Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

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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 decimated 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 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. In 2004, transects were established and permanently marked for long-term trend monitoring in 45 stands of whitebark pine. In six of these stands, we surveyed an additional transect to assess within stand variation in blister rust. In total, 51 transects were sampled and 1,012 live trees surveyed. The number of whitebark pine trees sampled within these transects ranged from 1 to 141. Blister rust infection was based on the presence or absence of aecia and cankers and was variable between observers. Of the 51 transects, 36 were infected with white pine blister rust, and 18 had beetle kill. A total of 229 of 1,012 live trees were infected with white pine blister rust.

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.

Forest Health Monitoring (FHM) is showing a rapid and precipitous decline of WbP in varying degrees throughout its range due to non-native white pine blister rust and more severely due to heavy mortality from endemic mountain pine beetle. Given the ecological importance of WbP in the ecosystem and that 98% of WbP occurs on public lands, the conservation of this species depends heavily on the collaboration of all public land management units in the GYE. Established in 1998, the Greater Yellowstone Whitebark Pine Committee, comprised of resource managers from eight federal land management units, has been working together to ensure the viability and function of WbP throughout the region. As a result of this mutual conservation interest by these agencies, an additional small working group was formed in 2003-2004 with representatives from the U.S. Forest Service (USFS), National Park Service (NPS), U.S. Geological Survey (USGS), and Montana State University (MSU) for the purpose of integrating their interest, goals and resources into one unified monitoring program for the Greater Yellowstone area. This project represents the initial results of that effort.

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.

Additional Objectives aimed at assessing recruitment and the effect of forest succession are being planned.

Study Area

Our study area is the Greater Yellowstone and is comprised of 6 National Forests and 2 National Parks (Figure 1). During 2004 all WbP stands sampled were within the Grizzly Bear Primary Conservation Area (PCA) because of limitations in the mapped distribution of WbP for the entire study area. This region includes approximately 50% of the known distribution of WbP within the GYE. An ongoing mapping effort should remove this limitation starting in 2005.

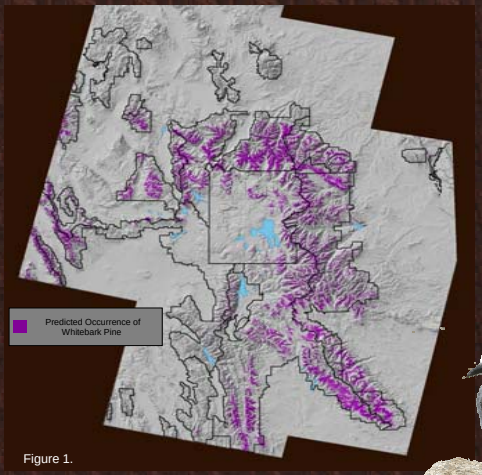
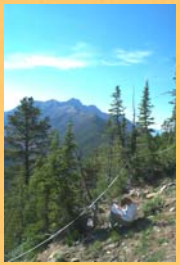


Figure 1.

Methods

The project used an existing protocol developed by the Whitebark Pine Ecosystem Foundation with modifications devised to meet our cooperative agency objectives and standards. Our basic approach was a 2-stage cluster design with stands (polygons) of whitebark pine being the primary units and 10x50 m transects being the secondary units. Transect locations as well as 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.



Observer Differences

Previous monitoring efforts for WbP have largely ignored observer variability in identifying white pine blister rust infection. To assess this effect, six transects were conducted independently by 3 different observers to evaluate the extent of observer error. The first observer marked the individual trees which were subsequently visited by each of the other two observers.

Preliminary Results

Proportion of Live Trees Infected with White Pine Blister Rust and Mountain Pine Beetle

A total of 51 transects were surveyed within 45 stands of WbP. Of the 51 transects, we observed some level of blister rust on 36 (71%). The proportion of infected trees on a given transect ranged from 0 to 1.0 (Figure 2). The number of live trees per transect ranged from 1 to 141 for a total of 1,012 live trees examined. Of these, 229 (22.8%) were determined to be infected with white pine blister rust. Although a formal spatial analysis has not yet been conducted, our preliminary data indicate that infection rates were highest in the northwest portion of our study area (Figure 3). The total number of live and dead trees for the 51 transects was 1,360. Of the live trees, 8 of 1,012 (<1%) had evidence of mountain pine beetle infestation, while 94 of 348 (27%) dead trees had successful mountain pine beetle attack.

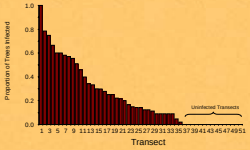


Figure 2. The proportion of whitebark pine trees infected on each of the 51 transects sampled during 2004 arranged in rank order from most infected to least infected.

Severity of White Pine Blister Rust on Infected Trees

The total number of cankers observed on infected live trees was 586, of which 458 (78%) were located on branches and 128 (22%) were located on a main trunk. The total number of cankers per infected tree ranged from 1 to 35. Trunk cankers are generally considered lethal to trees. Such cankers were less numerous than branch cankers and ranged from 0 to 4 per infected tree; whereas branch cankers ranged from 0 – 32 per infected tree (Figure 4).

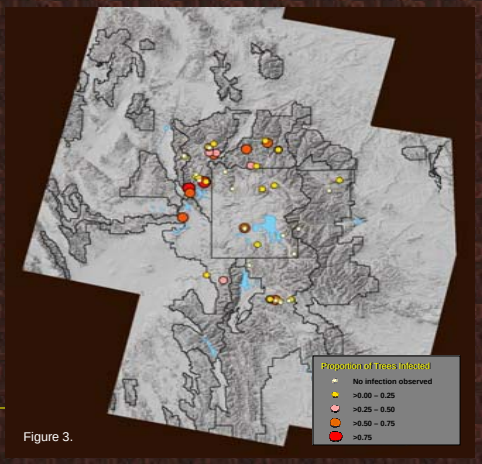


Figure 3.

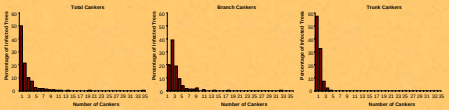
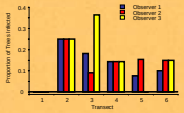


Figure 4. The percentage of whitebark pine trees infected with one, two, three, etc number of cankers per tree for (1) the total number of cankers, (2) branch cankers, and (3) trunk cankers.

Observer Differences

Of the 6 transects with multiple observers, 3 (50%) had differences in the proportion of trees infected with white pine blister rust that were attributable to observer variability (Figure 5). On one transect the estimates from 0.18 by one observer to 0.36 by another.

Figure 5. Estimates of the proportion of live trees infected with white pine blister rust by each of 3 observers on each of 6 transects.



Discussion

Our preliminary results indicated that the occurrence of white pine blister rust was widespread throughout the GYE, although in most cases, severity was at relatively low levels. Our overall estimate is likely conservative as it is based only on cases where conclusive evidence, aecia or cankers, were observed. Other evidence of blister rust (e.g., rodent chewing, flagging, oozing sap, roughened bark or swelling) was observed but not sufficiently conclusive. A more detailed analysis incorporating this other potential evidence will be forthcoming.

Our data also suggested that observer variability may be quite important. This result has broad implications for other monitoring efforts 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 will continue to assess observer variability in 2005 with a larger sample.

Based in part on these results from the 2004 field season, some changes in sampling regime are expected in 2005. Such changes may include some stratification of the study area, expansion of the study area beyond the Grizzly Bear PCA as mapping of WbP stands is completed, and an increase in the sampling effort within stands to provide both within and between-stand variation.

Acknowledgments

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