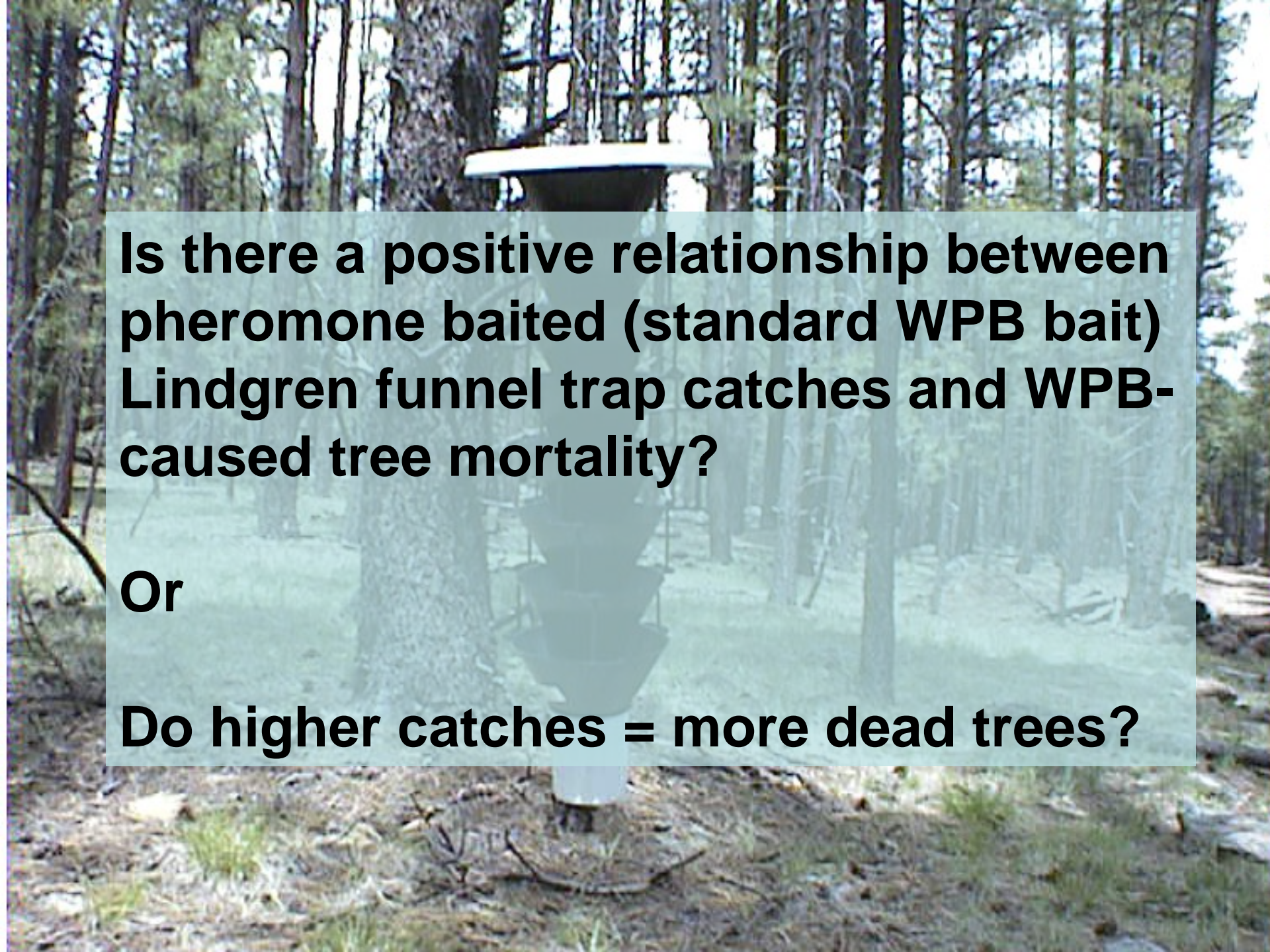


Evaluation of Multiple Funnel Traps and Stand Characteristics for Estimating Western Pine Beetle- caused Tree Mortality

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A Lindgren funnel trap is positioned in a forest. The trap is a white, funnel-shaped structure with a flat top and a narrow opening at the bottom. It is set on a wooden post. The background consists of many thin, vertical tree trunks, likely pines, under a bright sky. The ground is covered with dry leaves and twigs.

