Special Technology Development Program
New Project Proposal

PROJECT NUMBER: R4-2002-01

PROJECT TITLE: Estimation of Spruce Beetle Caused Tree Mortality from Pheromone Trap Catches

PROJECT STATUS: Resubmitted-not previously funded

EXPECTED PROJECT DURATION: 3 years

EXPECTED COMPLETION DATE OF THE PROJECT: 2005

SUBJECT:

1. Total Suppression/Prevention Technology	%		2. Survey and Monitoring Technology	%	
a. Total Biological Control i. Microbial % ii. Parasitoids % iii. Synthetic hormones/pheromones % iv. Other %	35	%	a. Advancements in Detection Technology	35	%
			b. Landscape Level Assessment Technology i. Data Visualization		%
b. Total Modeling i. Pesticide (Insecticide) Application % ii. Disturbance % iii. Growth and Yield % iv. Organism % v. Population % vi. Terrain %	10	%	c. Remote Sensing i. Aerial % ii. Hyperspectral % iii. Satellite %		%
			d. Other		%
c. Genetic, Cultural and Silvicultural Innovations For Controlling Pest Species i. Fire % ii. Methyl Bromide Alternatives % iii. Thinning/Regeneration Techniques and other Silvicultural Guidelines % iv. Resistance, Screening, and Breeding %		%	3. Assessment Technology	%	
			a. GIS % b. Spatial Analysis % c. Landscape Analysis % d. Decision Support % Risk and Hazard % Expert Systems %	20	
d. Pesticide Application (Spray) Technology i. Equipment innovations % ii. Methods and Guidelines %		%	4. Social Values	%	
			5. Technology Transfer Innovations	%	
e. Other		%	6. Other	%	

STATUS OF SUBJECT SPECIES: Native

PROJECT OBJECTIVES:

1) To quantify the relationship between pheromone baited funnel trap catches and spruce beetle caused tree mortality.

2) To quantify the relationship between year to year trends in spruce beetle caused tree mortality and year to year trends in pheromone trap catches.

BRIEF DESCRIPTION OF PROJECT: Multiple funnel traps (Lindgren 1983) are routinely used to monitor flight patterns and trends in bark beetle populations. However, there has been no attempt to associate funnel trap catch information with associated tree mortality in the general area where traps are deployed. We propose to

estimate the statistical association between trap catch information and tree mortality within 10 hectares of the traps for a range of spruce beetle population phases (i.e., endemic, building, epidemic). Trap deployment will be similar to that routinely used by Regions for monitoring spruce beetle populations. Preliminary data was collected at 22 sites in 2001 using 4 ha survey blocks and exploratory analysis indicates a significant relationship (r^2=0.53, see Appendix 1). Multiple surveys years are needed to adequately address Objective 2.

2002: Traps will be established at sites with active spruce beetle populations (endemic, building, and epidemic) in central and southern Utah. Trap catches will be monitored weekly. After beetle flight, beetle-caused mortality will be measured by surveying each trap site for spruce beetle attacked trees.

2003: Traps will be established at the same sites as in 2002. Trap catch monitoring and tree mortality measurements will be repeated as in 2002.

2004: Traps will be established at the same sites as in 2002. Trap catch monitoring and tree mortality measurements will be repeated as in 2002. Trap catch per year will be statistically associated with estimated tree mortality in the vicinity of each trap for that year. Survey data will be organized such that mortality within 1, 4, and 10 ha of the traps can be independently analyzed. Information from aerial detection surveys will be used to test the correlations for areas beyond our 10 ha ground surveys. Additional information including stand characteristics, elevation, slope, aspect, air temperature, surrounding beetle pressure (from aerial sketchmaps), and beetle population phase will be tested for significant contributions to estimation of tree mortality from trap catch data. Trends in trap catch will also be tested for statistical correlation to trends in beetle caused mortality at each site annually.

