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

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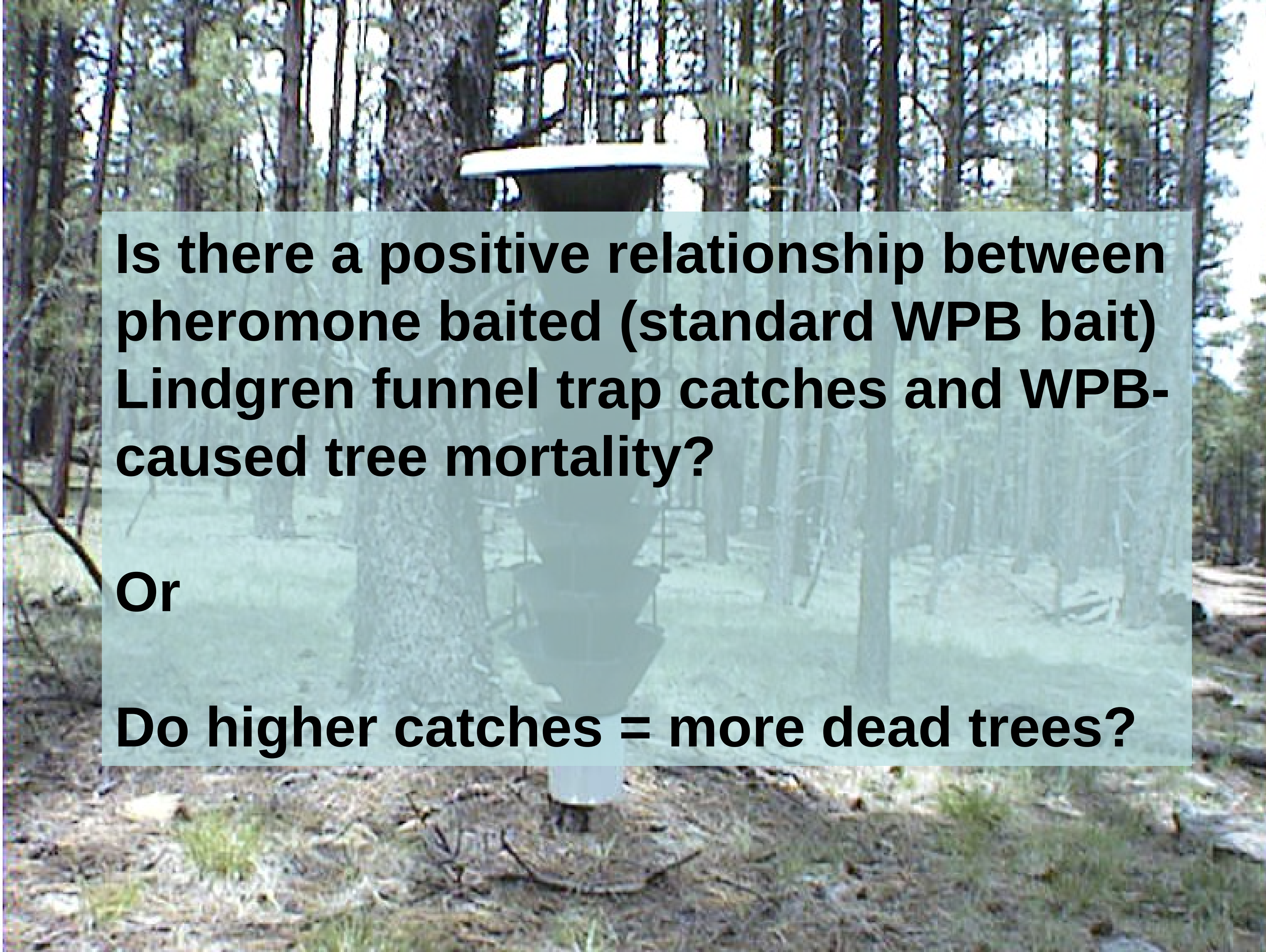


Is there a positive relationship between pheromone baited (standard WPB bait) Lindgren funnel trap catches and WPB-caused tree mortality?

