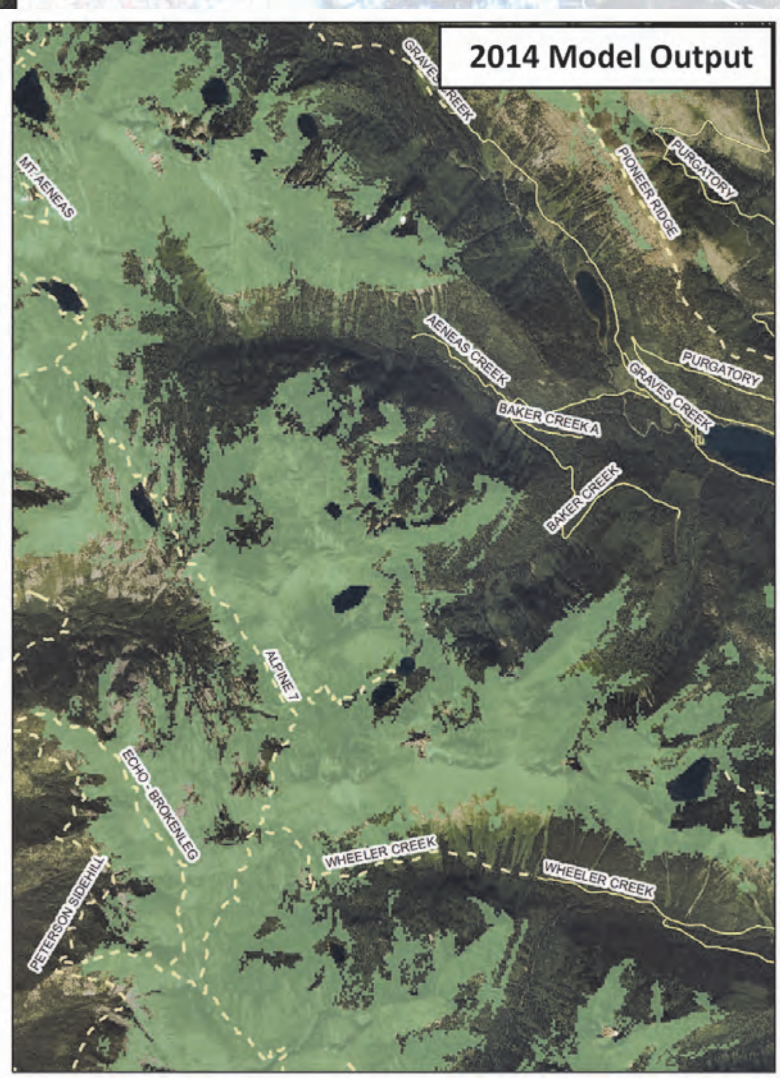
Issue No. 27: Winter/Spring 2014-2015

Whitebark Pine Ecosystem Foundation

Nutcracker Notes



Refining the WBP potential range model for the Flathead National Forest.
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Whitebark Pine Ecosystem Foundation

Nutcracker Notes, Issue No. 27;
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Update

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Our Mission: The Whitebark Pine Ecosystem Foundation (WPEF) is a science-based nonprofit organization dedicated to counteracting the decline of whitebark pine and enhancing knowledge of its ecosystems.

Membership Information and an application is found at <www.whitebarkfound.org>

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Director's Message
Diana F. Tomback

The Wilderness Act and Whitebark Pine

The importance of wilderness and the Wilderness Act to whitebark pine conservation

Last year, 2014, represented the 50th anniversary of the U.S. Wilderness Act, which created the National Wilderness Preservation System. The WPEF recognizes this landmark anniversary and the importance of the Wilderness Act to the protection of whitebark pine ecosystems. More than 2 million hectares (nearly 5 million acres) or nearly 40% of all whitebark pine habitat in the United States is protected by wilderness designation. Wilderness areas are often remote and pristine lands, and these descriptors also apply to most whitebark pine habitat. Given the high proportion of whitebark pine's range under wilderness protection, whitebark pine is truly a 'wilderness species'.

The Wilderness Act of 1964, approved by Congress during the Lyndon B. Johnson administration, was one of the most important laws enacted to protect and preserve our national wildlands, and arguably one of the most important from the perspective of conservation. Although the Forest Reserve Act of 1891 laid the groundwork for establishment of the U.S. Forest Service and management of a national system of forest and grassland reserves, and the creation of the National Park Service in 1916 provided the oversight for a growing portfolio of national parks and monuments, both these agencies were mandated to balance preservation with other societal values, including recreation, tourism, or economic development. The Wilderness Act established the only system of reserves with the objective of maintaining a truly natural state: "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation…" Given their "untrammeled" nature, wilderness areas protect charismatic mammals that do not flourish in proximity to humans, such as wolverine, grizzly bears, Canada lynx, and wolves. Wilderness areas protect a vast array of habitat types and their diverse plant and animal communities, allowing unimpeded ecosystem processes. Among tree species, however, few are as strongly associated with wilderness areas as whitebark pine.

Upon approval of the Wilderness Act in 1964, nearly 3.7 million hectares (9.1 million acres) of wildlands in 13 states were immediately protected. These newly-designated wilderness areas included three important regions for whitebark pine: the Bob Marshall Wilderness in Montana; the Bridger Wilderness in the Wind River Range, Wyoming; and the Ansel Adams Wilderness in the Sierra Nevada, California. The wilderness reserve system today includes more than 44 million hectares (110 million acres) in 44 states, and comprises lands managed by the National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, and Bureau of Land Management.

The Wilderness Act was written with immense care and dedication by Howard Zahniser, a former federal employee and Washington, D.C.-based executive secretary of the fledgling Wilderness Society, working alongside founder Robert Marshall. Zahniser wrote 66 drafts of the Wilderness Act over nearly two decades and championed the legislation through18 congressional hearings. He worked closely with notable conservationists and Wilderness Society leaders, including Aldo Leopold, Sigurd Olson, Olaus Murie, and Wallace Stegner, whose ideas and writings helped shape the legislation.

Trammeling that the Wilderness Act cannot prevent

Considering the immense thought and care that these towering figures of the American conservation movement invested in the legislation that created the National Wilderness Preservation System, it is disconcerting to realize that the protection offered by the Wilderness Act has been and will be inadequate to prevent "trammeling" by man as we progress into the 21st century; and, the problems are just beginning. Whitebark pine has literally been the "canary in the coal mine" as the victim of all of the following:

Fire suppression and altered fire regimes. Fire suppression in general eliminates the natural mosaic pattern of varying successional stages across the landscape. Fire suppression outside designated wilderness prevents fires from burning up into wilderness. Fire suppression within wilderness still occurs depending on current conditions, although there are concerted efforts to use wildland fire and prescribed fire to restore landscape heterogeneity within wilderness. Whitebark pine prevalence has declined in some wilderness areas in response to successional replacement from altered fire return intervals.

Invasive species and disease. Globalization has resulted in burgeoning worldwide transport of plants, pests, and diseases that can profoundly alter community composition and structure. We have not been able to control their entry into North America and subsequent spread. Aldo Leopold recognized this problem as he described the major changes to a range dominated by non-native cheat grass in his perceptive essay "Cheat takes over" in *A Sand County Almanac*. The pathogens that cause white pine blister rust and chestnut blight were inadvertently brought to the U.S. in the late 19th and early 20th centuries, at the beginning of rapid expansion of international trade and travel. Chestnut blight has virtually eliminated a major forest dominant, the American chestnut, and altered the structure and composition of eastern deciduous forests forever. White pine blister rust has destroyed two major logging economies, based on sugar pine and western white pine, respectively, as the disease spread rapidly in these species. In the Rocky Mountains and the Northwest, which include numerous wilderness areas, whitebark pine is experiencing increasing infection levels and mortality from white pine blister rust, as well as reduced cone production and little natural regeneration.

Climate change, native pest outbreaks, and shifts in distribution. Temperature records since the 1880s have documented an average increase in worldwide temperature of about 0.8˚C, with further temperature increases predicted as CO_2 levels continue to rise. Rising temperatures have been greatest at the higher latitudes in the northern hemisphere. Major outbreaks of bark beetles during the last 15 years, which include mountain pine beetles, are attributed to rising temperatures, and especially higher winter minimum temperatures. Mountain pine beetles have killed mature whitebark pine across more than 190,000 hectares (470,000 acres) in the western U.S. since 1998, including wilderness areas in the Greater Yellowstone and elsewhere. Lodgepole pine and other conifers have also experienced high mortality. As temperatures continue to rise, plant species will shift their range, change their phenology, and form new associations. Whitebark pine range and elevational distribution are predicted to shift northwards and upwards.

