

# Evaluation of Abiotic Factors on Ecological Restoration

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# Introduction

- Growing industry of ecological restoration
- Lack of well-defined metrics for success and cost
- Relative effectiveness of restoration techniques are not well known
- Environmental variation is generally ignored
- Large restoration experiment setup is more realistic as a model
- Experiments improve methods for restoring California coastal sage scrub restoration across different environments



# Site Background

- **Pre-restoration plant cover:**

- > 100% non-native (mustard and grasses)
- 3% native cover

- **Precipitation:**

- Average annual rainfall is 32 cm
- 1<sup>st</sup> year 22cm
- 2<sup>nd</sup> year 16cm

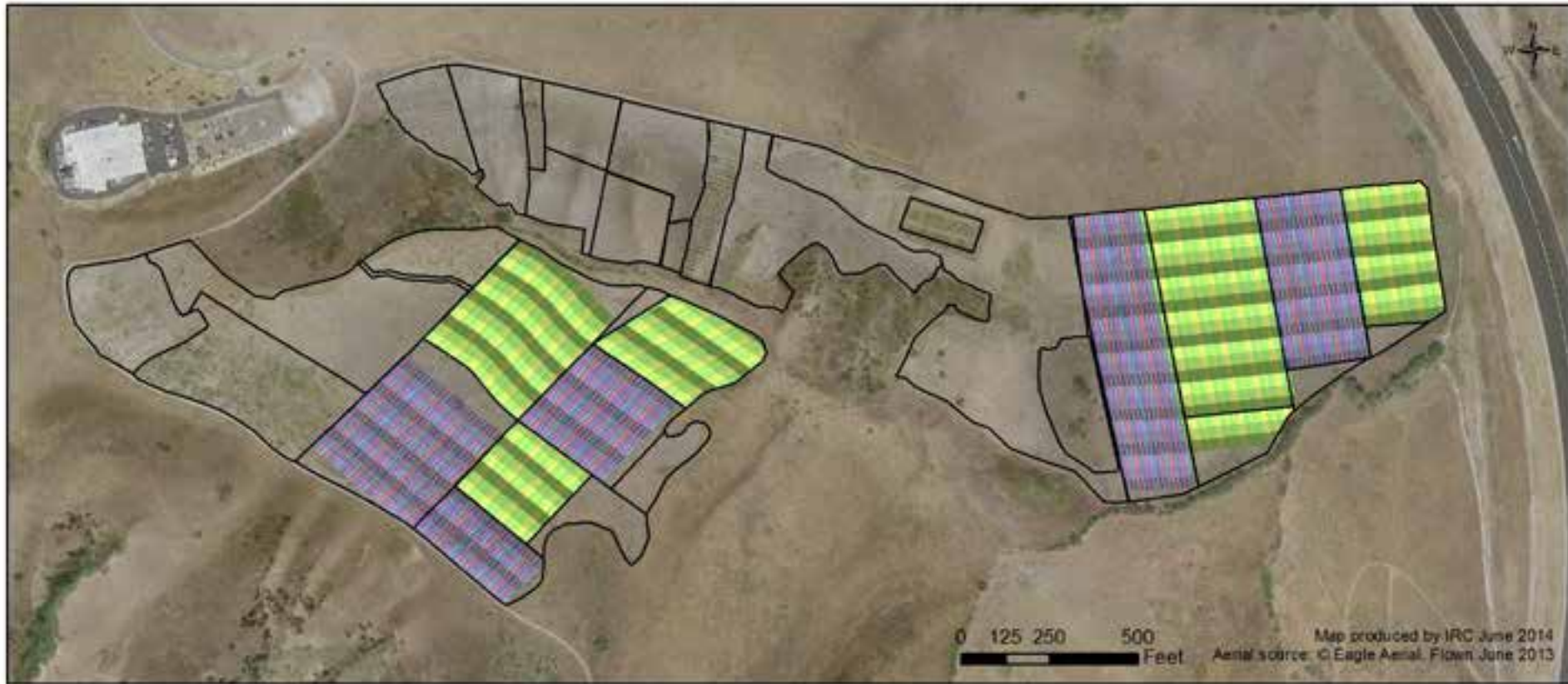
- **Soil:** clay loams

- **Topography:**

- Slope 0 ~289 % Rise






















# West Loma Restoration Experiment Site



## West Loma

### TYPE, SEED, MAINT

	CSS, All, High		CSS, Shrub, Low
	CSS, All, Low		CSS, Shrub, Medium
	CSS, All, Medium		Grass, All, High
	CSS, Forb, High		Grass, All, Low
	CSS, Forb, Low		Grass, All, Medium
	CSS, Forb, Medium		Grass, Forb, High
	CSS, Grass, High		Grass, Forb, Low
	CSS, Grass, Low		Grass, Forb, Medium
	CSS, Grass, Medium		Grass, Grass, High
	CSS, Shrub, High		Grass, Grass, Low
			Grass, Grass, Medium