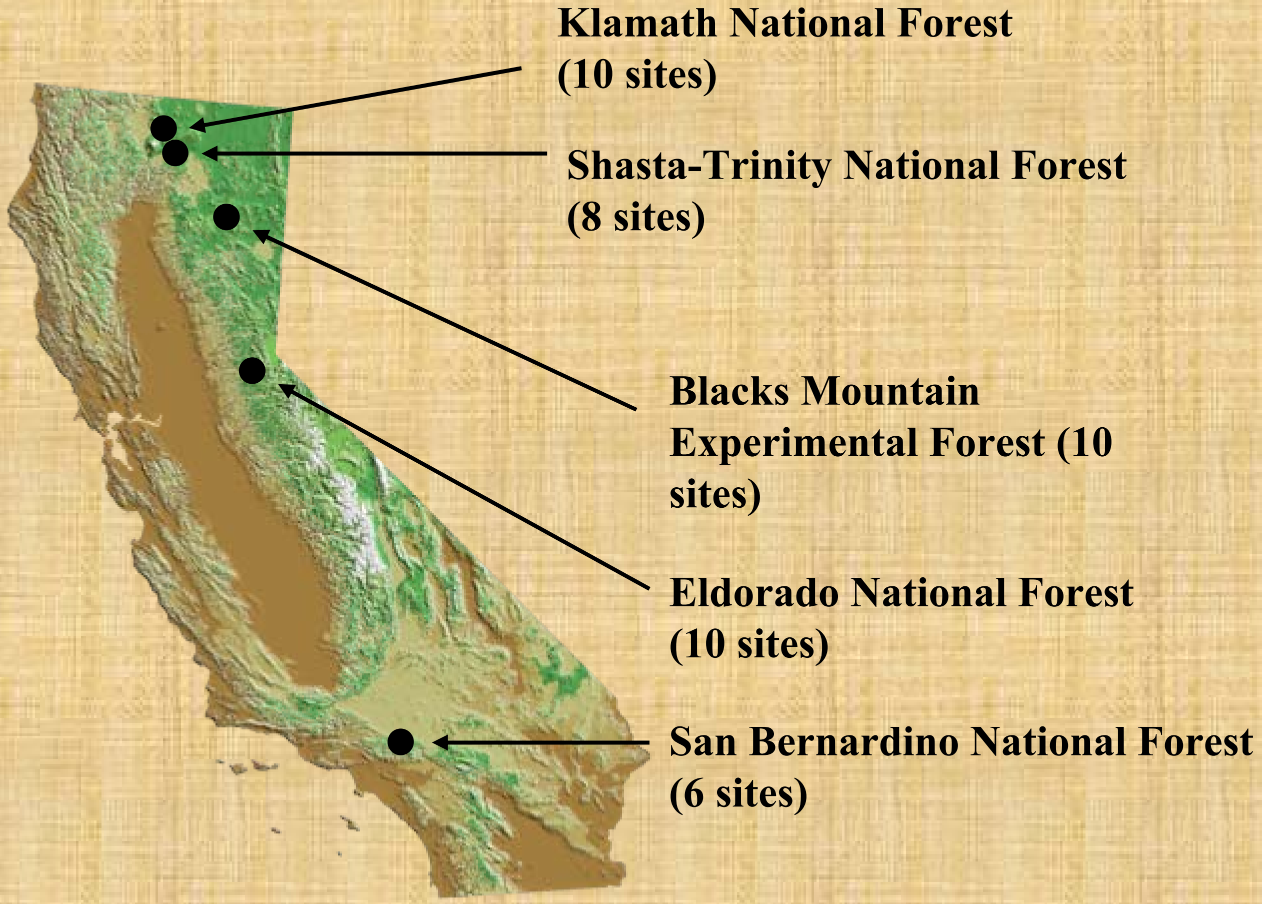
Or