Do we intervene?

Whitebark pine declined rapidly during the second half of the 20th century and continues on this trajectory. Since 2011, whitebark pine has been a candidate for listing under the U.S. Fish and Wildlife Service Endangered Species Act. It is remarkable that such a widely distributed, formally locally abundant species, could achieve so precarious a status so rapidly, especially with 40% of its range within wilderness.

The Wilderness Act protects very well against traditional human activities, such as development, habitat alteration, the use of motorized vehicles and equipment, and small-scale disturbance. But, Howard Zahniser and his distinguished colleagues could not foresee the global challenges that we face today. Some forms of trammeling cannot be controlled by designating wilderness boundaries. This raises a timely question: Should we begin to discuss ecosystem restoration in wilderness areas, or do we allow whitebark pine to go the way of the American chestnut?

Milestones and reminders

Dr. Steve Arno has been editor of *Nutcracker Notes* since 2001. Over the last year or two, he hinted that the time had come for us to find a new editor, but we called his bluff and stalled as long as we could. We finally had an ultimatum from Steve, and agreed to find another editor. This is the first issue without Steve at the helm, and we thank JoAnn Grant and Bob Keane for stepping in to help. The Board of Directors has made Steve an Honorary Member of the WPEF, and we look forward to his attendance at our annual Whitebark Pine Science and Management Workshops. On behalf of the Board of Directors, I would like to offer our sincere thanks to Steve Arno for making Nutcracker Notes an important feature of the WPEF, and a recognized publication for dissemination of the latest news about whitebark pine.

The Board of Directors of the WPEF has arrived at an historic conclusion: We cannot accomplish all our goals with just a volunteer board. We are seeking to hire a part-time staff member. Please see the ad here in *Nutcracker Notes* and feel free to recommend potential applicants for the position.

Finally, please donate to the **Whitebark Pine Forever 2015** restoration campaign. It really is a matter of life or death for whitebark pine. ■

Whitebark Pine Single-Species Mapping on the Flathead National Forest

Ian Housman, Onsite contractor at the Forest Service Remote Sensing Applications Center
Steve Brown, Region 1 Forest Service Remote Sensing Coordinator

Adapted from: Housman, I.; Brown, S.; Hamilton, R.; Fisk, H. 2014. Whitebark pine single-species mapping. RSAC-10034-RPT1. Salt Lake City, UT: U.S. Department of Agriculture, Forest Service, Remote Sensing Applications Center. 14 p.

Introduction

Currently, Whitebark pine (*Pinus albicaulis*) (WBP) is a relatively rare, but ecologically important species on the Flathead National Forest. As a result, WBP is largely absent from current mid-level vegetation maps, making consistent Forest-wide WBP management difficult. This study was initiated by Steve Brown, and funded as a 2013 USFS Remote Sensing Steering Committee (RSSC) project. It was completed in cooperation between Forest Service Region 1, the Flathead National Forest (FNF), and the Forest Service Remote Sensing Applications Center (RSAC). The goal of this study was to develop a consistent methodology for the mapping of current potential range, restoration suitability, and occurrence of WBP in areas where WBP abundance is too low for it to be a dominant species within the stand. These methods would then be applied to the rest of Region 1 in an attempt to help quantify the current extent of WBP within the Region.

METHODS

Current Potential Range

The goal of the current potential range map is to provide land managers with an idea of where WBP could potentially grow given the current climate. Currently, WBP is absent from most of its range in the FNF, largely due to vegetation succession from fire suppression, mortality from white pine blister rust (*Cronartium ribicola*), and mountain pine beetle (*Dendroctonous ponderosae*) infestation (Keane and Arno 1993). To gain a better sense of where WBP could potentially be found, numerous meetings were held with various WBP experts, resulting in a more detailed understanding of attributes impacting where WBP can grow. To address the need for calibration data for the current potential range model, field collected data from 2012 was combined with expert image-interpretation-based locations.
Independent predictor variables utilized by the model included the mean April 1, May 1, and June 1 snow depth, median minimum and maximum temperature, median precipitation, and various terrain metrics such as elevation, slope, and aspect. These calibration data were combined with independent predictor data in a Random Forests statistical model (Brieman 2001) to predict the potential range of WBP on the Flathead.

WBP Restoration Suitability

The goal of the restoration suitability map was to provide land managers with a consistent set of areas within the potential WBP range that would be suitable for planting/seeding treatments. This was defined as areas within the potential range that had experienced stand-replacing disturbances. These areas provide limited competition to shade-intolerant WBP, increasing the likelihood of successful establishment.

Suitable areas were identified using the Vegetation Change Tracker (VCT) (Huang et al, 2010). VCT is an automated method for detecting stand-replacing forest disturbances through time using the Landsat image archive. VCT was run across the FNF on Landsat 5 imagery from 1984-2012. Once identified as experiencing a stand-replacing disturbance event, the algorithm tracks the recovery of the area using spectral indices, providing an idea of which areas could provide limited competition to WBP based on the recovery trajectory for the site. The restoration suitability maps were qualitatively assessed by FNF Silviculturist Melissa Jenkins by identifying whether the restoration suitability map correctly characterized past WBP restoration treatment areas. Additionally, new restoration site locations were analyzed.

WBP Occurrence

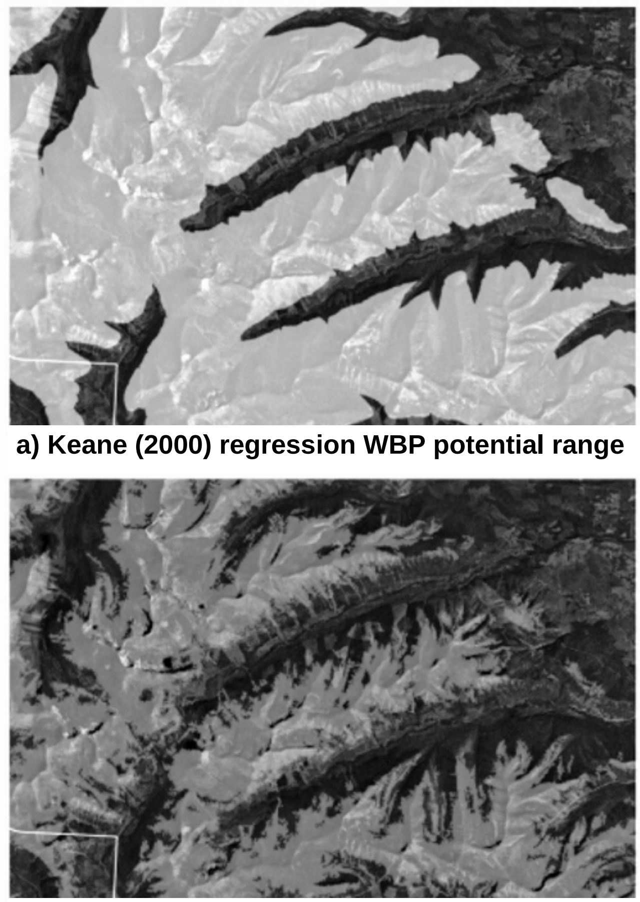
The last product was a map of where WBP is currently located. Because WBP is rarely a dominant species in the FNF, the maps needed to be able to characterize both the relative and absolute canopy cover of WBP within a 30m pixel. In order to develop the maps, field data were collected during the summers of 2013 and 2014 using methods specifically designed for use with 30m spatial resolution remote sensing data. Each plot had a 15m radius to correspond to the 30m x 30 m pixel size of the Landsat data. Plot attributes included the first 4 dominant species visible from above in the plot. Plot locations were selected based on known locations of WBP within the FNF, as well as areas within the potential range map that were thought to not contain WBP. Additional WBP absence model calibration data were collected from the WBP potential range calibration data that were not within the potential range product, 2012 field data, and image/terrain interpretation of additional absence locations.

