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Research

Dr. Lauren Fins

Forest Resources Professor
University of Idaho
Project Leader

Dr. Fins received a grant from the U.S. Forest Service to conduct research on wilderness whitebark pine plant communities.

Monitoring Whitebark Pine, Blister Rust and Fuels in the Frank Church River of No Return Wilderness Area

Whitebark Pine Poster

Objectives
Preliminary Results 2005-2006-2007
Activity Plans for 2008-2009

The **whitebark pine ecosystem** provides valuable and crucial habitat for many wildlife species, including birds, squirrels and bears. Whitebark pine *(Pinus albicaulis)* is a slow-growing, long-lived forest tree species found in the subalpine zones of southwestern Canada and the western United States. Across the species' range, whitebark pine populations have been declining steadily as a result of several factors: the introduced fungus Cronartium ribicola which causes white pine blister rust, infestations of mountain pine beetle *(Dendroctonus ponderosae),* and successional replacement by subalpine fir *(Abies lasiocarpa)*. Across the species' range, researchers are studying whitebark pine ecosystem dynamics, including the role of wildland fire. Our project involves the assessment of whitebark pine populations in the Frank Church River of No Return Wilderness Area.

The study was launched in 2005 to provide information on fuel loadings, forest health, disease incidence, mortality and reproduction. These results may be used to complement existing research and restoration initiatives on whitebark pine.

Ben Hoppus

Lead Field Researcher 2007-2008
Masters Candidate
Forest Resources Department
College of Natural Resources
University of Idaho

Professor: Dr. Lauren Fins

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COLLEGE OF NATURAL RESOURCES

First Year 2005 Report

First year preliminary results indicate that blister rust and incidence of mountain pine beetle attack were not related to slope or aspect, but unburned sites and plots with higher densities of whitebark pine had higher levels of blister rust. Within populations, elevation was negatively correlated with blister rust infection and plots with more and larger lodgepole pines had higher levels of mountain pine beetle attack. The amount of coarse woody debris was related to habitat series, with the highest levels in mixed subalpine types. Summary 2005

Catherine Roberts. Assistant 2005

Jodie Krakowski, Lead Field Researcher 2005

Plans for 2006

We plan to establish plots and collect first-year data in several additional whitebark pine populations, return to plots established in 2005 to re-assess infection and mortality, and, if available, collect cones/seeds for rust screening and genetic conservation. In 2007, we will return to all previously established plots to assess changes in infection and mortality, collect cones (if available) in areas where we were unable to collect in prior years, and conduct statistical analyses of infection levels, changes over time, fuel loadings and fire risk as a function of fuels.

Lauren Fins

University of Idaho, College of Natural Resources
Professor

Research focus:

- Ecological and genetic effects of blister rust infection in whitebark pines in the Frank Church River of No Return Wilderness
- Effects of wildfire and competition on whitebark pine reproduction and survival

Graduate student: Ben Hoppus

2004 - present

Blister Rust/White Bark Pine Trip - Notes[1]

- August 1, 2004. Cinnamon Robinson, Anna Pierce, Greg Hanson, Holly Akenson, and Lauren Fins took stock up Goat Creek and camped at Whiskey Springs. Lauren found first whitebark pine (large, mature, dying – yellow and brown needles all over – did not determine cause of death) on trail up to Whiskey Springs. That night went to observation site where Holly sat and looked for wolf pups on wolf trip a week ago. Howled and glassed meadow, no response.
- August 2, 2004. Hiked up from camp by Black Butte then took trail that leads to Coyote Springs. Looked for blister rust on whitebark pines.

- Results:

Mature Tree Data

#	years old	dbh	height	elevation	E	N	notes
1	80	13.4"	45.6'	8,545"	669744	5006007	Blister rust on bole and branches otherwise looks healthy, some animal damage near cankers
2	58	7.35	30.5	8,583	669761	5006027	Branch canker, one small flagged branch
3	62	4	25.5	8,583	669761	5006027	In clump with #2
4							In clump with #2 – diamond shaped canker on bole

- Surveys on Cabin Creek side of Papoose Peak, west of trail

- Tiny seedlings in 2000 burn, 10-20cm tall. Estimated 3 years old. No infection in sample of 3.

- Seedlings 4-6' tall are ~20-30 years old.

- 0.5 – 2' No infection out of 40 sampled. Estimated about 25 years old

- Seedlings 2-8' tall. Found 5 out of 45 infected with blister rust. Height in feet of infected trees: 3,7,7,4 and?.

- Bark beetle attacks 8-14" in Dead trees, west of trail. GPS: 670494E 5007721N

- Bark stripping evident in trees dead from beetles; also much bark stripping in rust infected live trees;

- Possible limber pines – check this?

- Pure whitebark pine at treeline; otherwise mixed primarily with lodgepole, then subalpine fir and Engelmann spruce; collected a few cones (all with seeds already harvested (by nutcrackers?) on ridge SW of Papoose Peak. saw several Clark's nutcrackers.
- CR, GH, and AP watched sun set on Black Butte, heard wolves howling in far distance directly N.

- Packed and went back to Taylor Ranch.
- Potential sampling sites for future: Return to Papoose Peak; Shellrock Ridge; Upper Big Creek; Bighorn Crags; Lauren needs to get copy of report from Craighead Institute on distribution of vegetation in FCWA

[1] Notes by Cinnamon Robinson; edited by Lauren Fins and Holly Akenson – August 4, 2004

Final Report to Dr. Lauren Fins, University of Idaho
College of Natural Resources

Results of Whitebark Pine Monitoring Plot Establishment, Stand, Fuels and Forest Health Surveys in the Frank Church - River of No Return Wilderness Area, South-Central Idaho

September 2005

Jodie Krakowski

Summary

Three populations of whitebark pines were surveyed and permanently tagged in the Frank Church - River of No Return Wilderness Area during July and August 2005, one north of Big Creek and two to the south. The population to the north, Black Butte, had a good representation of the three burn categories represented in the study: unburnt (no fire for 100+ years), old burns (fires 15-100 years ago) and young (fires <15 years ago). The two populations south of Big Creek each had only one burn type available: Dave Lewis Peak had only young burn and Lookout Mountain only unburnt. Black Butte and Lookout Mountain had stands of the three habitat series represented in the study: pure (>85%) whitebark pine, whitebark pine-lodgepole pine (sometimes mixed with Douglas-fir), and whitebark pine mixed with subalpine fir and other species (typically lodgepole pine). Dave Lewis Peak had only the latter two. It was not possible to replicate all factorial combinations, so populations were nested within habitat series and burn types for analysis. Lookout Mountain, which had only unburnt stands, had the highest white pine blister rust infection and mortality percentages. Unburnt sites generally had a higher percentage of infected trees than the other burn types. Dave Lewis Peak had the highest attack and mortality percentages caused by the mountain pine beetle. Elevation was negatively correlated with amount of infection, but only in unburnt sites and lodgepole-whitebark habitat series. Slope, aspect and percentage of trees in clumps were uncorrelated with any response variables. Larger fuel loadings (rotten CWD >3" diameter) were significantly affected by population nested within burn class: Lookout Mountain had the most while Dave Lewis had the least. Medium-sized fuels (1-3" diameter) were affected by successional status, where older stands had less. Black Butte had the thinnest duff layers. No trends were apparent for other fuel classes. Logistical considerations present a major challenge for field work in this Wilderness Area: thorough planning and packing support, if possible, are the keys to a successful project. Further sites for sampling in 2006 are suggested.

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Introduction

The recent rapid decline in the abundance and health of whitebark pine has spurred a coordinated effort throughout the species' range to document whitebark pine populations and ecology, and assess their health (Kendall and Keane 2001). The Species Survival Commission World Conservation Union has listed whitebark pine as critically endangered due to its rapid decline throughout its range and extirpation in some local populations (Howard 2002). The introduced fungal pathogen Cronartium ribicola has proven extremely detrimental to whitebark pine, causing 90-100% mortality in some portions of the range, particularly the Northern U.S. Rockies (Keane and Arno 1993; Keane et al. 1994). It is the most susceptible of all the five-needled North American pine species to white pine blister rust (Hoff and Hagle 1990; Hoff and McDonald 1993). Infection and associated mortality decline substantially to the north, toward Jasper National Park in Alberta (Stuart-Smith 1998; Campbell and Antos 2000; Zeglen 2002). Populations are declining and at some are risk of extirpation within a single generation. The wildlife species that rely on whitebark pine for food and habitat and associated subalpine plant communities are also at risk of losing this keystone species (Kendall and Keane 2001). Whitebark pine communities are extremely fragile since the short growing season may impede recovery of the ecosystem for decades after disturbance. Understanding the impacts of C. ribicola and the ecosystem dynamics in which the mountain pine beetle, succession, fire and human influence all play roles is key to developing a successful recovery strategy for this species (Kendall and Keane 2001; Wilson and Stuart-Smith 2002).

No studies have been conducted on whitebark pine in the Frank Church - River of No Return Wilderness Area. Situated west and southwest of the Bitterroot and Selway Mountains, this 2.2 million acre protected area harbours a diverse array of whitebark pine populations and stands. Their health status regarding white pine blister rust and mountain pine beetle, prior to initiating this study, was essentially unknown, leaving a large information gap with respect to the range of whitebark pine. Information on fire, forest health and disease resistance obtained during this study may be used to complement existing research and restoration initiatives on whitebark pine (e.g., Zeglen 2000; Kendall and Keane 2001; McDonald and Hoff 2001; Wilson and Stuart-Smith 2002).

This study had three objectives: (1) to establish permanent monitoring plots in whitebark pine stands to evaluate the dynamics of stand composition and health, (2) to collect baseline data on whitebark pine stands in the Frank Church - River of No Return Wilderness Area in order to determine the influence of habitat type and fire history on the composition and health of stands, and to identify putatively rust-resistant individuals, and (3) to collect information on forest fuels to estimate risk of population losses to wildland fire.

Study Area

The Frank Church - River of No Return Wilderness Area is approximately 2.2 million acres in south-central Idaho. The terrain is steep and mountainous, encompassing much of the Salmon River drainage. The study area was within the north half of the Wilderness Area in the Batholith geological formation, comprised of mostly igneous and metamorphic substrates dominated by granitic and grandioritic rocks. Steeper sections are overlain by colluvium and decomposed granite. The climate is fairly arid, with growing season water deficits and most precipitation occurring during the spring and late fall. Forested areas are dominated by ponderosa pine at low elevations, following an elevational cline upwards to Douglas-fir, lodgepole pine, subalpine fir and whitebark pine from approximately 8000' to the timberline. This Wilderness Area supports viable populations of small mammals, ungulates and large carnivores including black bears, and many species of fish, birds, herpetiles and invertebrates. Although no grizzly bears have been documented in the area for the past 75-80 years, the Frank Church has excellent habitat potential to support a population of the species. The Craighead Institute for Ecological Research[1] has documented large areas where whitebark pine stands comprise an important part of grizzly bears' diet (Mattson et al. 1992). Relatively large, intense fires were the main historic disturbance agent in the Frank Church. An extremely large and severe fire in August 2000 burnt much of the Big Creek drainage where some of the study populations were located.

Methods

Site selection

The study populations were selected initially based on landscape-level USFS fire history data and photogrammetric cover type data. Accessibility and logistics were also major considerations in site selection. Three populations were sampled, one north of Big Creek and two to the south (Figure 1). Populations were a minimum of 5 miles apart in order to minimize their genetic relatedness. Sites were accessed via backpacking and mule pack string based out of the University of Idaho Taylor Ranch Field Station.

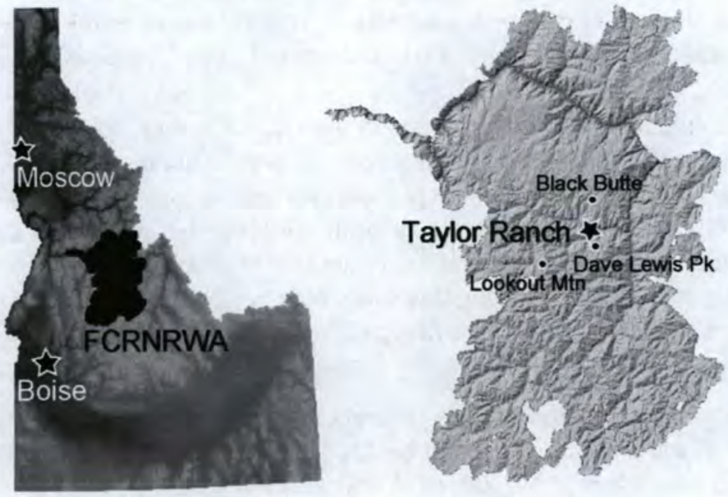

Figure 1. Map of the study area and populations.

Sample sites were selected in the field using random stratified sampling in accordance with Tomback et al. (2005). The goal was to sample three to four of each factorial combination: habitat series (pure whitebark pine, whitebark pine-lodgepole pine, whitebark-mixed subalpine) and burn class (young burn, <15 years; old burn, 16-100 years; unburnt, >100 years). The three habitat series categories were initially selected based on maps produced using GAP project data. Field plots were coarsely assigned in the field: criteria were that a minimum 25% potential canopy cover of each species was present based on current site conditions. For example, a site with 30% subalpine fir, 40% whitebark pine and 30% lodgepole pine was designated "mixed subalpine", while a site containing 55% lodgepole pine and 45% whitebark was designated "lodgepole-whitebark pine". Sites were subsequently keyed out to habitat types following Steele et al. (1981), more accurately reflecting potential climax vegetation in the absence of disturbance.

Site selection was constrained by availability of factor combinations and topography: some populations did not have all burn types or habitat series on the ground, or of sufficient extent for sampling. Burn types

[1] This data on grizzly bear habitat quality and suitability, part of the Grizzly Bear Model – Comparison Project remains unpublished to date, but it may be possible to obtain information by contacting the Institute directly: www.grizzlybear.org/

were determined based on the scorching and scarring on trees, charcoal on coarse woody debris, and burnt ground or forest floor. Initially a random number table was generated to facilitate random site selection, but the distribution of factorial combinations across the sample area was so patchy that this was not feasible. Plots were selected within the study area so that a 150' × 30' area was representative of a single, relatively homogeneous factorial combination, a minimum of 250' away from adjacent plots and a maximum of 1 mile away (Figure 2).

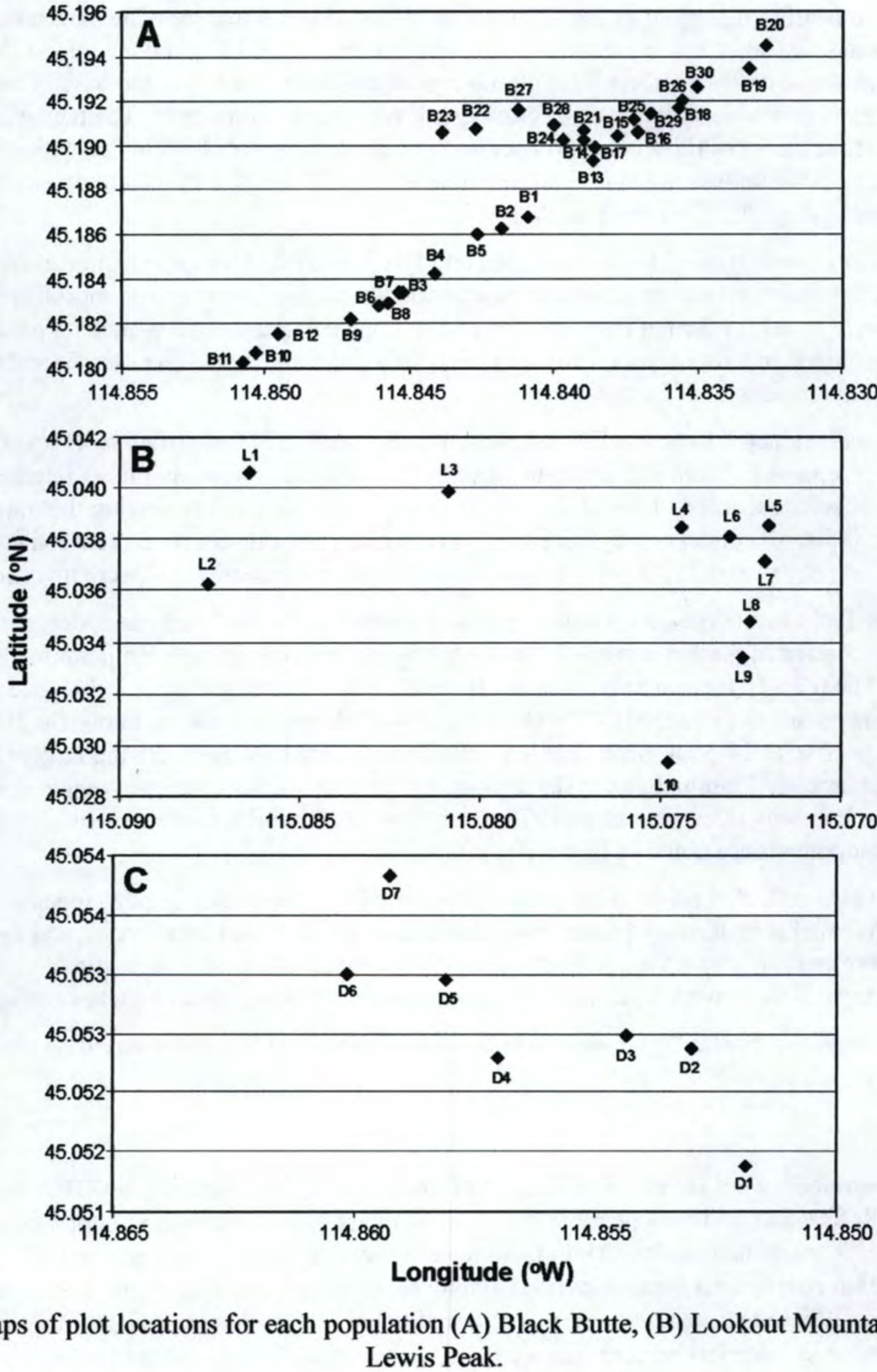

Figure 2. Maps of plot locations for each population (A) Black Butte, (B) Lookout Mountain, (C) Dave Lewis Peak.

Field data collection

The protocols described Tomback et al. (2005) were the main guidelines for data collection. Since permanent monumenting is restricted in Wilderness Areas, 150' transects were begun at an individually tagged whitebark pine tree along a bearing following the contour, with the uphill slope to the right, and terminated at 150' without monumenting. Location and elevation at the start point were recorded with a GPS (Garmin Summit™). Where the terrain changed aspect, the transect continued along the contour line and the change in bearing recorded, as per Tomback et al. (2005). All mature whitebark pine trees (taller than 4.5') and snags that were not hazardous to tag, which were within 15' on either side of the transect were tagged with sequentially numbered aluminum tags and aluminum nails at the base of the tree, facing away from the trail (in the vicinity of a trail) or on the downhill side of the tree. The tags were painted a matte grey to reduce their visibility in accordance with wilderness protocols. The last tagged tree along the transect and its position was noted to facilitate relocation. All stems within a clump were tagged if they were separate below 4.5' (Tomback et al. 2005).

Trees were measured with respect to their position and DBH, and rated for canopy mortality, overall health, white pine blister rust status, mountain pine beetle attack, bark damage and mortality. Putatively resistant trees were noted for further investigation and/or cone collection. All whitebark pines smaller than 4.5' were included in a regeneration survey which tallied the number of trees larger and smaller than 20" (50 cm) and the incidence of blister rust.

A fuel survey was conducted to assess fire risk, based on Brown (1974), modified by Byrne (USFS, Moscow ID, pers. comm.). From 0-6' along the transect, the number of woody pieces intersecting it 0-0.25" and 0.25-1" were recorded. From 1-10', the number of 1-3" pieces intersecting the transect was recorded. From 0-50', all coarse woody debris >3" intersecting the transect were recorded and evaluated for decay class. At 6', 10' and 25', depth (mm) of litter, humus and buried wood were measured.

The 0-0.25" fine fuel class corresponds with the most flammable, "flashy" fuel class, designated 1-hour fuels. Moisture content of these materials is controlled by weather conditions: temperature, cloud cover and humidity. The 0.25-1" fuels are also termed '10-hour fuels'. Flammability is influenced primarily by similar conditions as smaller materials. The medium, or 1-3" diameter fuels are known as 100-hour fuels. Hazard is associated with 24-hour mean weather conditions. 1000-hour fuels are the larger CWD classes, greater than 3" diameter. Flammability is determined by the past week's mean and range of moisture, temperature, and humidity (Deeming et al. 1978; Anderson 1982). Fuels models specific to whitebark pine biomass components are noted in Howard (2002).

Other data were also collected for each plot: canopy cover of all tree species in plot, species and percent cover of up to five major understory plants, cone abundance for 2005 and 2006 cones, and indications of Clark's nutcracker and other wildlife. Activity was only recorded where they were directly observed within the plot, even if there were signs of their presence at other times, such as caches or digging holes.

Habitat types recognized by the USFS were keyed out using Steele et al. (1981) based on tree and vegetation cover.

Data analysis

Plot means for variables were tabulated in Excel 2002 and SAS V.9.3. Factorial ANOVA was conducted in SAS using PROC GLM. All independent variables were assumed random, and populations were nested within burn classes and habitat series. Main factors were tested against the interaction EMS term. Pearson correlation coefficients were calculated among topographic, stand descriptive and health variables in PROC CORR. Where required, variables were transformed to meet assumptions of normality and homoscedasticity: rust infection percentages were square-root transformed. Stepwise linear regression ($\alpha = 0.05$ criterion for entry and retention in the model) was performed using PROC REG to determine whether transformed health variables for mature and juvenile trees were related to elevation, aspect, slope, tree numbers in plot or percentage of trees in clumps. Least-squares means of variables were calculated for each factor combination, and Duncan's multiple range test used to assess significant differences within factor classes, with EMS specified for the model as above. All significance levels were set at $\alpha = 0.05$; Bonferroni's adjustment for multiple comparisons was used to compare least-squares means.

The *a priori* habitat series used for plot selection were used to stratify the habitat type factor in the field, rather than the keyed habitat types because high-elevation habitats are poorly sampled in the guide and would likely be stratified and described further, already partially done by Cooper (1975) and Reed (1976), both cited in Steele et al. (1981). A parallel analysis was run using the keyed habitat types to determine whether actual or potential vegetation had a stronger relationship with dependent variables. More information may now be available as a result of recent studies on whitebark pine ecosystems; however there has not yet been a new formal approximation of habitat types for this region. Other states and studies have classified whitebark pine ecosystems in greater detail (e.g. Pfister et al. 1977; Arno and Hoff 1990; Ogilvie 1990; Campbell 1998; Perkins 2001).

In cases where blister rust or beetle presence in individual trees was uncertain, a minimum and maximum value was calculated for the plot, and the mean was used for the analysis. This applied to blister rust infection, beetle attack, and cause of mortality.

Fuels data for each plot were tabulated using a FORTRAN program supplied by John Byrne, USFS, Moscow ID following the protocols in Brown (1974). The outputs were analyzed using the models described above in SAS. Fuel variable classes were transformed as follows to meet statisitcal criteria for normality and distribution of residual variances: 0-0.25", no transformation; 0.25-1" and Total <3", ln (x+0.5); >3" rotten, ln (x+3); 1-3", >3" sound, Total >3", and Total CWD, ln (x+5). Successional phase was also added to the model to determine whether it influenced fuel loading. Actual (untransformed) values are reported here.

Results

The overall models for mean percentages of blister rust infected and mountain pine beetle attacked mature trees were significant ($p = 0.0018$ and $p = 0.0004$, respectively, Type I SS), but no individual term or interaction was significant. This indicated that the independent model terms and interactions together accounted for more of the variation than the random error term, but that no individual term could explain a significant proportion of variation (Type III SS). The models for percent mortality caused by rust and beetle were not significant.

Least-squares means of blister rust infection were significantly higher in the Lookout Mountain population than in any other population-burn class or population-habitat series combination (Table 1). Pure whitebark stands on Lookout Mountain had significantly higher rust-caused mortality percentages than other habitat series-population combinations (Table 2). Unburnt sites had significantly higher rust infection levels (45.32%) than young or old burns (21.94 and 29.32%, respectively) when all other factors were pooled; no other variables differed among burn types alone. Mountain pine beetle attack showed a gradient increasing with habitat series: pure whitebark (7.36%) ≤ whitebark-lodgepole (15.61%) ≤ mixed subalpine (21.47%); no other variables differed among habitat series alone.

Table 1. Distribution of blister rust and mountain pine beetle on mature trees (≥4.5' tall): populations nested within burn classes. Different superscript letters indicate significant differences (ANOVA, $p \leq 0.05$). B = Black Butte; D = Dave Lewis; L = Lookout.

			WPBR infected %		WPBR mortality %		MPB attack %		MPB mortality %	
Burn Class	**Pop**	**n**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**
Never	B	9	30.64^{a}	18.85	0.33^{a}	0.98	19.8^{ab}	15.04	0.33^{a}	0.98
Old	B	8	29.32^{a}	13.71	1.43^{a}	2.20	12.76^{ab}	13.68	2.25^{a}	3.20
Recent	B	13	23.03^{a}	14.66	1.75^{a}	2.34	5.02^{a}	6.64	1.98^{a}	2.46
Recent	D	7	19.92^{a}	18.57	0.70^{ab}	1.84	48.74^{b}	26.48	7.53^{a}	11.79
Never	L	10	60.44^{b}	13.76	5.73^{a}	9.06	6.15^{a}	7.64	2.04^{a}	5.51

Table 2. Distribution of blister rust and mountain pine beetle on mature trees: populations nested within habitat series. Different superscript letters indicate significant differences (ANOVA, $p \leq 0.05$). See Table 1 for population codes.