FHP LEAD CONTACT:

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
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FHP LEAD INVOLVEMENT:

	Role	Time Commitment
	Install funnel traps, conduct mortality surveys, co-author publication, technology transfer	10 weeks (over 3 years)

PRINCIPAL INVESTIGATOR(S) :

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Barbara Bentz	RMRS, Logan, UT	435-755-3577 Fax: 435-755-3563 bbentz@fs.fed.us
Matt Hansen	RMRS, Logan, UT	435-755-3575 Fax: 435-755-3563 Matthansen@fs.fed.us

PRINCIPAL INVESTIGATOR(S) INVOLVEMENT:

Name	Role	Time Commitment
Barbara Bentz	Install funnel traps, conduct mortality surveys, co-author publication	8 weeks (over 3 years)
Matt Hansen	Install funnel traps, supervise technical help, conduct mortality surveys & analyses, co-author publication	12 weeks (over 3 years)

JUSTIFICATION : Multiple funnel pheromone traps are routinely used to monitor spruce beetle flight patterns and population trends. However, there has been no attempt to correlate beetle-caused tree mortality in an area from trap catches in the same vicinity. Our proposed project will enhance the existing pheromone trap technology by providing methodology that will allow further information to be extracted from a routinely deployed trap. Estimates of mortality and population trends calculated from trap catches will provide resource specialists with additional forest management decision-making information.

URGENCY : The new technology developed from the proposed project would enhance the available information from a routinely used tool. In this sense, each time a pheromone trap is currently deployed, we are losing valuable information. Spruce beetle populations in Utah are currently at epidemic levels in some parts of the state, and

building in others. A 20,000-acre blowdown on the Routt National Forest, Colorado in 1997 created conditions conducive to spruce beetle population growth. The warm summers of 2000 and 2001 have resulted in large proportions of spruce beetles in both Utah and Colorado that matured in one year (rather than the typical two year generation), perhaps creating exponential population growth in the coming years.

NATIONAL FHP TECHNOLOGY DEVELOPMENT:

Priority 1: __ Priority 2: __ Priority 3: __ Priority 4: _x_

Improves an existing detection technology for spruce beetle by quantifying spruce mortality associated with trap catches. Currently, there is no quantitative basis to evaluate the resource impacts given funnel trap catch data. Relative to aerial detection surveys in which infested trees are not visible from the air for about 1 year, this technology will also provide decision makers with advance warning of increasing spruce beetle populations that may warrant suppression when management options and their efficacy are maximized.

TECHNICAL COMMITTEE DEVELOPMENT PRIORITY:

Priority 1: _x_ Priority 2: __ Priority 3: _x_ Priority 4: __
Priority 5: __Priority 6: __ Priority 7: __ Priority 8: __

This technology will enhance detection and provide quantification of spruce beetle impacts. Also, the surveys conducted during the proposed project can be used to validate existing stand hazard and risk rating models.

SCOPE OF APPLICATION: Equations and decision models from this project will be directly applicable to spruce beetle population monitoring in areas with Engelmann spruce throughout the west. Our results will require recalibration if alternative or additional semiochemicals or trap designs are used.

RESEARCH BASIS: Bentz and Munson (2000) observed disproportionate spruce beetle catch in a series of traps, most likely due to the topography of the area and wind direction. Due to the difficulties associated with this problem, little work has been directed at a correlation of bark beetle-caused tree mortality and trap catch data, although efforts have been made to estimate population trend with trap catch. Billings (1988) developed a system for using pheromone baited trap catch information to forecast trends in southern pine beetle populations, although these trends are not associated with tree mortality. Pheromone trap information has been used successfully for predicting trends in population density of spruce budworm (Sanders 1988; Sweeney et al. 1990), European pine sawfly (Lyytikainen et al. 1999), and gypsy moth (Carter et al. 1994; Thorpe et al. 1993), but not defoliation levels of the gypsy moth (Liebhold et al. 1995; Liebhold et al. 1998).