Is there a positive relationship between pheromone baited (standard WPB bait) Lindgren funnel trap catches and WPB-caused tree mortality?

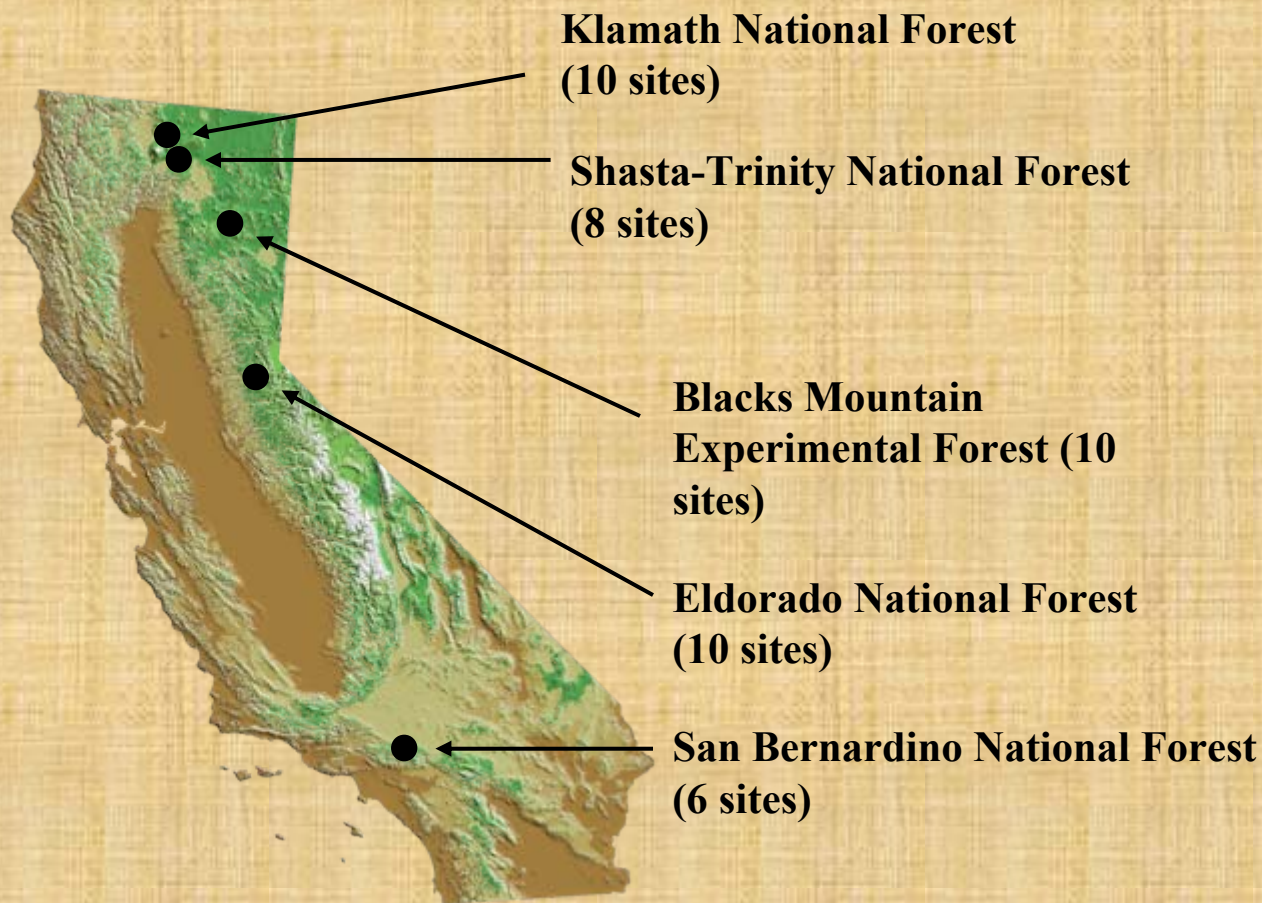
Or

Do higher catches = more dead trees?