			WPBR infected %		WPBR mortality %		MPB attack %		MPB mortality %	
Habitat Series	**Pop**	**n**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**
Mixed subalpine	B	11	31.24^{a}	15.95	1.64^{a}	2.10	16.34^{a}	16.71	2.24^{a}	2.84
Whitebark	B	7	28.62^{a}	17.16	0.42^{a}	1.11	10.79^{a}	10.21	0.42^{a}	1.11
Lodgepole-whitebark	B	12	22.15^{a}	14.44	1.34^{a}	2.34	7.53^{a}	9.35	1.59^{a}	2.52
Lodgepole-whitebark	D	4	24.44^{a}	20.63	1.22^{a}	2.44	49.18^{b}	32.33	10.39^{b}	15.01
Mixed subalpine	D	3	13.89^{a}	17.35	0.00^{a}	0.00	48.15^{b}	23.13	3.70^{ab}	6.42
Mixed subalpine	L	3	50.39^{b}	9.24	3.60^{a}	3.23	3.31^{a}	3.83	0.92^{a}	0.81
Whitebark	L	4	59.18^{b}	11.63	9.55^{b}	13.82	1.35^{a}	1.56	0.00^{a}	0.00
Lodgepole-whitebark	L	3	72.18^{b}	14.23	2.78^{a}	4.81	15.38^{a}	7.66	5.88^{a}	10.19

The Dave Lewis population had significantly more mountain pine beetle attack than the other populations or population-habitat series combinations (range (mean ± SE): 48.14 ± 8.41% to 49.18 ± 7.29%; Tables 2, 3). This population also had more beetle-caused mortality than all other populations or population-habitat series combinations (range: 3.70 ± 3.19% to 10.39 ± 2.77%) except for whitebark-lodgepole types on Lookout Mountain (5.88 ± 3.19%) (Table 2).

Table 3. Distribution of blister rust and mountain pine beetle on mature trees: populations nested within habitat series by burn types. Different superscript letters indicate significant differences (ANOVA, $p \leq 0.05$). See Table 1 for population codes.

Habitat Series	**Burn Class**			WPBR Infection %		WPBR Mortality %		MPB Attack %		MPB Mortality %	
		Pop	**n**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**	**LS Mean**	**SD**
Mixed subalpine	Never	B	4	35.45^{a}	14.92	0.00^{a}	0.00	24.61^{ab}	19.34	0.00^{a}	0.00
Mixed subalpine	Old	B	3	36.03^{a}	17.13	3.82^{a}	1.81	21.83^{ab}	15.86	6.00^{ab}	1.45
Mixed subalpine	Recent	B	4	23.43^{a}	17.39	1.65^{a}	2.03	3.96^{ab}	7.93	1.65^{a}	2.03
Whitebark	Never	B	1	38.24^{a}	–	2.94^{a}	–	20.59^{ab}	–	2.94^{ab}	–
Whitebark	Old	B	2	35.24^{a}	12.40	0.00^{a}	0.00	18.29^{ab}	3.24	0.00^{a}	0.00
Whitebark	Recent	B	4	22.92^{a}	20.83	0.00^{a}	0.00	4.58^{ab}	9.17	0.00^{a}	0.00
Lodgepole-whitebark	Never	B	4	23.92^{a}	24.80	0.00^{a}	0.00	14.82^{ab}	12.84	0.00^{a}	0.00
Lodgepole-whitebark	Old	B	3	18.67^{a}	3.90	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00
Lodgepole-whitebark	Recent	B	5	22.82^{a}	9.60	3.22^{a}	2.75	6.21^{ab}	4.37	3.82^{ab}	2.61
Mixed subalpine	Recent	D	4	24.44^{a}	20.63	1.22^{a}	2.44	49.18^{b}	32.33	10.39^{b}	15.01
Mixed subalpine	Recent	D	3	13.89^{a}	17.35	0.00^{a}	0.00	48.15^{b}	23.13	3.70^{ab}	6.42
Mixed subalpine	Never	L	3	50.39^{b}	9.24	3.60^{a}	3.23	3.31^{ab}	3.83	0.92^{a}	0.81
Whitebark	Never	L	4	59.18^{b}	11.63	9.55^{b}	13.82	1.35^{ab}	1.56	0.00^{a}	0.00
Lodgepole-whitebark	Never	L	3	72.18^{b}	14.23	2.78^{a}	4.81	15.38^{ab}	7.66	5.88^{ab}	10.19

When habitat types were used as opposed to habitat series, models were significant for transformed response variables: blister rust infection and mortality, and pine beetle attack and mortality (Type I SS). However, similar to the results where habitat series was an independent variable, no individual model terms accounted for a significant portion of the variation (Type III SS). Differences among least-squares-means were similar to the results of the analysis using habitat series, showing stronger differentiation among populations and burn types than among habitat types for the dependent variables (data not shown). The major differences were that in the Lookout and Dave Lewis populations, most of the whitebark-lodgepole habitat series corresponded to Douglas-fir habitat types, and several other whitebark-lodgepole types at Black Butte keyed out to pure whitebark habitat types.

Elevation and aspect were the only topographic variables that were significantly correlated with each other (r = -0.414, Table 4). Elevation was also significantly negatively correlated with infection percentages in mature and juvenile trees. Slope and aspect were not correlated with infection. Percentage of trees in a stand in clumps (i.e. not single stems alone) was not related to any other variable. Mature tree abundance was positively correlated with regeneration abundance and infection levels of juvenile and mature trees. Sample sizes of infected regeneration shorter than 20" were too small to analyze statistically; only three plots had blister rust in regeneration shorter than 20": two mixed subalpine fir stands at Dave Lewis and one pure whitebark stand at Lookout. The regeneration taller than 20" had far higher infection percentages. All but two of the plots at Lookout had blister rust on the taller regeneration (range: 5.26 to 75%); five of the 30 plots sampled at Black Butte had infections (range: 5.88 to 18.18%); only one plot had signs of blister rust at Dave Lewis (Table 5). By habitat series, pure whitebark stands had the most infected taller regeneration and the other series were similar (Table 5). Unburned sites had the most infected larger regeneration, while old burns had less and young burns the least.

Although the Pearson correlation coefficient between these variables was 0.442 (Table 2), regression analysis did not reveal a significant relationship between transformed percentages of juvenile and mature infection rates by habitat series or population; only the unburnt class had a significant regression (p = 0.0092, Root MSE = 1.55, $R^2 = 0.354$, $R^2_{adj} = 0.314$).

Table 4. Pearson correlation coefficients of topographic and health variables. Significant correlations ($p \leq 0.05$) are in bold font.

	Slope %	Aspect	No. of Mature WBP	Clump %	No. of Regen	Regen Infected %	Mean Mature Infected %	[Regen Infected %]$^{0.5}$	[Mean Mature Infected %]$^{0.5}$
Elevation	**-0.4145**	-0.1023	0.0046	0.0941	-0.0740	**-0.4484**	**-0.4456**	**-0.3947**	**-0.3225**
p	0.0038	0.4937	0.9754	0.5292	0.6209	0.0029	0.0017	0.0097	0.0271
n	47	47	47	47	47	42	47	42	47
Slope %		0.0009	0.1158	-0.1497	0.1168	0.2962	0.1735	0.2604	0.1688
p		0.9950	0.4383	0.3152	0.4341	0.0569	0.2435	0.0957	0.2566
n		47	47	47	47	42	47	42	47
Aspect			0.2868	0.0100	0.2239	0.2959	0.2344	0.2835	0.2009
p			0.0506	0.9466	0.1304	0.0571	0.1128	0.0688	0.1757
n			47	47	47	42	47	42	47
No. of Mature WBP				0.1922	**0.4330**	**0.5964**	0.2550	**0.5904**	**0.3049**
p				0.1956	0.0024	<.0001	0.0837	<.0001	0.0372
n				47	47	42	47	42	47
Clump %					-0.2777	0.25660	-0.0413	0.2654	-0.0662
p					0.0588	0.1009	0.7831	0.0894	0.6585
n					47	42	47	42	47
No. of Regen						0.1954	0.2457	**0.3069**	0.2493
p						0.2150	0.0960	0.0480	0.0910
n						42	47	42	47
Regen Infected %							**0.4648**	**0.9610**	**0.4256**
p							0.0019	<.0001	0.0050
n							42	42	42
Mean mature Infected %								**0.4728**	**0.9532**
p								0.0016	<.0001
n								42	47
[Regen Infected %]$^{0.5}$									**0.4425**
p									0.0033
n									42

Table 5. Distribution of blister rust infection on regeneration taller than 20". Different superscript letters indicate significant differences (one-tailed t-test with unequal variances, $p \leq 0.05$).

Burn Class	n	Mean	SD	SE
Never	9	23.61[a]	21.51	7.17
Old burn	3	15.08[ab]	4.59	2.65
Recent burn	2	7.69 [b]	0.00	0.00
Habitat Series				
Pure whitebark	6	14.40 [a]	9.56	3.90
Whitebark-lodgepole	3	38.94 [a]	12.27	7.08
Whitebark-subalpine	5	13.98 [a]	10.44	4.67
Population				
Black Butte	5	11.76 [a]	5.62	2.51
Dave Lewis*	1	7.69	–	–
Lookout	8	25.82 [a]	21.87	7.73

*only one plot was infected so no statistical comparisons are possible.

When topographic variables were regressed on transformed infection rates, a significant negative relationship was found between elevation and infection rates of mature trees for whitebark-lodgepole habitat series and unburnt plots ($R^2 = 0.453$, $p = 0.002$ and $R^2 = 0.313$, $p = 0.013$ respectively), supporting the results shown in Table 2. Juvenile infection rates had a significant relationship with the number of mature trees present in the stand at Black Butte ($R^2 = 0.175$, $p = 0.033$) and Lookout Mountain ($R^2 = 0.481$, $p = 0.026$), but not Dave Lewis. There was no significant trend between burn class and number of mature trees or regeneration in a plot.

A separate analysis using the same design and methods was carried out on the Black Butte population only, to assess how representative this population was of the three sampled, since it had combinations of all three burn types and three habitat series. The results were generally similar to those including all three populations. Both regression and correlation analyses both supported these results. Neither habitat series nor burn type significantly affected the incidence of beetles, blister rust or mortality of mature trees due to either agent. Burn type explained a significant proportion of variability for beetle ($p = 0.034$) attack percentages, but there were no significant differences among plot types overall. The interaction between burn type and habitat series was significant for mortality caused by rust and beetles ($p = 0.005$ and $p < 0.0001$, respectively). The percentage of regeneration taller than 20" infected by rust was significantly higher in old burns when habitat types were pooled (6.7% vs. 0.6% in other burn types). Elevation was the topographic factor that was most strongly correlated with blister rust infection levels in the Black Butte population. It was positively correlated with numbers of mature and juvenile trees in plots ($r = 0.428$, $p = 0.018$; 0.444, $p = 0.014$, respectively), and with percentage of mature trees infected ($r = 0.481$, $p = 0.007$, square-root transformed). Both elevation and slope combined accounted for a significant proportion of the variation in mature tree infection levels ($p = 0.009$, $R^2 = 0.69$) in recently burnt mixed subalpine plots. The number of mature whitebark trees in a plot was positively correlated to the number and infection levels of regeneration, but not to proportion of trees in clumps or to infection percentages of mature trees.

Population nested within burn class significantly affected the amount of rotten CWD larger than 3" diameter ($p = 0.009$). The only other model terms that were significant showed effects in the 1-3" diameter CWD class: the interaction between successional phase and burn class (with population nested within burn class; $p = 0.045$), and population nested within successional phase ($p = 0.267$), although since successional status had a significant interaction with burn class it is not possible to determine its impact as a single factor.

Recently burnt sites had slightly more rotten CWD. Variability was generally higher among plots than among habitat series, burn types or successional phase (Table 6, Figure 3). The mixed subalpine habitat series had more CWD, especially larger size classes (>3" diameter) and rotting wood. Early successional stands had far more small CWD than later phases, and also more sound CWD larger than 3" diameter. Sites were highly variable with respect to the quantity of large diameter CWD, but in general later successional phases had less medium to large CWD than the earliest phase.

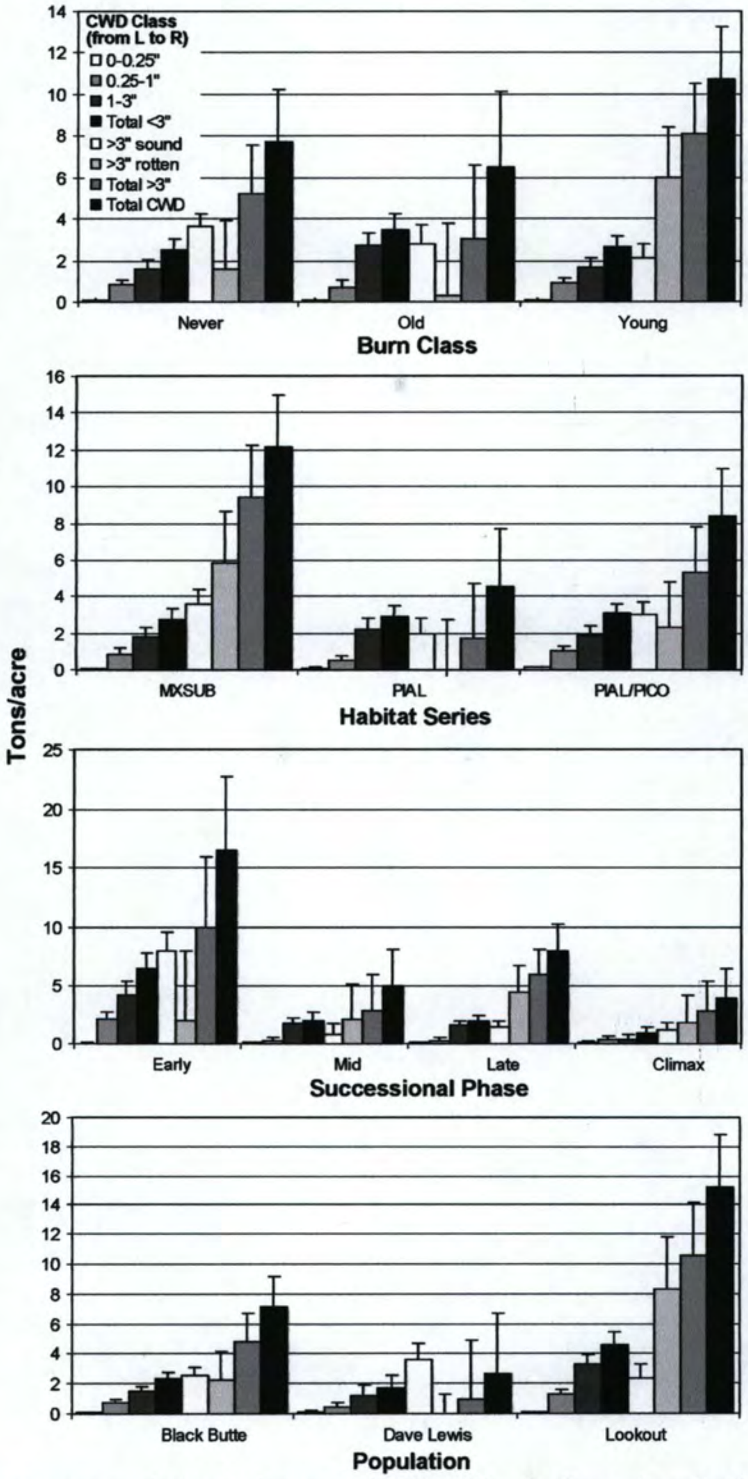

Figure 3. Least-squares means and standard errors of fuel loading by burn class, habitat series, successional phase and population. CWD class numbers refer to piece diameter (inches).

Black Butte had more biomass of the finest fuels than the other two populations; Lookout had the most 1-3" size CWD. Dave Lewis had no rotten CWD larger than 3", while Black Butte had an intermediate amount and Lookout the most (although variability was high enough to obscure significant differences). Lookout had far more large and total CWD biomass than the other populations. Litter and duff layer thickness (biomass) were not significantly affected by any model variable, although young burns had marginally thicker duff layers. Differences were strongest among populations, with Black Butte supporting the thinnest duff layers.

Table 6. Means and standard deviations of fuel size classes by burn class, habitat series and successional phase. Populations are nested within each primary factor for analysis. See Table 1 for population codes; PIAL are pure whitebark pine stands, PIAL/PICO are whitebark-lodgepole stands, and MXSUB are mixed subalpine.

CWD Size Class			Litter		Duff		0-0.25"		0.25-1"		1-3"		Total <3"		Sound >3"		Rotten >3"		Total >3"		Total CWD	
	Pop	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Burn Class																						
Never	B	12	1.37	0.97	3.83	2.91	0.15	0.13	0.56	0.48	0.40	0.72	1.10	0.99	1.86	2.92	1.70	4.01	3.56	4.68	4.66	4.41
Old	B	6	1.08	0.68	4.22	3.08	0.12	0.05	0.32	0.50	1.77	2.25	2.21	2.04	1.29	1.59	0.64	1.04	1.92	1.49	4.13	2.10
Young	B	12	1.22	0.80	5.29	3.85	0.14	0.09	0.56	1.21	0.59	1.66	1.30	2.81	1.04	2.59	6.26	10.38	7.30	10.31	8.60	10.92
Never	D	4	2.18	1.08	8.57	1.91	0.09	0.06	0.09	0.18	0.77	0.89	0.95	1.06	5.03	3.90	1.16	2.32	6.19	4.55	7.14	3.55
Old	D	1	1.97	-	8.57	-	0.23	-	0.00	-	0.00	-	0.23	-	0.00	-	0.00	-	0.00	-	0.23	-
Young	D	2	1.17	0.91	11.62	7.81	0.15	0.17	0.00	0.00	0.00	0.00	0.15	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.17
Never	L	3	0.88	0.83	5.39	3.35	0.17	0.13	0.78	0.81	1.00	1.73	1.96	2.52	0.84	1.45	3.82	4.81	4.66	4.14	6.61	3.59
Old	L	1	1.81	-	11.43	-	0.15	-	0.31	-	2.84	-	3.30	-	0.00	-	1.27	-	1.27	-	4.57	-
Young	L	6	2.19	1.04	10.32	4.32	0.15	0.14	1.06	1.35	1.65	2.65	2.85	2.37	0.19	0.46	12.72	14.63	12.91	14.44	15.76	15.18
Habitat Series																						
MXSUB	B	11	1.38	1.10	4.87	4.64	0.11	0.07	0.58	0.52	0.16	0.53	0.84	0.92	1.47	2.08	6.76	10.74	8.24	10.24	9.08	9.97
PIAL	B	7	1.21	0.68	3.89	2.11	0.14	0.11	0.41	0.40	0.84	0.78	1.39	0.74	0.83	2.20	1.02	1.15	1.85	2.29	3.24	2.50
PIAL/PICO	B	12	1.16	0.66	4.49	2.55	0.17	0.12	0.52	1.22	1.24	2.26	1.92	3.09	1.71	3.14	1.48	4.00	3.19	4.90	5.11	6.55
MXSUB	D	4	1.86	1.01	9.62	5.07	0.11	0.12	0.00	0.00	0.35	0.71	0.46	0.73	3.76	4.64	0.00	0.00	3.76	4.64	4.22	4.81
PIAL/PICO	D	3	1.86	1.15	9.21	1.98	0.15	0.07	0.12	0.21	0.55	0.96	0.83	1.14	1.69	2.93	1.54	2.67	3.23	5.60	4.06	5.07
MXSUB	L	3	0.82	0.75	6.03	3.61	0.11	0.08	0.54	0.94	1.47	1.50	2.13	2.44	0.84	1.45	14.80	17.57	15.63	16.59	17.76	15.80
PIAL	L	4	1.60	0.31	7.62	3.01	0.13	0.12	0.44	0.19	2.83	2.92	3.39	2.72	0.00	0.00	5.05	7.27	5.05	7.27	8.45	9.85
PIAL/PICO	L	3	2.90	1.04	13.65	3.06	0.23	0.17	1.88	1.58	0.00	0.00	2.10	1.58	0.38	0.65	8.15	14.12	8.53	13.80	10.63	15.14
Successional Phase																						
Early	B	2	0.99	0.23	2.67	1.62	0.07	0.06	2.15	3.03	3.57	3.02	5.78	6.13	7.34	2.16	1.17	0.85	8.51	3.02	14.29	9.14
Mid	B	9	0.69	0.69	4.51	2.76	0.12	0.10	0.36	0.50	0.84	1.49	1.31	1.56	1.13	2.54	1.98	4.61	3.11	4.87	4.43	4.55
Late	B	10	1.30	0.87	4.88	4.67	0.13	0.04	0.35	0.51	0.78	1.55	1.26	1.55	0.78	1.14	4.76	8.62	5.54	8.60	6.81	8.15
Climax	D	9	1.82	0.65	4.44	2.48	0.19	0.14	0.48	0.32	0.00	0.00	0.67	0.41	1.10	2.26	3.50	9.08	4.60	8.96	5.27	9.03
Mid	D	1	0.66	-	11.43	-	0.11	-	0.36	-	1.66	-	2.14	-	0.00	-	0.00	-	0.00	-	2.14	-
Late	D	6	2.06	0.90	9.11	4.01	0.13	0.11	0.00	0.00	0.24	0.58	0.36	0.59	3.35	3.99	0.77	1.89	4.12	4.76	4.49	4.82
Late	L	1	1.81	-	8.57	-	0.02	-	0.37	-	6.84	-	7.22	-	0.00	-	15.95	-	15.95	-	23.17	-
Climax	L	9	1.75	1.13	8.99	4.62	0.17	0.12	0.96	1.15	0.99	1.27	2.12	1.56	0.40	0.87	8.12	12.67	8.53	12.42	10.64	12.56

Discussion

Experimental design was the most challenging part of this study. Data at the landscape level often had only limited applicability at the stand (sampling) level. In particular, the USFS historic burn map, based on burn perimeters, did not always account for the complex effects of topography where sparks frequently ignite small fires over ridgetops, and overburns are frequent. Many areas mapped as unburned or old burns were actually young burns since they were reburnt in the 2000 fire. Plots identified as old burns during reconnaisance when there were still snowdrifts were often proven to be new burns when evidence on the ground was revealed after the snow melted.

The GAP data set, based largely on photo interpretation, was of limited utility for high elevation ecosystems. It is notoriously difficult to distinguish lodgepole and whitebark pines from air photos, and it can even be challenging from a distance in the field. Many areas mapped as pure whitebark stands were either mixed with lodgepole pine or subalpine fir. According to Holly Akenson (Univ. Idaho Taylor Ranch Field Station, pers. comm.), the Craighead Institute has ground-truthed many whitebark pine ecosystems in the Frank Church as a part of a grizzly bear habitat suitability study and has a more detailed and accurate data set, but they have not yet made it available to the University of Idaho despite offering to do so following their data collection in 1999. Pure whitebark pine stands were relatively rare in the sampled populations, far less so than indicated by the GAP map, but less so on Lookout Mountain.

More information on natural disturbance regimes is required to determine the return interval for stand-replacing and lower-intensity fires, since the climax stand type would vary with disturbance frequency and intensity (Wilson and Stuart-Smith 2002). Sites with periodic low-intensity ground fires would reduce fuel loadings and competing vegetation. More frequent stand-replacing fires may maintain a seral climax favoring whitebark pine as opposed to subalpine fir (Keane and Arno 1993; Keane et al. 1994). Furthermore, the USFS designated habitat types for ecosystems containing whitebark pine do not necessarily correspond with the apparent vegetation and climax stand type, but this is largely due to the low sample size in the habitat type approximation guide (Steele et al. 1981). There is general agreement that whitebark pine ecosystems have not been well classified, and that far more types exist than have been formally described (Howard 2002). Since the three general habitat series were used to select stands for sampling a priori based on GAP GIS-based maps and subsequently adjusted following field reconnaisance, these series were used throughout the analysis, although they often keyed to a different habitat type or even series. Lookout Mountain and Dave Lewis often had Douglas-fir growing in the lodgepole-whitebark sites, but they were still grouped into that habitat series since they had the same plant communities and edatopic conditions (i.e. the assigned series and keyed types were ecologically equivalent). For this reason, a separate analysis was done using habitat types to compare with habitat series.

Interestingly, slope and aspect were not correlated with number of mature trees or regeneration abundance. Other studies (Hutchins and Lanner 1982; Tomback et al. 1995, 2001; Wilson 2001) found that Clark's nutcracker preferentially selects south-facing slopes and more open sites, including recent burns because these sites have earlier snowmelt and more caching sites. Similar to the findings of Tomback et al. (1995), larger regeneration had much higher rates of infection than smaller regeneration, likely due to the larger surface area. The sample size of infected regeneration was too small to draw statistical comparisons, but pure whitebark and unburned stands had the highest infection rates and recent burns the least. This has implications for fire management and stand health: maintaining natural fire regimes may reduce the incidence and severity of blister rust both in regeneration, to enhance recruitment, and in mature trees, to reduce the alternate host prevalence and spore concentrations. Another possible explanation is that a moderate to intense fire would remove prior evidence of blister rust, especially in older burns where snags have no bark left.

