TITLE: A Survey of White Pine Blister Rust in California's Foxtail Pine (*Pinus balfouriana)*

LOCATION: California

DURATION: Year 1 of 2-year project **FUNDING SOURCE:** Base Plan

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PROJECT OBJECTIVES:

(1) To increase the number of long-term monitoring plots in foxtail pine stands.
(2) To supplement current information on the impact of white pine blister rust in foxtail pine.

JUSTIFICATION:

a. Linkage to FHM Detection Monitoring: White pine blister rust is an exotic invasive fungal pathogen that entered California in 1929. Since that time it has infected sugar pine as far south as the southern Sierra and Mt. Breckenridge. Permanent plots are in place (via FIA) and the infection in sugar pine is well documented. Prior to 2004, the infection of blister rust on the other five-needled pines (also called white pines) was not well-known or documented. Rust on foxtail pine had been reported anecdotally in the northern California stands. In 2004, FHM funding was obtained to assess the distribution and levels of blister rust on all five high-elevation white pines of California, including foxtail. The data from that survey documented that the northern stands of foxtail are being impacted by blister rust, i.e., 6 of 6 plots had rust-infected trees (Dunlap et al 2006). In the 2004-2005 survey, specific areas were not intensively sampled within the species' ranges as the objective was to distribute the plots so broad regional patterns would be revealed, especially in the widely-distributed whitebark and western white pines. As a result, a small number of plots were established for the remaining three species having more limited distributions in the State. Additional plots are needed in foxtail pine to more fully understand the impact of blister rust, especially in the northern stands. Current information on the health of foxtail pine stands is very limited. FIA plots are virtually non existent and no risk model has been developed for this species (Mike Bohne, pers. comm.).

b. Significance in geographical scale, biological impact and political importance:
White pine blister rust (*Cronartium ribicola*) is an exotic invasive pathogen that continues to spread over North American coniferous forests containing five-needled pines. Areas of the West have reported very high rust-infection levels as well as considerable variation in the infection levels (Schwandt 2006). To date, the pathogen has been found in eight of the 9 species in the U.S., including California's endemic foxtail pine (*P. balfouriana)*. Noteworthy of this species is its limited, disjunct distribution at high elevations in the northern coast-interior and southern Sierra mountains of the State (Griffin and Critchfield 1976). Moreover, this geographic separation also corresponds to significant genetic differences and the recognition of a northern and a southern ecotype (Oline et al 2000). The northern foxtail stands are also genetically diverse from one another, have small population sizes, are at their ecological limits, and located in a distinctive geological-vegetation complex of California. Both ecotypes occupy the highest elevations where they are adapted to harsh mountain climates. Foxtail pine has similar ecological values as other high elevation white pines, e.g., stabilizing soils, providing habitat and forage for wildlife, and having cultural value.

Data from the 2004-2005 survey documented that the northern stands of foxtail have rust-infected trees in the six long-term monitoring plots. Rust averaged 15% but varied from 2 to 33%. Given the continuous nature of the forests with white pines, i.e., lower elevation sugar pine, mid- to high-elevation western white pine, and high-elevation foxtail pine, it is expected that blister rust will have an increasing impact on foxtail over time. Northern populations already at their ecological margins are being exposed to this

exotic pathogen, with the potential consequences of greater mortality, limited regeneration, and loss of populations. Although the rust has not yet impacted the southern foxtail, as indicated by the 2004-2005 survey and others (Duriscoe & Duriscoe 2002), both sugar and western white pine have been impacted, suggesting that with time blister rust may enter into high-elevation foxtail there.