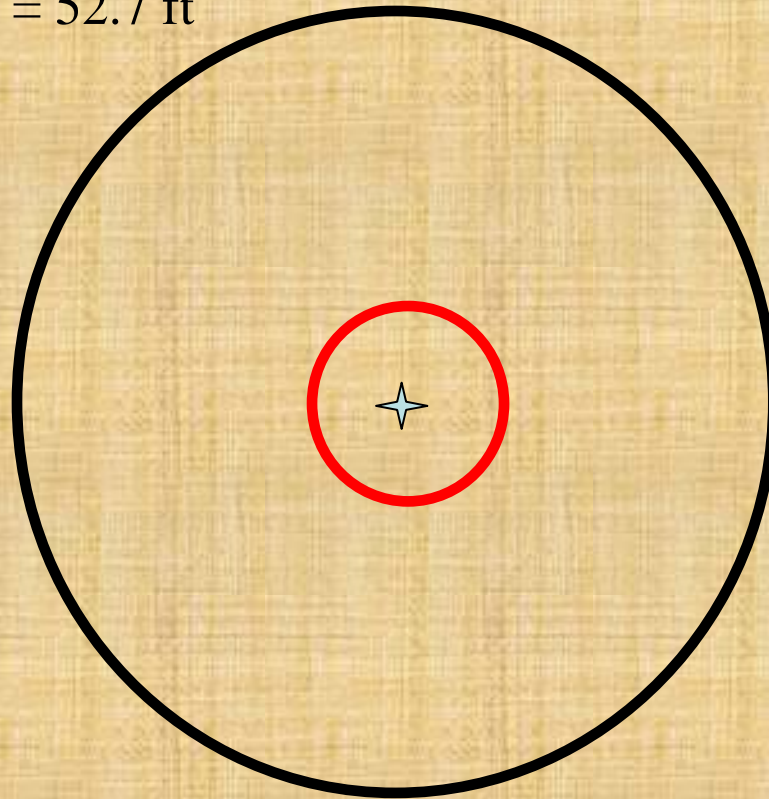
Modeling Successes

- ❖ European spruce beetle - *Ips typographus* (Faccoli and Stergulc 2004)
 - 40 traps deployed over 10,100 ha for 7 yrs
 - Mortality recorded on 30 ha plots around each trap (12% of forest surveyed)
 - Strong relationship between mean (n = 7) May – Aug. and May – June trap catches and volume of timber lost (e.g. $R^2 = 0.92$)
- ❖ Southern Pine Beetle – forecasting tool (Billing 1988)
 - Predicts population trends (e.g., increasing, declining, or static)
 - Uses *D. frontalis*/day and a ratio of *D. frontalis*:*T. dubius* (major predator)
- ❖ Spruce beetle – Utah (Hansen et al. 2006)
 - Established plots of 1, 4, and 10 ha around traps
 - Models had relatively poor fits (i.e., $R^2 < 40\%$)
 - Established threshold between endemic (< 2 mass attacked trees/ha) and epidemic (> 2 mass attacked trees/ha) – 842 *D. rufipennis* per season (used classification-tree analysis)

- Traps placed at 5 locations (forest scale; 3,000 – 14,000 ha)
- 6-10 traps deployed at each location, 44 total (stand scale; 2 ha)