We know that multiple funnel traps are efficient for catching spruce beetles (Bentz and Munson 2000; Werner and Holsten 1995; Borden et al. 1996), and have been used extensively to monitor flight periodicity. Although the numbers of beetles within a trap may change from year to year, it is not understood what those relative numbers indicate. Are 200-500 beetles in a trap indicative of endemic populations? Our goal is to estimate the correlation between trap catch of spruce beetles and tree mortality and population trend in the immediate vicinity. In a previous study, we found the ratio of spruce beetles caught in pheromone traps and associated mortality for two consecutive years to be similar (trap catch ratio between years 1 and 2 = 0.629; ratio of number of trees infested between years 1 and 2 = 0.609) (Bentz and Munson 2000). Our objective is to develop baseline values which can be

METHODS: The study will be conducted on the Manti-La Sal and Fishlake National Forests, Utah, with three "treatments" per site. The treatments will represent three spruce beetle population phases: endemic, building and epidemic populations (Bentz and Munson 2000). A treatment will consist of four Lindgren funnel traps (16 funnel) baited with the two component spruce beetle lure (Pherotech, Inc.). Traps will be placed with the requirement that each trap is at least 0.25 mile from another trap (i.e., we assume no trap-trap influence at this distance). The three treatments within a forest will be >2 miles apart (see Apendix 2). Traps at each site will be installed prior to spruce beetle flight and checked once per week through August or until the trap is no longer catching beetles. Traps will be hung from non-host trees with "No pest" strips placed within each trap cup to reduce losses to predators. All specimens from a trap cup will be placed in a baggie, labeled with date, site, trap number, and treatment and returned to the lab for counting. Air temperature will be recorded (Onset Corp., Bourne, MA) within each treatment.

Following beetle flight, a 100% survey will be conducted in a square 10 ha block surrounding each trap (see Apendix 2). All attacked trees will be identified by status (mass, strip, or pitch out) and by year of attack (current, previous year, or older). Diameter at breast height (DBH) will be measured for each attacked tree. To estimate stand conditions, 9 variable radius subplots will be established at each trap location. Species, status, and DBH will be recorded for all trees in a subplot. Elevation, slope, aspect, and topographic position will also be recorded at each plot. Basal area, trees per ha, and stand density index will be calculated from variable plot data. Based on the preliminary surveys conducted in 2001, we estimate that the surveys of twenty-four 10 ha blocks will

require 8 field days for two crews of 5 people (assuming that boundary delineations and variable radius plots are done in advance). Aerial Detection Survey data will be used to estimate tree mortality beyond each 10 ha block, and to aid in site selection relative to the three population phases.

For each year, tree mortality (by year of infestation) at each site will be regressed against trap catch. Additional information will be tested for significance in helping to predict mortality, including stand characteristics, beetle population phase, surrounding beetle pressure, site, air temperature, and topographic variables. An equation will be developed for prediction of population phase and associated mortality levels given trap catch data and significant ancillary data. Measures of variability and statistical goodness of fit will be associated with mortality predictions. We cannot assume a linear relationship, and will test for both linear and nonlinear relationships. Similar analysis will be used for analyzing year-to-year trends (ratios) in tree mortality with year-to-year trends (ratios) in trap catch information.

MEASURES OF SUCCESS:

Standard of Success: There has been no previous attempt to correlate bark beetle caused mortality with funnel trap catch information. Our project will be a success if estimates provide a relative measure of tree mortality and beetle population trend within a given area that help resource managers make timely treatment decisions.

Expected Outcomes: A model for tree mortality prediction that provides a relative measure of spruce beetle caused impact and generalized population trend in a given area.

Implementation of Products/methods: Using data from routinely deployed multiple funnel traps, users will be able to calculate a relative estimate of spruce beetle caused impact and generalized population trend in a given area. Users will be able to acquire the model equations from the RMRS 4501 website and/or publications. Resource specialists will be able to develop timely and more effective treatment strategies using the data provided by a routine trapping array and model outputs.

PRODUCTS AND DUE DATES: May 2005 for final product: Quantitative models to predict levels of spruce beetle caused mortality and population trend in a given area using data from multiple funnel traps. Exploratory analyses will be conducted after each field season and preliminary results will be updated and presented at Bark Beetle Working Group meetings and other suitable outlets.

PUBLICATIONS: One peer-reviewed journal article and web based information.

