TITLE: Interactions Among Prescribed Fire, Mechanical Treatments, Insect Pests and Pathogens in Red Pine

LOCATION: Muskrat Lakes area (Michigan DNR land), Luce County, Michigan

DURATION: Year 1 of 3-year project **FUNDING SOURCE:** Fire Plan

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PROJECT OBJECTIVES:
1) Determine the effects of fire and mechanical treatments, alone and in combination, on incidence and impact of forest insect pests and pathogens in mature red pine stands in the Lake States.
2) Document the effects of these treatments on forest vegetation and litter parameters, and relate these effects to the biology of forest pests.

We hypothesize that prescribed burning will decrease the incidence and impact of shoot blight pathogens and shoot and cone infesting beetles. However, mechanical treatments, alone or with fire, may increase the abundance and impact of scolytids, wood-borers, and root disease pathogens. Understanding the response of insects, pathogens and vegetation to fire and mechanical treatments is essential to the management of these organisms in red pine forests in which fire and mechanical tools are used to attain silvicultural and restoration goals.

JUSTIFICATION:
There are only 1.5 million acres of the red pine cover type in the Lake States today compared to approximately 22 million acres over a century ago. Fire regimes in red and white pine forests typically involved frequent (20-40 yr interval) low to moderate intensity fires, with less frequent (100-300+ yr interval) high intensity stand replacing fires. The great pine stands growing in xeric and dry-mesic habitats in the Lake States were maintained by this fire regime. However, since the implementation of coordinated fire prevention and suppression activities began in the 1920s, the pine-fire cycle has largely been broken. Compared to pre-settlement forests, today's short-interval, fire-adapted forest ecosystems tend to be denser, have more small trees and fewer large trees, and have much greater quantities of fuels. This results in deterioration in ecosystem integrity because of an increased probability of large, severe wildfires. Prescribed fire or fire surrogate treatments (such as thinning) have been proposed to help restore red pine to a "healthier" condition. On National Forests and state-owned lands in Michigan, prescribed fires

in mature red pine are already being used on a limited basis for fuels reduction and vegetation manipulation. Yet we have very little information on how this change in management will affect populations and impacts of insect pests and pathogens.

Meanwhile, incidences of shoot blight pathogens are increasing in frequency and intensity across the Lake States, as evidenced by FHM offplot survey data reported in the annual Forest Health Highlights. For instance, in Wisconsin significant damage by *Sphaeropsis sapinea* was recorded in 1999, and in 2002 in plantation survival surveys. In Minnesota's highlights, problems with pine bark beetles and shoot blight were reported in 1999- 2001. *S. sapinea* was reported as a special issue in Michigan in 1999-2002. In a recent survey encompassing 30 pine stands in Michigan, cone beetles caused more shoot damage to red pine than any other insect pest. In 2002, significant damage by the red pine cone beetle to shoots was reported in the Upper Peninsula of Michigan, indicating this is an emerging problem. Application of prescribed fire may reduce problems with shoot blight pathogens and effectively reduce cone beetles to tolerable levels. These benefits of prescribed fire, however, could be offset by increased vulnerability of residual trees to bark beetles, wood-borers or root-feeding weevils. In addition, red pine is a suitable host for the European pine shoot beetle, which has recently become established throughout Michigan and much of the northeastern region (Siegert and McCullough 2001, Kennedy and McCullough 2001). We need to know how prescribed fire and mechanical treatments will interact with these and other forest insect pests and pathogens.

Clearly there is a need for more information on how fire and pests interact in the Lake States. Item Ci in the National Fire Plan identified the knowledge gap regarding interactions of fire, pathogens and insect pests, and invasive species. However, of the 63 projects that the NFP funded at $26 million in 2001, none are addressing the ecological impact/role of fire in pine ecosystems in the Lake States or the interaction of fire, pests, and invasive species. In addition the USDA/USDI Joint Fire Science Program's Fire/Fire Surrogate study network does not have any sites in pine ecosystems of the North Central or Northeastern US. Our project will address several aspects of the fire plan issues within "rehabilitation and restoration" and "hazardous fuel reduction" categories, including ecological impacts of prescribed fire when used for fuels reduction, interaction of fire with pests and invasive species, restoration of fire-damaged ecosystems and use of fire to restore ecosystems.

DESCRIPTION:

a. Background:

Fire can act as a natural control of certain insects and diseases (Hardison 1976, McCullough et al. 1998). Infestations of the red pine and white pine cone beetles (*Conophthorus* sp.) can be managed by timely underburning (Miller 1978, Wade et al. 1989). Prescribed burning also increased the abundance and diversity of predaceous carabid ground beetles (Neumann 1997). Fire has been linked to reductions in the incidence of armillaria and annnosus root rots (Froelich et al. 1978, Reaves et al. 1990), and certain rust diseases (Parmeter and Uhrenholdt 1974). Shoot blight pathogens have been increasing in importance in the Lake States (Ostry et al. 1999, Nichols and Ostry 1990, Ostry et al. 1990). Surface fires reduce understory vegetation and may raise the lower-level of the canopy, changing microclimate and eliminating or reducing populations of shoot blight pathogens. High intensity fires, however, can exacerbate forest health problems. Trees stressed by excessive crown scorch are subject to colonization by bark beetles, wood-borers and root weevils. Fire-damaged roots can become infested with root infesting insects and pathogens. Low intensity prescribed fires, therefore, should be considered

an option for integrated pest management programs in red pine stands. Many questions about insects, pathogens, their interaction with fire, and the overall viability of non-traditional management strategies, however, remain unanswered.

