Greater Yellowstone Coordinating Committee

Project Completion Report
FY 2007

Unit: Cathy L. Cripps, MSU & Mary Hektner, Yellowstone National Park.

Project Name: Whitebark Pine Restoration, Dunraven Pass (Monitoring mycorrhizal status of seedlings)

Project Description: Goal: of this project is to determine if whitebark pine seedlings planted for the purpose of restoration along Dunraven pass have access to, and are effectively colonized by the native ectomycorrhizal fungi necessary for their establishment, health and sustainability, and if not, to consider the remedial steps that might be taken in the future.

Objectives:

1. To determine if appropriate mycorrhizal fungi are present in replaced and native soil along Dunraven Pass where whitebark pine seedlings are to be planted [GREENHOUSE SOIL BIOASSAY].
2. To determine if exotic "nursery fungi" are present on seedling roots before planting, and if they persist after planting or are replaced by native mycorrhizal fungi [NURSERY TREES].
3. To assess the mycorrhizal colonization of roots of whitebark pine seedlings nine months after planting along Dunraven Pass and correlate results with abiotic/biotic factors [ON- SITE MONITORING].
4. To assess future options if seedlings are not effectively colonized.

GYCC Funding Received: $5,000
Partner Funding/In-Kind Received: $0

Status of the Project: Research from this project is completed as is a more extensive final report. However, funds were not released until 9/26/07 and time is needed to process and complete spending for this grant at MSU. The final date for the MSU-YNP contract runs to August 2008, but the processing should be complete by end of June 2008.

Products that can be shared across the GYA: (GIS data layers, maps, new protocols and methods)

An in depth report (separate from this document) with supporting data will be available to be shared across the GYA. It has an extensive section on results and color photographs. This report will be available through Mary Hektner in YNP or Virginia Kelly GYCC. Products to date:

1. Cripps, CL and Mary Hektner 2008. Whitebark Pine Restoration, Dunraven Pass (Monitoring mycorrhizal status of seedlings). Final Report (hard copy). 15pp.
2. Cripps, CL and P. Trusty 2007. Monitoring mycorrhizal fungi on planted whitebark pines in the GYE. GYCC Annual Meeting, Oct. 30, Bozeman MT (oral presentation).
3. Cripps, CL and Trusty, P. 2007. A report of ectomycorrhizae on whitebark pine roots from Yellowstone, Glacier and Waterton Lakes National Parks. Whitebark Pine Foundation Annual meeting, Lincoln, MT, Sept. 28-30, 2007 (poster).
4. Small paper in progress.

Project results: (Information worth sharing on methods, results, partnerships, etc)

1. GREENHOUSE SOIL BIOASSAY determined native fungi are available in the replaced and native soil, at least at low levels.

A. The Soil Bioassay technique was reasonably successful, and revealed native mycorrhizal fungi appropriate for whitebark pine on 50-60% of seedlings grown in the non-sterilized soils.
B. Nursery E-strain fungus persisted in all four treatments however native fungi were still able to colonize the seedlings.

Note: You may expand and reduce size of blocks.

C. The soil bioassay revealed Suilloid fungi to be present in native and replaced soil.
D. The actual number of viable mycorrhizae on seedling roots was low after 1 year in the greenhouse and the Soil Bioassay technique could be further optimized.

2. Examination of nursery seedling roots prior to outplanting, revealed that non-native mycorrhizal fungi, including *Thelephora* and E-strain, were present at low levels.
These are likely different strains than those native to Yellowstone Park, although at the species level, the species do exist within the Park. E-strain was the most common and does not appear to be problematic on sites examined at this point, but should be monitored especially on other soil types. *Thelephora* was present in low levels on nursery seedlings; this fungus could be more problematic, but we did not find it on outplantings. Nursery seedlings with copious white mycorrhizae (likely *Thelephora*) should be monitored on out-planting to ensure this fungus does not spread in natural systems, or is easily replaced by native fungi.

3. Mycorrhizal colonization of out-planted whitebark pine seedlings on 10 sites 9 months after planting on Dunraven Pass revealed native fungi were present on 50% of sites but colonization levels of roots were low (< 4%).

A. Native mycorrhizal fungi were present on whitebark pine seedling roots on 50% of sites.
B. *70% of healthy whitebark pine seedlings examined hosted some type of mycorrhizal fungus* and *only 10% of the compromised seedlings were colonized. The compromised condition of the B seedlings could be due to abiotic factors which precluded mycorrhization or due to a priori lack of mycorrhizae.*
C. Mycorrhizal colonization rates were low and most were < 1% of the whole root system, with an overall average of 4.4%. *One seedling was well-colonized at 30% showing mycorrhization can occur in 9 months.*
D. The presence/abundance of mycorrhizae did not correlate directly with % survival by site in this study, however it did correlate somewhat with the diversity of fungi on roots.
E. Most of the mycorrhizae occurred from 4-12 cm in the soil, but occurred deeper/shallower on the burned sites.
F. *Both native and exotic nursery mycorrhizal fungi were found on out-planted whitebark pine seedlings after 9 months. Thus nursery fungi persisted, but native fungi were able to colonize.*
G. A diversity of native mycorrhizal fungi were found on planted whitebark pine seedlings after 9 months, including the important Suilloids. This shows that Suilloid fungi are in the soil and available to whitebark pine seedlings on some sites. These are important fungi for regeneration.
H. Most of the diversity (number of species) of native mycorrhizal fungi was found on the North side of the pass, and this area supports extensive mature whitebark pine forests

4. Recommendations and future options should include 1) long term monitoring of seedlings: seedlings should be assessed again in 2 years (field season 2009) to see if mycorrhizal colonization of planted seedlings has occurred and how this correlates with survival. This would include continued monitoring to determine the persistence of nursery fungi. 2) Individual soils on sites should be used in a Greenhouse bioassay to determine if fungi are still present on each site and if this correlates with subsequent survival (field season soil collecting 2008) and analysis in 2009. 3) The Greenhouse Bioassay method should be evaluated with different aged trees to see if younger seedlings are more amenable to colonization by mycorrhizal fungi. 4) We do not believe

that retroactive inoculation with mycorrhizal fungi should be implemented on these sites. The sites are more valuable as controls and many are near roadways and parking lots. 5) We are currently working with a native species of *Rhizopogon* from YNP that could be used to inoculate seedlings and tests would include a direct comparison of inoculated and uninoculated seedlings in selected areas of YNP, particularly areas where seedling survival is poor. 6) A commercial mycorrhizal inoculum should NOT be used for seedlings in YNP. Commerical fungi are not found with whitebark pine and could upset delicate natural systems.7) Most of the fungi we have discovered are pine associates and do not occur with spruce and fir; if used as inoculum these native fungi could promote a mycorrhizal system not conducive to other tree species. 8) The low colonization rates of seedlings on sites suggest that inoculation of native fungi in the greenhouse might be a benefit on some sites. Smith & Cordell found that inoculation of 5 million seedlings (pine and oak) increased survival from 50 to 90% and ultimately reduced reforestation costs because replanting was not necessary. 9) If subsequent plantings of whitebark pine are planned, the flow chart included in the longer report should be used to determine if inoculation is necessary. 10) We are also gaining information on the individual mycorrhizal species found with whitebark pine in mature forests which is not included here.
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Report Date: Do not close this account, we are not including an MSU invoice. We are expecting a no cost extension. Please talk to Mary Hektner about this.
Submit to Virginia Kelly**:** vkelly@fs.fed.us 406-587-6704. Contact Virginia with questions.