

1) Suppression of *Phytophthora ramorum* infections through silvicultural treatment in CA's north coast

2) Is stump sprout control necessary to effectively control *P. ramorum* in California's wildlands?

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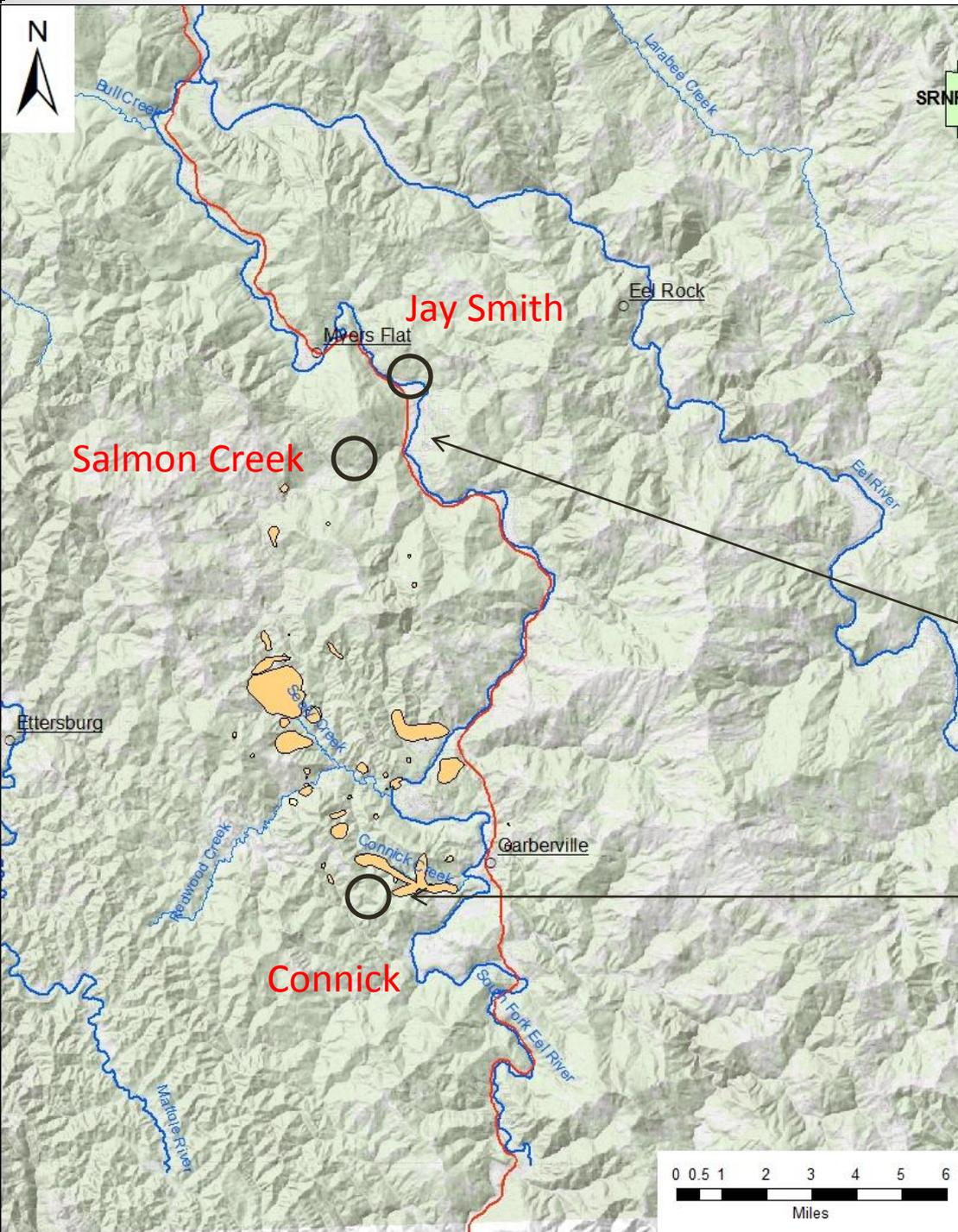
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CAL FIRE



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Study locations 2005

- Two hot spots
 - Jay Smith (50 ac or 20 ha)
 - Salmon Creek (25 ac or 10 ha)
- One slow the spread
 - Connick Creek (50 ac or 20 ha)

Total 125 ac 50 ha





Myers Flat

Miranda

Phillipsville

Garberville

Blacksburg

Image USDA Farm Service Agency
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

1998

40°14'05.61" N 123°38'09.05" W elev 303 ft

Eye alt 28344 ft

Management Experiment Designed

Three locations

(Jay Smith, Connick, Salmon Creek)

- In all study areas **NO SPROUT CONTROL**
 - Cut tanoak and California bay laurel, pile, burn piles, leave logs on site
- Alternate treatments
 - Bay + tanoak + **broadcast fire**
 - Bay + tanoak + **Pacific madrone**
 - Bay + tanoak using herbicides
 - Fuel hazard reduction (i.e. tanoak thinning + bay girdle)
 - Bay only
 - **Fire only**



Long-term monitoring

- 1/10 ac (0.04 ha)
permanent fixed area
circular plots
- 6 sampling periods 2006-2011
- 5% area permanent sample
 - All trees, stump sprouts, sprout clumps, saplings, seedlings
 - Focused on symptoms with supportive lab confirmations as there were too many individuals to monitor through time



