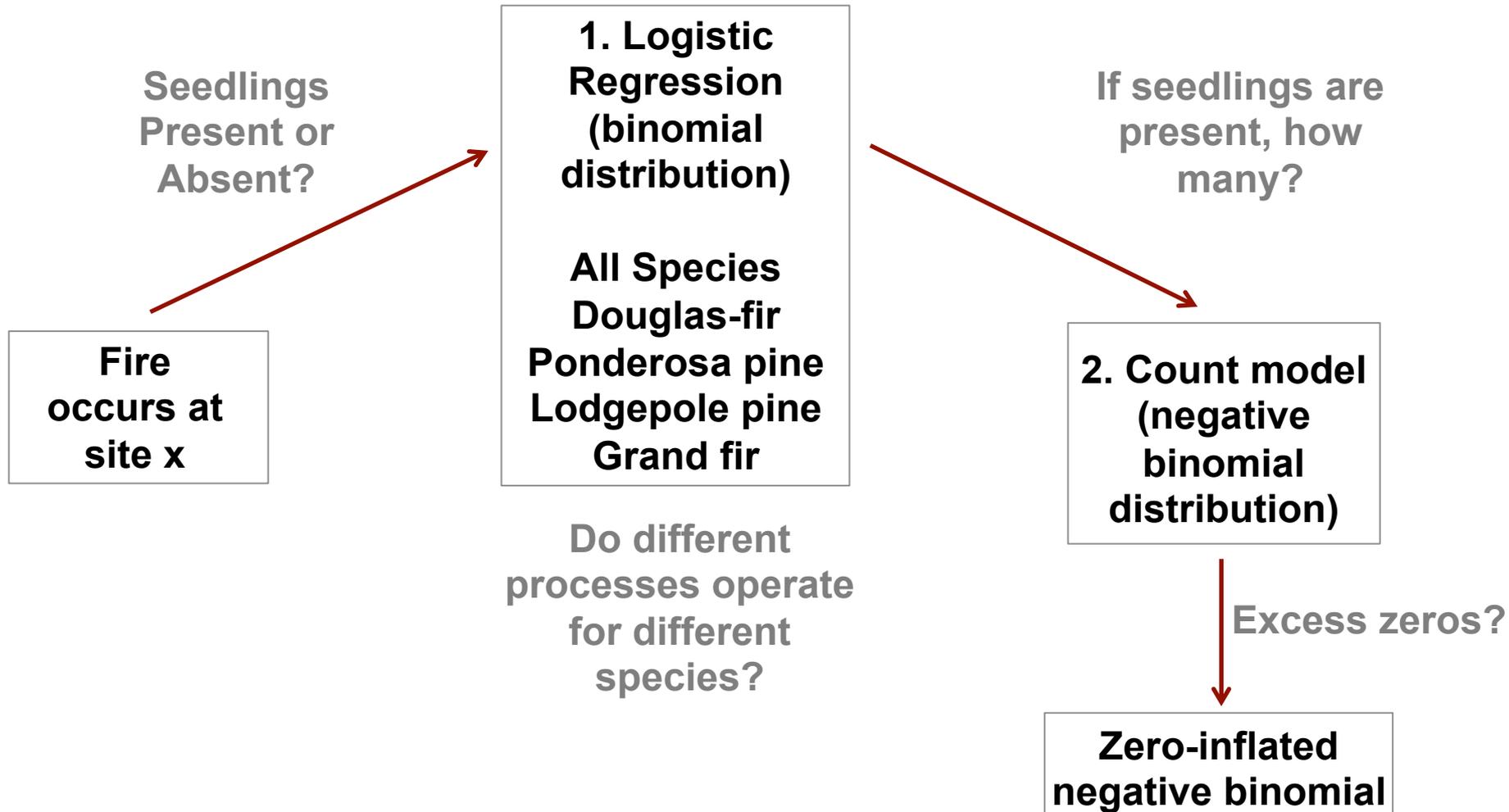
# Results

## 1. Logistic Regression by Spp.



# Statistical Analysis

## Logistic Regression & Count Models



# Results

## 2. Negative Binomial Count Model – All Spp.

	All Species	
	Presence/ Absence	Count
Distance to Seed Source	-0.014 ± 0.005**	-0.007 ± 0.001***
Low Burn Severity	--	--
Moderate Burn Severity	--	--
High Burn Severity	--	--
Time Since Fire	--	--
Elevation	--	--
Heat Load Index	--	--
Stand Basal Area	0.072 ± 0.027*	0.032 ± 0.013*
Vegetation Cover	--	--
Indicator Variable (Censored Dist. to SS)	--	--
Log(Area)	NA	-1.147 ± 0.157***



Distance to seed source is the overriding variable determining seedling presence and abundance post-fire.