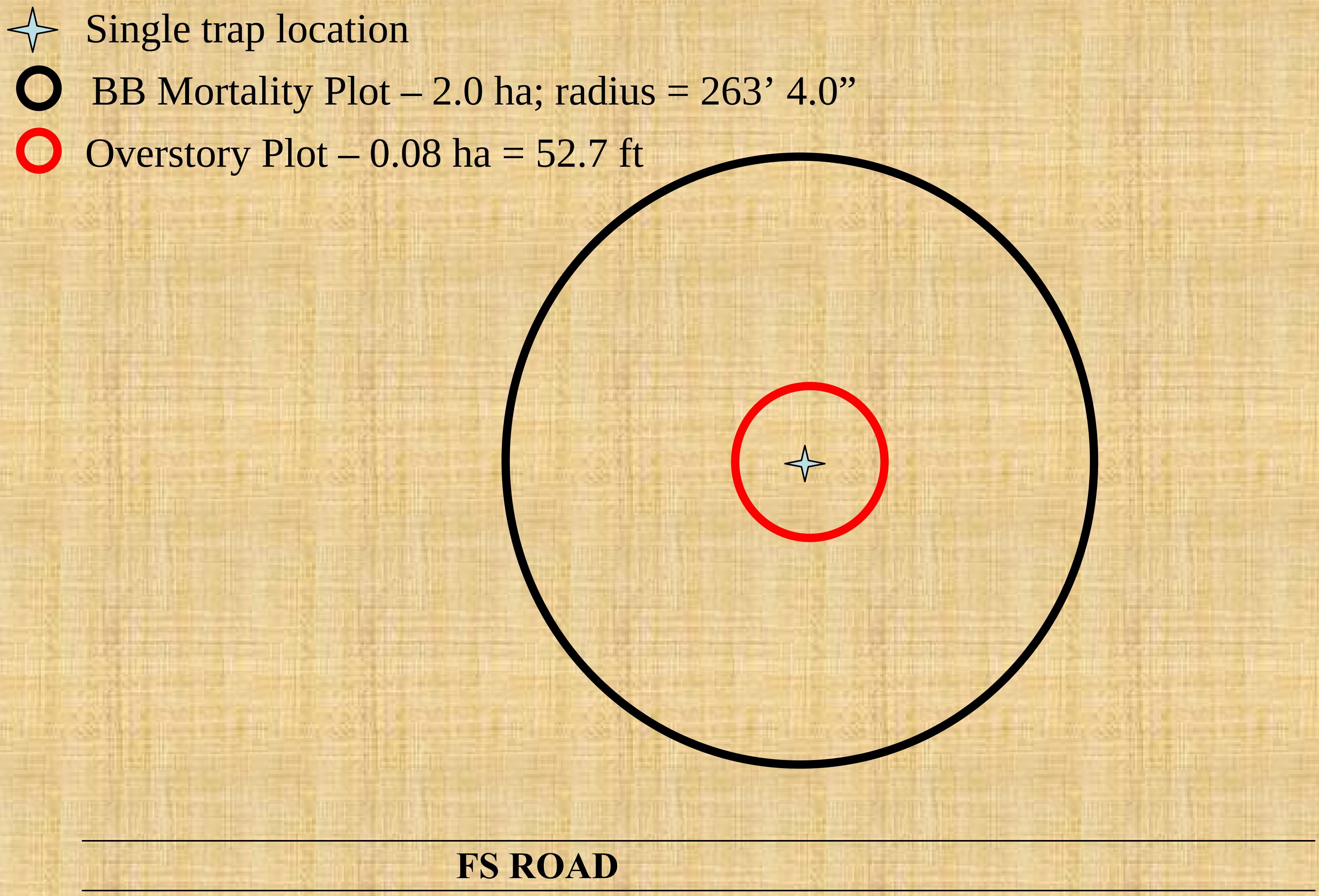
Do higher catches = more dead trees?