The incidence and severity of blister rust varied widely among populations. It is likely, however, that the actual incidence of blister rust at Black Butte was 10-20% higher than recorded since this population was surveyed immediately after snowmelt, and some cankers were still dormant. Trees often had evidence of rodent chewing but no associated canker indications at the time of surveying (i.e., orange margin on surface, spores, or cracked and thickened bark). Only cankers that could be definitely identified were recorded, otherwise trees or canopy sections were classed as uninfected or unknown, if a canker was likely due to flagging or other indications but not visible (e.g. due to lichen growth on branches) or not clearly identifiable. It was for this reason that maximum and minimum infection levels were calculated and the mean used as the dependent variable.

This highly unbalanced distribution of factors necessitated the nesting of populations within habitat series and burn types. In particular, two of the three populations had only one burn type represented, so burn type and population would be confounded if populations were analyzed separately (i.e. not nested within factors). Sampling additional populations to obtain a more comprehensive data set in 2006 would be beneficial.

As expected, sites dominated by mature lodgepole and whitebark pine trees had higher prevalence of mountain pine beetle (Baker et al. 1971). While all populations had some low, endemic level of beetle attack, it was far more severe and widespread at Dave Lewis. This likely was a synergistic factor related to the fire severity also, where the area was covered in dense stands of mature lodgepole pine with fairly heavy mountain pine beetle infestation and standing snags killed by the beetle (Perkins 2001). It was generally not possible to ascertain beetle or rust that may have infected or killed snags that had been dead for some years and had no remaining bark. Mountain pine beetle is recognized as an integral component of the natural successional dynamics in whitebark pine ecosystems: mature, large-diameter trees are more susceptible to beetle attack, creating infestation centers and eventually areas of large standing dead trees that drive the fire cycle (Ogilvie 1990; Keane et al. 1994). In northern populations, the beetle is a less important factor since stands of whitebark pine tend to be more mixed with other species and patchily distributed (Campbell and Antos 2000; Perkins 2001; Stuart-Smith 1998).

The results of this fuels output are compatible with the Fuels and Fire Effects Extension, Central Idaho variant of the Forest Vegetation Simulator model. The FVS is a tool developed by the USFS in collaboration with nationwide partners to model growth and yield at the tree and stand dynamic levels, based on individual-tree growth and yield data. The FFE module was developed to highlight the effects of fire on fuels accumulation, including the role of CWD on forest floor nutrient cycling, and vegetation dynamics in a fire-disturbed system. Further information on exploiting this option, including downloadable software, manuals and background information, is available at http://www.fs.fed.us/fmsc/fvs/description/model.php and http://www.fs.fed.us/fmsc/fvs/variants/ci.php. A comprehensive description of the model inputs, outputs, dynamics, assumptions and limitations, supported by example scenarios is presented by Reinhardt et al. (2003). R.E. Keane and colleagues also use FIRESUM, which works along similar lines, and can be integrated into LANDSUM for planning and projections at the landscape level.

The high variability of fuel loading among plots within populations may be a consequence of the patchy nature of fire behaviour in the area (Howard 2002). None of the standard USDA fire behavior fuel models for predicting fire spread, severity and intensity (Albini 1976; Anderson 1982) really corresponded to the fuel loads in these plots, likely because they were developed for more commercially viable forest and agricultural land types. The higher total volume of CWD in younger burns was likely the result of decaying snags and large branches left by the 2000 burn, and also occurred in areas that were burnt in the 1988 fire and overburnt in 2000. Although successional status and burn type were not significant variables in the model, stands at Lookout Mountain tended to be older due to their unburned history, which would account for the accumulation of rotting CWD in stands and the thicker forest floors.

Mixed subalpine stands have greater structural diversity, comprised of more overstory species than the other two stand types, enabling the stand components to capitalize on a wider range of ecological conditions for regeneration and growth. Subalpine fir is more susceptible to decay and far less resistant to fire than pine species and Douglas-fir, which dominate the other two habitat series. Subalpine fir is likely the major contributor to the higher fuel levels in the mixed subalpine habitat series. The higher volumes of large woody debris also indicate the changing nutrient status of these types of stands: whitebark pine may colonize a disturbed or non-forested site, and over time the microclimate around the whitebark pine trees is modified to such an extent that, in the absence of disturbance, ecological conditions favour subalpine fir regeneration (Callaway 1998). The deeper forest floors and more abundant CWD found on these mixed subalpine sites reflect this process.

Fire return frequencies in whitebark pine ecosystems are highly variable. Surface fires which consume fine fuels are more frequent, with return intervals in the region of the FCRNRWA ranging from two to 78 years, averaging approximately 36 years across sites (Arno 1980). Pure whitebark stands had less frequent fires, on the order of every century (Heinselman 1981; Brown 2002). These fires facilitate regeneration by providing attractive caching sites and germination conditions (Tomback et al. 2001). Stand replacing fires are less frequent, with return intervals averaging 140 years (Howard 2002), but serve an important role in reducing competition associated with successional replacement (Arno 1986; Kendall and Keane 2001). Fires tend to be highly variable in severity, size and return frequency (summarized in Howard 2002); patchy fires, increasing in severity with successional stage and thus interval between disturbance, are common in whitebark pine ecosystems (Brown and Smith 2000). Before it is mature, whitebark pine is susceptible to injury by fire due to its thin bark (Brown and Smith 2000).

Rollins et al. (2001) found that fire distribution in the Selway-Bitterroot Wilderness Complex, adjacent to the FCRNRWA, was characterized by few large fires and many small ones during dry summers, although fire patterns have changed from pre-contact times to reflect fire suppression since settlement that contributed to the bimodal pattern they detected (Rollins et al. 2002), which was also noted by others (Brown and Smith 2000). The fire history in the FCRNRWA is likely similar, with many small fires in high elevations caused by lightning strikes and few very large fires. No formal studies on the fire history of the area have been conducted.

The importance of maintaining a pristine wilderness appearance in whitebark pine ecosystems, although FCRNRWA has very low numbers and impact of visitors compared to other western protected areas. (Cole 1990). Keane (2000) noted that despite their pristine character, wilderness areas containing whitebark pine ecosystems are far from immune from the widespread population declines due to mountain pine beetle, fire suppression and blister rust. He suggests enhancing the role of fire in these areas, supplementing the frequency of wildland fires by actively managing through prescribed burning to more closely approximate historic fire conditions, which would restore stand health and favour regeneration (Brown 2002). Brown and Smith (2000) cite examples where fire has had only limited success as a tool for ecosystem restoration of whitebark pines. This would be a contentious option in the FCRNRWA, especially given the danger and damaged caused by the 1988 and 2000 fires. However, igniting small burns in remote whitebark pine ecosystems that would have little risk of spreading may be more supportable. Still, there is no consensus on what would constitute an appropriate level of human intervention in wilderness areas, even in a restoration context.

"Bark stripping" was recorded regardless of the cause. This index would be more informative if it could be recorded separately for chewing associated with blister rust. Many trees, especially in burned plots, had stripping associated with mechanical damage due to branches or trees falling. Trees also often had ungulate rubbing also recorded as stripping. In these cases, it would be unrelated to blister rust but still useful for tree identification, or else as a baseline from which the effects of future blister rust infection could be gauged.

At Black Butte, virtually every plot had evidence of abundant cones in 2004, and relatively few cones in 2005. Second-year cones were not visible until late July; pollen cones were first visible July 5. Lookout Mountain had a relatively good cone crop (2005) and evidence of a moderate crop in 2004, but few cones for 2006. Dave Lewis had a poor cone crop in 2005 and few scales on the ground from 2004, and little to no cones likely for 2006.

Trees within a clump were often of different sizes. This may reflect variability in germination speed, embryo maturity, and caching times for different seeds. Prior studies have found seeds took from one to several years to germinate following caching within a single clump (McCaughey 1993, Tomback et al. 2001). Germination and caching also vary depending on fire regime and stand openness.

Putatively resistant trees were identified only in plots with fairly uniform, heavy infections. Trees were selected based on either lack of cankers or if they had only dead or inactive cankers, implying potential for tolerance or resistance. Unfortunately, many selected trees were reproductively immature and would not likely be cone-bearing for decades.

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Follow-Up Items

1) Sampling whitebark pine in Wilderness Areas

Whitebark pine has long been overlooked since it is so difficult to sample. During the past two decades, there has been a sharp rise in the number of field studies of this species and its habitat, and associated environmental factors. This interest has been two-fold: (1) whitebark pines are highly susceptible to the introduced fungal pathogen that causes white pine blister rust and populations have been declining dramatically, far outpacing recruitment; and (2) recognition of its role as a keystone species for many plant, bird and wildlife species that depend on high elevation ecosystems. Most of these studies have taken place in areas with fairly easy road, air and trail access, such as National, State or Provincial Parks, Recreation Areas, or sites with other access maintained by mining or logging interests. Wilderness areas present unique logistical challenges for designing studies and collecting information in the field. Motorized access and tools are generally prohibited in these remote sites, and travel must be by foot or pack animal. These restrictions make studies in Wilderness Areas relatively inefficient relative to other areas since less area can be covered in a field season. Three populations were sampled in 2005 from July 1 to early August, for a total of 47 plots. This included a reconnaisance trip to one population in June to GPS preliminary site locations. Approximately three to five plots could be established per day, depending on their distribution and the abundance of trees.

Several more moderate to large populations are accessible using Taylor Ranch or Cabin Creek as a staging area, but they are at least 10-20 miles away, requiring two- to three-day trips each way. One other option would be to hike in from the eastern access point to the Bighorn Crags and establish plots in the vicinity. There is a road leading to Thunder Mountain for mining access, and populations could be hiked or packed to from there. Another alternative is to fly personnel and gear to the closest airstrip to a selected population, and either meet a packer or hike in. The limited number and distribution of airstrips, and the fact that most of them are not near whitebark pine populations, make meeting a packer there a more attractive option.

The Frank Church - River of No Return Wilderness Area is unique: not only is it the largest contiguous Wilderness in the continental United States, but it also has several airstrips available for public use that were grandfathered in since they were parts of preexisting inholdings before the Idaho Primitive Area was reclassified as a Wilderness Area. This area thus has the benefit of limited air access, as well as a rich heritage of pioneering. One of the legacies of this lifestyle is that pack animal support is still available through several providers in the area. The mule packing support provided by Taylor Ranch Field Station was invaluable for establishing plots during 2005. Stock packing will be necessary to establish additional plots in the future, and also for cone collecting, since backpacking a full trip worth of camp gear, field equipment and supplies is extremely arduous in this very steep terrain where the sites would be a full day or two from the closest base.

We are aware of two packers in the Big Creek drainage who may be able to support this project, and possibly more. It would be necessary to reserve their services in the fall or winter to guarantee availability. The most likely is Mile Hi Outfitters, led by Travis and based out of Cabin Creek. This site provides good access for most of the populations selected for further sampling. The Root Ranch (in Chamberlain Basin, north of Big Creek) and Flying B Ranch (on the middle fork of the Salmon River) also do pack trips, but they may or may not be available for hire. There may be others based locally as well.

Although we do not recommend this option, a strong hiker could establish and monitor plots without packing support. However, it would be far less efficient and for a 10-day trip a person would have to carry approximately 75-80 lbs of gear, of which about 18 would be food, 7-10 water and 25 would be field gear necessary for measuring, recording, plant identification, etc. Depending on population density, 4-8 lbs. worth of nails and tags would be left on site in the trees.

Scheduling is an important consideration since whitebark pine ecosystems have a narrow field work window. Access to the sites would only be possible for plot establishment and cone collection between July 1 and September 30 in a normal year. However, this window may preclude hiring a student if assistance is needed for that entire period, or else the field work could be scheduled for a portion of that time only. For monitoring it may be possible to access plots by snowshoe since additional field gear will not be needed.

Water is another critical time-sensitive factor in the FCRNRWA. By the second half of July, intermittent streams may be dry and springs may emerge lower down on the mountainsides. Dave Lewis, in particular, has limited water access and should be sampled earlier in the season. Lookout Mountain has an intermittent stream (Meadow Creek) but the only water source within 2 miles of the plots was Milk Lake. Black Butte had abundant springs and streams in the immediate area; Coyote Springs to the north and Cottonwood Butte to the northeast also have good water supplies. The Bighorn Crags have many water sources.

2) Additional populations in the FCRNRWA to consider establishing plots in during 2006

Local, recent information is important to determine accessibility. Conditions after the fire, especially downed trees and periodic washouts and slides all mean that information about trails more than 10 years old should be confirmed with another source, or ground truthed. Only some trails are maintained by the USFS, but there are quite a few outfitter trails that are not part of the formal trail network and not listed on any maps. Local knowledge is the only means of obtaining this information. Networking with local outfitters, USFS field personnel, backpackers and recreational resources like online hiking trip reports is essential.

1. Accessible from Big Creek road and/or USFS ranger station, in the Payette National Forest. There is a maintained trail S to Snowslide Peak (9104'), Center Mountain (9323') and Cougar Peak (9120'). There is McFadden Point to the N, but this area would likely be marginal to poor and a reconnaisance to confirm whether there is whitebark in the area is necessary. The southward sites would comprise an excellent location with good potential, but presently (mid-August 2005) there is a small fire on Center Mountain, so it will be useful to get an update on the status of the area before sampling. This could represent a population with at least two burn types in 2006. This route can loop back up to the headwaters of Monumental Creek and there are several potential sites in that area, depending on access.

2. Cottonwood Butte, 5-6 miles north of the population sampled at Black Butte, in the Payette National Forest. This would be a 2-day pack trip from either Taylor Ranch or Cabin Creek. Another alternative is to fly to Cold Meadows and meet the packer or hike from there, although it is still a 1-2 day trip that way: 15-20 miles. This is probably a good population and fairly abundant whitebarks spread throughout the area near the Butte. This area did not burn during any recent fires.

3. Bighorn Crags, in the Salmon National Forest. It may be possible to sample 2 populations in this area: 1 to the south where most of the trail access is and 1 to the north between the Roaring Creek Lakes and Goat Lake, by the Beehive (9610'). The southern access could be hiked in directly since the parking lot at the trailhead is at about 8200' and the terrain ranges between 8-9500'. The northern sites would require a pack trip either through the Crags, and consequently this would be 3 days 1 way from Cabin Creek, or from a trailhead by the main Salmon River by the Special Mining Management Zone (e.g. Clear Creek, or there looks like a trailhead several miles to the west also), a 1 to 2 day trip.

4. Rainbow Ridge by the head of Monumental Ck, there is an access road to the Thunder Mountain mining area. There are some good potential sites in this area, but it depends on packing access and trail conditions. Some small fires were burning in at high elevations in August 2005, but much of the area appears unburned.

5. Other sites that may be worth discussing with a packer: (1) ridges south of Mormon Mountain, e.g. Shellrock Ridge. There isn't really a trail though and there are steep tricky sections and also downed trees. (2) ridges south between Big Creek and Monumental Creek: there are some high spots and much of the area outside the Big Creek drainage itself didn't burn in the 2000 fire. There are also areas further to the northeast, N of the Salmon River that look like candidate sites, but these are much further away and are in different mountain ranges (Clearwaters and Bitterroots) and probably also in different geological and climatic zones (and forest districts). They are probably too far from the other sites and logistical support to consider at this time.

Appendices

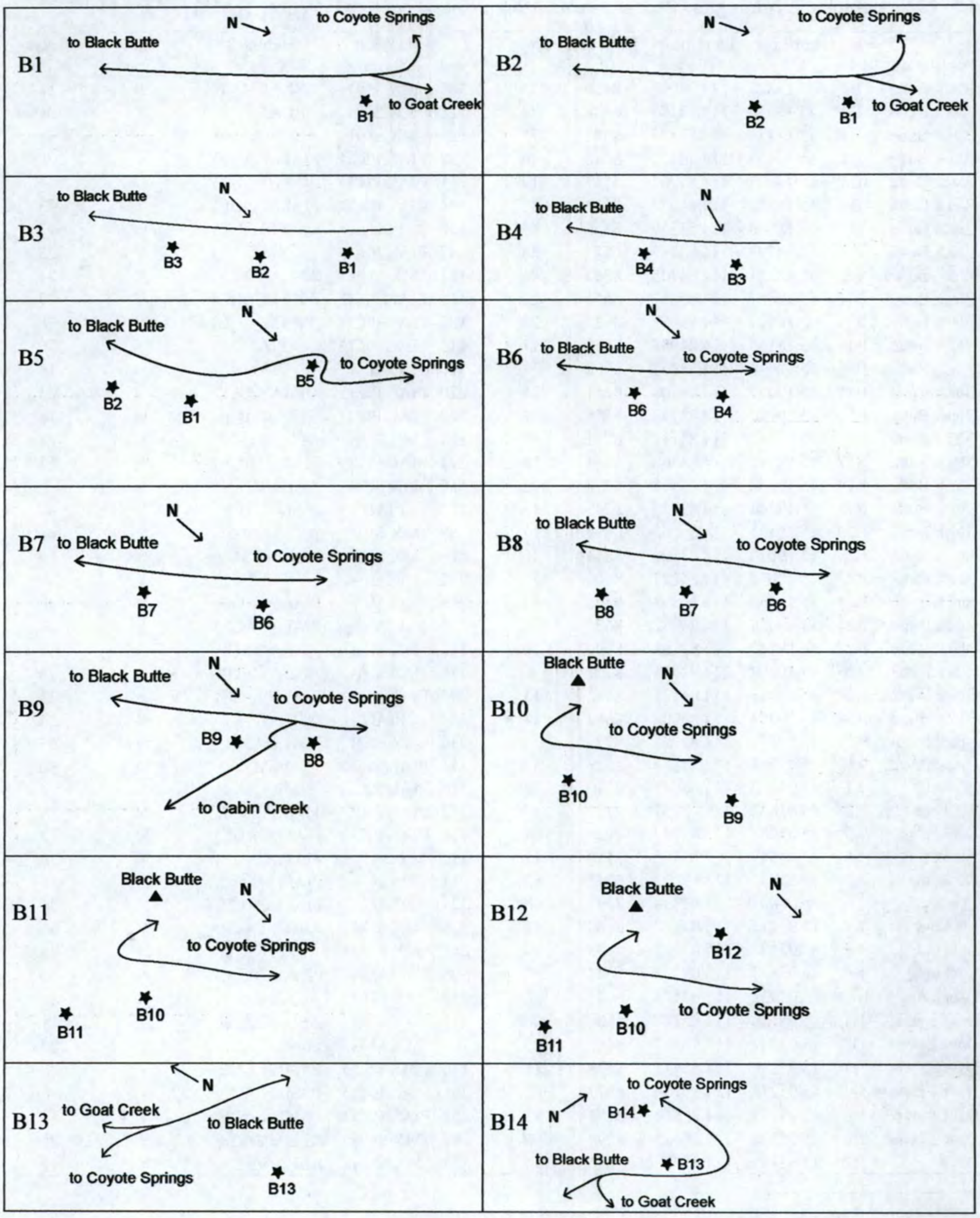
Appendix 1. Plot locations, transect start points and characteristics. GPS settings correspond to the USGS topographic quadrangles (Papoose Peak, Monument, Dave Lewis Peak): NAD27, Zone 11.

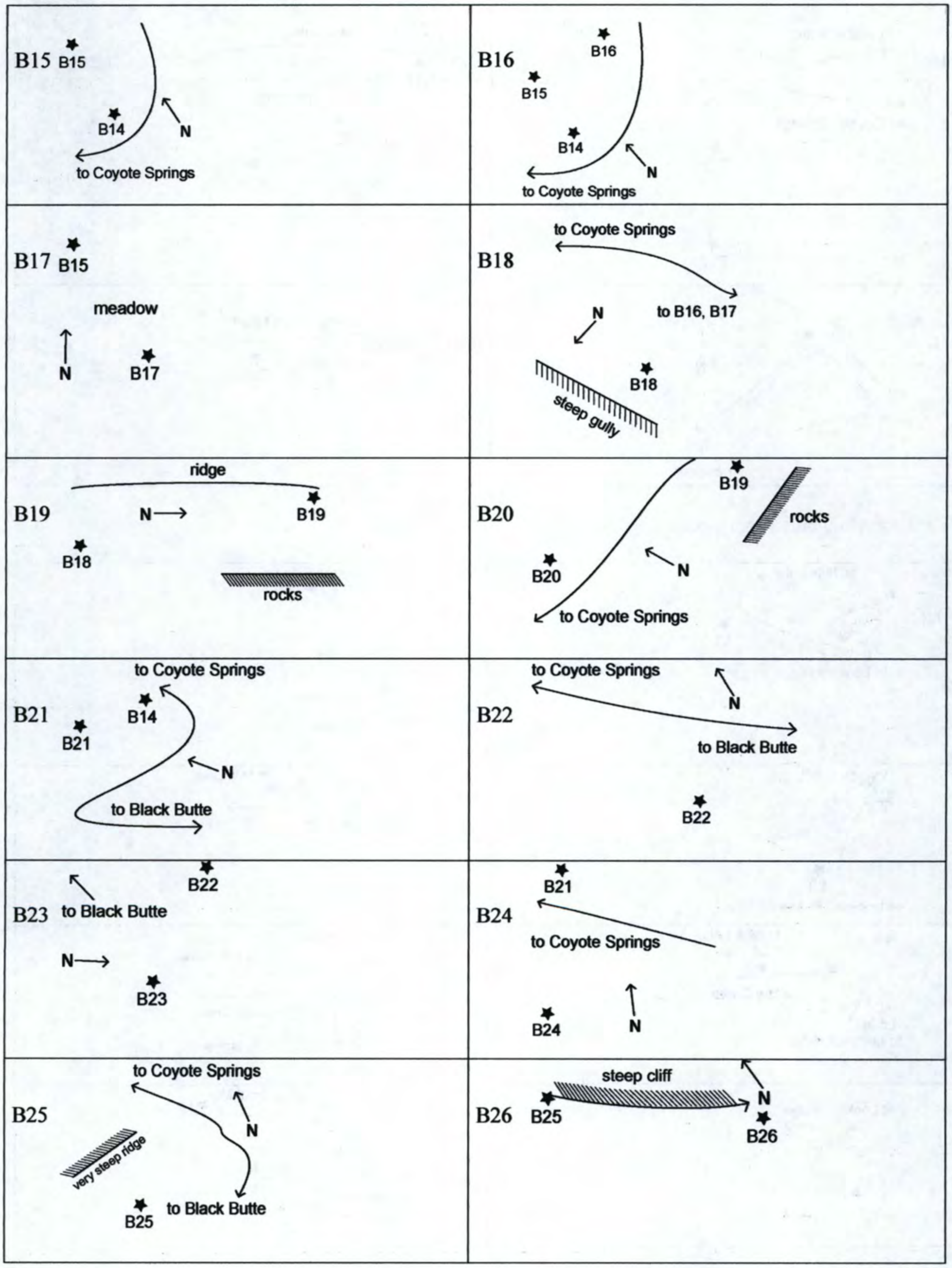
Population	Plot	Latitude (°N)	Longitude (°W)	Elevation (ft)	Slope %	Aspect	Habitat Series[1]	Habitat Type[2]	Burn Class[3]	Trees in plot
Black Butte	B1	45.18677	114.84093	8459	75	165	MX SUB	ABLA/CAGE	N	16
Black Butte	B2	45.18630	114.84180	8488	34	128	MX SUB	ABLA/CAGE	Y	8
Black Butte	B3	45.18337	114.84527	8552	75	129	MX SUB	ABLA/CAGE	Y	13
Black Butte	B4	45.18423	114.84417	8540	46	132	PIAL/PICO	PIAL(/CAGE)	Y	9
Black Butte	B5	45.18603	114.84267	8517	13	1	PIAL/PICO	PIAL(/VASC)	O	14
Black Butte	B6	45.18272	114.84587	8554	30	134	PIAL/PICO	PIAL(/CAGE)	Y	33
Black Butte	B7	45.18340	114.84537	8568	45	136	PIAL	PIAL	O	17
Black Butte	B8	45.18272	114.84587	8543	38	147	PIAL/PICO	PIAL	Y	23
Black Butte	B9	45.18223	114.84705	8567	46	131	MX SUB	ABLA/CAGE	Y	24
Black Butte	B10	45.18067	114.85032	8651	22	155	PIAL/PICO	PICO/CAGE	Y	27
Black Butte	B11	45.18027	114.85082	8623	28	180	PIAL/PICO	PICO/CAGE	N	9
Black Butte	B12	45.18155	114.84958	8657	11	114	PIAL/PICO	PIAL	Y	20
Black Butte	B13	45.18930	114.83865	8582	17	240	PIAL	PIAL	N	13
Black Butte	B14	45.19027	114.83900	8651	15	220	PIAL/PICO	PICO/ARRY	N	23
Black Butte	B15	45.19040	114.83783	8655	12	220	PIAL/PICO	PICO/CAGE	N	12
Black Butte	B16	45.19062	114.83712	8721	9	193	MX SUB	ABLA/CAGE	N	24
Black Butte	B17	45.18990	114.83860	8644	18	225	PIAL/PICO	PIAL(/CAGE)	N	13
Black Butte	B18	45.19168	114.83570	8738	22	156	MX SUB	ABLA/CAGE	N	7
Black Butte	B19	45.19348	114.83325	8735	15	127	PIAL	PIAL(/CAGE)	Y	30
Black Butte	B20	45.19445	114.83262	8697	17	55	MX SUB	ABLA/CAGE	Y	41
Black Butte	B21	45.19070	114.83900	8644	16	211	MX SUB	ABLA/CAGE	N	19
Black Butte	B22	45.19078	114.84273	8600	24	252	PIAL	PIAL	Y	4
Black Butte	B23	45.19062	114.84388	8528	14	268	PIAL	PIAL(/CAGE)	Y	6
Black Butte	B24	45.19028	114.83972	8655	16	224	PIAL	PIAL(/CAGE)	Y	6
Black Butte	B25	45.19140	114.83668	8700	10	342	MX SUB	ABLA/CAGE	O	17
Black Butte	B26	45.19202	114.83555	8727	8	336	MX SUB	ABLA/CAGE	O	20
Black Butte	B27	45.19163	114.84125	8685	13	290	PIAL/PICO	PIAL(/VASC)	O	23
Black Butte	B28	45.19093	114.84002	8662	18	232	PIAL	ABLA-PIAL	O	25
Black Butte	B29	45.19117	114.83727	8725	7	239	MX SUB	ABLA-PIAL	O	65
Black Butte	B30	45.19263	114.83503	8728	54	326	PIAL/PICO	PIAL	O	50
Lookout	L1	45.04060	115.08637	7510	72	310	PIAL/PICO	PSME/CAGE	N	34
Lookout	L2	45.03622	115.08755	7752	17	217	PIAL/PICO	PSME/CAGE	N	7
Lookout	L3	45.03988	115.08087	7925	54	158	PIAL/PICO	PIAL(/CAGE)	N	12
Lookout	L4	45.03848	115.07445	8110	11	230	PIAL	PIAL(/CAGE)	N	20
Lookout	L5	45.03852	115.07203	8245	67	44	PIAL	PIAL(/CAGE)	N	26
Lookout	L6	45.03807	115.07308	8241	68	324	PIAL	PIAL(/CAGE)	N	76
Lookout	L7	45.03713	115.07210	8380	44	326	MX SUB	ABLA/VACA	N	33
Lookout	L8	45.03480	115.07252	8533	6	282	MX SUB	ABLA/CAGE	N	41
Lookout	L9	45.03338	115.07272	8647	57	306	PIAL	PIAL(/CAGE)	N	42
Lookout	L10	45.02932	115.07478	8685	36	289	MX SUB	ABLA/CAGE	N	40
Dave Lewis	D1	45.05138	114.85188	8300	3	245	MX SUB	ABLA/CAGE	Y	41
Dave Lewis	D2	45.05237	114.85302	8467	26	204	MX SUB	PSME/CAGE	Y	22
Dave Lewis	D3	45.05248	114.85435	8488	21	176	PIAL/PICO	PSME/CAGE	Y	9
Dave Lewis	D4	45.05228	114.85700	8377	62	201	PIAL/PICO	PSME/CAGE	Y	9
Dave Lewis	D5	45.05295	114.85810	8473	43	208	PIAL/PICO	PSME/CAGE	Y	12
Dave Lewis	D6	45.05300	114.86015	8298	50	307	MX SUB	ABLA/VACA	Y	25
Dave Lewis	D7	45.05383	114.85927	8277	55	323	MX SUB	ABLA/VACA	Y	12