Because of limited spectral separability at any single date between cohabiting species, subtle differences were highlighted by using data to approximate the normal phenology curve. It was assumed that there may be some subtle differences between the normal phenology curve of WBP and cohabiting species. Median cloud-free Landsat 5 values were calculated for each month from May through October using Google Earth Engine (earthengine.google.org). Various statistics were used to summarize the phenology curve as it was represented by these monthly images and their derivatives. The phenology curve-based independent predictor variables were combined with terrain, climate, and snowfall metrics in a Random Forests model to predict the relative and absolute occurrence of WBP on the FNF.

Results

Current Potential Range Model results indicate that the model had an overall accuracy of 89.40% within the model calibration data. Qualitative comparison of the output to the Keane (2000) WBP range output indicated that this product was similar in general extent, but excluded open water, shady north-facing areas, and included some potential areas along the edges of avalanche paths (figure 1).

The future of the developed workflow will depend on the predictor and calibration data available for the model. As impacts of expected climate change on WBP range continue to manifest, new calibration and climate data can be used to adapt the model to the changes. Additionally, as better calibration data become available, model outputs can be updated, providing better information for future projects.



a) Keane (2000) regression WBP potential range

b) Random forests WBP potential range

Figure 1—Comparison of the Keane (2000) regression-based WBP potential range model (A) to the random forests modeled output (B) from this project. The new output builds on the Keane (2000) output by trying to exclude water, steep cliffs, steep shaded north-facing areas where WBP does not compete well with other species.

WBP Restoration Suitability

The restoration suitability map appears to fill the most immediate need for a map product on the Flathead. Project cooperators were very enthusiastic about the possibilities offered by the suite of restoration suitability products. While they were not formally validated using statistically rigorous methods, qualitative assessments yielded positive results. In particular, the product specifying remaining recovery at last observation was qualitatively field-validated during the summer 2013 field visit. Burned and harvest areas were correctly detected. Based on an assessment of past treatment areas, project cooperators concluded that the product is highly accurate. The detail offered by this product helped rule out areas that were unsuitable for restoration (figure 2).

The high level of perceived accuracy, along with the wall-to-wall nature of the product, provides land managers with a tool for planning treatments across the Forest. The map suite can be easily updated in the future by re-running VCT with more recent imagery, thereby ensuring its continued utility.

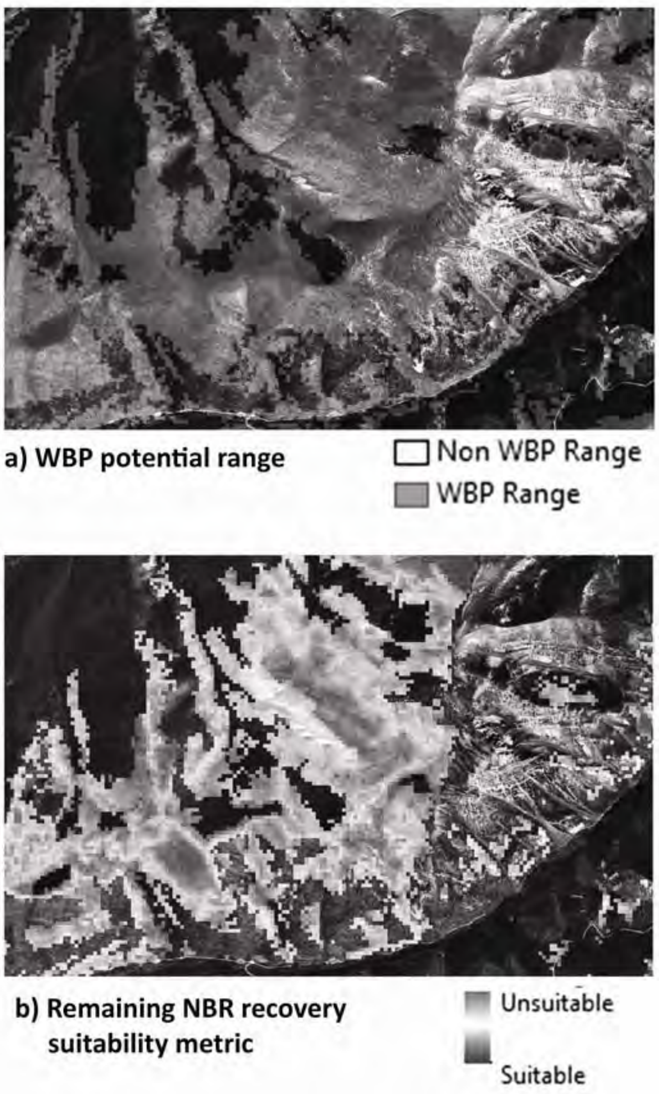


Figure 2—Example area displaying the modeled potential range (A) and the remaining recovery according to the normalized burn ratio (NBR) spectral index (B). This restoration suitability metric depicts the difference between the NBR value at the last observation and just before the detected disturbance. Notice that in valley bottom areas, the area is modeled as unsuitable, while in more exposed areas closer to the ridge lines, the areas are identified as being suitable for restoration.

WBP Occurrence Map

The maps' depiction of WBP's location and abundance was received positively by project cooperators (figure 3). A total of 33 WBP-containing field plots from the 2013 field season were available to calibrate the model. Using such a small sample across the entire FNF presented many limitations in properly sampling the variability of WBP location and spectral properties. The results are, however, encouraging given the limited nature of available data properly tailored to use with remote sensing data. Given the limited available field data, it was not possible to conduct an independent accuracy assessment of the occurrence maps. Qualitatively, the model generally properly characterized areas that provide limited competition to WBP as having relatively high WBP canopy cover, while it largely excluded areas such as valley bottoms and shady slopes. With additional high-quality field data, future iterations will likely yield improved products.

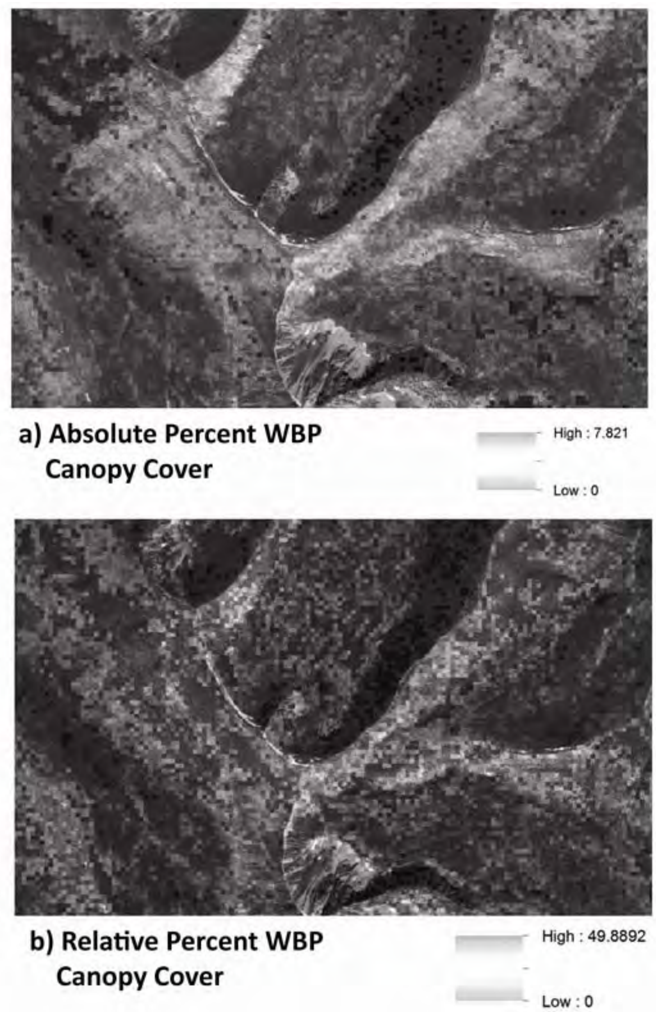


Figure 3—Comparison of different WBP occurrence model outputs. While both outputs have many similarities, the relative percent WBP canopy cover captures WBP in its most common setting on the Flathead NF—in exposed areas near ridge lines. Notice that the relative canopy cover is only high in areas with very little other canopy cover, while the absolute canopy cover is never any higher than 7.8% within the displayed view.

