

TITLE: Long-term Monitoring of White Pine Blister Rust Infection and Survival at 10 Sugar Pine Evaluation Sites

LOCATION: Southwest Oregon and Northern California

DATE: 30 September 2008

DURATION: 3-years, Inter-regional, Inter-agency

FUNDING SOURCE: Fire Plan

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PROJECT OBJECTIVES:

1) Provide the first definitive quantification of the occurrence and spread of white pine blister rust (WPBR), and subsequent mortality of sugar pine (SP) over several decades and multiple sites; 2) Examine WPBR impacts on a common set of SP families with different levels of rust resistance at sites with varying levels of rust hazard in SW Oregon, particularly after a decade of the warmest years on record; 3) Monitor the stability of major gene resistance (MGR) to WPBR in SP and detect any occurrence of a virulent strain of rust on SP in Oregon; 4) Examine seed sources from throughout the range of SP for differences in WPBR resistance and survival under widely differing field environments; 5) Establish or refine estimates of adaptation of various provenances to various environments, as benchmarks for future planting recommendations in changing climates.

JUSTIFICATION:

Priority Issues Addressed – Invasive Species - Insects, Diseases, and Plants.

Linkage to FHM Detection Monitoring – Goheen and Goheen examined data from FIA plots throughout the range of five-needle pines (>15,000 plots, 1991–2000 assessments, (http://fhm.fs.fed.us/posters/posters05/five_needlepines.pdf). They found that 14% of the plots had five-needle pines present, which underestimates the historical occurrence of five-needle pines, as they have been in decline for decades due to effects of WPBR and bark-beetle damage. These FIA plots provide only cursory data about forest health conditions, such as WPBR occurrence and damage. Aerial surveys are able to detect recent mortality in larger trees but do not detect branch dieback, diseased conditions in smaller trees below the canopy, or bole cankers which have not yet killed the tree. Additional ground surveys are needed to accurately assess conditions, including changes in WPBR activity.

Significance in terms of geographic scale – This unique set of four provenance trial sites is the most complete test of SP provenances in existence. Early data from these trials has already

enabled good estimates of sugar pine adaptation and seed transfer suitability. The trials will provide invaluable information on WPBR resistance trends from throughout the geographic range of SP (including areas currently uninfected with blister rust). The unique nature of these trials will continue to provide insights into adaptability of SP that will better enable managers to care for SP populations under climate change and increasing fire frequency.

Biological impact and/or political importance – Sugar pine is an important species in a wide array of ecosystems in southwestern OR and northern and central CA, as well as having commercial value. There is great interest from the Forest Service (R5 and R6) and the BLM (Oregon) in restoring SP and maintaining diverse, healthy forests. However, it is faced with challenges from global warming and related changes in fire regimes, increased mountain pine beetle attack, and the introduced, exotic disease white pine blister rust. Public and private land managers are reluctant to plant SP without knowledge of the level and durability of its WPBR resistance. An important feature in maintaining the species as a viable component of future forests is maintaining a wide degree of genetic diversity. This will help SP survive even in the face of warming conditions and the accompanying biotic and abiotic changes.

This is the only set of replicated field trials that includes the full range of sugar pine provenances planted in diverse environments. Data from these plantings will permit better estimates of adaptation and seed transferability, which will, in turn, better enable restoration of sugar pine to succeed. In addition, the progeny test sites will provide the first long-term evaluation of field resistance levels of sugar pine over a range of site hazards for this North American white pine species. Data from early assessments (<http://www.fs.fed.us/r6/dorena/publications/detail/pub006>) of these sites showed that WPBR reached high levels even on low hazard sites, but further data is needed to determine what types of resistance might be effective in the field.

The sites also provide an opportunity to select additional trees for the WPBR resistance breeding programs in R5 and R6. The six progeny test sites will also provide an indication of whether the virulent race of the rust ('Happy Camp' strain) is now present in Oregon. Presence of the virulent race of rust will limit the utility of the relevant resistance mechanism (MGR) in breeding programs and sugar pine seed deployment.