[1] Habitat series determined using GAP GIS-based maps and field reconnaisance
[2] Habitat types keyed out as per Steele et al. (1981)
[3] Y = young (burnt last 0-15 years), O = old (burnt 16-100 years ago), N = unburnt (no fires last 100+ years)

Appendix 2. Monitoring plot location diagrams

Black Butte Population




B15
B15
B14
N
to Coyote Springs
B16
B16
B15
B14
N
to Coyote Springs
B17
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meadow
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B18
to Coyote Springs
N
to B16, B17
B18
steep gully
B19
ridge
N
B19
B18
rocks
B20
B19
rocks
B20
N
to Coyote Springs
B21
to Coyote Springs
B14
B21
N
to Black Butte
B22
to Coyote Springs
N
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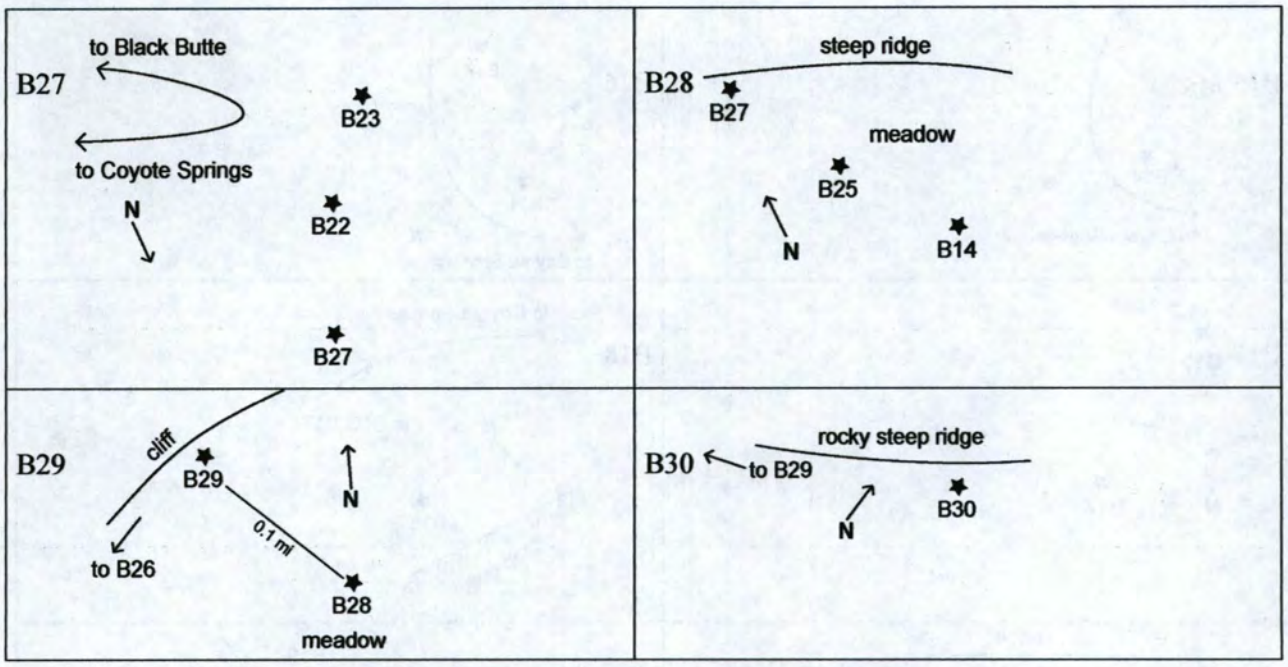
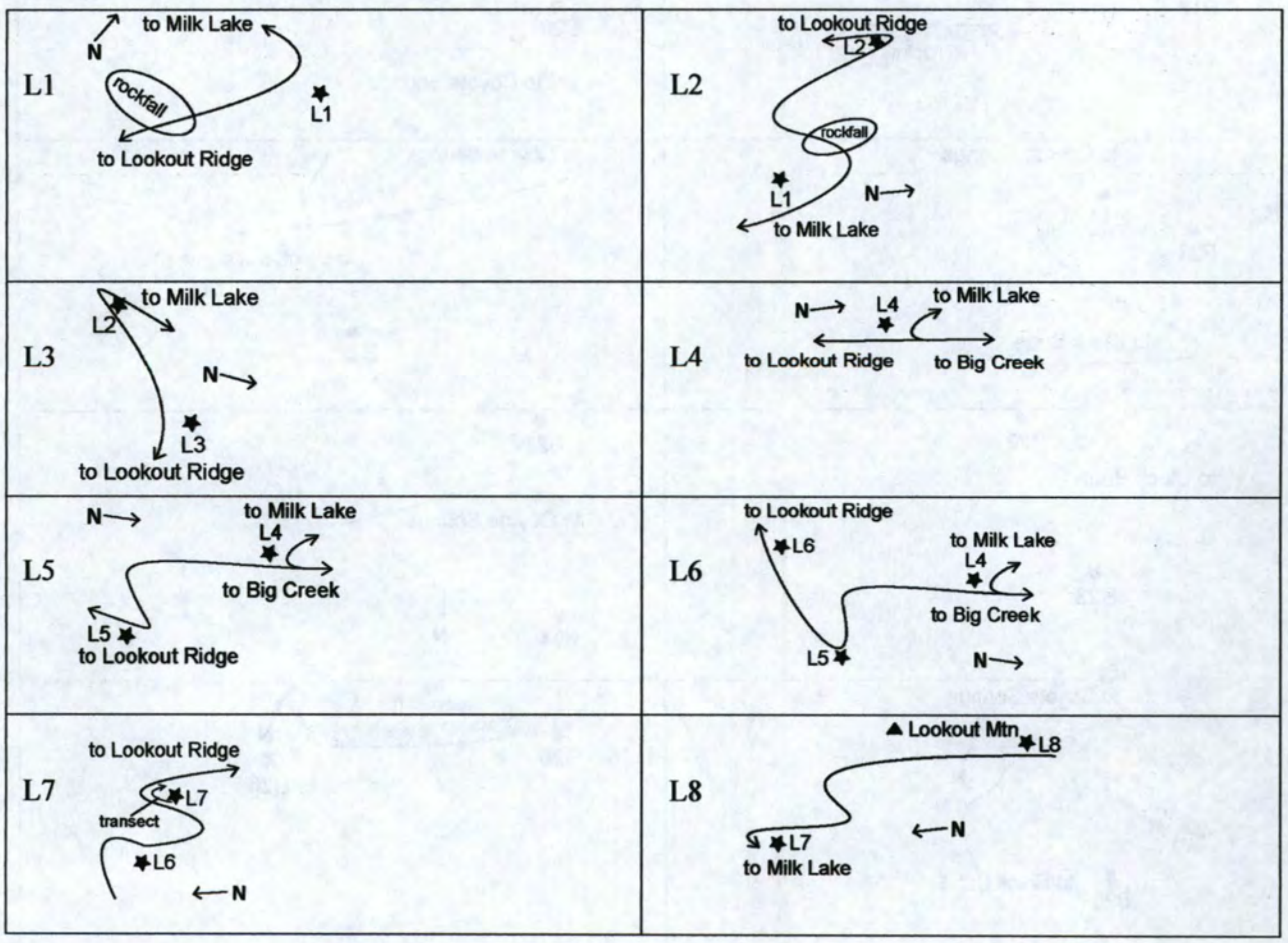
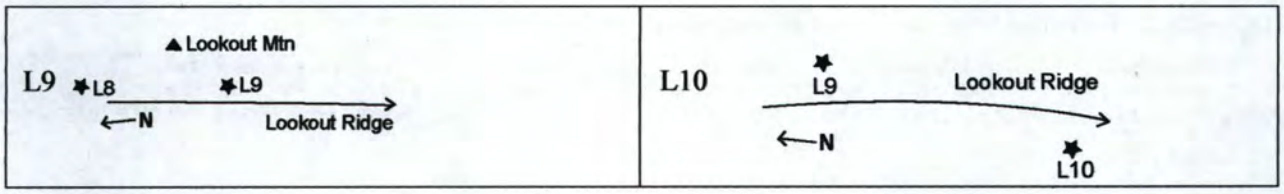
B22
B23
B22
to Black Butte
N
B23
B24
B21
to Coyote Springs
B24
N
B25
to Coyote Springs
N
very steep ridge
B25
to Black Butte
B26
steep cliff
B25
N
B26

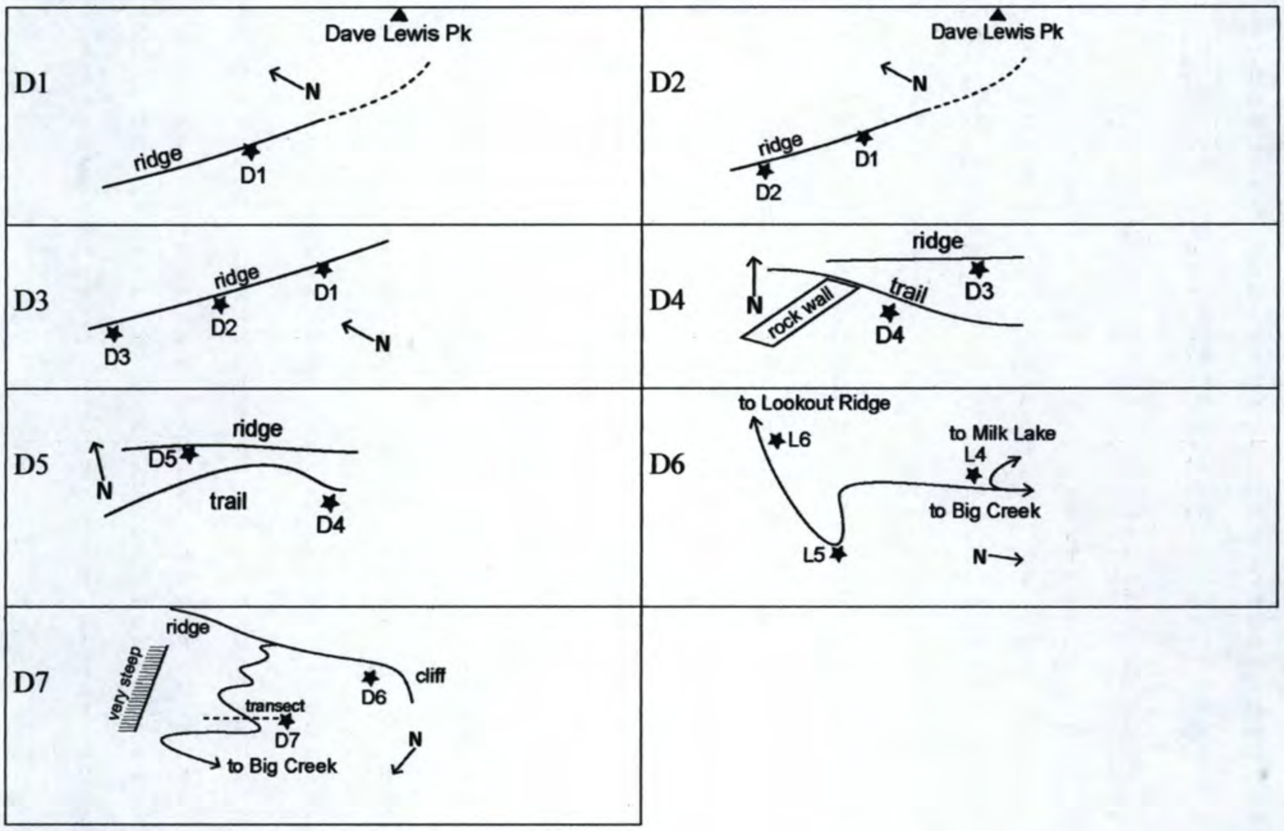


Lookout Mountain Population





Dave Lewis Population



Appendix 3. Putatively resistant trees. For exact locations see Appendix 4.

Plot No.	Tag	DBH (in.)	Indications	Cones
B5	58	1.3	canker scars on stem (possibly on branches also), looks like old cankers now inactive or dead	too young
B15	278	0.7	has several dead cankers but looks healthy	too young
L3	685	9.1	mature tree with no cankers in moderately infected stand	few
L3	688	3.8	mature tree with no cankers in moderately infected stand	none
L4	694	2.5	dead branch cankers but looks healthy in moderately infected stand	too young
L5	709	3.9	no cankers in moderately infected stand	few
L5	710	1.7	only dead branch cankers, looks healthy	too young
L5	711	3.0	only dead branch cankers, looks healthy	none
L5	718	3.0	only dead branch cankers, looks healthy	few
L5	720	2.4	only dead branch cankers, looks healthy	too young
L5	732	2.8	only dead branch cankers, looks healthy	too young

Appendix 4. Individual-tree data from all plots sampled in 2005.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B1	1	1	0.0	0.0	I	A	1.3	1	U	N	N	N	N	N	N	0	L	L	N	H	.
B1	2	2	0.0	0.0	I	B	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	3	16	0.0	8.8	R	B	2.2	10	U	N	N	N	N	N	N	0	L	H	N	S	.
B1	4	15	0.0	8.7	R	A	5.6	2	L	N	N	N	N	A	N	0	L	M	N	I	.
B1	5	17	2.3	8.9	R	C	2.1	1	L	N	N	N	N	D	N	0	N	L	N	I	.
B1	6	2	23.3	1.3	R	.	8.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	7	3	24.3	1.7	R	.	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	8	4	94.7	8.2	R	A	7.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	9	5	94.7	91.0	R	B	16.0	1	L	N	N	N	N	I	N	0	N	N	Y	I	.
B1	10	6	97.8	13.8	R	.	13.3	2	L	N	N	N	I	I	N	0	L	L	Y	I	.
B1	11	9	119.2	10.1	L	A	2.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	12	10	121.5	10.4	L	B	0.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	13	11	137.0	8.5	L	A	7.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	14	13	137.5	12.5	L	A	8.7	2	U	N	N	N	N	N	N	0	N	N	Y	H	.
B1	15	14	138.1	12.4	L	B	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B1	16	12	138.3	9.5	L	B	1.2	7	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	1	8	0.0	0.0	I	A	10.4	3	U	N	N	N	N	N	N	0	M	H	N	S	.
B2	2	25	1.1	2.1	L	D	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	3	18	1.3	3.2	L	B	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	4	21	1.6	2.4	R	B	8.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	5	20	1.6	1.4	R	A	8.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	6	19	3.0	1.0	L	C	1.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	7	22	6.5	3.4	R	.	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B2	8	23	34.7	9.1	R	.	0.3	1	U	N	N	N	N	N	N	0	N	M	N	S	.
B3	1	26	0.0	0.0	L	B	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B3	2	27	0.0	0.4	I	A	4.4	1	L	N	N	N	N	A	N	0	N	N	N	I	.
B3	3	28	1.3	0.6	L	C	4.4	1	U	N	N	N	N	N	N	0	L	L	N	H	.
B3	4	29	1.3	0.2	L	D	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B3	5	30	8.4	0.0	L	A	4.0	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B3	6	31	8.9	15.0	L	B	0.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B3	7	32	14.8	2.5	R	A	6.2	1	L	N	N	N	N	I	D	0	N	N	N	H	.
B3	8	33	15.2	4.6	R	B	8.1	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B3	9	34	15.8	4.6	R	C	7.8	10	??	U	U	U	U	U	U	0	M	H	N	S	.
B3	10	35	21.6	6.0	R	.	5.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B3	11	36	26.3	7.2	R	A	5.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B3	12	37	26.3	6.6	R	B	6.4	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B3	13	38	33.9	9.6	R	.	4.4	1	U	N	N	N	N	N	N	0	N	M	N	S	.
B4	1	39	0.0	0.0	I	A	10.4	1	L	N	N	N	N	D	N	0	N	M	N	S	.
B4	2	40	1.3	1.1	L	B	9.0	2	L	N	N	N	I	N	N	0	M	N	N	I	.
B4	3	41	17.2	8.8	R	.	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B4	4	42	53.0	12.7	L	.	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B4	5	43	53.8	12.2	L	.	2.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B4	6	44	58.8	11.4	L	.	0.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B4	7	45	61.0	13.5	L	.	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B4	8	46	64.7	10.1	L	.	0.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B4	9	47	67.3	9.2	L	.	2.1	11	U	N	N	N	N	D	N	0	H	H	N	D	U
B5	1	48	0.0	0.0	I	A	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	2	49	1.0	0.4	R	B	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	3	50	1.3	4.0	L	C	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	4	52	2.0	0.0	I	E	0.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	5	51	2.1	0.3	L	D	0.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	6	53	8.5	13.5	R	A	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	7	54	8.7	14.8	R	B	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	8	55	27.8	15.0	R	A	3.2	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B5	9	56	28.4	13.9	R	B	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	10	58	51.3	11.7	L	B	1.3	1	??	U	U	U	U	U	U	60	N	N	N	H	.
B5	11	57	52.3	11.2	L	A	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	12	61	73.1	5.6	R	C	2.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.

[1] from beginning of 150.0' transect to germination point of tree

[2] from 0.0-15.0' away from transect to germination point of tree

[3] direction from transect start: R=right, L=left, I=intersecting

[4] letter indicates member of clump, "." indicates single individual

[5] 1 (0-5%), 2 (6-15%), 3 (16-25%), 4 (26-35%), 5 (36-45%), 6 (46-55%), 7 (56-65%), 8 (66-75%), 9 (76-85%), 10 (86-95%), 11 (96-100%)

[6] U=uninfected, L=1-10 cankers, M=11-30, H=31+, ??=uncertain

[7] A=sporulating, I=alive & not sporulating, N=none, U=uncertain, O=other (other species), D=dead

[8] N=none, L=light, M=moderate, H=heavy

[9] H=healthy & uninfected, I=healthy & infected, S=sick, R=recently dead, D=dead