Conclusions

This project addressed the need to provide consistent geospatial data for managing WBP where the species is relatively rare. The developed methods offer an effective starting point to provide necessary data to characterize WBP's current status. The chosen pilot study area presented considerable challenges to single-species mapping in order to ensure that the methods from this study would likely be effective throughout Forest Service Region 1. Future iterations of field collection and model runs will likely improve the quality of these products.

Sources

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Research Progress Update:
IDENTIFICATION OF BLISTER RUST RESISTANCE GENES IN WHITEBARK PINE TO FACILITATE BREEDING AND RESTORATION

(2013 WPEF Student Research Grant)

Zolton Bair, PhD Student
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Given the worsening outlook for the imperiled whitebark pine and associated ecosystems, it has become imperative that we employ any available means to combat the endangerment of this foundational tree. While the mountain pine beetle epidemic may appear to be on the decline, the whitebark pine must still overcome the potential consequences of climate change and white pine blister rust (WPBR). *Cronartium ribicola*, the pathogen that causes WPBR, is an exotic rust species that infects all five-needle white pines. Since indigenous species of pines have not been co-evolving with this pathogen, many pine populations are especially susceptible to the disease. Although traditional methods of resistance breeding have been employed to discover major genes that confer blister rust resistance in several related pine species, no such major gene has been identified in whitebark pine. However, partial genetic resistance does exist in low frequencies within naturally occurring whitebark pine populations. Experimental results indicate that this resistance is likely quantitative, meaning it involves the additive effects of several distinct genes. Though conventional means have proven inadequate to characterize the nature of blister rust resistance in whitebark pine, great promise lies in the rapidly advancing field of bioinformatics. With the right experimental design, bioinformatic approaches should be able to reveal particular genes that are differentially expressed in resistant trees. After identifying these candidate resistance genes, we can develop genetic markers that breeders can use to quickly and efficiently target resistant individuals for restoration efforts. Over the past two years as a graduate student at Oregon State University, I have been working towards this goal. With the support of many agencies, organizations, and individuals, our research group has designed and executed an experiment that should reveal the genes underlying WPBR resistance in whitebark pine within the next year.

Initially, whitebark pine cones were collected from various populations in the Pacific Northwest and sown at Dorena Genetic Resource Center in 2010. In September 2012, we selected over 600 of these seedlings for our study of blister rust resistance. While half were inoculated with *C. ribicola*, the other half served as controls. Three days after inoculation, needles were collected from each experimental treatment and flash frozen in liquid nitrogen to preserve the tissue. Control seedlings were also inoculated shortly after their needles had been sampled, so we could still evaluate resistance phenotypes from trees whose needles were sampled before inoculation. This experimental design allows us to distinguish between four groups of seedlings, based on their treatment (inoculated or control) and phenotype (resistant or susceptible).

While both resistant and susceptible trees may have very similar genomes, their phenotypes might differ significantly with variations in gene expression. Although each tree's potential genetic information is stored as DNA, its cellular activity is actually driven by expressing genes in the form of RNA. The whole collection of RNA molecules, known as the transcriptome, reveals the degree to which each gene is expressed. By analyzing the differences in gene expression between resistant and susceptible seedlings, we can more accurately target candidate genes for blister rust resistance.

Throughout the past two years, we have assessed each of the seedlings for symptoms indicating either susceptibility or resistance to blister rust. Given the results of our phenotypic observations, we have focused our research on one particularly promising family of seedlings, the half-sibling progeny of a single resistant mother tree from Mt. Rainier. Though these resistance phenotypes were only exhibited months or years after inoculation, we had extracted RNA from needles that were cryogenically preserved during the initial stages of infection. As a result, our transcriptomic data will represent the gene expression profiles of the seedlings three days post inoculation, as they were actively undergoing and potentially responding to infection. This approach should allow us to reveal any active resistance responses mediated by changes in transcription.

Once the RNA was extracted from viable needle samples, we employed a two-pronged sequencing strategy. First, we assembled a reference transcriptome, an important molecular resource and prerequisite for gene expression studies. Over 100 million individual sequences were assembled into approximately 45,000 transcripts, representing about 35,000 genes. We used a newly-developed sequencing technology called MiSeq to generate long paired-end reads, which facilitated the best possible quality for our reference transcriptome assembly. Since this transcriptome was generated from the combined read data of individuals representing every pairing of treatment and phenotype, we have developed a comprehensive atlas of potentially expressed genes in the needle tissue of this whitebark pine seedling family.

With the reference transcriptome assembled, we have begun using differential expression analyses to identify candidate blister rust resistance genes. For this study, we utilized a cheaper sequencing technology called HiSeq to generate huge read quantities from the RNA of 24 seedlings, with six individuals representing each experimental category. Altogether, we generated over 700 million reads for this phase of the study. Despite being relatively short and only single ended, we can easily map these reads against the reference transcriptome to assign their identities with greater certainty. Therefore, we can compare the transcriptomes of susceptible and resistant individuals, revealing which specific transcripts are unique to resistant phenotypes. The experimental design and sample size will permit us to produce statistically significant results when comparing genes that are differentially expressed between treatments and phenotypes.

While annotating these genes may help us to understand the mechanism underlying WPBR resistance in whitebark pine, our primary objective is to discover genetic markers within or proximal to the putative resistance genes. First, we must identify a particular single nucleotide polymorphism (SNP), single sequence repeat (SSR), or relative insertion/deletion (InDel) that is differentially expressed between resistant and susceptible individuals. While many of these SSR, SNPs, and InDels may be completely unrelated to blister rust resistance phenotypes, a small percentage of these markers will almost certainly be borne within or proximal to putative resistance genes. Once we have validated these resistance markers, we can develop cheap bioassays that allow researchers to quickly test for WPBR resistance in the field.

With this goal in mind, we are currently developing a pool of putative markers from the massive quantities of RNA sequencing data that were generated. After an exploratory stage where we are discovering and characterizing any markers with potential utility, we will begin to validate their efficacy by screening for their presence in trees that are known to be resistant. If several markers are found to be effective at discriminating between susceptible and resistant individuals, we might even develop a panel with several markers. In this way, we could hypothetically reveal which (if any) quantitative resistance genes are present in any given whitebark pine population or individual tree. With any luck, this protocol will serve to demonstrate how genomic markers can be developed from transcriptome data and ultimately used in breeding programs to target desirable traits like disease resistance.

We are fortunate to have this research supported by an outstanding group of collaborators, including a team led by Dr. David Neale at the University of California, Davis. For over a decade, this research group has been at the cutting edge of bioinformatic science, specifically the sequencing and genetic analysis of the genomes and transcriptomes of various *Pinus* species. Until recently, researchers have encountered great difficulty when attempting to assemble the *Pinus* genomes, which are notoriously large and repetitive as a result of their evolutionary history. However, a combination of advances in sequencing technology, faster computers with better algorithms, and significant cost reductions have allowed us to begin cracking the genetic codes of these ecologically and commercially important tree species. In March 2014, the group published the completed assembly of the loblolly pine (*Pinus taeda*) genome in the journals *Genetics* and *Genome Biology*. At over 22 billion base pairs, this assembly represents the largest genome ever sequenced to date. Moreover, the same working group is making excellent progress toward the completion of the sugar pine (*Pinus lambertiana*) genome, which---at an estimated 35 billion bases---will surpass their previous record by leaps and bounds. In the process, they have developed and confirmed the efficacy of several computing pipelines with broad applications in both genomics and transcriptomics. The same working group has also created several immense databases for *Pinus* bioinformatics data. Not only do these accomplishments exemplify the quality of our collaborators' research efforts, the annotated genomes of these related species provide a valuable reference resource for our study of whitebark pine transcriptomics.