### CSS plots

- Shrub
- Forb
- Grass
- All

### Grass plots

- Forb
- Grass
- All

### Maintain

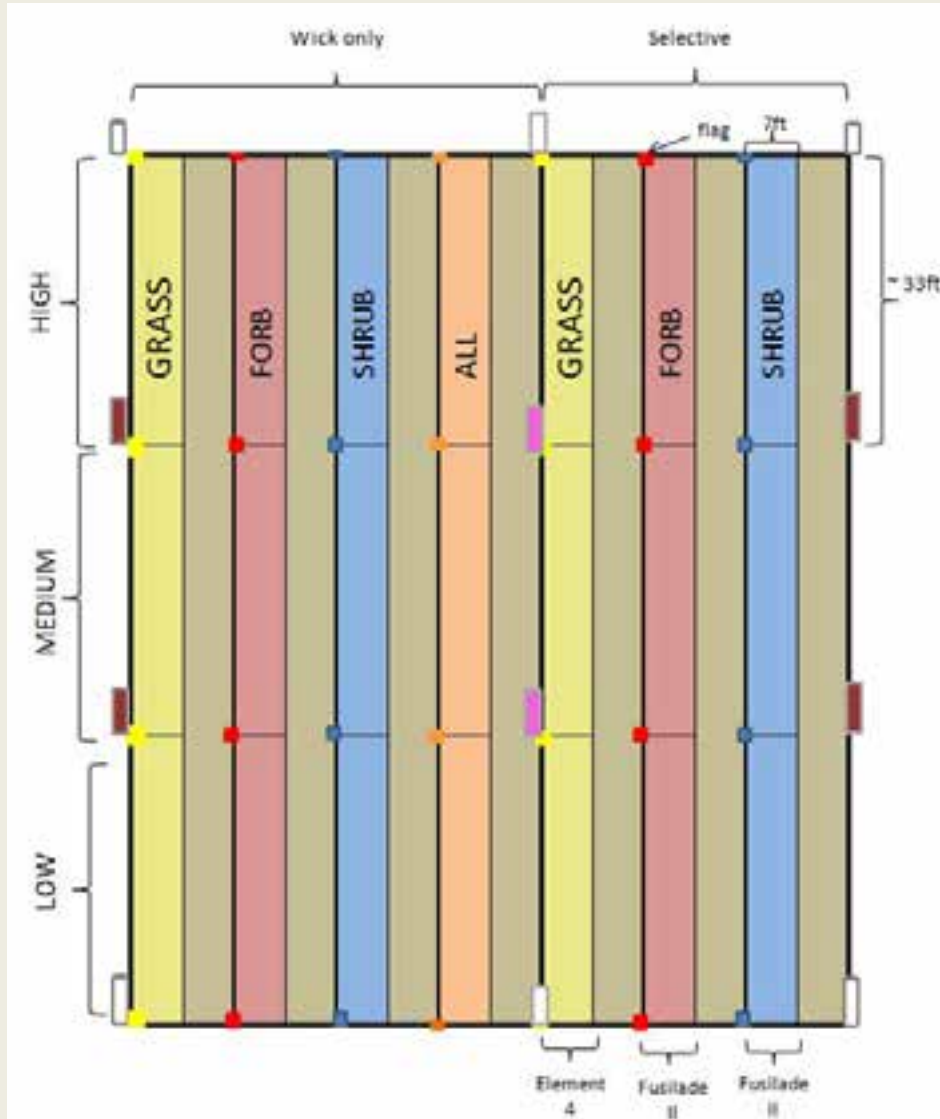
- High (4 weeks)
- Medium (6 weeks)
- Low (8 weeks)

### Herbicide

- Wick Only
- Selective

# West Loma Restoration Site

## CSS Communities



## Grass Communities



(Kimball et al. 2014)

# Seed Mixes/Functional Groups



CSS Plots	Plants	Scientific Name
FORB MIX	Tarweed	<i>Deinandra fasciculata</i>
	California poppy	<i>Eschscholzia californica</i>
	Common Eucrypta	<i>Eucrypta chrysanthemifolia</i>
	Cliff Aster	<i>Malacothrix saxitilis</i>
	Caterpillar phacelia	<i>Phacelia cicutaria</i>
	Chia	<i>Salvia columbariae</i>
GRASS MIX	Giant ryegrass	<i>Leymus condensatus</i>
	Purple needle grass	<i>Stipa pulchra</i>
SHRUB MIX	Coastal Sagebrush	<i>Artemisia californica</i>
	California sunflower	<i>Encelia californica</i>
	California buckwheat	<i>Eriogonum fasciculatum</i>
	Deerweed	<i>Acmispon glaber</i>
	Wishbone bush	<i>Mirabilis californica</i>
	White sage	<i>Salvia apiana</i>



