Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

The Greater Yellowstone Whitebark Pine Monitoring Working Group

Gregg A. DeNitto[1], Erin Shanahan[2], Steve Cherry[3], Robert E. Bennetts[2], Daniel P. Reinhart[2], Charles C. Schwartz[4], Jody Canfield[1], Jennifer Birdsall[2], Polly Buotte[2]

[1] US Forest Service, [2] National Park Service [3] Montana State University, [4] US Geological Survey; [3] US Forest Service,

Abstract

Whitebark pine is a "keystone" species throughout the GYE, the cones of which serve as a major food source for grizzly bears and other wildlife species. Whitebark pine stands have been diminished in areas of the northern Rocky Mountains due to the introduction of an exotic fungus white pine blister rust as well as mountain pine beetles. Our objectives were to estimate current status of whitebark pine relative to infection with white pine blister rust and to determine the probability of whitebark pines persisting in the Greater Yellowstone Ecosystem (GYE). The objectives of our monitoring was aimed at assessing the current status of white pine blister rust, whether or not blister rust is increasing within the GYE, and whether the resulting mortality of whitebark pine sufficient to warrant consideration of management intervention (e.g., active restoration)? Resource managers from eight federal land management units have worked together to ensure the viability and function of whitebark pine through the Greater Yellowstone Whitebark Pine Committee.

Introduction

Whitebark pine (WbP) occurs in the subalpine zone of the Pacific Northwest where it is adapted to a harsh environment of poor soils, steep slopes, high winds and extreme cold temperatures. Although its inaccessibility and sometimes crooked growth form lead to low commercial value, it is an important species ecologically, and is considered a "keystone" species of the subalpine zone. Whitebark can grow under conditions tolerated by few other trees and often functions as a "nurse" plant for species such as subalpine fir and Engelmann spruce. Its occurrence on wind-swept ridges acts as a natural snow fence allowing for snow accumulations that benefit a multitude of other life forms. Within the Greater Yellowstone Ecosystem (GYE), WbP's best known role is probably as a food source for a variety of wildlife, in particular grizzly bears, red squirrels and Clark's nutcrackers. Grizzly bears gain access to large quantities of seeds that are stockpiled in red squirrel middens. Clark's nutcrackers form a mutualistic relationship with WbP by caching thousands of seeds, thus serving as a primary means of seed dispersal.

Objectives

Our objectives are intended to estimate current status of whitebark pine relative to infection with white pine blister rust as well as to assess the vital rates that would enable us to determine the probability of whitebark pines persisting in the Greater Yellowstone Ecosystem.

Objective 1 - To estimate the proportion of individual whitebark pine trees (>1.4 m high) infected with white pine blister rust, and to estimate the rate at which infection of trees is changing over time.
Objective 2 - Within infected transects, to determine the relative severity of infection of white pine blister rust in whitebark pine trees > 1.4 m high.
Objective 3 – To estimate survival of individual whitebark pine trees > 1.4 m high, explicitly taking into account the effect of infection with and severity of with white pine blister rust, and infestation by mountain pine beetle and dwarf mistletoe, and fire.
Objective 4 -- Currently in the planning stages, this objective is aimed at assessing recruitment into the cone producing population. We anticipate a pilot effort to begin in 2007.
Objective 5 -- This objective is aimed at assessing the effect of forest succession and is being planned for future implementation.

Study Area

Our study area is the Greater Yellowstone Ecosystem and is comprised of 6 National Forests and 2 National Parks (Figure 1).