In conjunction with these new bioinformatic resources, our successful sequencing efforts collectively bolster our prospects of identifying transcriptomic signatures of resistance. In addition to our primary funding provided by the Forest Service's Special Technology Development Program, we have received a great deal of support from the Whitebark Pine Ecosystem Foundation (WPEF). Last year, the WPEF generously provided additional financial support for my graduate research on blister rust resistance in whitebark pine. The WPEF Student Research Grant has enabled me to sequence the transcriptomes of a greater number of individuals, providing a greater sample size for our differential gene expression study. In doing so, the WPEF has granted us the ability to assess a larger gene pool and yield more statistically robust results. I commend the members of this organization for spearheading the effort to halt and reverse the decline of the whitebark pine. Through our research, we aim to foster a basic scientific understanding of blister rust resistance in whitebark pine and to facilitate marker-assisted selection for resistance breeding programs. The student research grant funded by your WPEF membership has certainly supported our efforts. ■

Limber Pine Assessed as Endangered in Canada

By Cyndi Smith and Peter Achuff

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), during its meeting November 23-28, 2014, assessed limber pine as Endangered due to declining population numbers throughout its Canadian range. In Canada, most limber pine occurs along the eastern slopes of the Rocky Mountains in Alberta, with smaller isolated populations in southeastern British Columbia. Current threats to limber pine include white pine blister rust, mountain pine beetle, climate change and other human impacts. This assessment will be forwarded to the Government of Canada, which will decide whether or not to legally list limber pine under the *Species at Risk Act (SARA)*, usually within 1-2 years.

Alberta Recovery Plans for Limber Pine and Whitebark Pine

By Robin Gutsell, Alberta's Species at Risk Program

Limber pine (*Pinus flexilis*) in Alberta represents the northern extent of its global range. It occurs along the eastern slopes of the Rocky Mountains from the Kootenay Plains area (~52° N) south to the United States border (Figure 1). British Columbia holds only a few isolated pockets of limber pine in the southeast corner in and around the Columbia Valley. Approximately 10% of the global range of limber pine occurs in Canada with 80% of that in Alberta.

In Alberta, whitebark pine (*Pinus albicaulis*) is near the northern edge of its global range; in British Columbia, its range is somewhat larger, and extends slightly further north. This species grows in the high mountain forests of western Alberta at treeline and in upper subalpine forests. Its range in Alberta spans from the U.S. border to the northernmost extent of the Albertan Rocky Mountains (~54° N; Figure 2). Limber pine and whitebark pine have overlapping distributions in Alberta south of about 52° N. Approximately 56% of the global range of whitebark pine occurs in Canada, with 24% of that in Alberta.

Both whitebark and limber pine were listed as *Endangered* under Alberta's *Wildlife Act* in October of 2008. The basis for listings was the ongoing and projected population decline across the species' provincial ranges, caused by the introduced white pine blister rust (*Cronartium ribicola*) and mountain pine beetle (*Dendroctonus ponderosae*). The *Limber Pine Initial Conservation Action Statement* and *Whitebark Pine Initial Conservation Action Statement* specified that recovery plans would be prepared and that sufficient new resources should be made available to support recovery planning. The action statements advised that pending development of the recovery plans, Alberta Environment and Sustainable Resource Development (ESRD) should enhance programs to carry out cone collection (both to find and propagate rust-resistant trees and to conserve genotypic diversity), inventory, monitoring, and research into the use of the anti-aggregation pheromone, verbenone, to protect trees from mountain pine beetle.

The provincial recovery plan for whitebark pine was approved by the provincial minister of Environment and Sustainable Resource Development in January 2014 and the recovery plan for limber pine was approved in September 2014.

Both plans emphasize the following objectives:

1. Reduce the direct mortality of trees;
2. Develop and introduce white pine blister rust-resistant strains;
3. Conserve genetic diversity; and
4. Manage habitat and natural regeneration.

To help achieve this goal and meet the objectives, several general strategic approaches are proposed, including:

1. Population monitoring;
2. Tree and stand protection;
3. Conservation of genetic resources;
4. Habitat management;
5. Education and outreach;
6. Research that will elucidate or facilitate recovery actions.

One of the priority action items of the plan is to assess health of both species on a regular basis. Alberta has an extensive network of health plots based on the Whitebark Ecosystem Foundation's recommended protocol (Tomback et al. 2005). Monitoring plots for both whitebark and limber pine were first established in Alberta in 1996 and the network was subsequently expanded and re-measured in 2003 and 2004 and again in 2009, by various agencies. A large portion of the data collected has been published by Parks Canada and the Canadian Forest Service (e.g., Smith *et al.* 2013a, 2013b). This year, all agencies with plots in their jurisdictions collaborated for a reassessment of the complete network of 282 plots. Plots extend from Waterton Lakes National Park to the Willmore Wilderness Park, as far east as the Porcupine Hills, and there are several plots in protected areas in eastern British Columbia. Data collected during the 2014 initiative are being collated for assessment and eventual publication.

Another priority action is to determine when seeds are mature in situ for collection and whether collection can be based on local growing degree days, as well as to find out if immature seed can be matured ex situ and to what extent. This work was done for limber pine in 2013, and is planned for whitebark pine in the near future. For this study, cones are caged in July/August and then cone collections are made approximately every two weeks from the beginning of September to the end of October. Laboratory tests are used to examine both in situ and ex situ seed maturation by monitoring embryo lengths, seed germination, desiccation tolerance and seed longevity. This study is informing the collection and proper handling required for storage of good quality whitebark and limber pine seed, which is necessary for blister rust screening.

A germination methodology trial began in 2013 and the results are in but not analysed. We are now confident that we can achieve 100% germination of viable seeds in Alberta with a germination rate of around four days, which will make producing seedlings easier and more efficient. Artificial ageing trials and real-time storage retests are now underway for both whitebark and limber pine seeds. These results will give us a good way of predicting the life of these species in cold seed storage and indicate if ultra-cold storage methods should be considered.

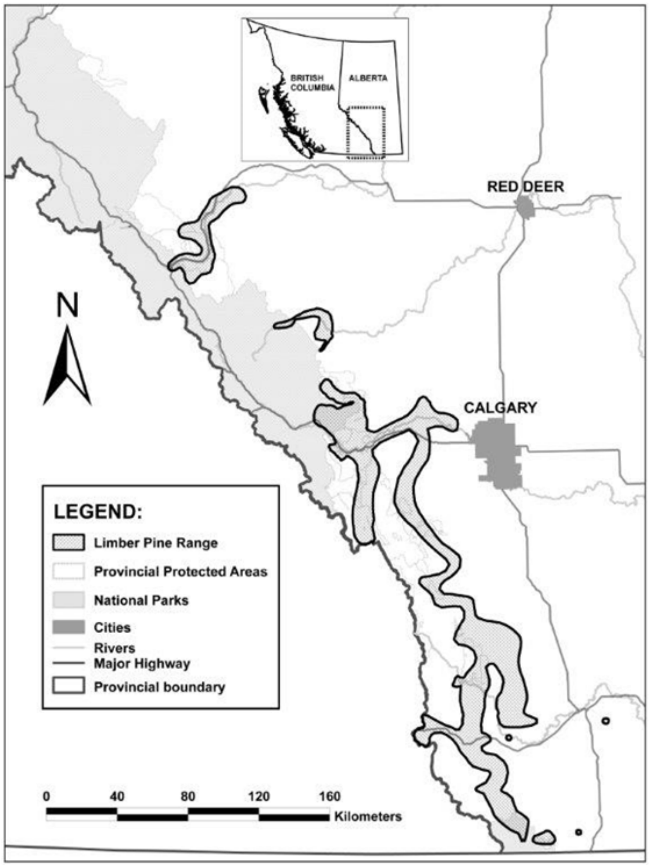

Figure 1. Known range of limber pine in Alberta.

A limber pine direct seeding experiment was initiated with volunteers in September 2014 with seed collected, and extracted from adult trees in late August 2014. Approximately, 180 planting sites, spaced at 10 m intervals, were sown with 10 unstratified seeds, 2.5 cm below ground, in a 10 cm x 10 cm area, behind nurse objects that sheltered them from prevailing winds. To test the effects of seed removal by rodents, 40 of these plots were sown overtop of hardware cloth buried 5 cm below ground, and then covered by wire mesh exclosures above ground (1 cm / 1cm mesh), and buried underground. Seed removal and germination will be assessed in the summer of 2015.

Additional actions/projects that are ongoing in Alberta include: identification of whitebark and limber pine individuals and populations that are putatively resistant to white pine blister rust, community-based (volunteer) planting of seedlings, characterization of regeneration sites and secondary seed dispersal.

Alberta will also be exploring collaboration with neighbouring British Columbia on initiatives of common interest, and has been working cooperatively with the government of Canada (Environment Canada) as they develop the national recovery strategy for whitebark pine, which is listed as *Endangered* at the federal level as well.