Modeling Successes

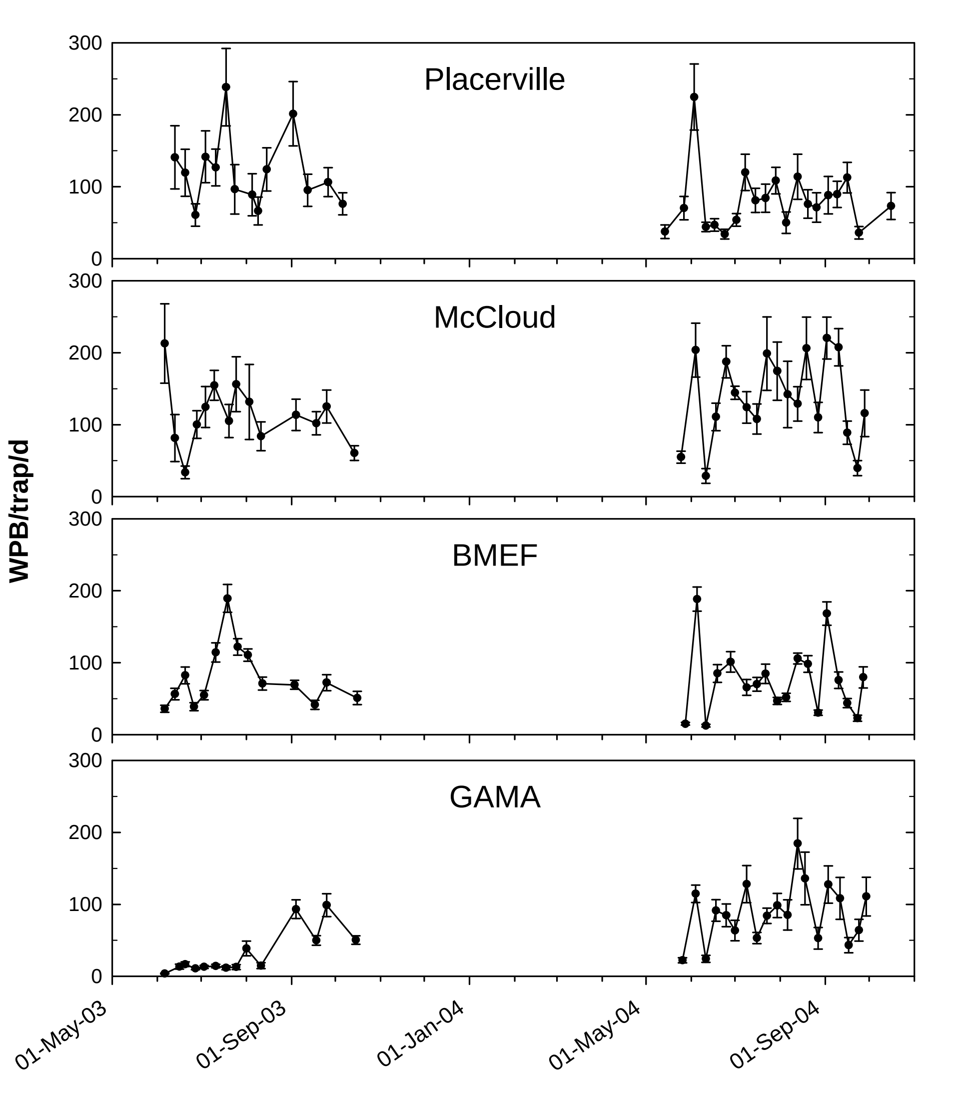
- European spruce beetle - *Ips typographus (Faccoli and Stergulc 2004)*
  - 40 traps deployed over 10,100 ha for 7 yrs
  - Mortality recorded on 30 ha plots around each trap (12% of forest surveyed)
  - Strong relationship between mean (n = 7) May – Aug. and May – June trap catches and volume of timber 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)

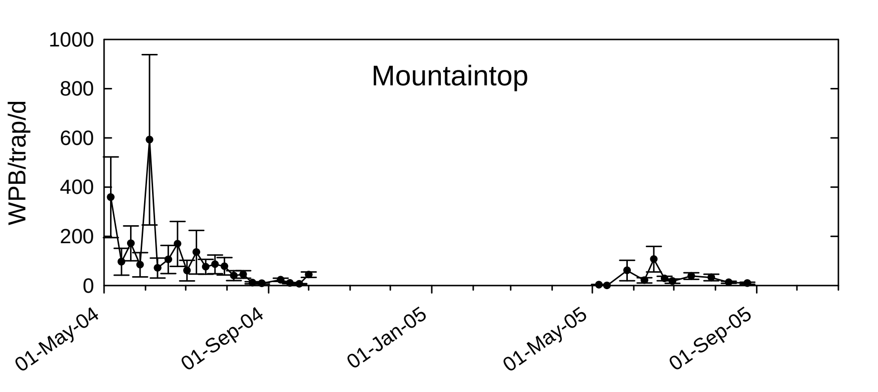
- Traps placed at 5 locations (forest scale; 3,000 – 14,000 ha)
- 6-10 traps deployed at each location, 44 total (stand scale; 2 ha)