Current information on the level of blister rust in foxtail pine relies on anecdotal observations and a relatively small number of plots. Supplementing with additional plots would provide a better understanding of the rust impact on this species, especially in the northern stands. Such information is basic to developing conservation and management strategies, as this species is part of the larger concern about the threat of blister rust to all high elevation five-needled pines (Samman et al. 2003). Given foxtail's limited distribution, the risk of significant, more rapid loss of trees (or populations) to blister rust may be higher than in the widely-distributed high-elevation white pines of California. More information is needed to adequately develop recommendations which mitigate against adverse impacts and maintain or restore foxtail pine populations as a response to public concerns about forest health of these ecosystems.

c. Feasibility or probability that the project will be successfully completed: In 2004 and 2005, Region 5 established 116 long-term monitoring plots to examine levels of blister rust over a broad regional scale on all 5 high-elevation white pines. The Region's blister rust resistance program will take the lead in coordinating efforts to obtain this information. Personnel on the Klamath National Forest already have knowledge about accessible sites where additional plots could be established in the north. More plots may be established and some existing plots in Sequoia and Kings Canyon National Parks may be re-visited to increase the number in the southern foxtail. A private contractor is currently working on the 2004-2005 survey data and has expressed interest in contributing to this project. Other individuals who have participated in the previous survey may also be interested in this project.

DESCRIPTION:

a. Background: This project will focus on the impact of white pine blister rust on foxtail pine in California and will add to the current number of 12 foxtail plots (6 in the north and 6 in the south) established in the 2004-2005 field survey described previously. Long-term monitoring plots following protocols of the 2004-2005 field survey will be established in both areas, but some areas from a previous study (Duriscoe & Duriscoe 2002) may be revisited as part of the southern plot additions. Typically, field observations have been made while approaching the plot sites. Transect plots will be established with the collection of tree, *Ribes*, blister rust, other pest, forest, and landscape data. The plot protocol is a modified version of the Whitebark Ecosystem Foundation's protocols for evaluating whitebark and limber pine.

b. Methods:

Foxtail pine populations will be found by examining vegetation and topographic maps, contacting local natural resource personnel, and from descriptions in previous reports and publications. Plots will be 30 by 50 m, with size being adjusted to accommodate site factors, and contain at least 30 live foxtail pines out of 50 trees total. For each tree, data will be collected on diameter, tree status (live, dead), crown condition (1≤10% dead, dying, damaged, infected; 2=11-20%, etc.), and the presence/absence of WPBR. Disease is determined by the presence of swollen cankers and of aecia on stems and/or branches. Canker location, numbers, and status (blisters present or not) are also recorded. Individuals with dead "flagged" branches but no aecia are noted as unconfirmed WPBR; additional notes are made on other traits typical of rust-infected branches. In addition, data will be taken on other "unknown" flagging, pests or pathogens such as mountain pine beetle (*Dendroctonus ponderosae*), and on cone production. At the plot level, seedlings/saplings are counted as live or dead and whether infected with WPBR, and *Ribes* species, percent cover, and WPBR infection are noted. Information is recorded on plot conditions, location, slope traits, other tree species, aecia phenology, and presence/absence of *Castilleja*, *Pedicularis*, and Clark's nutcrackers. Stem maps and photographic records are also developed.

c. Products:

Year 1: (Summer 2007) Establish long-term monitoring plots and collect data in the northern and southern foxtail pine stands.

Year 2: (Fall 2007 - Spring 2008) Enter and analyze data. Develop a report on the impact of white pine blister rust on foxtail pine in the plots established from this project and the previous 2004-2005 survey.

COSTS:

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR ONE				
Administration	Salary		6,880	R5
	Overhead @ 15%		1,032	R5
	Travel		2,000	R5
Procurements	Contracting:			
	1 field pathologist @$1450/wk, 7 wks	10,150		
	1 field crew @$830/wk, 7 wks	5,810		
	Travel ($500/wk, 7 wks)	3,500		
	Vehicle ($300/wk, 7 wks)	2,100	1,200	R5
	Equipment/Supplies	1,000		
TOTAL		22,560	11,112	
YEAR TWO				
Administration	Salary		3,440	R5
	Overhead @ 15%		516	R5
Procurements	Contracting:			
	1 field pathologist @$1450/wk, 6 wks	7,250		
	Supplies	300	300	
TOTAL		7,550	4,256	

REFERENCES CITED:

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