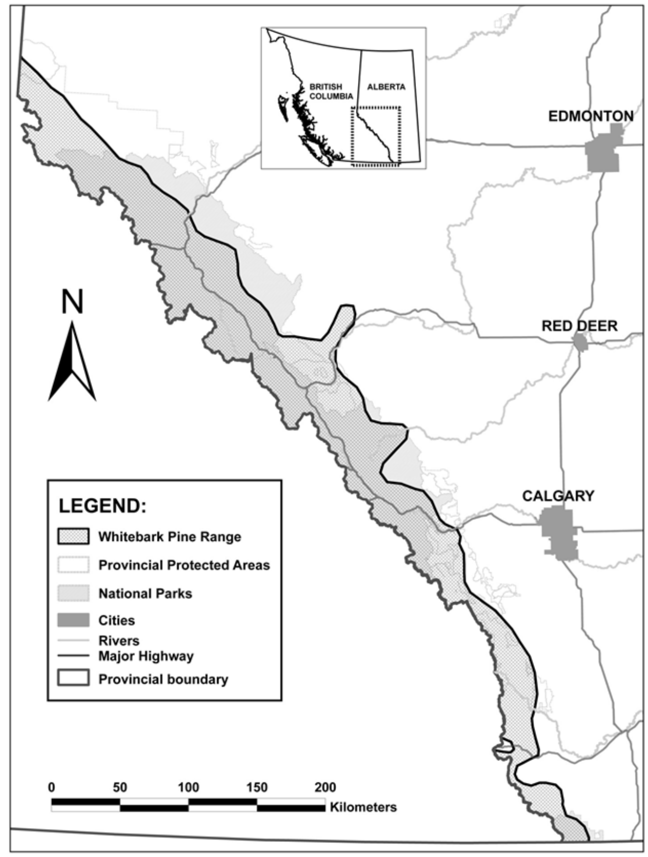

Figure 2. Known range of whitebark pine in Alberta.

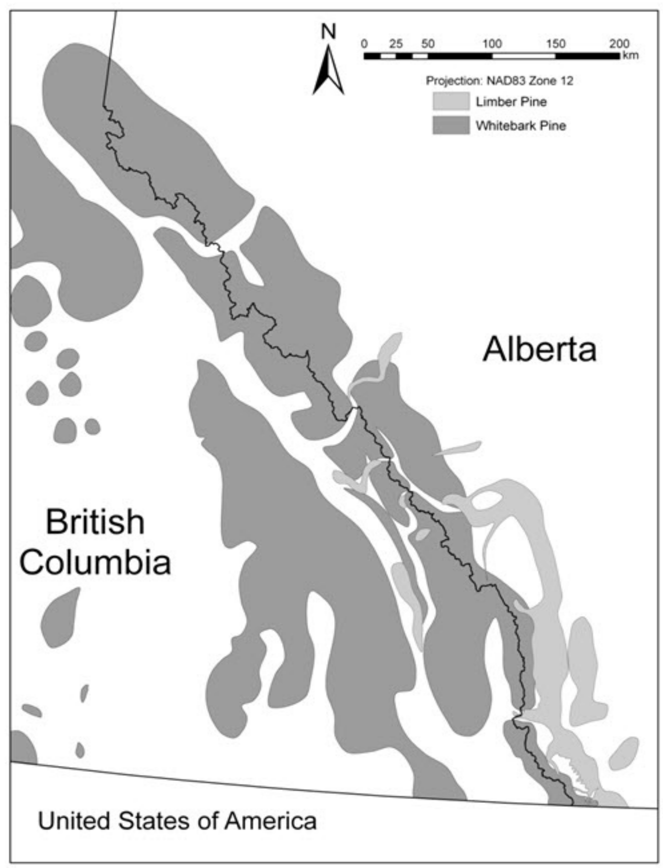

Figure 3 Combined Ranges for Limber Pine and Whitebark Pine

Alberta Links:
Limber pine recovery plan:
http://esrd.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/plants/documents/SAR-LimberPine-RecoveryPlan-Sep2014.pdf

Whitebark pine recovery plan:
http://esrd.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/plants/documents/SAR-WhitebarkPineRecoveryPlan-Jan-2014.pdf

Whitebark and limber pine Species at Risk brochure:
http://esrd.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/plants/default.aspx

Literature cited:
Smith, C. M., B. Shepherd, C. Gillies and J. Stuart-Smith. 2013a. Changes in blister rust infection and mortality in whitebark pine over time. Canadian Journal of Forest Research 43:90-96.

Smith, C.M., D. Langor, C. Myrholm, J. Weber, C. Gillies, and J. Stuart-Smith. 2013b. Changes in blister rust infection and mortality in limber pine over time. Canadian Journal of Forest Research: 43: 919–928.

Tomback, D.F., Keane, R.E., McCaughey, W.W., and Smith, C.M. 2005. Methods for surveying and monitoring whitebark pine for blister rust infection and damage [online]. Whitebark Pine Ecosystem Foundation, [accessed 8 December 2006]. ■

Coeur d'Alene Hosts Whitebark Conference

Steve Arno

On September 19, 2014, more than 80 people attended WPEF's annual Science and Management Workshop held at the Idaho Panhandle National Forests' conference room and the Forest Service Tree Nursery. The previous day WPEF's Board of Directors met and was treated to a tour of John Schwandt's family arboretum featuring dozens of species of conifers, hardwoods, and native shrubs and perennials. That evening WPEF Director Diana Tomback and USFS Ecologist Art Zack gave a public presentation at the Coeur d'Alene Library about whitebark pine's perilous status and current efforts to restore it.

The September 19th workshop began with Mary Frances Maholovich presenting highlights of the extensive genetics and tree breeding program she has supervised for many years. She and her colleagues have investigated cold hardiness, drought tolerance, and blister rust resistance in whitebark pine and have found that the species displays great genetic variability and virtually no inbreeding, a good sign for enhancing rust resistance. She estimates that about 70 percent of the fundamentals of rust resistance is now known. The program includes 1300 healthy mature "plus trees" in four breeding zones across the Northern U.S. Rockies. Also a high-elevation whitebark pine seed orchard has been established in each of the four zones. Whitebark pine seedlings have been planted on 4,300 acres since 1988, but Mary Frances notes that this program needs to be greatly expanded using gains recently made in improving rust-resistance of planting stock. She explained that to achieve sustainability of whitebark pine habitat the goal should be to maintain 10 cone-bearing whitebark pines per acre.

Area ecologist Art Zack described whitebark pine restoration efforts on the Idaho Panhandle National Forests (IPNF). Surveys suggest that whitebark habitat makes up about 6 percent of the IPNF, and upwards of 90 percent of this is early successional, where whitebark pine is subject to replacement by subalpine fir and other more shade-tolerant conifers. Whitebark is going through an evolutionary/genetic bottleneck due to extensive damage by blister rust, bark beetles, and climatic warming. Nine Research Natural Areas on the IPNF contain whitebark habitat. Most of the 55 plus trees on the forest have been protected from bark beetle attack using verbenone, and this has been highly successful thus far. The largest area of whitebark pine habitat, in the Selkirk Range, was heavily damaged by a beetle outbreak in 1999 to 2006, and an aerially-ignited prescribed burn was applied to more than 1000 acres there in the fall of 2006. Verbenone was applied in 2007, and about 10,000 whitebark seedlings have been planted each year there and elsewhere on the IPNF.

The Coeur d'Alene tree nursery

A few highlights of the presentations that followed include, Rocky Mountain Research Station ecologist Bob Keane making recommendations for restoring whitebark pine in the face of climatic warming, which include planting as much whitebark and allowing as much fire as possible. Diana Tomback described investigations of whitebark pine's role at the alpine treeline, where its dwarf form provides better micro-habitats for other plants than the dense krummholz forms of Engelmann spruce and subalpine fir.

Graduate student Taza Schaming of Cornell University reported on radio tracking 76 Clarks Nutcrackers. Nutcrackers failed to breed during two years when the whitebark cone crop was poor, but did breed in three years following better cone crops. In non-breeding years the birds ate largely Douglas-fir seeds, which are much less nutritious. Nutcrackers are long-lived, thus occasional non-breeding years seem relatively unimportant to their populations.