[10] R=rust, B=beetle, U=unknown/other, F=fire

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B5	13	59	73.4	3.5	R	A	4.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B5	14	60	73.5	4.2	R	B	5.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	1	63	0.0	0.0	I	A	3.6	1	U	N	U	N	N	I	I	15	L	N	N	I	.
B6	2	64	0.0	1.2	R	B	7.3	1	L	N	N	N	N	N	N	0	L	L	N	H	.
B6	3	62	1.0	1.1	R	C	7.0	1	L	N	N	N	N	I	A	0	N	L	Y	I	.
B6	4	68	7.1	13.2	L	A	7.5	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B6	5	69	9.3	15.0	L	B	9.3	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B6	6	65	9.8	4.7	R	A	5.7	1	U	N	N	N	I	N	N	0	N	L	N	I	.
B6	7	70	9.8	14.9	L	C	6.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	8	71	10.2	14.5	L	D	5.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	9	66	10.8	4.4	R	B	5.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	10	67	11.3	4.6	R	C	6.5	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B6	11	75	20.4	7.5	R	.	2.2	1	L	N	N	N	I	N	N	0	N	L	N	I	.
B6	12	73	22.5	10.1	R	B	10.6	1	L	N	N	N	I	N	N	0	N	N	Y	H	.
B6	13	72	23.2	9.0	R	A	10.8	1	L	N	N	N	N	I	N	0	N	H	Y	H	.
B6	14	74	23.3	11.2	R	C	18.3	11	??	N	N	N	N	N	N	0	N	N	N	D	B
B6	15	80	26.5	10.2	R	D	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	16	77	26.7	9.6	R	A	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	17	78	26.9	9.4	R	B	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	18	76	27.3	7.4	R	.	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	19	81	27.6	13.9	R	.	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	20	79	27.7	10.0	R	C	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	21	82	40.8	8.0	L	A	7.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B6	22	83	42.1	7.5	L	B	7.6	11	U	N	N	N	N	N	N	0	L	H	N	D	U
B6	23	84	50.4	6.2	R	A	5.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B6	24	85	51.4	5.7	R	B	4.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	25	86	55.1	9.5	R	A	5.0	1	L	N	N	N	A	N	N	0	N	M	N	I	.
B6	26	87	56.3	9.1	R	B	67.0	1	M	N	A	N	A	A	A	35	N	H	N	S	.
B6	27	88	57.5	9.9	R	C	5.1	1	L	N	A	N	N	N	N	85	M	M	N	S	.
B6	28	89	113.9	7.9	R	A	2.3	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B6	29	90	114.3	7.8	R	B	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B6	30	91	115.3	6.9	R	C	1.2	1	U	N	N	N	N	A	N	0	N	N	N	I	.
B6	31	92	131.1	7.1	L	A	5.3	1	L	N	N	N	A	N	N	0	N	M	N	I	.
B6	32	93	132.2	7.8	L	B	3.3	1	L	N	N	N	N	D	N	0	L	N	Y	H	.
B6	33	94	139.3	6.9	L	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B7	1	95	0.0	0.0	I	A	6.2	3	U	N	N	N	N	N	N	0	H	M	N	H	.
B7	2	96	0.7	1.6	L	B	6.5	1	L	N	N	N	I	A	N	0	L	H	Y	I	.
B7	3	97	1.8	2.2	L	C	6.0	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B7	4	98	1.9	3.2	L	D	5.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B7	5	100	2.1	0.5	L	F	5.2	2	U	N	N	N	N	N	N	0	L	H	N	H	.
B7	6	99	2.5	1.5	L	E	4.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B7	7	101	14.7	3.8	R	A	7.4	3	L	N	N	N	A	N	N	0	M	M	N	I	.
B7	8	102	17.2	4.6	R	B	6.4	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B7	9	105	22.8	15.1	L	B	2.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B7	10	103	24.8	9.7	L	.	10.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B7	11	104	32.9	15.1	L	A	4.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B7	12	106	33.9	14.7	L	C	4.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B7	13	107	34.1	14.1	L	D	4.4	1	L	N	N	N	A	N	N	0	N	M	N	I	.
B7	14	108	64.6	10.3	R	.	16.5	5	U	N	N	N	N	N	N	0	M	N	N	H	.
B7	15	109	67.6	5.7	L	A	3.3	11	.	.	.	.	.	.	.	.	.	.	.	D	F
B7	16	110	67.8	6.3	L	B	4.5	11	.	.	.	.	.	.	.	.	.	.	.	D	F
B7	17	111	68.5	6.7	L	C	6.7	11	.	.	.	.	.	.	.	.	.	.	.	D	F
B8	1	112	0.0	0.0	I	A	4.9	11	.	.	.	.	.	.	.	.	H	H	N	R	U
B8	2	113	1.0	0.0	I	B	11.2	1	U	N	N	N	N	N	N	0	M	M	Y	H	.
B8	3	114	2.3	0.4	L	C	9.7	11	.	.	.	.	.	.	.	.	H	H	N	D	U
B8	4	115	17.4	4.2	R	.	9.2	1	L	N	N	N	A	A	A	0	L	N	N	I	.
B8	5	116	23.7	2.4	L	.	1.8	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	6	117	73.7	5.9	L	A	1.2	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	7	118	74.0	5.5	L	B	2.5	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B8	8	120	93.4	5.1	R	B	4.0	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B8	9	119	93.8	5.1	R	A	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B8	10	121	105.3	2.2	R	.	3.5	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B8	11	122	111.2	13.5	R	A	4.0	11	.	.	.	.	.	.	.	.	H	H	.	D	U
B8	12	123	112.1	13.3	R	B	4.6	1	U	N	N	N	N	N	N	0	L	H	N	H	.
B8	13	124	114.7	10.8	R	.	1.3	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B8	14	125	115.0	6.3	R	A	2.9	2	U	N	N	N	N	N	N	0	N	M	N	H	.
B8	15	126	116.4	4.7	R	B	4.3	2	U	N	N	N	N	N	N	0	L	M	N	H	.
B8	16	127	121.3	14.5	R	.	9.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B8	17	128	125.4	3.2	L	.	1.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B8	18	129	132.5	9.2	L	A	1.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	19	130	132.7	9.1	L	B	2.6	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	20	133	136.9	4.4	R	.	1.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	21	131	138.2	4.5	L	.	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B8	22	132	138.6	13.9	L	.	0.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B8	23	134	138.8	7.2	R	.	1.1	1	L	N	N	N	I	N	N	0	N	M	N	I	.
B9	1	135	0.0	0.0	I	A	3.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B9	2	136	1.3	1.0	L	B	4.9	2	U	N	N	N	N	N	N	0	N	M	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B9	3	138	1.8	0.3	R	D	6.5	1	L	N	N	N	N	U	A	0	N	L	N	I	.
B9	4	137	2.1	0.5	L	C	6.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B9	5	139	6.8	7.8	L	.	6.3	1	L	N	N	N	A	N	N	0	L	L	N	I	.
B9	6	140	14.3	15.2	L	A	1.8	9	M	N	N	A	.	.	.	90	H	H	N	S	.
B9	7	141	14.8	13.0	L	B	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B9	8	142	15.0	13.0	L	C	2.9	1	L	N	N	N	A	N	N	0	N	M	N	I	.
B9	9	145	28.4	13.4	L	.	3.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B9	10	143	33.0	5.3	L	A	3.8	1	L	N	N	A	N	N	A	50	N	N	N	I	.
B9	11	144	33.4	5.7	L	B	5.4	1	L	N	N	N	I	I	N	0	N	N	N	I	.
B9	12	146	52.8	11.8	R	A	2.5	1	U	N	N	N	N	N	N	0	L	L	N	H	.
B9	13	147	53.1	11.6	R	B	2.3	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B9	14	148	53.5	9.6	R	A	0.5	2	U	N	N	N	N	N	N	0	L	N	N	H	.
B9	15	158	54.4	10.8	R	F	1.6	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B9	16	149	54.5	9.8	R	B	3.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B9	17	150	54.5	10.3	R	C	2.1	11	U	N	N	N	N	N	N	0	H	H	N	S	.
B9	18	151	54.5	9.6	R	D	3.1	1	L	N	N	N	N	N	N	0	N	N	N	I	.
B9	19	152	55.1	9.8	R	E	3.6	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B9	20	153	56.6	98.0	R	.	0.6	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B9	21	155	79.0	9.6	R	B	4.3	11	U	N	N	N	N	N	N	0	H	H	N	D	U
B9	22	154	79.3	8.8	R	A	4.1	11	U	N	N	N	N	N	N	0	H	H	N	D	U
B9	23	156	96.5	5.4	L	A	10.4	11	U	N	N	N	N	N	N	0	H	H	N	D	F
B9	24	157	97.3	5.4	L	B	13.0	11	U	N	N	N	N	N	N	0	H	H	N	D	F
B10	1	159	0.0	0.0	I	A	5.7	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B10	2	160	0.0	1.0	L	B	9.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	3	161	15.8	0.5	L	.	2.2	1	L	N	A	N	.	.	.	70	N	M	N	S	.
B10	4	162	21.1	5.9	L	.	4.5	2	U	N	N	N	N	N	N	0	L	L	N	H	.
B10	5	163	23.1	0.6	L	A	12.6	1	L	N	N	N	N	A	N	0	L	L	Y	I	.
B10	6	166	23.1	0.4	R	D	5.0	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B10	7	164	24.3	1.3	L	B	1.1	4	U	N	N	N	N	N	N	0	L	L	N	H	.
B10	8	165	24.3	0.6	L	C	7.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	9	167	25.7	2.5	R	A	0.4	3	U	N	N	N	N	N	N	0	N	M	N	H	.
B10	10	168	25.9	2.4	R	B	1.3	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B10	11	169	26.3	2.7	R	C	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	12	170	30.5	4.6	R	.	12.3	1	L	N	N	N	I	N	N	0	N	N	Y	I	.
B10	13	171	31.5	6.9	R	.	4.4	1	L	A	N	N	N	N	N	40	N	L	N	I	.
B10	14	183	121.8	11.0	L	E	5.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	15	185	121.8	10.0	L	H	4.5	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B10	16	184	122.2	10.6	L	F	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	17	173	122.3	3.9	L	B	10.1	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B10	18	175	122.3	4.7	L	D	8.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	19	172	123.2	3.5	L	A	6.4	5	L	N	N	N	N	A	N	0	N	M	N	I	.
B10	20	174	123.4	5.0	L	C	3.0	4	L	I	N	N	N	N	N	0	N	L	N	I	.
B10	21	177	124.3	3.7	L	F	8.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	22	178	124.5	2.9	L	G	4.9	3	U	N	N	N	N	N	N	0	N	L	N	H	.
B10	23	176	125.3	3.8	L	E	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	24	179	125.6	8.0	L	A	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	25	181	126.6	6.9	L	C	9.2	6	L	A	N	N	A	N	N	100	N	L	N	S	.
B10	26	182	127.5	7.2	L	D	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B10	27	180	127.9	6.5	L	B	7.1	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B11	1	186	0.0	0.0	I	A	11.0	1	U	N	N	N	N	N	N	0	L	N	N	H	
B11	2	187	0.0	1.4	L	B	12.6	2	U	N	N	N	N	N	N	0	M	N	N	H	
B11	3	190	13.0	11.4	L	.	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	
B11	4	188	14.8	10.2	L	A	9.4	1	U	N	N	N	N	N	N	0	N	N	N	H	
B11	5	189	15.7	10.2	L	B	11.1	1	U	N	N	N	N	N	N	0	N	N	N	H	
B11	6	191	47.4	10.6	L	.	8.1	1	L	N	N	N	N	A	A	0	L	N	N	I	
B11	7	193	53.6	8.0	R	B	7.7	1	U	N	N	N	N	N	N	0	N	N	N	H	
B11	8	192	53.9	6.7	R	A	10.6	1	U	N	N	N	N	N	N	0	N	N	Y	H	
B11	9	194	63.5	12.0	L	.	6.0	4	U	N	N	N	N	N	N	0	L	M	N	H	
B12	1	195	0.0	0.0	I	.	11.4	4	U	N	N	N	N	N	N	0	M	M	Y	H	
B12	2	196	30.8	16.0	R	.	4.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B12	3	197	39.2	0.0	I	A	10.6	11	U	N	N	N	N	N	N	0	N	N	N	D	F
B12	4	198	40.3	0.0	I	B	7.4	11	U	N	N	N	N	N	N	0	N	N	N	D	F
B12	5	199	45.5	4.7	L	A	2.5	11	U	N	N	N	N	N	N	0	M	L	N	D	U
B12	6	200	45.5	4.3	L	B	5.7	1	U	N	N	N	N	N	N	0	L	H	N	H	.
B12	7	201	74.2	9.3	R	.	8.7	11	U	N	N	N	N	N	N	0	N	N	N	D	F
B12	8	202	75.8	10.5	L	A	8.1	11	U	N	N	N	N	N	N	0	N	N	N	D	F
B12	9	203	76.5	10.5	L	B	9.5	11	U	N	N	N	N	N	N	0	N	N	N	D	F
B12	10	204	104.2	10.4	L	.	7.8	1	L	N	N	N	U	A	A	0	L	N	N	I	.
B12	11	205	106.5	15.0	R	A	10.2	11	U	N	N	N	N	N	N	0	H	H	N	D	F
B12	12	206	107.3	14.4	R	B	9.3	11	U	N	N	N	N	N	N	0	H	H	N	D	F
B12	13	207	111.5	12.6	R	.	8.5	11	U	N	N	N	N	N	N	0	H	H	N	D	F
B12	14	208	124.8	8.1	L	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B12	15	209	125.0	8.4	L	B	3.2	1	L	N	N	I	N	A	N	40	N	L	N	I	.
B12	16	210	129.3	7.1	L	.	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B12	17	211	134.4	12.9	L	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B12	18	212	140.3	9.3	L	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B12	19	213	140.6	10.1	L	B	0.5	1	U	N	N	N	N	N	N	0	N	M	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B12	20	214	143.9	7.3	L	.	1.8	1	U	N	N	N	N	N	N	0	N	H	N	H	.
B13	1	220	0.0	0.0	I	F	5.1	2	L	N	N	U	N	N	D	0	L	N	Y	I	.
B13	2	221	0.0	8.2	L	.	3.7	11	.	.	.	.	.	.	.	.	L	N	N	D	U
B13	3	219	1.4	1.5	L	E	6.2	3	U	N	N	N	N	N	N	0	L	L	Y	H	.
B13	4	215	1.6	0.7	R	A	2.7	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B13	5	218	1.8	2.0	L	D	7.9	1	U	N	N	N	N	N	N	0	N	L	Y	H	.
B13	6	217	2.2	2.7	L	C	9.2	4	M	I	N	N	.	.	.	45	L	M	Y	S	.
B13	7	216	2.7	1.3	L	B	8.7	8	M	D	I	N	.	.	.	100	H	H	Y	S	.
B13	8	224	52.9	12.0	L	B	2.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	9	227	53.5	12.5	L	E	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	10	230	53.5	12.8	L	H	5.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	11	223	53.8	10.9	L	A	7.4	1	M	N	N	N	A	A	N	0	N	L	N	I	.
B13	12	226	53.8	12.2	L	D	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	13	228	53.8	12.9	L	F	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	14	225	54.1	12.6	L	C	3.5	1	L	N	N	N	N	N	D	0	N	L	N	I	.
B13	15	229	54.2	13.2	L	G	5.2	2	M	N	N	I	N	N	D	0	N	M	N	S	.
B13	16	231	73.2	14.8	R	A	4.0	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B13	17	234	74.0	12.2	R	D	9.2	2	U	N	N	N	N	N	N	0	L	N	N	H	.
B13	18	232	74.3	14.5	R	B	12.0	2	U	N	N	N	N	N	N	0	N	N	Y	H	.
B13	19	233	74.3	13.1	R	C	12.7	2	M	N	N	N	A	A	A	0	M	N	Y	I	.
B13	20	235	74.7	13.2	R	E	8.8	1	M	.	.	A	.	.	A	20	L	N	N	I	.
B13	21	236	74.7	14.3	R	F	9.9	2	L	N	N	I	N	N	N	25	M	L	N	I	.
B13	22	240	102.2	15.0	R	A	5.2	1	M	N	N	N	A	N	A	0	N	L	N	I	.
B13	23	241	102.5	15.0	R	B	3.1	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	24	237	103.3	7.8	R	A	16.4	4	??	U	U	U	U	U	U	.	M	N	N	S	.
B13	25	242	104.4	14.9	R	C	3.5	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B13	26	243	104.5	15.0	R	D	1.4	1	L	N	N	N	N	A	N	0	N	L	N	I	.
B13	27	238	105.1	7.1	R	B	1.8	10	U	N	N	N	N	N	N	0	H	M	N	S	.
B13	28	239	105.8	7.5	R	C	5.0	11	U	N	N	N	N	N	N	0	H	H	N	D	U
B13	29	244	114.1	7.2	R	.	6.3	1	L	N	N	N	N	D	N	0	N	N	N	I	.
B13	30	245	137.4	12.1	L	A	4.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	31	246	138.0	12.3	L	B	2.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	32	247	138.8	12.6	L	C	8.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	33	248	139.3	13.1	L	D	4.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B13	34	249	139.5	12.7	L	E	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	1	250	0.0	0.0	I	A	10.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	2	252	0.0	1.3	L	C	13.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	3	251	1.7	0.4	L	B	9.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	4	253	21.1	11.8	L	.	5.6	1	L	A	N	N	.	.	.	25	L	L	N	I	.
B14	5	254	29.6	1.5	L	A	1.5	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B14	6	255	30.3	2.6	L	B	2.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	7	256	31.0	2.1	L	C	9.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	8	260	31.3	8.5	L	D	4.2	1	L	N	N	A	.	.	.	100	N	N	N	S	.
B14	9	259	31.8	9.3	L	C	8.0	1	L	N	N	N	N	N	A	0	N	N	N	H	.
B14	10	258	32.3	9.1	L	B	8.9	2	L	N	N	N	N	N	A	0	L	N	N	H	.
B14	11	257	32.8	6.7	L	A	8.8	2	M	N	N	N	A	A	N	0	L	N	N	I	.
B14	12	262	90.8	14.1	L	B	14.9	2	M	N	A	N	.	.	.	80	M	M	Y	S	.
B14	13	261	91.3	12.7	L	A	10.7	2	M	A	N	N	.	.	.	100	M	L	Y	S	.
B14	14	263	92.3	14.9	L	C	11.2	1	M	N	A	N	N	A	N	75	N	N	Y	I	.
B14	15	264	93.5	14.5	L	D	8.3	2	M	A	N	N	.	.	.	100	M	M	Y	S	.
B14	16	267	104.3	14.5	L	B	6.3	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B14	17	268	104.3	15.0	L	C	5.5	1	L	N	N	N	A	N	N	0	L	N	N	I	.
B14	18	266	104.6	13.5	L	A	0.4	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B14	19	269	104.8	13.9	L	D	8.3	1	M	N	N	N	I	I	A	0	N	N	N	I	.
B14	20	270	104.9	14.8	L	E	2.1	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B14	21	271	105.8	14.8	L	F	2.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B14	22	272	106.4	3.9	R	A	0.7	1	L	N	N	N	N	A	A	0	N	N	N	I	.
B14	23	273	106.8	4.3	R	B	3.2	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B15	1	274	0.0	1.3	R	A	1.2	1	U	N	N	N	N	N	N	0	L	L	N	H	.
B15	2	279	0.0	0.0	I	F	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	3	275	1.5	1.7	R	B	1.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B15	4	277	1.5	0.3	R	D	2.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	5	276	2.1	1.4	R	C	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	6	278	2.7	0.0	L	E	2.2	2	L	N	N	N	D	D	N	0	L	L	N	I	.
B15	7	280	5.8	0.8	R	A	3.6	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B15	8	281	6.2	0.8	R	B	2.9	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B15	9	282	87.7	14.0	L	.	5.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	10	283	108.5	14.0	R	A	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	11	284	108.5	13.0	R	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B15	12	285	108.8	13.0	R	C	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	1	286	0.0	0.0	I	A	4.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B16	2	287	0.0	0.6	L	B	4.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	3	288	3.8	14.7	L	A	1.0	1	L	N	N	N	I	N	A	0	N	N	N	I	.
B16	4	289	4.2	14.7	L	B	1.4	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B16	5	290	10.9	13.5	L	A	3.6	2	U	N	N	N	N	N	N	0	M	M	N	H	.
B16	6	291	11.3	13.5	L	B	2.3	9	M	N	I	N	.	.	.	100	H	H	N	S	.
B16	7	292	22.6	1.8	R	A	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B16	8	293	22.8	2.2	R	B	3.8	1	L	N	N	N	N	A	N	0	L	M	N	I	.
B16	9	297	52.9	5.0	R	D	0.5	1	U	N	N	N	N	N	N	0	L	L	N	H	.
B16	10	298	53.1	9.0	R	E	3.6	2	U	N	N	N	N	N	N	0	N	H	N	H	.
B16	11	295	53.3	5.6	R	B	0.7	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B16	12	296	53.3	5.7	R	C	0.7	3	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	13	299	53.6	5.3	R	F	2.7	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B16	14	294	53.8	5.0	R	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	15	300	54.5	1.0	L	.	2.9	2	L	N	N	N	N	A	N	0	L	L	N	I	.
B16	16	301	69.6	9.9	L	.	6.4	1	L	N	A	N	.	.	.	40	N	N	N	I	.
B16	17	302	69.6	11.8	L	.	0.5	1	L	N	I	N	.	.	.	33	N	N	N	I	.
B16	18	303	120.6	4.6	L	A	1.1	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	19	304	124.6	5.0	L	B	1.0	3	U	N	N	N	N	N	N	0	L	N	N	H	.
B16	20	306	139.4	6.1	L	B	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	21	305	149.3	5.9	L	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B16	22	307	149.3	7.0	L	C	2.3	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B16	23	308	149.7	7.3	L	D	2.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B16	24	309	149.7	6.8	L	E	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B17	1	310	0.0	0.0	I	A	1.0	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B17	2	311	0.3	1.8	L	B	12.1	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B17	3	314	0.4	2.8	L	E	8.0	1	L	A	N	N	.	.	.	30	N	L	Y	I	.
B17	4	313	0.5	2.9	L	D	10.3	1	L	N	N	N	N	I	I	0	M	N	Y	I	.
B17	5	315	2.0	4.4	L	F	1.8	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B17	6	312	2.1	2.3	L	C	11.5	1	L	N	N	N	N	A	A	0	N	N	Y	I	.
B17	7	316	43.6	7.5	R	A	6.0	2	L	N	N	N	A	N	N	0	N	N	N	I	.
B17	8	317	43.6	8.6	R	B	4.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B17	9	318	50.2	4.6	R	A	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B17	10	319	50.3	5.0	R	B	4.9	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B17	11	320	57.0	6.4	R	.	7.5	1	L	N	N	N	N	N	A	0	L	N	N	I	.
B17	12	322	82.0	6.6	L	.	5.3	1	L	N	N	N	N	A	N	0	N	L	N	I	.
B17	13	321	86.2	7.1	R	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B18	1	323	0.0	0.0	I	A	13.1	1	L	N	N	N	N	A	N	0	N	N	Y	I	.
B18	2	324	1.3	1.5	L	B	19.3	3	L	N	N	N	A	N	N	0	N	L	Y	I	.
B18	3	325	2.4	1.3	L	C	14.6	1	L	N	N	N	I	N	N	0	L	N	Y	I	.
B18	4	328	63.9	5.5	R	.	0.7	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B18	5	329	66.2	14.3	R	.	0.6	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B18	6	331	68.2	5.5	R	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B18	7	332	71.6	6.2	R	.	0.4	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B19	1	326	0.0	0.0	I	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	2	327	1.3	0.5	L	B	5.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	3	330	1.8	0.5	L	C	6.5	1	L	A	N	N	I	I	N	35	N	N	N	I	.
B19	4	333	3.1	1.3	R	A	1.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	5	336	3.3	1.9	R	D	5.3	1	L	N	N	N	N	N	A	0	N	L	N	I	.
B19	6	334	3.5	1.2	R	B	6.7	1	L	N	N	N	A	A	N	0	N	N	N	I	.
B19	7	335	3.7	1.8	R	C	3.3	2	L	N	N	N	N	A	N	0	N	N	N	I	.
B19	8	338	15.5	13.7	L	B	0.7	1	L	N	N	N	N	A	A	0	N	N	N	I	.
B19	9	337	15.8	13.5	L	A	2.4	1	L	N	N	N	N	A	A	0	N	N	N	I	.
B19	10	339	23.2	5.8	R	A	11.1	1	L	N	N	N	N	N	A	0	N	N	Y	I	.
B19	11	340	23.6	5.8	R	B	10.4	1	M	N	N	N	A	N	N	0	L	N	Y	I	.
B19	12	341	32.8	6.9	R	.	8.8	1	M	N	N	N	A	A	A	0	N	N	N	I	.
B19	13	342	33.8	8.1	R	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	14	343	37.5	3.8	R	.	2.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	15	344	39.2	1.2	R	A	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	16	345	39.3	1.5	R	B	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	17	346	42.5	5.2	R	.	9.7	1	M	N	N	N	A	A	A	0	L	N	Y	I	.
B19	18	347	43.8	9.8	R	.	4.0	8	U	N	N	N	N	N	N	0	N	N	N	S	.
B19	19	349	45.3	9.8	R	A	5.4	11	??	.	.	.	.	.	.	.	N	L	N	D	F
B19	20	350	50.3	9.8	R	B	6.2	11	??	.	.	.	.	.	.	.	N	N	N	D	F
B19	21	348	54.0	1.0	L	.	7.6	5	L	N	N	N	A	N	N	0	N	N	N	I	.
B19	22	351	64.3	11.4	R	A	2.6	11	??	.	.	.	.	.	.	.	L	N	N	D	F
B19	23	352	64.3	11.4	R	B	3.4	11	??	.	.	.	.	.	.	.	N	L	N	D	F
B19	24	353	64.3	11.4	R	C	3.1	11	??	.	.	.	.	.	.	.	N	L	N	D	F
B19	25	354	72.4	14.2	R	.	12.8	2	U	N	N	N	N	N	N	0	N	N	Y	H	.
B19	26	355	79.0	6.1	R	.	14.5	11	??	.	.	.	.	.	.	.	H	H	??	D	F
B19	27	356	123.5	9.2	L	.	5.4	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B19	28	358	140.4	6.6	R	.	6.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B19	29	357	141.8	7.5	R	.	14.5	2	U	N	N	N	N	N	N	0	M	N	Y	H	.
B19	30	359	145.7	2.5	R	.	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	1	360	0.0	0.0	I	A	15.9	1	L	N	N	N	A	N	N	0	N	N	N	I	.
B20	2	362	0.6	2.6	R	C	10.9	1	M	N	N	N	A	N	N	0	N	N	N	I	.
B20	3	361	1.0	1.2	R	B	6.8	5	U	N	N	N	N	N	N	0	L	H	Y	H	.
B20	4	363	7.8	1.0	R	.	4.5	3	L	N	N	N	A	N	N	0	L	M	N	I	.
B20	5	364	10.3	7.5	R	.	11.6	11	U	U	U	U	U	U	U	0	H	H	N	D	F
B20	6	365	12.0	4.3	L	.	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	7	366	18.8	2.5	R	A	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	8	367	19.2	3.6	R	B	0.3	2	L	N	I	N	N	A	N	0	N	N	N	I	.
B20	9	368	19.3	4.0	R	C	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	10	370	21.4	5.9	L	.	5.3	1	M	N	N	N	N	A	N	0	N	N	N	H	.