TECHNOLOGY TRANSFER: Products will be available on the RMRS 4501 website. Information will be disseminated through workshops at conferences including the Western Forest Insect Work Conference. If our estimates prove useful with acceptable levels of correlation, the technology can be adapted for other bark beetle assessments.

LONG-TERM BUDGET REQUEST:

	Item	Requested FHP STDP Funding	Other-Source Funding	Source
FY 2002				
Administration	Salary	15,000	7,700 9,400	RMRS FHP
	Overhead	3,170		
	Travel	10,900		
Procurements	Contracting	4,000		
	Equipment			
	Supplies	500		
YEAR TOTALS		33,570	17,100	

FY 2003				
Administration	Salary	15,400	7,900 9,700	RMRS FHP
	Overhead	3,240		

	Travel	11,200		
Procurements	Contracting	4,100		
	Equipment			
	Supplies	400		
YEAR TOTALS		34,340	17,600	

FY 2004				
Administration	Salary	15,900	8,100 10,000	RMRS FHP
	Overhead	3,340		
	Travel	11,500		
Procurements	Contracting	4,200		
	Equipment			
	Supplies	400		
YEAR TOTALS		35,340	18,100	
PROJECT TOTALS		**103,250**	**52,800**	

LONG-TERM BUDGET REQUEST EXPLANATION: Contributed salaries are for Munson, Bentz, Hansen and for other entomologists and technicians, from FHP and RMRS, assisting with annual mortality surveys. Salary requested is for 2 GS-5 technicians for 4 months per year to collect and count trap catches, delineate survey boundaries, and assist with annual mortality surveys. Travel is for 2 people for 12 weeks (trap collections and boundary delineations) and 10 people for 2 weeks (mortality surveys). Contracting costs are for a leased vehicle for seasonal employees. RMRS overhead (12%) is charged on funds going to RMRS 4501 in Logan. Supply costs are for pheromones and repair/replacement of funnel traps (FHP and RMRS have all other equipment needed, including temperature dataloggers). Estimated expenditures from FHP and RMRS in 2001 for preliminary surveys (twenty-two 4 ha blocks): Salary: 22,700; Travel: 11,600 (includes GSA mileage); Equip/supplies: 2,100 (includes temperature dataloggers). Total: 36,400 (overhead not included).

BENEFITS: Benefits will include: (1) the use of early intervention tactics to mitigate the effects of a spruce beetle population increase, (2) reduced preventative treatment costs, and (3) a shift from salvage to green tree removal. Other benefits that are difficult to quantify include maintaining visual quality, the recreation experience and wildlife habitat.

LITERATURE CITED:

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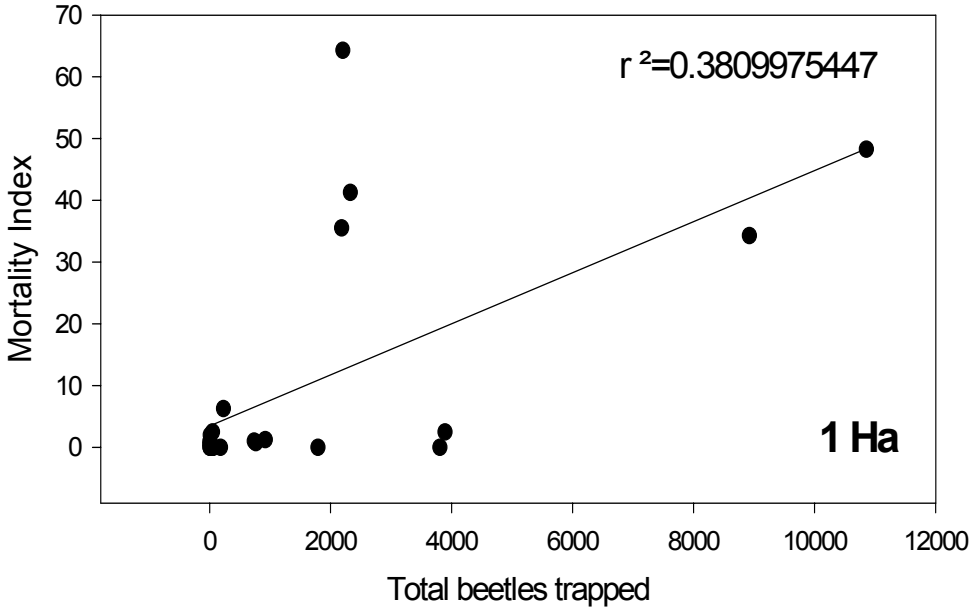
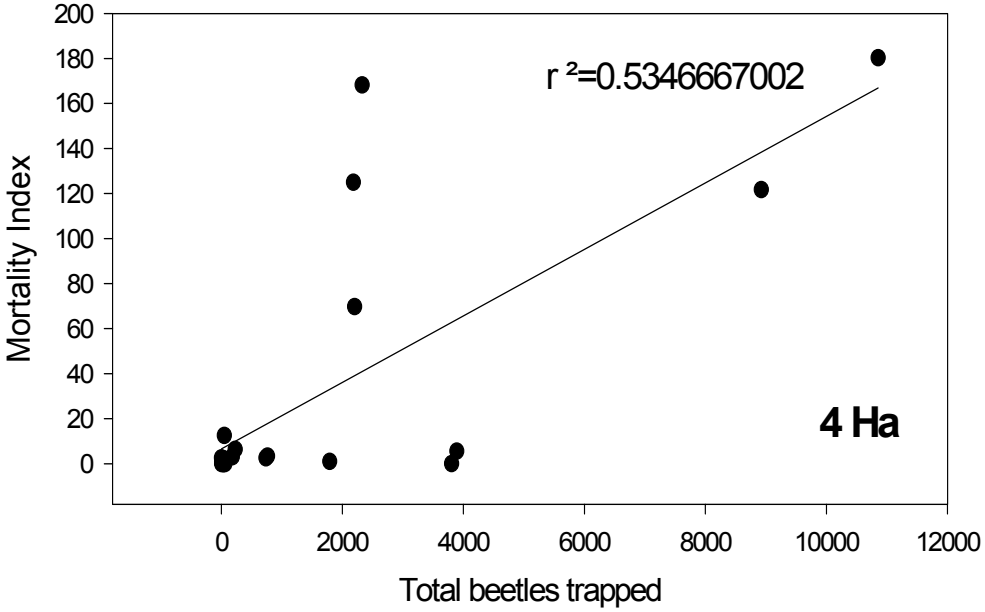
Appendix 1