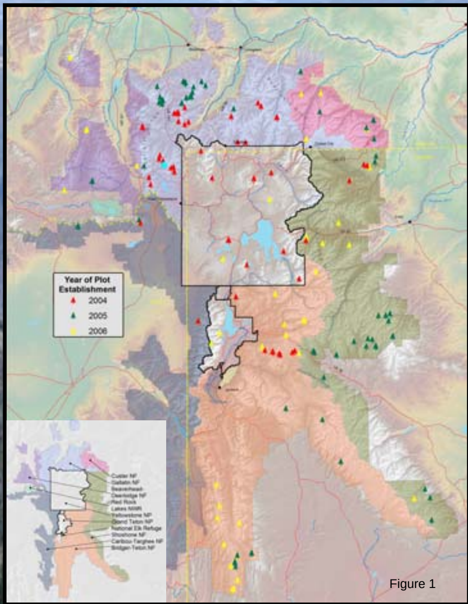


Figure 1

Methods

Our basic approach was a stratified 2-stage cluster survey design with stands (polygons) of whitebark pine being the primary units and 10x50 m transects being the secondary units. Treating within and outside the PCA as different strata enabled us to account for map limitations during 2004 and to derive separate inference for these areas. Transects and individual trees within each transect were permanently marked in order to estimate changes in infection and survival rates over an extended period. Transects will be revisited as part of a rotating panel with approximately a 5 year interval between surveys. For each live tree, the presence or absence of indicators of blister rust were recorded. For the purpose of analyses presented here, a tree was considered infected if either aecia or cankers were present. Ancillary indicators of blister rust included flagging, rodent chewing, oozing sap, roughened bark, and swelling. For a canker to be conclusively identified as resulting from blister rust, at least three of the ancillary factors needed to be present.

Preliminary Results

From 2004-2006, a total of 166 transects (160 permanently marked) were surveyed and 4550 trees were tagged in the GYE. Our preliminary results indicate that the occurrence of white pine blister rust is widespread throughout the GYE (i.e, 81% of all transects had some level of infection). In contrast, the severity of infection per tree was much less, with 25% of the trees in the GYE estimated as having some level of infection (Table 1), of which the vast minority of infections were due to bole cankers. Bole cankers are generally considered lethal to trees compared to branch cankers.

Table 1. Summary statistics for 2004-2006.

Year	2004	2005	2006
Location[1]	Within PCA	Outside PCA	Full Study Area
Number Stands	45	55	36
Number of Transects	51	76	39
Number of Trees Sampled	1,012	2,732	806
Proportion of Transects Infected	0.71	0.86	0.87
Estimated Proportion of Trees Infected	0.17 ± (0.06 se)	0.27 ± (0.04 se)	0.25 ± (0.03 se)

[1] 2004 and 2005 were sampled entirely within and outside the PCA, respectively due to the lack of availability of mapped stands in 2004.

Discussion

Our overall estimate of blister rust infections is likely conservative. Our criteria of having aecia or at least three of the other indicators (rodent chewing, flagging, oozing sap, roughened bark or swelling) present to confirm infection, may result in the rejection of questionable cankers. We are continuing to evaluate the efficacy of this criteria for future sampling.

Our data also suggests that observer variability may be quite important. This result has broad implications for all monitoring efforts of whitebark pine where observer differences are not considered. For monitoring efforts to be reliable, differences in infection rates observed over time should not be confounded with observer differences. We are in the process of analyzing this potential concern and our findings will be forthcoming.

Accounting for Access

One concern that reviewers of this project have raised is the selection of transects that might be difficult or time consuming to access. Some feel that we have decreased our sample size "potential" by using a random selection resulting in a percentage of extremely remote stands. It has been argued that if we had implemented a stratified approached based on distance to roads, we would have been able to sample more stands. However, two circumstances of our sampling diminish this concern. First, our total sample was not limited to a set number of seasons, such that we were prepared to spend as many seasons as necessary to attain the desired sample. With this in mind, we met our target sample size in 3 seasons without jeopardizing statistical validity. Second, a stratified sample would still have required a minimum sample in remote areas if our inference was to remain as the total study area. Our unstratified sample also resulted in most of our transects having reasonable access. Given the remote nature of our study area, very few stands are accessible with some effort hiking. In the 3 years of plot establishment, only a few of the transects selected were extremely remote (e.g., > 5 miles one way) (Figure 2). In addition, hiking distance to a given plot was seldom the limiting factor in the number of plots sampled per day. The number of trees and level of infection tended to play a greater role in the time required to survey a plot.