Plot	No.	TreeTag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B20	11	369	21.7	3.8	L	.	0.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	12	371	25.3	1.0	R	A	0.9	6	L	N	N	N	N	N	A	0	N	H	N	S	.
B20	13	372	25.3	1.0	R	B	2.3	1	L	N	A	N	.	.	.	80	L	M	N	I	.
B20	14	374	27.3	8.0	R	.	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	15	373	28.1	5.7	R	.	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	16	375	35.3	9.1	R	.	1.7	1	L	N	N	N	I	A	N	0	N	L	N	I	.
B20	17	376	36.6	7.6	R	.	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	18	377	38.5	4.9	L	A	8.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	19	378	38.5	5.4	L	B	6.3	11	??	U	U	U	U	U	U	0	H	H	N	D	U
B20	20	379	43.6	2.6	R	.	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	21	380	47.6	13.3	R	.	0.9	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B20	22	382	52.8	10.8	L	.	1.0	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B20	23	381	53.3	10.3	R	.	11.3	4	L	I	N	N	N	N	N	100	N	L	Y	S	.
B20	24	383	69.4	1.6	R	A	1.3	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B20	25	384	69.8	1.6	R	B	0.5	10	U	N	N	N	N	N	N	0	N	L	N	H	.
B20	26	385	71.1	8.3	R	A	7.3	1	L	N	N	N	A	A	N	0	N	N	Y	I	.
B20	27	386	71.7	7.8	R	B	5.5	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B20	28	387	76.2	14.5	L	A	2.4	1	L	N	A	N	.	.	.	100	N	M	Y	S	.
B20	29	388	77.2	14.9	L	B	1.8	2	U	N	N	N	N	N	N	0	N	L	N	H	.
B20	30	389	77.5	14.5	L	C	0.9	11	??	U	U	U	U	U	U	??	H	H	N	D	U
B20	31	390	80.6	5.2	R	.	3.6	2	U	N	N	N	N	N	N	0	N	L	??	H	.
B20	32	391	84.3	4.4	R	.	0.5	9	U	N	N	N	N	N	N	0	M	M	N	H	.
B20	33	392	106.1	14.4	R	.	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	34	393	108.0	14.7	R	.	1.9	2	U	N	N	N	N	N	N	0	N	M	N	H	.
B20	35	394	111.9	6.2	R	A	1.6	2	U	N	N	N	N	N	N	0	N	M	N	H	.
B20	36	396	112.3	10.5	R	.	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B20	37	395	112.4	6.4	R	B	0.7	3	L	N	N	N	A	N	N	0	N	N	N	I	.
B20	38	397	135.8	5.6	R	.	3.9	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B20	39	398	136.3	9.2	R	.	1.8	1	L	N	N	N	I	A	N	0	N	L	N	I	.
B20	40	399	138.5	1.4	L	.	1.1	2	U	N	N	N	N	N	N	0	N	M	N	H	.
B20	41	400	146.3	5.6	R	.	1.2	2	L	N	N	N	A	N	N	0	N	N	Y	I	.
B21	1	265	0.0	0.0	I	A	2.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	2	403	1.2	0.4	R	D	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	3	401	1.4	2.6	R	B	7.1	1	L	N	N	I	N	N	D	50	N	M	Y	I	.
B21	4	402	1.4	2.0	R	C	7.1	5	L	N	I	A	N	N	A	60	L	H	Y	S	.
B21	5	404	2.1	1.3	R	E	1.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	6	409	35.3	13.2	R	A	6.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B21	7	410	35.7	13.1	R	B	8.0	1	L	N	N	N	A	N	N	0	N	N	Y	I	.
B21	8	405	35.9	7.8	R	A	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	9	406	36.3	7.9	R	B	11.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B21	10	407	36.5	7.6	R	C	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	11	411	36.8	13.3	R	C	4.0	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B21	12	408	36.9	7.5	R	D	3.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	13	412	50.2	3.1	R	A	3.1	1	L	U	N	N	N	A	N	0	N	N	N	I	.
B21	14	413	50.3	2.9	R	B	3.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	15	417	53.2	6.2	R	.	4.3	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	16	414	53.7	3.0	R	A	7.8	1	L	A	N	N	A	.	.	33	N	N	Y	I	.
B21	17	415	54.6	2.8	L	B	11.9	1	U	N	N	N	N	N	N	0	L	L	Y	I	.
B21	18	416	54.7	4.7	L	.	2.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B21	19	418	114.2	13.1	L	.	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B22	1	419	0.0	0.0	I	.	6.6	2	M	N	N	A	N	N	A	70	L	N	N	S	.
B22	2	420	95.5	4.4	L	A	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B22	3	421	95.1	4.2	L	B	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B22	4	422	106.2	1.0	R	.	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B23	1	424	117.5	1.9	L	B	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B23	2	423	117.7	1.7	L	A	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B23	3	425	142.4	2.6	L	A	2.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B23	4	426	142.6	2.0	L	B	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B23	5	427	143.1	2.3	L	C	3.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B23	6	428	150.0	0.0	L	.	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	1	429	0.0	0.0	I	A	2.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	2	432	0.7	0.6	L	D	5.1	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	3	430	1.0	0.3	R	B	5.2	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	4	433	1.2	0.9	L	E	3.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	5	434	1.6	0.5	L	F	3.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B24	6	431	1.7	0.6	R	C	4.4	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B25	1	435	0.0	0.0	I	A	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	2	438	0.0	10.7	L	.	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	3	436	0.8	0.2	L	B	1.0	11	.	.	.	.	.	.	.	.	H	H	N	D	U
B25	4	437	1.3	1.0	L	C	2.6	1	L	N	N	N	N	A	N	0	N	N	N	I	.
B25	5	439	17.1	12.0	L	.	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	6	440	26.3	3.7	L	A	2.7	1	L	A	N	A	N	N	N	15	L	N	N	I	.
B25	7	441	26.3	2.7	L	B	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	8	445	38.3	2.5	L	D	4.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	9	443	38.8	0.9	L	B	5.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	10	444	39.0	19.0	L	C	9.4	1	L	N	N	N	A	N	N	0	L	N	N	I	.
B25	11	442	39.7	1.0	L	A	4.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot	No.	TreeTag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B25	12	446	50.5	9.4	L	.	2.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B25	13	447	55.9	12.8	L	.	9.7	2	L	U	U	U	I	U	U	0	M	N	Y	I	.
B25	14	448	72.2	11.2	L	.	8.6	11	.	.	.	.	.	.	.	.	H	H	??	D	U
B25	15	449	77.8	11.2	L	.	9.0	1	L	N	N	N	I	N	N	0	N	N	N	I	.
B25	16	450	97.8	7.3	L	.	14.0	3	L	N	N	N	I	A	N	0	L	M	Y	I	.
B25	17	451	149.0	11.8	L	.	2.8	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B26	1	454	0.4	1.4	L	C	11.4	1	L	N	N	N	N	I	N	0	N	N	Y	I	.
B26	2	453	1.3	0.5	L	B	7.5	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B26	3	457	1.3	1.7	L	E	2.4	11	.	.	.	.	.	.	.	.	H	H	Y	D	B
B26	4	459	1.8	1.4	L	G	11.9	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B26	5	456	2.0	0.5	L	D	7.0	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B26	6	452	2.2	0.0	I	A	3.7	4	U	N	N	N	N	N	N	0	M	N	Y	H	.
B26	7	458	2.4	2.6	L	F	3.4	1	L	N	N	N	N	A	N	0	N	N	Y	I	.
B26	8	460	7.8	12.9	R	.	5.1	1	L	N	N	N	N	A	N	0	N	N	N	I	.
B26	9	462	39.8	14.0	R	B	12.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B26	10	461	40.1	12.8	R	A	5.0	3	L	N	N	N	N	D	N	0	N	L	N	I	.
B26	11	463	48.1	3.6	L	.	6.1	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B26	12	464	49.5	7.4	L	.	4.2	3	L	N	N	N	N	N	A	0	N	L	N	I	.
B26	13	465	78.5	4.5	L	A	0.7	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B26	14	455	79.4	4.5	L	B	1.0	11	.	.	.	.	.	.	.	.	N	L	N	D	U
B26	15	466	109.1	12.4	L	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B26	16	467	109.6	12.9	L	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B26	17	468	123.2	0.3	R	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B26	18	469	124.8	8.5	L	A	2.8	1	L	N	N	N	I	N	N	0	N	N	N	I	.
B26	19	470	125.0	8.9	L	B	1.6	2	L	N	N	N	A	A	N	0	N	N	N	I	.
B26	20	471	125.0	8.7	L	C	1.2	1	L	N	N	N	N	D	N	0	N	N	N	I	.
B27	1	472	0.0	0.0	I	A	2.5	1	L	N	N	N	A	N	I	0	N	N	N	I	.
B27	2	473	0.0	0.3	L	B	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	3	474	0.6	0.5	L	C	3.1	1	L	N	N	N	N	N	A	0	N	L	N	I	.
B27	4	475	0.8	0.0	L	D	3.5	1	L	N	N	N	N	A	N	0	N	L	N	I	.
B27	5	476	1.5	0.3	L	E	5.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	6	477	7.4	1.7	R	.	5.2	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	7	478	19.3	5.4	L	.	3.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	8	479	40.3	12.4	R	.	3.0	1	L	N	N	N	N	A	N	0	N	L	N	I	.
B27	9	480	130.3	12.0	R	A	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	10	481	130.4	11.9	R	B	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	11	482	130.6	12.2	R	C	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	12	483	135.9	9.0	R	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	13	484	138.8	7.3	R	.	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	14	485	139.6	13.2	R	A	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	15	486	140.0	13.4	R	B	3.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	16	487	140.0	13.0	R	C	1.0	3	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	17	488	144.6	4.2	L	A	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	18	489	145.0	4.2	L	B	1.6	2	L	N	N	N	N	D	N	0	N	N	N	I	.
B27	19	490	145.1	3.8	L	C	2.3	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	20	491	145.9	1.7	R	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	21	493	149.1	4.7	L	B	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	22	492	149.3	4.9	L	A	1.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B27	23	494	149.3	4.7	L	C	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	1	496	0.0	0.0	I	B	10.1	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B28	2	495	0.2	1.5	R	A	12.2	2	M	N	N	N	I	A	N	0	M	N	Y	I	.
B28	3	497	1.3	0.0	I	C	10.7	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
B28	4	498	52.3	11.1	L	.	5.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	5	501	62.5	5.8	L	A	8.1	1	L	N	N	N	N	A	N	0	L	N	N	I	.
B28	6	502	62.8	6.6	L	B	8.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	7	499	62.9	6.9	L	A	3.5	1	U	N	N	N	N	N	N	0	N	N	N	I	.
B28	8	500	63.3	6.4	L	B	7.0	1	L	N	N	N	N	A	N	0	N	L	N	H	.
B28	9	503	64.2	11.4	L	C	8.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	10	504	80.3	10.6	R	A	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	11	505	80.6	10.7	R	B	4.3	1	L	N	N	N	A	A	N	0	L	N	N	I	.
B28	12	506	81.6	10.3	R	C	5.8	1	L	N	N	N	A	A	N	0	L	N	N	I	.
B28	13	507	81.6	11.1	R	D	5.6	1	L	N	N	N	N	A	I	0	L	N	N	I	.
B28	14	509	112.8	12.4	L	B	2.4	3	L	I	N	N	N	A	N	30	N	N	N	H	.
B28	15	510	112.8	14.1	L	C	6.4	2	M	N	N	N	I	A	A	0	L	N	N	I	.
B28	16	508	113.1	12.1	L	A	0.7	8	U	N	N	N	N	N	N	0	N	M	N	H	.
B28	17	511	114.2	13.3	L	D	13.0	2	M	N	N	N	A	A	N	0	L	N	Y	I	.
B28	18	512	122.7	3.0	L	.	2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	19	513	135.2	4.8	L	A	5.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	20	514	135.2	4.2	L	B	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	21	515	136.2	4.2	L	C	4.2	1	M	N	N	N	N	A	N	0	N	N	N	I	.
B28	22	516	136.7	4.1	L	D	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	23	517	149.0	13.0	R	A	4.1	2	L	N	N	N	N	A	N	0	N	N	N	I	.
B28	24	518	149.8	14.1	R	B	5.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B28	25	519	150.4	14.1	R	C	6.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	1	520	0.0	0.0	I	A	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	2	522	0.1	0.5	L	B	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	3	521	0.4	0.3	R	C	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot	No.	TreeTag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B29	4	540	2.3	10.6	L		0.8	1	L	N	U	N	N	N	A	0	N	N	N	I	.
B29	5	523	3.3	3.8	R	A	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	6	524	3.6	4.3	R	B	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	7	539	3.6	13.0	L	.	1.7	1	L	N	N	N	N	N	N	0	N	N	N	I	.
B29	8	527	4.6	9.8	R	A	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	9	528	4.6	9.6	R	B	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	10	525	5.4	5.1	R	A	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	11	526	5.7	4.8	R	B	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	12	529	7.3	9.8	R	A	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	13	530	8.0	9.4	R	B	2.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	14	537	8.0	10.4	L	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	15	531	8.3	9.9	R	C	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	16	538	8.3	12.6	L	.	0.7	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	17	532	8.6	9.7	R	D	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	18	533	9.4	0.2	L	.	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	19	534	9.5	4.0	L	.	8.2	2	U	N	N	N	N	N	N	0	L	L	N	H	.
B29	20	536	11.3	8.8	L	.	6.2	4	U	N	N	N	N	N	N	0	M	M	N	H	.
B29	21	535	13.8	2.1	L	.	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	22	541	17.0	2.7	R	A	6.0	11	??	.	.	.	.	.	.	.	M	Y	Y	D	B
B29	23	542	17.0	0.9	R	B	6.3	11	??	.	.	.	.	.	.	.	M	M	Y	D	B
B29	24	543	17.3	2.1	L	A	10.0	11	??	.	.	.	.	.	.	.	M	N	Y	D	U
B29	25	544	17.7	2.2	L	B	5.3	11	??	.	.	.	.	.	.	.	N	L	Y	D	U
B29	26	545	26.6	5.5	L		8.4	2	L	N	N	I	N	N	I	60	N	M	Y	I	.
B29	27	546	29.7	5.3	L	.	2.0	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B29	28	547	30.3	4.9	L	A	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	29	548	30.4	4.3	L	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	30	549	36.2	9.7	L	A	0.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	31	551	36.5	10.2	L	C	8.2	2	L	N	N	I	N	N	I	10	L	N	Y	I	.
B29	32	552	36.8	10.1	L	D	5.5	3	M	N	A	N	A	A	A	70	M	M	Y	S	.
B29	33	550	37.5	10.2	L	B	0.6	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B29	34	553	37.6	10.8	L	E	1.1	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B29	35	554	38.2	10.2	L	F	2.6	3	L	I	N	N	N	N	N	100	N	L	N	I	.
B29	36	555	38.7	9.5	L	G	0.8	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	37	556	47.3	4.9	L	.	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	38	557	51.9	14.3	R	.	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	39	584	56.3	12.0	R	.	0.7	6	U	N	N	N	N	N	N	0	L	L	N	H	.
B29	40	558	59.2	11.0	R	.	0.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	41	565	61.6	14.3	L	.	0.4	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B29	42	560	65.3	5.8	L	A	8.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	43	559	65.8	3.8	L	.	6.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	44	561	66.1	6.2	L	B	8.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	45	562	66.6	7.0	L	C	8.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	46	563	66.6	5.8	L	D	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	47	564	67.4	11.0	R	.	1.6	2	U	N	N	N	N	N	N	0	M	H	N	H	.
B29	48	566	75.4	8.1	L	A	3.9	8	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	49	567	75.8	8.6	L	B	7.4	1	U	N	N	N	N	N	N	0	N	L	N	H	.
B29	50	568	76.5	9.4	L	C	2.5	5	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	51	569	105.2	13.6	R	.	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	52	570	119.8	10.2	R	.	6.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	53	571	125.7	4.7	R	A	5.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	54	573	126.1	4.9	R	C	5.8	2	L	N	N	N	I	N	D	0	N	L	N	I	.
B29	55	572	126.3	3.9	R	B	3.0	11	M	D	D	D	N	N	N	100	N	H	N	D	R
B29	56	574	129.4	15.0	L	A	6.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	57	575	130.7	14.6	L	B	9.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	58	576	136.5	10.6	L	.	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	59	579	140.0	2.7	R	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	60	580	140.3	2.7	R	B	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	61	577	141.6	5.9	L	A	0.8	1	L	I	N	N	N	N	N	100	N	N	N	I	.
B29	62	578	141.9	5.6	L	B	4.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	63	581	144.4	6.0	R	.	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	64	582	149.8	4.9	R	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B29	65	583	149.9	5.1	R	B	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	1	585	0.0	0.0	I	.	11.5	2	M	N	N	N	N	A	N	0	L	N	N	I	.
B30	2	586	0.6	8.1	R	.	1.9	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	3	587	9.8	8.4	R	.	5.2	1	L	N	N	N	N	A	N	0	N	N	N	I	.
B30	4	588	10.4	3.6	L	.	3.0	1	L	N	N	N	N	A	N	0	N	N	N	I	.
B30	5	589	10.7	7.0	L	A	2.3	1	L	N	N	N	D	N	N	0	N	N	N	I	.
B30	6	590	10.8	7.7	L	B	0.5	3	U	N	N	N	N	N	N	0	N	M	N	H	.
B30	7	593	16.8	7.4	R	A	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	8	594	17.1	7.8	R	B	1.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	9	591	17.2	12.3	L	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	10	592	19.0	8.4	L	.	0.7	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	11	595	23.3	1.2	R	.	2.3	1	U	N	N	N	N	N	N	0	N	M	N	H	.
B30	12	596	26.5	8.4	R	A	2.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	13	597	26.9	8.6	R	B	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	14	598	34.8	14.3	R	.	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	15	599	39.3	2.8	L	.	3.4	2	U	N	N	N	N	N	N	0	L	L	N	H	.