Stars indicate that parameter estimates are significant at the following levels: \* 0.05, \*\* 0.01, \*\*\* 0.001

# Results

## 2. Negative Binomial & Zero-inflated NB Count Models - by Species

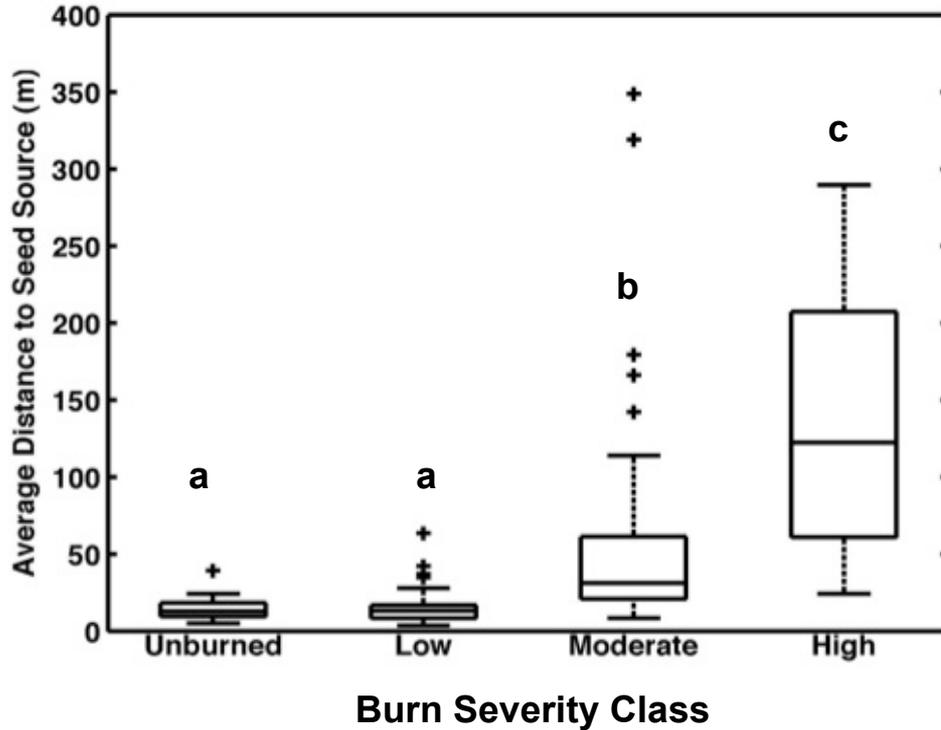
	Douglas-fir		Ponderosa pine		Lodgepole pine		Grand fir	
	Presence/ Absence	Count	Presence/ Absence	Count	Presence/ Absence	Count	Presence/ Absence	Count
Distance to Seed Source	-0.011 ± 0.004**	-0.006 ± 0.002**	-0.011 ± 0.005*	-0.009 ± 0.005*	--	--	-0.013 ± 0.007*	--
Low Burn Severity	--	2.051 ± 0.877*	--	--	--	--	--	--
Moderate Burn Severity	--	2.578 ± 0.922**	--	--	--	--	--	--
High Burn Severity	--	--	--	--	--	--	--	--
Time Since Fire	--	0.146 ± 0.040***	--	--	--	--	--	--
Elevation	0.001 ± 0.001*	0.001 ± 0.000**	--	--	0.002 ± 0.001*	--	--	--
Heat Load Index	-2.452 ± 1.095*	-2.997 ± 0.695***	--	--	-2.271 ± 1.149*	--	--	--
Stand Basal Area	0.072 ± 0.025**	0.042 ± 0.014**	--	--	--	--	--	-0.070 ± 0.033*
Vegetation Cover	--	--	--	--	--	--	--	-0.043 ± 0.008***
Indicator Variable (Censored Dist. to SS)	--	-1.203 ± 0.519*	-2.630 ± 0.593***	-3.085 ± 0.672***	-3.134 ± 0.691***	-2.252 ± 0.837**	-2.701 ± 0.675***	-2.049 ± 0.650**
Log(Area)	NA	-1.020 ± 0.158***	NA	--	NA	-1.505 ± 0.595 *	NA	-0.895 ± 0.370*

Stars indicate that parameter estimates are significant at the following levels: \* 0.05, \*\* 0.01, \*\*\* 0.001

# Discussion

## Distance to Seed Source

Kruskal-Wallis Test:  $X^2_{df=3}$ : 117.8091;  $p < 0.001$



Distance to seed source is the mechanism by which burn severity influences seedling reestablishment.



Balsamorhiza in full bloom on hillside high above the S. Fork of the Salmon River, Payette National Forest, ID; July, 2013

# Discussion

## Conceptual Model



**Disturbance  
(Fire)**



**Dispersal**



**Germination**



**Survival**



**Growth**

↓  
Distance to  
Seed Source

↓  
Heat Load  
Elevation  
Stand Basal Area

**Presence or  
Absence**

Distance to  
Seed Source

Stand Basal Area  
Vegetation Cover

**Density  
(Count)**

# Summary

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1. Distance to seed source is the overriding factor influencing seedling regeneration (both presence and abundance) on a site.
2. Different factors were important for different species, and some of these factors are properties of the landscape.
3. As expected, high severity patches are further from live seed sources. “Burn severity” may be better represented by other proxies that mechanistically influence regeneration.
4. The size of high severity patches may influence whether or not those patches recover post-fire.



Looking across the Big Creek Drainage, Frank Church – River of No Return Wilderness; June, 2012



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