Treatment Examples

Bay and tanoak removal



Bay girdle



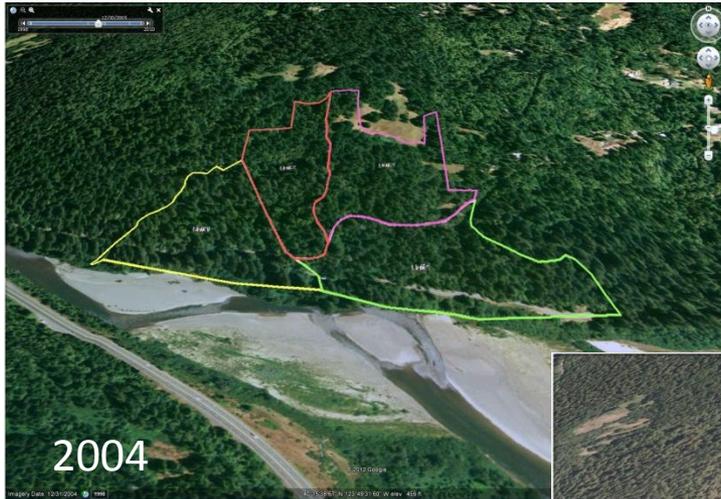
Prescribed burn



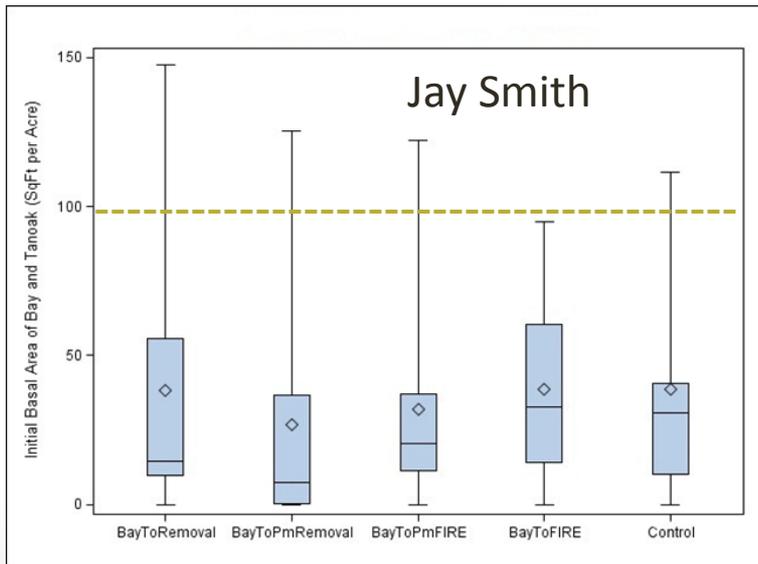
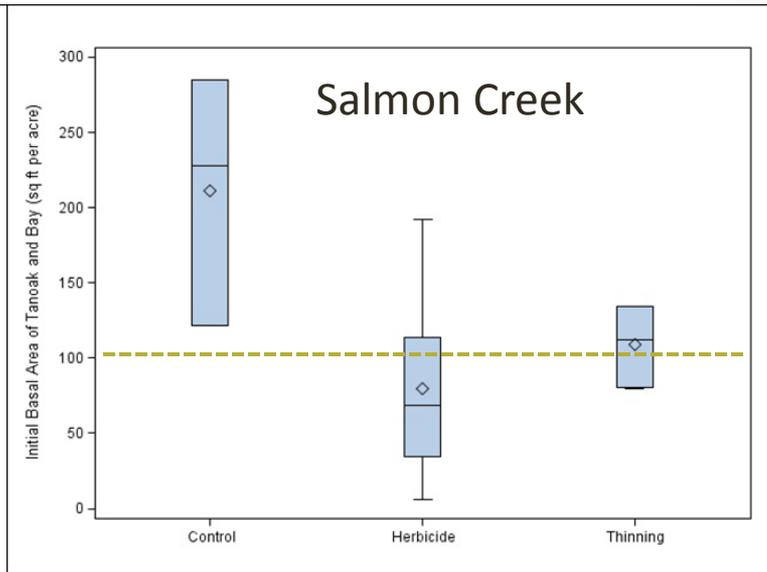
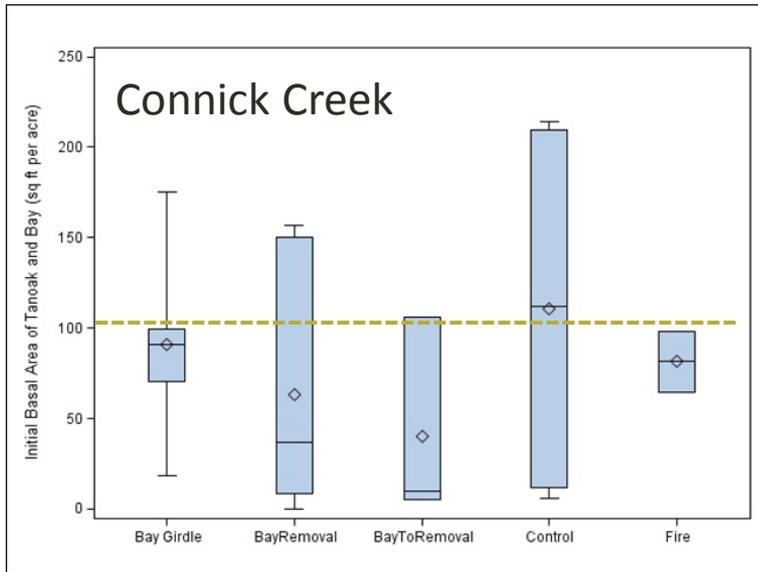
Herbicide treatment