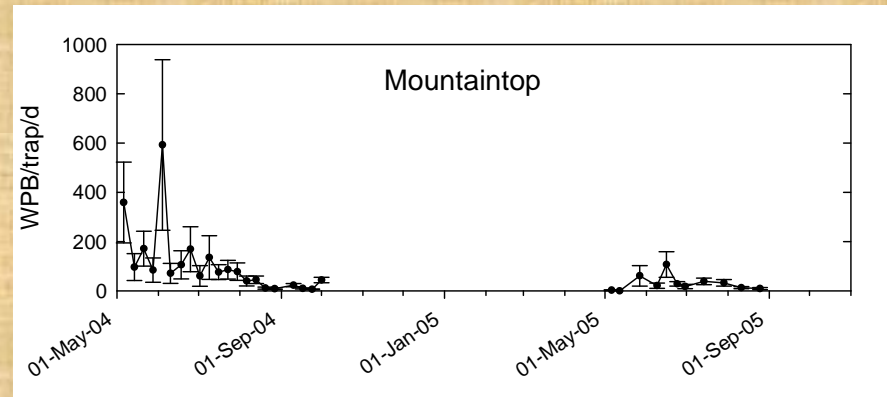
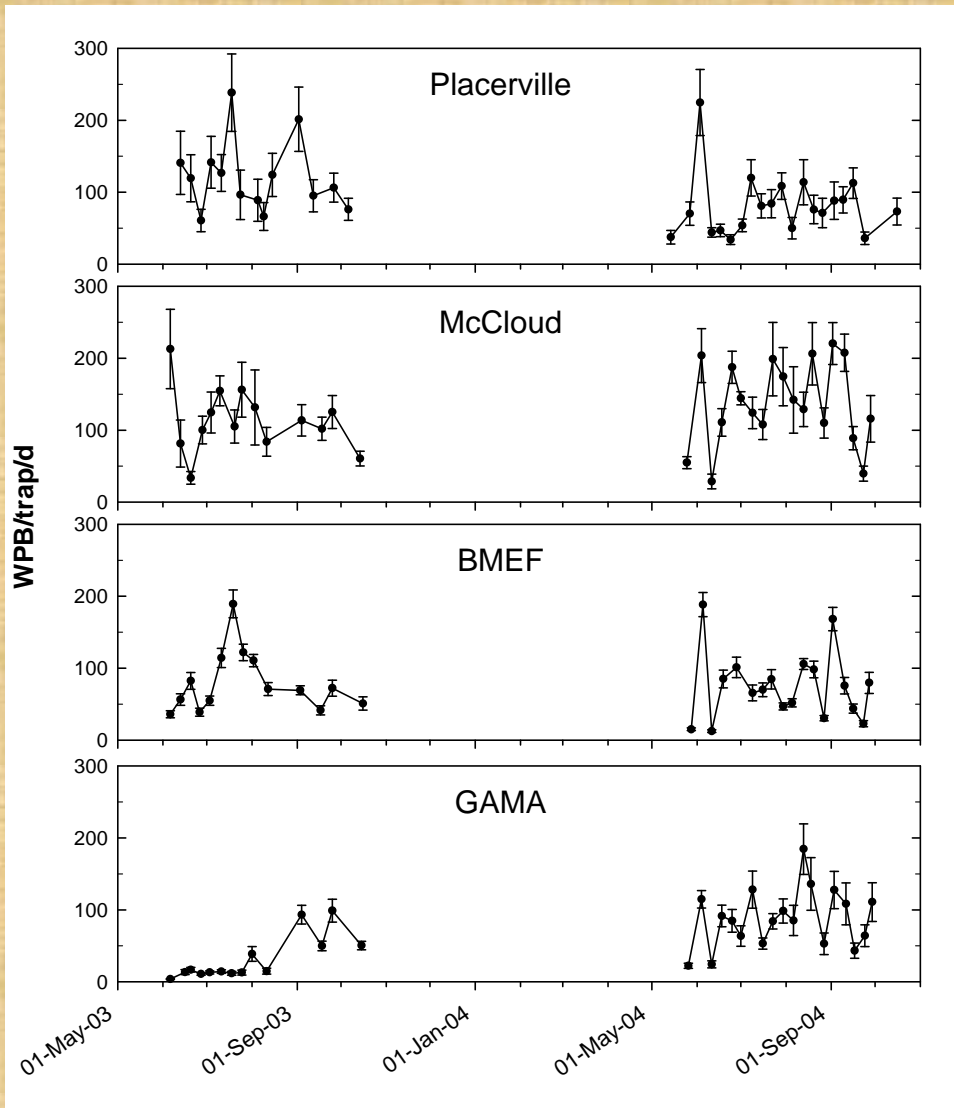


- ✦ Single trap location
- BB Mortality Plot – 2.0 ha; radius = 263' 4.0"
- Overstory Plot – 0.08 ha = 52.7 ft



FS ROAD

Flight Periodicity



Independent (Predictor) Variables

Yr-1

WPB trapped/day

June WPB

trapped/day

WPB: *T. chlorodia*

(major predator)

% catch WPB

Yr-2

WPB trapped/day

June WPB

trapped/day

WPB: *T. chlorodia*

(major predator)

% catch WPB

Stand data

Trees/ha (all spp.)

BAA (BA all spp.)

