

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

LOCATION: Southwest Oregon and Northern California

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DURATION: Year 3 of a 3-year project

FUNDING SOURCE: Fire Plan

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PROJECT OBJECTIVES:

1) 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 on common set of genetic sources; 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 (1991–2000 assessments, >15,000 plots). They found that 14% of the plots had five-needle pines present. This probably underestimates the historical occurrence of five-needle pines, which have been in decline for decades due to effects of WPBR and bark-beetles. 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 lower level damage such as branch dieback, infections in smaller trees below the canopy, or bole cankers which have not yet killed the tree. Additional ground surveys were needed to accurately assess conditions, including changes in WPBR activity.

Significance in terms of geographic scale – The five provenance sites and the BLM progenysites constitute the most complete test of SP seed sources in existence. Early data from these trials has already enabled good estimates of sugar pine adaptation and seed transfer suitability. They 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 manage 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 as part of maintaining diverse, healthy forests. However, SP is faced with challenges from global warming and related changes in fire regimes, increased mountain pine beetle attack, and WPBR. 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 diversity will help SP survive even in the face of warming conditions and the accompanying biotic and abiotic changes.

The plantings included here are the only set of replicated field trials that includes an extensive range of sugar pine provenances planted in a variety of 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 species. Data from early assessments 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 additional opportunities: 1) to select additional trees for the WPBR resistance breeding programs in R5 and R6 and 2) provide evidence of whether the strain of rust virulent to sugar pine (*vcr1*, ‘Happy Camp’ strain) is present in Oregon. Presence of *vcr1* would limit the utility of one resistance mechanism (‘MGR’) in breeding programs and sugar pine seed deployment.

Feasibility or probability that the project will be successfully completed – Evaluations have been completed at all 10 sites in the original proposal, plus an additional related site. The high level of interest from geneticists, tree improvement staff, and FHP staff has permitted us to complete this assessment. Dorena, PSW, BLM, R5 and R6 personnel have combined to complete the measurements. Data validation and analysis has begun.

DESCRIPTION

Background:

SP Provenance trials: Sugar pine seed was collected from 122 sources (provenances) from as far south as Baja, CA and as far north as Mt. Jefferson in Oregon. In 1984 and 1988, sets of up to 62 of these provenances were planted at four diverse test sites in CA and southwest OR; 42 sources are common to all four sites. A fifth site (Harrel) was planted in California in 1992 with 122 provenances. The Harrel site complements the other 4 sites. A subset of these seedlots was also used to establish linked trials in Spain. The OR & CA sites were established by PSW 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 survey was done for WPBR. Much information about WPBR infection of sugar pine would have been lost if these trials had not been measured.

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; 31 families are common to all 6 sites. The trials have been previously 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 (prior to

planting). All 6 of the sites have now been evaluated (2005/06/08/09/10) for growth and WPBR infection. These assessments show a high level of infection and rust mortality at all sites.

Methods: All sites were assessed for tree status (alive, dead, damaged), incidence of rust and reproductive status. Diameter (DBH) and height were measured where feasible to provide growth information and the impacts of rust on tree growth. SAS and other software will be used to analyze the data in 2011.

Products: Information will be provided to land managers on the growth and survival of sugar pine in OR and CA. A poster was presented at the 2010 FHM meeting. Further publications, as well as presentations to genetics and forest pathology meetings, are planned.

Schedule of Activities: Analyses are now in progress and will continue into 2011. Dorena and PSW personnel will take the lead on summarizing the trials. Short validation visits to some plantings to verify unusual data are likely.. Report writing is scheduled for FY2011. The final summary will be provided to FHM and a poster prepared for a FHM meeting (if scheduled for FY2012).

Progress and Accomplishments: Evaluations have been completed on all provenance trial sites. These were accomplished by a combined effort of Dorena GRC (R6), R5 Genetics & FHP personnel (including the Regional Pathologist and Regional Geneticist) and PSW personnel. Evaluation of the progeny test sites was completed by DGRC and BLM personnel, with the assistance of the the Rogue River-Siskiyou NF Silviculturist. The 2010 evaluations occupied about 17 days (>120 man-days) in the spring and summer. Evaluations have thus been completed at all of the 10 sites included in the proposal, plus one additional site. Data validations and preliminary analyses are in progress. All live trees in the BLM plantings were retagged with numbered aluminum tags. Significant blister rust infection and mortality was found at all sites except Cannon; infection rates as high as 80% and up to about 90% rust mortality. Many BLM sites have only 100-200 trees left.

COSTS:

YEAR: FY 2009-11	Item	Requested FHM EM Funding			Other Funding*	Source
		2009 1st Year	2010 Last Year	2011 Current Proposal		
Administration	Salary or Overtime	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 course of this project (funded from other agency sources).