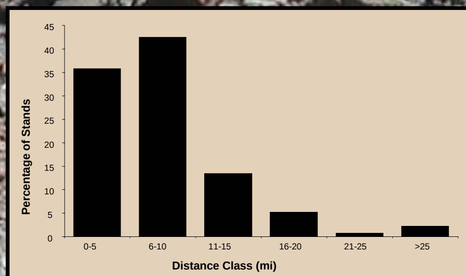
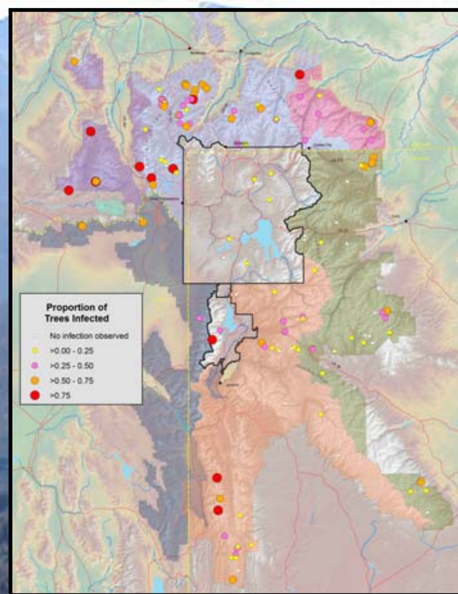
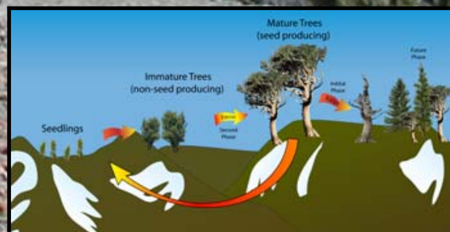


Figure 2. The percentage of stands in each round-trip distance from road class.



Future Directions

At the present time we have a sufficient sample to expect reasonable inference about changes in blister rust infection overtime in the GYE. Other than filling in a few remaining gaps that were not previously mapped, our current sample of 160 permanently marked transects will remain our final sample for estimating blister rust infection and associate mortality at approximately 5-year intervals. However, with the exception of seedling counts on existing transects, our sampling thus far is focused on mortality of whitebark pine. Of equal concern is the ability for whitebark pine to be reproductively viable. The decline of whitebark pine can result from either increased mortality (e.g., as a result of blister rust and/or mountain pine beetle), or from a lack of recruitment into the reproductive population. A lack of recruitment can result from changes in a variety of life history stages such as decreased cone production and/or recruitment of immature trees into the cone-producing population. Cone production itself is currently being monitored by the Interagency Grizzly Bear Study Team, and other interested groups. The number and survival of seedlings is also an area of relevance; however, seedlings naturally exhibit very high mortality rates. Therefore, we are more concerned about the recruitment of those individuals that have survived into the mature population. The next phase of this project will focus on the recruitment of immature trees into the cone-producing population. Future efforts also may include the effects of forest succession.



Acknowledgments

We thank Justin Hof, Karla Sartor, Amy Jesswein, Maria Newcomb, Veronika Klukas, Lisa Landenburger, Dale Dawson, Rachael Feigley, Andy Pils, Bill Oliver, Rob Daley, Jim Robertson, Steve Schadt, Jodie Canfield, Dennis Barron, Al Kyles, David Meyers, Marcus Engler,Jeff Dibennitto, Ellen Jungck, Bev Dixon and Anne Schrag for their advice and/or field and logistic support. Funding for the field work portion of this project was provided by USFS FHM and NPS (Greater Yellowstone Network and the Greater Yellowstone Coordinating Committee). The USGS (Interagency Grizzly Bear Study Team) provided additional logical and technical support.