Plot	No.	TreeTag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
B30	16	600	41.1	6.1	L	.	1.7	2	L	N	N	N	N	I	N	0	L	L	N	I	.
B30	17	608	42.3	4.7	L	B	1.8	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	18	607	42.4	5.0	L	A	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	19	609	43.6	1.2	L	A	2.5	1	L	N	N	N	N	I	N	0	N	N	N	I	.
B30	20	601	43.7	8.9	L	A	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	21	610	43.7	0.7	L	B	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	22	602	43.8	9.2	L	B	0.7	1	U	N	N	N	N	N	N	0	L	N	N	H	.
B30	23	603	43.9	9.5	L	C	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	24	605	43.9	8.9	L	E	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	25	606	44.0	6.5	L	.	2.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	26	604	44.5	9.0	L	D	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	27	612	46.8	10.9	L	B	0.9	3	U	N	N	N	N	N	N	0	L	L	N	H	.
B30	28	611	47.1	10.3	L	A	2.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	29	613	55.7	7.2	R	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	30	616	56.3	6.4	R	D	3.4	1	M	N	A	N	.	.	.	100	L	L	N	S	.
B30	31	614	56.8	7.2	R	B	5.3	4	M	N	A	A	.	.	.	80	M	H	N	S	.
B30	32	615	56.9	6.4	R	C	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	33	618	58.8	11.8	L	.	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	34	619	59.8	12.3	L	.	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	35	617	61.0	10.5	L	.	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	36	620	82.8	6.8	R	.	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	37	634	87.3	1.0	L	.	2.4	1	L	N	N	N	N	N	A	0	N	N	N	I	.
B30	38	621	95.9	2.7	L	.	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	39	622	97.1	11.8	L	.	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	40	623	106.1	4.3	L	A	0.8	3	U	N	N	N	N	N	N	0	N	L	N	H	.
B30	41	624	106.2	4.6	L	B	2.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	42	625	106.3	5.0	L	C	2.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	43	626	106.6	4.5	L	D	3.6	3	U	N	N	N	N	N	N	0	N	L	N	H	.
B30	44	627	107.1	4.5	L	E	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	45	628	114.0	9.8	L	A	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	46	629	114.0	10.3	L	B	2.7	1	L	N	N	N	I	N	N	0	N	N	N	I	.
B30	47	631	114.3	9.9	L	D	5.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	48	630	114.5	10.7	L	C	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	49	632	127.3	5.2	L	.	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
B30	50	633	129.0	1.0	L	.	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L1	1	635	0.0	0.0	I	A	4.7	1	L	N	N	N	A	N	N	0	N	L	Y	S	.
L1	2	637	1.2	0.5	R	C	7.2	11	L	N	N	N	D	N	N	0	N	L	Y	D	B
L1	3	638	1.8	2.0	R	D	4.9	11	?	.	.	.	.	.	.	0	H	H	Y	D	B
L1	4	639	2.3	6.3	R	.	2.4	5	U	N	N	N	N	N	N	0	L	H	N	H	.
L1	5	636	5.0	1.3	R	B	5.2	11	L	N	N	N	D	N	N	0	N	M	Y	D	B
L1	6	640	6.6	1.4	R	.	4.0	2	L	N	N	N	I	I	N	0	N	N	N	I	.
L1	7	641	17.5	3.7	R	A	6.1	11	M	D	N	N	D	.	.	90	N	L	Y	D	B
L1	8	642	17.5	7.9	R	B	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L1	9	643	23.6	5.8	L	A	7.2	6	L	I	N	N	N	N	N	100	M	L	N	I	.
L1	10	644	24.3	6.0	L	B	7.5	2	L	N	N	N	I	N	I	0	L	L	N	I	.
L1	11	645	28.9	6.7	L	.	5.5	3	M	I	N	N	.	.	.	100	N	M	N	I	.
L1	12	646	31.3	2.2	L	.	6.0	1	M	N	N	N	A	I	N	0	N	N	N	I	.
L1	13	647	38.6	9.5	R	.	0.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L1	14	648	43.5	2.8	R	A	3.1	2	L	N	N	N	A	I	N	0	N	N	N	I	.
L1	15	649	44.2	2.3	R	B	1.4	10	L	N	N	N	D	N	N	0	N	N	N	S	.
L1	16	650	50.1	2.4	R	.	1.1	8	L	N	I	N	.	.	.	100	N	M	N	S	.
L1	17	651	54.3	0.9	R	.	3.0	4	L	N	N	N	N	N	A	0	N	N	N	I	.
L1	18	652	59.3	5.9	L	A	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L1	19	653	59.6	6.1	L	B	0.8	2	L	N	N	N	N	D	D	0	N	N	N	I	.
L1	20	654	76.2	1.7	R	.	1.0	8	L	N	N	N	N	D	D	0	N	L	N	I	.
L1	21	656	86.3	2.8	L	A	2.2	2	L	I	N	N	.	.	.	100	N	L	N	I	.
L1	22	655	96.0	4.0	L	.	6.3	1	M	N	N	N	I	A	N	0	L	N	N	I	.
L1	23	657	96.9	2.7	L	B	2.8	3	M	N	N	N	I	I	N	0	N	N	N	I	.
L1	24	658	103.5	0.2	R	.	2.2	6	L	D	N	N	N	N	N	100	N	L	N	I	.
L1	25	660	111.1	9.6	L	.	8.5	2	L	N	N	N	I	I	N	0	L	L	N	I	.
L1	26	659	111.6	4.2	L	.	7.1	1	L	N	N	N	I	N	N	0	N	N	N	I	.
L1	27	661	113.5	4.7	R	.	5.2	1	L	N	N	N	N	D	N	0	N	N	Y	I	.
L1	28	662	120.0	11.2	R	.	8.5	1	L	N	N	N	D	N	N	0	L	N	N	I	.
L1	29	667	123.1	11.0	L	A	7.0	1	M	N	N	N	N	I	I	0	M	N	N	I	.
L1	30	668	124.1	10.8	L	B	1.8	6	L	N	D	N	N	N	D	100	M	L	N	I	.
L1	31	663	127.7	1.7	R	A	2.1	5	L	N	N	N	I	N	N	0	L	N	N	I	.
L1	32	664	128.2	1.7	R	B	3.1	5	L	N	N	N	A	I	N	0	N	N	N	I	.
L1	33	665	128.7	4.3	L	A	3.2	11	L	D	N	N	.	.	.	100	N	L	Y	D	B
L1	34	666	128.8	3.6	L	B	4.6	11	L	D	N	N	.	.	.	100	N	M	Y	D	B
L2	1	669	0.0	0.0	I	.	3.6	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L2	2	670	5.3	14.6	L	.	3.5	1	L	N	N	N	N	N	A	0	N	N	N	I	.
L2	3	671	86.7	10.9	R	A	1.8	1	L	N	I	N	A	N	N	25	N	L	N	I	.
L2	4	672	87.0	10.4	R	B	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L2	5	673	89.3	9.8	R	A	0.8	1	L	N	N	D	U	N	N	50	N	N	N	I	.
L2	6	674	89.3	9.8	R	B	1.7	8	L	I	N	N	.	.	.	100	N	N	N	I	.
L2	7	675	141.4	8.9	L	.	7.2	1	M	N	N	N	I	I	N	0	L	N	Y	I	.
L3	1	676	0.0	0.0	I	A	1.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
L3	2	677	0.5	0.0	I	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L3	3	678	0.9	0.4	R	C	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L3	4	679	6.3	1.3	L	A	1.7	9	M	N	N	A	.	.	.	100	H	H	N	S	.
L3	5	680	6.3	1.6	L	B	1.5	1	L	A	N	N	.	.	A	50	N	N	N	I	.
L3	6	682	32.0	10.0	L	A	3.5	2	M	N	N	N	A	A	A	0	L	N	N	S	.
L3	7	683	32.4	9.8	L	B	3.0	5	M	N	I	N	N	N	N	100	N	N	N	S	.
L3	8	684	32.6	9.6	L	C	3.2	7	H	I	I	I	I	I	I	100	N	N	N	S	.
L3	9	685	88.0	5.8	R	.	9.1	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
L3	10	687	111.3	12.6	L	.	3.9	1	L	N	N	N	N	A	A	0	N	N	N	I	.
L3	11	686	111.8	10.4	L	.	1.7	11	L	N	N	D	.	.	.	100	N	M	N	D	R
L3	12	688	126.4	7.7	L	.	3.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L4	1	681	0.0	0.0	I	A	3.7	1	U	N	N	N	N	N	N	0	N	N	N	U	.
L4	2	689	0.6	0.2	L	B	3.7	2	U	N	N	N	N	N	N	0	L	L	N	U	.
L4	3	690	1.3	0.4	L	C	4.3	1	U	N	N	N	N	N	N	0	N	N	N	U	.
L4	4	691	10.8	1.1	L	A	4.6	11	M	N	D	D	.	.	.	100	L	M	N	R	R
L4	5	692	11.6	1.5	L	B	3.8	9	M	D	I	I	.	.	.	100	H	H	N	S	.
L4	6	693	82.3	11.8	R	A	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L4	7	694	83.3	12.5	R	B	2.5	1	L	N	N	N	N	D	D	0	N	N	N	I	.
L4	8	695	83.4	11.7	R	C	5.4	9	M	I	N	N	.	.	.	100	H	H	N	S	.
L4	9	696	83.8	12.7	R	D	2.5	9	M	N	N	I	.	.	.	100	N	N	N	I	.
L4	10	698	84.9	2.0	L	A	7.7	3	M	N	I	A	.	.	.	60	H	H	N	S	.
L4	11	697	85.1	11.5	R	E	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L4	12	699	86.6	3.7	L	B	8.2	7	M	N	I	N	.	I	I	100	H	H	N	S	.
L4	13	701	108.3	8.0	L	A	2.0	2	U	N	N	N	N	N	N	0	N	N	N	S	.
L4	14	700	108.7	1.7	L	.	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L4	15	702	109.7	8.5	L	B	6.6	11	M	N	D	N	D	D	D	100	N	L	N	D	R
L4	16	703	109.9	9.8	L	C	9.3	11	H	D	D	D	.	.	.	100	M	M	N	D	R
L4	17	706	110.4	6.2	R	B	4.0	11	M	N	N	D	.	.	.	100	M	H	N	D	R
L4	18	704	110.6	10.6	L	D	8.4	11	M	D	D	D	.	.	.	100	M	M	N	D	R
L4	19	705	110.9	5.7	R	A	3.2	11	M	N	N	D	.	.	.	100	N	H	N	D	R
L4	20	707	111.3	6.3	R	C	4.5	1	L	N	N	N	N	A	A	0	L	N	N	I	.
L5	1	708	0.0	0.0	I	A	9.2	11	M	D	D	D	.	.	.	100	M	L	Y	R	R
L5	2	709	0.7	0.7	L	B	3.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	3	710	4.2	14.8	L	A	1.7	1	L	N	N	N	N	N	D	0	N	L	N	I	.
L5	4	711	4.7	14.9	L	B	3.0	1	L	N	N	N	N	D	N	0	L	L	N	I	.
L5	5	712	4.8	14.5	L	C	2.6	1	L	N	N	I	.	.	.	25	L	N	N	I	.
L5	6	713	5.4	14.8	L	D	0.9	1	L	I	N	N	.	.	.	15	N	N	N	I	.
L5	7	714	5.7	15.0	L	E	1.5	1	U	N	N	N	N	N	N	0	N	L	N	I	.
L5	8	715	19.3	13.8	L	A	2.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	9	716	20.1	13.8	L	B	2.5	2	U	N	N	N	N	N	N	0	N	L	N	H	.
L5	10	717	20.5	13.4	L	C	3.2	6	M	N	A	N	.	.	.	100	H	H	N	H	.
L5	11	718	31.0	9.8	R	.	3.0	1	L	N	N	N	N	D	N	0	N	N	N	S	.
L5	12	719	59.1	7.4	L	.	1.8	1	L	N	N	I	.	.	A	80	N	N	N	I	.
L5	13	720	63.4	9.0	L	A	3.4	1	L	N	N	D	.	.	D	33	N	N	N	I	.
L5	14	721	64.1	9.0	L	B	3.9	1	L	N	N	N	N	I	N	0	N	N	N	I	.
L5	15	722	66.3	93.0	L	C	3.5	1	L	N	I	N	N	I	N	20	N	M	N	I	.
L5	16	723	79.4	4.4	R	A	2.5	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	17	724	79.9	4.5	R	B	3.6	3	L	N	N	N	I	N	N	0	N	L	N	I	.
L5	18	725	80.1	3.9	R	C	3.5	11	L	D	N	N	N	N	N	0	N	L	N	D	R
L5	19	726	98.5	9.3	L	A	2.2	2	U	N	N	N	N	N	N	0	N	L	N	H	.
L5	20	727	98.5	9.0	L	B	4.0	9	M	N	N	I	.	.	.	100	N	H	N	S	.
L5	21	731	99.1	9.8	L	F	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	22	728	99.2	8.6	L	C	3.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	23	732	99.3	9.1	L	G	2.8	1	L	N	N	N	N	N	D	0	N	N	N	I	.
L5	24	730	99.8	9.2	L	E	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	25	729	100.0	8.6	L	D	2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	26	735	113.2	7.0	R	C	0.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	27	733	113.3	6.5	R	A	4.9	8	H	N	A	N	.	.	.	100	H	H	N	S	.
L5	28	734	114.3	6.2	R	B	8.3	1	L	N	N	N	N	I	A	0	N	N	N	I	.
L5	29	736	128.0	6.8	L	.	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	30	737	133.1	3.8	R	A	5.7	1	L	N	N	N	N	A	A	0	L	N	N	I	.
L5	31	738	133.5	3.1	R	B	2.6	5	L	N	A	N	.	.	.	100	L	H	N	S	.
L5	32	739	137.3	2.4	L	.	4.9	1	M	N	N	N	N	I	A	100	N	N	N	I	.
L5	33	740	139.8	14.3	R	A	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	34	741	140.3	13.8	R	B	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	35	743	140.8	14.6	R	D	2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L5	36	742	141.1	13.6	R	C	2.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	1	744	0.0	0.0	.	A	3.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	2	745	1.3	0.0	.	B	4.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	3	749	1.4	10.3	L	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	4	750	1.8	10.4	L	B	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	5	746	3.9	1.8	L	A	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	6	747	4.2	2.0	L	B	1.9	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	7	748	4.4	2.2	L	C	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	8	751	10.9	0.4	R	A	2.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	9	753	11.6	0.8	L	C	5.0	8	M	D	I	N	.	.	.	100	M	M	N	S	.
L6	10	752	11.8	1.0	L	B	3.9	2	L	N	N	N	I	I	N	0	L	N	N	I	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
L6	11	754	16.5	4.2	L	A	5.7	3	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	12	756	16.8	1.2	L	.	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	13	755	17.7	4.5	L	B	1.3	10	L	N	D	A	.	.	.	80	M	H	N	S	.
L6	14	757	22.8	3.2	R	A	2.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	15	758	23.3	3.3	R	B	1.7	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	16	759	23.8	2.0	R	C	8.9	1	M	N	N	N	A	I	I	.	N	N	N	I	.
L6	17	760	29.3	3.2	L	A	4.9	10	L	N	I	N	.	.	.	100	L	H	N	S	.
L6	18	761	29.5	3.7	L	B	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	19	762	29.8	3.3	L	C	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	20	763	29.8	2.8	L	D	3.7	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	21	764	39.4	5.0	R	A	10.7	2	M	N	I	N	N	N	N	50	L	N	N	I	.
L6	22	765	40.7	4.7	R	B	7.8	2	L	I	N	N	.	.	.	20	L	L	N	I	.
L6	23	767	42.0	0.3	L		4.5	1	L	N	N	N	N	I	N	0	N	N	N	I	.
L6	24	766	42.6	4.7	R	C	6.6	1	L	N	N	N	I	I	N	0	L	N	N	I	.
L6	25	768	49.5	2.4	L	.	3.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	26	769	55.6	1.1	L		2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	27	55.6	57.2	6.1	L	A	5.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	28	771	57.8	6.5	L	B	6.0	8	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	29	772	65.9	8.6	R	.	7.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	30	778	69.7	2.6	L	A	1.1	11	L	N	N	D	.	.	.	100	N	M	N	D	R
L6	31	779	71.6	3.4	L	B	5.8	8	L	N	A	N	.	.	.	100	N	M	N	S	.
L6	32	773	71.7	6.7	R	A	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	33	774	72.0	6.8	R	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	34	775	72.3	6.7	R	C	3.0	3	L	N	N	N	D	N	N	0	L	N	N	I	.
L6	35	776	72.6	6.7	R	D	3.1	6	L	N	N	A	.	.	.	100	L	N	N	S	.
L6	36	777	72.6	6.2	R	E	5.6	3	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	37	780	76.3	1.0	R	.	3.7	11	L	N	N	D	.	.	.	100	M	M	N	D	R
L6	38	781	98.6	11.1	R	A	2.3	9	M	N	N	I	.	.	.	100	L	M	N	S	.
L6	39	782	99.7	10.4	R	B	3.7	6	M	N	N	I	.	.	.	100	M	H	Y	S	.
L6	40	784	100.1	11.5	R	D	4.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	41	783	100.2	10.6	R	C	4.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	42	785	108.7	7.9	L	.	6.1	1	L	N	I	A	.	.	A	65	L	N	N	I	.
L6	43	787	119.8	13.8	L	B	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	44	786	119.9	13.2	L	A	1.2	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	45	788	120.3	13.8	L	C	3.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	46	789	120.9	14.0	L	D	4.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	47	795	123.2	6.8	R	A	5.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	48	796	123.4	8.2	R	B	5.9	11	L	N	N	I	.	.	.	100	H	H	N	S	.
L6	49	790	123.5	4.3	L	A	1.3	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	50	797	124.2	8.2	R	C	6.1	5	U	N	N	N	N	N	N	0	N	N	N	S	.
L6	51	792	124.3	3.3	L	C	0.7	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	52	791	124.4	5.2	L	B	3.5	2	U	N	N	N	N	N	N	0	L	N	N	H	.
L6	53	793	125.3	3.6	R	A	4.5	3	L	N	A	N	.	.	.	100	N	M	N	S	.
L6	54	794	125.8	3.7	R	B	7.2	1	L	N	N	N	I	I	N	0	L	N	N	I	.
L6	55	799	133.9	5.8	R	A	3.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	56	798	134.0	0.2	L	.	3.7	6	M	N	I	N	.	.	.	100	L	M	N	S	.
L6	57	800	134.5	5.2	R	B	6.8	2	M	N	I	N	.	.	.	100	N	M	N	S	.
L6	58	801	135.0	4.7	R	C	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	59	802	135.6	6.1	R	D	4.5	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L6	60	803	135.6	5.3	R	E	1.2	5	L	A	N	N	.	.	.	100	N	M	N	I	.
L6	61	806	135.9	4.3	R	H	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	62	804	136.0	5.5	R	F	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	63	805	136.3	4.9	R	G	6.1	4	L	N	I	N	.	.	.	100	L	M	N	S	.
L6	64	809	136.3	5.6	R	K	3.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	65	807	136.4	4.3	R	I	2.4	1	L	N	N	N	A	N	N	0	N	N	N	I	.
L6	66	808	136.6	4.9	R	J	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	67	810	136.8	5.9	R	L	7.2	2	M	N	N	I	I	I	I	25	N	N	N	I	.
L6	68	811	139.1	1.7	R	A	3.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	69	812	139.4	1.0	R	B	4.7	8	M	I	I	I	.	.	.	100	M	H	N	S	.
L6	70	813	142.8	12.9	L	A	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	71	814	143.0	12.9	L	B	1.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	72	815	143.4	13.0	L	C	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	73	816	143.8	12.8	L	D	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L6	74	817	148.5	5.4	L	A	1.9	1	U	N	N	N	N	N	N	0	L	N	N	I	.
L6	75	818	148.6	5.0	L	B	7.3	3	M	N	N	A	.	.	.	100	N	M	Y	S	.
L6	76	819	148.6	5.7	L	C	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	1	820	0.0	0.0	I	.	3.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	2	822	6.5	9.8	R	B	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	3	821	6.9	8.7	R	A	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	4	823	6.9	9.2	R	C	3.2	11	L	N	N	D	.	.	.	100	L	L	N	D	R
L7	5	824	7.4	8.4	R	D	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	6	825	11.0	10.0	R	A	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	7	826	11.3	10.0	R	B	2.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	8	827	19.5	10.4	R	A	6.0	1	L	N	A	N	.	.	.	33	N	N	N	I	.
L7	9	828	20.3	10.0	R	B	3.1	11	??	.	.	.	.	.	.	0	N	N	N	D	U
L7	10	830	21.3	1.7	R	B	2.8	1	L	N	N	N	N	D	N	0	N	N	N	I	.
L7	11	829	21.6	1.4	R	A	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
L7	12	831	21.9	2.0	R	C	6.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	13	833	22.0	3.9	L	.	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	14	832	22.3	2.3	R	D	2.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	15	834	28.0	14.5	L	A	3.2	1	U	N	N	N	N	N	N	0	L	N	N	H	.
L7	16	835	28.4	14.6	L	B	3.5	5	L	I	I	N	.	.	.	100	M	M	N	I	.
L7	17	836	29.1	15.0	L	C	10.4	1	L	N	N	N	A	N	N	0	N	N	N	I	.
L7	18	837	38.3	3.8	R	.	3.5	8	L	I	I	N	.	.	.	100	N	M	N	I	.
L7	19	838	78.8	3.3	L	.	5.4	1	L	N	N	N	N	N	I	0	N	N	N	I	.
L7	20	839	83.2	1.2	L	.	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	21	840	85.1	2.5	R	.	1.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	22	841	95.5	2.3	R	A	0.9	7	L	N	N	A	.	.	.	100	M	M	N	S	.
L7	23	842	95.8	2.3	R	B	4.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	24	843	97.5	2.6	R	C	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	25	844	97.6	2.4	R	D	2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	26	845	103.1	2.0	R	.	4.0	5	L	N	I	N	.	.	.	100	N	.	N	S	.
L7	27	846	113.3	4.8	R	A	4.7	4	L	N	I	N	.	.	.	100	N	.	N	S	.
L7	28	847	113.8	5.0	R	B	4.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	29	848	119.8	4.9	R	A	1.4	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L7	30	849	120.0	5.2	R	B	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L7	31	850	120.3	5.0	R	C	3.4	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L7	32	851	146.2	4.0	R	A	6.3	1	M	N	N	A	I	A	.	15	L	N	N	S	.
L7	33	852	147.6	4.2	R	B	3.5	1	M	N	N	A	.	.	.	65	N	L	N	S	.
L8	1	853	0.0	1.2	L	A	10.4	2	L	N	I	N	N	I	N	30	L	N	N	I	.
L8	2	854	0.0	0.0	I	B	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	3	855	0.0	13.2	L	A	5.6	4	L	I	I	N	.	.	.	100	M	M	N	S	.
L8	4	856	0.1	14.9	L	B	3.6	2	L	N	I	N	.	.	.	75	M	N	N	S	.
L8	5	858	11.8	13.6	L	B	2.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	6	857	12.1	12.9	L	A	6.7	1	L	N	N	N	N	I	I	0	L	N	N	I	.
L8	7	859	22.6	10.9	L	.	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	8	860	25.6	1.5	R	.	1.8	1	U	N	N	N	N	N	N	0	N	L	N	H	.
L8	9	861	29.3	12.8	R	.	8.0	3	M	N	I	N	.	.	.	80	L	M	Y	S	.
L8	10	862	30.0	12.5	R	A	5.9	2	L	N	N	N	I	N	N	0	L	N	N	I	.
L8	11	863	30.3	12.1	R	B	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	12	864	31.8	15.8	R	A	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	13	865	31.8	15.0	R	B	0.9	1	L	N	N	N	I	N	N	0	N	N	N	I	.
L8	14	866	32.3	15.3	R	C	1.0	8	L	N	N	I	.	.	.	100	N	L	N	S	.
L8	15	867	33.1	11.5	R	.	2.9	3	M	N	A	A	.	.	.	100	L	M	N	S	.
L8	16	871	50.5	10.4	R	D	1.6	1	L	N	N	N	A	N	N	0	N	L	N	I	.
L8	17	868	50.7	9.4	R	A	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	18	872	50.8	11.1	R	E	3.3	2	L	N	N	N	D	I	N	0	N	L	N	I	.
L8	19	870	51.1	10.7	R	C	2.1	2	U	N	N	N	N	N	N	0	N	L	N	H	.
L8	20	869	51.3	10.2	R	B	2.5	3	L	I	I	N	.	.	A	66	N	N	N	S	.
L8	21	873	61.8	10.7	R	A	2.3	9	L	N	N	A	.	.	.	100	N	M	N	S	.
L8	22	874	62.3	10.4	R	B	2.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	23	875	62.8	10.8	R	C	4.8	3	M	N	N	A	.	.	.	70	L	L	N	S	.
L8	24	876	69.0	13.0	R	A	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	25	877	69.0	12.7	R	B	1.4	1	L	A	N	N	.	.	.	100	N	N	N	I	.
L8	26	882	73.0	12.3	R	E	3.8	5	L	N	I	N	.	.	.	100	L	M	N	I	.
L8	27	878	73.3	11.2	R	A	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	28	880	73.4	11.6	R	C	6.7	6	M	I	N	I	.	.	.	100	L	M	N	S	.
L8	29	881	73.4	12.1	R	D	5.1	3	L	N	A	N	.	.	.	90	L	L	N	S	.
L8	30	879	73.7	11.1	R	B	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	31	883	80.8	4.4	L	A	1.6	1	L	N	N	A	.	.	.	40	N	N	N	I	.
L8	32	884	81.3	4.1	L	B	2.5	1	L	N	N	A	.	.	.	20	L	N	N	I	.
L8	33	885	81.7	3.9	L	C	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	34	886	94.1	2.4	L	A	6.4	2	M	N	A	N	.	I	I	65	L	M	N	S	.
L8	35	887	94.8	2.5	L	B	5.2	8	M	N	A	N	.	.	.	100	M	H	N	S	.
L8	36	888	101.7	6.1	R	A	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	37	889	102.0	5.1	R	B	3.6	2	L	N	I	N	.	.	.	25	N	N	N	I	.
L8	38	891	107.5	2.7	R	.	2.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L8	39	890	108.3	9.5	R	.	3.4	2	L	N	N	N	I	N	A	0	N	N	N	I	.
L8	40	893	135.1	2.9	L	B	5.7	1	L	N	N	N	N	I	N	0	N	N	N	I	.
L8	41	892	135.5	1.9	L	A	2.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	1	894	0.0	0.0	I	A	4.2	1	L	N	N	A	.	.	.	40	L	N	N	I	.
L9	2	895	1.3	0.0	I	B	8.3	1	L	N	I	N	.	A	.	20	L	N	N	I	.
L9	3	896	1.6	1.4	R	C	1.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	4	897	1.8	0.7	L	D	6.0	2	L	N	A	N	.	.	.	55	L	L	N	I	.
L9	5	898	37.8	5.6	L	A	2.3	1	L	N	N	N	N	N	I	0	N	N	N	I	.
L9	6	899	38.4	5.3	L	B	2.8	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L9	7	900	38.4	5.6	L	C	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	8	902	38.8	9.8	R	A	5.3	1	L	I	N	N	N	N	N	0	N	N	N	I	.
L9	9	903	39.1	9.8	R	B	0.8	1	L	N	N	N	.	.	.	80	N	N	N	S	.
L9	10	904	43.4	12.0	R	A	0.7	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	11	905	43.8	11.8	R	B	2.9	7	L	N	I	N	N	N	N	100	M	H	N	S	.
L9	12	906	45.7	11.2	R	A	2.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	13	907	46.2	10.9	R	B	3.0	1	L	N	N	N	N	N	D	0	N	N	N	I	.
L9	14	908	46.2	11.7	R	C	2.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
L9	15	909	47.0	11.1	R	A	3.4	1	L	N	N	N	N	I	N	0	N	N	N	I	.
L9	16	910	47.4	11.0	R	B	3.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	17	911	50.8	13.8	R	A	2.6	11	M	N	N	I	.	.	.	100	H	H	N	S	.
L9	18	912	51.3	13.8	R	B	3.8	2	M	N	A	N	.	.	.	100	L	L	N	S	.
L9	19	913	51.6	13.5	R	C	4.3	1	L	N	N	A	.	.	.	50	N	L	N	S	.
L9	20	914	65.7	3.7	L	.	1.8	1	L	N	N	N	N	I	N	0	N	N	N	I	.
L9	21	915	68.4	2.6	R	.	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	22	916	77.0	7.1	R	.	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	23	917	95.8	12.0	L	.	5.8	1	L	N	I	N	.	.	.	100	L	M	N	I	.
L9	24	918	111.0	5.5	R	A	4.0	10	M	N	I	I	.	.	.	100	H	H	N	S	.
L9	25	919	111.3	6.2	R	B	4.1	2	L	N	N	A	.	.	.	100	L	L	N	I	.
L9	26	921	111.8	5.6	R	D	1.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	27	920	112.0	6.2	R	C	7.4	1	L	N	N	N	N	I	N	100	L	L	N	I	.
L9	28	922	112.2	5.6	R	E	2.2	4	L	A	N	N	.	.	.	100	N	L	N	I	.
L9	29	923	113.0	5.7	R	F	1.2	1	L	N	N	A	.	.	.	100	L	N	N	I	.
L9	30	924	120.7	5.9	L	.	5.9	2	L	N	I	A	.	.	.	100	M	M	N	S	.
L9	31	925	133.2	1.7	R	A	1.3	2	L	N	A	N	.	.	.	100	N	N	N	I	.
L9	32	926	133.3	1.8	R	B	3.0	1	L	N	A	N	.	.	.	60	L	N	N	I	.
L9	33	927	134.4	1.7	R	C	2.1	7	M	N	A	A	.	.	.	100	H	H	N	S	.
L9	34	929	135.1	5.9	R	B	8.2	1	L	N	N	A	.	.	.	100	L	M	N	I	.
L9	35	928	135.5	5.1	R	A	6.5	3	L	N	N	A	.	.	.	80	N	L	N	I	.
L9	36	930	147.3	9.3	R	A	1.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	37	931	147.8	8.9	R	B	4.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	38	932	148.3	9.3	R	C	5.1	1	L	N	I	N	.	.	.	100	L	M	N	I	.
L9	39	933	148.4	8.4	R	D	5.2	1	L	N	N	N	I	N	N	0	N	N	N	I	.
L9	40	934	148.8	9.1	R	E	2.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L9	41	935	149.1	9.3	R	F	3.2	11	M	I	I	I	.	.	.	100	L	M	N	S	.
L9	42	936	149.7	8.4	R	G	3.6	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L10	1	937	0.0	0.0	I	A	4.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	2	938	1.0	0.7	R	B	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	3	939	1.6	15.0	R	A	10.7	1	L	N	N	N	N	N	D	0	L	N	Y	I	.
L10	4	940	2.3	14.8	R	B	7.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
L10	5	941	13.3	11.7	L	.	1.3	2	L	N	N	N	D	N	N	0	N	N	N	I	.
L10	6	942	14.8	11.2	L	A	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	7	943	15.8	12.0	L	B	8.8	4	M	A	I	N	A	.	.	100	L	M	N	S	.
L10	8	944	17.9	5.2	L	.	6.0	1	L	N	N	N	N	I	A	0	N	N	N	I	.
L10	9	945	34.8	7.9	L	A	6.7	2	L	I	N	N	I	.	.	70	L	L	N	I	.
L10	10	946	35.6	7.7	L	B	8.9	2	M	U	U	N	.	.	.	50	L	L	N	I	.
L10	11	947	37.0	6.5	R	.	5.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	12	948	43.3	7.4	L	.	1.1	11	??	.	.	.	.	.	.	.	N	N	N	D	U
L10	13	949	45.7	12.6	L	A	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	14	950	46.5	12.6	L	B	1.5	3	U	N	N	N	N	N	N	0	L	N	N	H	.
L10	15	951	46.8	12.8	L	C	1.4	2	U	N	N	N	N	N	N	0	N	L	N	H	.
L10	16	952	46.9	12.5	L	D	2.5	3	L	I	N	N	.	.	.	100	N	L	N	I	.
L10	17	976	50.4	6.8	L	.	9.3	2	L	I	N	N	.	.	.	100	N	N	N	I	.
L10	18	953	50.8	14.8	L	A	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	19	954	51.4	14.6	L	B	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	20	955	52.0	14.8	L	C	0.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	21	956	52.3	14.7	L	D	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	22	957	52.3	13.1	L	A	6.9	1	U	N	N	N	N	N	N	0	N	L	N	H	.
L10	23	958	53.6	12.6	L	B	9.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	24	959	57.9	10.7	L	A	2.9	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L10	25	960	58.8	10.7	L	B	6.8	2	L	N	N	N	N	I	A	0	L	N	Y	I	.
L10	26	961	124.6	8.8	R	A	9.1	1	M	N	N	N	N	I	A	0	L	N	N	I	.
L10	27	965	125.5	9.6	R	E	5.9	1	L	N	N	N	N	A	N	0	N	N	N	I	.
L10	28	962	125.8	7.7	R	B	2.3	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	29	963	126.1	7.9	R	C	1.4	2	L	N	N	N	N	N	A	0	N	N	N	I	.
L10	30	964	126.1	8.5	R	D	0.7	1	L	N	N	N	I	N	N	0	N	N	N	I	.
L10	31	966	130.5	10.2	L	.	3.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	32	967	135.4	9.4	R	A	5.1	1	L	N	N	N	I	N	A	0	N	N	N	I	.
L10	33	968	136.1	8.4	R	B	1.8	1	U	N	N	N	N	N	N	0	L	N	N	H	.
L10	34	969	136.1	9.2	R	C	4.2	11	??	.	.	.	.	.	.	.	H	H	N	D	R
L10	35	970	136.3	9.5	R	D	2.0	11	L	N	I	I	.	.	.	100	L	M	N	S	.
L10	36	973	136.3	9.7	R	G	0.6	2	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	37	974	136.3	9.3	R	H	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	38	972	136.4	10.1	R	F	5.0	4	U	N	N	N	N	N	N	0	N	N	N	H	.
L10	39	975	136.7	9.0	R	I	1.8	5	L	A	A	N	.	.	.	100	N	L	N	S	.
L10	40	971	136.8	9.5	R	E	4.5	11	??	.	.	.	.	.	.	.	H	H	N	D	R
D1	1	1	0.0	0.0	I	A	3.9	3	U	N	N	N	N	N	N	0	M	L	N	H	.
D1	2	2	0.9	0.3	L	B	5.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	3	3	10.5	10.3	L	A	3.5	3	U	N	N	N	N	N	N	0	M	M	N	H	.
D1	4	4	11.0	11.3	L	B	4.2	1	U	N	N	N	N	N	N	0	L	N	N	H	.
D1	5	5	11.6	10.0	L	C	4.6	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	6	6	46.8	9.9	R	.	13.1	11	U	N	N	N	N	N	N	0	N	N	Y	D	B
D1	7	7	52.6	5.5	R	.	9.1	11	U	N	N	N	N	N	N	0	N	N	Y	D	B
D1	8	8	54.5	14.1	R	.	10.2	11	U	N	N	N	N	N	N	0	M	M	Y	D	B
D1	9	9	55.0	8.9	L	A	11.7	11	M	.	.	.	.	.	.	0	M	N	Y	D	B