# Data Collection



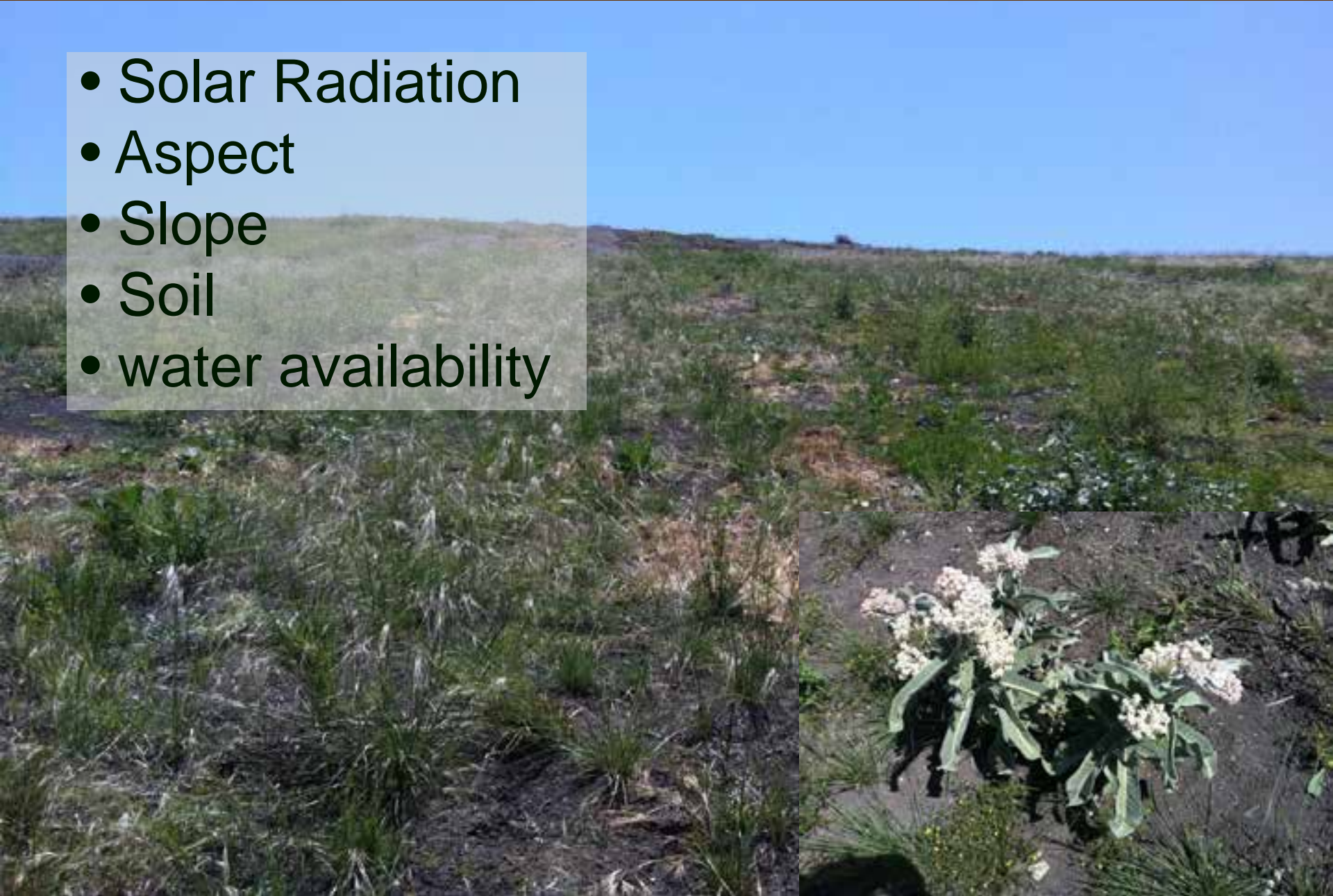
- Total 1230 CSS plots
- 567 CSS plots were selected to collect cover data
- Use Wick only plots (324) to do data analysis on environmental variation

## Total Native cover (CSS plots)

- 0 - 0.3
- 0.3 - 0.7
- 0.7 - 1.71
- No Data Collection CSS plots

# Environmental Variable

- Solar Radiation
- Aspect
- Slope
- Soil
- water availability





# Environmental Variable

**Area Solar Radiation**

Input raster: ned3m\_loma

Output global radiation raster: S:\Science & Stewardship\GIS\Restoration\WestLoma\_Restoration\Solar Radia