BAP (BA

ponderosa pine)

Mean dbh

Dependent Variables

Yr-1 WPB-caused

ponderosa pine

mortality/ha

Yr-2 WPB-caused

ponderosa pine

mortality/ha

Yr-1 % WPB-caused

ponderosa pine mortality

Yr-2 % WPB-caused

ponderosa pine mortality

Combined (Yr-1 and Yr-2)

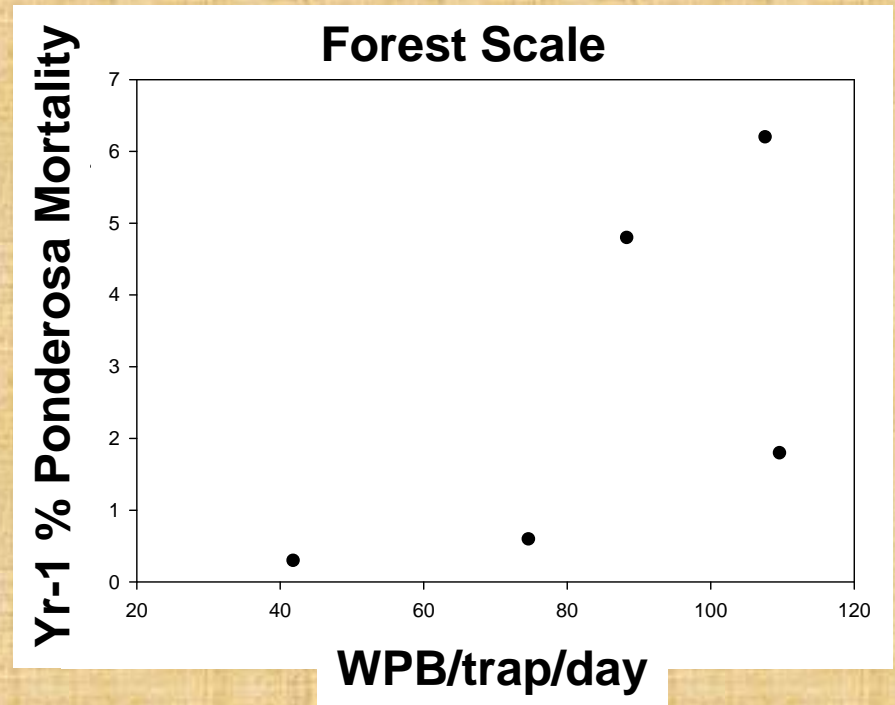
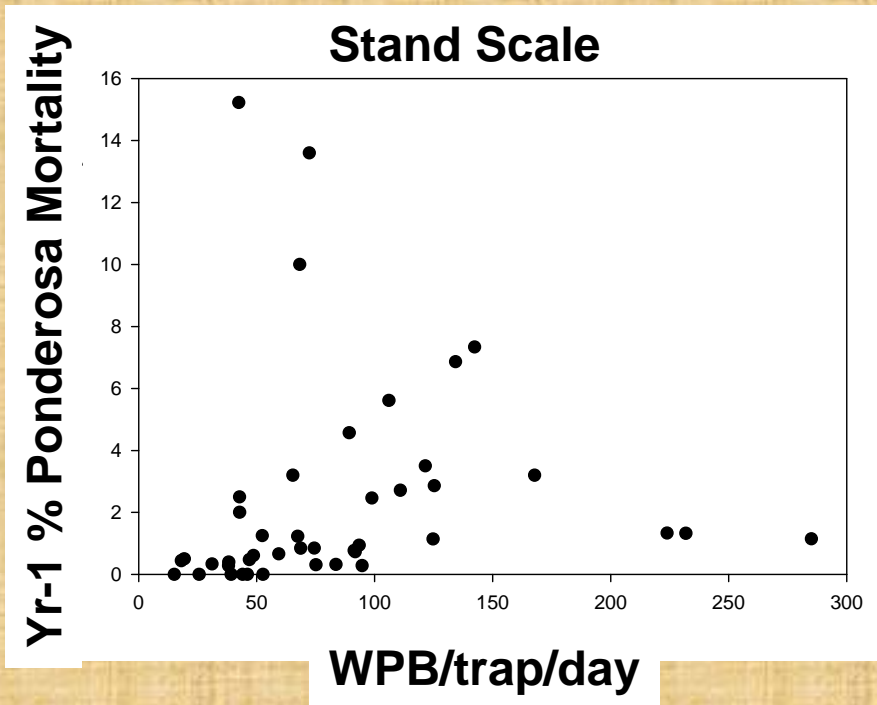
% WPB-caused ponderosa

pine mortality

Model Criteria

- Criteria used for inclusion of all models included:
 - model P -value ($P < 0.05$)
 - even distribution of plotted standardized residuals
 - low partial P -values for individual independent variables
 - and (high) R^2 values (min. adjusted $R^2 = 0.20$).
- Simple linear (and possible curvilinear) regressions were run for all significant independent variables,
- Along with all combinations of two predictor variable multiple regressions at both spatial scales [forest ($n = 5$) and stand ($n = 44$)].
- Identification of more complex models (small scale only) was done using forward stepwise analysis.