Jay Smith pre- and post-treatment



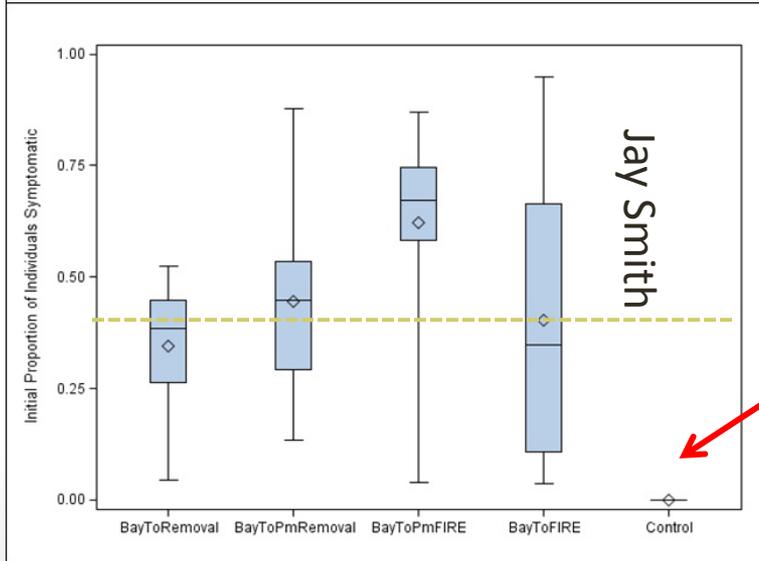
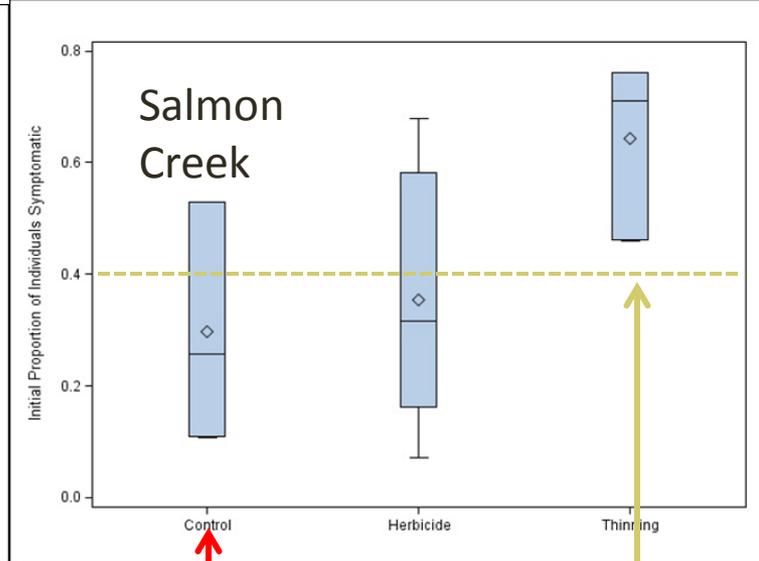
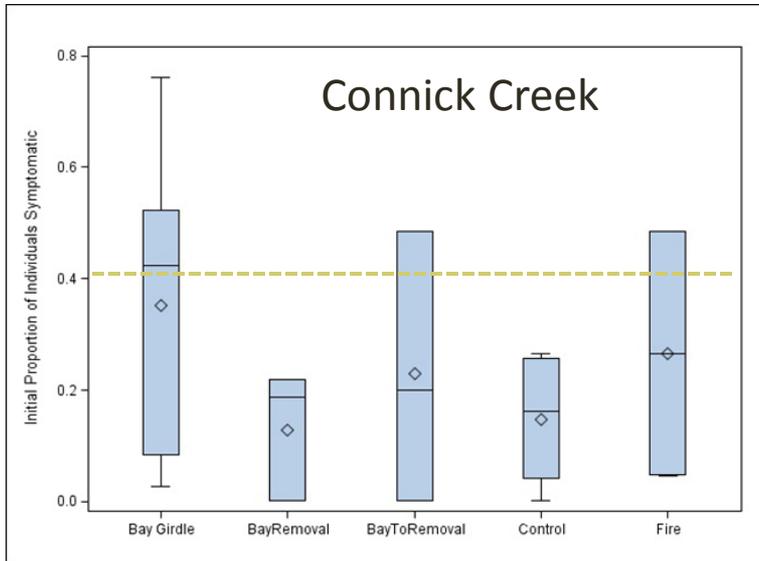
Initial Basal Area of Tanoak and Bay



Stands within each treatment area were reasonably similar before treatment, but Jay Smith is statistically lower than others.



Initial Proportion of Individuals Symptomatic



This treatment was not properly installed and was converted into a control.

Controls at Jay Smith and Salmon Creek were established in 2007 and have low replication.



Treatment installation issues

Herbicide Treatment

- Imazapyr was slow to affect bay and took 3 years, allowing for the pathogen to spread during this time.
- Now we know that Imazapyr + Glyphosate is effective in early top kill of treated trees

Fire only

- Did not burn well and did not produced desired affects

Girdling of bay

- Does not cause top kill of bay trees

Incomplete treatments

- At Jay Smith some patches of bay were untreated (because of a very short window for falling operations)