Latitude (optional): 33.7591157321578

Sky size / Resolution (optional): 200

Time configuration (optional): Multiple days in a year

Date/Time settings:

Year: 2012

Start day: 92

End day: 182

Day interval (optional): 14

Hour interval (optional): 0.5

Create outputs for each interval (optional)

☑ Topographic parameters

☑ Radiation parameters

☑ Optional outputs

OK Cancel Environments... Show Help >>

**Slope**

Input raster: ned3m\_loma

Output raster: S:\Science & Stewardship\GIS\General\Slope\slopedg\_loma

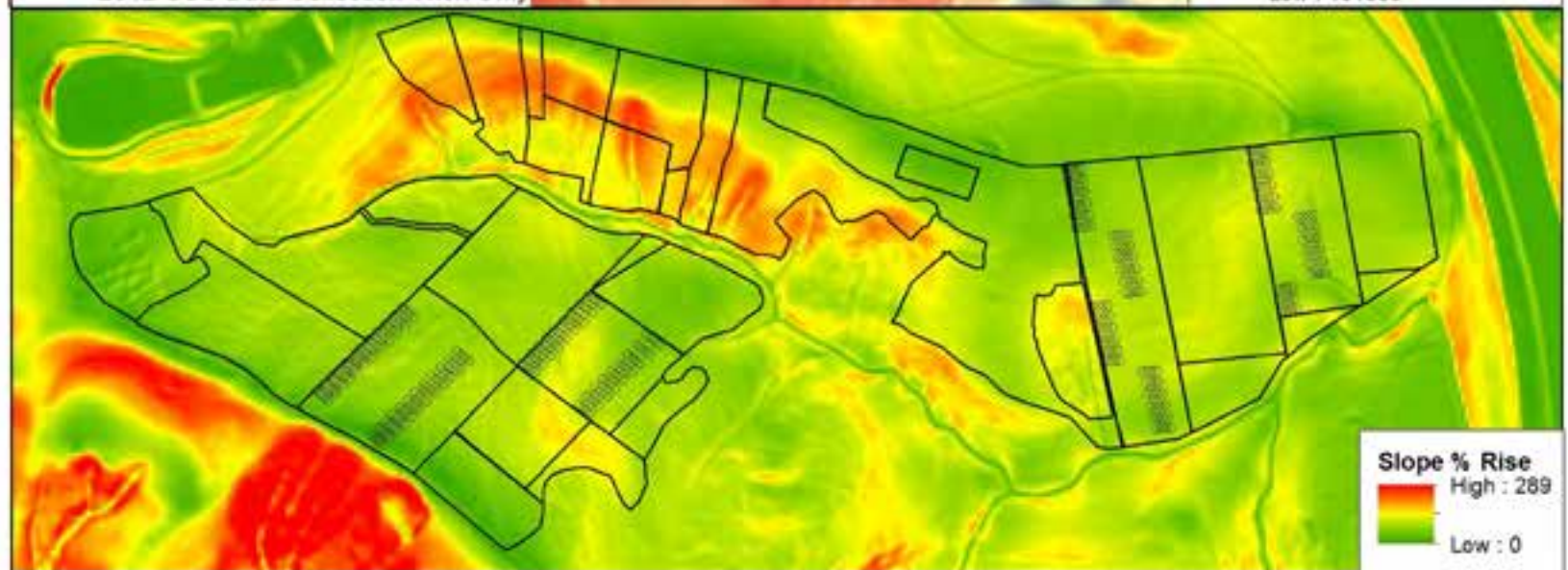
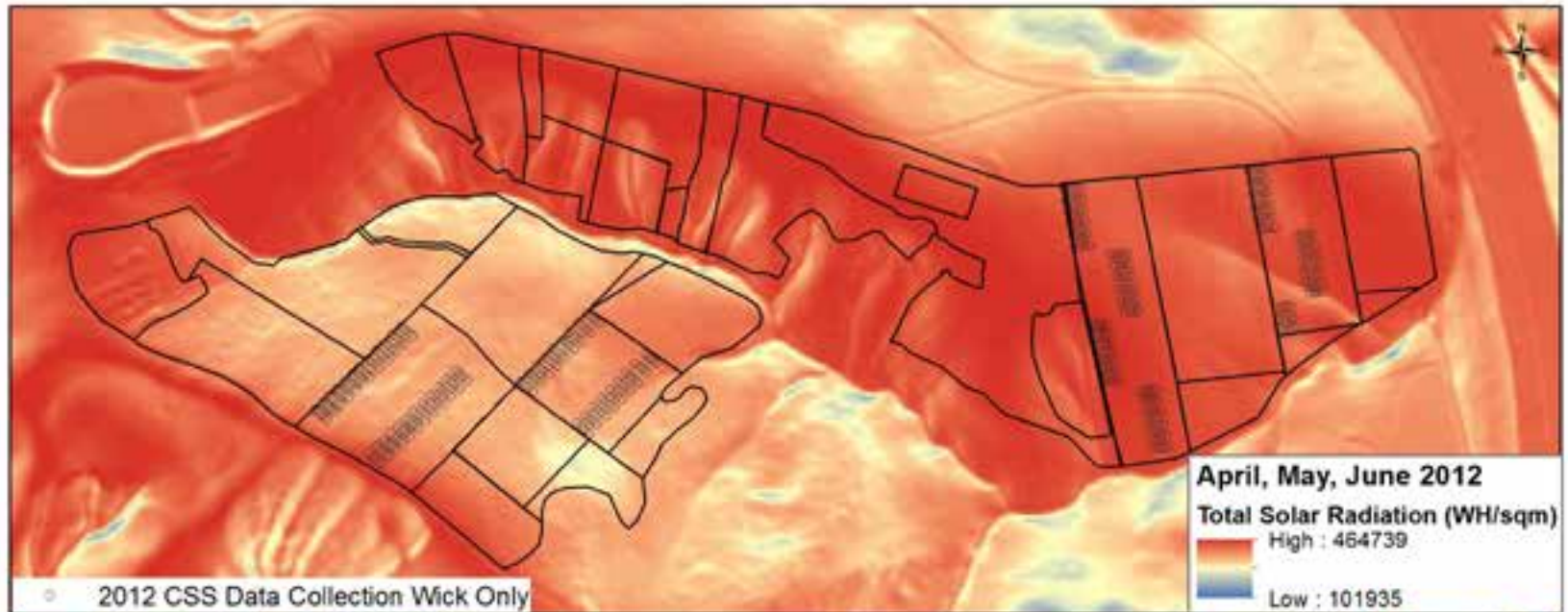
Output measurement (optional): DEGREE