In 1997, Linda Haugen, Mike Ostry, and Al Saberniak began a preliminary study in a 400 acre red pine stand on the Hiawatha National Forest, which was partially prescribed burned in 1998 and 2000. We used this effort to determine what response variables and means of data collection are feasible. Andrew Storer is an entomology and pathology site discipline leader at the Blodgett forest site (in CA) of the National Fire/Fire Surrogate (FFS) study funded by the Joint Fire Sciences Council. In 2002, Dr. Storer and Dr. Linda Nagel selected and undertook preliminary work on Michigan DNR land in the Upper Peninsula of Michigan, in the vicinity of Muskrat Lakes in Luce County, as a potential addition to the FFS, but no new sites are currently being added to that network. Michigan Department of Natural Resources is committed to managing and protecting the land in accordance with the needs of the project, and the USDA Forest Service, Hiawatha National Forest, will assist with the burning of treated areas. Dr. Don Dickmann and Dr. Deb McCullough, who are highly regarded experts in fire ecology and forest insects in the Lake States, are committed to advising on the project as needed.

b. Methods:

Study site and treatments: Twelve treatment areas of approximately 17 hectares each have been divided into 3 blocks based upon predominant species composition. Twenty plot centers, 50m apart, have been permanently marked in each treatment area; the basal area by species information has been collected from each of the plot centers. The cost involved at establishing this site, estimated at over $10,000, has been paid for from Michigan Technological University sources. The proposed treatments are:

1. Untreated control - No cutting or burning will take place in these blocks.
2. Prescribed fire only - No trees will be harvested in these blocks. A spring burn will be prescribed to coincide with treatments described below.
3. Initial cutting, followed by mechanical fuel treatment and/or physical removal of residue with no use of prescribed fire. An initial cut reducing crown closure to below 50% will be implemented, favoring red and white pine. Residual fuels will be mechanically treated with a hydro-ax or a brush mower. Alternatively, a whole-tree removal harvest will be implemented, eliminating the need for mechanical fuel treatment.
4. Initial cutting, followed by prescribed fire. An initial cut reducing crown closure to below 50% will be implemented, favoring red and white pine in the stand. Slash will be lopped and scattered, creating uniform fuel conditions. An understory burn will be prescribed during the spring following the harvest.

The USDA Forest Service will apply fire treatments as part of prescribed fire training programs.

Data collection: Data on incidence of insects and pathogens, as well as vegetation, will be collected in all treatment areas each year. This sampling will be based around the plot centers already established in each treatment area. 1/10 acre plots will be used for most sampling, though different plot size may be used to record some variables as appropriate. Vegetation will be quantified in late spring and late summer in the fixed-radius plots. All trees in each treatment area will be assessed for beetle activity by conducting 360 degree scans from each plot center and recording trees with discolored crowns or thin crowns. Trees exhibiting these symptoms will be visited to determine the cause of decline. Wood infesting insects will be assessed using passive flight intercept traps (Storer et al, 2002), and sticky traps placed on trees Stark et al.

2002). Linear transects in spring and summer will be used to quantify shoot and cone damage attributable to *Conophthorus* beetles (or other shoot-feeding insects such as *T. piniperda*). Pathogens will be evaluated using spore traps (Vaseline-coated slides), and potted red pine seedlings or saplings set below the overstory trees. When appropriate, FFS methodology will be used in order to increase opportunities to compare between this study and FFS studies in other parts of the country.

Data analysis: The significance of the treatments will be tested using parametric and nonparametric statistics. Linear, multiple and logistic regression and multivariate analyses will be used to evaluate relationships among vegetation, insect and pathogen variables.

c. Products: Results will be incorporated into recommendations that enable managers to make more informed decisions about how prescribed fire may alleviate or exacerbate specific pest problems. We will provide this information to end-users in "how-to" leaflets, extension bulletins and web sites (e.g. USFS FHP web site in St. Paul). Our results and recommendations will be presented at state and regional meetings of federal, state and private forest managers and landowners, and presented at FHM working group meetings. We will also document results in technical reports and scientific publications.

d. Schedule of Activities:

2004	Finalize study plan, collect baseline data, mark mechanical treatments, test sampling methods. Initiate mechanical treatments. Poster at FHM working group meeting.
2005	Apply prescribed burn treatments in spring, continue monitoring. Poster presentation at FHM working group meeting. Presentation at NCFPW.
2006	Continue monitoring, data analysis. Publish results; develop and report management information, FHM report, and FHM fact sheet.

COSTS:

The 2004 funding request is $36,151. Total project funding request for 3 years would be approximately $105,000.

		2004			2005			2006		
	Item	**Requested FHM EM-Fire Funding**	**Other-Source Funding**	**Source**	**Projected FHM EM-Fire Funding**	**Projected Other-Source Funding**	**Source**	**Projected FHM EM-Fire Funding**	**Projected Other-Source Funding**	**Source**
Admin-istration	Salary (MTU)	19,218	7,506	MTU	20,179	7,881	MTU	21,189	8,276	MTU
	Salary (FS)	4,000	4,000	FS	4,000	2,000	FS	3,000	2,000	FS
	Overhead (MTU, 15%)	3,933	9,438	MTU	3,927	9,424	MTU	3,778	9,068	MTU
	Travel (MTU)	5,000			5000			3500		
	Travel (FS)	1,000			1000			1400		
Procure-ments	Contracting									
	Equipment									
	Supplies (MTU)	2,000			1000			500		
	Supplies (FS)	1,000			300			200		
	Total	**$36,151**	20,944		35,406	19,305		33,567	19,344	

Appendix 1:
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