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

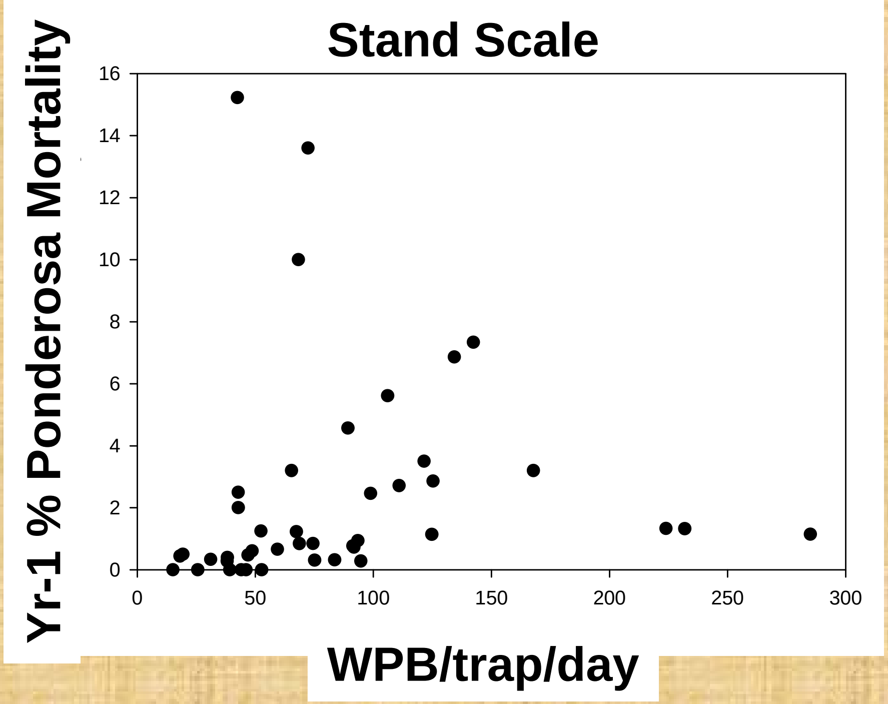
Yr-2 % WPB-caused ponderosa pine mortality

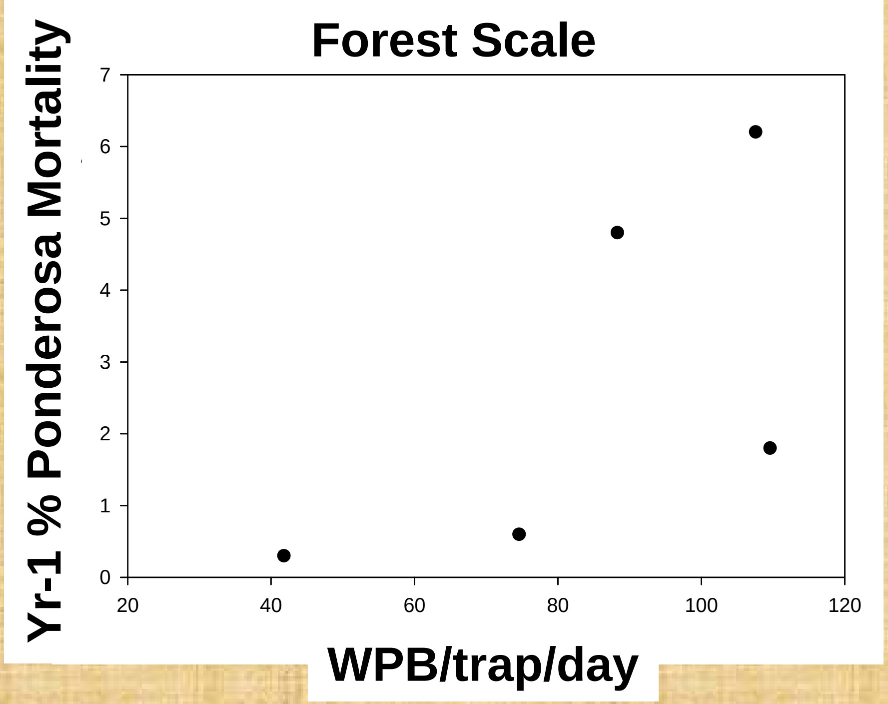
Combined (Yr-1 and Yr-2) % WPB-caused ponderosa pine mortality