Z factor (optional): 1

OK Cancel Environments... Show Help >>

Elevation data source: USGS  
<http://viewer.nationalmap.gov/viewer/>

# Environmental Variation



# Analysis

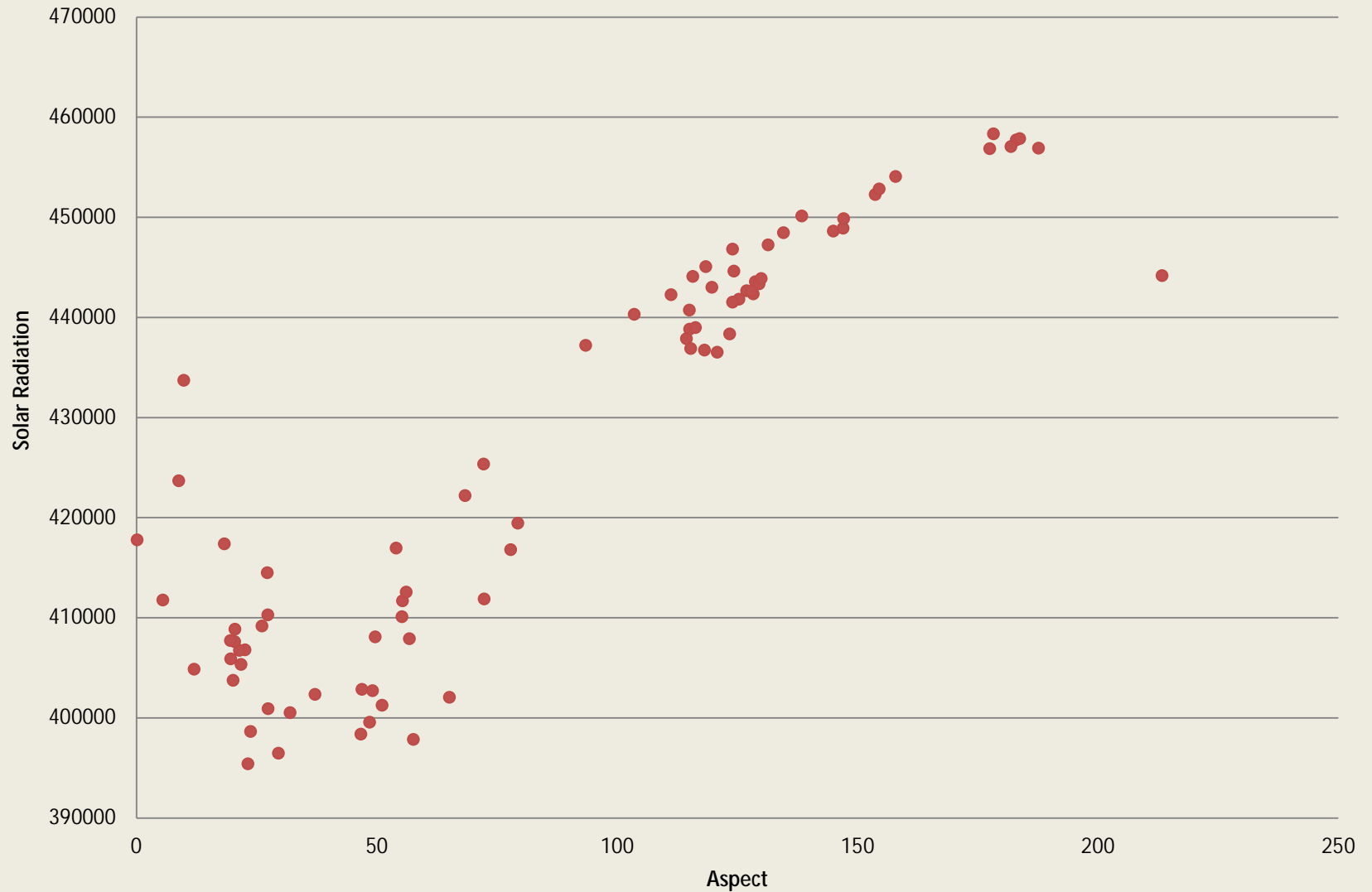
## ANOVA for 2012 June % Native Cover in CSS Wick Only Plots

