Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

The Greater Yellowstone Whitebark Pine Monitoring Working Group

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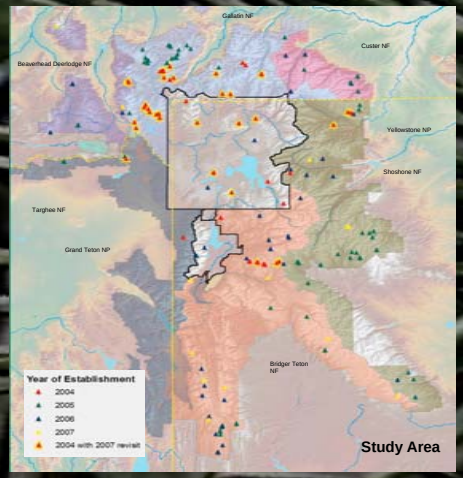
Abstract

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 white pine blister rust infection, infestation by mountain pine beetle and dwarf Mistletoe, and fire.
Objective 4 -- Currently in the planning and ground truthing stages, this objective is aimed at assessing recruitment into the cone producing population.
Objective 5 -- This objective is aimed at assessing the effect of forest succession and is being planned for future implementation.

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 grizzly bear Primary Conservation Area (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. 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 2004-2007, a total of 181 transects (175 permanently marked) were surveyed and over 4,700 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, 80% of all transects had some level of infection) (Figure 1.). In contrast, the severity of infection per tree was much less, with the vast majority of infections due to bole cankers. Bole cankers occurred on 25% of trees and are considered lethal.

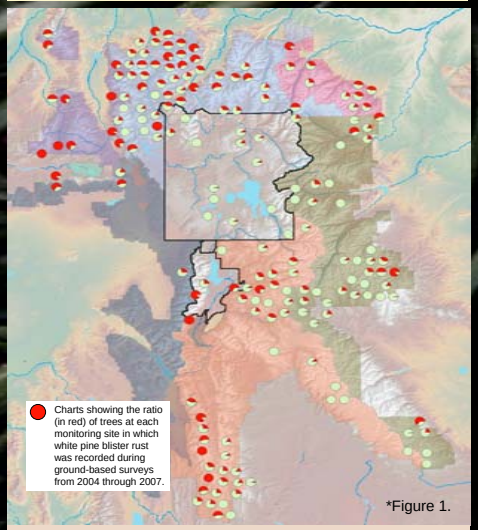


*Figure 1.

*Due to map scale, the pie charts are distributed for readability, therefore, some symbols are not placed on the corresponding survey location.

Year	2004	2005	2006	2007
Location	Within PCA	Outside PCA	Full Study Area	Full Study Area
# Stands	45	55	36	15
# Transects	51	76	40	15
# Trees Sampled	1,012	2,732	806	292
Proportion of Trees Infected	0.71	0.86	0.87	0.80
Estimated Proportion of Trees Infected	0.17 ± (0.06 se)	0.27 ± (0.04 se)	0.25 ± (0.03 se)	0.20 (0.03 se)

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. With an additional 15 transects established in 2007, we have completed our survey panel of 150 stands. These 150 stands provide a representative distribution throughout the ecosystem. Seven transects were potentially burned by fires in 2007. Any burned transects will remain as part of the panel and will be monitored for regeneration. With our survey panel selected and established, we now must decide upon a revisitation interval. The revisitation interval will be based on the results obtained from re-surveying transects established in 2004 and 2005.

Observer Variability

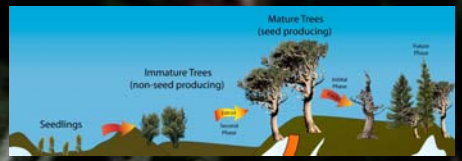
Our data also suggest that observer variability may be quite important. This result has broad implications for all monitoring efforts of whitebark pine where observer differences are not considered. For monitoring efforts to be reliable, differences in infection rates observed over time should not be confounded with observer differences. We continue to address this concern through our data analysis.

Mountain Pine Beetle

Over the past 4 years, we have recorded the presence and/or absence of mountain pine beetle (Fig. 2). Of the 45 stands visited in 2004, 10 (22%) had evidence of mountain pine beetle attacks in live or recently dead (i.e., with intact needles) trees. Of the 1,062 live or recently dead trees we sampled in these stands, 30 (3%) had evidence of mountain pine beetle attacks. In 2005, 12 out of 55 (22%) stands had evidence of mountain pine beetle attacks and of the 2,827 live or recently dead trees, 26 (1%) had evidence of mountain pine beetle attacks. For 2006, 15 (41%) of the 36 stands surveyed had evidence of mountain pine beetle attacks with 55 (6%) of the 805 live or recently dead trees exhibiting signs of mountain pine beetle attack. And finally, in 2007, 6 (40%) of 15 stands displayed mountain pine beetle attacks with 33 (9%) of the 292 live or recently dead trees showing signs of an attack.

2004 Transects Revisited in 2007

Thirty-three transects established in 2004 were re-visited in 2007. All tagged trees were re-surveyed for blister rust infection. Seedling/sapling (>1.4m) counts were tallied, and trees on the existing transect that had reached 1.4m in height within the last 3 years were tagged and surveyed. Results from these revisits are forthcoming and will help to establish the time interval for our rotating panel.



Future Directions

At the present time we have a sufficient sample to expect reasonable inference about changes in blister rust infection over time. Our current sample of 175 permanently marked transects will remain our final sample for estimating blister rust infection and associated mortality. However, with the exception of seedling counts on existing transects, our sampling thus far is focused on mortality. Of equal concern is the ability for whitebark pine to be reproductively viable. The decline of whitebark pine can result either from increased mortality (e.g., as a result of blister rust and/or mountain pine beetle), or it can result from a lack of recruitment into the reproductive population. A lack of recruitment can result from changes in a variety of life history stages from decreased cone production to 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. We began an initial ground truthing effort focusing on stands that had been historically mapped (Fig. 3) as "whitebark dominant" forest types and had burned at some point in time. Four of the five stands visited had regenerated to lodgepole pine. This information will direct the protocol development for determining the recruitment of immature trees into the cone-producing population. Future efforts also may include the effects of forest succession.

Acknowledgments

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