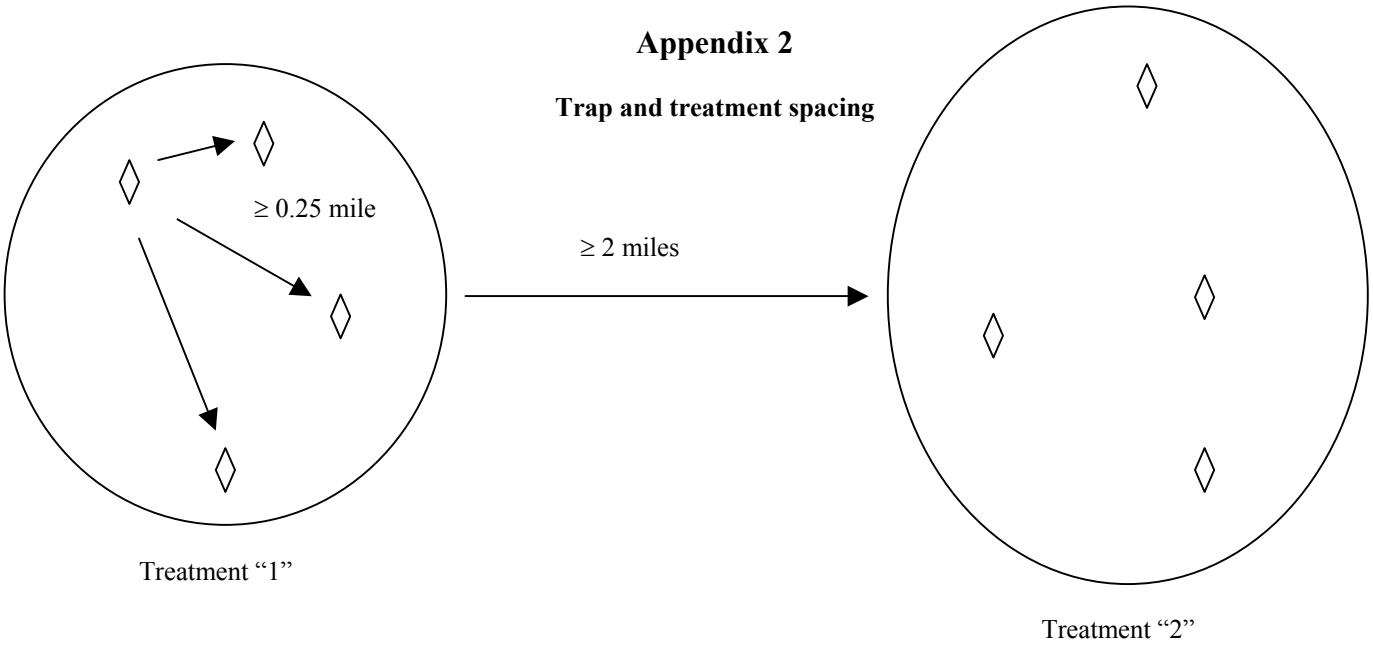




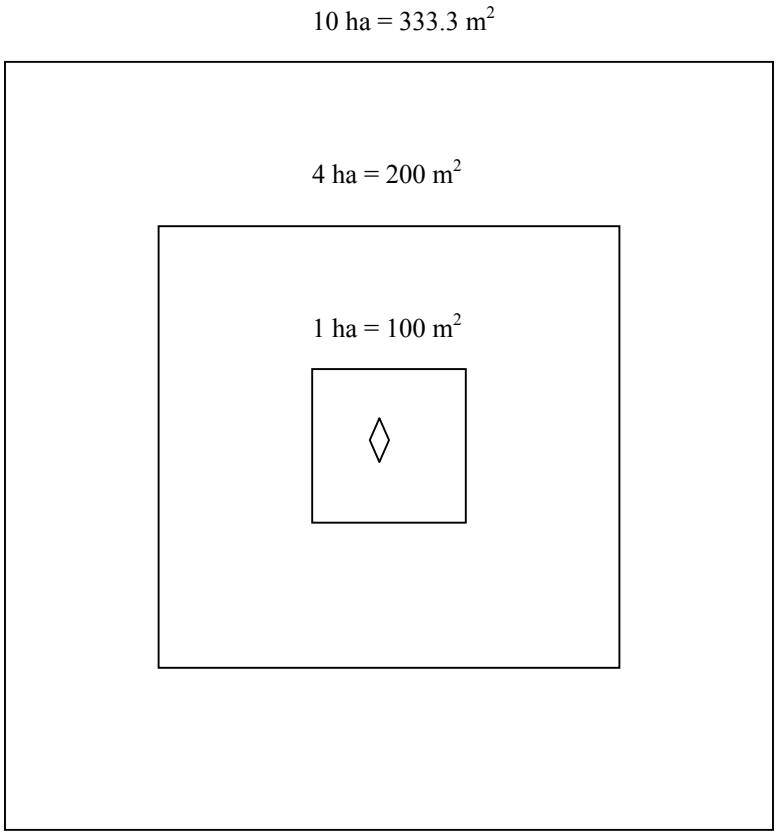
Linear regressions of current mortality against total spruce beetle captures for 1 and 4 ha blocks around funnel traps. Using our "Mortality Index", all currently infested stems are summed as follows: each mass attacked spruce within a block counts as 1, each strip attack counts as 0.5, and each pitch-out counts as 0.25. In this simple linear regression, no attempt has been made to adjust for stand characteristics, estimated beetle population phase, or topographic position.

Appendix 2

Trap and treatment spacing



Survey design (each trap)



Variable plots to be spaced at 100 m on 3 x 3 grid.