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Sol_2012	1	1.30	1.302	17.067	4.24e-05	***
slope_perc	1	0.39	0.390	5.112	0.024204	*
Maintenance	2	1.42	0.712	9.334	0.000105	***
Mix	3	25.87	8.624	113.022	< 2e-16	***
Sol_2012:Maintenance	2	0.03	0.014	0.180	0.835173	
Sol_2012:Mix	3	3.92	1.306	17.112	1.38e-10	***
slope_perc:Maintenance	2	0.05	0.026	0.342	0.710194	
slope_perc:Mix	3	0.32	0.107	1.405	0.240637	
Maintenance:Mix	6	0.23	0.039	0.509	0.801834	
Residuals	492	37.54	0.076			

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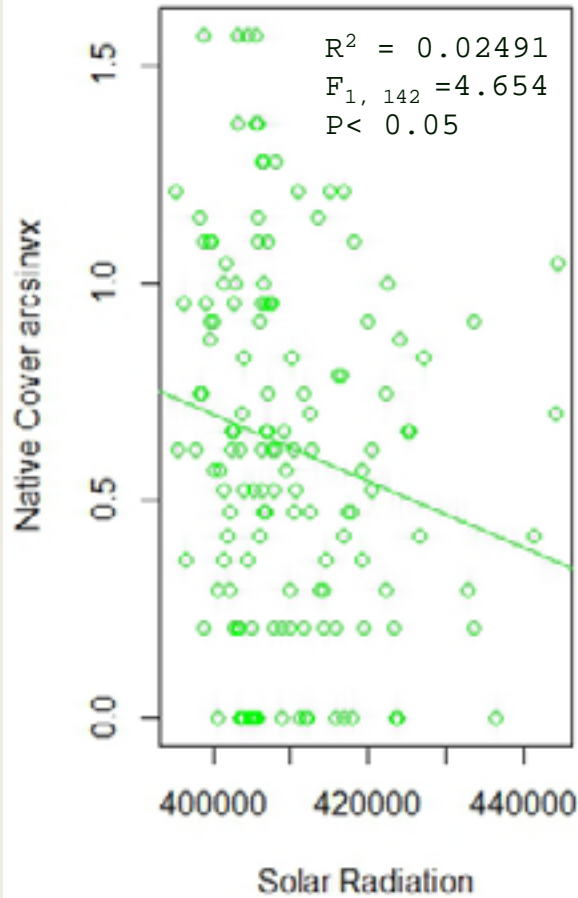
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
51 observations deleted due to missingness