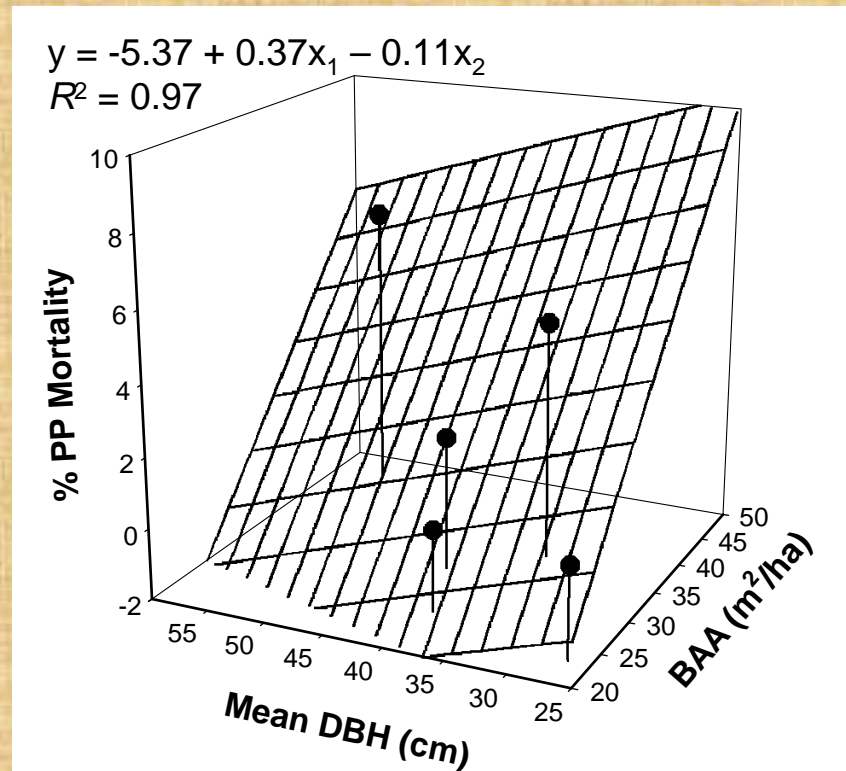
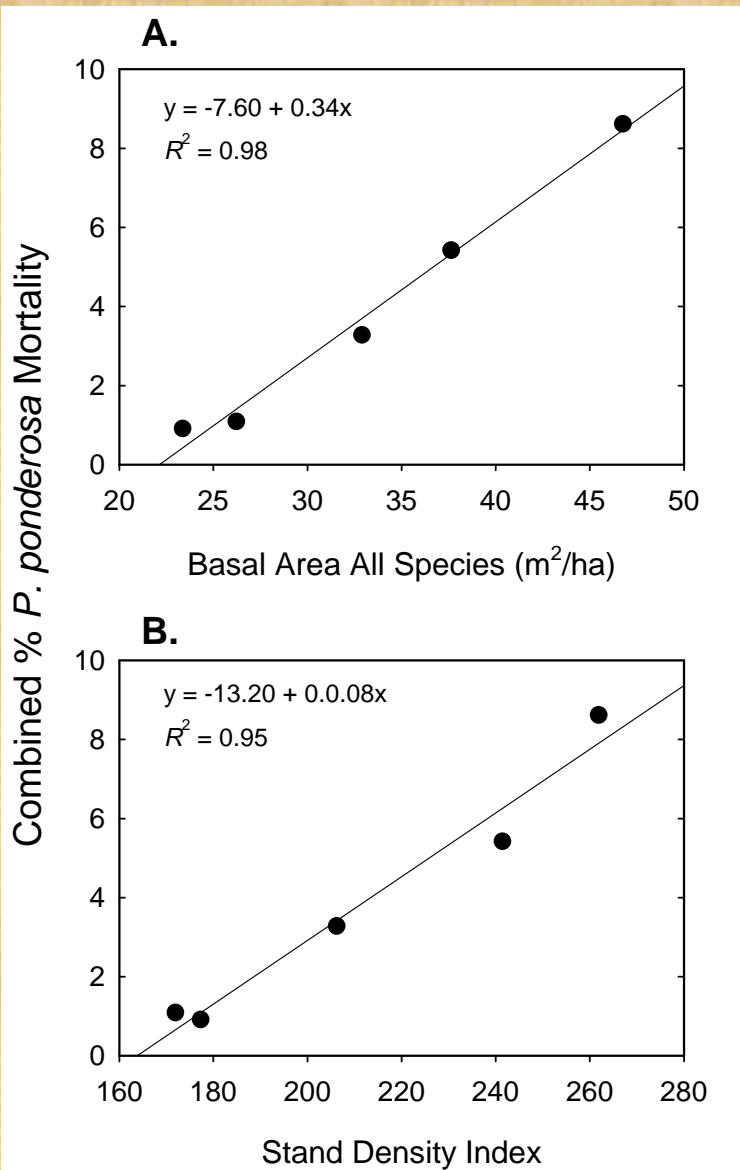
Yr-1 WPB Trap Catch v. WPB-Caused Ponderosa Mortality Scatter Plots