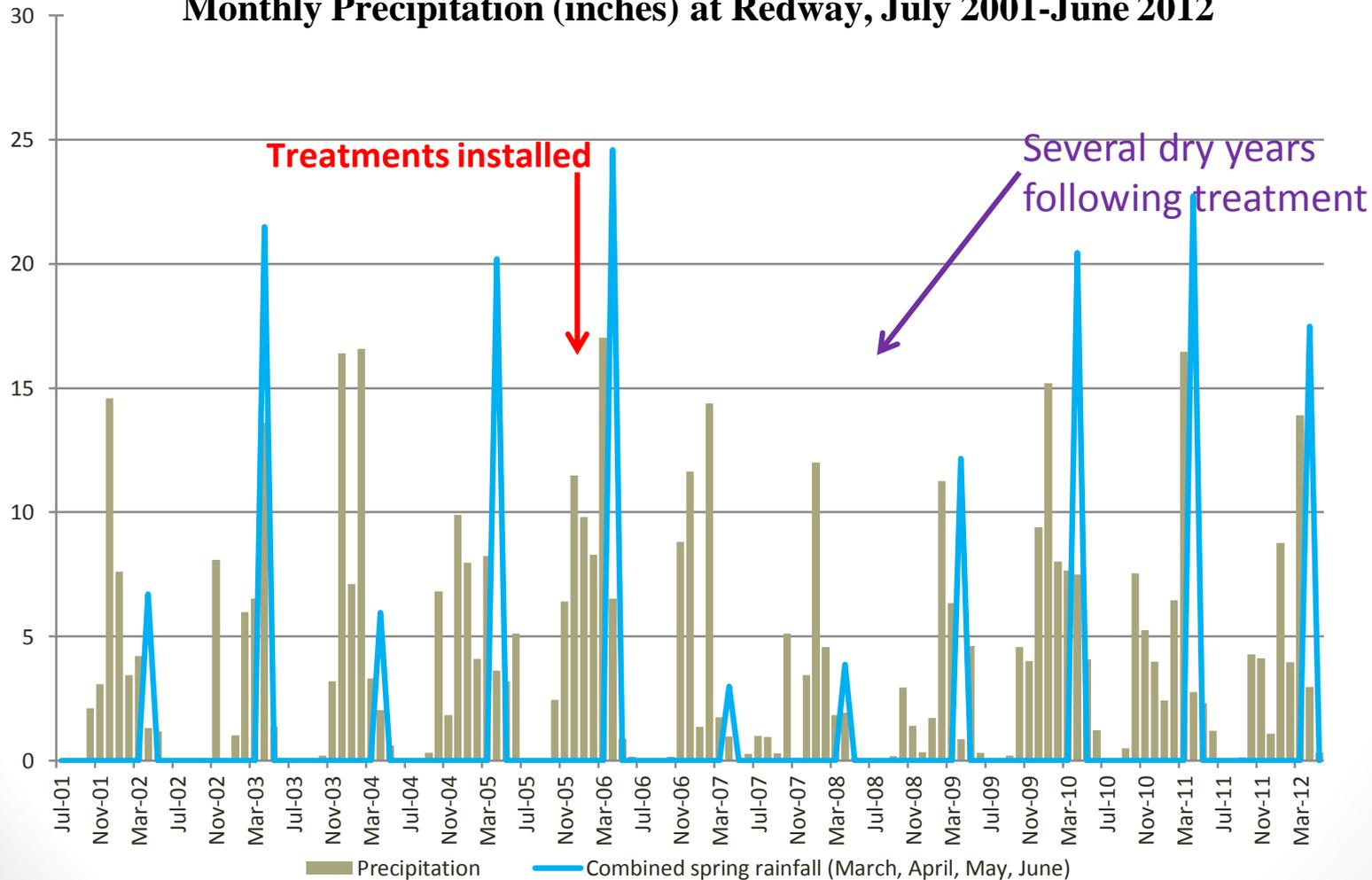
General

- Random allocation of treatment units are not possible

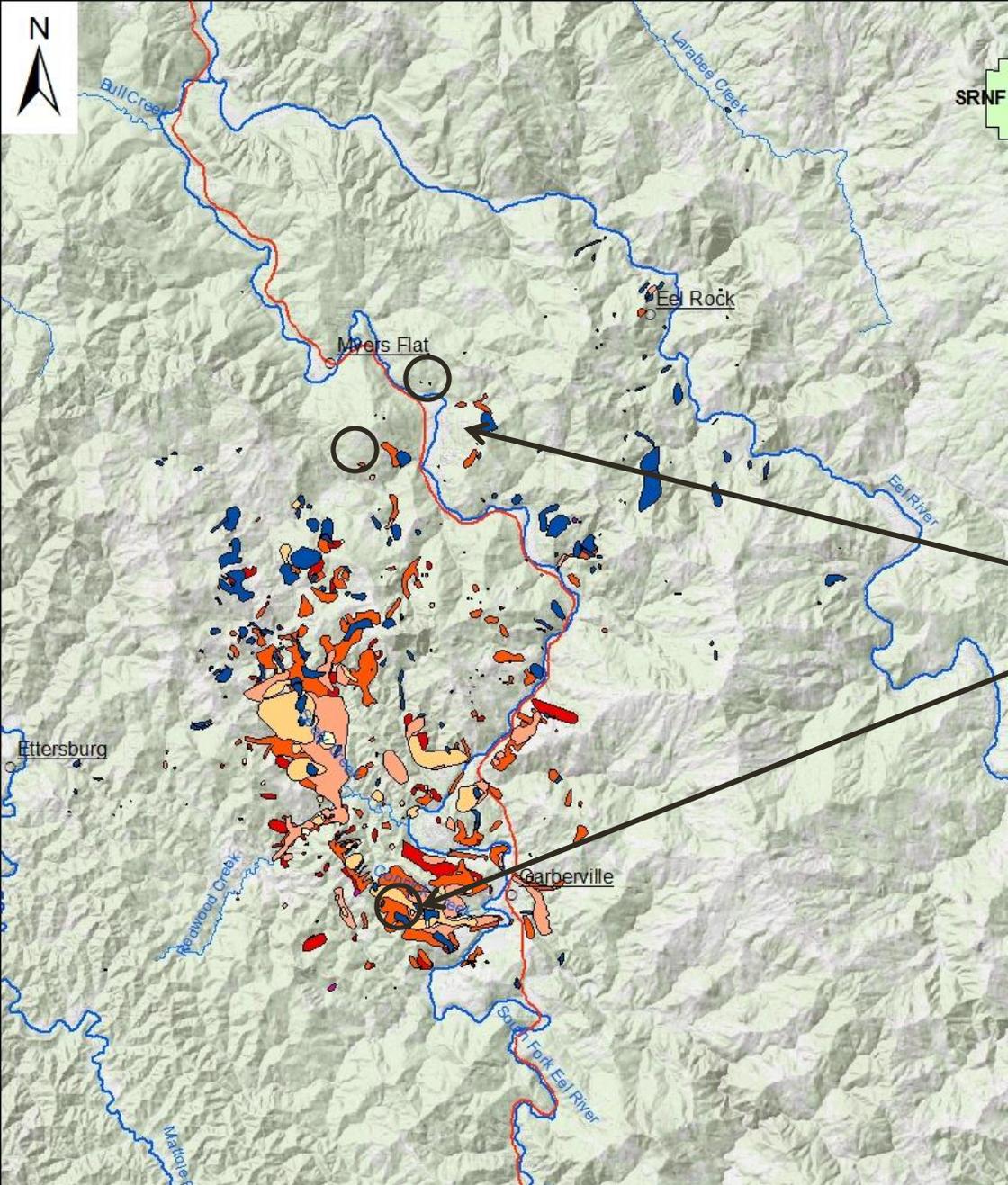
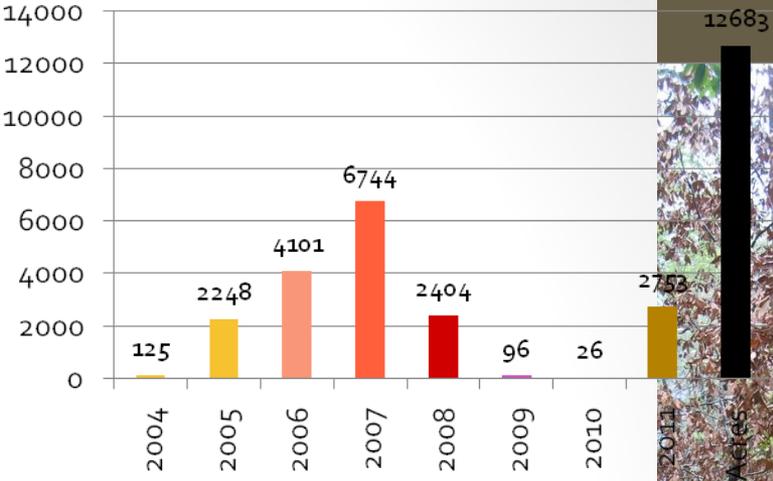