Michael Murray of the British Columbia Ministry of Forests discussed restoration efforts in Canada. B.C. has set up permanent monitoring plots, and is engaged in thinning to favor whitebark pine and direct seeding trials. The province has also established a facility for breeding rust resistance at Kalamalka in the Okanogan Valley, where 40 families are being propagated.

Terrie Jain explained direct seeding trials of whitebark pine primarily in northern Idaho. In most areas caging to prevent animal depredations had little effect. Germination and survival of seeds ranged from 12 to 35 percent, and multiple seeds in caches had worse success. Planted seedlings had a significantly better survival rate.

In the afternoon we visited the Forest Service's impressive Coeur d'Alene tree nursery, which is currently producing about four million tree seedlings per year for outplanting as well as many species of native shrubs. Dave Fouchee briefed us on the nursery's five functions: container-grown seedlings, bare-root seedlings, seed extraction, shrub regeneration, and the tree improvement program. We entered the blister-rust inoculation chamber which is kept cool and moist with fog nozzles. The goal is to expose whitebark pine seedlings to 20,000 spores per square centimeter, more than enough to distinguish rust-resistance.

In the cone shed, temperatures of 100 degrees (F) or higher are used to dry cones for seed extraction. The seeds are exposed to a multi-staged stratification and scarification process before being planted in seedling beds, and later exposed to a copious rain of blister rust spores. More than 200,000 whitebark pine seedlings, as 2-year-old stock, are produced each year.

On Saturday, September 20th, we caravanned east on Interstate 90 to Saint Regis, MT, and then headed back west to the Idaho-Montana Divide at the head of the Little Joe Creek drainage. Here on south-facing slopes above 6,000 feet elevation we looked at operational-scale "daylighting" (thinning) to favor the scattered remaining whitebark pine in a mature forest dominated by subalpine fir and mountain hemlock. John Schwandt and Sidnee Dittman explained that drawbacks at this remote site include the lack of an economically viable market for competing trees, and constraints that prevented killing or removal of competing overstory trees. As a result, daylighted whitebarks did not show a significant growth response to the treatment. Bob Keane pointed out that at a nearby site young, post-fire stands were daylighted, and there the whitebark pine did respond with faster growth. Charlie Cartwright noted that in B.C. whitebark pine in former clearcuts also released well in response to daylighting.

Along nearby south-facing slopes we visited a 2005 timber sale that burned in a wildfire and was then experimentally seeded with whitebark pine. Seeds that received a 30-day warm stratification after the customary cold stratification germinated at a higher rate. After germinating, seedlings situated next to fresh snags to avoid damage by extreme solar insolation were often smothered by sloughing bark. Down logs provided more-reliable shelter. Planted seeds on scalped or other bare soil were often inundated by surface erosion on this steep slope. Overall, the group concluded that regeneration efforts utilizing nursery-raised seedlings are more successful and cost-effective; however in special cases in inaccessible areas or classified Wilderness planting seed may be the only feasible method for regenerating whitebark pine.

After a warm afternoon of examining prospects for restoring whitebark pine along the interstate divide, participants re-grouped briefly at the Saint Regis Work Center before heading off in all directions to their home bases. Several stopped at the nearby store to top off the stimulating conference with a huckleberry ice cream cone. ■

Silent Auction Raised $1,246 for Student Research Grant

by Cyndi Smith, Associate Director, WPEF

The Silent Auction held during the science meeting at Coeur d'Alene on September 19th, 2014, was very successful, raising $1,246. The auction ran during the meeting, and concluded at the wonderful evening gathering at La Peep Restaurant. The Board of Directors has decided that each year, funds from the Silent Auction would be dedicated to a particular aspect of the Foundation's efforts, rather than going into the general account. Proceeds from the 2014 auction are being dedicated to the annual Student Research Grant. The Board would like to shout out a big THANK YOU to Laura DeNitto for running the Silent Auction again with such skill and enthusiasm – we couldn't do it without her. We would also like to recognize both the donors and purchasers: ■

Aaron Wagner
Adrian Leslie
Alberta Fish & Wildlife
Bob Hardy
Brenda Sheppard
Bryan Donner
Crater Lake Institute
Cyndi Smith
Dana Perkins
Debbie Paul
Diana Tomback
Glenda Scott
Gov't of Alberta
Jered Bowman
John Schwandt
Kella Sadler
LeAnn Abell
Laura & Gregg DeNitto
Liz Davy
Marlee Jenkins
Melissa Jenkins
Michael Murray
Mike Giesey
Peter Achuff
Randy Moody
Robin Garwood
Robin Gutsell
Rose Lehman
Sander Denham
Sandy Kegley
Bonnie Arno
Steve Shelly
Susan Harries

Upcoming Whitebark Pine Ecosystem Foundation Science and Management Conferences

One of the biggest successes of the WPEF is the annual "Science Conference" held at various places throughout the range of whitebark pine. It has been held in an amazing number of interesting settings from Lincoln, Montana, to Nelson, British Columbia. It has been held in Cody, Wyoming, Glacier National Park, and in Missoula, Montana, several times. The WPEF conference committee is trying to plan the next five Science Conferences so that members can make plans well ahead of time to attend.

2015 – Ashland, Oregon
2016 – Kalispell, Montana
2017 – Jasper National Park, Alberta
2018 – to be announced
2019 – to be announced
2020 – Missoula, Montana

Next year, we are having the conference in Ashland, Oregon, at Southern Oregon University on September 17-20. A committee of folks including Kristen Chadwick, Richard Sniezko, and Jennifer Beck are organizing a really exciting event with several field trips, the most important being a trip to see whitebark in Crater Lake National Park and maybe a trip to see foxtail pine. They also plan a trip to Dorena Genetic Resource Facility. This committee has already compiled a partial list of speakers to give some very interesting presentations. The theme of the conference is "Genetics and restoration of whitebark pine in the Pacific Northwest". This conference precedes that Western International Forest Disease Work Conference 2015 meeting in western Oregon so you can get two for one.

The 2016 Science Conference will be in Kalispell, Montana, at a venue to be named later. Organizer Melissa Jenkins and others guarantee a stunning event complete with field trips to Glacier and surrounding majestic mountain settings.

In 2017, plan on joining us in Jasper National Park, Alberta, as the Canadian WPEF is hosting a wonderful meeting in this incredibly beautiful setting. Michael Murray and Brenda Jackson are the organizers. Skipping two years, we plan to have the 2020 WPEF Science Conference be the fourth Whitebark Pine Symposium in Missoula, Mont. But that is a long way away.

We skipped 2018 and 2019 because we have yet to find anyone to host that year's conference. If any WPEF member wishes to propose to host the conference, please email rkeane@fs.fed.us with your ideas and Bob Keane will present it to the Conference Committee. We will also take any ideas on where to have the 2018 and 2019 conferences.

We hope you will find the set of future conferences interesting and we dearly hope you will attend.

The WPEF Conference Committee ■

Call for Nominations for Board of Directors

By Cyndi Smith, Associate Director

We are now seeking nominations to fill two positions with the WPEF: Membership/Outreach Coordinator and one general board member. These new members would start serving on the BOD in September 2015. Nomination forms are available in this issue of *Nutcracker Notes* and on the Foundation's website(www.whitebarkfound.org), along with a list of responsibilities for each of the positions. Nominations close on 1 February 2015.

Please consider running for one of these positions, or nominating someone else – all nominees must be (or become) members of the Foundation. Your active participation is critical to keeping the Foundation relevant to the general membership.

If you have any questions about any of the positions or the nomination process, please contact me at cyndi.smith9@gmail.com. ■

WANTED Part-Time Project Coordinator

WPEF is seeking a highly motivated person as the project coordinator. The job is part time, 80 hours per month, $15-$22/hour. Employee will provide their own office, computer and phone. Duties entail organizing Board meetings and annual conferences, budget tracking, maintaining donor database, newsletter publication and mailings, and grant writing. Skills required: organized, personable, facilitation, professional phone voice. Send ***resumes no later than February 14, 2015*** to melissa.jenkins@whitebarkfound.org or WPEF, P.O. Box 17943, Missoula, MT 59808. Detailed job description below available. Phone Bob Keane with questions at 406-329-4846.