Results: Stand Scale Models

Model	Independent variables (x_i)				Model statistics			
	Variable	Range of values	Coefficient (SEM)	Partial P	F	df	P	Adj. R^2
A. $y = \sqrt{\text{Yr-1 \% } P. \textit{ponderosa} \text{ mortality } (n = 43) \text{ (range of values, 0.0-3.9 \%)}}$								
	Constant	-	-0.42 (0.40)	0.30	18.0	1,41	<0.001	0.29
	x_1 Mean dbh	19.5 – 75.4 cm	0.10 (0.02)	<0.001				
B. $y = \sqrt{\text{Yr-1 \% } P. \textit{ponderosa} \text{ mortality } (n = 43) \text{ (range of values, 0.0-3.9 \%)}}$								
	Constant	-	-0.71 (0.42)	0.10	11.2	2,40	<0.001	0.33
	x_1 WPB/d	18.1 – 285	0.004 (0.002)	0.08				
	x_2 Mean dbh	19.5 – 75.4 cm	0.02 (0.02)	<0.001				
C. $y = \sqrt{\text{Yr-1 \% } P. \textit{ponderosa} \text{ mortality } (n = 43) \text{ (range of values, 0.0-3.9 \%)}}$								
	Constant	-	0.91 (0.38)	0.02	6.5	2,40	0.004	0.21
	x_1 TPH	61.8 – 766.0	-0.002 (0.001)	0.04				
	x_2 BAA	14.3 – 77.3 m ² /ha	0.006 (0.002)	0.004				
D. $y = \sqrt{\text{Combined \% } P. \textit{ponderosa} \text{ mortality } (n = 43) \text{ (range of values, 0.0-4.1 \%)}}$								
	Constant	-	0.64 (0.32)	0.05	10.7	1,41	0.002	0.19
	x_1 BAA	14.3 – 77.3 m ² /ha	0.03 (0.01)	0.002				
E. $y = \sqrt{\text{Combined \% } P. \textit{ponderosa} \text{ mortality } (n = 43) \text{ (range of values, 0.0-4.1 \%)}}$								
	Constant	-	-0.23 (0.40)	0.57	22.6	1,41	<0.001	0.34
	x_1 Mean dbh	19.5 – 75.4 cm	0.05 (0.01)	<0.001				

Results: Best Forest Scale Models Found



Why didn't we find a relationship between trap catches and tree mortality?

- A problem of scale and/or variance
- Geographic variation in beetle response to lure
- Effect of stand density on pheromone plumes
- Influence of near-by brood trees
 - source of competing pheromones
 - source of beetles that biases individual trap
 - Spillover

Stand Density and WPB-caused Ponderosa Mortality

- Slower growing trees have been shown to be more susceptible to WPB attack
- Other studies found relationship between stand density and increased probability of bark beetle infestations
- Increased bark beetle-caused tree mortality is most likely due to the effect of stand density on individual tree vigor and water availability
- Fuels reduction and restoration treatments should also increase stand resistance to WPB outbreak

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