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

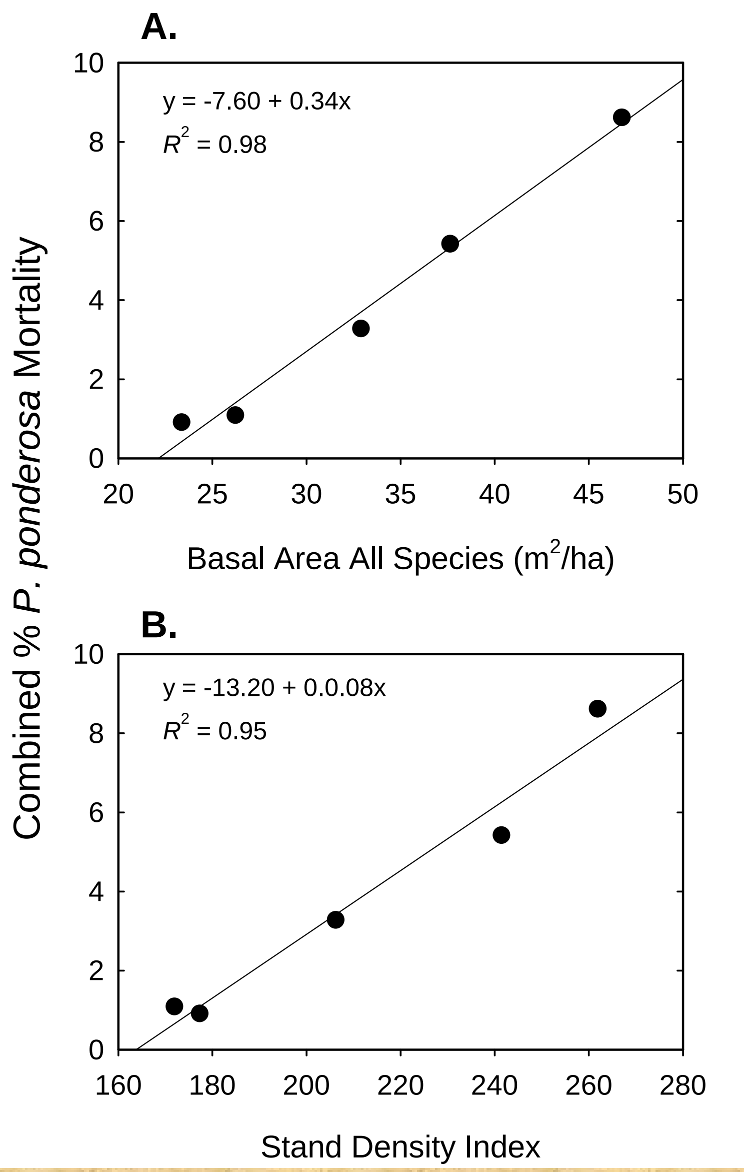


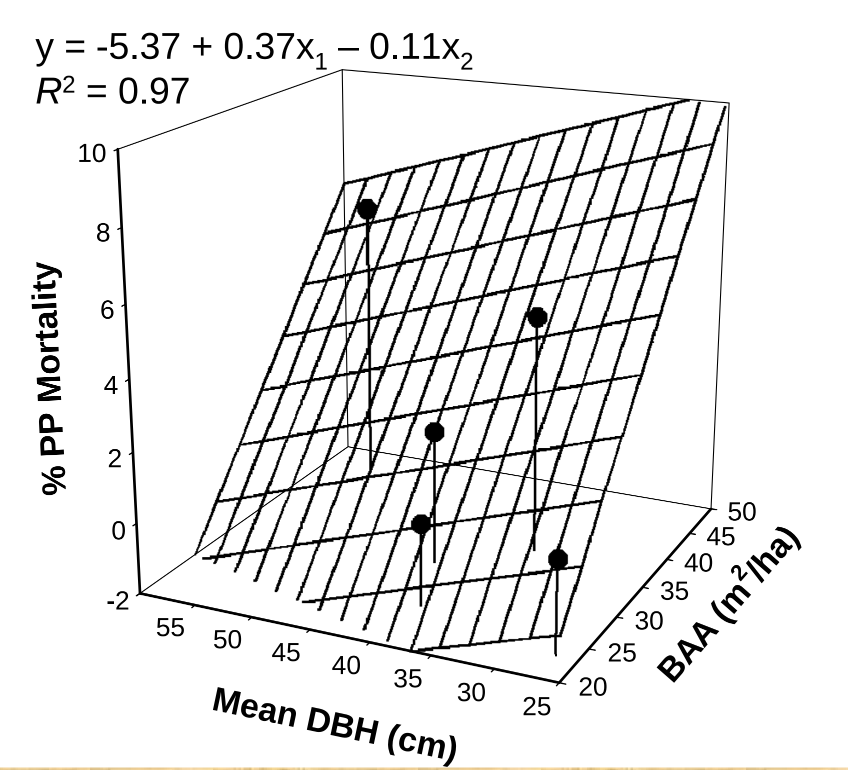


Results: Stand Scale Models

Model								
	Independent variables (x_i)				**Model statistics**			
	Variable	Range of values	Coefficient (SEM)	Partial *P*	*F*	df	*P*	**Adj. R^2**
A. y = √ Yr-1 % *P. ponderosa* mortality (*n* = 43) (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 = √ Yr-1 % *P. ponderosa* mortality (*n* = 43) (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 = √ Yr-1 % *P. ponderosa* mortality (*n* = 43) (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 = √ Combined % *P. ponderosa* mortality (*n* = 43) (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 = √ Combined % *P. ponderosa* mortality (*n* = 43) (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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