Years 03, 05, 06, 10, 11 and 12 have been highly supportive for pathogen spread

Monthly Precipitation (inches) at Redway, July 2001-June 2012



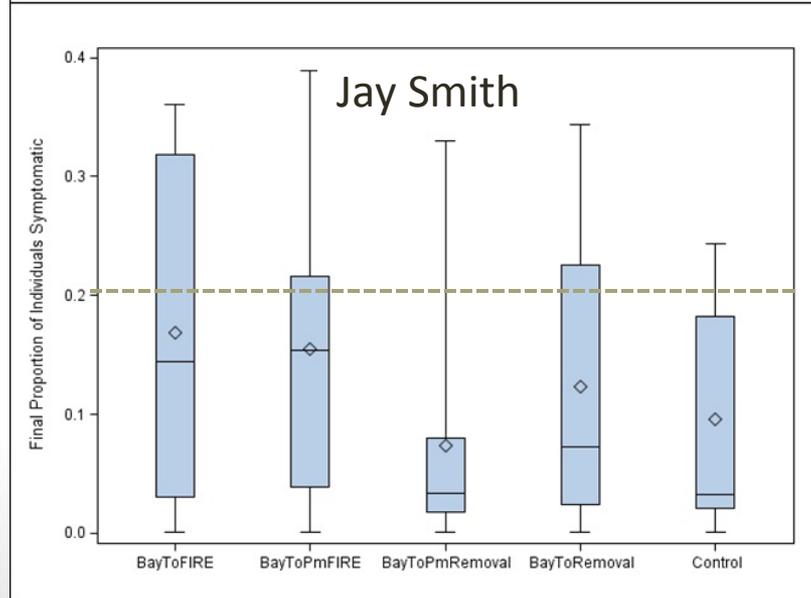
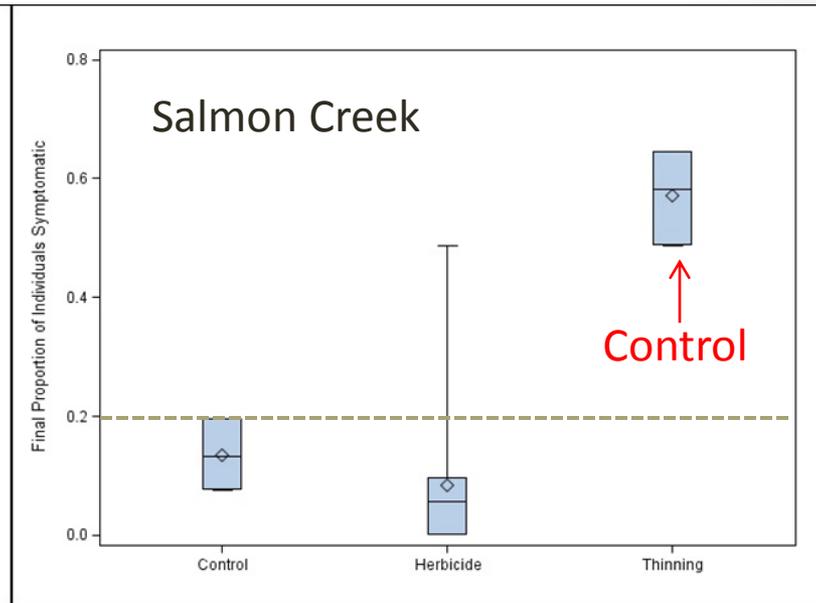
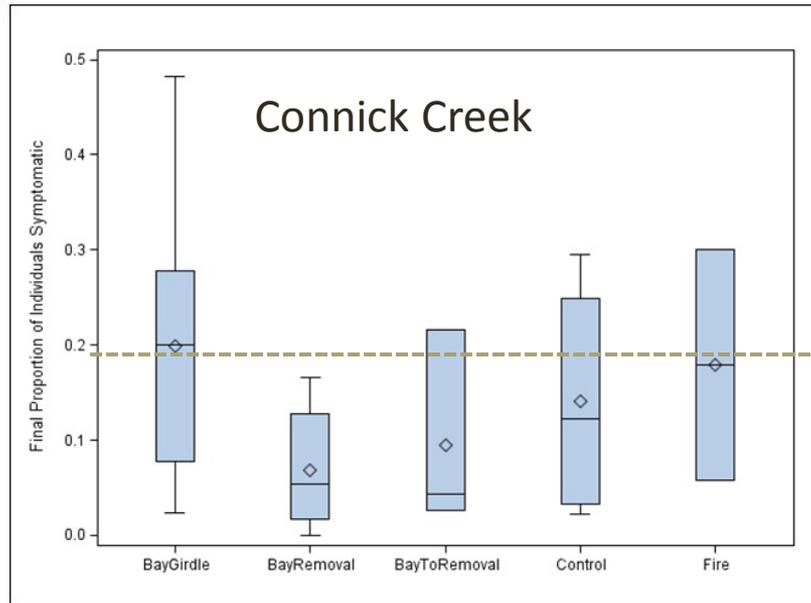
Aerial Detection (ac) by Year



Status near to the treatment areas in 2011.