Plot	No.	TreeTag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
D1	10	10	55.0	11.1	L	B	7.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	11	11	61.7	14.5	R	A	1.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	12	12	61.9	14.6	R	B	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	13	13	64.3	9.2	R	A	6.4	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	14	14	64.3	8.5	R	B	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	16	15	70.1	10.7	R	B	7.3	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	17	16	70.8	10.7	R	C	7.8	1	U	N	N	N	N	N	N	0	N	N	Y	I	.
D1	15	17	72.3	9.6	R	A	1.6	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D1	18	18	91.0	11.7	R	A	4.1	11	L	D	D	N	.	.	.	100	L	M	N	D	R
D1	19	19	91.3	12.6	R	B	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	20	20	97.4	11.6	R	.	3.0	11	L	N	D	N	.	.	.	100	N	M	N	D	R
D1	21	21	97.5	5.3	R	.	10.3	1	L	N	N	N	N	I	I	0	N	N	N	I	.
D1	22	22	102.9	12.9	L	.	9.3	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	23	23	112.0	14.3	L	A	14.5	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	24	24	112.0	15.0	L	B	6.5	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	25	25	112.4	15.5	L	C	1.6	8	L	D	N	N	.	.	.	100	L	L	N	S	.
D1	26	26	115.8	2.8	R	A	9.1	2	M	N	N	N	N	I	I	0	N	N	Y	I	.
D1	27	27	116.8	2.5	R	B	4.2	2	U	N	N	N	N	N	N	0	L	N	Y	H	.
D1	31	28	119.3	14.9	L	A	1.2	3	M	N	I	I	I	I	I	40	N	L	N	S	.
D1	32	29	119.5	15.0	L	B	1.0	1	L	N	N	N	N	N	D	0	N	N	N	I	.
D1	33	30	120.8	12.4	L	A	8.2	1	U	N	N	N	N	N	N	0	L	N	Y	H	.
D1	29	31	120.9	7.7	R	B	11.0	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	34	32	121.2	12.4	L	B	8.7	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	28	33	121.6	6.7	R	A	11.1	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	35	34	121.8	12.2	L	C	8.6	1	U	N	N	N	N	N	N	0	L	L	Y	H	.
D1	36	35	121.8	13.1	L	D	8.8	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	30	36	122.1	7.9	R	C	4.2	1	M	N	I	N	.	.	.	15	L	N	Y	I	.
D1	37	37	122.3	13.6	L	E	3.1	2	U	N	N	N	N	N	N	0	L	L	N	H	.
D1	38	38	140.1	8.9	L	A	0.8	9	U	N	N	N	N	N	N	0	N	L	N	H	.
D1	39	39	140.7	9.1	L	B	0.8	3	U	N	N	N	N	N	N	0	N	N	N	H	.
D1	40	40	141.5	8.9	L	C	8.0	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D1	41	41	142.3	8.5	L	D	2.0	2	U	N	N	N	N	N	N	0	N	N	N	H	.
D2	1	42	0.0	0.0	I	.	3.5	1	L	N	N	N	N	N	D	0	N	N	N	I	.
D2	2	44	9.7	7.7	L	B	0.8	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D2	3	43	9.8	7.0	L	A	6.0	1	L	N	N	N	N	I	N	0	N	L	N	I	.
D2	4	45	10.3	7.3	L	C	1.3	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D2	5	46	10.3	7.9	L	D	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D2	6	47	10.8	6.9	L	E	0.7	1	L	A	A	N	.	.	.	100	N	M	Y	S	.
D2	7	48	61.0	13.9	R	A	4.9	11	U	N	N	N	N	N	N	0	N	L	Y	D	F
D2	8	49	61.8	13.9	R	B	3.7	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D2	9	50	72.5	9.7	R	A	10.1	11	U	N	N	N	N	N	N	0	N	M	Y	D	B,F
D2	10	51	72.5	10.7	R	B	4.8	11	U	N	N	N	N	N	N	0	M	M	Y	D	B,F
D2	11	52	74.3	9.8	R	C	7.8	11	U	N	N	N	N	N	N	0	L	N	Y	D	B,F
D2	12	53	74.5	11.1	R	D	3.7	11	U	N	N	N	N	N	N	0	L	M	Y	D	B,F
D2	13	55	74.8	10.3	R	F	2.9	11	U	N	N	N	N	N	N	0	N	M	Y	D	B,F
D2	14	54	75.3	9.3	R	E	7.0	11	U	N	N	N	N	N	N	0	L	L	Y	D	B,F
D2	15	56	109.8	8.3	R	A	4.3	2	U	N	N	N	N	N	N	0	L	N	Y	H	.
D2	16	57	109.8	7.8	R	B	5.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D2	17	58	110.4	7.8	R	C	6.7	1	U	N	N	N	N	N	N	0	L	N	Y	H	.
D2	18	63	110.5	8.0	R	H	3.4	11	U	N	N	N	N	N	N	0	L	L	Y	D	B
D2	19	59	111.3	7.7	R	D	5.6	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D2	20	62	111.3	8.3	R	G	5.3	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D2	21	60	111.8	7.3	R	E	1.8	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D2	22	61	111.8	7.9	R	F	5.0	1	U	N	N	N	N	N	N	0	L	N	Y	H	.
D3	1	64	0.0	0.0	I	A	6.2	11	U	N	N	N	N	N	N	0	L	N	N	D	F
D3	2	65	0.6	0.0	I	B	6.5	11	U	N	N	N	N	N	N	0	L	N	N	D	F
D3	3	66	49.2	13.8	R	A	6.1	3	U	N	N	N	N	N	N	0	N	N	N	H	.
D3	4	67	50.2	14.7	R	B	6.9	11	U	N	N	N	N	N	N	0	N	M	Y	D	B
D3	5	68	51.6	13.3	R	C	2.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D3	6	69	62.0	5.2	R	A	8.3	3	U	N	N	N	N	N	N	0	N	N	Y	H	.
D3	7	70	62.6	4.5	R	B	5.2	2	U	N	N	N	N	N	N	0	N	L	Y	H	.
D3	8	71	66.6	6.7	L	A	7.9	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D3	9	72	67.4	6.7	L	B	8.3	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D4	1	74	0.0	0.0	I	.	0.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	2	75	0.0	4.5	R	A	4.2	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	3	76	1.3	4.3	R	B	8.1	2	M	N	N	N	N	I	N	0	N	N	Y	I	.
D4	4	77	1.6	3.3	R	C	3.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	5	78	2.3	2.0	L	A	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	6	80	2.5	1.5	L	C	1.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	7	79	2.6	1.9	L	B	3.5	1	L	N	N	N	N	N	D	0	N	N	N	I	.
D4	8	81	11.9	1.5	L	.	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D4	9	82	14.3	2.4	L	.	7.7	1	L	N	N	N	N	I	N	0	L	N	Y	I	.
D5	1	83	0.0	0.0	I	.	7.3	1	U	N	N	N	N	N	N	0	N	M	N	H	.
D5	2	84	25.8	0.0	L	.	7.4	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D5	3	87	44.1	0.6	R	B	7.2	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D5	4	86	54.4	1.7	R	A	7.3	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D5	5	89	54.6	2.6	R	D	7.0	11	U	N	N	N	N	N	N	0	N	N	Y	D	F

Plot No.	Tree	Tag	[1]Along Transect (ft.)	[2]From Transect (ft.)	[3]R/L	[4]Clump	DBH (in.)	[5]Canopy Kill Class	[6]WPBR Class	[7]Bole Cankers Top	Bole Cankers Mid	Bole Cankers Bottom	Branch Cankers Top	Branch Cankers Mid	Branch Cankers Bottom	Canker % Bole Girdle	[8]Bark Strip Branch	Bark Strip Bole	MPB	[9]Health	[10]Mortality
D5	6	88	56.0	1.4	R	C	5.8	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D5	7	90	68.5	2.0	R	A	5.0	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D5	8	91	68.9	3.9	R	B	3.5	11	U	N	N	N	N	N	N	0	N	M	N	D	F
D5	9	92	76.3	5.0	R	.	7.9	11	L	N	N	D	N	N	N	0	N	N	Y	D	F
D5	10	93	80.2	9.3	L	.	5.4	11	U	N	N	N	N	N	N	0	N	L	N	D	F
D5	11	94	85.0	6.1	R	.	0.7	3	U	N	N	N	N	N	N	0	N	M	N	H	.
D5	12	95	87.3	5.3	R	.	2.4	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D6	1	85	0.0	0.0	I	.	0.9	2	L	N	N	A	.	.	.	100	N	N	N	I	.
D6	2	98	4.9	6.1	R	.	0.6	2	U	N	N	N	N	N	N	0	L	N	N	H	.
D6	3	96	5.7	2.6	R	.	2.5	2	U	N	N	N	N	N	N	0	N	M	N	H	.
D6	4	97	6.6	1.0	L	.	1.2	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D6	5	99	12.0	2.9	R	.	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	6	100	16.5	3.8	L	.	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	7	101	25.8	11.7	L	.	2.1	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	8	105	29.1	3.6	L	.	3.3	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D6	9	102	29.6	12.7	L	A	2.2	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D6	10	103	29.6	13.0	L	B	1.6	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D6	11	104	30.8	6.8	L	.	1.6	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D6	12	106	36.8	9.6	L	.	3.4	11	U	N	N	N	N	N	N	0	N	N	N	D	F
D6	13	119	52.2	12.5	R	.	1.1	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D6	14	107	108.9	3.5	R	.	7.6	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D6	15	108	116.2	3.1	L	A	1.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	16	109	116.5	3.1	L	B	3.0	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	17	111	124.3	12.1	R	A	1.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	18	112	124.5	12.3	R	B	1.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	19	110	125.6	10.1	R	.	1.9	1	L	N	N	N	N	I	N	0	N	N	N	I	.
D6	20	113	132.0	7.5	R	A	1.3	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	21	114	132.2	7.4	R	B	1.8	2	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	22	115	134.3	4.2	R	A	0.9	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	23	116	134.5	4.1	R	B	0.8	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	24	117	134.8	3.9	R	C	1.5	1	U	N	N	N	N	N	N	0	N	N	N	H	.
D6	25	118	135.3	10.2	R	.	1.0	3	U	N	N	N	N	N	N	0	N	N	N	H	.
D7	1	120	0.0	0.0	I	.	4.6	3	U	N	N	N	N	N	N	0	L	N	N	H	.
D7	2	121	24.8	5.5	L	.	10.2	1	L	N	N	N	I	N	N	0	L	N	Y	I	.
D7	3	122	57.9	10.6	R	.	8.3	2	L	N	N	N	N	D	N	0	N	N	Y	I	.
D7	4	123	60.8	2.4	R	.	8.9	7	L	N	I	N	.	.	.	100	M	H	N	S	.
D7	5	124	61.8	6.8	R	A	7.0	1	U	N	N	N	N	N	N	0	N	L	N	H	.
D7	6	125	62.4	6.8	R	B	8.7	11	??	.	.	.	.	.	.	.	H	H	N	D	F
D7	7	126	64.0	2.9	L	A	9.6	1	L	N	N	N	N	I	N	0	L	N	Y	I	.
D7	8	127	65.1	3.1	L	B	10.9	1	L	N	N	N	I	N	N	0	L	N	Y	I	.
D7	9	128	101.4	1.7	L	A	4.9	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D7	10	129	102.1	2.4	L	B	6.8	11	U	N	N	N	N	N	N	0	N	N	Y	D	F
D7	11	130	115.3	10.4	L	.	9.2	1	U	N	N	N	N	N	N	0	N	N	Y	H	.
D7	12	131	130.3	3.9	R	.	11.9	11	L	N	N	N	N	D	N	0	L	N	Y	D	F

Monitoring Whitebark Pine, Blister Rust and Fuels in the Frank Church - River of No Return Wilderness Area

University of Idaho

Lauren Fins[1] and Jodie Krakowski[2]

Introduction

Over the past two decades, populations of whitebark pine (*Pinus albicaulis*) have declined dramatically in much of the species' range. Causal factors include: *Cronartium ribicola*, the exotic fungus that causes white pine blister rust; fire suppression, which drives successional replacement to more shade tolerant species; extended periods of drought, which weaken trees stressed by low moisture conditions; and attack by mountain pine beetle, which kills trees in a single season. Because mature trees are lost, these conditions destroy potential seed sources, thereby reducing the reproductive capacity of the populations, building up fuels on the forest floor and reducing the availability of favorable seed-bed conditions for regeneration.

Whitebark pine seed is a primary, high energy food source for grizzly bears and Clark's nutcrackers through much of the species' range. In the Frank Church Wilderness Area, nutcrackers are relatively abundant but grizzly bears do not currently inhabit the area. Nonetheless, grizzly bear reintroduction has been proposed. With this keystone species potentially at risk in the Frank Church Wilderness Area, baseline information on the condition of the native populations is critical for developing evaluation criteria for ecosystem function and to determine the best mitigation steps, should they become necessary.

Although the status of this species has been the focus of many recent studies, the condition of populations in the Frank Church River of No Return Wilderness Area remains largely undocumented. The rugged, largely roadless character of the area poses substantial challenges for field research.

Objectives

After a preliminary evaluation that verified the presence of blister rust in the Frank Church, it was clear that a more thorough assessment of the status of whitebark pine in these populations would provide important information that could be used in current as well as future management regimes. Our objectives were to:

1. Establish permanent monitoring plots in whitebark pine stands in the FCRNRWA to evaluate stand health and composition dynamics.
2. Collect and summarize baseline data to determine the influence of habitat type and fire history on the stand health and composition.
3. Assess levels of forest fuels data to estimate risk of losses to wildfire of remaining trees.
4. Collect seed and screen for genetic resistance to blister rust.

Methods

During the summer of 2005, we established a total of 47 plots distributed across 3 populations, and 3 burn and 3 habitat categories in the FCRNRWA. Plots were laid out as 150' x 30' transects in which all trees 4.5' or taller were unobtrusively tagged.[3,4] Data collected included DBH, rust status, mountain pine beetle status, damage, mortality, vegetation, humus, regeneration, fuels, topography and current and developing cones. Where possible, putatively rust-resistant trees were identified. Plots were photo-documented and GPS co-ordinates recorded.

Frank Church - River of No Return Wilderness Area

Populations sampled

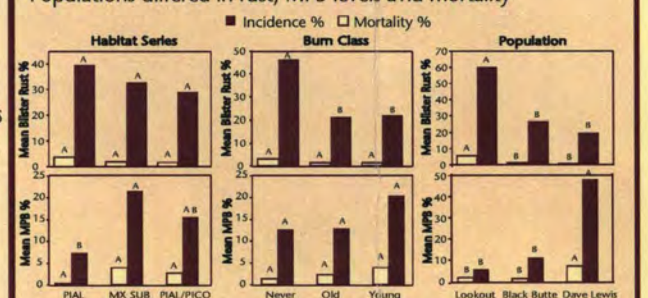
Burn Classes:
Never (>100 yrs ago), Old (15-100 yrs), Young (<15 yrs)

Habitat Classes:
PIAL (>85% whitebark pine),
MX SUB (>25% subalpine fir and >25% whitebark pine),
PIAL/PICO (>25% lodgepole pine and >25% whitebark pine)

Data were analyzed using factorial ANOVA, correlations and step-wise linear regression and in SAS and Excel. Where required, variables were transformed to meet assumptions of normality and variance homogeneity; actual values are reported here. All effects were considered random, populations nested within factors.

Results

- Stands were heterogeneous and very patchy
- Rust and MPB levels were unrelated to slope, aspect, clumpiness
- Populations differed in rust, MPB levels and mortality



- Unburned sites, plots with higher whitebark pine densities and taller regeneration had comparatively high levels of blister rust
- Significant interactions: site-specific effects only
  - Elevation negatively correlated with WPBR infection
  - Plots with more, larger lodgepole pines had more MPB
- Burn class did not affect mature tree or regeneration abundance
- Later successional stands had less medium to large coarse woody debris (CWD)
- Early successional stands had far more small CWD than later phases
- Mixed subalpine habitat series had the most CWD, especially larger size classes (>3" diameter) and rotting wood
- Recently burnt sites had slightly more rotten CWD

Follow-up

Activities proposed for 2006 and 2007:

1. Sample and tag additional populations.
2. Monitor health status of selected populations.
3. Collect cones/seeds for rust screening.

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3 Tomback, D.F., Keane, R.E., McCaughey, W.W., Smith, C. 2005. Methods for surveying and monitoring whitebark pine for blister rust infection and damage. Whitebark Pine Ecosystem Foundation, Missoula, MT. 30 pp.
4 Permanent and obvious monumenting is restricted in Wilderness Areas.

Acknowledgements

Catherine Roberts was a fantastic field assistant. Holly and Jim Akenson, Managers/Research Scientists of Taylor Ranch Field Station, provided logistical support. D. Ferguson, J. Byrne and J. Schwandt, USFS, provided materials, training and data analysis. This project was funded by USFS grant 05-DG-11010000-005.

TITLE: Evaluation and Monitoring of Whitebark Pine Regeneration After Fire in the Frank Church River of No Return Wilderness

LOCATION: Frank Church River of No Return Wilderness; Payette National Forest

DURATION: Year 1 of 3-year project **FUNDING SOURCE**: Fire Plan

PROJECT LEADER: Lauren Fins, Department of Forest Resources, College of Natural Resources, University of Idaho, Moscow, ID 83843-1133; 208-885-7920; lfins@uidaho.edu

PROJECT OBJECTIVES:

- Investigate and compare whitebark pine reproduction in old burns, recent burns and unburned areas in the Frank Church River of No Return Wilderness (FC-RONRW)
- Evaluate changes in fire risk and fuel loading related to mortality from blister rust and bark beetles
- Evaluate and monitor whitebark pine populations for incidence of and mortality from white pine blister rust and mountain pine beetle
- Collect cones/seeds from whitebark populations at high risk of loss in order to contribute to the ongoing USFS Whitebark Pine Genetic Restoration program for the Intermountain West for ecosystems degraded by white pine blister rust; Archive seed for potential use in restoration of fire-damaged ecosystems and for long-term conservation of germplasm

JUSTIFICATION:

Whitebark pine is a keystone species of high elevation Rocky Mountain ecosystems. The species' reproductive success depends largely on the interaction of wildland fire and Clark's nutcracker. There has been an extensive increase in fire in the FC-RONRW since 2000. While no specific FHM surveys have been completed in the wilderness, we confirmed the presence of blister rust on mature and juvenile whitebark pines during a reconnaissance trip in August 2004. Incidents of both white pine blister rust and mountain pine beetle were detected.

The FC-RONRW includes a significant portion of the whitebark pine distribution west of the Greater Yellowstone Ecosystem. These populations have not been included in efforts to monitor reproductive success after fires, or to evaluate the incidence, spread and mortality due to blister rust. These populations have also not been included in the USFS Genetic Restoration Program for the Intermountain West.

Currently by virtually all measures of population vigor, whitebark pine populations are in decline throughout the species' range. Losses are primarily due to white pine blister rust, which rapidly kills old and young trees alike; mountain pine beetles are also killing a significant number of trees. With high levels of mortality (80-90 percent in some stands), fuel loadings and the risk of fire are likely increasing at higher than historical levels. Where only a few scattered whitebark pines remain, fires have the potential to destroy the remnants of these potentially unique and ecologically important populations. The rapid decline and possible loss of whitebark pine populations can have a domino effect on high elevation forest communities where their seeds provide a critical food source for wildlife, and the trees provide soil and habitat stability in environments too harsh for most other tree species.

Because this keystone species is in decline, it is imperative to evaluate and monitor incidence, spread and mortality from blister rust and mountain pine beetles, to assess their interaction with fire risk and ecological impacts of fires and to evaluate current reproductive success on old and new burns. The outcome of this monitoring effort will be useful in both wildland fire use and fire restoration decisions. In addition, seed samples will be archived for use in potential future efforts to restore fire-damaged ecosystems and ecosystems altered by invasive species such as blister rust, to hedge against potential loss of these populations.

DESCRIPTION:

a. Background: Whitebark pine is a high elevation conifer with a competitive edge in harsh environments. While it often occurs in mixed stands with subalpine fir and lodgepole pine, whitebark pine out-competes other species on high ridges where soils are poor and cold temperatures prevail. As the only North American pine with wingless seeds and cones that remain closed even after they mature, whitebark is unique. Its closed cones, with their large, heavy, nutrient-laden and calorie-rich seeds, provide a critical food source for Clark's nutcrackers, pine squirrels and, in some parts of its range, grizzly bears. As a pioneer species that repopulates after burns, whitebark pine also stabilizes soils and moderates the environment for new communities of flora and fauna.

White pine blister rust, a disease caused by an invasive exotic fungus (*Cronartium ribicola*), was introduced into western North America in 1910. The disease, which first appeared on whitebark pine in Idaho in 1938, can kill susceptible trees within just a few years after infection, although some infected trees may live for many years. Genetic resistance to blister rust has been found in whitebark and other five-needle pines, but only in low frequencies. In addition to the risk of death from blister rust, mountain pine beetles tend to be attracted to trees that are infected with blister rust. Beetles can kill trees in a single season.

The combination of blister rust and bark beetles has begun to decimate whitebark pine populations. The resulting rapid build-up of fuels has likely increased the probability of stand-replacing fires and potential fire damage to whitebark pine ecosystems, threatening the long-term viability of this keystone species. Thus, it is critical to assess the effects of insect and disease on whitebark pine populations and the reproductive status of the species. In anticipation of, and as insurance against total population loss, seed collections will be made for long-term gene conservation and for potential future restoration efforts. Although restoration is not generally undertaken in wilderness, the large-scale decimation of this species by an invasive exotic and the likely fire damage to whitebark pine ecosystems suggests a possible exception.

b. Methods: We plan to evaluate and monitor the condition of 3 whitebark pine populations in the FC-RONRW. Measures will include fuel loadings; reproduction on old burns, newly burned and unburned sites; incidence of and mortality due to blister rust; and mortality due to mountain pine beetles. The University of Idaho Taylor Ranch will be used as the "base camp" for this study. Two students, one graduate and one undergraduate, will be involved in the fieldwork. Pack animals will be used to access the remote, high elevation areas where whitebark pine populations can be found. Populations will be selected to the north and south of Big Creek. We will generally follow protocols for plot establishment and monitoring developed by the Whitebark Pine Ecosystem Foundation but will conduct the study in accordance with the guidelines in the Wilderness Plan. Any aerial detection survey and/or FIA monitoring will be incorporated into the data.

In year 1, permanent plots will be established in each population; our target is 10 plots per population. Plots will be identified by GPS and mapped using more traditional methods. In years 2 and 3, cones will be protected and later collected. Seeds will be extracted and contributed to the USFS Whitebark Pine Genetic Restoration Program for the Intermountain West. These genotypes will be particularly useful if entire whitebark pine populations are lost to fire, rust and/or beetles. Additional seeds will be archived for long-term genetic conservation to be used in future breeding programs.

Data collected will include tree size and location, incidence and mortality from blister rust, canker location, tree condition, mortality from beetles, regeneration counts, occurrence of other tree species and predominant understory species. Analyses will compare regeneration numbers and types in burned and unburned areas, rust incidence and annual mortality from rust or beetles.

c. **Products**: Annual reports will be written and sent to the USDA Forest Service. We will present results of this work at a professional meeting, for example, at a meeting of the Whitebark Pine Ecosystem Foundation. We will also write a manuscript for publication.

d. **Schedule of activities**:

- Year 1: Establish plots in 3 populations; collect baseline data; preliminary analysis and summaries of data
- Year 2: Cage developing cones in 1 population; collect data in permanent plots; collect mature cones; conduct analysis comparing data from year 2 to baseline
- Year 3: Cage developing cones in 2 populations; collect data in permanent plots; collect mature cones; conduct analysis comparing year 3 to baseline and year 2; present results at professional meeting; write manuscript for publication

COSTS:

	Item	Requested FM EM Funding	Other Source Funding	Source
Year 2005				
Administration	Salaries and Fringe	$29,665 $5,590		
	Travel	$6,350		
Procurements	Supplies and OE	$1,500		
	Overhead	$13,578		
TOTAL REQUESTED		$56,683		

Funding for years 2 and 3 is projected to be similar to year 1.