Job Description

Organizational:

- Facilitate organize, schedule, record meetings for Foundation Board and subcommittee meetings
- Formulate Board meeting agendas in consultation with Executive Committee
- Attend all meetings associated with this group either virtually or in person
- Write and distribute all meeting notes
- Maintain all WPEF records
- Assist in organization of annual conference

Financial:

- Track annual Budget expenditures
- Write and research grants to fund WPEF projects
- Track and record all donations
- Track all grant monies
- Write required grant progress reports
- Maintain donor/member database
- Manage all WPEF merchandise (inventory, ship, and sell at annual meetings)

Communication:

- Be the primary contact for the Foundation (respond to phone call, email, and written inquires)
- Coordinate publication and mailing of Nutcracker Notes
- Update Nutcracker Notes spreadsheet after each issue is published
- Mail out election ballots, Nutcracker Notes, and other items as required by the Board
- Maintain public and group webpage
- Update Executive Handbook when needed

Skills required

- Organized
- Multi task oriented
- Personable
- Computer and database skills
- Creative and technical writing
- Facilitation
- Meeting organization
- Professional presence and phone voice
- Knowledge of whitebark pine, wildlife or natural resources is a plus ■

Nominations for 2015 Whitebark Pine Ecosystem Foundation Board Elections

Our bylaws dictate that elections are to be held every year for various positions – this way there is always a rotation of experienced Board Members and Executive Committee officers and we would never face a complete turnover of officers and the chaos that could ensue. Please consider running for one of these positions!

Board members and officers commit to working collectively to advance the business of the WPEF and the conservation and restoration of high elevation pines. This includes attending two board meetings per year, one of which is usually in March or April in Missoula, MT, and the second is in conjunction with the annual WPEF science meeting and field trip in mid-to-late September somewhere within the range of whitebark pine. To find out more about the duties of these positions, please refer to the back of this form, consult the WPEF Executive Handbook on the website www.whitebarkfound.org, or contact one of us.

Diana F. Tomback, Ph.D.
Director diana.tomback@ucdenver.edu

Cyndi Smith
Associate Director cyndi.smith@whitebarkfound.org

Nomination Form – Whitebark Pine Ecosystem Foundation

Nominations are being sought for the following two (2) positions, to begin serving on the Board of Directors in September, 2015. All positions are for a 3-year term:

- Membership/Outreach Coordinator
- Board Member

RULES:

- All board members can serve up to 3 terms consecutively [Bylaw E(h), E(i) and F(a)].
- All nominees must be members of the WPEF in good standing [Bylaw F(b)(iv)].
- Any nomination must be made by 2 members in good standing [Bylaw F(b)(i)]; signatures can be on one form, or on separate forms.
- Any nomination must be validated by the signature of the nominee [Bylaw F(b)(i)]; this signature can be on the same form as a nominator, or on a separate form.
- **Only one nomination per form**. If you need more forms, please copy this one, or download another one from our website <www.whitebarkfound.org>.
- Nominations may be sent by mail [Box 17943, Missoula, MT, 59808], E-mail melissa.jenkins@whitebarkfound.org or fax (406-758-5379), and must be postmarked/dated no later than **01 Feb 2015.**

We, the undersigned, nominate ____________________________________ for the position of
MEMBERSHIP/OUTREACH COORDINATOR ___, BOARD MEMBER ___
[*please check the one that applies*].

Nominator #1: ________________________ ________________________ ________________________
Signature *Print Name* *E-mail address*

Nominator #2: ________________________ ________________________ ________________________
Signature *Print Name* *E-mail address*

Nominee: ________________________ ________________________ ________________________
Signature *Print Name* *E-mail address*

The purpose of the Board of Directors (BOD) is to make decisions affecting the general membership of the WPEF. This includes making policy, deciding on major spending, or solving major problems concerning the organization.

1. Responsibilities of the Membership/Outreach Coordinator:

- Maintain membership database
- Prepare and mail new member packets
  - Certificate
  - Welcome letter
  - Latest copy of *Nutcracker Notes*
  - Brochure
  - Any membership promotions (book, T-shirts, etc)
- Prepare and mail annual renewal notices
  - Include current membership information for updating
- Work with newsletter editor to include renewal reminder in Fall *Nutcracker Notes*
- Prepare and mail income tax statements to members by the second week in January
- Promote and recruit new members
- Maintain database of past and prospective members
- Supply newsletter editor with mailing labels for *Nutcracker Notes*
- Supply Secretary with mailing labels for election ballots
- Provide e-mail addresses to other board members for BOD-approved use and only with a majority of BOD approval
- Provide invoices or receipts for those members who request these items
- Provide membership status report at board meetings

2. Responsibilities of a general board member:

- Members of the WPEF Board of Directors (BOD) that are NOT members of the Executive Committee have the following responsibilities:
- Attend all BOD meetings
- If it is impossible to attend, the BOD member must notify the Chair as to their absence.
- Attendance can be in person or via a conference call.
- Attend all WPEF annual meetings
- Participate in WPEF activities when appropriate
- Form Working Groups
- Organize annual meetings
- Volunteer for Evaluation Committee
- Perform fundraising as needed
- Other tasks as needed

Deadline for the 2014 Student Research Grant EXTENDED

by Cyndi Smith, Associate Director, WPEF

We know you're out there … students working on whitebark pine … so why didn't you submit a proposal to the Whitebark Pine Ecosystem Foundation (WPEF) for our Student Research Grant? We did not receive any requests for funding before our deadline, so we have EXTENDED the deadline to **January 30, 2015**.

The mission of the WPEF is to "promote the conservation of whitebark pine and other high elevation five needle white pine ecosystems through education, restoration, management, and research." In support of this mission, the WPEF offers an annual research grant of $1,000 to either an undergraduate student who is writing a thesis or graduate student (MS or PhD) conducting research on whitebark pine. Relevant areas of research include, but are not limited to: threats to whitebark pine, including mountain pine beetle, white pine blister rust, successional replacement, and climate change (only in whitebark ecosystems); interactions with wildlife, such as Clark's nutcracker or other birds, red squirrels and bears; restoration strategies for whitebark pine, including both field operations and nursery seedling production; and ecosystem level impacts of whitebark pine die-off.

Monies can only be used for travel expenses for field work, or consumable research supplies. Grants shall not be used to buy equipment that will be used beyond the duration of the project (and thus would be retained by the lab in which the student works).

Please submit a short (two single-spaced pages at most, not including references) proposal covering:

- The purpose and need for the research.
- A brief description of the study plan and methods, including expected dates of data collection and thesis completion.
- Expected outcomes of the research.
- A brief explanation of how the money will be spent.
- Contact information and academic affiliation of the student.

In addition to the proposal, applications should include a CV as well as a letter of recommendation from the student's research advisor.

Grant recipients will be expected to publish a summary of their research in a future issue of *Nutcracker Notes*, and are encouraged to present at one of the WPEF annual science meetings. All applicants are encouraged to join the WPEF, and the grant recipient will receive a free subscription to *Nutcracker Notes* for one year.

Please send application materials (electronic only) to <Cyndi.smith9@gmail.com> by January 30th, 2015.

Status of Whitebark Pine Forever Fundraising Campaign

Thanks to you our dedicated members, we have raised a bit over $1,500 towards our 2015 restoration campaign. We have a ways to go to reach our goal. Many of you who attended the September Science meeting in Coeur D'Alene learned about ongoing restoration efforts and their importance in combating climate change and the other threats facing whitebark pine.

Our goal is to raise **$100,000 by June 2015** to fund projects that keep whitebark pine functioning on the landscape. Your donation will contribute to these projects

Planting whitebark pine seedlings
Collecting whitebark pine cones for future seedlings
Growing blister rust resistant trees
Protecting high value whitebark pine trees from bark beetle attacks

Go to our website **whitebarkpinefound.org** and donate NOW to Whitebark Pine Forever 2015. Click on **RESTORATION** or mail your donation to WPEF, P.O. Box 16775, Missoula, MT 59808. Your money will be matched by funds from the Forest Service.

Be a part of keeping whitebark pine, an iconic western tree on the landscape. Thank you for restoring whitebark pine,

Liz Davy, Development Committee Chair

Touring whitebark pine seedling beds during the Science Meeting in September.

Paul Zambino, a scientist at the Forestry Sciences Lab in Moscow, ID, being interviewed during the field trip.

Whitebark pine at 9,500 ft. elevation, Twin Peaks, Challis National Forest, Idaho. Photo by Jim Habeck