Final Proportion of Individuals Symptomatic



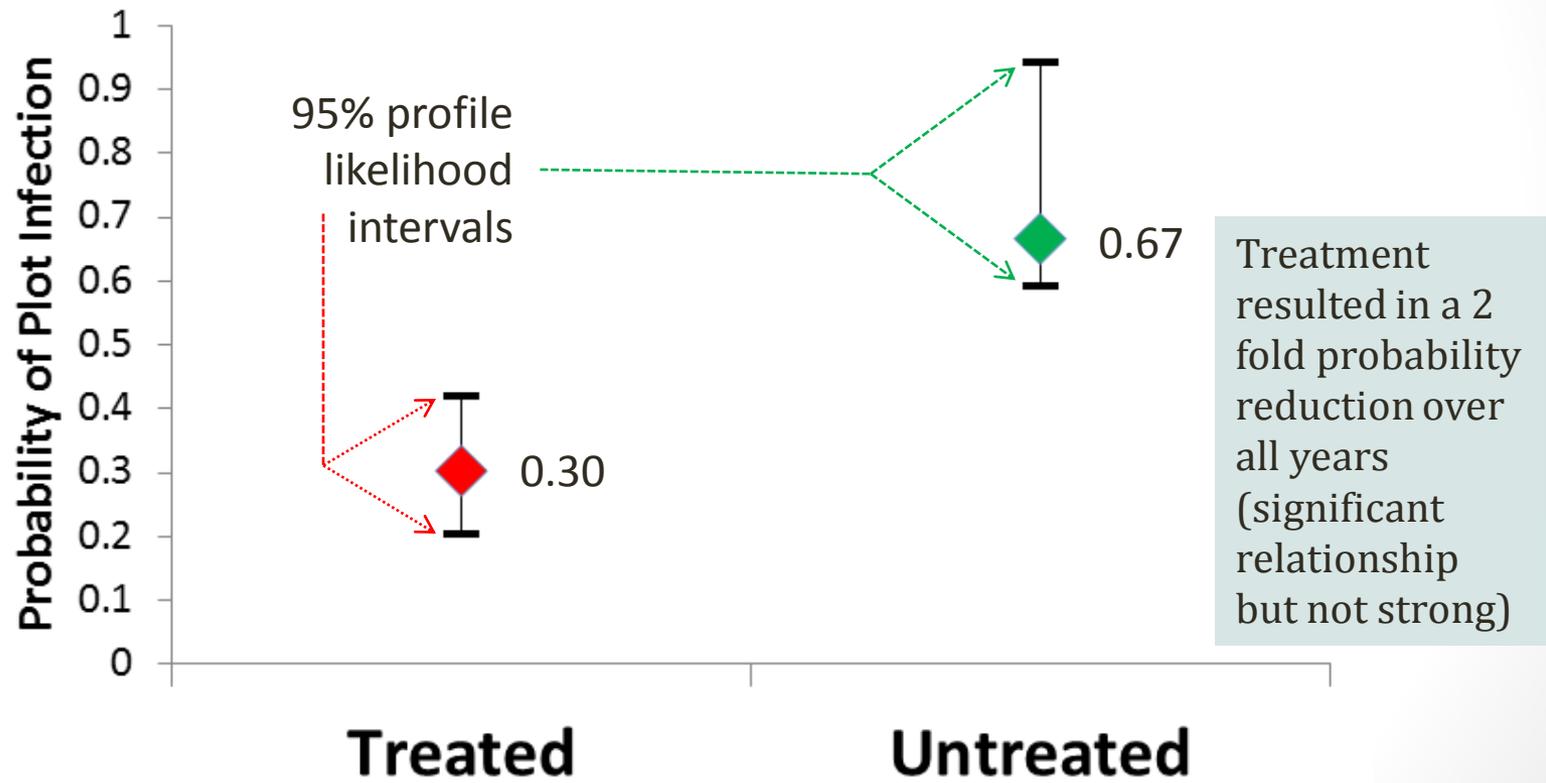
... later we learned that symptomatic tissue did not yield the pathogen with any regularity, though it suggests some trends.

Focused analysis on only actual recovery of *P. ramorum*.

Note: this does not reflect frequency of detection



The Simple Logistic Regression Model: Cumulative Post-Treatment Infection Rates – Treated* vs. Untreated Plots

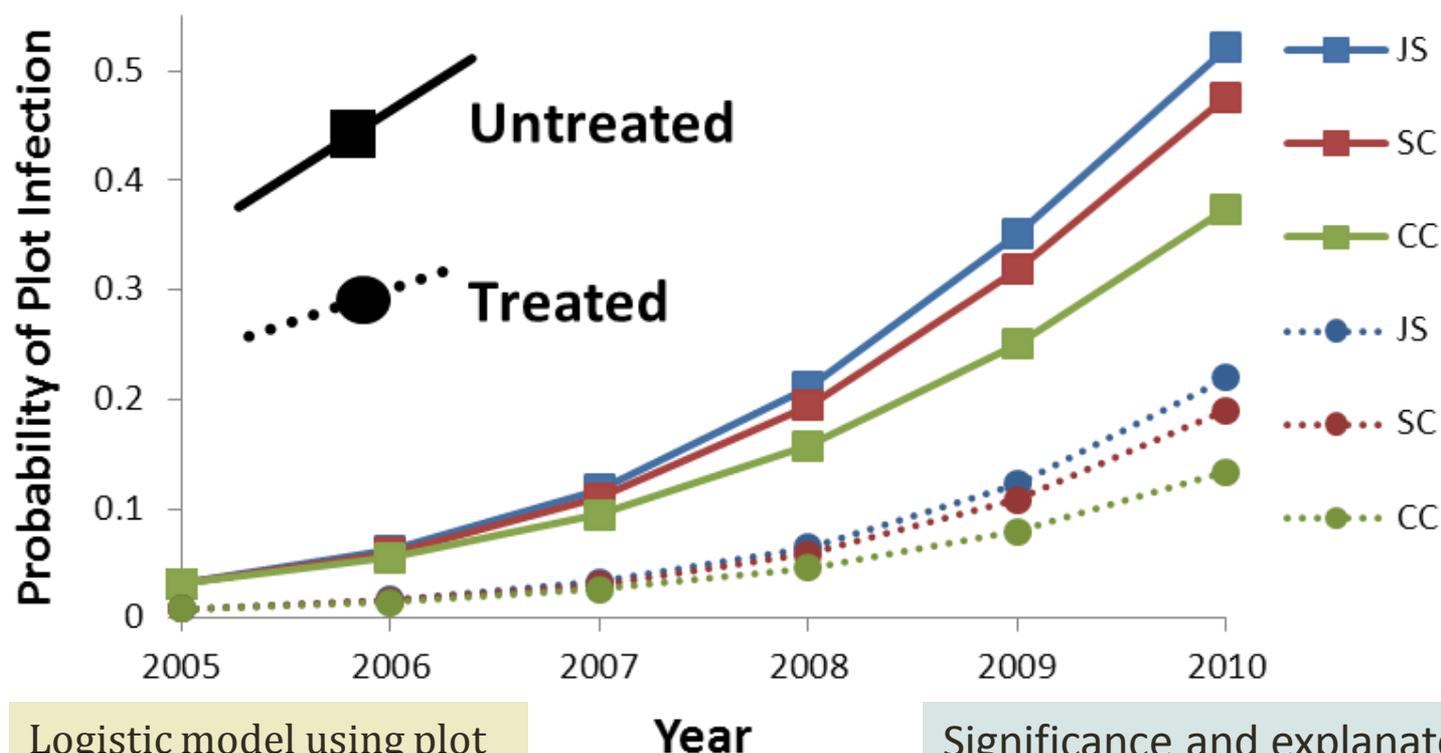


* All treatment types are included except thinning at Salmon Creek and fire only

Model With Site by Survey Interaction Term

-Model of probability of plot infection at a given survey time

- Area under ROC curve = 0.81 (logistic regression analog to R^2)
- An improvement of 0.17 over model with only treatment effect



Logistic model using plot as repeated subject

Year

Significance and explanatory power strong. 2010 driving observed effects.



Why does Jay Smith have higher infection rates?

Perhaps because more plots in those treatment units were close to bays that didn't get removed—either within the units or directly outside them...