Feasibility or probability that the project will be successfully completed – The feasibility of completing the assessments is very high. All ten sites are still accessible. Considerable time and resources from FS and BLM cooperators have already been invested in establishing, measuring, and analyzing data from previous assessments for these trials. There is considerable interest from geneticists, tree improvement staff, and FHP staff to complete this assessment. Most have committed to helping with measurements. DGRC and BLM personnel have already completed assessments at two of the progeny test sites but a more concerted effort is needed to complete the other sites in a timely fashion (i.e., while the data is available).

DESCRIPTION

Background:

SP Provenance trials: Sugar pine seed was collected from 62 sources (provenances) from as far south as Baja, CA to as far north as the Mt. Hood NF. In 1984 and 1988, different sets of these provenances were planted at sites with varying elevation in CA and southwest OR (2 sites, each). 42 sources are common to all four test sites. A fifth site (Harrell), planted in 1992, contains all provenances and families planted at the other sites. These sites were established by the PSW R.S. and the Siskiyou and El Dorado NFs for the purpose of evaluating seed-transfer guidelines. They were measured at regular intervals for growth and survival, but only a single, cursory survey has

been made for WPBR. Much data about WPBR infection is likely to be lost if these trials are not measured in the next few years, since many cankers are on branches that will self-prune, some trials need thinning, and trees are being lost to other causes of mortality.

Progeny Tests of rust resistant families: Six sites (5 BLM, 1 FS) were established in 1982-83 to examine field resistance of 53 of the earliest selections from the rust resistance program. Progeny of a subset of these selections was planted at each site, and 31 families were common to all 6 sites. The trials have been assessed three times, most recently in 1996-97. That assessment showed a large increase in infection at several sites, including sites rated as low hazard (see <http://www.fs.fed.us/r6/dorena/publications/detail/pub006>). Two of the sites have been evaluated more recently (2005, 06, and 08) for growth and WPBR infection. These assessments have shown a high level of infection and rust mortality, plus other interesting rust behavior.

Methods: All sites will be assessed for tree status (alive, dead, and/or damaged), incidence of rust and reproductive status (presence of cones). We will also note mortality from other causes. DBH and height will be measured as feasible to provide growth information and the impacts of rust on tree growth. Other variables may be measured for different sites. The Harrell site may be substituted for one California site which has been severely affected by other tree losses. SAS and other software will be used to analyze the data.

Products: Information will be provided to land managers on the growth and survival of sugar pine in OR and CA in the face of both climate change and blister rust. Posters and publications to various groups as well as presentations to genetics and forest pathology meetings are also planned, along with annual progress reports at the FHM Meeting.

Schedule of Activities: Funding permitting, assessments of the remaining sites are scheduled to begin in spring of 2009 and will continue through the winter of 2010. Annual progress reports will be completed after the summers of 2009 and 2010. Time during winter and spring of 2011 be dedicated to data analysis and writing up final results. The final summary at the end of the project will be presented at the annual Forest Health Meeting in early 2012.

COSTS:

YEAR: FY 2009-11	Item	Requested FHM EM Funding			Other Funding*	Source
		2009	2010	2011		
Administration	Salary (Additional GS-5)	1,000	1,000	0	> 70,000	DGRC, other R-5 & R-6 FS & BLM personnel, PSW
	Overhead					
	Travel	20,000	20,000	3,000		
Procurements	Contracting					
	Equipment	1,000				
	Supplies	1,000				
Total		23,000	21,000	3,000	> 70,000	

* BLM and FS offices funded the establishment, maintenance, and assessment of the progeny sites for the first 15 years of these trials as did the FS for the provenance trials. These early costs totaled probably several hundred thousand dollars. The \$70,000 for other salaries is a very conservative estimate of the salary costs over the remaining time of this project (funded from other agency sources).