# Solar Radiation VS Aspect

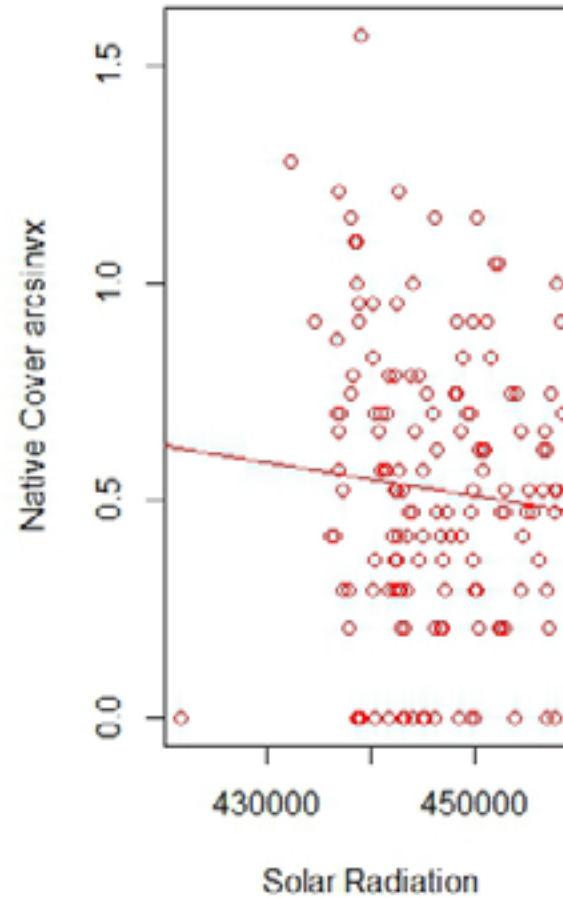


# Solar Radiation

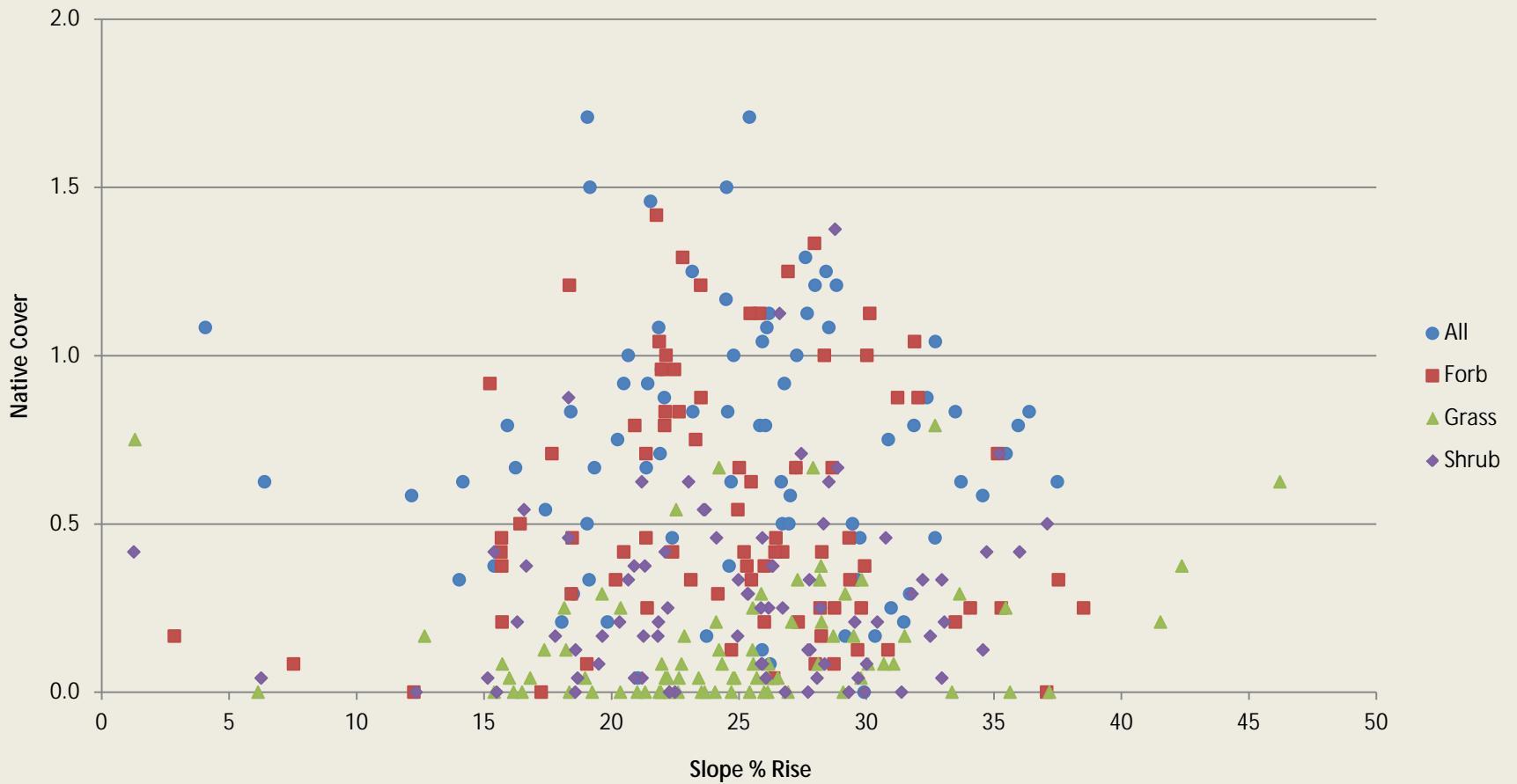
## North Facing Slope



## South Facing Slope

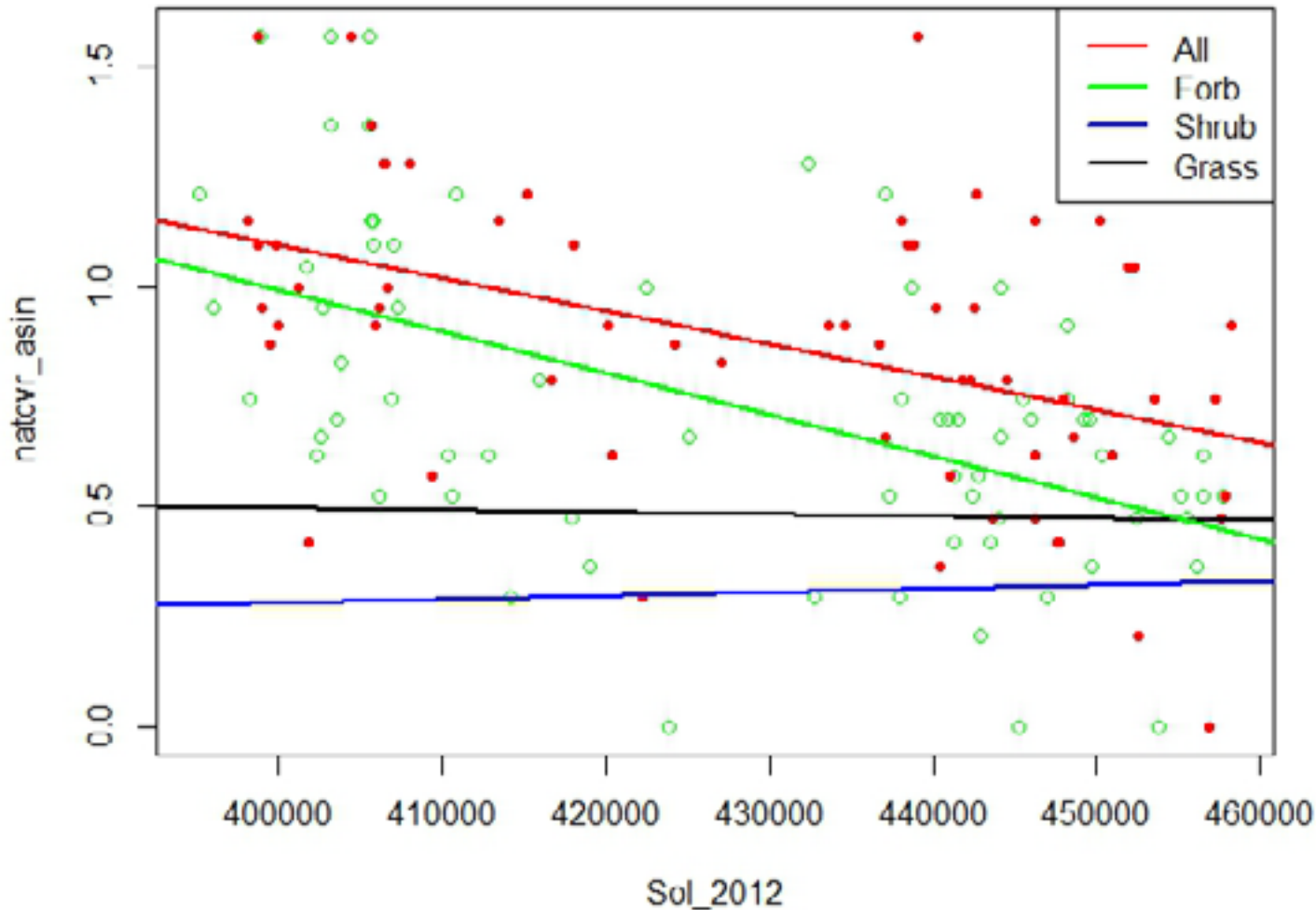


# Slope



# Solar Radiation & Seed Mix

Functional Groups and Solar Radiation



All  
 $R^2 = 0.1924$   
 $F_{1,60} = 15.53$   
 $P < 0.001$

Forb  
 $R^2 = 0.273$   
 $F_{1,68} = 26.91$   
 $P < 0.001$

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# Question?

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