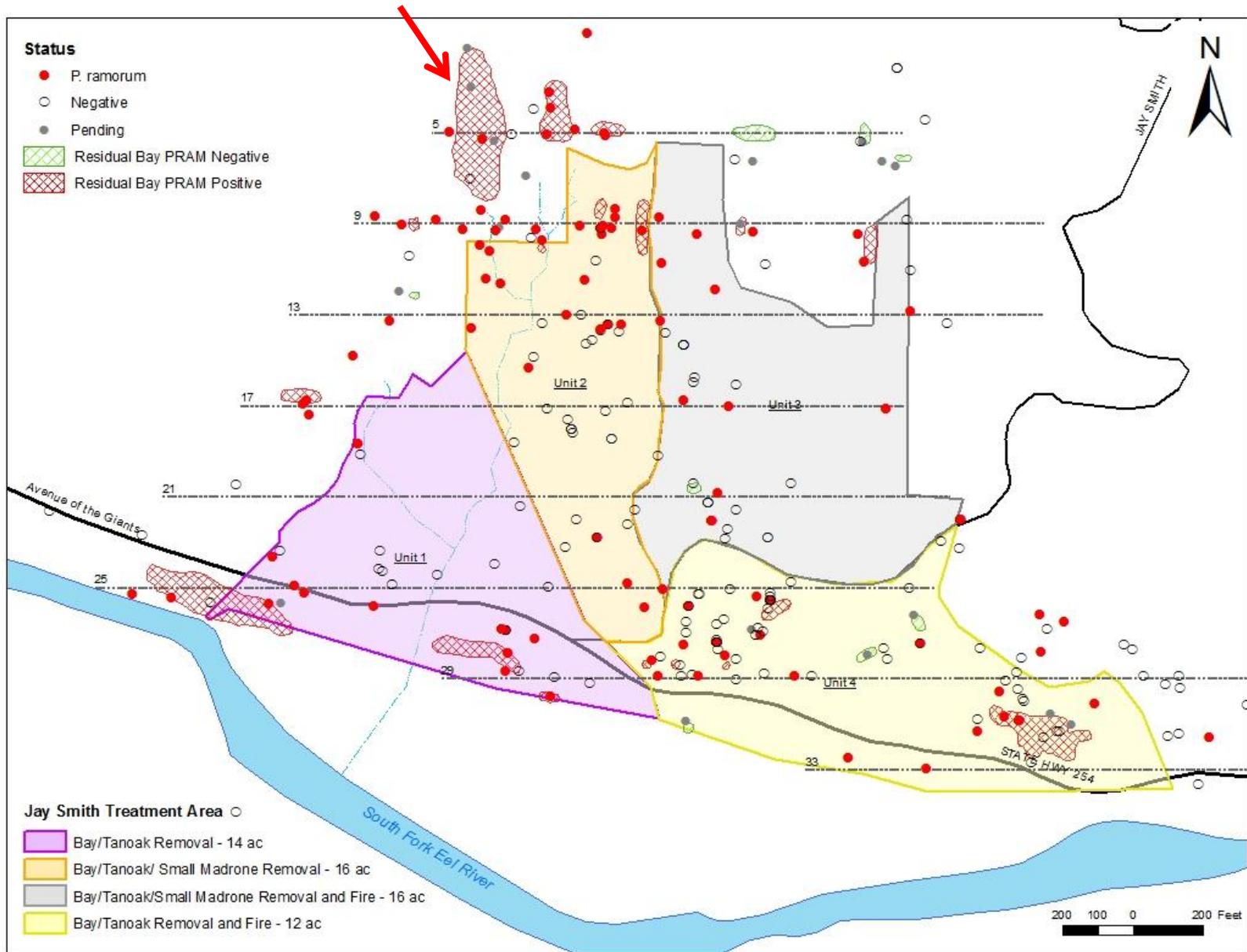
- Proximity within 50 m to these bay patches, shows positive relationship with infection probability (transect 2011 data)
 - This relationship is present but weak in data from our permanent plots

...and / or because initial amounts of bay in units may have been related to patchy initial infection conditions

- Pre-treatment basal area of bay was positively related to infection
 - $p = .09$; this model shows area under ROC of .81 alone, or increases ROC by .17 (to .87) when added to model with only treatment effect and does explain some of the higher incidence at Jay Smith



Distribution of residual bay and pathogen recovery at Jay Smith



Variables Tested for Ability to Predict Infection

Most variables were tested on both the cumulative per-plot infection and infection rates by survey year

1. **Basal Area** – initial and current survey; bay, tanoak, total
 - Interactions are present between site for some of these variables
2. **Canopy cover**- Not significant
3. **Site** as a random variable- Not significant
4. **Proximity of bay trees** to samples/plots at Jay Smith
 - Distance (as a continuous variable) to nearest bay patch- Not significant
 - Sum of inverse distances to all patches Not significant
 - Sum of inverse dist.* size of all patches within 50 and 100 m Not significant
 - Categorical (y/n): bay within 10, 15, 20, 25, 30, 40, 50, 60 m



Secondary study in 2010-

Is sprout treatment necessary?



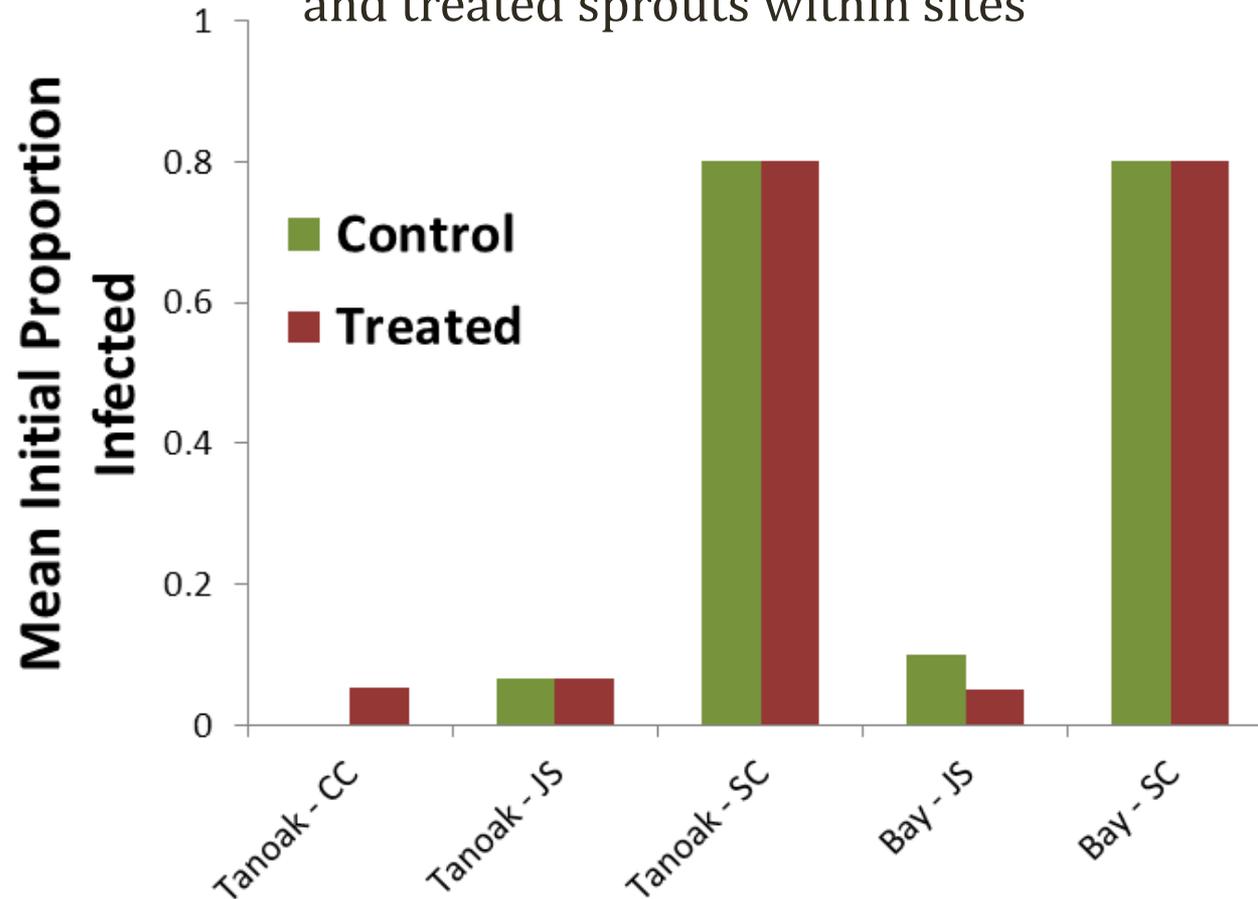
Up till 2010 little pathogen recovery observed (~10%).

- Was this an effect of season or sprout clump age?
- Created a new cohort of sprout clumps, paired with 6 year old neighbors.
- Added a more intensive sampling effort across sites.



Initial Infection Rates of Sprout Pairs by Species and Treatment

Initial conditions were similar between control and treated sprouts within sites



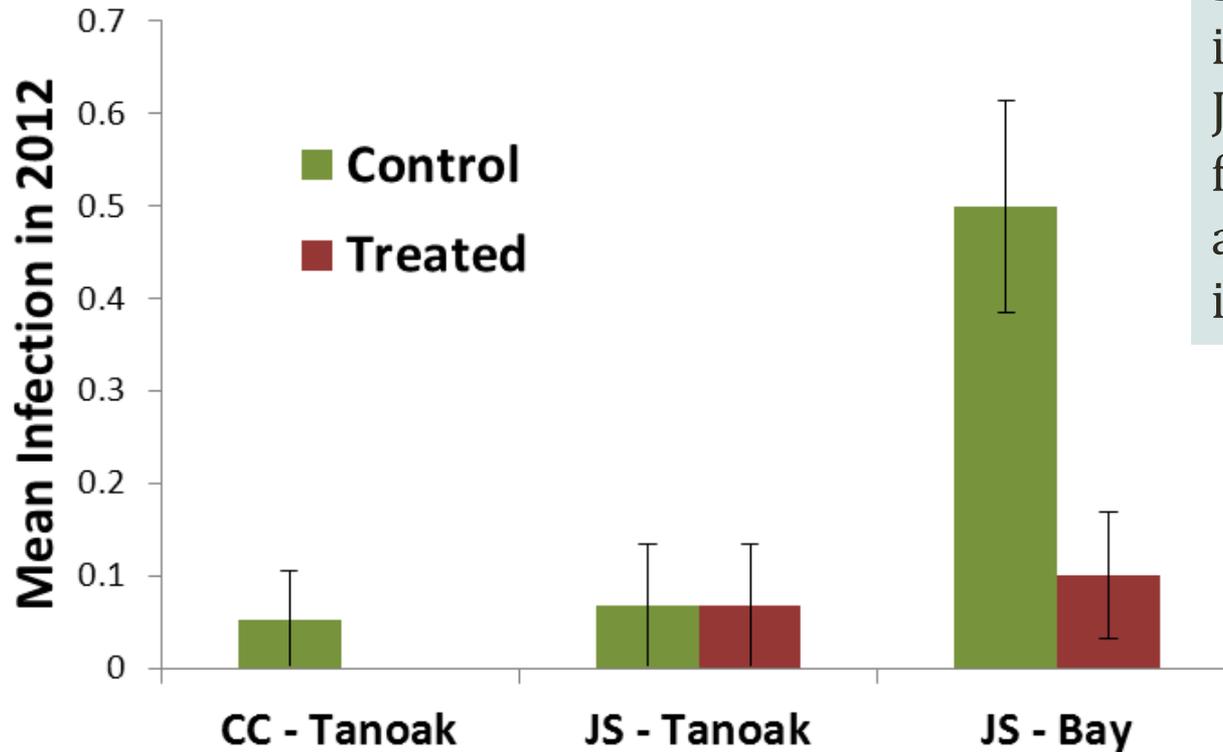
Clumps differed across sites, but were similar within pairs



One Year After Treatment

Species and treatment both are significant predictors in logistic model (treatment as split-plot effect); ROC = 0.78

Untreated (6 year old) bays sprout show higher infection rate at Jay Smith--a 10-fold increase above **initial** infection rate



Conclusions

- **Treatment issues**
 - Appropriate herbicides are critical
 - Bay girdling is ineffective →
 - Prescribed burn not necessary
 - Residual bay (islands and neighbors) is an issue and may be driving pathogen re-establishment in the sites
 - Bay treatment is essential
- Initially **sprout clump** management may not be necessary, but we need to follow these sprout clumps through time
 - More transect surveys are planned. Connick Creek bay and tanoak unit is surrounded by *P. ramorum*. There has been little recovery in this unit, we need larger data set to demonstrate this.
- **Transects** are better than fixed plots to record patchy distribution.



Acknowledgements

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- ARRA

Treatment

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